Enhancement of Speeded Up Robust Features (SURF)

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Abstract: Radar technology has become the future technology that is in use today since the radar can improve the securing and bordering of a countries, cities or areas that having a range in kilometres or in meters. Old radar technologies are based upon signal processing techniques that can give a specific characteristic to the on an object but in somehow a development of anti-radar signals materials and radar jamming, so a method in object detection focus on image processing for detection. In this work an enhancement of object detection using and enhanced “SURF” point.

Keywords: Object Detection, image recognition, “SURF”, Image Processing.

1. Introduction

In image processing “speeded up robust features” with abbreviation “SURF” is a original internal established by many algorithms developed to handle the detection and description of an object. Usually used for applications as object recognizing, image registration process and classification procedures. The ““SURF”I” is inspired by the “scale invariant feature transform” in abbreviations called "SIFT" descriptor. The “SURF” is faster than “SIFT”. To detect center points the “SURF” uses an integer estimate of the determinant of Canvas blob_detector., and it is established by the summation of the “Haar_Wavelet_Response” round the interest points that can be also be computed established by the integral image. The
descriptor "SURF" is used for the identification of images or images. The development was in 2006 “SURF” presented by HrbertBaity, et. Al., at the “European_Conference” on “Computer_Visions”.

2. “SURF” algorithm

The working principles "SURF" algorithm" are the same as "SIFT" in their processing steps but differ in detail in each of the steps. Three main parts is the consistency “interest_point_detection”, “internal_neighorr_hood_descriptionand “matching”. Moreover the “SURF” established by a square_shaped filters as an estimator of “Gaussian_smoothing”.

![Figure 1. System Flowchart](image)

Using the square filter for filtering the image is much faster if the integral of the image is used:
The summation of the original image within a rectangle shape can be estimated fast using the integral image, it requires an estimation to the rectangle “4” corners.

“SURF” uses a "Hessian blob detector" to identify points of interest. The determinant of the Hessian matrix is used as a measure of internal change around the point and points are chosen where this determinant is maximal. Similar to the Hessian Laplacian detector, "SURF" also uses the "Hessian" determinant to select a scale, Given a point “p=(x, y)” in an image “I”, the Hessian-matrix “H(p, σ)” at point “p and scale “σ”, is:

\[
H(p, \sigma) = \begin{pmatrix}
L_{xx}(p, \sigma) & L_{xy}(p, \sigma) \\
L_{yx}(p, \sigma) & L_{yy}(p, \sigma)
\end{pmatrix}
\]

Where

“Lxx(p,σ)” is the convolution of the second_order_derivative of “Gaussian” with the image “I(x,y)” at the point “x”

The filter box with a size “9×9” is an approximation of a “Gaussian” with “σ=1.2” and denotes the lowest_level “highest spatial resolution” for blob_response_maps.

3. General Block Diagram

The following block diagram represent the processing steps for the image and the SURF processing, in this block diagram several steps are used to detect the object after a surf point algorithm is used.
4. Database
A three-dimension visual sensor which consists of a “TOF” and two “CCD” cameras is used to get color and “3D” information to construct a database.

5. Input Image
Acquires in real time color information by calibrating the "TOF" and two "CCD Cameras."

6. Segmentation Process
"Super pixels" have been used in a lot of mainframe vision applications such as "depth estimation, "image segmentation" and "object detection," etc. "SURF" 's main role is to find two images matching key points of the same object. The "SURF" algorithm structure is divided into three stages:

1) “Interest key point detection”;
2) “Estimation of feature vector, descriptor”;

3) Matching_between_images.

The interest point detection is employed to localize relevant points in one image or object, in order to allocate valuable information that is going to be computed by an internal descriptor, by means of the “Hessian_Laplace_matrix” detectors. The Estimation of a feature vectors describes the applicable areas within the interest point “neighborhood”. It has to be distinctive at the same time robust to noise, detection, geometric and photometric displacement deformations. Low distance descriptors comparing a predetermined threshold are used. Lastly, the best results meet the threshold.

Test setup 2: (a) Input Image ;(b)Evaluation of super pixels; (c) Probability map of green tea carton box; (d) Probability map of milk tea carton box; (e) Probability map of potatoes red carton box; (f) Detected object.

7. Conclusion

This paper proposes a novel object detection method using internal features inside the super_pixel. The proposed algorithm shows that the detection of objects could be improved by using "SURF" and super pixel "SLIC.". The proposed
algorithm shows that the detection of objects could be improved by using "SURF" and super pixel "SLIC." Our approach can be used in an online robot system for real-world application. Experimental results illustrated the capabilities of the algorithm to detect the object, which is used as the average criteria of evaluation for recall and precision as well as the detection rate. The evaluation results show that the proposed algorithm works quite well in most scenarios, although its performance degrades when transparent plastic objects need to be detected. Our method exceeds Mae et al.’s state of the art. for object detection, obtaining better results for objects that are small and have round “SURF” aces, especially when the distance between the object and robot is larger than “1.2 m”. In future projects, we propose to increase the object database and develop our object detection system by using data "3D".

8. REFERENCES


Enhancement of Power Consumption of Cloud Computing Based on DVFS

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Abstract: Data centers become one of the advanced technology in data computing that enable online applications and services, moreover data centers use high power consumption due to many factors including the number of hardware servers, virtual machines and hardware specifications, these equipment's uses a high power consumption which become the main problem, also reducing the power increases Central Processing Unit (CPU) processing time, in this paper the non-power aware method will be compared to the power enhancement method Dynamic Voltage Frequency Scaling (DVFS), also a simulation environment based in Java eclipse, and the CloudSim Simulation Program is done. It was found that the DVFS reduce the power of the data centers with approximately 45% compared to the non-power aware method and this was due to the scheduling algorithm round robin.

1. INTRODUCTION
The rapid growth today in IT demands reflects the increased use of cloud data centers. Reducing computational power consumption in cloud data center is one of the challenging research issues in the current era. Power consumption is directly proportional to a number of resources assigned to tasks. So, the power consumption can be reduced by a demotivating number of resources assigned to serve the task.
Cloud computing infrastructures are designed to support the accessibility and availability of various services to consumers over the Internet. Data centers hosting Cloud applications consume massive amount of power, contributing to high carbon footprints to the environment.

Energy consumption of cloud data centers is an important factor since the amount of the consumed energy is increasing, mainly due to non-energy aware usage of cloud infrastructures. It has been reported that about 0.5% of the worldwide energy consumption concerned cloud data centers, while this is expected to quadruply in 2020. For this reason, cloud simulation frameworks have introduced energy models in order to develop strategies for the optimization of the usage of the cloud resources[1].

2. Problems Background

Cloud computing services have become gradually popular due to the evolving data centers and parallel computing paradigms.

The goal of cloud computing is to allow users to take benefit from all of these technologies, without the need for deep knowledge about or expertise with each one of them. The cloud aims to cut costs, and helps the users focus on their core business instead of being impeded by IT obstacles. The main problem is the massive power consumption of the data centers, the researchers focus on solving the problem by optimizing and scheduling task into clouds and virtual machines, some of the solutions' comes with a perfect power consumption, but it degrades the quality of service parameters such as delay time increasing, and increase of the processing time.

The growing demands of consumers for computing services are inspiring the service providers to deploy large number of data centers, all over the world that consume very large amount of energy.
Increasing amount of energy consumption by the data centers is one of the reasons of increase in the level of carbon dioxide in our ecosystem.

3. Objectives

The aim of green cloud internet data center is to reduce the power consumption on same side it leverage live virtual machine migration technology and guarantee the performance from user’s perspective. A major challenge for Green Cloud is to automatically make the scheduling decision for dynamically consolidating/migrating virtual machines among physical servers to meet the workload requirements meanwhile saving energy.

4. Methodology

Simulate the cloud environment into CloudSim simulation software which is based on java and can be coded with Java editors and compilers such as Eclipse, in this case the Eclipse was selected, then a generation of 10 to 400 000 cloud to evaluate the power consumption before and after using DVFS method.

The information-centric networking (ICN) concept is a significant common approach of several future Internet research activities. The approach leverages in-network caching, multiparty communication through replication, and interaction models decoupling senders and receivers. The goal is to provide a network infrastructure service that is better suited to today’s use (in particular. Content distribution and mobility) and more resilient to disruptions and failures. The ICN approach is being explored by a number of research projects. We compare and discuss design choices and features of proposed ICN architectures, focusing on the following main components: named data objects, naming and security, API, routing and transport, and caching. We also discuss the advantages of the ICN approach in general.
5. Related Work

In 2015, Data centers consume about 2% of the worldwide energy production, originating more than 43 million tons of CO2 per year. Cloud providers need to implement an energy-efficient management of physical resources in order to meet the growing demand for their services and ensure minimal costs. From the application-framework viewpoint, Cloud workloads present additional restrictions as 24/7 availability, and SLA constraints among others. Also, workload variation impacts on the performance of two of the main strategies for energy-efficiency in Cloud data centers: Dynamic Voltage and Frequency Scaling (DVFS) and Consolidation. Our work proposes two contributions [2]:

1) a DVFS policy that takes into account the trade-offs between energy consumption and performance degradation;

2) a novel consolidation algorithm that is aware of the frequency that would be necessary when allocating a Cloud workload in order to maintain QoS. Our results demonstrate that including DVFS awareness in workload management provides substantial energy savings of up to 39.14% for scenarios under dynamic workload conditions.

In 2016 Online Demand Response of GPU Cloud Computing with DVFS Yu He, Lin Ma, Chuanhe Huang GPU cloud computing is emerging as a new type of cloud service that drives computation-extensive jobs, such as big data analytics and distributed machine learning. The introduction of GPU brings parallel processing power at the cost of excessive energy consumption. Dynamic Voltage and Frequency Scaling (DVFS) is a promising method to control energy consumption of GPU VMs. This work focuses on using DVFS to reduce energy of cloud computing in datacenter demand response [3].
We first consider an online demand response scenario where users arrive stochastically, aiming at maximizing social welfare and meeting energy reduction goals by employing DVFS. We address the challenge posed by DVFS through a new technique of compact infinite optimization. A more practical scenario where both energy and resource limitations present is further studied. We design a primal dual approximation algorithm that can compute a feasible solution in polynomial time with guaranteed approximation ratio, and a payment scheme that works in concert to form a truthful cloud job auction.

In 2013, Energy-conscious Cloud Computing Adopting DVFS and State-switching for Workflow Applications, Chih-hsuan Hsu

Reducing energy consumption without scarifying service quality is important for cloud computing. Efficient scheduling algorithms HEFT-D and HEFT-DS based on frequency-scaling and state switching techniques are proposed. Our scheduling algorithms use the fact that the hosts employing a lower frequency or entering a sleeping state may consume less energy without leading to a longer make span. Experimental results have shown that our algorithms maintain the performance as good as that of HEFT while the energy consumption is reduced [4].

In 2017, A DVFS Based Energy-Efficient Tasks Scheduling in a Data Center, Songyun Wang; Zhuzhong Qian; Jiabin Yuan; Ilsun You With the popularity of cloud computing and high performance computing, the size and the amount of the datacenter develop rapidly, which also causes the serious challenges on energy consumption. Dynamic voltage and frequency scaling (DVFS) is an effective technique for energy saving. Many previous works addressed energy-officiate task scheduling based on DVFS[5].

In 2014, Energy-Conscious Cloud Computing Adopting DVFS and State-Switching for Workflow Applications Chih-hsuan Hsu; Cho-chin Lin; Tsan-sheng
Reducing energy consumption without scarifying service quality is important for cloud computing. Efficient scheduling algorithms HEFT-D and HEFT-DS based on frequency-scaling and state-switching techniques are proposed. Our scheduling algorithms use the fact that the hosts employing a lower frequency or entering a sleeping state may consume less energy without leading to a longer make span. Experimental results have shown that our algorithms maintain the performance as good as that of HEFT while the energy consumption is reduced[6].

In 2014, Reducing Energy Consumption with Dvfs for Real-Time Services in Cloud Computing Vrunda J. Patel Cloud computing has revolutionized the information technology industry by enabling elastic on demand provisioning of computing resources. The increase of Cloud computing has resulted in the organization of large-scale data centers around the world contain thousands of total nodes. This paper presents overview of cloud computing, issues in cloud computing, novel techniques, and software for distributed dynamic consolidation of Virtual Machines (VMs) in Cloud data centers. The goal is to improve the utilization of computing resources and reduce energy consumption under workload independent quality of service constraints [7].

In 2015, Green Cloud Computing: A Review on Green IT Areas for Cloud Computing Environment Yashwant Singh Patel#1, Neetesh Mehrotra*2, Swapnil Soner#3 With the increasing growth of large data storage and computational demand, Green Cloud Computing is known to be a broad area and hot field for research. To capitalize various IT resources, Cloud computing has produced an ultimate and impressing way to virtualize servers and data centers and to make energy efficient [8].

In 2014 Green Cloud Computing, Sindhu S. Pandya Green computing is defined as the study and practice of designing, manufacturing, using, and disposing of computers, servers, and associated subsystems-such as monitors, printers, storage
devices, and networking and communications systems efficiently and effectively with minimal or no impact on the environment. The goal of green computing is to reduce the use of hazardous materials, maximize energy efficiency during the product's lifetime, and promote the recyclability of outdated products and factory waste [9].

In 2017, Green Cloud Computing: A Literature Survey, Laura-Diana Radu. Cloud computing is a dynamic field of information and communication technologies (ICTs), introducing new challenges for environmental protection. Cloud computing technologies have a variety of application domains, since they offer scalability, are reliable and trustworthy, and offer high performance at relatively low cost [9]. The cloud computing revolution is redesigning modern networking, and offering promising environmental protection prospects as well as economic and technological advantages. These technologies have the potential to improve energy efficiency and to reduce carbon footprints and (e-) waste. In 2015, Green cloud computing: A review on Green IT areas for cloud computing environment, Yashwant Patel[10].

Jiandun Li et al. Introduced a hybrid energy efficient scheduling scheme. This approach reduces the incoming request response time by optimally scheduling the workload especially in case of nodes running in low power mode [11]. The scheduling algorithm is based on pre power technique and Least Load First Algorithm. The paper shows that above approach save more energy and optimizes load balancing [12].

Kejiang Ye et al. presented energy efficient data center architecture for cloud computing, which provides a key technology to consolidate the operation of the server that reduces the overall energy consumption. Server Consolidation achieves energy efficiency by enabling multiple instantiations of operating systems to run
simultaneously on a single physical machine. The other technology used is the live migration of VM requests and thereby minimizing the tradeoff between performance and Energy efficiency attaining higher energy saving goal[13].

Aman Kansal et al. Proposed methods for power metering and provisioning architecture based on virtual machine in which Joulemeter is used for measuring the power of virtual machines per second in watt in cloud environment. Bo Li, Jianxin Li et al. [4] came up with algorithm for energy efficiency that aims in distributing maximum workload onto minimum number of virtual machines using Live Application Placement approach. The Live Application Placement approach is abstracted as Bin Packing problem for adjusting the virtual machine resources. Over-provision approach is presented to deal with the varying resource demands of applications in cloud. The experimental results show that the above approach is feasible[14].

R. Vijindra introduced a ranking algorithm based scheduling framework for reducing energy in cloud computing. It has following three main objectives - 1. reducing completion time of jobs 2. reducing overall energy consumption of datacenter 3. balancing the incoming workloads. The ranking algorithm assigns a rank to each VM’s based on the available resources and allows the scheduler to assign the task to suitable VM thereby reducing execution time. Migration and load balancing technique is used to schedule the task to VM’s running on lower power mode. The simulation results show that it can conserve more energy as well as it can reduce the total execution time[15].

Amandeep Verma et al. proposed workflow scheduling with cost time optimization based on deadline and budget. A workflow schedule is developed
such that it minimizes the execution cost and works to the time constraints of the user[16].

Gunho Leey et al. introduced “Heterogeneity-Aware Resource Allocation and Scheduling in the Cloud”, in which a new fairness metric is defined to facilitate sharing of the jobs in cloud environment with heterogeneity in the incoming requests[17].

Ke Liu et al. proposed “A Compromised-Time-Cost Scheduling Algorithm in SwinDeW-C for Instance-Intensive Cost-Constrained Workflows on a Cloud Computing Platform” that incorporates characteristics of cloud computing to accommodate instance intensive cost constrained workflows by compromising execution time and cost [18].

P.K. Srinivasan presented “Time-Cost Scheduling Algorithm”, a novel dispensation time cost scheduling algorithm which considers the characteristics of cloud computing to accommodate order-intensive cost-constrained workflows by compromising execution time and cost with user input enabled on the fly[19].

Ruben Van den Bossche et al. Presented “Cost-Optimal Scheduling in Hybrid IaaS Clouds for Deadline Constrained Workloads” that proposes a design of a software architecture model for the HICCAM project in order to highlight and emphasize the purpose of the Optimization Engine component[20].

6. CloudSim Simulation Tool

CloudSim is a simulation tool that allows cloud developers to test the performance of their provisioning policies in a repeatable and controllable environment, free of cost. It helps tune the bottlenecks before real-world deployment. It is a simulator; hence, it doesn’t run any actual software. It can be defined as ‘running a model of an environment in a model of hardware’, where technology-specific details are abstracted.
CloudSim is a library for the simulation of cloud scenarios. It provides essential classes for describing data centers, computational resources, virtual machines, applications, users, and policies for the management of various parts of the system such as scheduling and provisioning. Using these components, it is easy to evaluate new strategies governing the use of clouds, while considering policies, scheduling algorithms, load balancing policies, etc. It can also be used to assess the competence of strategies from various perspectives such as cost, application execution time, etc. It also supports the evaluation of Green IT policies. It can be used as a building block for a simulated cloud environment and can add new policies for scheduling, load balancing and new scenarios. It is flexible enough to be used as a library that allows you to add a desired scenario by writing a Java program.

By using CloudSim, organizations, R&D centers and industry-based developers can test the performance of a newly developed application in a controlled and easy to set-up environment. The prominent features offered by CloudSim are given in Figure 1.

7. Architecture of CloudSim

The CloudSim layer provides support for modelling and simulation of cloud environments including dedicated management interfaces for memory, storage, bandwidth and VMs. It also provisions hosts to VMs, application execution management and dynamic system state monitoring. A cloud service provider can implement customized strategies at this layer to study the efficiency of different policies in VM provisioning.

The user code layer exposes basic entities such as the number of machines, their specifications, etc., as well as applications, VMs, number of users, application types and scheduling policies.
The main components of the CloudSim framework:

Regions: It models geographical regions in which cloud service providers allocate resources to their customers. In cloud analysis, there are six regions that correspond to six continents in the world.

Data centers: It models the infrastructure services provided by various cloud service providers. It encapsulates a set of computing hosts or servers that are either heterogeneous or homogeneous in nature, based on their hardware configurations.

Data center characteristics: It models information regarding data center resource configurations.

Hosts: It models physical resources (compute or storage).

The user base: It models a group of users considered as a single unit in the simulation, and its main responsibility is to generate traffic for the simulation.

Cloudlet: It specifies the set of user requests. It contains the application ID, name of the user base that is the originator to which the responses have to be routed back, as well as the size of the request execution commands, and input and output files. It models the cloud-based application services. CloudSim categorizes the complexity of an application in terms of its computational requirements. Each application service has a pre-assigned instruction length and data transfer overhead that it needs to carry out during its life cycle.

Service broker: The service broker decides which data center should be selected to provide the services to the requests from the user base.

VMM allocation policy: It models provisioning policies on how to allocate VMs to hosts.

VM scheduler: It models the time or space shared, scheduling a policy to allocate processor cores to VMs.
9. CloudSim and Eclipse

CloudSim is written in Java. The knowledge you need to use CloudSim is basic Java programming and some basics about cloud computing. Knowledge of programming IDEs such as Eclipse or NetBeans is also helpful. It is a library and, hence, CloudSim does not have to be installed. Normally, you can unpack the downloaded package in any directory, add it to the Java class path and it is ready to be used. Please verify whether Java is available on your system.

10. Results and Discussion

Energy improvement for different no. of nodes

In this only the number of Nodes are changes the number of Hop are remain same. By changing number of Nodes there is comparison for power consumption with the existing work and the proposed work using three processors at DVFS.

Table 4.1: IP with DVFS

<table>
<thead>
<tr>
<th>No of Nodes</th>
<th>Total Power consumed</th>
<th>Total Processing time</th>
<th>Total Processing Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>43658.52</td>
<td>196.66</td>
<td>600.01</td>
</tr>
<tr>
<td>50</td>
<td>204255.54</td>
<td>920.07</td>
<td>2807.13</td>
</tr>
<tr>
<td>100</td>
<td>409965.18</td>
<td>1846.69</td>
<td>5634.25</td>
</tr>
<tr>
<td>500</td>
<td>2035666.74</td>
<td>9169.67</td>
<td>2796.66</td>
</tr>
<tr>
<td>1000</td>
<td>4072787.58</td>
<td>18345.89</td>
<td>55973.31</td>
</tr>
<tr>
<td>1500</td>
<td>6104730.27</td>
<td>27498.78</td>
<td>83898.79</td>
</tr>
<tr>
<td>2000</td>
<td>8140372.59</td>
<td>36668.34</td>
<td>111875.12</td>
</tr>
<tr>
<td>2500</td>
<td>10177512.3</td>
<td>45844.65</td>
<td>139872.03</td>
</tr>
<tr>
<td>3000</td>
<td>12209454.99</td>
<td>54997.54</td>
<td>167797.51</td>
</tr>
<tr>
<td>4500</td>
<td>18314136.42</td>
<td>82496.11</td>
<td>251695.63</td>
</tr>
</tbody>
</table>
The above Table 1 and table 2 shows that as the number Nodes increases the execution time also increases. As Nodes i.e. number of instruction lines are increases the execution time also increases. Throughput remains the same as the number of processes completed per second and the average execution time is approximately same every time. This is the initial stage of the proposed algorithm
in which it checks that if the demand of the users are increases the execution time also increases that means number of Nodes are directly proportional to the execution time.

Table 4.2: ICN with DVFS

<table>
<thead>
<tr>
<th>No of Nodes</th>
<th>Total Power consumed</th>
<th>Total Processing time</th>
<th>Total Processing Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>22186.24</td>
<td>133.33</td>
<td>444.39</td>
</tr>
<tr>
<td>50</td>
<td>116087.04</td>
<td>697.64</td>
<td>2325.25</td>
</tr>
<tr>
<td>100</td>
<td>233416.96</td>
<td>1402.75</td>
<td>4675.39</td>
</tr>
<tr>
<td>500</td>
<td>1172048.64</td>
<td>7043.56</td>
<td>23476.37</td>
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<td>1000</td>
<td>2345340.16</td>
<td>14094.59</td>
<td>46977.63</td>
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<td>1500</td>
<td>3518630.4</td>
<td>21145.62</td>
<td>70478.87</td>
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<tr>
<td>2000</td>
<td>4691920.64</td>
<td>28196.64</td>
<td>93980.11</td>
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<td>2500</td>
<td>5865212.16</td>
<td>35247.67</td>
<td>117481.37</td>
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<td>3000</td>
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<td>4500</td>
<td>10558374.4</td>
<td>63451.77</td>
<td>211486.35</td>
</tr>
<tr>
<td>5000</td>
<td>11731664.64</td>
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<td>141013.29</td>
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<tr>
<td>15000</td>
<td>35197731.84</td>
<td>211524.83</td>
<td>705017.59</td>
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<td>20000</td>
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<tr>
<td>25000</td>
<td>58663971.84</td>
<td>352547.91</td>
<td>1175051.06</td>
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<tr>
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<td>70397091.84</td>
<td>423059.45</td>
<td>1410067.8</td>
</tr>
<tr>
<td>35000</td>
<td>82130211.84</td>
<td>493570.98</td>
<td>1645084.53</td>
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<tr>
<td>40000</td>
<td>93863331.84</td>
<td>564082.52</td>
<td>1880101.27</td>
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<tr>
<td>50000</td>
<td>117329571.8</td>
<td>705105.6</td>
<td>2350134.74</td>
</tr>
<tr>
<td>70000</td>
<td>164262051.8</td>
<td>987151.75</td>
<td>3290201.68</td>
</tr>
</tbody>
</table>
In Table 2, there is a comparison of power by using DVFS technique or without using DVFS. As it is clearly shown in the table that as we increase the number of Nodes the power consumption will also increase and without DVFS power consumption is more as compare to with DVFS. In DVFS that is dynamic voltage/frequency scaling limit the frequency in particular like if the number of instructions are greater than or equal to 10 crore than machine will run in high frequency mode that means in 100% utilization of machine. If the instruction length is between 1-10 crore than run machine in moderate mode i.e. 70% and if the instruction length is less than 1 crore than run machine in low mode i.e. 50%. As the number of Nodes increase the difference between with or without DVFS also increases.

% improvement in energy consumption = difference/ without DVFS*100

It is clearly shown that there is incremental increase in energy and performance efficiency by using combination of load balancing with DVFS technique.
The above table 2 shows the improvement in energy as we change the number of Nodes that is as we increase the workload power consumption by the machine also increases. The above has the following bar chat which clearly shows the reduction in power consumption by using proposed technique i.e. hybrid technique for energy efficiency in load balancing.

![Power Consumption Chart](image)

**Figure 1. Power Consumption Comparison**

The above bar chat shows the difference between the power consumption as we increase the number of Nodes the power consumption by the data center also increases. It also shows that energy consumption in the existing work is more as compare to with using DVFS technique. In this technique first sorted the Nodes in according to their instruction length and then apply frequency limit that called as DVFS technique.

The below bar chart in the figure 3 shows the processing times as the number of Nodes are changes. There is signification reduction in processing time in the current work and the proposed work.
Figure 2. Processing Time comparison

11. PROCESSING COST:

In all above results the number of Nodes are changes and there is significant improvement in the cost involved for processing the Nodes. Now, in this section, we have calculated the processing cost of the Nodes for the existing work and the proposed work.

Figure 3. Comparison between with and without DVFS

The user applications is based on the size of instruction (number of MIPS) of the applications. The applications are divided into three cases that are defined below:
• Case 1: High frequency mode- The applications with greater or equal to 10cr MIPS run under the high frequency mode i.e. in 100% or fully utilization of machine. As the number of instructions increases the execution time of that application will also increases. So, these applications should allocated to the large or to fast virtual machines as a result it reduced the power consumption.

• Case 2: Moderate frequency mode- The applications having instruction size between 1cr to 10cr MIPS can run under the moderate mode i.e. about 70% utilization of machine.

• Case 3: Low frequency mode- The applications having instruction size less than 1cr MIPS can run under the lower mode i.e. 50% utilization of machine. These type applications should be allocated to small or fast virtual machines of data centers.

12. Conclusion

This thesis gives the introduction of Cloud computing and background of various workload consolidation techniques to manage heterogeneous workloads. As the energy efficiency is one of major problems in cloud computing. So, in this work efficient energy consumption technique has been proposed. Many load balancing algorithms are existing today where there is no one energy efficient as they balance the load among the nodes of virtual machines. The proposed technique can balance the load as well as the energy efficient. In the proposed technique cloud environment is designed or developed in java, deployed on CloudSim toolkit and Experimental results have been gathered. Existing load balancing algorithms are not energy efficient therefore, in proposed technique along with load balancing algorithm, DVFS is combined which decreases the CPU
clock speed. In dynamic voltage/frequency scaling set the frequency range or modes according to length or size of instruction of applications. In this work frequency is divided into three modes that are high frequency mode, moderate frequency mode, low frequency mode.

13. References


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Applications of Adomain Decomposition Method for solving initial value problems

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Abstract: In this paper, we convert initial value problem to Volterra integral equations of the second kind. The Adomain Decomposition method is then being used to solve the linear of the VIEs of the second kind. Some examples are prepared to show the efficiency and simplicity of the method.

Keywords: Initial Value Problem (IVP), Volterra Integra Equation (VIE ), Adomain Decomposition Method (ADM).

1. INTRODUCTION

In this paper, we consider convert the initial value problem given by

\[ y''(x) + p(x)y'(x) + q(x)y(x) = g(x) \] \hspace{1cm} (1)

To Volterra integral equation of the second kind under the initial conditions

\[ y(0) = a \quad , \quad y'(0) = \beta \] \hspace{1cm} (2)

Where \( \alpha \) and \( \beta \) are constants, the function \( p(x) \) and \( q(x) \) are analytic functions, and \( g(x) \) is continuous through the interval of discussion. The Volterra integral equation of the second kind in the form

\[ u(x) = f(x) + \lambda \int_\alpha^x k(x,t)u(t)dt \] \hspace{1cm} (3)
The kernel $k(x, t)$ and the function $f(x)$ are given real-valued functions, and $\lambda$ is a parameter. In this paper, we present exact solution of the volterra integral equation of the second kind.

1. Converting IVP to Volterra integral equation:

We will study the technique that will convert an initial value problem (IVP) to an equivalent volterra integral equation of the second kind. For the simplicity reasons, we will apply this process to general initial value problem:

$$y^{(n)} + a_1(x)y^{(n-1)} + \cdots + a_{n-1}(x)y' + a_n(x)y = g(x) \quad (4)$$

Subject to the initial conditions

$$y(0) = c_0, y'(0) = c_1, y''(0) = c_2, \ldots, y^{(n-1)}(0) = c_{n-1}$$

We assume that the functions $a_i(x), \ 1 \leq i \leq n$ are analytic at the origin, and the function $g(x)$ is the continuous through the interval of the discussion. And we consider the transformation:

$$y^{(n)}(x) = u(x) \quad (5)$$

Integrating both sides with respect to $x$ gives

$$y^{(n-1)}(x) = c_{n-1} + \int_0^x u(t) \, dt \quad (6)$$

Integrating again both sides with respect to $x$ yields

$$y^{(n-2)}(x) = c_{n-2} + c_{n-1}x + \int_0^x \int_0^x u(t) \, dt \, dx = c_{n-2} + c_{n-1}x + \int_0^x (x - t) u(t) \, dt \quad (7)$$

Obtained by reducing the double integral to a single integral, proceeding as before we find

$$y^{(n-3)}(x) = c_{n-3} + c_{n-2}x + \frac{1}{2}c_{n-1}x^2 + \int_0^x \int_0^x \int_0^x u(t) \, dt \, dx \, dt = c_{n-3} + c_{n-2}x + \frac{1}{2}c_{n-1}x^2 + \frac{1}{2} \int_0^x (x - t)^2 u(t) \, dt \quad (8)$$

Continuing the integration process leads to

$$y(x) = \sum_{k=0}^{n-1} \frac{c_k}{k!} x^k + \frac{1}{(n-1)!} \int_0^x (x - t)^{n-1} u(t) \, dt \quad (9)$$
Substituting (5)—(9) into (4) gives
\[ u(x) = f(x) - \int_0^x K(x,t) u(t) \, dt \quad (10) \]

Where
\[ K(x,t) = \sum_{k=1}^{n} \frac{\alpha_n}{(k-1)!} (x-t)^{k-1} \quad (11) \]

And
\[ f(x) = g(x) - \sum_{j=1}^{n} \alpha_j \left( \sum_{k=1}^{j} \frac{\xi_{n-k}}{(j-k)!} (x)^{j-k} \right) \quad (12) \]

The technique presented above to convert general initial value problems to equivalent Volterra integral equations of the second kind can be second order initial value problem (1) Subject to the initial conditions (2). To achieve our goal, we first set
\[ y''(x) = u(x), \quad (13) \]

Where \( u(x) \) is a continuous function. Integrating both sides of (4) from 0 to \( x \) yields
\[ y'(x) - y'(0) = \int_0^x u(x) \, dt \quad (14) \]

Or equivalently
\[ y'(x) = \beta + \int_0^x u(t) \, dt \quad (15) \]

Integrating both sides of (15) from 0 to \( x \) yields
\[ y(x) - y(0) = \beta x + \int_0^x \int_0^x u(t) \, dt \, dt \quad (16) \]

Or equivalently
\[ y(x) = \alpha + \beta x + \int_0^x (x-t)u(t) \, dt \quad (17) \]

Substituting (2), (15) and (17) into the initial value problem (1) yields the Volterra integral equation:
The last equation can be written in the standard Volterra integral equation of the second kind form:

\[ u(x) + p(x) \left[ \beta + \int_0^x u(t) dt \right] + q(x) \left[ \alpha + \beta x + \int_0^x (x-t)u(t)dt \right] = g(x) \]  

(18)

The following examples will highlight the process to convert initial value problem to an equivalent Volterra integral equation.

2. The Adomian Decomposition Method:

The Adomian Decomposition Method (ADM) consists of decomposing the unknown function \( u(x) \) of any equation into a sum of an infinite number of components defined by the decomposition series:

\[ u(x) = \sum_{n=0}^{\infty} u_n(x) \]  

(20)

Or equivalently

\[ u(x) = u_0(x) + u_1(x) + u_2(x) + u_3(x) + \cdots \]  

(21)

Where the components \( u_n(x), n \geq 0 \) will be determined recurrently. The ADM concerns itself with finding the components \( u_n(x), u_1(x), u_2(x), \ldots \) individually. As will be seen through the text, the determination of these components can be achieved in an easy way through a recurrence relation that usually involves simple integrals that can be easily evaluated.
To establish the recurrence relation, we substitute \( (20) \) into the VIE(3) to obtain

\[
\sum_{n=1}^{\infty} u_n(x) = f(x) + \lambda \int_{0}^{x} k(x,t) \left( \sum_{n=0}^{\infty} u_n(t) \right) dt \quad (22)
\]

Or equivalently

\[
u_0(x) + u_1(x) + u_2(x) + \cdots = f(x) + \lambda \int_{0}^{x} k(x,t) (u_0(t) + u_1(t) + u_2(t)) dt \quad (23)
\]

The zeroth component \( u_0(x) \) is identified by all terms that are not included under the integral sing. Consequently, the components \( u_j(x), j \geq 0 \) of the unknown function \( u(x) \) are completely determined by setting the recurrence relation

\[
u_0(x) = f(x), \quad u_{n+1}(x) = \lambda \int_{0}^{x} k(x,t) (u_n(t)) dt , n \geq 0 \quad (24)
\]

Or equivalently

\[
u_0(x) = f(x), \quad u_1(x) = \lambda \int_{0}^{x} k(x,t) (u_0(t)) dt, \quad u_2(x) = \lambda \int_{0}^{x} k(x,t) (u_1(t)) dt, \quad u_3(x) = \lambda \int_{0}^{x} k(x,t) (u_2(t)) dt \quad (25)
\]

And so on other components.

In view of (25) the components \( u_0(x), u_1(x), u_2(x), \ldots \) are completely determined. As a result, the solution \( u(x) \) of the VIEs (3) is readily obtained in series form by using series assumption in (20).

3. Illustrations:

In this section, we will consider four examples, two example of the convert IVP to VIEs, and another examples solution of the VIEs of the second kind.

Example 1. Convert the following initial value problem to an equivalent Volterra integral equation of the second kind:
We first set
\[ y'(x) = u(x) \] (27)
Integrating both side of (27), using the initial condition \( y(0) = 1 \) gives
\[ y(x) - y(0) = \int_0^x u(t) \, dt, \] (28)
Or equivalently
\[ y(x) = 1 + \int_0^x u(t) \, dt, \] (29)
Substituting (27) and (29) into (26) gives the equivalent Volterra integral equation of the second kind:
\[ u(x) = 2x + e^{x^2} + 2\int_0^x u(t) \, dt. \] (30)

**Example 2.** Convert the following initial value problem to an equivalent Volterra integral equation:
\[ y''' - y'' - y' + y = 0, \quad y(0) = 1, y'(0) = 2, y''(0) = 3 \] (31)
We first
\[ y''' = u(x) \]
Integration both side
\[ \int_0^x d(y''(x)) = \int_0^x u(t) \, dt \]
\[ y'' = \int_0^x u(t) \, dt \]
Using the initial condition \( y''(0) = 3 \) we obtain
\[ y'' = 3 + \int_0^x u(t) \, dt \]
The integration again
\[ \int_0^x d(y'(x)) = \int 3 \, dx + \int_0^x \int_0^x u(t) \, dt \, dt \]
Using the condition $y'(0) = 2$

$$y'(x) = 2 + 3x + \int_{0}^{x} \int_{0}^{x} u(t) dt \ dt$$

Integration again

$$\int_{0}^{x} d(y(x)) = \int_{0}^{x} (2 + 3x) dx + \int_{0}^{x} \int_{0}^{x} u(t) dt \ dt \ dt$$

Using initial condition $y(0) = 1$ obtain

$$y(x) = 1 + 2x + \frac{3}{2} x^2 + \int_{0}^{x} \int_{0}^{x} u(t) dt \ dt \ dt$$

$$= 1 + 2x + \frac{3}{2} x^2 + \frac{1}{2} \int_{0}^{x} (x - t)^2 u(t) dt$$

**Example 3.** Solve the VIE:

$$u(x) = 1 - \int_{0}^{x} u(t) dt. \quad (32)$$

We notice that $f(x) = 1$, $\lambda = -1$, $k(x, t) = 1$ recall that the solution $u(x)$ is assumed to have a series form given in (20). Substituting the decomposition series (20) into both sides of (32) gives

$$\sum_{n=0}^{\infty} u_n(x) = 1 - \int_{0}^{x} \sum_{n=0}^{\infty} u_n(x) dt, \quad (33)$$

Or equivalently

$$u_0(x) + u_1(x) + u_2(x) + \cdots = 1 - \int_{0}^{x} [u_0(x) + u_1(x) + u_2(x) + \cdots] dt \quad (34)$$

We identify the zeroth component by all terms that are not included under the integral sign. Therefore, we obtain the following recurrence relation:

$$u_0(x) = 1,$$

$$u_{k+1}(x) = - \int_{0}^{x} u_k(t) dt, \quad k \geq 0, \quad (35)$$

So that


\[ u_0(x) = 1, \]
\[ u_1(x) = - \int_0^x u_0(t) \, dt = - \int_0^x 1 \, dt = -x, \]
\[ u_2(x) = - \int_0^x u_1(t) \, dt = - \int_0^x t \, dt = \frac{1}{2} x^2, \]
\[ u_3(x) = - \int_0^x u_2(t) \, dt = - \int_0^x \frac{1}{2!} t^2 \, dt = \frac{1}{3!} x^3, \]
\[ u_4(x) = - \int_0^x u_3(t) \, dt = - \int_0^x \frac{1}{3!} x^3 \, dt = \frac{1}{4!} x^4, \]

And so on, using (20) gives the series solution:

\[ u(x) = 1 - x + \frac{1}{2!} x^2 - \frac{1}{3!} x^3 + \frac{1}{4!} x^4 + \cdots, \quad (36) \]

That converges to the closed form solution:

\[ u(x) = e^{-x} \]

**Example 4.** Solve the VIE:

\[ u(x) = 1 - x - \frac{1}{2} x^2 - \int_0^x (t-x)u(t) \, dt. \quad (37) \]

Notice that \( f(x) = 1 - x - \frac{1}{2} x^2, \lambda = -1, k(x,t) = t - x. \) Substituting the decomposition series (20) into both sides of (37) gives

\[ \sum_{n=0}^{\infty} u_n(x) = 1 - x - \frac{1}{2} x^2 - \int_0^x \sum_{n=0}^{\infty} (t-x)u_n(x) \, dt, \quad (38) \]

Or equivalently

\[ u_0(x) + u_1(x) + u_2(x) + \cdots = 1 - x - \frac{1}{2} x^2 - \int_0^x (t-x)[u_0(x) + u_1(x) + u_2(x) + \cdots] \, dt \]

This allows us to set the following recurrence relation:
\[ u_0(x) = 1 - x^2, \]
\[ u_{k+1}(x) = - \int_0^x \sum_{n=0}^{\infty} (t-x)u_k(x) dt, \quad k \geq 0 \]

That gives
\[ u_0(x) = 1 - x^2, \]
\[ u_1(x) = - \int_0^x (t-x)u_0(t) dt = \frac{1}{2!}x^2 - \frac{1}{3!}x^3 + \frac{1}{4!}x^4, \]
\[ u_2(x) = - \int_0^x (t-x)u_1(t) dt = \frac{1}{4!}x^4 - \frac{1}{5!}x^5 + \frac{1}{6!}x^6, \]
\[ u_3(x) = - \int_0^x (t-x)u_2(t) dt = \frac{1}{6!}x^6 - \frac{1}{7!}x^7 + \frac{1}{8!}x^8 \]
(39)

And so on. The solution in a series form is given by
\[ u(x) = 1 - \left( x + \frac{1}{3!}x^3 + \frac{1}{5!}x^5 + \frac{1}{7!}x^7 + \ldots \right) \]

And in closed form by
\[ u(x) = 1 - \sinh x, \]

Obtained upon using the Taylor expansion for \( \sinh x \).

4. CONCLUSIONS

In this paper, the initial value problem has been converted to Volterra integral equation of the second kind. The Adomain Decomposition Method was successfully applied to study the Volterra integral equation of the second kind. The results show ADM is powerful and efficient techniques in finding exact solutions for VIE of the second kind.

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Steganography and Cryptography In Computer System
Department Of Embedded System

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Abstract: Digital communication experienced a tangible and ongoing development in many applications in the internet. Hence a well done communication lectures must be presented to the security of data shipped across a worldwide network performance measure. Cryptography and steganography are two urgent methods that are used to support network security. In this paper a high untroubled manner is being developed by combining Cryptography and steganography security. We conduct a comparative study of Cryptography and steganography. We study a series of methods concerning Cryptography and steganography in addition classification concerning these methods is presented.

1. INTRODUCTION

Information security has developed as an important issue in our digital life. The development of new transmission technologies lead to a certain strategy of security performance and security in terms of communications.
Figure (1) system security

Usually in cry, the component of secret message is scrambled while in ste, the secret message is included into the cover medium.

1.1. Overview:

Cryptography and stegnography are closely related. Cryptography is traced back to Greek word cruptos meaning and logos meaning to study science cryptology can be classified into two parts cryptanalysis and cryptography is message thrown together disorderly and can’t be understood while in stegnography The message is included, and so is protected, we doubted about the hidden messages and actually we don’t in invisible message. Both sciences are working together to make us better protection of the message, the other option will be cry.
1.1.1. **Cry.** Is a method of protecting information by inscribing it into a text that can’t be read unless if you font have a secret key.

Cry: is there for is a traditional techniques that keep the privacy of communication between parties, This method is an art of secret writing by using the key into cipher text to exchanged between different parties on an in secure channel. And nobody can read the plain text without a key.

Cry: can play an important in different aspects like: confidence, key exchange, authentication and non repudiation.

Cry: give these services for guaranteeing communications across insecure channel.

1.1.2. **Steganography.** Is ability to conceal information and to prevent people seeing with the naked eyes. Ste. Its have three types of data, they are text, image, audio, and video. Text ste. in this type limited data usually used audio – video ste. they are complicated in use. Image ste. its commonly applicated ste. For concealing data since it gives secure and proper way to send information over the internet. Image are frequently used in many areas such as medical, military, science, engineering, advertising education in addition to training with the advancing use if digital techniques for sending and storing images, the basic issue of maintaining entrust, integrity as well as genuiness of images have become
major concern. The quality of a cry. system rely on the secret key and unless you know the key required to reveal Generic process of encoding and decoding. You cant found the massage.

<table>
<thead>
<tr>
<th>Cover information</th>
<th>Implementing</th>
<th>Detecting</th>
<th>Defeating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Text</td>
<td>The first-letter algorithm, amount of whitespace after lines or between words, is using a publicly available cover source, a book or a newspaper, and</td>
<td>can be detected by looking for patterns in texts or disturbing thereof, odd use of language and unusual amount of whitespace.</td>
<td>The best way of removing hidden messages is rewriting &amp; reformulating the contents. Except the usage of a publicly available cover source.</td>
</tr>
<tr>
<td></td>
<td>using a code which consists</td>
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<td></td>
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<thead>
<tr>
<th>Cover information</th>
<th>Implementing</th>
<th>Detecting</th>
<th>Defeating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Image</td>
<td>involve the usage of the least-significant bit or LSB, masking, filtering and transformations on the cover image.</td>
<td>statistical analysis and the LSB modification technique, the difference between random values and real image values can easily be detected.</td>
<td>Compressing an image using lossy compression will remove messages that are hidden using the LSB modification technique. is resized, the color palette is modified.</td>
</tr>
<tr>
<td>Audio</td>
<td>Using the least significant bit, involves taking advantage of human limitations, a message can be encoded using musical tones with a substitution scheme.</td>
<td>statistical analysis and the LSB modification technique. Except for High, inaudible frequencies. the methods of detecting hidden information are also a combination of techniques used for audio</td>
<td>Use same techniques of image. several lossy compression schemes use the limits of the human ear to their advantage by removing all frequencies that cannot be heard.</td>
</tr>
</tbody>
</table>
1.1.3. Watermarks: are similarly concealed to stop their detection and removal, they are said to be an untainable watermarks. Also visible watermarks is like watermarks used in non-digital formats.

A watermark is a form of text or image that is deeply affected image or text and a guarantee authenticity. Watermark fixes a signal directly into the data and directly integrated with data and travel with it. Here, its said that the data can be available when watermark is available [7]

![Digital watermark life-cycle phases with embedding, attacking, and detection and retrieval functions](image)

Figure (3): Digital watermark life-cycle phases with embedding, attacking, and detection and retrieval functions

2. Methodology:

There are three schemes for securing the data aiming to realize three goals, these schemes are pubic key cry. and hash function. There are three means of categorizing cry. algorithms which their main function is encryption and decryption, the algorithms that must be discussed are: [10]

A\ symmetric key cryptography:

It’s called symmetric key, shared, and single key. In this method is applied for two encryption and decryption messages. The plaintext is inscribed by the transmitter and is used by receiver to remove the cyphering message. The two parties are
responsible to do cry. and decry. This technique gives good security for transmission.

The security encryption based to secrecy of the key and cut algorithm and we keep only secret key, that means the manufacture is very cheap due implementation of the data encryption algorithm, these type are widely available.[12]

**B\ Asymmetric-Key Cryptography:**

Public key cry. Actually uses public and private key. This property is different, if the encryption applied the receiver using private key and vise versa.[7]

**C\ Hash Function:**

It depends on mathematical transform to encrypt information. It is an algorithm that doesn’t deal with any key. However a fixed length hash value is calculated rely on the input, and it doesn’t applicable in virtue of computation to gain data from the hash value. Hash work are usually applied to obtain digital fingerprint of file and guarantee the integrity of the files. [10]

It is also named message digest and 1 way encrypt this two are algorithm use no key fixed enough hash value is connected to based depends on the plain text make impossible of their content or the length to be restored. [7]

**2.1.2 Types of cryptographic attack:** cryptography Attacks are made to destroy the security of cryptographic algorithms and they are applied to decrypt data without which is the art of revealing encrypted data.

**2.1.3 Cryptographic attack methods:** there are three plaintexts based methods and three cipher text based method.
These techniques are applied as the base of cryptographic attacks:

3) **KNOWN PLAINTEXT, and CIPHER TEXT – ONLY ATTACK**

Known plaintext attack is a onrush where a cryptanalyst has an entrance both and try to find interaction between them.

A cipher text only attack is an onrush where cryptanalyst has entrance to a cipher text but doesn’t have an entrance to correspondence plaintext and with simple ciphers, frequency analysis can be used to breach the cipher.

B CHOSEN PLAINTEXT AND CHOSEN CIPHER ATTACKS: a chosen plaintext is an onrush where cryptanalyst has entrance to a public key. A chosen cipher text attack is an onrush where cryptanalyst select a cipher text and try to find matching plaintext.

It's possibly to be carried out on an onrush against public key encryption, it started with cipher and look for matching publicly – posted plaintext data.

C ADAPTIVE CHOSEN PLAINTEXT AND ADAPTIVE CHOSEN CIPHER TEXT ATTACKS: in both a cryptanalyst select plaintext or cipher text depend on prior results.

i SIDE CHANNEL ATTACKS: side channel attacks average additional information depend on physical application of a cryp. Algorithms including hardware to crypt or decrypt data.

II BRUTE FORCE ATTACK: it used sometimes in known plaintext or cipher text only attack.

**2.2 types of steganography techniques:**
2.2.1 Spatial Domain Steganography: the secret message is included in pixel values it intended to save cipher messages, the tech. not complicated but if influence on other techniques has.

\[ \text{LSB Substitution algorithm} \] : the alternative algorithm is one of the simplest from of algorithms, through which LSBs of the cover image can be transformed with the cipher message. Its yet efficient methods to include secret data into images. Every pixel contains 8 bits in case of gray scale images. Colored RGB images use 24 bits to save color information. The advantages of this algorithm is simplicity and easy to be understood.

\[ \text{Pixel Value Differencing} \]: here the cover picture is subdivided into no overlapping blocks contain relating pixels. This methods conceal the data by changing the difference between the two related pixels. High difference in the cover image pixel value permits the higher modification field of the pixel determines the concealing capacity of this method for example if edge area is to include the secret message that is having more embedding capacity. Stego image brought by better remarkable has more attributes and has better remarkable results.

\[ \text{Grey Level Modification} \]: in this methods data is mapped and will not be hidden or included. Group of pixels are chose for mapping using the mathematical function. It applies the idea of odd and even numbers for mapping the data in cover image. High concealing and low computational are some benefits from this methods.

\[ \text{Prediction Based Steganography} \]: In this method pixel value are forecasted by assistance of predictors. This techniques clears the loop holes of other techniques which are directly included data into pixel values. In order to enhance concealing capacity and visual quality its used to predict mistakes values. EV are modified to conceal secret data. It composed of two steps which they are prediction step and
entropy coding. In prediction phase predictors decided the pixel value of a cover image, on the other hand entropy coding of prediction error values is conducted.

**Quantization Index Modulation**: organization index modulation is a method of special field steganography in which secret information is included in cover image by modulating an index with included information and then quantization process is applied to the host signal with associated quantizer, this technique has many benefits for example high embedded capacity and is highly robust techniques. [4]

### 2.2.2 Transform or FD steganography:

Transform or frequency domain steganography techniques are the most complicated way to include the secret data in the cover image. Any image is created by high and low frequency element. Digital images can have smooth edge area which represents low frequencies.

On the other side, sharp areas of the cover image represent high frequency. Low frequency can be changed so as to be seen to the naked eye. So it is unlikely to include equal amount of secret information in all regions. Also it has many benefits over the special domain method, of steganography like its more robust against compression image, processing, cropping. These methods are quite enough to be attacked. These methods are not depend on image file format. Transform domain steganography methods are widely stored out into these types.

**Discrete Wavelet Transformation Technique**: the cover image is divided into four sub bands where the highest one represent the fine details while the lower band has more important information. Entropy coders locate the transformed coefficient and encode them. D.W.T methods has extra edge over D.C.T that gives and effective energy compaction more than D.C.T without any blocking
After coding’s process. The kinds of transforms can be applied with D.W.T such as integer transformation, curvelet transform, contourlet transform dual tree D.W.T etc. **Discrete Conserve Transformation Technique**: its very popular steganography method which is highly fitted JPEG images. These images are widely applied over the internet and has no feature of compression. DCT is intensively applied for picture and video compression. Every block of DCT is quantized with the help of quantizing table of JPEG. Quantized coefficient are used to include the secret message, after that coding. In this method high frequency fields are better for information concealing as they often become zero after the process of quantization if the embedded data is zero we have no need to modify the coefficient value. **Spread Spectrum Steganography**: its very popular methods in digital and wireless communication, through which narrow and is modulated across the wider band of frequency. After spreading, resulting signal is added to the cover image and the outcome image is stego image with secret information included signal not strong enough to discover the presence of steganography. So in this case signal – to – noise is very less. It must require synchronization of Pseudo random noise come out as transmitter as well as receiver end to create needed results.

This method applies symmetric key system that requires and receiver to apply same key for communication. The profit of this technique are good stego image quality and keeps the strength against various attack. Its not easy for the attacker to discover and have included secret information. There are many improvement which improve the embedding capacity and lessen the bit error.

Rate during embedding process – peak – signal – to – noise – ration (PSNR) and mean squire error (MSE) can be used to analyse the carrying out of steganography algorithm concerning image quality with respect to original cover image.
v. Adaptive Steganography: the number of advantages of the transform domain steganography methods over image or special domain methods instigates the application of these techniques. Adaptive steganography also called model based steganography or statistic aware embedding. In this method statistical ownerships of the cover image is applied. This technique: firmly surrounds the secret information in cover image without changing it properties. It can be divided to two kinds: firstly we choose random adaptive pixel relying on cover image and secondly we chose those pixels which have got higher local deviation value. This technique has large embedding capacity that supplies solidity to the stego so as not to be exposed to any attack. So every steganographic method has merits and demerits. According to the kind and need of application one can apply a technique which is best suited his / her requirement.

2.3 Types of the watermarking: visible marking and invisible are:

i\ Visible watermarking\ its goes back to the information seen on the data.

Visible water marks are typically logos or text.

ii\ Invisible Watermarking \ it connect to seen or precieved by sight or hearing but it can be discovered by different ways, also it’s a kind of steganography and its widely used, and it can is simply recovered.

3. Results:

The Table (1) shows the differences between cry. and steg. and table (2) show the comparison of cry. and steg.

<table>
<thead>
<tr>
<th>Steganography</th>
<th>Cryptography</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unknowing message Passing</td>
<td>Knowing message passing</td>
</tr>
<tr>
<td>Criteria/Method</td>
<td>Steganography</td>
</tr>
<tr>
<td>----------------</td>
<td>--------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Definition</td>
<td>Cover writing deals with composing hidden messages so that only the sender and the receiver know that the message even exists.</td>
</tr>
<tr>
<td>Objective</td>
<td>Maintaining message’s existence secret, Secret communication</td>
</tr>
</tbody>
</table>

Table(1) differences between cry. and steg. [8]
<table>
<thead>
<tr>
<th>Criteria/Method</th>
<th>Steganography</th>
<th>Cryptography</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carrier</td>
<td>Any digital media</td>
<td>Usually text based</td>
</tr>
<tr>
<td>Input file</td>
<td>At least two</td>
<td>One</td>
</tr>
<tr>
<td>Key</td>
<td>Optional</td>
<td>Necessary</td>
</tr>
<tr>
<td>Visibility</td>
<td>Never is only the sender and the receiver know the existence of the message.</td>
<td>Always be seen by all whereas</td>
</tr>
<tr>
<td>Security services Offered</td>
<td>Authentication, Confidentiality, Identification</td>
<td>Confidentiality, Identification, Data Integrity and authentication Nonrepudiation</td>
</tr>
<tr>
<td>Type of Attack</td>
<td>Steganalysis: Analysis of a file with an aim of finding whether it is a stego file or not</td>
<td>Cryptanalysis</td>
</tr>
<tr>
<td>Attacks</td>
<td>Broken when attacker reveals that steg. has been used. known as Steganalysis.</td>
<td>Broken in case the secret message is understood known as Cryptanalysis.</td>
</tr>
<tr>
<td>Methods</td>
<td>try to protect the message’s content</td>
<td>hide both the message and the content.</td>
</tr>
<tr>
<td>Criteria/Method</td>
<td>Steganography</td>
<td>Cryptography</td>
</tr>
<tr>
<td>---------------------</td>
<td>--------------------------------</td>
<td>-------------------------------</td>
</tr>
<tr>
<td>Resultant Output</td>
<td>Stego file</td>
<td>Ciphertext</td>
</tr>
<tr>
<td>Applications</td>
<td>Used for securing information</td>
<td>Used for securing information</td>
</tr>
<tr>
<td></td>
<td>against potential eavesdroppers</td>
<td>against potential eavesdroppers</td>
</tr>
<tr>
<td>Methods of the hide</td>
<td>the use of mathematics and</td>
<td>Not much mathematics is</td>
</tr>
<tr>
<td></td>
<td>number theory to hide data</td>
<td>Involved</td>
</tr>
<tr>
<td>Known Technology</td>
<td>Little known Technology</td>
<td>Common technology</td>
</tr>
</tbody>
</table>

Table (2) comparison of cry. and steg.[6]

4. Discussion of the results:

We summarize the differences between steg. And cryp. concisely, then present comparative analysis of the method in the table that shows the differences between steganography and cryptography in field of definition, purposes, carrier, impute files, importance of the key, visibility security service effort, type of attacks, result output and application.

Cryptography and steganography are both famous techniques able to provide security, the purposes of cryptography are protecting data and the target of steganography is secret communication. Cryptography transforms the data into the cipher text so as not to be readable format for the normal users on the opposite side.
Steganography conceal the being of the message by firmly surrounding data into other digital media. Both of them have difficulties. Crypto-steganography allies (unity) can overcome each other weakness and prevent the intruders from attacking or steal sensitive information.

5. Conclusion:

Information hiding is very remarkable roles in protecting and maintaining secrecy in this digital world. In the paper a basic three techniques for hiding information are well discussed, the differences between the techniques were also found out. Also the applications areas of the techniques are also provided.

6. References:


Enhancement of Quality of Service in Cloud Computing Environment a comparative Study

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¹,² Department of communication, Faculty of Engineering, Al-Neelain University, Khartoum Suddan

Abstract: Cloud computing is a practical method gives wide scope look at the appearing model of internet based enterprise application and services. Now it has seen a great deal of migration to the cloud. The allocating responses to application one of the most outstanding problems that guarantee a service level along dimensions such as performance, availability and reliability. In this paper we will present on overview on the quality of service in cloud computing terms of techniques used advantages and disadvantages.

Keywords: cloud computing, quality of services.

1- Introduction

It’s a new transformation, instead of storing and applying information on computer, everything is done on cloud through which a network of computers and servers approached through internet. Cloud computing allows you access applications and document from anywhere in the world, there are many difficulties in the field of quality of services despite the large advantage of cloud computing. Quality of services shows: performance, reliability, and availability standards, (Q of S) is important for cloud dealer, for difficulties by which many researchers have been promoted to find out automated methods for managing quality of services to be sure if technology can tackle the quality of service difficulties in computing cloud.
1.1 Overview of Cloud Computing

1.1.1. Definition of Cloud Computing

The term cloud is typical to internet. The term cloud go back to be used in the past to represent telephone network as well as represent internet in cloud. And later the term go back to a series of sources and system, computer urgent on demand through the network which give a number of services work together without being affected by local responses, so as to simplify it for the user, storage capacity, synchrony, automation.

The responses contain, processing, capabilities, programming and scheduling of function and push e-mail and remote printing, here the user can take hold when its connected to the network.[1]

1.1.2 Cloud models:

There too many different services which are introduced by the cloud providers they are:

I. Cloud services models:
   - SaaS (Software as a Service), network – hosted application.
   - DaaS (Data as a Service), customer lines versus provider’s database.
   - PaaS (Platform as a Service), network hosted software development platform.
   - IaaS (Infrastructure as a Service), provider hosts customer VMs or provide network storage.[2]

II. Cloud development model:
   - Public cloud:
     Computing infrastructure is hosted at the vendor’s premises. The customer can’t see the side of the cloud computing. The organization has the right to share computing infrastructure.
   - Private cloud:
Computing architecture is completely owned by the customer who doesn’t share it with other organizations. They are valuable and it’s surely assumed to be more secure than public cloud. It’s externally hosted and in assumption. Hosted clouds too.

- **Hybrid cloud:**
  Some important secure applications are hosted by organizations. The least important application, are hosted in public cloud. The combination is called hybrid cloud.

  The term bursting cloud is a term emphasize, when organizations deal with its infrastructure as the normal usage, but cloud is applied for top loads.

- **Community cloud:**
  The organization of the same community is entitled to share the cloud infrastructure for example the government come together to share same cloud only.[3]

2. Methodology

   2.1 Quality of service techniques
   Quality services designate the standard of performance, reliability, availability given by an application and infrastructure that host. QoS is essential to cloud dealers and providers, who are in need to find the right exchange between QoS level and operation lost. To discover a suitable exchange is difficult decision, because it contains service level agreement which stipulates QoS purposes and economic penalties joined SLA violations, service providers are obliged to abide by SLA bonds (rules) which limits the revenue and penalties due the basis of the level of the work conducted. Service level agreement are signed between the service owners and clients. Through QoS properties have taken continuous interest, even before the development of cloud computing.
Performance have significantly OoS analysis, therefore several research is going to have advantage of programming of hardware and software resources in the cloud. * P.C. Harchy. Et.al suggested a SoS methods to make easy controlling, management and response that present computing as a service through a cloud weather. Enterprise Monitoring, Management and Response Architecture in Cloud Computing environment (EMMRACC) strong example presented for conducting the new SoS method to a real world scenarios (vi2) distributed denial of services. The method is very practical but it was not conducted in real time.

This system first presented two advantages to raise quality of OoS performance and oppose Distributed Denial Of Services (DDOS) performance attacks on the other hand this system make defect such as, its difficult to apply it to federate cloud, because cloud dealers were not cooperated in real time.

*M. Salam et. Al. suggested a framework of federated cloud computing where too many independent cloud dealers can cooperate easily to present reachable QoS assured services. Cloud coordinator and federation coordinator act as the key element that make cloud federation effective.

This method present two advantages first make provider act effectively as a helper for each other in peak time.

On the other side this technique has two advantage first complex services were not built using a mixture of services from different cloud provider and no supply was made for distributed denial of service attack.

*W. C. Chu et. Al. suggested: formal example to help not only the EECC services design and building up through SssS, LaaS but conceded monitoring and dynamic analysis on the QoS factors for the promises from QoS service providers and the service level agreement (SLA) for multi ECC.
Consumer analysis model and testing model are mainly created to help automatic testing and runtime monitoring to make sure of satisfaction to the requirement / (SLA) difficulties. This function had some difficulties such as the storage of adapting the feature and solution to field experiment.

The main advantages of the previous are establishing integrated cloud data service to help (QoS) and (SLA) full treatment.

The main advantages of the last method are the features and solution of IOT. The technique was not accommodated into the frame as well as the field experiments.

*M. M. Hassau et. al. studied and examined a large amount of data by testing a group of similar bug data job on Amazon cloud. They found out a simulate scenario, and compared the suggested techniques with approaches.

The suggested methods has some defect in metrics performance example delay, variable delay and through put were not considerate. The main benefit of the last method are effective cost and dynamic VM allocation model to handle enormous amount of data. The main advantages of the last system are metric performance example delay, delay variation and through put were not taken in consideration.

*R. Karim et. al. suggested a new way to map the users QoS requirement of cloud services to the right QoS specification, of SaaS then may them be the best LaaS service that give the suitable QoS guarantee. The end to end Qos values were counted as the result of the mapping. They suggested group of rules to conduct the mapping process. Using the analytic hierarchy process method, the QoS of service was modeled. The based model help to simplify the mapping process across the cloud layer and to rank the chosen cloud services for the end users.
A case study was applied to instance and formalize the solution approach. No conduction was made rely on real QoS data, set of cloud services.

The past system gives advantage, example the new method of calculating end to end values in cloud environment.

*S Lee et. al. suggested and architecture that find top for technical agent to handle monitoring of demanded QoS needs and service level agreement to help verification and validation. Moreover resources allocation and deployment have been analyzed by agent technology. The weak point of this approach was the decreasing of self learning algorithm to decide the timing of automatic allocation of system resource.

The last system present two advantages: automated resource allocation and improve transmission of cross layer control information concerning to some services performance example SLA.

*L Bin et. al. suggested a novel QoS aware dynamic data reproduction delete strategy for disk space and maintenance cost saving purpose. Experimental results told us that the DRDS algorithm can maintain disk space and maintenance costs for distributed storage system while the availability and conductions equality of services requirement, increase overhead on update . contradiction of data is usually combined with data.

The main advantages of this systems are saving disk and maintaining cost and the disadvantages are increased overhead on update and contradictions of data.

*P Zhang et. al. suggested a QoS services framework cloud computing and an adaptive QoS controlling process to control QoS assurance in mobile cloudMore over they gave QOS management model depend on fuzzy cognitive map (FCM)no good model was given . the main disadvantage of this system is no good model with suitable configuration was generated.
*Y. Xiao et al. Gave an effect reputation based QOS supplying scheme which can lessen the cost of computing recourses while make quite enough desired QOS matric. they assumed that the statistical probability of the response time as a practical metric rather than the typical mean response time. so QOS supplying algorithm was not applied to unity security and privacy metrics.

The last system may have advantages e.g suggested management framework gives an effect QOS supplying scheme for cloud computing. The main disadvantage of the system is QOS supplying algorithm was not applied to unify security and privacy metrics.

*M. Xu et al. Presented double constrained scheduling strategy of multi-workers to deal with issue of multiple workers with different QOS requirement. the suggested strategy could schedule too main different work flows which might started any time though QOS difficulties examples availability and reliability which were not added to work flows the main advantages of the former system is the better scheduling but on the other hand there are some difficulties such as they did not add rehabilitee to workflows [4]

3. Results:

Table shows an analysis of the quality of service technologies in cloud computing in terms of the technology used and the advantages and the disadvantages:

Table (1): Analysis of QoS techniques in cloud computing[5]

<table>
<thead>
<tr>
<th>Title</th>
<th>Technique used</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/ System of Systems for Quality of Service Observation and</td>
<td>Enterprise monitoring, Management and Response Architecture</td>
<td>i) Enhanced Qos Performance ii) Prevents distributed denial of service (DDoS) attacks.</td>
<td>The solution cannot be applied to federate clouds because cloud</td>
</tr>
</tbody>
</table>


<table>
<thead>
<tr>
<th>Title</th>
<th>Technique used</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Response in Cloud Computing Environment</td>
<td>in Cloud Computing (EMMRA CC) and System of System Approach (SoS)</td>
<td></td>
<td>providers servers were not integrated in real time</td>
</tr>
<tr>
<td>2\ QoS Oriented Inter Cloud Federation Framework</td>
<td>QoS Oriented Cloud Computing Framework, Cloud Coordinators (CC) and Federated Coordinators (FC)</td>
<td>\i Enables providers dynamically act as backup for each other in peak times \i Protect the Providers from any possible SLA violation</td>
<td>\i Complex services were to not constructed using a mixture of services from different cloud providers. \i No provision was made for distributed denial of service (DDoS) attacks.</td>
</tr>
<tr>
<td>3\ An Approach of Quality of Service assurance for Enterprise Cloud Computing (QoSAECC)</td>
<td>Multi agent model</td>
<td>Established an integrated cloud data service to support QoS and SLA manipulation.</td>
<td>The features and solutions of JOT was not adapted into the framework as well as the field experiments.</td>
</tr>
<tr>
<td>4\ QoS-Aware Resource</td>
<td>Heuristic algorithms</td>
<td>Cost effective and dynamic Vm allocation</td>
<td>Performance metrics such as delay.</td>
</tr>
<tr>
<td>Title</td>
<td>Technique used</td>
<td>Advantages</td>
<td>Disadvantages</td>
</tr>
<tr>
<td>----------------------------------------------------------------------</td>
<td>--------------------</td>
<td>----------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Provisioning for Big Data Processing in Cloud Environment</td>
<td></td>
<td>model to handle big data tasks.</td>
<td>delay variation and throughput were not taken into consideration</td>
</tr>
<tr>
<td>5\ An End-To-End QoS Mapping Approach for Cloud Service Selection</td>
<td>AHP based ranking</td>
<td>Presented a new way of computing end to end values in cloud environment</td>
<td>No performance evaluation was done based on real QoS datasets of cloud services</td>
</tr>
<tr>
<td>6\ A QoS Assurance Middleware Model for Enterprise Cloud Computing</td>
<td>Agent technology</td>
<td>Automated resource allocation</td>
<td>No self-learning algorithm was used to determine the timing of automatic allocation of system resources</td>
</tr>
<tr>
<td>7\ A QoS-Aware Dynamic Data Replica Deletion Strategy for Distributed Storage Systems under Cloud</td>
<td>DRDS Algorithm</td>
<td>Save disk space and maintenance cost for distributed storage system</td>
<td>Increased overhead on update and inconsistency of data</td>
</tr>
<tr>
<td>Title</td>
<td>Technique used</td>
<td>Advantages</td>
<td>Disadvantages</td>
</tr>
<tr>
<td>----------------------------------------------------------------------</td>
<td>----------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>8\ A QoS-Aware System for Mobile Cloud Computing</td>
<td>Fuzzy cognitive map and QoS Prediction Algorithm</td>
<td>Facilitates QoS prediction, establishment, assessment and assurance</td>
<td>No good model with suitable configurations was generated.</td>
</tr>
<tr>
<td>9\ Reputation-based QoS Provisioning in Cloud Computing via Dirichlet Multinomial Model</td>
<td>Dirichlet Multinomial model</td>
<td>The proposed management framework provides an efficient QoS provisioning scheme for cloud computing</td>
<td>QoS provisioning algorithm was not used to integrate security and privacy metrics</td>
</tr>
<tr>
<td>10\ A Multiple QoS Constrained Scheduling Strategy of Multiple Workflows for Cloud Computing</td>
<td>Scheduling Algorithm</td>
<td>Produced better scheduling results</td>
<td>QoS constraints such as reliability and availability was not added to workflows</td>
</tr>
</tbody>
</table>

4. Discussion of the results:
many researchers have introduced techniques such as a system of systems for quality of service observation and response in cloud computing environment to treat the quality of service in cloud computing, a Qos oriented inter cloud federation framework, an approach of quality of service assurance for enterprise cloud computing … etc.
I suggested the techniques of service quality management and response system in the cloud computing environment then I chose it because it’s a method that can control manage and respond to cloud computing. (SoS) system enhance service accomplishment and prevent an attack on the QoS (DDoS) service the SUSE system can’t used for cloud clouds for servers of cloud suppliers were not integrated in real time.

5. Conclusion:

In this paper I have discussed QoS methods to make sure that the QoS problems are solved. Many researchers have presented methods such as access control, traffic control, dynamic resource provision etc to solve the issue of quality of service in cloud computing.

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[5] A Survey on Quality of Service in Cloud Computing Helen Anderson Akpan#1,B.RebeccaJeya Vadhanam#2 #1MSc Student, Department of Information Technology,#2Assistant Professor, Department of Computer Science, SRM University, Chennai, Tamil Nadu, India.
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The Effectiveness of Using IDPS and Firewall in Private Cloud Computing Environment
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Plant Control Improvement Using Model Free Adaptive (MFA) Control Technology

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Abstract: Model-Free Adaptive (MFA) control is a technology that has made a major impact on the automatic control industry. MFA control users have successfully solved many industry-wide control problems in various applications and achieved significant economic benefits. Now, the challenge is extending the many advantages of MFA control technology to diverse and fragmented markets, which could benefit from its unique capabilities. Since single-loop MFA controllers can directly replace legacy PID controllers without the need for "system" redesign (plug-and-play), they are readily embeddable in various instruments, equipment, and smart control valves. This alleviates concerns relative to cost of change and also makes MFA an appealing tool for OEM applications on a large scale.

Key Words: Model-Free Adaptive (MFA) control, PID (Proportional, Integral, Derivative) controller, neural network, setpoint
1. Introduction

Model-Free Adaptive (MFA) control, as its name suggests, is an adaptive control method that does not require process models. A Model-Free Adaptive control system is defined to have the following properties:

(1) Precise quantitative knowledge of the process is not necessary;
(2) Process identification mechanism or identifier is not included in the system;
(3) Controller design for a specific process is not needed;
(4) Manual tuning of controller parameters is not required; and
(5) Closed-loop system stability analysis and criteria are available to guarantee the system stability.

Variations of the core MFA control technology address specific control problems as described here.

• SISO (Single Input Single Output) MFA to replace PID (Proportional, Integral, Derivative) controller so that manual controller tuning is eliminated,
• Nonlinear MFA to control nonlinear processes,
• MFA pH controller to control pH processes,
• Feedforward MFA controller to deal with measurable disturbances,
• Anti-delay MFA to control processes with large time delays,
• Robust MFA to protect the process variable from running outside a bound,
• Time-varying MFA controller to control time varying processes,
• Anti-delay MFA pH controller for pH processes with varying time delays, and
• MIMO (Multi Input Multi Output) MFA to control multivariable processes.

General-purpose or application-specific MFA controllers can be readily embedded and are becoming available on more and more platforms offered by various vendors supplying building controllers, single-loop controllers, programmable...
logic controllers (PLCs), hybrid controllers, process automation controllers (PAC), control software, and distributed control systems (DCS). [1]

A. CONCEPT AND SIGNIFICANCE OF MODEL-FREE ADAPTIVE CONTROL.
A Model-Free Adaptive control system has the following properties and features:
• No precise quantitative knowledge of the process is available;
• No process identification mechanism or identifier is included in the system;
• No controller design for a specific process is needed;
• No complicated manual tuning of controller parameters is required; and
• Stability analysis criteria are available to guarantee the closed-loop system stability.

The essence of MFA control is described with discussions relating to combustion process control on the following five issues:

B. PROCESS KNOWLEDGE ISSUE
Most advanced control methods are based on a good understanding of the process and its environment. Laplace transfer functions or differential equations are used to represent the process dynamics. In many process control applications, however, the dynamics may be too complex or the physical process is not well understood. Quantitative knowledge of the process is then not available. This is called a “black box” problem.

In many cases, one may have some knowledge of the process but are not sure if the knowledge is accurate or not. In process control including combustion control applications, it is often deal with raw materials, wild inflows, changing fuel type and heating values, unpredictable downstream demand changes, and frequent switches of product size, recipe, batch, and loads. These all lead to a common problem: that is, one is not sure if the process knowledge is accurate or not. This is called a “gray box” problem.
If quantitative knowledge of the process is available, we have a “white box” to deal with. It is a relatively simple task to design a controller for the process in this case because we can use well-established control methods and tools. Although Model-Free Adaptive control can actually deal with black, gray, and white box problems, it is more suitable to deal with the gray box problem. Most industrial processes are gray boxes.

C. Process Identification Issue.

For traditional adaptive control methods, if the quantitative knowledge of the process is not available, an on-line or off-line identifier is required to obtain the process dynamics. This contributes to a number of fundamental problems:

- The headache of off-line training that might be required,
- The tradeoff between the persistent excitation of signals for correct identification and the steady system response for control performance,
- The model convergence and local minimum problems, and
- The system stability issues.

The main reason that identification-based control methods are not well suited for process control is that control and identification are always in conflict. Good control will lead to a steady state where setpoint (SP), controller output (OP), and process variable (PV) will show straight lines on a trend chart. Since any stable system can reach a steady state where process dynamic changes cannot be seen, good identification may require insertion of test signals. This requirement is not easily accepted by plant operators.

MFA control avoids the fundamental problems by not using any identification mechanism in the system. Once an MFA controller is launched, it will take over control immediately. The MFA algorithms used to update the weighting factors are based on a sole objective, which is to minimize the error between SP and PV. That means, when the process is in a steady state where error is close to zero, there
is no need to update the MFA weighting factors.

D. Controller Design Issue.

The main reason PID is still popular is that it is a general-purpose controller that does not require controller design procedures. Designing a controller for a specific application requires special expertise. Since most advanced controllers are model-based, they cannot be a general-purpose controller. Thus, they are not widely used in process control, although these methods have been developed for 30 to 40 years. MFA controllers are general-purpose controllers too. A number of MFA controllers have been developed to control a variety of problematic industrial loops. Examples include SISO MFA to replace PID and requires no manual tuning, Nonlinear MFA to control extremely nonlinear processes, Anti-delay MFA to control processes with large time delays; MIMO MFA to control multivariable processes; Feedforward MFA to deal with large measurable disturbances; and Robust MFA to force the process variable to stay within defined bounds.

For an MFA controller user, there are no controller design procedures required. One can simply select the appropriate controller as its name suggests, configure the controller with certain parameters and launch the MFA controller. This is one of the major differences between a Model-Free Adaptive controller and other model-based advanced controllers.

E. Controller Parameter Tuning Issue.

An adaptive controller should not need to be manually tuned. This is also true for MFA controllers. MFA can adapt to new operating conditions due to changes in process dynamics, loads, or disturbances, and there is no manual tuning required. As a user-friendly feature, certain parameters are available to allow the user to quickly adjust the control performance.
F. SYSTEM STABILITY ISSUE.

Control system stability analysis is always an important issue because it determines if the controller will be useful in practice. When the system stability criterion is available, one can use the criterion to decide if the control system can be safely put in operation.

The stability of the overall closed-loop control system is related to the process, the controller, and the model in the following way:

• stability of the process is assumed (i.e., the process is open-loop stable);
• stability of the control loop must be guaranteed by the convergence of the model; but
• convergence of the model is dependent on the stability and persistent excitation of signals originating from the control loop.

This is a circular argument that it is difficult to resolve. Thus, there is no general stability criterion available for a model-based adaptive control system. In other words, each time a model-based adaptive controller is used in a control system, its stability has to be analyzed. This is certainly a major technical barrier in applying model-based adaptive control methods.

In contrast, since MFA does not have an identifier, a general system stability criterion is developed. That is, if the process is passive (a process that does not generate energy or heat by itself), the closed-loop MFA control system stability is guaranteed, and the process can be linear/nonlinear, time invariant/time-varying, etc. A combustion process (for example, the internal combustion engine) is a passive process since the heat it generates has to come from burning fuel from outside of the process. [2]
I. SISO Model – Free Adaptive Controller.

A single-loop MFA control system includes a single-input-single-output (SISO) process, a SISO MFA controller, and a feedback loop as illustrated in figure 1 below.

![Fig.1 Single-loop MFA control system](image)

The control objective is for the controller to produce an output \( u(t) \) shown in above figure as OP to force the process variable \( y(t) \) shown in above figure as PV to track the given trajectory of its setpoint \( r(t) \) shown in above figure as SP under variations of setpoint, disturbances, and process dynamics. In other words, the task of the MFA controller is to minimize the error \( e(t) \) in an online fashion, where \( e(t) \) is the difference between the setpoint \( r(t) \) and the process variable \( y(t) \). The minimization of error \( e(t) \) is achieved by (i) the regulatory control capability of the MFA controller, and (ii) the adjustment of the MFA controller weighting factors that allow the controller to deal with process dynamic changes, disturbances, and other uncertainties. [4]

II. MFA Controller Architecture

Figure 2 illustrates the core architecture of a SISO MFA controller. Used as a key component, a multilayer perceptron neural network consists of
one input layer, one hidden layer with N neurons, and one output layer with one neuron.

Fig.2 Architecture of a SISO MFA controller.

Within the neural network there is a group of weighting factors (w_{ij} and h_i) that can be updated as needed to vary the behavior of the controller. The algorithm for updating the weighting factors is based on the goal of minimizing the error between the setpoint and process variable. Since this effort is the same as the control objective, the adaptation of the weighting factors can assist the controller in minimizing the error while process dynamics are changing. In addition, the artificial neural network based MFA controller "remembers" a portion of the process data providing valuable information for the process dynamics. In comparison, a digital version of the PID controller remembers only the current and previous two samples. In this regard, PID has almost no memory and MFA possesses the memory that is essential to a "smart" controller. [3]
A conceptual formula of an SISO MFA controller is given in the equation (1) below:

\[ U(t) = f(e(t), K, t), \quad (1) \]

Where \( K \) is the MFA controller Gain. The weighting factors of the MFA controller are updated at every calculation cycle using a learning algorithm so as to produce the correct output \( U(t) \) to minimize the error \( e(t) \).

The actual algorithm governing the input – output of the SISO MFA controller consists of the following difference equations:

\[ p_j(n) = \sum_{i=1}^{N} w_{ij}(n)E_i(n) + 1, \quad (2) \]

\[ q_j(n) = \varphi(p_j(n)), \quad (3) \]

\[ o(n) = \sum_{j=1}^{N} h_j(n)q_j(n) + 1, \quad (4) \]

\[ v(t) = K_c[o(t) + e(t)], \quad (5) \]

Where \( n \) denotes the \( n \)th iteration, \( o(t) \) is the continues function of \( o(n) \), \( v(t) \) is the output of the Model – Free Adaptive controller, \( K_c \) > 0, controller gain, is a parameter used to adjust the magnitude of the controller output. This parameter is useful to fine tune the controller performance or keep the system within a stable range. Please refer to figure (2) for the architecture of SISO MFA and its related parameters and variable.

An online learning algorithm is used to continuously update the values of the weighting factors of the MFA controller as follows:

\[ \Delta w_{ij}(n) = \eta K_c e(n)q_j(n)(1 - q_j(n))E_i(n) \sum_{k=1}^{N} h_k(n), \quad (6) \]

\[ \Delta h_j(n) = \eta K_c e(n)q_j(n), \quad (7) \]
They are towards the goal of minimizing $e(t)$, which is the difference between the set point and process variable.

### III. Multivariable MFA Control System

In control applications, most processes have multiple inputs and multiple outputs with interactions in between. The level and density loops of an evaporator, and the temperature loops of a multi-zoned furnace are good examples of multivariable processes. Lacking general-purpose multivariable controllers, a large percentage of multivariable processes are treated as single variable processes resulting in poor control, wasted energy and materials, inconsistent quality, and plant upsets.

This graph illustrates a multivariable Model-Free Adaptive (MFA) control system, which consists of a multi-input multi-output (MIMO) process and an MIMO MFA controller.

![Multivariable MFA control system](image)

**Fig. 3 Multivariable MFA control system**

Similar to a SISO system, the MIMO system has controller setpoints $r(t)$, error signals $e(t)$, controller outputs $u(t)$, process variables $y(t)$, and disturbance signals $d(t)$. Since it is a multivariable system, all the signals here are vectors.
represented in bold case.

2-INPUT-2-OUTPUT MFA CONTROL SYSTEM

Without losing generality, we will show how a MIMO MFA controller works with a 2-input-2-output (2x2) system as illustrated in following graph. In the 2x2 MFA system, the 2x2 MFA controller consists of two main controllers C11, C22, and two compensators C21, and C12. The process has four sub-processes G11, G21, G12, and G22.

The measured process variables y1 and y2 are used as the feedback signals for the main control loops. They are compared with the setpoints r1 and r2 to produce errors e1 and e2. The output of each controller associated with one of the inputs e1 or e2 is combined with the output of the compensator associated with the other input to produce control signals u1 and u2. The output of each sub-process is cross-added to produce measured process variables y1 and y2. Notice that in real applications the outputs from the sub-processes are not measurable and only their combined signals y1 and y2 can be measured. Thus, by the nature of the 2x2 process, the inputs u1 and u2 to the process are interconnected with outputs y1 and y2. The change in one input will cause both outputs to change.

The control objective for this 2x2 MFA control system is to produce control
outputs $u_1(t)$ and $u_2(t)$ to force the process variables $y_1(t)$ and $y_2(t)$ to track their setpoints $r_1(t)$ and $r_2(t)$, respectively. The minimization of $e_1(t)$ and $e_2(t)$ is achieved by (i) the regulatory control capability of the MFA controllers, (ii) the decoupling capability of the MFA compensators, and (iii) the adjustment of the MFA weighting factors that allow the controllers to deal with the dynamic changes, large disturbances, and other uncertainties.

2x2MFACONTROLLER CONFIGURATION
A 2x2 MFA controller can be considered to have 2 main controllers $C_{11}$ and $C_{22}$. For each main controller, the parameters to configure are: (1) Sample Interval, $T_s$ - the interval between two samples or calculations in seconds. A high speed MFA controller can run at a 1 millisecond rate; (2) Controller Gain, $K_{c1}$ - use of a default value is recommended, (3) Time Constant, $T_c$ - a rough estimate of the process Time Constant in seconds; (4) Acting Type - direct or reverse acting of the process; and (5) Compensator Gain, $K_{c2}$ - to deal with the interaction from the other loop.

IV. CONCLUSION AND RESULTS
Table (1) below provides a comparison of PID, Model Predictive Control (MPC), Robust control design method, Model-based Adaptive control, and Model-Free Adaptive (MFA) control. It can be concluded that MFA combines the merits of all of these control methods and is the best candidate to be the next generation of mainstream process controller.
Table 1: Comparison of Control Methods

<table>
<thead>
<tr>
<th>Compared Item</th>
<th>PID</th>
<th>Model Predictive</th>
<th>Robust Control</th>
<th>Model-based Adaptive</th>
<th>Model-Free Adaptive</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Purpose</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>Adaptive Capability</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>No process model</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>No identification</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>No controller design</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>No controller manual tuning</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Stability criteria available</td>
<td>Y</td>
<td>Y/N</td>
<td>Y</td>
<td>Y/N</td>
<td>Y</td>
</tr>
<tr>
<td>Easy to use and maintain</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>Candidate for next generation</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
</tr>
</tbody>
</table>

V. SUMMARY AND CONCLUSION.

A MIMO system can be much more complex than a SISO system, therefore precautions must be taken when applying a MIMO MFA controller. When designing a multivariable control system, the first step is to decide which process variable is paired with a manipulated variable. A MIMO MFA control system should follow these pairing rules: (1) Each main process (G11, G22) has to be controllable, open-loop stable, and either reverse or direct acting; (2) A process with a large static gain should be included in the main loop as the main process (G11, G22), and a process with a small static gain should be treated as a subprocess. (G21, G12); (3) A faster process should be paired as the main process,
and a slower process or processes with time delays should be treated as sub-processes; and (4) If Pairing Rules 2 and 3 are in conflict, a tradeoff is the only option. As a general guide, an MFA control system should be designed based on the degree of interactions between the loops. This table lists the control system design strategy based on the degree of interaction of a MIMO process.

**Table 2 MFA control system design strategy**

<table>
<thead>
<tr>
<th>Interaction Measure</th>
<th>Control Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small to non interaction</td>
<td>Tighten both loops with SISO MFA.</td>
</tr>
<tr>
<td>Moderate interaction</td>
<td>Tighten important loops with SISO MFA and de-tune less important loops; or Use MIMO MFA for better overall control.</td>
</tr>
<tr>
<td>Severe interaction</td>
<td>Use MIMO MFA to control the process. May need to de-tune less important loops.</td>
</tr>
</tbody>
</table>

**References.**

Routing Enhancement Using Equal Cost Multipath Algorithm

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Abstract: To obtain the best quality of service (QOS) is the issue of concern among telecommunication fields. A group of parameters is set to represent the Quality of services of the network. During the last decade mobile telecommunication became a network that does not only carry voice calls it became one of the networks that supports high data rates and high consumption applications. Routing is the process of selecting a path for traffic in a network. The routing in any network is based on hardware and software, each has its benefits. In this paper there are a study and an analysis of routing techniques and the way to avoid the traffic congestion in open short path first (OSPF) algorithm, in order to test and set the parameters of the network to improve the performance of experimental network to achieve fast routing by splitting traffic between multipaths. The design and simulation of multipath network was done by MATLAB to illustrate the OSPF network while applying an Equal Cost Multipath [ECMP].

Keywords: ECMP, OSPF, Routing Protocols, Load Balance.

1. Introduction

The significance and requirement of the IP networks has increased constantly during the last years. Not only the size of the Internet including the backbone,
access networks and number of connected devices has increased, but also the requirements for network performance from end-users and network efficiency from Internet service providers (ISPs) and mobile service providers have increased. Track engineering tries to optimize both network efficiency, and the performance to the current network conditions. One traffic engineering method is Equal Cost Multipath (ECMP) that enables the usage of multiple equal cost paths from the source node to the destination node in the network. The benefit is that the traffic can be split more evenly to the whole network avoiding congestion and increasing bandwidth. ECMP is also a protection method, because during link failure, traffic flow can be transferred quickly to another equal cost path without severe loss of traffic [1].

Dijkstra's algorithm (or Dijkstra's Shortest Path First algorithm, SPF algorithm) for finding the shortest paths between nodes was represented in a graph, for example, road networks. It was introduced by computer scientist Edsger W. Dijkstra in 1956 and published three years later.

Dijkstra’s algorithm is an attempt to find the shortest path from one node to all other nodes in the network. It assumes that the link lengths are always non-negative. Every node is assigned a label with two components \((x, y)\) [1]. A label could either be temporary or permanent. The algorithm stops when all labels are permanent. As will soon become apparent, after completion of the labels give information on the shortest distances (OSPF) as well as shortest path from a particular node to all other nodes. Also a node is referred to being in the open state if its associated label is temporary; it is to be in the closed state if the label is permanent [1].

Open Shortest Path First (OSPF) is an Interior Gateway Protocol. It is a routing protocol developed for Internet Protocol (IP) networks by the Interior Gateway Protocol (IGP) working group of the Internet Engineering Task Force (IETF) [1][2]. The working group was formed in 1988 to design an IGP based on the Shortest Path First (SPF) algorithm for use in the Internet. OSPF was created
because in the mid-1980s, the Routing Information Protocol (RIP) was increasingly incapable of serving large, heterogeneous internetworks [2]

2. Problem Statement
The congestion in networks is traffic congestion, and one of the main problems in the networks, and it effects on the real time data transmission. Network Congestion occurs due to high traffic loads which require a high bandwidth that exceeds the available bandwidth.

3. Related work
Routing is the process of selecting a path for traffic in a network, routing techniques is the to avoid traffic network congestion in OSPF algorithms by using ECMP. This paper proposes a method of finding the multipath available in the network, using disjoint edges and disjoint nodes strategy. In single path routing, congestion is a big issue, multipath routing is helpful to find less-congested or congestion free route from source to destination. Disjoint nodes means having no repetition of node that are followed earlier by the data packets to avoid packet congestion or load over the network. Disjoint edge means having no repetition of edges while following the path. The paths have been chosen on the basis of available bandwidth, time required, and sequential order of node or hop-count. The sequence of every available single path from the given source to destination have been found using minimum hop Dijkstra algorithm so that it is shortest among all available remaining paths. Results are shown on the basis of bandwidth and delay for single path and multipath routing (using disjoint node and disjoint edges). It can be concluded that multipath routing is better than single path routing. This Paper is basically a case study for comparison of single path routing and multipath routing. For future work we can be used to improve our network efficiency. Better multipath routing techniques than disjoint node and disjoint edge
using different parameters/metrics for improving efficiency of networks [3]. In this the author proposed a systematic algorithmic method was used and a brief introduction to the TE in large IP networks which is typically relies on configuring static link weights and splitting traffic between the resulting shortest-paths via the Equal-Cost-Multipath (ECMP) mechanism. Yet, despite its vast popularity, crucial operational aspects of TE via ECMP are still little-understood from an algorithmic viewpoint. The embark upon a systematic algorithmic study of TE with ECMP. It was considered that the standard model of TE with ECMP and prove that, in general, even approximating the optimal link-weight configuration for ECMP within any constant ratio is an intractable feat, settling a long-standing open question. It was establish, in contrast, that ECMP can provably achieve optimal traffic flow for the important category of Clos datacenter networks [4]. In this the author in this paper improve that the increasing efficiency and quality demands of services from IP network service providers and end users drive developers to offer more and more sophisticated traffic engineering methods for network optimization and control. Intermediate System to Intermediate System and Open Shortest Path First are the standard routing solutions for intra-domain networks. An easy upgrade utilizes Equal Cost Multipath (ECMP) that is one of the most general solutions for IP traffic engineering to increase load balancing and fast protection performance of single path interior gateway protocols. ECMP provides a simple solution that is easy to configure and maintain. It outperforms single path solutions and competes with more complex MPLS solutions. The only thing to take care of is the adjustment of link weights of the network in order to create enough load balancing paths. The importance of IP networks has constantly increased during the past decade. Not only the size of the Internet including the backbone, access networks and number of connected devices has increased but also the requirements for network performance from end-users and network efficiency from Internet service providers (ISPs) and mobile backhaul service providers have increased.
Traffic engineering tries to optimize both network efficiency and the performance to the current network conditions. One traffic engineering method is Equal Cost Multipath (ECMP) that enables the usage of multiple equal cost paths from the source node to the destination node in the network. It was concluded that the performance of the load balancing algorithm was one of the key points. In the load balancing part, traffic distribution between the different links and the value of the bandwidth increase in comparison to a single path case was tested. In the fast protection part, the value of packet loss was measured, when one of the ECMP links was removed. It consists of two Tellabs routers and an Agilent N2x tester [6]. In this the author Improves that the high quality is the matter of concern among any telecommunication fields, and a group of parameters is set to represent the how grade is the Quality of services of the network, during the last decade the mobile telecommunication become a network that not only carry voice calls it become one of the networks that supports high data rates and support high consumption applications, the routing in any network is based on a hardware and software, each has its benefit [5].

4. General objectives

To obtain the performance of experimental network by achieving fast routing to be share traffic between paths.

To escape the traffic congestion and increase the network throughput.

Study and analysis of network traffic congestion.

5. Mathematical model

The following parameters are often considered important:

a) Link Cost Detection

The link cost is calculated through the division of default bandwidth reference over the actual bandwidth available.

\[ \text{Link _Cost} = \frac{\text{BR}}{\text{Available bw}} \ldots\ldots(1) \]
Where
BR is Reference bandwidth=100,000
Available bw is Available Bandwidth
b) Throughput
Throughput is the number of messages successfully delivered per unit time. Throughput is controlled by available bandwidth, as well as the available signal-to-noise ratio and hardware limitations. Throughput for the purpose of this article will be understood to be measured from the arrival of the first bit of data at the receiver, to decouple the concept of throughput from the concept of latency. For discussions of this type the terms 'throughput' and 'bandwidth' are often used interchangeably.

\[ TP = \frac{\sum (\text{Packet size})}{\text{Packet arrival} - \text{Packet start}} \] (2)

Where:
Packet-Size i: is the Packet-Size of the packet received at the destination,
Packet Start o: is the time when the first packet left the transmitter.
Packet-Arrival n: is the time when the last packet to arrive at the receiver.

c) Delay time
The first important property of networks that can be measured quantitatively is delay. The delay of a network specifies how long it takes for a bit of data to travel across the network from one computer to another; delay is measured in seconds or fractions of seconds[7].

\[ D t= \frac{B}{DR} \] (3)

Where
B=the amount of data
DR= data rate
Data rate
The data rate is a term to denote the transmission speed, or the number of bits per second transferred. The useful data rate for the user is usually less than the actual data rate transported on the network[8].

Methodology
A study and analysis of routing techniques, and the way that to avoid the traffic congestion in OSPF algorithm, in this study data will be collected through related works. Then a study and analysis to the network structure will be done in order to simulate the network. After that a simulation program will be written using MATLAB to evaluate the performance of network after using Equal Cost Multipath.

The simulation will cover OSPF based network structure with an Cost Multipath [ECMP] Algorithm, the simulation results will be obtained including delay, data rate, and throughput of the network in two scenarios.

6. Design
The simulation of this paper some considerations must be taken, such as the usage of high data rate that leads to high CPU usage that can end the simulation with Matlab crash, so a limited number of nodes was used with optimal data rates, in addition to the usage of node creation in Matlab based on a graphical functions that represent the nodes as an object and it is used to visualize the network status and to simplify the understanding of system flow.

Moreover randomization of all of the parameters in the written code end the simulation with non-fixed results which will affect the accuracy and the final conclusions, thus some parameters will be used as fixed values.

7. Network scenario
The total number of used routers inside OSPF network is six routers, and the outside of the OSPF are four routers, the IP address was set to static IP address with different classes.
The bandwidth also was set between each link to another as a fixed constant, after setting the link costs three major algorithms were used to simulate the network. Bellman algorithm and it is used to detect the neighbors and create the dynamic routing table, Dijkstra algorithm was used to detect short path, and another algorithm to simulate the data flow into the links.

Table 1 Simulation Parameters: used as number routers and data size

<table>
<thead>
<tr>
<th>No.</th>
<th>Parameter</th>
<th>Settings</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PE1(192.168.0.1)</td>
<td>Router</td>
</tr>
<tr>
<td>2</td>
<td>PE2(192.168.0.3)</td>
<td>Router</td>
</tr>
<tr>
<td>3</td>
<td>P1(192.168.0.2)</td>
<td>Router</td>
</tr>
<tr>
<td>4</td>
<td>P2(192.168.0.4)</td>
<td>Router</td>
</tr>
<tr>
<td>5</td>
<td>P3(192.168.0.5)</td>
<td>Router</td>
</tr>
<tr>
<td>6</td>
<td>P4(192.168.0.6)</td>
<td>Router</td>
</tr>
<tr>
<td>7</td>
<td>CEA1(10.0.0.10)</td>
<td>Router</td>
</tr>
<tr>
<td>8</td>
<td>CEA2(10.0.1.20)</td>
<td>Router</td>
</tr>
<tr>
<td>9</td>
<td>CEB1(20.0.0.10)</td>
<td>Router</td>
</tr>
<tr>
<td>10</td>
<td>CEB2(20.0.1.20)</td>
<td>Router</td>
</tr>
<tr>
<td>11</td>
<td>Data size</td>
<td>512 byte/n</td>
</tr>
</tbody>
</table>

Table 2 Simulation Parameters used as data for output results

<table>
<thead>
<tr>
<th>No.</th>
<th>Parameter Name</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Number of nodes</td>
<td>11</td>
</tr>
<tr>
<td>2</td>
<td>IP Address Class</td>
<td>A</td>
</tr>
<tr>
<td>3</td>
<td>Reference</td>
<td>100,000</td>
</tr>
</tbody>
</table>
8. Computer Model

![OSPF System Flowchart]

Figure 1 OSPF System Flowchart
This flowchart shows the steps of Open shortest path algorithm for MATLAB. The simulation starts by creating an “IP address” to each node this “IP Address” identifies the “routing IP” between stations and network equipment, then the packet size is set while the label for each node was set. The simulation determine the “IP” and “label” of the source to destination by setting the “sender IP” and the “recipient IP”. Then it starts sending data using conditional statements it can be determined that a successful transmission and receiving was done, then a calculation of the “delay” and “throughput” is done to evaluate the system while using short path.

Figure 2 Equal Cost System Flowchart
This ECMP simulation starts at the same as of OSPF flow chart, this flow chart by creating an “IP address” to each node this “IP Address” identifies the “routing IP” between stations and network equipment, then the packet size is set while the a label for each node was set. The simulation does not determine the “IP” and “label” of the path because the path is determined automatically to the destination. And by Using conditional statements it can be determined that a successful transmission and receiving was done then to detect equal cost, then a calculation to the delay and throughput is done of estimate the system while using short path.

9. Network performance

Network performance refers to measures of service quality of a network as seen by the customer.

There are many different ways to measure the performance of a network, as each network is different in nature and design. Performance can also be modeled and simulated instead of measured; one example of this is using state transition diagrams to model queuing performance or to use a Network Simulator.

10. Designed Network

In this design there are routing using OSPF to send the data packet the shortest path in was implemented to represent the network and its elements used in the simulation.
Simulation results:

Delay time

While running the simulation the following graph of delay time appears.
The y axis represents delay time in microseconds, and the x axis represents the transfer bits over the simulation.
The above figure shows an equal cost simulation and theoretical results along with the single path simulation and results. According to the graph the equal path has a delay time less than the signal path due to the split of the packet into two different paths with an equal cost.

**Throughput**

While running the simulation the following graph of throughput appears, the y axis represents throughput in Bit/us, and the x axis represents the time in seconds over the simulation.
The above figure shows an equal cost simulation and theoretical results along with the single path simulation and results.

According to the graph the equal path has a throughput higher than the signal path due to the split of the packet into two different paths with an equal cost which increase the throughput of the network.

**Data rate**

While running the simulation the following graph of throughput appears.

The y axis represents Data rate, and the x axis represents the time in seconds over the simulation.

![Datrate Comparison](image)

**11. Conclusion**

The project simulation was successfully implemented to solve the problem of traffic congestion and its effects on the real time applications such as real time data transmission. Splitting of packets between links to avoid congestion is one technique used to increase performance of the network. The used simulation and algorithm help to improve the performance of educational network by achieving fast routing by split traffic between path in order to avoid the congestion traffic and increase the network throughput.
A design a network using Matlab to illustrate the OSPF based network structure and applying Equal Cost Multipath [ECMP] in OSPF algorithm was done using Matlab 2016a version and the obtained results of the network includes delay, data rate, and throughput, and it was found that using equal cost technique has a higher throughput and a minimum delay time compared with the signal path propagation with an identical data rate.

12. References


Dimensional Reductions of the Equations of Motion of the Six-Dimensional Self-Dual Three Form Field

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Abstract: We investigate the twistorial derivations of self-dual string equation, the Maxwell equation and the Bogomolny equation via dimensional reductions of the equations of motion of the six-dimensional self-dual three-form field strength $H = dB$.

1. Introduction:

The complexified space-time $\mathbb{C}^4$ is used to replace Minkowski space-time $\mathbb{R}^{1,3}$ by the space of projective light cones in this space, $\mathbb{R}^{1,3} \times S^2$ which is diffeomorphic to the open subset $\mathbb{P}^3_0 \equiv \mathbb{P}^3 / \mathbb{P}^1$ called Twistor Space. This is due to Penrose who further used the above correspondence to construct penrose transform by which we can describe solution of zero-rest mass fields by complex analytic data (cohomology groups). Moreover, holomorphic vector bundles over the Twistor space may also be used to describe Yang-Mills instantons on $\mathbb{C}^4$. Then a twistorial description of chiral theories is demonstrated by a twistor space $\mathbb{P}^6$ that enables a description of chiral zero-rest-mass fields on six-dimensional space-time and certain cohomology groups on $\mathbb{P}^6$. This construction generalizes Penrose-ward transform to $\mathbb{P}^6$.

In this review paper we introduce the dimensional reductions of the six-dimensional spinor fields to four and three space-time dimensions. The twistor
space $P^6$ would contain the ambitwistor space that describes Maxwell and Yang-Mills equations, the hyper-plane twistor space that describes the self-dual string equation and the minitwistor space for monopole construction. In this paper we only describe Maxwell and Yang-Mills fields in addition to self-dual strings. So we consider the reduction of $P^6$ to ambitwistor and hyper-plane twistor spaces.

2. Reduction of $M^6$ to $M^4$:

To dimensionally reduce $M^6$ to $M^4$, we split the $6 \cong 4 \times 4$ representation of $so(6,\mathbb{C}) \cong sl(4,\mathbb{C})$ into the bi-fundamental representation $(2, 2)$ of $sl(2,\mathbb{C}) \oplus sl(2,\mathbb{C}) \cong so(4,\mathbb{C})$ plus twice the trivial representation to obtain

$$
\chi^{AB} \rightarrow (\chi^{a\dot{b}}, \varepsilon^{a\beta} \chi^{+}, \varepsilon^{\dot{a}\dot{b}} \chi^{-}). \tag{1}
$$

where $\alpha, \beta, ... , \dot{\alpha}, \dot{\beta}, ... = 1,2$. The symplectic forms $\varepsilon^{a\beta}$ and $\varepsilon^{\dot{a}\dot{b}}$ of $sl(2,\mathbb{C}) \oplus sl(2,\mathbb{C})$ can be used to raise and lower $sl(2,\mathbb{C})$ spinor indices. Four-dimensional space-time $M^4$ is then given by the quotient $M^4 := M^6/D_{M^6}$ with the distribution $D_{M^6} := (\partial_{\pm})$.

A general three-form $H = dB$ in six dimensions is given by a pair of symmetric bi-spinors $H_{AB} = \partial_c (A_B)^c$ and $H^{AB} = \partial^{c}(A_B)^c$ via a (traceless) two-form potential $B_B^A$. Self-duality of $H$ is equivalent to saying that $H^{(AB)} = 0$.

A two-form potential in six dimensions $B_B^A$ reduces then to

$$
B_B^A \rightarrow (A_{\alpha a}, A_{\dot{a}a}, B_{a\beta} = B_{(a\beta)}, B_{\dot{a}\dot{b}} = B_{(\dot{a}\dot{b})} = 0) \tag{2}
$$

and represents in four dimensions two one-form potentials $A_{\alpha a}^\pm$, a two-form potential $(B_a^\beta, B_{\dot{a}\dot{b}})$ and a scalar field $\emptyset$. Correspondingly, gauge transformations of $B_B^A$,
where $\Lambda_{AB} = -\Lambda_{BA}$ reduce in four dimensions to $\Lambda_{AB} \rightarrow (\Lambda_{\alpha\dot{\alpha}}, \Lambda^{+}, \Lambda^{-})$ with

$$A_{\alpha\dot{\alpha}} \rightarrow A_{\alpha\dot{\alpha}} + \partial_{\alpha\dot{\alpha}} \Lambda_{\pm},$$

$$B_{\alpha\beta} \rightarrow B_{\alpha\beta} + \epsilon^{\dot{\alpha}\dot{\beta}} \partial_{(\alpha\dot{\alpha}} \Lambda_{\beta)}_{\dot{\beta}}.$$  \hspace{1cm} (4)

Furthermore, the (first-order) self-duality equation $H_{\alpha\dot{\alpha}} = \partial^{C}(A_{\alpha\dot{\alpha}} B_{\dot{C}})$ reduces to

$$H_{\alpha\dot{\alpha}} := \epsilon^{\beta\gamma} \partial_{\alpha\beta} \Lambda_{\dot{\alpha}}{\dot{\gamma}} - \epsilon^{\beta\gamma} \partial_{\dot{\beta}} B_{\alpha\gamma} = \partial_{\alpha\dot{\alpha}} \emptyset$$ \hspace{1cm} (5-a)

and

$$f_{\alpha\beta}(A^{+}) = 0 \quad \text{and} \quad f_{\dot{\alpha}\dot{\beta}}(A^{-}) = 0.$$ \hspace{1cm} (5-b)

where $f_{\alpha\beta}$ and $f_{\dot{\alpha}\dot{\beta}}$ are the self-dual and anti-self-dual parts of the curvature of a potential $A_{\alpha\dot{\alpha}}$, i.e.

$$f_{\alpha\beta}(A) := \epsilon^{\dot{\alpha}\dot{\beta}} \partial_{(\alpha\dot{\alpha}} \Lambda_{\beta)}_{\dot{\beta}} \quad \text{and} \quad f_{\dot{\alpha}\dot{\beta}}(A) := \epsilon^{\alpha\beta} \partial_{(\alpha\dot{\alpha}} \Lambda_{\beta)}_{\dot{\beta}}.$$ \hspace{1cm} (5-c)

Note that under this decomposition, $H_{AB} \rightarrow (f_{\alpha\beta}(A^{+}), f_{\dot{\alpha}\dot{\beta}}(A^{-}), \partial_{\alpha\dot{\alpha}} \emptyset)$. Equation (5-a) is the self-dual string equation $H = *_{4} d\emptyset$ in spinor notation, while (5-b) says that the curvature of $A^{+}$ (respectively, $A^{-}$) is self-dual (respectively, anti-self-dual).

3. Maxwell Equation:

The Maxwell equation for a gauge potential $A_{\alpha\dot{\alpha}}$ in spinor notation is given by:

$$\epsilon^{\beta\gamma} \partial_{\alpha\beta} f_{\alpha\dot{\gamma}} + \epsilon^{\beta\gamma} \partial_{\dot{\beta}} f_{\alpha\dot{\gamma}} = 0.$$ \hspace{1cm} (6-a)
And the Bianchi identity is given by:

$$\varepsilon^{\beta\gamma} \partial_{\alpha\beta} f_{\alpha\gamma} - \varepsilon^{\beta\gamma} \partial_{\beta\alpha} f_{\alpha\gamma} = 0,$$

so that the equations for $f_{\alpha\beta}$ and $f_{\alpha\gamma}$ decouple as

$$\varepsilon^{\beta\gamma} \partial_{\alpha\beta} f_{\alpha\gamma} = 0 = \varepsilon^{\beta\gamma} \partial_{\beta\alpha} f_{\alpha\gamma}.$$

The general Maxwell field $A_{\alpha\dot{\alpha}}$ is expressed as $A_{\alpha\dot{\alpha}} = A^{+}_{\alpha\dot{\alpha}} + A^{-}_{\alpha\dot{\alpha}}$, where $A^{\pm}_{\alpha\dot{\alpha}}$ reflects the degrees of freedom.

4. Bogomolny Equation (in three dimensions):

To further reduce to three dimensions, we split the $(2, 2)$ of $sl(2, \mathbb{C}) \oplus sl(2, \mathbb{C})$ into the $3 \oplus 1$ of $sl(2, \mathbb{C})$: $x^{\alpha\dot{\alpha}} \rightarrow (x^{\alpha\dot{\alpha}} = x^{(\alpha\beta)}, x^{[12]})$. We then have

$$M^3 := M^4 / D_{M^4}$$

with $D_{M^4} = \{ \frac{\partial}{\partial x^{[12]}} \}$ Here, the field strength of a gauge potential reduces directly according to:

$$\partial_{\alpha\beta} A_{\gamma\delta} - \partial_{\gamma\delta} A_{\alpha\beta} = \varepsilon_{\alpha\gamma} f_{\beta\delta} + \varepsilon_{\beta\delta} f_{\gamma\alpha},$$

and the BPS subsector of the reduced Maxwell equation is described by the Abelian Bogomolny equation $F = x_3 \, d\emptyset$, which reads in spinor notation as

$$f_{\alpha\beta} = \partial_{\alpha\beta} \emptyset$$

This equation can be obtained from the self-dual string equation by defining $= \frac{\partial}{\partial x^{[12]}} H$. In spinor notation, this amounts to defining $f_{\alpha\beta} = H_{\alpha\beta}$ and (5-a) reduces to (8).
5. Ambitwistor space:

Recall that three-dimensional totally null-planes in $M^6$, which are in one-to-one correspondence with points in $P^6$, are given by

$$\chi^{AB} = \chi_0^{AB} + \varepsilon^{ABCD} \mu^C \lambda_D,$$

where $\mu_A$ is defined modulo terms proportional to $\lambda_A$. In view of the splitting $sl(4,\mathbb{C})$ into $sl(2,\mathbb{C}) \oplus sl(2,\mathbb{C})$ used in reducing $M^6$ to $M^4$, we now split the spinors $\lambda_A$ and $\mu_A$ according to

$$\lambda_A \rightarrow (\mu_\alpha, \lambda_{\dot{\alpha}}) \quad \text{and} \quad \mu_A \rightarrow (\kappa_\alpha, \nu_{\dot{\alpha}}).$$

Correspondingly, upon using (1), the equation (9) decomposes as

$$\chi^{\dot{\alpha} \beta} = \chi_0^{\dot{\alpha} \beta} + \mu^\alpha \nu_{\dot{\alpha}} - \kappa_\alpha \lambda^{\dot{\alpha}}, \chi^+ = x_0^+ + \nu_{\dot{\alpha}} \lambda^{\dot{\alpha}}, \text{and} \quad \chi^- = x_0^- + \kappa_\alpha \mu^\alpha, (11)$$

where we have raised spinor indices with $\varepsilon^{\alpha \beta}$ and $\varepsilon^{\dot{\alpha} \dot{\beta}}$, respectively. Next we impose $x^\pm = 0 = x_0^\pm$ to dimensionally reduce to four dimensions. Hence, $\nu_{\dot{\alpha}} \lambda^{\dot{\alpha}} = 0$ and $\kappa_\alpha \mu^\alpha = 0$. There are essentially three cases emerging from these equations:

I. $\mu_\alpha = 0$ but $\lambda_{\dot{\alpha}} \neq 0$ and $\kappa_\alpha$ arbitrary and $\nu_{\dot{\alpha}} \propto \lambda_{\dot{\alpha}}$ so that the first equation (11) reduces to

$$\chi^{\dot{\alpha} \dot{\alpha}} = \chi_0^{\dot{\alpha} \dot{\alpha}} - \kappa_\alpha \lambda^{\dot{\alpha}}.$$

This equation parametrises anti-self-dual two-planes in four dimensions (so-called $\alpha$-planes).

II. $\mu_\alpha \neq 0$ but $\lambda_{\dot{\alpha}} = 0$ and $\kappa_\alpha \propto \mu_\alpha$ and $\nu_{\dot{\alpha}}$ arbitrary so that

$$\chi^{\dot{\alpha} \dot{\alpha}} = \chi_0^{\dot{\alpha} \dot{\alpha}} + \mu^\alpha \nu^{\dot{\alpha}}.$$
which parametrises self-dual two-planes in four dimensions (so-called \( \beta \)-planes).

III. we can have both \( \mu_\alpha \neq 0 \) and \( \lambda_\dot{\alpha} \neq 0 \) together with \( k_\alpha \propto \mu_\alpha \) and \( v_\dot{\alpha} \propto \lambda_\dot{\alpha} \).

This gives

\[
\chi^{\alpha\dot{\alpha}} = x_0^{\alpha\dot{\alpha}} + q \mu^\alpha \lambda^{\dot{\alpha}} \quad \text{for} \quad q \in \mathbb{C},
\]

which are the null-lines in four dimensions arising from intersecting \( \alpha \)-planes and \( \beta \)-planes.

Choosing the \( \alpha \)- or \( \beta \)-planes will lead to either Penrose’s twistor space or Penrose’s dual twistor space which are the twistor spaces parametrising such null-planes. In the following, we shall work with the null-lines obtained from intersections of \( \alpha \)- and \( \beta \)-planes. This yields the ambitwistor space \( P^5 \) which is the twistor space parametrising such null-lines. As we shall show momentarily, the ambitwistor space \( P^5 \) as well as the correspondence space \( F^6 \) can be obtained by factoring out certain distributions. The quadric equation defining \( P^6 \) in the open subset \( P^7 \) of \( P^7 \) will reduce to the quadric equation defining \( P^5 \) in the open subset \( P^3 \times P^3 \) of \( P^3 \times P^3 \).

We now decompose all the twistor coordinates \( (z^A, \lambda_A) \) on \( P^6 \) according to the splitting of \( sl(4, \mathbb{C}) \) into \( sl(2, \mathbb{C}) \oplus sl(2, \mathbb{C}) \) to obtain

\[
(z^A, \lambda_A) \rightarrow (z^\alpha, -\omega^{\dot{\alpha}}, \mu_\alpha, \lambda_\dot{\alpha}).
\]

Let us first consider the base space \( P^3 \) of the fibration \( P^6 \rightarrow P^3 \). To reduce \( P^3 \) with homogeneous coordinates \( \lambda_A \) to \( P^1 \times P^1 \) with homogeneous coordinates \( (\mu_\alpha, \lambda_\dot{\alpha}) \), we consider the corresponding reduction of the structure sheaf \( O_{P^3} \) of \( P^3 \). Local sections \( f \) of \( O_{P^3} \) fulfil the equation \( Yf = 0 \), where \( Y := \lambda_A \frac{\partial}{\partial \lambda_A} \) is the Euler vector field on \( P^3 \).
This reflects the invariance under re-scalings $\lambda_A \to t \lambda_A$, with $t \in \mathbb{C}^*$. Local sections $f$ of $\mathcal{O}_{\mathbb{P}^1 \times \mathbb{P}^1}$ fulfill $\mu_\alpha \frac{\partial}{\partial \mu_\alpha} f = 0$ and $\lambda_\alpha \frac{\partial}{\partial \lambda_\alpha} f = 0$. Therefore, the quotient of $\mathbb{P}^3$ by the distribution
\[ D_{\mathbb{P}^3} := \langle \mu_\alpha \frac{\partial}{\partial \mu_\alpha} - \lambda_\alpha \frac{\partial}{\partial \lambda_\alpha} \rangle \] (16)
can be identified with $\mathbb{P}^1 \times \mathbb{P}^1$.

Analogously, one reduces $\mathbb{P}^7$ with homogeneous coordinates $(z^A, \lambda_A)$ to $\mathbb{P}^3 \times \mathbb{P}^3$. Since we are interested in non-compact versions, let us directly remove the $\mathbb{P}^3$ defined by $z^A \neq 0$ and $\lambda_A = 0$ from $\mathbb{P}^7$ to obtain the ambient space $\mathbb{P}^7_0 = \mathbb{P}^7 / \mathbb{P}^3 \cong \mathcal{O}_{\mathbb{P}^3}(1) \oplus \mathbb{C}^4$ of the twistor space $\mathbb{P}^6$. The quotient of $\mathbb{P}^7_0$ by the distribution
\[ D_{\mathbb{P}^7_0} := \langle z^\alpha \frac{\partial}{\partial z^\alpha} + \lambda_\alpha \frac{\partial}{\partial \lambda_\alpha} - \omega^\delta \frac{\partial}{\partial z^\delta} - \mu_\alpha \frac{\partial}{\partial \mu_\alpha} \rangle \] (17)
can be identified with $\mathbb{P}^3 \times \mathbb{P}^3$, where $\mathbb{P}^3$ and $\mathbb{P}^3$ are each biholomorphic to the total space of the bundle $\mathcal{O}_{\mathbb{P}^1}(1) \oplus \mathbb{C}^2$. The quadric condition $z^A \lambda_A = 0$, which defines $\mathbb{P}^6 \to \mathbb{P}^7_0$, descends to the quadric equation
\[ z^\alpha \mu_\alpha - \omega^\delta \lambda_\delta = 0, \] (18)
which defines the ambitwistor space $\mathbb{P}^6 \to \mathbb{P}^3 \times \mathbb{P}^3$ as a quadric hypersurface of $\mathbb{P}^3 \times \mathbb{P}^3$. Note that $\mathbb{P}^3$ is Penrose’s twistor-space of four-dimensional space time while $\mathbb{P}^3$ is the dual twistor space.

The correspondence space $F^6$ is obtained as the quotient of $F^6 \cong \mathbb{C}^6 \times \mathbb{P}^3$ by the distribution
\[ D_{F^6} := \langle \frac{\partial}{\partial z^A}, \mu_\alpha \frac{\partial}{\partial \mu_\alpha} - \lambda_\alpha \frac{\partial}{\partial \lambda_\alpha} \rangle \] (19)
and we have $F^6 := F^9 / D_{F^6} \cong \mathbb{C}^4 \times \mathbb{P}^1 \times \mathbb{P}^1$. Altogether, we arrive at the following double fibration:
Where $\pi_4$ is the trivial projection and
\[ \pi_3 : (x^\alpha, \lambda_\alpha, \mu_\alpha) \rightarrow (z^\alpha, \omega^\alpha, \mu_\alpha, \lambda_\alpha) = (x^\alpha \lambda_\alpha, \mu_\alpha, \lambda_\alpha), \] (21)
Note that the twistor distribution in this case is of rank one and generated by the vector field $\mu_\alpha \lambda_\alpha \partial^{\alpha \hat{\alpha}}$, i.e. $P^5 \cong F^6 / \langle \mu_\alpha \lambda_\alpha \partial^{\alpha \hat{\alpha}} \rangle$ with
\[ \partial^{\alpha \hat{\alpha}} = \varepsilon^{\alpha \beta \hat{\alpha} \hat{\beta}} \frac{\partial}{\partial x^\beta \hat{\beta}}. \]

Geometrically, a point $x$ in four-dimensional space-time $M^4$ corresponds to a holomorphic embedding of $\tilde{x} : = \pi_3 (x_4^{-1} (x)) \cong \mathbb{P}^1 \times \mathbb{P}^1 \rightarrow P^5$. On the other hand, a point $p$ in ambitwistor space $P^5$ corresponds to a null line $\pi_4 (x_3^{-1} (x)) \rightarrow M^4$ given by
\[ x^{\alpha \hat{\alpha}} = x^{0 \hat{\alpha}} + q \mu^\alpha \lambda^{\hat{\alpha}} \quad \text{with} \quad q \in \mathbb{C}, \] (22)
in agreement with our initial choice of null-space.

Moreover, if we introduce the two projections $pr_{1,2} : \mathbb{P}^1 \times \mathbb{P}^1 \rightarrow \mathbb{P}^1$ to the first and second copy of $\mathbb{P}^1$, respectively, and in addition
\[ \mathcal{O}_{\mathbb{P}^1 \times \mathbb{P}^1} (k, l) : = pr_1^* \mathcal{O}_{\mathbb{P}^1} (k) \otimes pr_2^* \mathcal{O}_{\mathbb{P}^1} (l), \] (23)
\[ \mathcal{O}^p_{\mathbb{P}^1 \times \mathbb{P}^1} (k, l) = \mathcal{O}^p_{\mathbb{P}^1 \times \mathbb{P}^1} (r_1^* \mathcal{O}_{\mathbb{P}^1} (k) \otimes pr_2^* \mathcal{O}_{\mathbb{P}^1} (l)) \]
for $k, l \in \mathbb{Z}$, we get the following sequence for the ambitwistor space
\[ 0 \rightarrow P^5 \rightarrow \mathcal{O}_{\mathbb{P}^1 \times \mathbb{P}^1} (1,0) \oplus \mathcal{O}_{\mathbb{P}^1 \times \mathbb{P}^1} (0,1) \otimes \mathbb{C}^2 \rightarrow \mathcal{O}_{\mathbb{P}^1 \times \mathbb{P}^1} (1,1) \rightarrow 0. \] (24)
Here, \( k: (z^\alpha, \omega^\dot{\alpha}, \mu_\alpha, \lambda^{\dot{\alpha}}) \mapsto z^\alpha \mu_\alpha - \omega^\dot{\alpha} \lambda^{\dot{\alpha}} \). Upon dualising and twisting by \( \mathcal{O}_{\mathbb{P}^1 \times \mathbb{P}^1}(1,1) \) the Euler sequence for \( \mathbb{P}^1 \times \mathbb{P}^1 \), we find

\[
0 \to \Omega^p_{\mathbb{P}^1 \times \mathbb{P}^1}(1,1) \to P^5 \to \mathcal{O}_{\mathbb{P}^1 \times \mathbb{P}^1}(1,1). \tag{25}
\]

This implies that \( P^5 \) can be identified with the bundle of first-order jets \( \text{Jet}^1 \mathcal{O}_{\mathbb{P}^1 \times \mathbb{P}^1}(1,1) \) of \( \mathcal{O}_{\mathbb{P}^1 \times \mathbb{P}^1}(1,1) \) as a consequence of the jet-sequence

\[
0 \to \Omega^1_X(S) \to \text{Jet}^1 S \to S \to 0 \tag{26}
\]

for an Abelian sheaf \( S \) on a complex manifold \( X \) (see e.g. [12]).

The above constructions show that we have a factorisation of the tangent bundle \( T_M \) into the two bundles of undotted and dotted chiral spinors. We shall denote these bundles by \( S \) and \( \tilde{S} \); and therefore, \( T_M \cong S \otimes O_M \tilde{S} \), which is the reduction of the corresponding factorisation in six dimensions. Note that such a factorisation amounts to choosing a holomorphic conformal structure. Hence, we shall make use of the following notation (for \( k, l \in \mathbb{Z} \)):

6. Penrose—Ward Transforms:

Let us consider an open set \( U \subset M^4 \) and define \( \widehat{U} := \pi_3(\pi_4^{-1}(U)) \subset P^5 \) with covering \( \widehat{U} = \{ \widehat{U}_a \} \). We start from holomorphic line bundles over \( \widehat{U} \) which are holomorphically trivial on any \( \widehat{\mathbb{C}} \cong \mathbb{P}^1 \times \mathbb{P}^1 \to \widehat{U} \). Such line bundles are characterised by Čech one-cocycles \( \widehat{f} = \{ \widehat{f}_{ab} \} \in H^1(\widehat{U}, \mathcal{O}_{\widehat{U}}) \). The pull-back of \( \widehat{f} \) to the correspondence space can be split holomorphically, \( f'_{ab} = \pi^* \widehat{f}_{ab} = h'_a - h'_b \). Since \( \widehat{f}_{ab} \) gets annihilated by the twistor distribution, we find \( A' := \mu_\alpha \lambda^{\dot{\alpha}} \partial^{\dot{\alpha}} \partial h'_a \) which is globally defined. Hence \( A' \) must be of the form \( A'_a := \mu_\alpha \lambda^{\dot{\alpha}} A^{\alpha\dot{\alpha}} \), where \( A^{\alpha\dot{\alpha}} \) depends only on space-time. Since the twistor distribution is one-dimensional, we do not obtain any spacetime field equations for
Moreover, since the splitting \( f'_{ab} = h'_a - h'_b \) is not unique, we can always consider \( h'_a \mapsto h'_a + \varphi' \), where \( \varphi' \) is defined globally on \( \hat{U}' := \pi^{-1}_4(U) \subset \mathbb{P}^5 \). Therefore, \( \varphi' \) can only depend on space-time (since the \( \mathbb{P}^1 \)'s are compact) and thus, it corresponds to transformations of the form \( A_{\alpha\dot{\alpha}} \mapsto A_{\alpha\dot{\alpha}} + \partial_{\alpha\dot{\alpha}} \varphi' \). In summary, this shows that \( H^1(\hat{U}, \mathcal{O}_{\hat{U}}) \) can be identified with the Maxwell potentials on \( U \) modulo gauge transformations. Notice that this construction also applies to the non-Abelian setting, that is, to Yang-Mills potentials.

As is well-known, in order to construct self-dual (or anti-self-dual) solutions to the Maxwell/Yang-Mills equations, one employs Ward’s construction [5] starting from holomorphic vector bundles over Penrose’s twistor space \( \mathbb{P}^3 \) (or the dual twistor space \( \hat{\mathbb{P}}^3 \)) subject to certain triviality conditions. Because ambitwistor space incorporates both twistors and dual twistors, it can be used to give a twistor interpretation of the Maxwell/Yang-Mills equations. As we have seen above, however, the ambitwistor space itself is not quite sufficient to recover these equations. To resolve this problem, one needs to thicken the ambitwistor space into its ambient space \( \mathbb{P}^3 \times \hat{\mathbb{P}}^3 \) to a certain order.

**Theorem 2.** ([8,9]) Let \( U \) be an open subset of \( \mathbb{M}^4 \) such that any null line intersects \( U \) in a convex set. Then there is a one-to-one correspondence between gauge equivalence classes of complex holomorphic solutions to the Yang-Mills equations on \( U \) and equivalence classes of holomorphic vector bundles which are holomorphically trivial on any \( \hat{x} \cong \mathbb{P}^1 \times \mathbb{P}^1 \to \mathbb{P}^5 \) for all \( \chi \in U \) and which admit an extension to a 3-rd order thickening \( \mathbb{P}^5^{[3]} \) of \( \mathbb{P}^5 \) in \( \mathbb{P}^3 \times \hat{\mathbb{P}}^3 \).

Note that if the holomorphic vector bundle can be extended to a finite neighbourhood within the ambient space \( \mathbb{P}^3 \times \hat{\mathbb{P}}^3 \), then the space-time gauge field constructed from this vector bundle is either self-dual, anti-self-dual or Abelian. Thus, if one is only interested in the Maxwell equation (as we are in the present
case) one may work with holomorphic line bundles on the ambient space $\mathbb{P}^3 \times \widehat{\mathbb{P}}^3$ which are holomorphically trivial on $\mathbb{P}^1 \times \mathbb{P}^1 \rightarrow \mathbb{P}^3 \times \widehat{\mathbb{P}}^3$. Since $F^3$ is Penrose’s twistor space while $\widehat{\mathbb{P}}^3$ its dual, one finds a self-dual and an anti-self dual field strength. Both can be linearly superposed to obtain a solution to the Maxwell equation. This is possible as the equations for the two helicities decouple.

7. Hyperplane Twistors and Self-Dual Strings:

In this section, we introduce a new twistor space $P^3$. We shall see below, this twistor space underlies a Penrose-Ward transform mapping a certain cohomology group on $P^3$ to solutions to the self-dual string equation on $M^4$ in a bijective manner.

While ambitwistor space describes the intersection of $\alpha$- and $\beta$-planes, the hyperplane twistor space will describe the span of the union of both types of intersecting null-planes. Because these two kinds of planes intersect along a null-line, the span describes a three-dimensional hyperplane in $M^4$, hence the name hyperplane twistor space.

In the corresponding double fibration, space-time obviously remains the same. Recall that the two spheres in the correspondence space $F^6 \cong \mathbb{C}^4 \times \mathbb{P}^1 \times \mathbb{P}^1$ specify the choice of an $\alpha$- and a $\beta$-plane. Because we need the same data in the definition of a hyperplane twistor, the correspondence space remains the same, too. The equivalence relation between points, however, is different: while two points in the correspondence space are equivalent if they correspond to the same null-line in the case of ambitwistors, in the case of hyperplane twistors, two points in the correspondence space are considered equivalent if they correspond to the same hyperplane. Therefore the twistor distribution for the hyperplane twistor
space contains that of the ambitwistor space, but it is strictly larger, and the hyperplane twistor space is a subspace of the ambitwistor space.

Explicitly, the hyperplane twistor space $P^3$ can be obtained by quotenting $P^5$ by the distribution

$$D_{P^5} := \langle \mu^\alpha \frac{\partial}{\partial x^\alpha}, \lambda^{\dot{\alpha}} \frac{\partial}{\partial \omega^{\dot{\alpha}}} \rangle \tag{29}$$

It is rather straightforward to see that $P^3 := P^5/D_{P^5}$ is bi-holomorphic to the total space of the holomorphic line bundle $\mathcal{O}_{\mathbb{P}^1 \times \mathbb{P}^1}(1,1) \rightarrow \mathbb{P}^1 \times \mathbb{P}^1$. Altogether, we may write down the following double fibration:

$$\begin{array}{ccc}
F^6 & \xrightarrow{\pi_5} & P^3 \\
\downarrow & & \downarrow \\
P^3 & \xrightarrow{\pi_6} & M^4
\end{array} \tag{30}$$

where $\pi_6$ is the trivial projection and

$$\pi_4 : (x^{\alpha \dot{\alpha}}, \mu_\alpha, \lambda^{\dot{\alpha}}) \mapsto (z, \mu_\alpha, \lambda^{\dot{\alpha}}) = (x^{\alpha \dot{\alpha}} \mu_\alpha \lambda^{\dot{\alpha}}, \mu_\alpha, \lambda^{\dot{\alpha}}) \tag{31}$$

Note that the twistor distribution is of rank three and generated by the vector fields $\mu_\alpha \partial^{\alpha \dot{\alpha}}$ and $\lambda^{\dot{\alpha}} \partial^{\alpha \dot{\alpha}}$, i.e. $P^6 \cong F^4 / \langle \mu_\alpha \partial^{\alpha \dot{\alpha}}, \lambda^{\dot{\alpha}} \partial^{\alpha \dot{\alpha}} \rangle$, with $\partial^{\alpha \dot{\alpha}} := \varepsilon^{\alpha \beta \dot{\alpha} \dot{\beta}} \frac{\partial}{\partial x^{\beta \dot{\beta}}}$ as before.

The geometric twistor correspondence here is as follows. By virtue of the incidence relation $z = x^{\alpha \dot{\alpha}} \mu_\alpha \lambda^{\dot{\alpha}}$, a point $x \in M^4$ corresponds to a holomorphic embedding of $\hat{x} := \pi_5(\pi_6^{-1}(x)) \cong \mathbb{P}^1 \times \mathbb{P}^1 \rightarrow P^3$, while a point $p \in P^3$ corresponds to a hyperplane $\pi_6(\pi_5^{-1}(p)) \rightarrow M^4$ in space-time. To see this, note that the incidence relation $z = x^{\alpha \dot{\alpha}} \mu_\alpha \lambda^{\dot{\alpha}}$ can be solved for fixed $p = (z, \mu, \lambda) \in P^3$ by
\[ \chi^a_{\dot{a}} = \chi^a_{0\dot{a}} + \mu^a_{\dot{a}} v^a_{\dot{a}} - \kappa^a_{\lambda\dot{a}} \quad (32) \]

Here, \( \chi^a_{0\dot{a}} \) is a particular solution and \( \kappa^a_{\alpha} \) and \( v^a_{\dot{a}} \) are arbitrary, which parametrise translations of \( \chi^a_{0\dot{a}} \) along totally null two-planes (the \( \alpha \)- and \( \beta \)-planes). The apparent four parameters in the spinors \( v^a_{\dot{a}} \) and \( \kappa^a_{\alpha} \) are reduced to three, because the shifts

\[ \kappa^a_{\alpha} \mapsto \kappa^a_{\alpha} + \varphi \mu^a_{\alpha} \quad \text{and} \quad v^a_{\dot{a}} \mapsto v^a_{\dot{a}} + \varphi \lambda_{\dot{a}} \quad \text{for} \quad \varphi \in \mathbb{C} \quad (33) \]

leave the solution (32) invariant.

**Remark:**

The above constructions show again that we have a factorisation of the tangent bundle \( T_{\mathcal{M}^4} \) into the two bundles of undotted and dotted chiral spinors. As before, we shall denote these bundles by \( S \) and \( \hat{S} \) and therefore, \( T_{\mathcal{M}^4} \cong S \otimes \mathcal{O}_{\mathcal{M}^4} \hat{S} \). We introduce

\[ \mathcal{O}_{\mathbb{P}^3}(k,l) := pr^* \mathcal{O}_{\mathbb{P}^1 \times \mathbb{P}^1}(k,l) \quad \text{for} \quad k, l \in \mathbb{Z}, \quad (34) \]

where \( pr \) is the bundle projection \( pr : \mathbb{P}^3 \rightarrow \mathbb{P}^1 \times \mathbb{P}^1 \) and \( \mathcal{O}_{\mathbb{P}^1 \times \mathbb{P}^1}(k,l) \) was.

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The Application of Decomposition Technique to Wave Equation and Heat Flow

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Abstract: In this paper we introduced the Adomian decomposition method. We explained the analytical points and then used the operator form obtained to solve the problem of wave Equation and heat flow.

The method is also illustrated by partial differential equation. The examples given are three dimensional wave equation as well heat flow.

1- Introduction

In this paper we will discuss the initial-boundary value problems that control the wave equation and heat flow in three dimensional space. The decomposition method consists of decomposing the unknown function \( u \) into an infinite sum of components \( u_0, u_1, u_2, ... \), and concerns itself with determining these components recurrently. The zeroth component \( u_0 \) is usually identified by the terms arising from integrating inhomogeneous terms and from initial-boundary conditions. The successive components \( u_1, u_2, ... \) are determined in a recursive manner. The decomposition method will be applied to three dimensional wave equation.

2- The Methodology

2-1 Methodology For Three Dimensional Wave Equation

The propagation of waves in a three dimensional volume of length \( a \), width \( b \), and height \( d \) is governed by the following initial boundary value problem.
Where \( o < x < a, o < y < b, o < z < d \), and \( u = u(x,y,z,t) \) is the displacement of any point located at the position \((x,y,z)\) of a rectangular volume at any time \( t \) and \( c \) is the velocity of a propagation wave.

the solution in the space minimizes the volume of calculations. Accordingly, the operator \( L_t^{-1} \) will be applied here, we first rewrite (1) in an operator form by

\[
L_t u = c^2 \left( L_x u + L_y u + L_z u \right)
\]  

(2)

Where the differential operators \( L_x, L_y \) and \( L_z \) are defined by

\[
L_t = \frac{\partial^2}{\partial t^2}, L_x = \frac{\partial^2}{\partial x^2}, L_y = \frac{\partial^2}{\partial y^2}, L_z = \frac{\partial^2}{\partial z^2}
\]  

(3)

So that the integral operator \( L_t^{-1} \) represents a two-fold integration from \( o \) to \( t \) given by.

\[
L_t^{-1}(.) = \int_0^t \int_0^t (.) dt
\]  

(4)

This means that

\[
L_t^{-1} L_t u (x,y,z,t) = u(x,y,z,t) - u(x,y,z,0) - tu_t(x,y,z,0)
\]  

(5)

Applying \( L_t^{-1} \) to both sides of (1), noting (5) and using the initial conditions we find.

\[
u(x,y,z,t) = F(x,y,z) + t g(x,y,z) + c^2 L_t^{-1} \left( L_x u + L_y u + L_z u \right)
\]  

(6)

The decomposition method defines the solution \( u(x,y,z,t) \) as a series given by.

\[
u(x,y,z,t) = \sum_{n=0}^{\infty} u_n(x,y,z,t)
\]  

(7)

Substituting (7) into both sides of (5-7) yields
\[
\sum_{n=0}^{\infty} u_n = F(x,y,z) + t g(x,y,z) + c^2 L^{-1}_t \left( L_x \left( \sum_{n=0}^{\infty} u_n \right) + L_y \left( \sum_{n=0}^{\infty} u_n \right) + L_z \left( \sum_{n=0}^{\infty} u_n \right) \right)
\]  

The components \( u_n(x,y,z,t) \), \( n \geq 0 \) can be completely determined by using the recursive relation:

\[
\begin{aligned}
    u_0(x,y,z,t) &= F(x,y,z) + t g(x,y,z) \\
    u_{k+1}(x,y,z,t) &= c^2 L^{-1}_t (L_x u_k + L_y u_k + L_z u_k), k \geq 0
\end{aligned}
\]  

Having determined the components \( u_n \), \( n \geq 0 \)

by applying the scheme (9), the solution in a series form follows immediately.

**2-1-1 Homogeneous wave Equations:**

The decomposition method will be used to discuss the following homogeneous wave equations in three dimensional space with homogeneous or in homogeneous boundary conditions.

**Example (1):**

We shall use the Adomian decomposition method to solve the initial boundary value problem.

\[
\begin{aligned}
    u_{tt} &= 3 \left( u_{xx} + u_{yy} + u_{zz} \right), 0 < x, y, z < \pi, t > 0 \\
    u(0, y, z, t) &= u(\pi, y, z, t) = 0 \\
    u(x, 0, z, t) &= u(x, \pi, z, t) = 0 \\
    u(x, y, 0, t) &= u(x, y, \pi, t) = 0 \\
    u(x, y, z, 0) &= 0, u_t(x, y, z, 0) = 3 \sin x \sin y \sin z
\end{aligned}
\]  

To do that

The PDE of (10) can be rewritten by

\[
L_t u = 3 \left( L_x u + L_y u + L_z u \right)
\]  

Applying the inverse operator \( L_t^{-1} \) to (10), using (5) and substituting the initial conditions we obtain
Using the decomposition series

\[ u(x, y, z, t) = \sum_{n=0}^{\infty} u_n(x, y, z, t) \]  \hspace{1cm} (13)

Into both sides of (12)

\[ \sum_{n=0}^{\infty} u_n = 3t \sin x \sin y \sin z + 3L_z^{-1}\left(L_x\left(\sum_{n=0}^{\infty} u_n\right) + L_y\left(\sum_{n=0}^{\infty} u_n\right) + L_z\left(\sum_{n=0}^{\infty} u_n\right)\right) \]  \hspace{1cm} (14)

Identifying the zeroth component as discussed before we then set the relation.

\[ u_0(x, y, z, t) = 3t \sin x \sin y \sin z \]
\[ u_{K+1}(x, y, z, t) = 3L_z^{-1}(L_xu_k + L_yu_k + L_zu_k), k \geq 0 \]  \hspace{1cm} (15)

The first few components of the decomposition of \( u \) are given by

\[ u_0(x, y, z, t) = 3t \sin x \sin y \sin z \]
\[ u_1(x, y, z, t) = 3L_z^{-1}(L_xu_0 + L_yu_0 + L_zu_0) = 3L_z^{-1}(-t \sin x \sin y \sin z - t \sin x \sin y \sin z - t \sin x \sin y \sin z) = 3L_z^{-1}(-3t \sin x \sin y \sin z) = -9L_z^{-1}(t \sin x \sin y \sin z) = -27 \left(\frac{t^3}{6} \sin x \sin y \sin z\right) = -\frac{(3t)^3}{3!} \sin x \sin y \sin z \]
\[ u_2(x, y, z, t) = 3L_z^{-1}(L_xu_1 + L_yu_1 + L_zu_1) = -\frac{(3t)^5}{5!} \sin x \sin y \sin z \]
\[ u_3(x, y, z, t) = 3L_z^{-1}(L_xu_2 + L_yu_2 + L_zu_2) = -\frac{(3t)^7}{7!} \sin x \sin y \sin z \]  \hspace{1cm} (16)

So that

The solution in a series form is given by
And in a closed from by

\[ u(x, y, z, t) = \sin x \sin y \sin z \sin(3t) \quad \text{(18)} \]

**Example (2):**

Now we apply the Adomian decomposition method to solve the initial boundary value problem.

\[
\begin{align*}
\frac{\partial^2 u}{\partial t^2} &= \frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} + \frac{\partial^2 u}{\partial z^2} - u, \quad 0 < x, y, z < \pi, t > 0 \\
\frac{\partial u}{\partial t}(0, y, z, t) &= -u(\pi, y, z, t) = \sin y \sin(z + 2t) \\
\frac{\partial u}{\partial x}(x, 0, z, t) &= -u(x, \pi, z, t) = \sin x \sin(z + 2t) \\
\frac{\partial u}{\partial y}(x, y, 0, t) &= -u(x, y, \pi, t) = \sin(x + y) \sin(2t) \\
\frac{\partial u}{\partial z}(x, y, z, 0) &= \sin(x + y) \sin z, \quad u_t(x, y, z, 0) = 2 \sin(x + y) \cos z
\end{align*}
\]  

(19)

Applying \( L_t^{-1} \) to (19), using (5) gives

\[ u(x, y, z, t) = \sin(x + y) \sin z + 2t \sin(x + y) \cos z + L_t^{-1}(L_xu + L_yu + L_zu - u) \quad \text{(20)} \]

Therefore we find

\[
\begin{align*}
\sum_{n=0}^{\infty} u_n &= \sin(x + y) \sin z + 2t \sin(x + y) \cos z + L_t^{-1} \left( L_x \left( \sum_{n=0}^{\infty} u_n \right) \right) \\
&\quad + L_y \left( \sum_{n=0}^{\infty} u_n \right) - L_z \left( \sum_{n=0}^{\infty} u_n \right)
\end{align*}
\]  

(21)

This means that

\[
\begin{align*}
u_0(x, y, z, t) &= \sin(x + y) \sin z + 2t \sin(x + y) \cos z \\
u_{k+1}(x, y, z, t) &= L_t^{-1}(L_xu_k + L_yu_k + L_zu_k - u_k), k \geq 0
\end{align*}
\]  

(22)

and therefore we obtain
The solution in a series form is given by

\begin{align}
  u_0(x, y, z, t) &= \sin(x + y) \sin z + 2t \sin(x + y) \cos z \\
  u_1(x, y, z, t) &= L_t^{-1} \left( L_x u_0 + L_y u_0 + L_z u_0 - u_0 \right) = \\
  &\left\{ \begin{array}{c}
  \frac{(2t)^2}{2!} \sin(x + y) \sin z - \frac{(2t)^3}{3!} \sin(x + y) \cos z \\
  \frac{(2t)^4}{4!} \sin(x + y) \sin z + \frac{(2t)^5}{5!} \sin(x + y) \cos z
  \end{array} \right\}
  \tag{23}
\end{align}

We now consider the inhomogeneous wave equation in a three dimensional space of the form.

\begin{equation}
  u_{tt} = c^2 (u_{xx} + u_{yy} + u_{zz}) + h(x, y, z)
  \tag{26}
\end{equation}

Where \( h(x, y, z) \) is an inhomogeneous term.

The decomposition method can be applied without any need to transform this equation to a homogeneous equation.

The following examples will be used to explain the implementation of the method.

\textbf{Example (1)}

In this example we apply Adomian decomposition method to solve the initial boundary value problem.
Operating with $L_t^{-1}$ on (27) gives

$$u = \sin x + \sin y + t \sin z + \frac{t^2}{2!} \sin x + \frac{t^2}{2!} \sin y + L_t^{-1}(L_x u + L_y u + L_z u) \quad (28)$$

We substitute the decomposition series

$$u(x, y, z, t) = \sum_{n=0}^{\infty} u_n(x, y, z, t) \quad (29)$$

in to both sides of (2) to obtain

$$\sum_{n=0}^{\infty} u_n = \sin x + \sin y + t \sin z + \frac{t^2}{2!} \sin x + \frac{t^2}{2!} \sin y$$

$$+ L_t^{-1} \left( L_x \left( \sum_{n=0}^{\infty} u_n \right) + L_y \left( \sum_{n=0}^{\infty} u_n \right) + L_z \left( \sum_{n=0}^{\infty} u_n \right) \right) \quad (30)$$

This leads to

$$u_0(x, y, z, t) = \sin x + \sin y + t \sin z + \frac{t^2}{2!} \sin x + \frac{t^2}{2!} \sin y$$

$$u_1(x, y, z, t) = L_t^{-1}(L_x u_0 + L_y u_0 + L_z u_0) = -\frac{t^2}{2!} \sin x - \frac{t^2}{3!} \sin y - \frac{t^4}{4!} \sin x - \frac{t^4}{4!} \sin y$$

$$u_2(x, y, z, t) = L_t^{-1}(L_x u_1 + L_y u_1 + L_z u_1) =$$

$$\frac{t^4}{4!} \sin x + \frac{t^4}{4!} \sin y + \frac{t^5}{5!} \sin z + \frac{t^6}{6!} \sin x + \frac{t^6}{6!} \sin y$$

$$u_3(x, y, z, t) = L_t^{-1}(L_x u_2 + L_y u_2 + L_z u_2) =$$

$$\frac{t^6}{6!} \sin x + \frac{t^6}{6!} \sin y - \frac{t^7}{7!} \sin z - \frac{t^8}{8!} \sin x - \frac{t^8}{8!} \sin y \quad (31)$$

The series solution and the exact solution are given by
Example (2)

In this example we apply Adomian decomposition method to solve the inhomogeneous problem

\[
\begin{align*}
\frac{\partial^2 u}{\partial t^2} &= \frac{1}{2} \left( \frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} + \frac{\partial^2 u}{\partial z^2} \right) - 1, \quad 0 < x, y, z < \pi, \quad t > 0 \\
\frac{\partial u}{\partial x}(0, y, z, t) &= 0, \quad \frac{\partial u}{\partial x}(\pi, y, z, t) = 2\pi \\
\frac{\partial u}{\partial y}(x, 0, z, t) &= -\frac{\partial u}{\partial y}(x, \pi, z, t) = \sin z \cos t \\
\frac{\partial u}{\partial z}(x, y, 0, t) &= -\frac{\partial u}{\partial z}(x, y, \pi, t) = \sin y \cos t \\
u(x, y, z, 0) &= x^2 + \sin x \sin z, \quad u_t(x, y, z, 0) = 0
\end{align*}
\]  

(34)

Operating with \( L_z^{-1} \) on (34)

\[
u = x^2 + \sin x \sin z - \frac{t^2}{2!} + \frac{1}{2} L_z^{-1} \left( L_x u + L_y u + L_z u \right) \]

(35)

\[
u(x, y, z, t) = \sum_{n=0}^{\infty} u_n(x, y, z, t)
\]

(36)

\[
\sum_{n=0}^{\infty} u_n = x^2 + \sin x \sin z - \frac{t^2}{2!} + \frac{1}{2} L_z^{-1} \left( L_x \left( \sum_{n=0}^{\infty} u_n \right) + L_y \left( \sum_{n=0}^{\infty} u_n \right) + L_z \left( \sum_{n=0}^{\infty} u_n \right) \right)
\]

(36)

\[
\begin{align*}
u_0(x, y, z, t) &= x^2 + \sin x \sin z - \frac{t^2}{2!} \\
u_1(x, y, z, t) &= \frac{1}{2} L_z^{-1} \left( L_x u_0 + L_y u_0 + L_z u_0 \right) = \frac{t^2}{2!} - \frac{t^2}{2!} \sin x \sin z \\
u_2(x, y, z, t) &= \frac{1}{2} L_z^{-1} \left( L_x u_1 + L_y u_1 + L_z u_1 \right) = \frac{t^4}{4!} \sin x \sin z
\end{align*}
\]

(37)

The series solution and the exact solution are given by

\[
u(x, y, z, t) = x^2 + \sin x \sin z - \frac{t^2}{2!} \sin x \sin z + \frac{t^4}{4!} \sin x \sin z
\]

\[
= x^2 + \sin x \sin z \left( 1 - \frac{t^2}{2!} + \frac{t^4}{4!} - \ldots \right)
\]

(38)
and

\[ u(x, y, z, t) = x^2 + \sin x \sin z \cos t \quad (39) \]

### 2-2 Methodology For Three Dimensional Heat Equation:

**Three Dimensional Heat Flow:**

The distribution of heat flow in a three dimensional space is governed by the following initial boundary value problem.

\[
\begin{aligned}
    & u_t = \bar{k}(u_{xx} + u_{yy} + u_{zz}), \quad t > 0, \\
    & 0 < x < a, 0 < y < b, 0 < z < c \\
    & u(0, y, z, t) = u(a, y, z, t) = 0 \\
    & u(x, 0, z, t) = u(x, b, z, t) = 0 \\
    & u(x, y, 0, t) = u(x, y, c, t) = 0 \\
    & u(x, y, z, 0) = F(x, y, z)
\end{aligned} \tag{40}
\]

Where \( u = u(x, y, z, t) \) is the temperature of any point located at the position \((x, y, z)\) of a rectangular volume at any time \( t \), and \( \bar{k} \) is the thermal diffusivity. We first rewrite (40) in an operator form by

\[ L_t u = \bar{k}(L_x u + L_y u + L_z u) \tag{41} \]

Where the differential operators \( L_x, L_y \) and \( L_z \) are defined by

\[ L_z = \frac{\partial}{\partial t}, L_x = \frac{\partial^2}{\partial x^2}, L_y = \frac{\partial^2}{\partial y^2}, L_z = \frac{\partial^2}{\partial z^2} \tag{42} \]

So that the integral operator \( L_t^{-1} \) exists and given by

\[ L_t^{-1}(.) = \int_0^t (.) dt \tag{43} \]

Applying \( L_t^{-1} \) to both sides of (41) and using the initial condition leads to

\[ u(x, y, z, t) = F(x, y, z) + \bar{k} L_t^{-1}(L_x u + L_y u + L_z u) \tag{44} \]

The decomposition method defines the solution \( u(x, y, z, t) \) as a series given by

\[ u(x, y, z, t) = \sum_{n=0}^{\infty} u_n(x, y, z, t) \tag{45} \]

Substituting (45) into both sides of (44)
The components can be completely determined by using the recursive relationship.

\[ u_0(x, y, z, t) = F(x, y, z) \]

\[ u_{k+1}(x, y, z, t) = \bar{K}L_t^{-1}(L_xu_k + L_yu_k + L_zu_k), k \geq 0 \]  \hspace{1cm} (47)

The components can be determined recursively as we like. Consequently, the components \( u_n \), \( n \geq 0 \), are completely determined and the solution in a series form follows immediately.

2-2-1 Homogeneous Heat Equations:

The decomposition method will be used to discuss the following homogeneous heat equations.

**Example (1):**

We shall use the Adomian decomposition method to solve the following initial–boundary value problem.

\[
\begin{align*}
\frac{u}{t} &= u_{xx} + u_{yy} + u_{zz}, 0 < x, y, z < \pi, t > 0 \\
u(0, y, z, t) &= u(\pi, y, z, t) = 0 \\
u(x, 0, z, t) &= u(x, \pi, z, t) = 0 \\
u(x, y, 0, t) &= u(x, y, \pi, t) = 0 \\
u(x, y, z, 0) &= 2\sin x \sin y \sin z
\end{align*}
\]  \hspace{1cm} (48)

Applying the inverse operator \( L_t^{-1} \) to the operator form of (48) gives.

\[ u(x, y, z, t) = 2\sin x \sin y \sin z + L_t^{-1}(L_xu + L_yu + L_zu) \]  \hspace{1cm} (49)

Using the decomposition series

\[ u(x, y, z, t) = \sum_{n=0}^{\infty} u_n(x, y, z, t) \]  \hspace{1cm} (50)

In (49)
The components $u_n(x, y, z, t), n \geq 0$ can be determined by using the recurrence relation

$$u_0(x, y, z, t) = 2 \sin x \sin y \sin z$$

$$u_{k+1}(x, y, z, t) = L_t^{-1}(L_x u_k + L_y u_k + L_z u_k) k \geq 0 \quad (52)$$

It follows that the first few terms of the decomposition series of $u(x, y, z, t)$ are given by,

$$u_0(x, y, z, t) = 2 \sin x \sin y \sin z$$

$$u_1(x, y, z, t) = L_t^{-1}(L_x u_0 + L_y u_0 + L_z u_0) = -2(3t) \sin x \sin y \sin z$$

$$u_2(x, y, z, t) = L_t^{-1}(L_x u_1 + L_y u_1 + L_z u_1) = \frac{(3t)^2}{2!} \sin x \sin y \sin z$$

$$u_3(x, y, z, t) = L_t^{-1}(L_x u_2 + L_y u_2 + L_z u_2) = -2 \frac{(3t)^3}{3!} \sin x \sin y \sin z$$

and so on.

The solution in a series form is given by

$$u(x, y, z, t) = 2 \sin x \sin y \sin z \left(1 - 3t + \frac{(3t)^2}{2!} - \frac{(3t)^2}{3!} + \ldots\right) \quad (54)$$

and in a closed form by

$$u(x, y, z, t) = 2e^{-3t} \sin x \sin y \sin z \quad (55)$$

**Example (2)**

Now we apply the Adomian decomposition method to solve the homogeneous initial boundary value problems:

$$u_t = 2(u_{xx} + u_{yy} + u_{zz}), 0 < x, y, z < \pi, t > 0$$

$$u(0, y, z, t) = u(\pi, y, z, t) = 0$$

$$u(x, 0, z, t) = u(x, \pi, z, t) = 0$$

$$u(x, y, 0, t) = u(x, y, \pi, t) = 0$$

$$u(x, y, z, 0) = \sin x \sin y \sin z$$

Applying the inverse operator $L_t^{-1}$ to (56) give

$$u(x, y, z, t) = \sin x \sin y \sin z + 2L_t^{-1}(L_x u + L_y u + L_z u) \quad (57)$$

and hence we find
\[ \sum_{n=0}^{\infty} u_n = \sin x \sin y \sin z \]
\[ + 2L_t^{-1}\left( L_x \left( \sum_{n=0}^{\infty} u_n \right) + L_y \left( \sum_{n=0}^{\infty} u_n \right) + L_z \left( \sum_{n=0}^{\infty} u_n \right) \right) \]  
\[ u_0(x, y, z, t) = \sin x \sin y \sin x \]
\[ u_{k+1}(x, y, z, t) 2L_t^{-1}(L_x u_k + L_y u_k + L_z u_k), k \geq 0 \] 
Consequently, the first few components
\[ u_0(x, y, z, t) = \sin x \sin y \sin z \]
\[ u_1(x, y, z, t) = 2L_t^{-1}(L_x u_0 + L_y u_0 + L_z u_0) = -6t \sin x \sin y \sin z \]
\[ u_2(x, y, z, t) = 2L_t^{-1}(L_x u_1 + L_y u_1 + L_z u_1) = \frac{(6t)^2}{2!} \sin x \sin y \sin z \]
\[ u_3(x, y, z, t) = 2L_t^{-1}(L_x u_2 + L_y u_2 + L_z u_2) = -\frac{(6t)^3}{3!} \sin x \sin y \sin z \]

The solution in series form is given by
\[ u(x, y, z, t) = u_0(x, y, z, t) + u_1(x, y, z, t) + u_2(x, y, z, t) + u_3(x, y, z, t) + \ldots \]  
\[ u(x, y, z, t) = \sin x \sin y \sin z (1 - 6t + \frac{(6t)^2}{2!} - \frac{(6t)^3}{3!} + \ldots) \]

and in closed form by
\[ u(x, y, z, t) = e^{-6t} \sin x \sin y \sin z \]

2-2-2 In Homogeneous Heat Equation:
In the following, the Adomian decomposition method will be applied to inhomogeneous heat equations.
The method will be implemented in a like manner to that used inhomogeneous cases.

Example (1):
Now we apply the Adomian decomposition method to solve the following initial – boundary value problem.
\[ u_t = u_{xx} + u_{yy} + u_{zz} - 4, 0 < x, y, z < \pi, t > 0 \]
\[ u(0, y, z, t) = 0, u(\pi, y, z, t) = 2\pi^2 \]
\[ u(x, 0, z, t) = u(x, \pi, z, t) = 2x^2 \]
\[ u(x, y, 0, t) = u(x, y, \pi, t) = 2x^2 \]
\[ u(x, y, z, 0) = 2x^2 + \sin x \sin y \sin z \]
Operating with $L_t^{-1}$ on (64) we obtain

$$u(x,y,z,t) = -4t + 2x^2 + \sin x \sin y \sin z + L_t^{-1}(L_x u + L_y u + L_z u)$$ (65)

and proceeding as before we fined

$$\sum_{n=0}^{\infty} u_n = -4t + 2x^2 + \sin x \sin y \sin z + L_t^{-1} \left( L_x \left( \sum_{n=0}^{\infty} u_n \right) + L_y \left( \sum_{n=0}^{\infty} u_n \right) + L_z \left( \sum_{n=0}^{\infty} u_n \right) \right)$$ (66)

We next set the recurrence relation.

$$\begin{align*}
u_0(x,y,z,t) &= -4t + 2x^2 + \sin x \sin y \sin z \\
u_{k+1}(x,y,z,t) &= L_t^{-1}(L_x u_k + L_y u_k + L_z u_k), k \geq 0 \end{align*}$$ (67)

The first few terms of the decomposition series are

$$\begin{align*}
u_0(x,y,z,t) &= -4t + 3x^2 + \sin x \sin y \sin z \\
u_1(x,y,z,t) &= L_t^{-1}(L_x u_0 + L_y u_0 + L_z u_0) = -3t \sin x \sin y \sin z + 4t \\
u_2(x,y,z,t)L_t^{-1}(L_x u_1 + L_y u_1 + L_z u_1) &= \frac{(3t)^2}{2!} \sin x \sin y \sin z \\
u_3(x,y,z,t)L_t^{-1}(L_x u_2 + L_y u_2 + L_z u_2) &= \frac{(3t)^3}{3!} \sin x \sin y \sin z \end{align*}$$ (68)

The solution in a series form is given by

$$u(x,y,z,t) = 2x^2 + \sin x \sin y \sin z \left( 1 - 3t + \frac{(3t)^2}{2!} - \frac{(3t)^3}{3!} + \cdots \right)$$ (69)

and in a closed form by

$$u(x,y,z,t) = 2x^2 + e^{-3t} \sin x \sin y \sin z$$ (70)

**Example (2):**

In this example we apply the Adomian decomposition method to solve the inhomogeneous initial – boundary value problems.
Applying the inverse operator $L^{-1}_t$ to (71) gives

$$u(x, y, z, t) = \sin x + \sin(y + z) + t \sin x + L^{-1}_t(L_x u + L_y u + L_z u)(72)$$

and this turn gives

$$\sum_{n=0}^{\infty} u_n = \sin x + \sin(y + z) + t \sin x$$

$$+ L^{-1}_t \left( L_x \left( \sum_{n=0}^{\infty} u_n \right) + L_y \left( \sum_{n=0}^{\infty} u_n \right) + L_z \left( \sum_{n=0}^{\infty} u_n \right) \right) (73)$$

Accordingly, we set the recursive relationship.

$$u_0(x, y, z, t) = \sin x + \sin(y + z) + t \sin x$$

$$u_{k+1}(x, y, z, t) = L^{-1}_t(L_x u_k + L_y u_k + L_z u_k), k \geq 0 \} (74)$$

Consequently, the first few components

$$u_0(x, y, z, t) = \sin x + \sin(y + z) + t \sin x$$

$$u_1(x, y, z, t) = L^{-1}_t(L_x u_0 + L_y u_0 + L_z u_0) = -t \sin x - 2t \sin(y + z) - \frac{t^2}{3!} \sin x$$

$$u_2(x, y, z, t) = L^{-1}_t(L_x u_1 + L_y u_1 + L_z u_1) = \frac{t^2}{2!} \sin x + \frac{t^2}{2!} \sin(y + z) + \frac{t^3}{3!} \sin x$$

$$u_2(x, y, z, t) = L^{-1}_t(L_x u_2 + L_y u_2 + L_z u_2) = -\frac{t^3}{3!} \sin x - \frac{(2t)^3}{3!} \sin(y + z) - \frac{t^4}{4!} \sin x$$

The solution in a series form is given by

$$u(x, y, z, t) = \sin x + \sin(y + z) \left( 1 - 2t + \frac{(2t)^2}{2!} - \frac{(2t)^3}{3!} + \cdots \right)(76)$$

$$u(x, y, z, t) = \sin x + e^{-2t} \sin(y + z) \quad (77)$$
Packet Loss Performance Of VoIP Over LTE

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Abstract—Long Term Evolution (LTE) is the last step towards the 4th generation of cellular networks. This revolution is necessitated by the unceasing increase in demand for high speed connection on LTE networks. This thesis mainly focuses on performance evaluation of end-to-end delay (E2E) for VoIP in the LTE network. Performance evaluation, simulation approach is realized using simulation tool OPNET 16.0. Three scenarios have been produced. The first single is the baseline network while among other two, one consists of VoIP traffic solely and the other consisted of FTP along with VoIP. In light of the resulting analysis, the performance quality of a VoIP network (with and without the presence of additional network traffic) in LTE has been defined and discussed. The default parameters in OPNET 16.0 for LTE have been used during simulation.

Keywords: LTE, delay, Packet Loss and OPNET

I. INTRODUCTION

The trend of the modern society is as the days go by, time is getting more expensive and commodity is getting cheaper. To make a world compatible for this, it is necessary to produce a network backbone for the whole creation so the information along with communication, is instant. The study of the performance of Voice-over-IP (VoIP) over LTE thus has a great significance. Introduction of Long Term Evolution (LTE), the 4th Generation (4G) network technology releases 8 specifications are being finalized in 3GPP have developed and planning to
globalize extensively compared to 3rd Generation (3G) and 2nd Generation (2G) networks [1].

LTE determines the goals peak data rate for Downlink (DL) 100 Mbps and Uplink (UL) data rate for 50 Mbps, increased cell edge user throughput, improved spectral efficiency and scalable bandwidth 1.4 MHz to 20 MHz [2]. VoIP capacity of LTE has to show better performance as Circuit Switch voice of UMTS. LTE should be at least as well as the High Speed Packet Access (HSPA) evolution track also in voice traffic.

The core network of LTE is purely packet switched and optimized for packet data transfer, thus speech is also transmitted purely with VoIP protocols. Simultaneously, the demand for the higher quality of wireless communications has increased as well. Use of demand driven applications and services has been growing rapidly to satisfy users. Meeting such demand poses a challenge for the researchers to solve till now.

Among such demands, enhance quality of voice and data transfer rates are one of the main aspects to improve. Thus, to improve the performance of such important aspects, performance evaluation of VoIP can point out the issues which can be resolved to improve the overall performance of LTE networks. In this paper, VoIP Application is used to represent the class of inelastic, real-time interactive applications that is sensitive to end-to-end delay but may tolerate packet loss. It is expected that LTE should support a significantly higher number of VoIP users. The important factor is now the quality of service (QoS) of VoIP. To user's sure QoS of VoIP in an LTE network, the first basic evaluation can be done in terms of maximum end to end delay and acceptable packet loss [3].
II. LTE FUNDAMENTAL

A. Background

Lately, the demand for high data rates to support the Internet services and the wide range of multimedia has received a substantial attraction around the globe from mobile researchers and industries. An international collaboration project, known as Third Generation Partnership Project (3GPP), takes a host of members into account, specially from both mobile industry and research institutes in a bid to delivering a globally applicable third generation (3G) mobile phone system specification [6].

The organization started their journey on December 1998 and was initially based on 2nd generation (2G) mobile system, i.e. Global System for Mobile Communications, which is nowadays known as Universal Mobile Telecommunications System (UMTS). The key function of 3GPP involves improving the UMTS standard to cope with the ever-evolving future requirements such as services, boosting, exploiting the spectrum facilities, lowering costs, efficiency improvement and better integration with other standards. The following table (Table1) demonstrates few complete sets of technical specifications produced by 3GPP.
For both transmission and reception, the bandwidth capability of a UE is required to be 20MHz [15]. Though, the service provider can deploy the cells with any of the bandwidths specified in a given table. This eventually allows the service providers to alter their offering depends on the amount of available spectrum or the ability to initiate with fixed spectrum for lower upfront cost and grow the spectrum for additional capacity.

In LTE, the interworking with existing UTRAN/GERAN systems and non-3GPP systems should be ensured. Multimode terminals need to support handover from and to UTRAN and GERAN and also the inter-RAT measurements. In real time services, the interruption time of handover between E-UTRAN and UTRAN/GERAN should be less than 300 ms, and in case of no real time services,
the time should be less than 500 ms. Ability of cost-effective migration from release 6 UTRA radio interface and architecture should be available. Cost and power consumption, reasonable system and terminal complexity are to be provided. It is mandatory for all the interfaces to be open for multivendor equipment interoperability.

<table>
<thead>
<tr>
<th>Metric</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak Data Rate</td>
<td>DL: 100 Mbps, UL: 50 Mbps (for 20 MHz spectrum)</td>
</tr>
<tr>
<td>Mobility Support</td>
<td>Up to 500 km/h but optimized for low speeds from 0 to 15 km/h</td>
</tr>
<tr>
<td>Control Plane Latency</td>
<td>&lt; 100 ms (from idle to active state)</td>
</tr>
<tr>
<td>User Plane Latency</td>
<td>&lt; 5 ms</td>
</tr>
<tr>
<td>Control Plane Capacity</td>
<td>&gt; 200 users per cell (for 5 MHz spectrum)</td>
</tr>
</tbody>
</table>

| Coverage (Cell size)      | 5–100 km with slight degradation after 30 km                               |
| Spectrum Flexibility      | 1.4, 3, 5, 10, 15, and 20 MHz                                              |

Table 2: LTE performance requirements

C. Multiple Access Techniques

A Multiple access technique effectively utilizes the expensive transmission resources among multiple users to minimize the communication interferences. The conventional multiple access strategies are based on dividing the available resources through implementing the frequency, time, or code division.
multiplexing techniques. For instance, in Time Division Multiple Access (TDMA), each user is allocated to a unique time slot, either on demand or in a fixed rotation. But in Frequency Division Multiple Access (FDMA), each user is assigned to a unique carrier frequency and bandwidth. And in Code Division Multiple Access (CDMA), the users will belong to the unique code for transmission, allowing each user to share the entire bandwidth and the time slots [7].

III. METHODOLOGY

Table 3 demonstrates the LTE general parameters used in the process of all simulation models of the study. One of the other important entities is the mobility configuration, which is used to determine the mobility model of the workstations.

<table>
<thead>
<tr>
<th>LTE Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>QoS Class Identifier (Voice)</td>
<td>1 (GBR)</td>
</tr>
<tr>
<td>QoS Class Identifier (FTP)</td>
<td>6 (Non-GBR)</td>
</tr>
<tr>
<td>Uplink Guaranteed Bit Rate (bps)</td>
<td>1 Mbps</td>
</tr>
<tr>
<td>Downlink Guaranteed Bit Rate (bps)</td>
<td>1 Mbps</td>
</tr>
<tr>
<td>Uplink Maximum Bit Rate (bps)</td>
<td>1 Mbps</td>
</tr>
<tr>
<td>Downlink Maximum Bit Rate (bps)</td>
<td>1 Mbps</td>
</tr>
<tr>
<td>ULBase Frequency (GHz)</td>
<td>1920 MHz</td>
</tr>
<tr>
<td>ULBandwidth (MHz)</td>
<td>20 MHz</td>
</tr>
<tr>
<td>ULCyclic Prefix Type</td>
<td>7 symbols perslot</td>
</tr>
<tr>
<td>DLBase Frequency (GHz)</td>
<td>2110 MHz</td>
</tr>
<tr>
<td>DLBandwidth (MHz)</td>
<td>20 MHz</td>
</tr>
<tr>
<td>DLCyclic Prefix Type</td>
<td>7 symbols perslot</td>
</tr>
</tbody>
</table>

Table 3 LTE Parameter
The following network is deployed with the help of OPNET Modeler16.0 [31]. LTE supports scalable bandwidth i.e. 1.4, 3, 5, 10, 15 and 20MHz. To evaluate the throughput, six different simulation scenarios are designed for scalable bandwidth. Figure 1 illustrates the simulation scenario based on LTE 1.3MHz. In this scenario, two eNodeB namely eNB_1 and eNB_2 are connected to EPC (Evolved Packet Core) via PPP_DS3 links.

The speed of DS3 link is 44.736 Mbps. Each NodeB has three nodes where the nodes of eNB_1 perform as a source while the nodes of eNB_2 perform as a destination. Unlimited numbers of VoIP calls are generated in this scenario to evaluate the maximum throughput of the simulation scenario.

Figure 2: VoIP Congested with FTP Network
IV. RESULTS AND DISCUSSIONS

Packet Loss Performance for Baseline VoIP Network

Figure 3 shows the sent and received traffic of different case scenarios in baseline VoIP network where X axis represents the simulation time in seconds and Y axis represents the sent and received traffic in bytes per seconds. As can be seen in the figure, sent and received data are overlapped in all the cases in the simulation scenarios.
Figure 4 illustrates the sent and received traffic of different case scenarios in VoIP Congested with FTP network. As observed in figure4, sent and received data are overlapped between 100 seconds to 130 seconds in all the case scenarios. The packet starts to drop from 130 seconds.

![packet loss graph](image)

**Fig. 4 Packet Loss of VoIP Congested with FTP Network**

In the Congested VoIP and VoIP congested with an FTP network scenario, on an average, packet loss in the VoIP Congested with FTP network for case 1 is about 74% higher than that of the Congested VoIP network. In the other three cases, average packet losses are 88%, 95% and 84% higher respectively. To wrap it, wholly of the voice traffic corresponding to four different cases in VoIP Congested with FTP experience higher packet loss than Congested VoIP network.
V. CONCLUSION

In this work, an effective study, analysis and evaluation of the delay performance evaluation for VoIP in the LTE network have been done. The evaluation is made by simulating in OPNET Modeler 16.0 Based on some performance metric throughput. Three network scenarios have been simulated: Baseline VoIP network Scenario, congested VoIP network scenario and VoIP congested with FTP network scenario. The rate of packet loss for the two networks in the previously mentioned four cases have been analyzed. Packet loss remain quite minimal for congested with VoIP network regard less of the node speed. Meanwhile, for VoIP with FTP network, packet loss rate is also quieting significant for fixed node case but the rate up shots as the node starts moving. FTP network is approximately 28%, 8.5% and 17.5% higher than Congested VoIP network.

REFERENCE


Brain-tumors Classification using Principal Component Analysis
and Artificial Neural Network

Sherougbdel Wahab Abdalla Dr .Zainab

Abstract: The abnormality growing of the cells in brain is known as brain-tumors. The brain-tumors is kind of a disease that can hit children’s, adults and elders. In this work a proposed method for brain-tumors detection and classification using MATLAB and based on “Magnetic Resonance Imaging “MRI”” which play an essential role in the brain-tumors disease diagnostic application that is based on manual and automatic detection. Moreover various kinds of tumors exists so it is complicated to detect and take decision. The correct segmentation and image enhancement give an accurate classification of brain-tumors types. The Probabilistic_Neural_network “PNN” was applied for the classification. Two steps were used for taking the correct decision making the 1st is the Feature extraction based on Principal-Component-Analysis “PCA” and the 2nd is the classification were done using Probabilistic_neural_network “PNN”. The known classification are “Normal”, “Benign’ and "Malignant”

Keywords: PNN,MRI, MATLAB,PCA

1. INTRODUCTION
The abnormality growing of the cells in brain is known as brain-tumor. The brain-tumors is kind of a disease that can hit children’s, adults and elders or the central backbone canal or an intracranial dense neoplasm known as brain-tumor [4]. The classification of tumor
correctly in order to classify and detect the type of tumor that agonized by the patients is the main objective. Various kinds of test used to detect brain-tumor mainly the “MRI”, and CT scan”. Correct classification increase the decision making and provide particular treatment. The computerized method detect the tumor in its early stage thus good classification is essential part. The 1st stage is to extract features from “MRI” using “PCA” and the 2nd stage train the “PNN” for classification. The principal component analysis “PCA” method give the existing attributes a new calculated parameters [2] [1], [3], [7].

2. PRINCIPAL COMPONENT ANALYSIS
The feature extraction done using “PCA”. And it is used to reduce the large dimension of the data [1]. Feature extractions were done for training the network. The main purpose of “MRI” recognition system is to identify max similarities by comparing between training “MRI”s and test “MRI”.

3. PROBABILISTIC_NEURAL_NETWORK FOR CLASSIFICATION
The probabilistic_neural_network “PNN” was introduced by Donald Specht. This network depends on the Bayesian theory and the probability of estimated density function. It is necessary to classify the input vectors into one of the two classes in “Bayesian” optimal manner. This allows cost function to give the fact that it may be worse to misclassify a vector that is actually a member of “class A” than it’s classified a vector that belongs to “class B” [6]. The “Bayes” rule such that the input vector have its place to “class A” is classified as

![Fig. 1: “MRI” recognition system.](image)
“PACAfAx>PBCBfBx”  

(1)

Where

“PA” – Priori probability of event of example in class A
“CA” - Cost associated with classifying vectors.
“FAx” - Probability density functions of class A.

"PNN" is generally used for grouping since it has more upsides rather than Back Propagation "BP" multilayer perceptron. "PNN" is faster than "BP" networks and more efficient. This network is comparatively indifferent to outliers and generates accurate predicted probability. Most important advantage of “PNN” is that training is easy and rapid [1]. Weights are assigned. Existing weights will never be replaced but new vectors are added into weight matrices while training.

Fig. 2 represent the architecture of “PNN”. The architecture of “PNN” is made up of four types of units.
- Input units
- Pattern units
- Summation units
- Output units

1" Input units: Hear input unit "xp", "p=1,2,...,P" are associated with all example units.
2" Pattern units: Create design unit "ZP". Weight vector for unit "ZP" is processed as "WP=xp". Unit "ZP" is either "ZA" or "ZB" unit.  

3" Summation units: Connect the pattern unit to summation unit. If “xp” goes to “class A”, connect pattern unit “ZP” to summation unit “SA’. Else interface design unit "ZP" to summation unit “SB”. The weight used by the summation unit for “class B” is

\[ VB= - \frac{PBCmA}{PACAmB} \] (2)

4" Output units: It adds up the signals from "fA" and "fB". If the total input is positive the input vector would be named "class A” y is the final output.

4. METHODOLOGY

The primary reason for proposed technique to identify tumor consequently from the "MRI"s. The "PNN" classifier introduced great exactness, very less training time, strong to weight changes, and imperceptible retraining time [1]. The proposed strategy is comprised of "6" steps which are beginning from input data to output. In the initial step, utilize "MRI" as info picture. Convert input picture into darker level and resize it into "256 x 256" estimate. This process is performed in second step. In the third step, apply "PCA" for highlight extraction. Highlights are extricated from preparing and additionally testing. In the 4th step, “PNN” is train for classification of “MRI”s. Finally efficiency on the outcome will be analyzed towards the ending of the development phase. The propose brain tumor grouping technique is shown in "Fig .3" The final output of the proposed method is either “normal”, “benign” or “malignant”. Other “malignant” are grouped either as “Glioma” or “Meningioma”.

5. RESULTS AND DISCUSSIONS

Various individualize experiments were applied and the sizes of the training set and testing sets determine the classification accuracy.

The dataset divided into four datasets
- Two datasets for training and two datasets for testing.

The first training dataset was used to train “MRI”s for “normal”, “benign” and “malignant”. This dataset contain 70 “MRI”s.

The second training dataset which contain “24” brain-tumor “MRI”s of “Glioma” and “Meningioma”. The testing dataset was utilized to confirm the precision of prepared "PNN" network for brain-tumor order.

The “MATLAB R2016a” is used to implement “PNN”. In this method smoothing factor used to evaluate the accuracy of the classifier. The spread value “SV” was used as smoothing factor and examined the classifier accuracy when different values of spread value were used. If “S.V.” is near zero, the network will act as a nearest neighbor classifier, and the network will take into account several nearby design vectors if its value
becomes larger [1]. “PNN” were examined using testing datasets. Clinical and operation assessment regrading “normal”, “benign” and “malignant” are shown in “Table 1” and “Table 2” respectively. The accuracy of the classifier of both tables was tested for different values of the “S.V.”.

True positives “TP” mention to the positive tuples that were correctly detected by the classifier, while true negatives “TN” are the negative tuples that were correctly detected by the classifier. False positives “FP” are the negative tuples that were incorrectly detected. Similarly false negatives “FN” are the positive tuples that were incorrectly detected [5].

Table 1. Clinical assessment of “PNN” regrading “normal”, “benign” and “malignant”.

<table>
<thead>
<tr>
<th>SV</th>
<th>Training Sample</th>
<th>Testing Sample</th>
<th>TP</th>
<th>TN</th>
<th>FP</th>
<th>FN</th>
</tr>
</thead>
<tbody>
<tr>
<td>10^2</td>
<td>70</td>
<td>35</td>
<td>9</td>
<td>11</td>
<td>4</td>
<td>11</td>
</tr>
<tr>
<td>10^3</td>
<td>70</td>
<td>35</td>
<td>10</td>
<td>11</td>
<td>3</td>
<td>11</td>
</tr>
<tr>
<td>10^4</td>
<td>70</td>
<td>35</td>
<td>10</td>
<td>12</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td>10^5</td>
<td>70</td>
<td>35</td>
<td>10</td>
<td>13</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>10^6</td>
<td>70</td>
<td>35</td>
<td>10</td>
<td>13</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>10^7</td>
<td>70</td>
<td>35</td>
<td>12</td>
<td>22</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>10^8</td>
<td>70</td>
<td>35</td>
<td>12</td>
<td>19</td>
<td>1</td>
<td>3</td>
</tr>
</tbody>
</table>

The sensitivity and specificity methods can be used for correct classification. Sensitivity is also referred to as the true positive “Detection” rate that is, the percentage of positive tuples that are correctly recognized, while specificity is the true negative rate that is the percentage of negative tuples that are correctly recognized [5]. These calculations are defined as

\[
\text{Sensitivity} = \frac{\text{t_pos}}{\text{pos}} \quad (3)
\]

\[
\text{Specificity} = \frac{\text{t_neg}}{\text{neg}} \quad (4)
\]
The precision is a component of affectability and specificity:
Accuracy = Sensitivity “pos’/”pos+neg” + “Specificity neg” . “pos+neg”

Table 2. Performance evaluation of “PNN” regrading “normal”, “benign” and “malignant”.

<table>
<thead>
<tr>
<th>SV</th>
<th>Training Sample</th>
<th>Testing Sample</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>$10^3$</td>
<td>70</td>
<td>35</td>
<td>69.23%</td>
<td>50%</td>
<td>57%</td>
</tr>
<tr>
<td>$10^3$</td>
<td>70</td>
<td>35</td>
<td>76.92%</td>
<td>50%</td>
<td>60%</td>
</tr>
<tr>
<td>$10^4$</td>
<td>70</td>
<td>35</td>
<td>76.92%</td>
<td>54.54%</td>
<td>62.85%</td>
</tr>
<tr>
<td>$10^5$</td>
<td>70</td>
<td>35</td>
<td>76.92%</td>
<td>59%</td>
<td>65.71%</td>
</tr>
<tr>
<td>$10^6$</td>
<td>70</td>
<td>35</td>
<td>76.92%</td>
<td>59%</td>
<td>65.71%</td>
</tr>
<tr>
<td>$10^7$</td>
<td>70</td>
<td>35</td>
<td>92.30%</td>
<td>100%</td>
<td>97.14%</td>
</tr>
<tr>
<td>$10^8$</td>
<td>70</td>
<td>35</td>
<td>92.30%</td>
<td>86%</td>
<td>88.37%</td>
</tr>
</tbody>
</table>

Fig. 4: Accuracy of normal, benign and malignant “MRI”s on the basis of performance measurement.
n "Table 2", "70" training tests and "35" training tests have been utilized. The classifier accuracy varies from “57%" to “97.14%". With “90” training samples and 35 testing samples, the results remain unchanged.

Along these lines "70" preparing tests can get the job done to get the satisfactory precision and it likewise decreases the classifier preparing time.

As a result "70" training tests can reduce the amount of training time and get the standard precisionWhere S.V. =”107”, accuracy is “97.14 %”.

Table 3 and Table 4 show results for “Glioma” and Meningioma.

Table 3. Clinical evaluation of “PNN” with respect to “Glioma” and Meningioma.

<table>
<thead>
<tr>
<th>SV</th>
<th>Training Sample</th>
<th>Testing Sample</th>
<th>TP</th>
<th>TN</th>
<th>FP</th>
<th>FN</th>
</tr>
</thead>
<tbody>
<tr>
<td>$10^2$</td>
<td>24</td>
<td>20</td>
<td>12</td>
<td>6</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>$10^3$</td>
<td>24</td>
<td>20</td>
<td>12</td>
<td>6</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>$10^4$</td>
<td>24</td>
<td>20</td>
<td>12</td>
<td>6</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>$10^5$</td>
<td>24</td>
<td>20</td>
<td>12</td>
<td>6</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>$10^6$</td>
<td>24</td>
<td>20</td>
<td>14</td>
<td>6</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 4. Performance assessment of “PNN” regrading “Glioma” and meningioma.

<table>
<thead>
<tr>
<th>SV</th>
<th>Training Sample</th>
<th>Testing Sample</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>$10^2 - 10^5$</td>
<td>24</td>
<td>20</td>
<td>85.7%</td>
<td>100%</td>
<td>90%</td>
</tr>
<tr>
<td>$10^6$</td>
<td>24</td>
<td>20</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Fig. 5: Performance Accuracy of “Glioma” and “Meningioma”.

“Table 1” and ‘Table 2” shows clinical and performance evaluation linked to “normal”, “benign” and “malignant” whereas further classification are shown in “Table 3’ and “Table 4 “PNN” was set up to test the precision with various spread value ranges from "102" to "107" and "102" to "106" as appeared in "Table 2" and "Table 4" Classifier accuracy increased to “100%” when S. V. was “106”.

Fig. 6 show normal “MRI” which indicate MR brain image without tumours. “Fig.7” and “Fig.8” represent benign and “malignant” “MRI”s. Brain scans of “Glioma” and Meningioma are shown in “Fig.9” and “Fig.10”.

“Fig.4” and “Fig.5” have shown the precision regrading “S.V” for a several classes of brain-tumours.

![Normal MRI](image1)

*Fig. 6: Normal “MRI”.*

![Benign MRI](image2)

*Fig. 7: Benign “MRI”.*
Fig. 8: “Malignant MRI”.

Fig. 9: “Meningioma MRI”.

Fig. 10: “Glioma MRI”.

6. CONCLUSION
After implementation of the Matlab code it was successfully classify the tumor automatically into “normal”, “benign” and “malignant” using “PNN” classifier. Moreover the “malignant_image” is further diagnosed into “meningioma” and “Glioma” tumor. And it was found that the maximum accuracy of “97.14%” and “100%” was found with spread value =”107” and “106’.

7. Future Scope
We can apply this method on foreign patient images and also we can try for more features for better accuracy.

8. REFERENCES