GLOBAL JOURNAL
OF COMPUTER SCIENCE AND TECHNOLOGY: C

Software & Data Engineering

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Highlights

Database Management Systems

Comparative Study with Relational

Discovering Thoughts, Inventing Future

VOLUME 15 ISSUE 3 VERSION 1.0

Global Journal of Computer Science and Technology: C
Software & Data Engineering

Global Journal of Computer Science and Technology: C
Software & Data Engineering

Volume 15 Issue 3 (Ver. 1.0)

Open Association of Research Society

Incorporation No.: 0423089
License No.: 42125/022010/1186
Registration No.: 430374
Import-Export Code: 1109007027
Employer Identification Number (EIN):
USA Tax ID: 98-0673427

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Contents of the Issue

Global Journal of Computer Science and Technology: C
Software & Data Engineering
Volume 15 Issue 3 Version 1.0 Year 2015
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 0975-4172 & Print ISSN: 0975-4350

Factors for Measurement of ITES Quality for Higher Education Institutions in Saudi Arabia

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Abstract- Information technology has blessed the current scientific era with the promising initiatives that are un-match able with the past. The range of impact is diversified in nature and massive in scale. Information Technology Enabled Services (ITES) have emerged over time in many disciplines. ITES are becoming increasingly prevalent in the global economy. Due to the growing importance of ITES Service Science has emerged as a fundamental area in Information Systems (IS) research and it combines technical and managerial knowledge under the umbrella of the more popular interdisciplinary approach of Service Science Management and Engineering (SSME). Along with the emergence of the ITES the question to measure the quality has also arisen. The measurement of ITES quality in different areas requires different factors to be considered. This paper addresses the identification of the factors for measuring the quality of ITES in higher education institutes in Saudi Arabia. The paper unleashes number of factors that can be used to measure the quality of ITES in higher education institutions.

Keywords: *saudia e-services, academic e-services, saudi academics online, saudi it services.*

GJCST-C Classification : *D.2.9*

Strictly as per the compliance and regulations of:

Factors for Measurement of ITES Quality for Higher Education Institutions in Saudi Arabia

Romana Aziz [α] & Basit Shahzad [σ]

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I. Introduction

Information technologies are now considered a core resource for all universities and universities are currently making massive investments in information technology. In addition to the learning management systems universities tend to invest in administrative systems for students, financial and human resource services [1]. The common reason stated by Bates and Sangra (2011) for these huge investments in information technology is to improve the cost effectiveness of universities by increasing flexible access for students. In order to demonstrate the achievement of this goal it is important to measure the quality of ITES from the users' point of view [2].

Much of the research on service quality in higher education can be linked with the marketing discipline [3, 4]. These scholars have mainly focused on the physical facilities or the outcomes of teaching and learning process and they have ignored the role of ITES like admissions, registrations, learning management and library systems in higher education.

We have reviewed the knowledge of service quality and service quality measurement in many different contexts and transferred it to the domain of ITES service quality measurement in higher education. The paper in short identifies the factors required to measure the quality of ITES in Saudi universities. Section 2, describes the background of the problem and section 3 describes the literature review for the identification of the factors to measure quality of ITES. Section 4, is on identification of service quality measurement factors for higher education institutions and conclusions.

II. Background

Services are defined as the non-material equivalent of a good or product and are intangible. Services sector is expanding in most developed economies of the world and according to a recent report eight out of ten workers are employed in the services sector in the United States [5]. Some services are still delivered interpersonally but these days most of the services are based on information and they are delivered via some technology. Organizations measure their service quality in order to use this measurement as a basis for improvement. Investigation of alternative models of service quality is an active research area [6]. Over the past years three broad and overlapping streams of research [7] have emerged in this area from the disciplines of marketing, supply chain management and information technology.

Information Technology enabled services (ITES) are becoming increasingly prevalent in the global economy. Due to the growing importance of ITES Service Science has emerged as a fundamental area in Information Systems (IS) research and it combines technical and managerial knowledge under the umbrella of the more popular interdisciplinary approach of Service Science Management and Engineering (SSME). The objective of SSME "is to help organizations improve their competiveness in a rapidly changing business environment by exploring the true requirements of their customers, and setting up an effective service process with the support of IT" [8].It is important to distinguish between IT Services and IT-Enabled Services. In the literature there are a number of definitions of IT enabled services[9, 10] but a comprehensive definition is given by Meyer and Fähnrich[11] as: "*IT-enabled services are solutions, whose added value for the customer is generated significantly through the use of information and communication technologies using networked software. They manifest themselves in the form of*

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services which can only be delivered efficiently and in their entirety by using information and communications technology, or alternatively as services in support of information and communications technology products, as well as complex hybrid solutions consisting of services combined with information and communications technology."

Advances in internet related technologies have led to informatization of service sector. Historically the term Information Technology Enabled Services (ITES) was used in the context of business process outsourcing. Today ITES refers to services which are provided via information and communication technologies (ICT) and Information systems (IS) [12]. Reengineering of traditional forms of paper and labor intensive forms of organizational activities and enabling them with ICT leads to IT enabled service delivery and offers substantial opportunities for service innovation. ITES are prevalent in many industries. The industries that rely most heavily on ITES include government, healthcare, finance, retail and last but not the least higher education[13-19].

ITES consist of a wide range of services delivered over a network in the above mentioned domains whereas IT services are the various IT applications and engineering services typically provided by the IT department of an organization [20]. Sudan et. al. [20] have given a typology of IT Services and IT-Enabled Services. They identify three categories of ITES. Firstly ITES encompass horizontal business processes like customer support, human resource management, finance, administration and supply chain management, secondly ITES cover most vertical processes of many sectors like banking, insurance travel, etc. and lastly the high end business processes like business and financial research and data analytics are also offered as ITES under business process outsourcing. IT services include application services and engineering services covering application development and maintenance, system integration, IT infrastructure services, simulation, design engineering and software product development. The software development standards need to be at par with the risk management techniques to avoid any development challenges [21-38].

The important research question of how to measure the service quality of ITES was first identified in 2005 [39] and after a lapse of almost a decade we still do not see substantial progress in this area [7]. Moreover scholars [5] agree that ITES provide the user with personal value added experience instead of a mere transaction. Therefore, it is suggested that factors affecting service quality will differ from one country to another due to cultural differences.

Measuring service quality of ITES in higher education as a field of study seems to have been neglected and as such there is very little that is understood about this contemporary phenomenon of growing importance. Therefore, there is a need to develop a comprehensive understanding and description of the phenomenon, investigate its theoretical foundations and develop an instrument to measure it.

III. Literature Review

In this section we give an overview of service quality measurement in the related domains of marketing and retailing, e-services, e-government, IT/IS services, web services, nterprise systems and higher education services and service quality of ITES in higher education.

a) Marketing and Retailing Service Quality

In marketing research SERVQUAL [40-42] is the most widely used model for service quality assessment and is very frequently used for gap analysis. SERVQUAL uses five factors containing twenty two indicators and these five factors are: tangibles, reliability, responsiveness, assurance and empathy to measure the gap between customer expectations and perceptions of service quality. A number of marketing service quality models have descended from SERVQUAL, e.g. [43][44][45][46]. Although the original SERVQUAL was developed for assessment of quality in physical markets it has been used to measure the quality of IS systems as well [47, 48].Roses et al [49] have applied SERVPERF which is an instrument based on SERVQUAL to measure IT service quality in banking sector.

The authors of SERVQUAL developed E-S-QUAL and E-RecS-QUAL for measuring service quality delivered by on-line shopping web sites[50]. The E-S-QUAL scale has four dimensions efficiency, fulfillment, system availability and privacy. The E-S-QUAL is for non-routine encounters and it has eleven items in three dimensions namely responsiveness, contact and compensation. With the passage of time as the delivery of electronic services became widespread the same group of authors developed E-SQ which is a conceptual model for consumer evaluation of electronic services [51]. E-SQ has eleven dimensions: access, ease of navigation, efficiency, flexibility, reliability, personalization, security/privacy, responsiveness, assurance/trust, site aesthetics, and price knowledge.

b) E-service Quality

E-service is different from traditional service in three main aspects [52]: no face to face sales staff, services process takes place in a virtual environment and self service of customers. E-service quality can be defined as the evaluations by the customer or user of the quality of service obtained from internet based virtual environment.Li and Suomi [52] did a review of the dimensions of e-service quality. They covered twenty five articles covering e-service concepts applied in the

areas of online retailing, online shopping and online financials. They proposed that the most relevant dimensions or measures of e-service are website design, reliability, responsiveness, security, fulfillment, personalization, information and empathy. Each of these eight dimensions consists of four items.

Swaid and Wigand [53] have studied service quality in on-line retailing. They developed a scale containing twenty eight items divided into six dimensions, namely information quality, reliability, responsiveness, assurance, website usability and personalization to evaluate service quality. This study performed exploratory factor analysis and structural equation modeling to investigate the influence of service quality attributes on three aspects of customer loyalty. The three loyalty constructs were preference loyalty, price tolerance and complaining behavior.

H. F. Lin[54], in his research on identifying the factors in measuring the quality of service for the banking sector, has identified some 16 factors in this regard. The factors include 'Response Time', 'Security', 'Reliability', 'Responsiveness', 'Competence', 'Trust', 'Multimedia capability', 'Accessibility', 'Accuracy', 'Currency', 'Relevance', 'Understandability', 'Navigability', 'Empathy', and 'Format'. In response to an exploratory study in their paper the author linked these factors to four categories including 'Functionality', 'Content', and 'Interface design 'and 'Customer service. L. Yitong[55] mentioned that the measurement for the quality of service for the streaming service can be measured by focusing on 'Definition', 'Fluency' and 'Responsiveness'. The number of factors used to measure the quality of service are too few to be useful and also the streaming service are different in nature as compared to the electronic transactions.

George [56] has worked to identify the impact of the service dimensions on internet banking with respect to the customer satisfaction. The service quality dimensions identified were Website attributes, Reliability, Responsiveness, Fulfillment, Efficiency, and Privacy and Security. It was identified that all the factors except the efficiency factor do not have a significant influence on the customer satisfaction. The findings of the study are very crucial in improving the quality of service for internet banking to gain more customer satisfaction.

c) E-government Service Quality

The work of Alanezi [57] is focused on reformulating the SERVQUAL[42] for measuring e-government service quality. They have studied dimensions for measuring service quality in the domain of e-service, online retailing, online shopping, online banking, libraries, online travel, online financial services and web portals. They have successfully transferred the knowledge of service quality measurement from these different domains to e-government service quality. After compiling a list of fifty three dimensions from a survey of thirty two papers, they selected seven dimensions for measuring e government service quality. The seven dimensions are defined by a number of items. The dimensions and their number of associated items are website design: seven items, reliability, responsiveness, information and personalization: three items each, security/privacy: four items and easy to use dimension has two items.Another recent work [58] identified information layout and content, ease of use, performance, citizen support, behavior and public value as the primary dimensions for e-government service evaluation.

A comprehensive survey was done by Tan et al[59] to study the dimensions of e-service quality. They systematically analyzed thirty seven empirical and conceptual studies in the related areas of website quality and e-service quality. They have proposed a scale for e-government service delivery quality assessment based on eighteen statements covering six dimensions: accessibility, navigability, interoperability, adaptability, security and interactivity.

d) IT/IS Service Quality

Lepmets [60], [61] has proposed a comprehensive framework for the measurement of IT service quality. This frame work is based on SERVQUAL [42] and Practical Software Measurement [62] concepts. The framework consists of customer satisfaction, service behavior, IT service value, IT service management process performance, IT service quality and IS quality. Customer satisfaction is based on customer feedback andcustomer support while service behavior depends on IT service climate and sustainability of a service system. The suggested measurement categories for value of IT service are mutual value creation, value production and IT governance. The performance of the process for IT service management can be measured via compliance efficiency and effectiveness. The framework considers the information systems (IS) as the main channel through which the IT services are delivered. The IS service quality attributes are functional correctness, portability, availability, reliability, maintainability, component capacity, scalability and adjustability whereas they have based IT service quality on availability, continuity, capacity, performance, utilization, information security and monetary value of the IT service.

SERVQUAL has been applied by many authors to measure the performance of IT/IS services. Kettinger and Lee[63] and Pitt et al [64] have studied and stated that the dimensions of SERVQUAL are applicable to measure IT service quality. There are many reservations and concerns about this claim notably by van Dyke et al and Asubonteng et al.[65, 66]The main concern is that SERVQUAL dimensions are likely to be industry specific and simple adaptation of SERVQUAL to different sectors is not sufficient.

L. F. Pitt [67]have adopted the SERVQUAL factors for the evaluation of the quality of service of the information technology enabled services. The factors include: tangible, reliability, responsiveness, assurance, and empathy. These five factors behave like five classes and consists of the following attributes. Tangible (up-to-date computational resources, physical facilities visually appealing, smart employees and appearance of physical facilities), reliability (keeping promised deadlines, interest in solving problems, dependable, time keeping and error-free records), responsiveness (notice in advance, prompt service to users, willingness to help users and never too busy to respond), assurance (confidence in users, safe transactions, courteous with users and knowledge to do the job) and empathy (individual attention, convenient operating hours, giving user personal attention, having the user's best interest at heart and understanding the specific needs of the users).

Campbell [68] has also identified several attributes for measuring the effectiveness of the IT services, that include efficiency, profit, quality, accidents, growth, absenteeism, turn over, job satisfaction, motivation, morale, control, conflict cohesion, flexibility adaptation, planning and goal setting, goal consensus, internalization of organizational goals, role and norm congruence, managerial interpersonal skills, information management and communication, readiness, utilization of environment, evaluation by external entities, stability, value of human resources, participation and shared influence, training and development emphasis and achievement emphasis.

e) Web Service Quality

Researchers have extensively used and adapted the theory of Technology Acceptance Model (TAM) [69], the Unified Theory of Acceptance and Use of Technology (UTAUT) [70] and the DeLone and McLean model of information systems success [71] to propose models for web service quality evaluation. According to TAM users' intention to use information systems is influenced by users' beliefs about the information system. TAM states that two factors: perceived usefulness and perceived ease of use impact the intention to use a system, eventually leading to the use of the system. In line with TAM, UTAUT is also a framework for predicting the acceptance and use of IT/IS. UTAUT extends TAM and UTAUT2 has seven dimensions: facilitating condition, performance expectancy, effort expectancy, social influence, hedonic motivation, price value, and habit. DeLone and McLean include six inter-related dimensions to explain IS success in their updated model. The dimensions are system quality, information quality, service quality, use, user satisfaction and net benefits.

Udoet al [72] has drawn upon TAM, UTAUT and DeLone and McLean model to develop and test an instrument that captures the constructs of the dimensions web service quality. Their model consists of twenty seven indicators belonging to six constructs. The constructs are Individual PC skill, service convenience, perceived risk, web site content, web service quality, satisfaction and behavioral intentions. Yang et al [73]developed an instrument to measure users' perceived service quality of information presenting web portals. They identified and verified five quality dimensions: usability, usefulness of content, adequacy of information, accessibility and information.

f) Enterprise Systems Quality

Sadera [74] in her findings has come up with the identification of following factors in four classes including system quality, information quality, individual impact and organizational impact. The attributes include: ease of use, availability, learning organizational costs, ease of learning, usability, awareness/recall staff requirements, user requirements, understandability, decision effectiveness, cost reduction, system features, relevance, individual productivity, overall productivity, system accuracy, format, improved outcomes/outputs, flexibility, conciseness, increased capacity, sophistication e-government and integration business process change.

g) Service Quality in Higher Education

Much of the research on service quality in higher education can be linked with the marketing discipline [3, 4]. These scholars have mainly focused on the physical facilities or the outcomes of teaching and learning process and they have ignored the role of ITES like admissions, registrations, learning management and library systems in higher education. There is some evidence in literature about the application of service quality measures in higher education industry. Scholars have adapted SERVQUAL to do comparative analysis of nonacademic service quality assessment among students and faculty members [75]. A small scale study based on SERVQUAL was done to investigated the discrepancy between students' expectations and their perceptions towards the quality of services [76]. SERVQUAL has been modified into HEDPERF [77] and applied within a higher education setting. The concept of total quality management has also been applied in higher education industry as HETQMEX [78]. These models of service quality focus on behavioral aspects and physical facilities and have not attempted to include IT enabled services.

Noor et al [79] has investigated to identify the critical factors for measuring the quality of service in the education sector in Malaysia. The authors have used the International Islamic University of Malaysia as a test case and chose to conduct this study in the school of management. The authors have identified that

administrative service, tangibles academic programs, academic staff, delivery of teaching, assurance and empathy of academic staff. The factors are different from other factors already identified in other papers. The reason for the difference is that this specific study is specific to the education industry and the parameters for measurement are different. However this study is specific to the quality of education and the electronic / technology enabled services have not been addressed in this study.

IV. Factors for Measuring Service Quality of ITES in Higher Education

The main purpose of literature review was to identify a set of salient factors which scholars have used to measure service quality in different domains. There is a large number of studies that have attempted to identify the dimensions of service quality in the areas of marketing, retailing, e-services, e-government, web services and IT/IS services. Authors have arranged these dimensions into factors and items where each factors is described by a number of related items. After a comprehensive literature review one hundred and two unique factors were identified from twenty two studies. These factors are listed in Table 1. Besides the twenty two research papers included in our study there are numerous other articles in the extant literature on service quality measurement. The reason that we limited our study to the twenty two published papers was that we were interested in identifying as many unique factors as possible. The other studies were mostly repeating the already listed factors and there were hardly any new factors to be added to the list.

Table 1: Initial identified quality factors

No	Factor	Reference
1	Academic programs	[79]
2	Academic staff	[79]
3	Accessibility	[57][51][73][59][80]
4	Accuracy	[80]
5	Adaptability	[59]
6	Adequacy of information	[73]
7	Administrative service	[79]
8	Assurance	[42][81][49][47][48][64][79][57][53]
9	Assurance / trust	[51]
10	Availability	[57][80]
11	Behavior	[58]
12	Behavior intentions	[72]
13	Citizen support	[58]
14	Collaboration	[57]
15	Communication	[57]
16	Compensation	[50]
17	Competence	[57]
18	Completeness	[80]
19	Contact	[57][50]
20	Content	[54][57]
21	Convenience	[57]
22	Convenience of service	[72]
23	Courtesy	[57]
24	Credibility	[57]
25	Customer satisfaction	[72][61][60]
26	Customer service	[57][54]
27	Customization	[80][57][59]
28	Customization/personalization	[51]
29	Data integrity	[80]
30	Definition	[55]
31	Delivery	[57]
32	Delivery of teaching	[79]
33	Ease of navigation	[80][51]
34	Ease of use	[57][58][80]
35	Efficiency	[57][50][51][56]
36	Empathy	[64][57][42][49][47]
37	Empathy of academic staff	[79]
38	Entertainment	[57]

39	Features	[57]
40	Flexibility	[80][51]
41	Flow	[57]
42	Fluency	[55]
43	Fulfillment	[50][56][57]
44	Functionality	[57][54]
45	Graphic style	[57]
46	Incentive	[57]
47	Individual impact	[82]
48	Information	[57]
49	Information - layout and content	[58]
50	Information quality	[82][53]
51	Innovativeness	[57]
52	Interaction	[73]
53	Interactivity	[57][59]
54	Interface design	[54]
55	Interoperability	[59]
56	Intuitiveness	[57][80]
57	Linkage	[57]
58	Loyalty intentions	[50]
59	Monitoring	[59]
60	Navigability	[59]
61	Organizational impact	[82]
62	Perceived risk	[72]
63	Perceived service content quality	[59]
64	Perceived value	[50]
65	Performance	[58][57]
66	Personalization	[57][53]
67	Presentation	[80]
68	Privacy	[56][50][57]
69	Processing speed	[57]
70	Product portfolio	[57]
71	Reliability	[57][42][49][51][64][56][53]
72	Reputation	[80][57]
73	Response time	[57]
74	Responsiveness	[57][80][42][50][49][48][64][56][53][55][51]
75	Security	[56][57][59]
76	Security / privacy	[57]
77	Service differentiation	[57]
78	Service reliability	[80]
79	serviceability	[57]
80	Simplicity	[80]
81	Site aesthetics	[51]
82	Site design	[80]
83	Speed	[80]
84	Structure	[57]
85	Substitutability	[57]
86	System availability	[57][50]
87	system integrity	[57]
88	System quality	[82]
89	Tangible	[47][42][64][49][79][80]
90	Technical reliability	[80]
91	Transaction capability	[57]
92	Trust	[57]
93	Understanding	[57]
94	Usability	[73][57]
95	Usefulness	[80]
96	Usefulness of content	[73]
97	Web service quality	[72]
98	Web site content	[72]

99	Web site design	[57]
100	Website attributes	[56]
101	Website designs/ appearance / aesthetics	[57]
102	Website Usability	[53]

These factors were assessed for their applicability to the domain of ITES in higher education by a panel of experts using the Analytic Hierarchy Process [83]. As a result seventeen factors were chosen for measuring service quality of ITES in higher education and are given in Table 2.

Table 2 : Description of identified factors for measuring ITES quality.

No	Factor	Description
1	Accessibility	Accessibility is the degree to which the users are able to access the routine information as well as information related with maintenance downtime and archives and backup.
2	Customization	Customization factor is concerned with the provision of such features which allow the users to configure the ITES according to their own preferences.
3	Delivery of teaching	Delivery of teaching is the level of various academic programs offered by the university and the quality of academic staff and the learning management systems.
4	Efficiency	The factor efficiency measures the degree to which the users save time by using the ITES.
5	Functionality	Functionality refers to the degree to which the various functions are completely implemented with the ability to reflect the progress of activities and tracking of dates and events.
6	Information quality	Information quality includes accuracy, level of detail and understandability of the information delivered by ITES.
7	Interoperability	Interoperability is the level to which users are able to access and complete different ITES from the same portal or website.
8	Privacy	Privacy is the degree to which the personal information of users is protected via effective mechanisms including monitoring of inconsistent access attempts.
9	Response time	Response time factor is related with the level to which ITES response time is consistent at different times and acceptable.
10	Security	Security factor reflects the adequacy of security features implemented in the ITES.
11	Service reliability	Service reliability is the percentage of time the ITES is available for use without failure.
12	Service usability	Service usability factor refers to the degree to which the users find it easy to use the various ITES. It is understood that availability of easy to understand instructions and procedures improves service usability.
13	Site design	Site design factor measures the quality of site design in terms of user satisfaction and ease of use.
14	System integrity	System integrity is the degree to which the ITES system is able to present consistent information by eliminating redundancy and barring malicious attacks.
15	Trust	Trust factor is the level of goodness of reputation of the ITES related with the trustworthiness and consistency of information provided by them
16	Usefulness	Usefulness is the degree to which the users find it easier to do their work via the ITES in a convenient and less time consuming way.
17	User support	User support factor refers to the degree to which the ITES department personnel are willing to serve the users in case their help and support is required.

V. Conclusion and Future Work

It can be concluded that several factors for measuring the quality of ITES in higher education institutes have been identified. The identification process used the Analytic Hierarchy Process that was applied on the 102 initially identified factors from 22 recent publications. The identified factors cover several dimensions, including user support, responsiveness, trust, security, functionality and customization. In the findings of this paper seventeen quality measurement factors have been identified that can contribute in measuring the quality of ITES in any higher education institute. This study is focused to the education institutes and identified quality factors belonging to this specific domain. However, the study can be extended to derive the possible quality factors in any other scientific application / setup where the quality of services is to be quantified and scaled. Such areas include but are not limited to health information systems, library information systems and financial management systems.

VI. Acknowledgement

This research is funded by the Research and Translation Center at Prince Sultan University, Riyadh, Saudi Arabia.

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Global Journal of Computer Science and Technology: C
Software & Data Engineering
Volume 15 Issue 3 Version 1.0 Year 2015
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 0975-4172 & Print ISSN: 0975-4350

Object Oriented Database Management Systems-Concepts, Advantages, Limitations and Comparative Study with Relational Database Management Systems

By Hardeep Singh Damesha

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Abstract- Object Oriented Databases stores data in the form of objects. An Object is something uniquely identifiable which models a real world entity and has got state and behaviour. In Object Oriented based Databases capabilities of Object based paradigm for Programming and databases are combined due remove the limitations of Relational databases and on the demand of some advanced applications. In this paper, need of Object database, approaches for Object database implementation, requirements for database to an Object database, Perspectives of Object database, architecture approaches for Object databases, the achievements and weakness of Object Databases and comparison with relational database are discussed.

Keywords: *relational databases, object based databases, object and object data model.*

GJCST-C Classification : *F.3.3*

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I. Introduction

History of data processing goes through many different changes with different technologies along with the time. In decade there is huge increase in the volume of data that need to be processed due to which sometimes old technology do not work and need to come with new technology to process the data. History of database technology has used Unit Records & Punch Card, Punch Card Proliferation, Paper Data Reels, & Data Drums, File Systems, Database Systems, NoSQL and NewSQL databases. From last five decades, the mostly used technology is database management systems.

After some limitations of file systems, researchers come up with new technology known as Database Management Systems which is the collection of software or programs to maintain the data records. Initially, two models are proposed are hierarchical and network models, but these models don't get much popularity due to their complex nature. Then a researcher E.F. Codd comes up with a new data model known as relational model in which data items are stored in a table. Many DBMS's are developed on the basis of this model. This is the most popular model till now because it has conceptually foundation from relational mathematics.

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In mid-1980's ,no doubt RDBMS are very much popular but due to some limitation of relation model and RDBMS do not support for some advanced applications[1] OODB comes in the picture. At that time Object Oriented Programming paradigm is very much popular. Due to this researcher think to combine the capabilities of database and object based paradigm for programming. In Object databases data is stored in the forms of objects. These database management systems are not very much popular because due to the lack of standards.

Research is going on the database technology from 1960's up to this day. Many improvements are done in database technology by researcher in last decade and more technologies are coming to improve the database technology. The new database technologies include new transaction management and concurrency control methods and Redundant Array of Independent Disks (RAID) for efficient storage and Big Data and Cloud Computing.

II. Why Object Oriented Databases?

There are three reasons for need of OODBMS:

A. Limitation of RDBMS
B. Need for Advanced Applications
C. Popularity of Object Oriented Paradigm

A. Limitation of RDBMS

These limitations are in relational model. Due to this these limitations are reflected to all RDBMS [2]. These limitations are:

1. *Poor representation of real world entities:* The Relational model cannot represent real world in proper way because it has only one semantic that is table which can represent the real world entity in proper way.
2. *Normalization is necessary, but sometimes not useful:* Normalization in RDBMS to maintain the consistency of the database, but some broken relations is not related to real world.
3. *Overloading of semantic structure:* Relational Data Model has only one semantic structure for representing data and relationship that is table. Due

to this, sometimes it becomes very difficult to find out that which is going to model data or relationship?

4. *Poor support for integrity and enterprise constraints:* Constraints are very much needed for your database have to be desired data. RDM supports only limited number of constraints. The enterprise constraints are those which are defined by industry standards.
5. *Homogeneous data structure:* RDM requires homogeneous data structures like:
   - RDM assumes both horizontal and vertical homogeneity.
   - Relational mathematics algebra has only fixed number of operations due to which Relational Model operations cannot be extended.
6. *Tables can store only atomic/single value:* No doubt, this is property of RDM. But sometimes in many situations this property becomes its limitation.
7. *Normalization is strongly recommended:* Most of the situations, you have must normalize the relation make the data consistency inside your database.
8. *Difficulty in handling recursive queries:* There is very poor support to handle recursive queries in RDBMS. For this you must know:
   - Depth of recursive query must be known.
   - You can use the transitive closure operations to handle recursive queries in RDBMS.
9. *Impedance mismatch:* SQL Data Manipulation Language (DML) is lack computational completeness [10]. To overcome this situation, you must embed the SQL with any high programming language like C++, Java, and C #. Due to there will be impedance mismatch between two language SQL and higher programming language.
10. *Poor support for long duration transactions:* In RDBMS, generally transactions are short lived and concurrency control techniques or mechanisms are not good for .long duration transactions.
11. *Poor Schema Evolution support:* Schema Evolution means making changes to schema of database at runtime without interrupt the execution of the application.
12. *Poor Navigational Access:* There is very poor support for the navigational access in RDBMS.

There are some advanced applications need the database with deeper structural and functional foundation of capabilities that are not provided by conventional database [1]. These applications are:

B. Need for Advanced Applications

a) Computer Aided Design (CAD):

- In these types of applications, relevant data about buildings, airplanes and integrated circuit chips is stored and managed. In this type of applications, database design may be very large.
- Design in these types of applications is not static. This design is evolves through the times. Updates need to be propagated.
- These applications require version control and configuration management.
- These applications require complex objects for their development. For example, a car's component may be related to other components.
- Need long duration transactions because sometimes updates are for reaching.
- Support for cooperative engineering because most of the times many people work on same design.

b) Computer Aided manufacturing (CAM):

- These application data is very much similar to CAD, but needs discrete production.
- These applications must respond to real time events.
- Generally algorithms and custom rules are used to respond to a particular situation.

c) Computer Aided Software Engineering (CASE):

- These applications manage data about the phases of software development life cycle.
- Design may be extremely large.
- Involves cooperative work.
- Need to maintain dependencies among components.
- Versioning and configuration management.

d) Network Management Systems:

- Coordinates communication services across the network.
- These systems are used for such tasks as network path management, problem management and network planning.

e) *Other Applications:* The Object Oriented Database also used in Office Information Systems, Multimedia systems, Digital Publishing and Geographic information Systems.

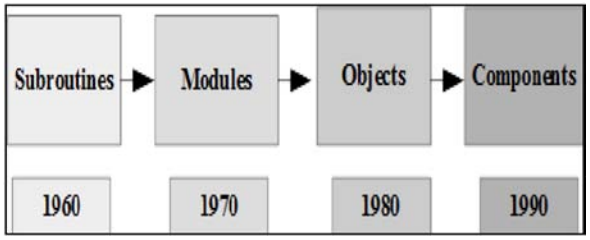
C. Popularity of Object Oriented Paradigm

Another domain that enforces the development of OODBMS is popularity of object oriented programming paradigm [4], [5], [6], [7], [8] because a real life situation can be model in best way by using object oriented programming.

OO Programming Aspects:

1. *Abstraction:* It is process of finding important aspects of an entity and ignoring unimportant aspects such as implementation details. The properties comprise two things state and behaviour. A state is models through the attributes of object and behaviour is models through operations executed on data by object.

2. *Object:* An object is something uniquely identifiable, models a real world entity and has got state and behaviour. The only big difference between entity and object is that entity has only state has no behaviour, but object contains both state and behaviour. Example: Student
3. *Encapsulation:* An object contains both current state (Attributes) and set of methods used to manipulate it. It is called encapsulation.
   Information Hiding: It is process of separates external properties of an object from its internal properties, which are hidden from external environment. These two concepts also related with abstraction.
   Importance: These two concepts support the facility that internal properties of an object to be changed without affecting applications that use it, provided external properties remain same. It also provides data independence.
4. *Attributes:* These represent the current state of an object. They can be two types:
   - Simple Attribute
   - Complex Attribute
5. *Object Identity (OID):* It is the unique identifier associated with every object in the system. It has following characteristics:
   - It is generated by system.
   - It is unique to that object in the entire system.
   - It is used only by the system, not by the user.
   - It is independent the state of the object.
6. *Methods and Messages:* These implement the behaviour of an object and involve encapsulation.
   Message: It is a request or call to an object to execute the method that is defined by message.
7. *Class:* It is Container/Template/Blue-print for objects. Objects inside a class called instances. It comprises many definitions in many different situations. For example: A Class behaves like an object with its own class data and operations.
8. *Inheritance:* It is the special type of relationship between classes: The inheriting class inherits the some or all properties of the base class depend which mode of inheritance is used. Special classes or inheriting classes are called subclasses and general classes are called super classes.
   Generalization: It is method to create a superclass is called generalization.
   Specialization: It is process of forming a sub class is called specialization.
9. *Polymorphism:* It means "many forms". It is dynamic feature which executes at run time of program. It involves the concept of overriding and overloading [10].
10. *Complex Objects:* An object is called complex object if it contains many sub objects and it is viewed as single object.
    Example: Country. Because it contains many states and again states contains cities.
11. *Relationships:* It is basically an association between two things. These are represented through reference attributes, typically implemented through OID's. Types of binary relationships are:
    - One to One relationship
    - One to Many relationship
    - Many to One relationship
    - Many to Many relationship
    - The different programming paradigm during the different decades:



    - Due to this researchers think to combine OO Paradigm and DB.

III. Approaches for OODBMS

A. Relational Extension Based DBMS
B. Object/Relational DBMS
C. Pure OODBMS

A. *Relational Extension Based DBMS*

This is the first approach that is adopted by industry and academia towards the implementations of OODBMS is to extend the relational model to provide the OO features [1], [2]. The advantages of this approach are:

- Stick to relational model
- Have to OO features like complex object and UDT (User Defined Types).

Design techniques for relational extensions: In mid-80's a researcher named Stonebraker in OODBMS field represent the design techniques in this field with different proposals for Extended Type System for an OODBMS should follow:

- Definition of new data types
- Definition of new operations of so defined data types.
- Implementation of access methods.
- Optimized query processing for the queries on new data types.

Other Extensions in RDBMS: The different techniques are adopted by different DBMS to support to support OO features:

- Support for variable length "undefined" data values. Using this support, generalized user defined data types can be represented. Like Oracle supported RAW, LONG and LONGRAW (65535 bytes).

- Sybase support TEXT and IMAGE up to 2GB and also others. These features were partial support for storing complex data. Such facilities were mainly used to capture non-text data like voice, medical charts and fingerprints.
- User defined procedure are associated with used defined data types.
- Example: POSTGRES

Postgres: It is developed at UC Berkeley in mid-80 by Prof. Stonebroker and his group. It is commercialized as ILLUSTRA. In this INGRES which is basically a relational database management system to support OO features. Basic idea in POSTGRES was to introduce minimum changes in the Codd's original relational model to achieve the objective. Advantage is the continuity with the previous product (INGRES) and provision of OO features in the new product. Design objectives of POSTGRES declared by Stonebraker were:

- To provide fully implemented functionality of complex objects.
- Support for User/Abstract Defined Types, operators and functions for accessing.
- To provide functionality of Active Databases and Inferencing.
- QUEL is the manipulation language in INGRES.
- POSTQUEL in POSTGRES :Most of QUEL commands are included in POSTQUEL:
  1. Time varying data (snapshots and historical data)
  2. Iterative queries
  3. Alerters, Triggers and Rules for Inferencing.

B. *Object/Relational DBMS*

These systems have relational and object based both features by the definition [1], [2]. They provide similar objectives as provided by the Relational Extension approach of RDBMS. In this approach, build an object layer on the top of relational system like Open ODB and ODAPTER. They are built on different architectures like Query Server or Client/Server.

Open ODB/ODAPTER: Open ODB is an ORDBMS from HP during mid's 90 and aims to support for broad base applications. It has following features:

- Based on Iris DBMS
- Based on Client/Server architectures
- Both data and applications can be shared by the user applications.
- Clients use Application Program Interface (API) to access information.
- OSQL is data manipulation language for Open ODB/ODAPTER.
- Open ODB uses relational techniques to support to OO features.
- Object Model is implemented by Object Manager.
- Mapping to OO schema and queries to relational ones.
- The underlying relational storage manager is ALLBASE/SQL.

C. *Pure OODBMS*

These type OODB's systems are not much popular because lack of standards [9]. There is no single definition for a single concept. For Example: An Object has many definitions, but in RDB there is a fixed standard for or single definition for each concept like table .Here defining some definitions which are mostly accepted but not standardize [2].

OODB Model: It is data model that capture semantics of objects suited in object based programming paradigm.

ZDONIK and MAIER give a threshold model that an Object database must have following features:

- Database functionality like transaction management, concurrency control etc.
- Facility of Object Identity (OID).
- Facility of encapsulation.
- Facility of complex objects.
- Inheritance not must but may useful.

OODB: It is permanently stored and sharable collection of objects suited with an Object Data Model.

OODBMS: It is system which contains application programs which are used to manage all object oriented database activities like manipulation of objects.

Some Commercial OODBMS [9]:

- Gemstone OODBMS is developed by Gemstone Systems Incorporation.
- Objectivity/DB OODBMS is developed by Objectivity Incorporation.
- Objectstore OODBMS is developed by Progress Software Corporation.
- Ontos OODBMS is developed by Ontos Incorporation.
- DB4O from Versant Corporation.

IV. Oodbms Manifesto

a) *Mandatory Features*

The OODBMS paradigm manifesto set the minimum fundamental directional basis for an OODBMS model [3], [4], [5, [8].These characteristics can be classified as mandatory and optional features:

1. *Support for complex objects:* A OODBMS must support for complex objects. Complex objects can be obtained by applying constructor on basic objects.
2. *Object Identity:* It is the unique identifier associated with every object in the system. It has following characteristics:
   - It is generated by system.

- It is unique to that object in the entire system.
- It is used only by the system, not by the user.
- It is independent the state of the object.

3. *Encapsulation:* An OODBMS should enforce encapsulation through access objects only.
4. *Types or Classes:* A OODBMS must support for one of them types or classes.
5. *Inheritance and Hierarchies:* A OODBMS must support for concept of super classes and subclasses. The types of heritance can be:
   - Substitution
   - Inclusion
   - Constraint
   - Specialization
6. *Dynamic Binding:* An OODBMS must support concept of dynamic binding in programming language such as:
   - Overloading
   - Overriding
   - Late binding
7. *Computationally Complete DML:* To provide a support for data processing database have use computationally completely language like SQL-3.
8. *Extensible set of data types:* A OODBMS must support for used defined data types.
9. *Data Persistence:* This is basic requirement for any DBMS.A OODBMS must provide persistent by storing object in proper way.
10. *Managing very large databases:* A OODBMS must support for large databases.
11. *Concurrent Users:* This is basic requirement for any DBMS. It must support for concurrency control.
12. *Transaction Management:* This is also basic requirement of any DBMS.
13. *Query Language:* This is also a basic requirement of any DBMS. This query language must be computationally complete.

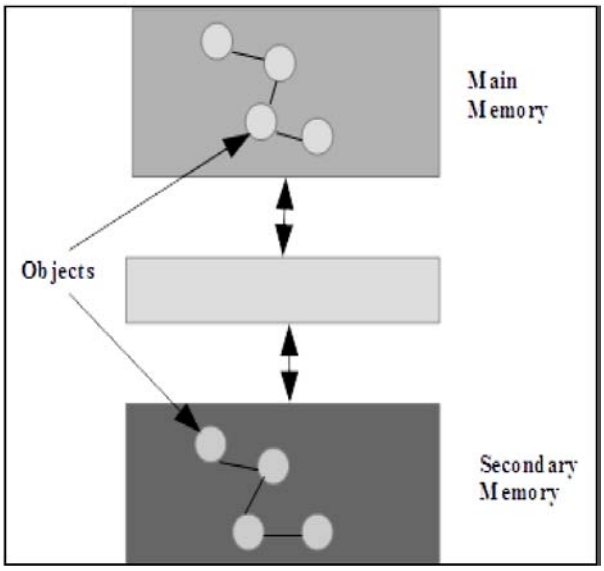
b) Optional Features

1. *Multiple Inheritance:* Multiple inheritance is not directly support by multiple objects oriented programming languages. An OODBMS can also support for multiple inheritance.
2. *Type checking and inferencing:* Type Checking and Inferencing features can be added to Object Databases.
3. *Long duration and Nested Transactions:* Relational database transactions are short-lived. An OODBMS can support for .long duration transactions and also for nested transactions.
4. *Distributed databases:* An object database may have support for distributed database which is a collection of multiple databases logically related and distributed over the network.
5. *Versions:* An OODBMS can support for version control and configuration management.

V. OODBMS Perspectives

Memory Management in OODBMS: There are different memory management techniques for different OODB systems [2]. For Extended Relational Model database Systems and Object/Relational (by definition) Database Systems (ORDBMS) Two Level Storage Model is used and for pure OODBMS is Single Level Storage Model is used.

a) Single Level Storage Model



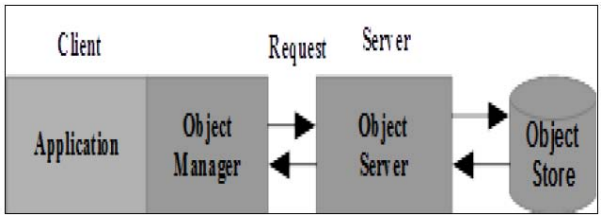
VI. OODBMS Architectures Approaches

The basic theme of OODBMS is to add persistence to OOPL as they provide object orientation. The major difference is that here database needs to store data as well as methods [1].

Client/Server Architecture: There three basic client/server architecture approaches [2]:

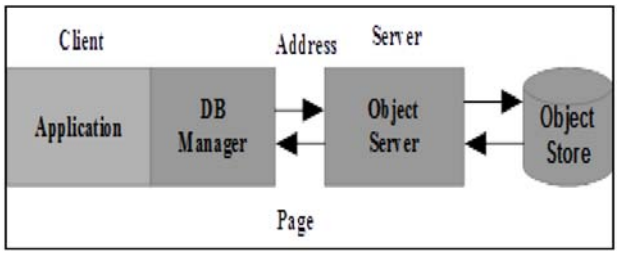
a) Object Server
b) Page Server
c) Database Server

a) *Object Server:* There is a distributed processing environment between the two parts client and server. Typically, server is responsible for other OODBMs functions. Transaction control management and interface to programming language is handled by Client.

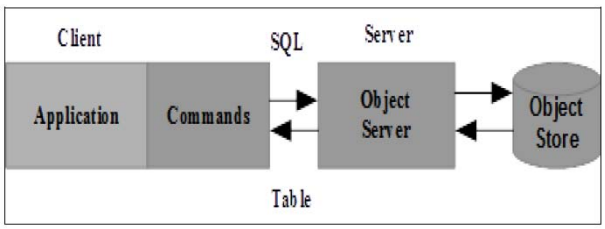


b) *Page Server:* In this client-server model, client is responsible for database processing most of the times. Secondary storage management and

response to requests is handled by server. A page can contain many complex objects or normal objects.



c) *Database Server:* In this approach, Client simply passes the request to the server, receives results and passes them to application. Most of database processing done at server .This approach is used mainly by RDBMS's.



VII. Achievements and Weaknesses of OODBMS

a) Achievements

1. *Support for User Defined data types:* OODBs provides the facilities of defining new user defined data types and to maintain them [9].
2. *OODB's allow creating new type of relationships:* OODBs allow creating a new type of relationship between objects is called inverse relationship (a binary relationship) [11].
3. *No need of keys for identification:* Unlike, relational model, object data model uses object identity (OID) to identify object in the system [8].
4. *Development of Equality predicates:* In OODBs, four types equality predicates [8], [10] are:
   - Identity equality
   - Value equality of objects
   - Value equality of properties
   - Identity equality of properties
5. *No need of joins for OODBMS's:* OODBs has ability to reduce the need of joins [9].
6. *Performance gains over RDBMS:* Performance gains changes application to application. Applications that make the use of object identity concept having performance gains over RDBMS's [9].
7. *Provide Facility for versioning management:* The control mechanisms are missing in most of the RDBMS's, but it is supported by the OODBMS's [9].
8. *Support for nested and long Duration transactions:* Most of the RDBMS's do not support for long and nested transactions, but OODBMS's support for nested and long duration transactions [9].
9. *Development of object algebra:* Relational algebra is based on relational mathematics and fully implemented, but object algebra has not been defined in proper way. Five fundamental object preserving operators are [12]: union, difference, select, generate and map.

d) Weaknesses

1. *Coherency between Relational and Object Model:* Relational databases are founded in every organization. To overcome relational databases, object databases have to be providing coherent services to users to migrate from relational database to object database. Architecture of Relational model and Object model must be provide some coherency between them [9].
2. *Optimization of Query Expression:* Query expression optimization is done to increase the performance of the system [13].Optimization of queries is very important for performance gains. But due to following reasons it is difficult to optimize queries in object databases:
   - User defined data types
   - Changing variety of types
   - Complex objects, methods and encapsulation
   - Object Query language has nested structure
   - Object Identity
3. *No fixed query algebra for OODBMS's:* Due to lack of the standards in OODBMS, there is no standard query algebra for OODB. Lack of standard query algebra becomes one of the reasons for problem of query optimization. There are different query languages for different object databases.
4. *No full-fledged query system:* Query system also not fully implemented. Some query facilities lacks in Object databases like nested sub-queries, set queries and aggregation function [9], [11].
5. *No facility for Views:* In relational databases, views are temporary tables. Object databases having no facility for views. An object oriented view capability is difficult to implement due to the features of Object Model such as object identity. Object oriented programming concepts like inheritance and encapsulation makes the difficult to implement views in object databases [11].
6. *Security problems in Object databases:* Security is related to authentication, authorization and accounting. Discretionary Access Control (DAC), Mandatory Access Control (MAC) security policies are implemented in object databases to secure data. In some systems provide security on the basis of object oriented concepts like encapsulation. Object database having to facilities for authorization [9].

7. *No support for schema evolution with OODBs:* Most object databases do not allow schema evolution. Schema Evolution is facility which allows changing the schema at run time such as adding a new attributes or methods to the class, adding new superclass to the class.
8. *Consistency constraints mechanisms are not fully implemented:* Only limited numbers of features are provided by OODBMS's for uniqueness of constraints, integrity constraints and other enterprise constraints [11].
9. *No full-fledged facilities to implement complex objects:* No doubt, object oriented databases provide some facilities to implement the concept of complex objects. But there is no full –fledged implementation of complex objects [11].
10. *Interoperability between OODB and Object Oriented Systems:* In Object Oriented Programming objects are transient in nature. To provide persistent to data, OODB and OO systems need to be interoperable. Many problems may arise during interoperable between OODB and OO systems [11].
11. *Limited performance gains over RDBs Decrease in performance:* Performance gains changes application to application. Applications that make the use of object identity concept having performance gains over RDBMS's. But application that requires bulk database loading and does not make use of OID then performance of OODBMS's is not good [9].
12. *Some basic features are not present:* Some basic features like triggers, meta data management [11] and constraints such as UNIQUE and NULL [9] not present in object databases.

VIII. Comparison of OODBMS and RDBMS

Parameter	OODBMS	RDBMS
Model	OODB Model	Relational Model
Standards	Lack of standards	Fully standardized
OO Programming	Direct and extensive	No Direct Support
Name Of Standards	ODMG-3.0	SQL2(ANSI X3H2)
Conceptually Foundation	No particular	Relational Mathematics
Relationships	Support only for simple and Complex relationships	Support only for simple relationships
User Defined Types	Full support for UDTs	Less Support for UDT's
Advanced Applications	Full support for advanced applications	No support for advanced applications
Complex Objects	Support for complex objects, but not to full extent	Less support for complex objects
Navigational Access	Good	Poor
Schema Evolution	Easy	Difficult
Transactions	Long-lived	Short-lived
Query Language	Depend upon product	SQL
Recursive Queries	Easy to handle	Difficult to handle
SQL	computationally complete	Not computationally complete
Normalization	No need	Strongly recommended
Store data in	Object	Table
Representation	Strong representation for real world entity	Poor representation for real world entity
Semantic nature	Semantically very strong	Semantically very weak
Constraints	Integrity constraints and Enterprise constraints are fully implemented	Integrity constraints and other Enterprise constraints are not fully implemented
Algebra	Object Algebra	Relational Algebra
Operations	Easily extension of operations	Fixed set of operations due to relational algebra
Multimedia data	Full support for multimedia data	Less support for multimedia data

IX. Summary and Conclusion

No doubt, relational databases are very popular and there are found everywhere. The object oriented database comes into action in mid-1985's to remove the limitations and to support some advanced database applications like CAD, CASE etc. Another point that provides the momentum to develop object based database is popularity of object based programming. So; researchers in the field of database think to combine the object oriented programming concepts with database to make powerful database management systems. Different approaches are adopted by industry to make the database with object oriented features. These approaches include relational extensions and pure object oriented are most popular to develop object oriented database systems. OODBMS's are made by many vendors by using different approaches. OODBMS's removes the limitations of RDBMS's, also provide support for advanced database application with some additional features. But due to the lack of standards, they do not get much popularity in the industry. Then after some time, some limitations are found in object oriented database management systems.

X. Acknowledgement

The Author would like to special thanks Sardar Chet Singh Damesha, Sardarni Sachiar Kaur Damesha and whole Damesha family for inspiring me everytime and always with me.

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Global Journal of Computer Science and Technology: C
Software & Data Engineering
Volume 15 Issue 3 Version 1.0 Year 2015
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 0975-4172 & Print ISSN: 0975-4350

Data Security Using Tree Traversal

By L. Eswara Chandra Vidya Sagar

K.L. University, India

Abstract- We all know that presently in 21st century one of the most emerging problem is Data Security. There is no guarantee that the data we have sent may be hacked by any Hacker or the data we have sent may reach correctly to the receiver or not. So many data security techniques have been emerged from past 2 to 3 years. But still we need a best technique to protect the data from third parties.

Cryptography is an art of scrambling the data in order to provide security and confidentiality. Cryptography is being used in order for the securely transmission of the data. This paper provides a new idea for Data encryption and decryption in order to provide security for data.

Keywords: *cryptography, encryption, decryption, hacker.*

GJCST-C Classification : *G.2.2*

Strictly as per the compliance and regulations of:

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I. Introduction

Cryptography is an art of hiding information. A lot of research has been done in the field of cryptography. There are various encryption algorithms used for secure data transmission. For example like security using Random number generator using chipper text and by using symmetric and asymmetric keys.

But still a new algorithms are emerging because still we require a better technique for data encryption and decryption. Better technique in a sense stronger the security. For a strong security so many persons are using two encryption algorithms at encryption side. But it takes long time for decryption.

Our technique Data security using Tree traversal overcomes the problem of week security because it is more difficult to decrypt the information by any unauthorized user.

In this mechanism we are using one of the important part of Data Structures that is Trees. Now let us discuss the topics required to be known in Data Structures to understand this paper.

Tree is a widely used abstract data type (ADT) or data structure implementing this ADT that simulates a hierarchical tree structure, with a root value and subtrees of children, represented as a set of linked nodes.

For example your family can also be represented in tree like your grandfather will be root your grandfather children's are nodes to your grandfather and your are node to your father like this a family can be represented in the form of a tree.

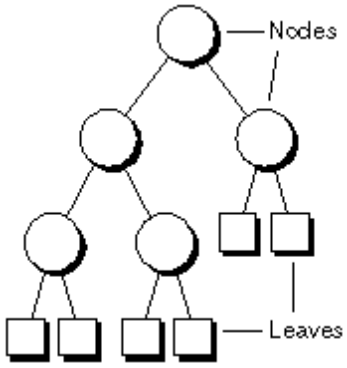

Figure 1: Represents the Tree Data Structure

Tree traversal (also called tree search) could be a sort of graph traversal and refers to the method of visiting (examining and/or updating) every node in an exceedingly tree system, precisely once, in an exceedingly systematic method. Such traversals area unit classified by the order within which the nodes area unit visited.

There are mainly three types of tree traversals they are INORDER, PREORDER, POSTORDER. Order of visiting nodes by In-order is "Left Root Right" by Pre-order is" Root Left Right" by Post-order is "Left Right Root" . These traversals are clearly represented in below diagram.

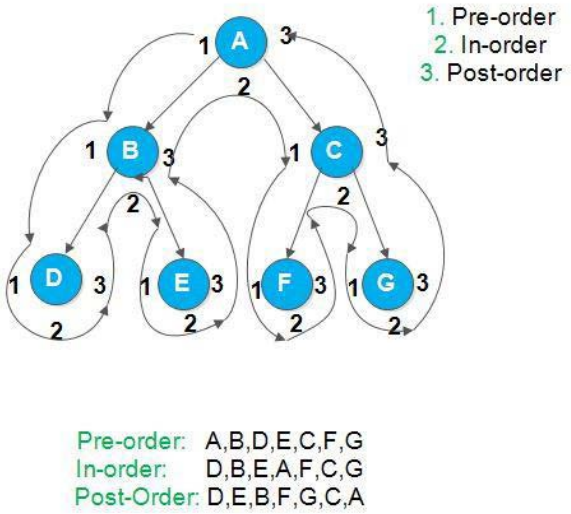

Figure 2 : Represents the Three Tree Traversals

II. Our Proposed idea

The Idea we are going to propose is mainly divided into two types one is mechanism followed at sender for encryption and another mechanism followed

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at receiver for decryption. Let us discuss clearly about encryption mechanism

The steps to be followed during encryption is explained in below flow chart

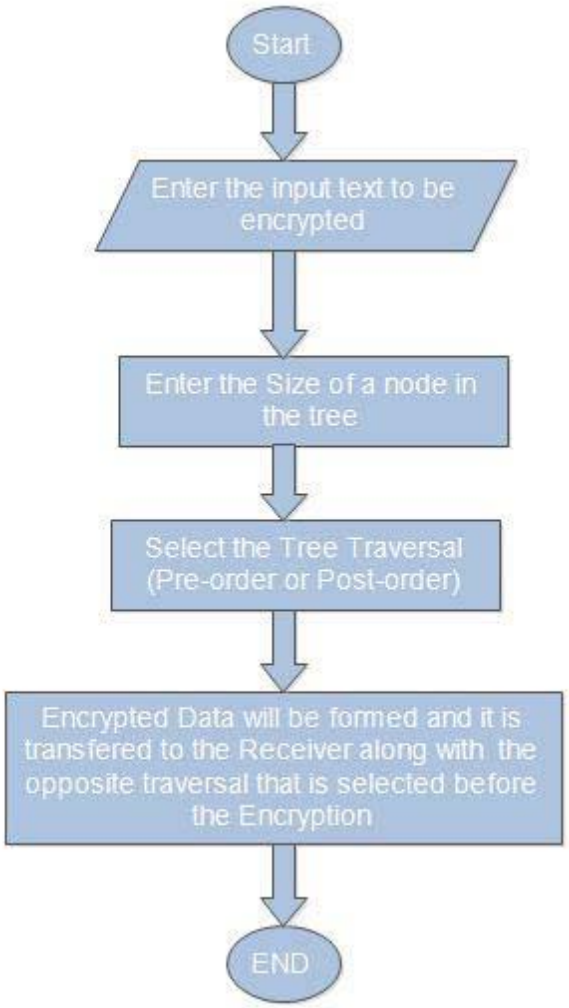

Figure 3 : Steps @ sender for Encryption

First read the text wishing to send identify the length of the sending text identify the required node length and divide the length of text with node size then create the number of nodes based on the outcome from the above operation.

Arrange the text in the nodes in the form of BFS mechanism after arranging the text we will get an trees structure then apply the in-order and either pre-order or post-order on the arranged tree. Send the traversal outcomes to the receiver then receiver apply the decryption mechanism.

This is explained with an example let us consider a text as

"Hello World this is the new encryption technique" and node size as "7" means each node can hold 7 character including spaces provided in the text. Tree formed contains 7 nodes since when we divide length on the above string with node size we will get output as 7 i:e No. of Nodes=Abs ((length of string (49)/Node size (7)).

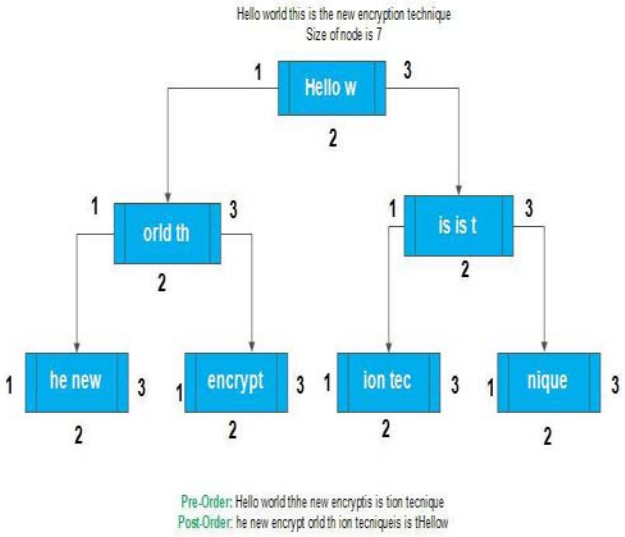

Figure 4 : Example for encryption

Pre-order and post-order is shown in the above diagram now apply in-order traversal to the above then send the in-order and pre-order traversal data to receiver. Receiver can decrypt only when he had in-order and either pre-order or post-order data otherwise no one can decrypt it.

The steps to be followed at reception end by the desired receiver are

First receiver have to receive both the in-order and either pre-order or post-order data. After that construct a tree with max 2 child for each node. After forming the tree apply the mechanism of BFS (Berth First Search). Detailed information about BFS can be available in Internet. When you apply the BFS for the tree formed from the received traversal data the receiver will get the original data send by the sender.

In this way the reception procedure follows the above procedure is explained with an example in below section along with required flow chart. 3

Take the sample example that is taken at sender side or for encryption. i:e "Hello World this is the new encryption technique". So receiver receives in-order and post-order for the above text.

In-order Data: *"he neworld th encrypt Hello W ion tec is is t nique"*

Post-order Data*: "he new encrypt orld th ion techniqueis is t Hellow ".*

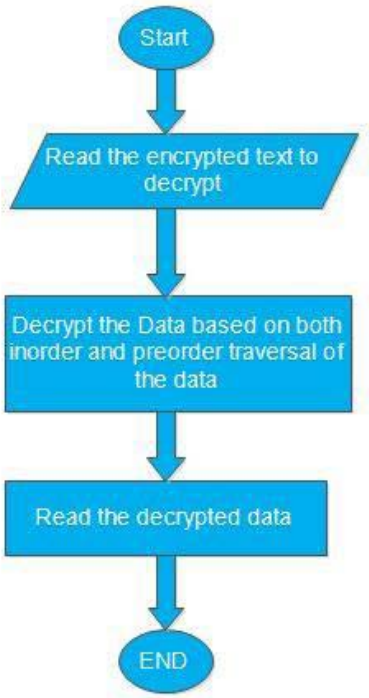

Figure 5 : Describes the method to be followed at decryption end

After receiving the data construct a binary tree with the help of in-order and post –order data received after that apply the BFS you will get the required data.

Constructing a tree based on the traversal data is explained in this section. Before constructing we need to know is that for in-order the visiting of node sequence is left, root, right and for pre-order is root, left, right for post-order is left, right, root. First take the 7 characters from the received post-order data and match the position of selected data in in-order and keep it as root node for the tree that is to be constructed from the root node the left side text is left tree and right side text is right tree.

Follow the procedure till you reach the last node of a tree.

In this way a tree is constructed after constructing apply BFS.

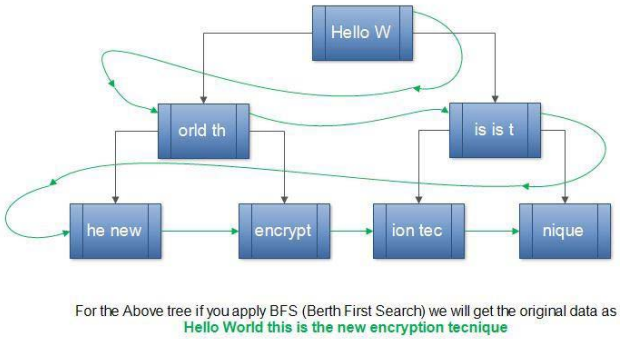

Figure 6 : Describes application of BFS on the derived tree This is all the data related to decryption end.

a) Advantages

- This mechanism provides more security for the data from hackers means the performance of secure level is more

b) Dis-Advantages

- Memory wastage because of sending the data in two different traversals
- Developing of algorithm for this mechanism is somewhat complex.

III. Conclusion

According to me this the best encryption and decryption techniques using tree traversal mechanism which provides high end security to the data and the development of the mechanism is explained in this paper completely.

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Global Journal of Computer Science and Technology: C
Software & Data Engineering
Volume 15 Issue 3 Version 1.0 Year 2015
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 0975-4172 & Print ISSN: 0975-4350

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Keywords: chloroplast; microsatellites; bioinformatics; genomes; repeats; distribution; computational analysis;.

I. Introduction

Chloroplasts, the organelles responsible for photosynthesis, are in many respects similar to mitochondria. Both chloroplasts and mitochondria function to generate metabolic energy, evolved by endosymbiosis, contain their own genetic systems, and replicate by division. However, chloroplasts are larger and more complex than mitochondria, and they perform several critical tasks in addition to the generation of ATP. Most importantly, chloroplasts are responsible for the photosynthetic conversion of Carbon Di-oxide to carbohydrates. In addition, chloroplasts synthesize amino acids, fatty acids, and the lipid components of their own membranes. The reduction of nitrite to ammonia, an essential step in the incorporation of nitrogen into organic compounds, also occurs in chloroplasts. Moreover, chloroplasts are only one of several types of related organelles (plastids) that play a variety of roles in plant cells[1-7].

Microsatellites (sometimes referred to as a variable number of tandem repeats or VNTRs) are short segments of DNA that have a repeated sequence, and they tend to occur in DNA. In some microsatellites, the repeated unit may occur four times, in others it may be seven, or two, or three[8]. These repeats are ubiquitous in nature and are responsible for causing several diseases and cancers [9][10].

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These are used in various applications like DNA Fingerprinting, DNA Forensics, Paternity Studies, and have been considered as potential markers for identifying species, for establishing phylogenetic relationships and also to study evolution [11]. Microsatellites are ubiquitously found in both coding and non-coding regions of all organisms and their distribution in coding regions (genes) is known to affect protein formation and gene regulation [12].

Next-generation sequencing enabled researchers to study biological systems at a level never before possible. Studying mutations in chloroplast microsatellite repeats can be very helpful to understand various biological questions and their usage in various other diverse applications. Few studies [13-16] earlier analyzed the distribution of microsatellites in chloroplast genomes but they are only confined to single or very low number of genomes. This paper describes the study performed to analyze microsatellite repeats in more than 370 chloroplasts genomes and details have been presented.

II. Materials & Methods

Imperfect microsatellites have been extracted from Chloro Mito SSRDB[17] version 2.0, an open-source microsatellite repository of sequenced organelle genomes. For this study, a total of 370 chloroplast genome sequences have been used that belong to various classes as shown in Table 1.

Table 1 : Category-wise chloroplast genomes used in this analysis and their numbers.

Category	Total No.
Alveolata	9
Cryptophyta	3
Euglenozoa	5
Glaucocystophyceae	1
Haptophyceae	4
Rhizaria	2
Rhodophyta	9
Stramenopiles	14
Viridiplantae	323
Total Genomes	370

Among the 370 genomes, 323 genomes belong to Viridiplantae (Green Plants), 47 genomes belongs to Non-Viridiplantae which include genomes of Alveolata, Cryptophyta, Euglenozoa, Glaucocystophyceae, Haptophyceae, Rhizaria, Rhodophyta and

Stramenopiles (Refer Table 1). A total of 78,536 microsatellites from these 370 genomes have been analyzed by querying the database Chloro MitoSSRDB2.0 using in-house C and Java programs. The current study focuses on microsatellite distribution and their frequency of occurrence in the two major categories namely Viridiplantae, and Non-Viridiplantae.

III. Discussion

a) Genome Size Analysis

We did a preliminary study to analyze the genome sizes of all chloroplasts. The chloroplast genome sizes vary from few kbs to a maximum of 1 Mb. The smallest chloroplast genome reported is of size 29529bp that belongs to plant named Plasmodium falciparum HB3 apicoplast (ID: NC_017928) belongs to Non- Viridiplantae category. The largest chloroplast genome spans about 1021616 bp of length that belongs to Paulinella chromatophora chromatophore (ID: NC_011087) belongs to Rhizaria.

In Viridiplantae, the smallest chloroplast genome is Helicosporidium sp. ex Simulium jonesii plastid(ID: NC_008100) of length 37454 bp where as the largest chloroplast genome is Floydiella terrestris(ID: NC_014346) chloroplast of length 521168 bp.

In Non- Viridiplantae, the smallest chloroplast genome is found as Plasmodium falciparum HB3 apicoplast (ID: NC_017928) of length 29529 bp where as the largest chloroplast genome is Paulinella chromatophora chromatophore (ID: NC_011087) chloroplast of length 1021616 bp. It is observed that this non-Virdiplantae category genome size is greater than the Viridiplantae genomes.

When the average genome sizes of chloroplast are considered category wise, it has been observed that the average lengths of Viridiplantae chloroplast genomes are little bit higher when compared to those of other non Virdiplantae(Refer Fig 1).

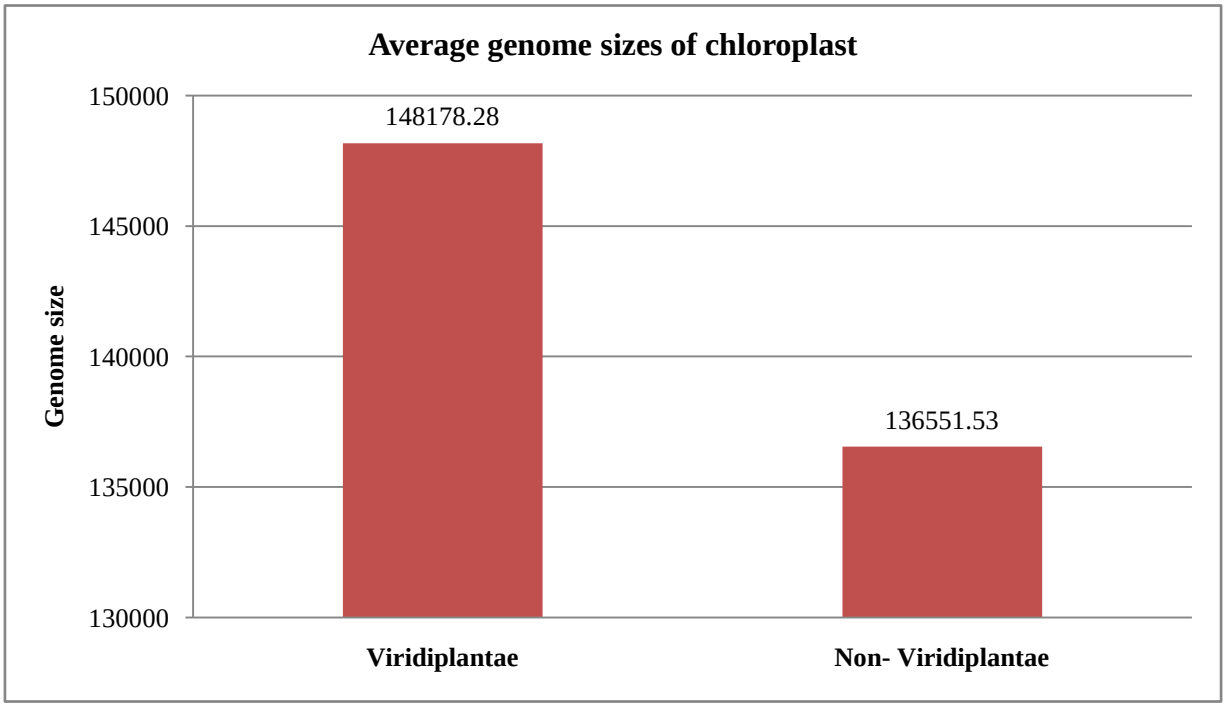

Figure 1 : Bar Graph representing the average genome sizes of Viridiplantae and Non-Viridiplantae

Table 2 gives a summary of the total number of genomes categorized based on genome sizes of the two classes of chloroplast. It has been observed that majority of the genome sizes lie between 10kb to 500kb, only two genomes namely *Floydiella terrestris* chloroplast (NC_014346) and *Paulinella chromatophora* chromatophore (NC_011087) are found to be greater than 500kb. On the other hand, 311 plants of Viridiplantae show genome sizes between 100kb and 500kb.

Table 2 : Chloroplast Genome Sizes and their classification based on different size ranges

Size Range	No. of plants
>= 10 Kb and <50 Kb	
Non- Viridiplantae	5
Viridiplantae	2
>= 50 Kb and <100 Kb	
Non- Viridiplantae	10
Viridiplantae	9
>= 100 Kb and <500 Kb	
Non- Viridiplantae	31

Viridiplantae	311
>= 500 Kb and < 1Mb	
Viridiplantae	1
>1Mb	
Non- Viridiplantae	1

b) Distribution of Microsatellites

Microsatellites in or near genes (coding regions) are found to impact protein formation and gene regulation. When the distribution of microsatellites has been analyzed overall, it is found that around 57% of microsatellite repeats fall in coding regions of all chloroplast genomes. Out of the total 78536 chloroplast microsatellites, 45518 microsatellites fall in gene regions where as the rest 33018 repeats fall in non-coding regions. However, it is surprising to see that the distribution differs when the two classes have been compared separately (Refer Fig.2).

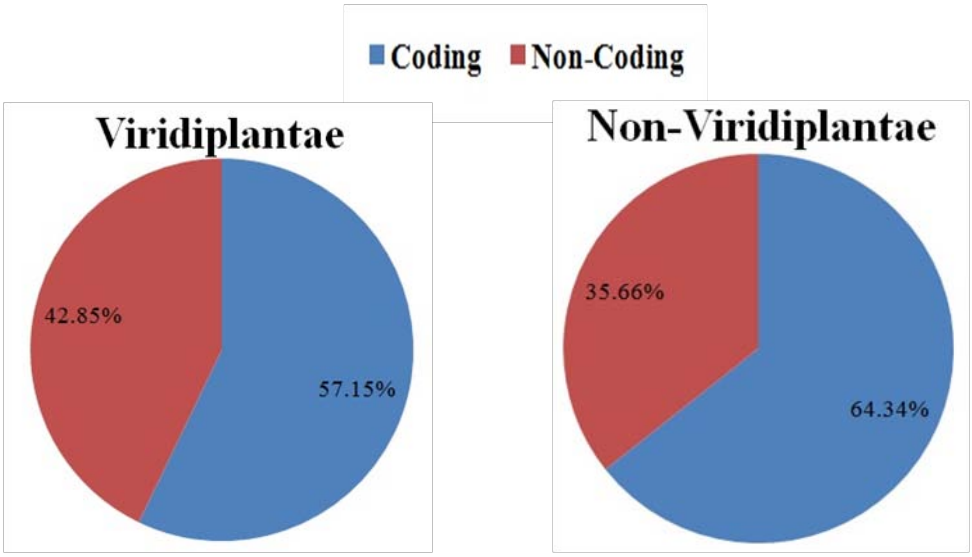

Figure 2 : Distribution of Microsatellite Repeats in Coding and Non-coding regions of Viridiplantae, Non-Viridiplantae

Genomes of Non-Viridiplantae are found to be having majority of its microsatellites in coding regions (64%). On the other hand, green plants (Viridiplantae) show that around 57% of their microsatellites to be distributed in coding regions. When two chloroplast categories are compared (Refer Fig. 3), these two categories exhibit a similar distribution of its microsatellites in coding and non coding regions.

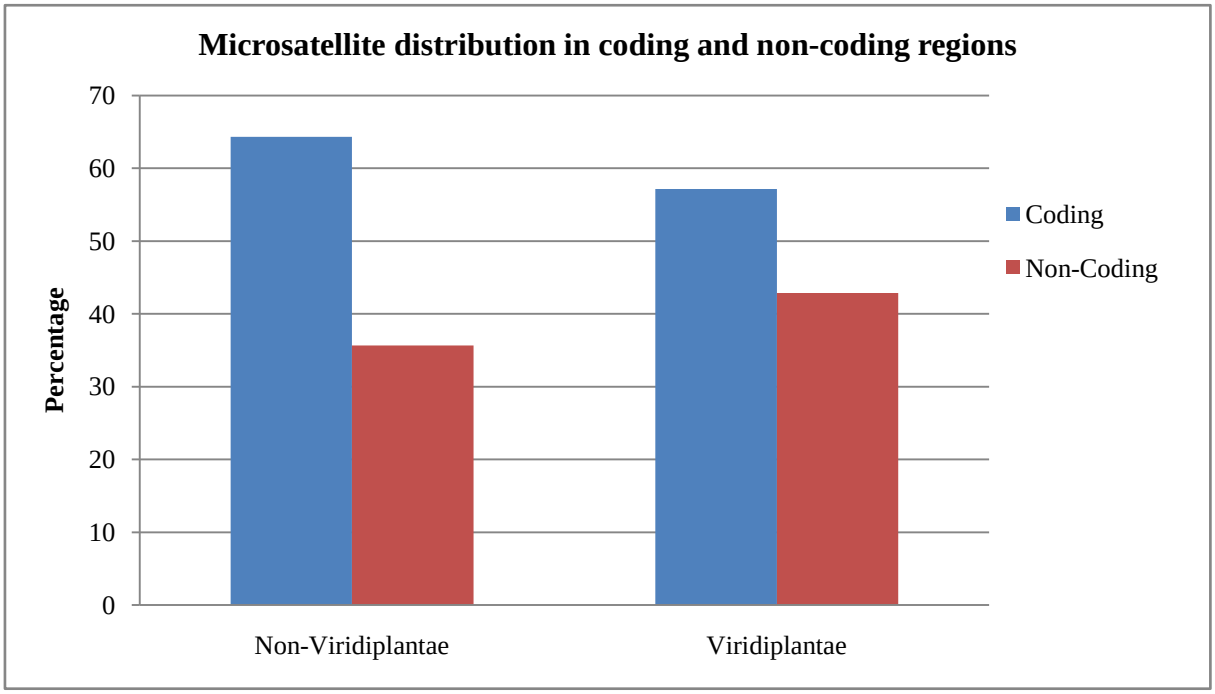

Figure 3 : Distribution of Microsatellite Repeats in Coding and Non-coding for all chloroplast Categories

It would be interesting to study the reason behind the major number of microsatellite repeats in Viridiplantae.

c) Motif-size wise Analysis

We have further analyzed the distribution of chloroplast microsatellites based on their motif sizes. Table 3 lists the proportionate distribution of chloroplast microsatellites motif-size wise. It has been observed that chloroplast genomes are rich in tri and tetra nucleotide repeats which tohether account for more than 77% in Non-virdiplantae, and around 62% in Virdiplantae. Mono, Penta and Hexa-nucleotide repeats are found to be very low in number.

Table 3 : Motif-size wise distribution of Microsatellites in chloroplast Genomes of Non-Viridiplantae and Viridiplantae

Motif Size	Non-Viridiplantae	Viridiplantae
Mono	159(1.80%)	8602(12.33%)
Di	840(9.55%)	7909(11.34%)
Tri	3506(39.87%)	17055(24.45%)
Tetra	3300(37.52)	26796(38.42%)
Penta	623(7.08%)	5680(8.14%)
Hexa	365(4.15%)	3701(5.31%)
Total	8793	69743

When the microsatellite tract lengths have been analyzed, the genomes reported few interesting tract lengths for almost all motif sizes. The average microsatellite tract lengths are usually observed to be not more than 19 bp. But, it is surprising to note that some of the tetra and tri repeats have shown exceptional tract lengths as large as 276bp have been observed.

Table 4 : Motif-size wise report Microsatellite Tract Lengths (High, Low and Average) in chloroplast Genomes of Non-Virdiplantae and Viridiplantae

	Non-Viridiplantae			Viridiplantae		
Motif Size	High	Low	Avg	High	Low	Avg
MONO	25	12	13.93	46	12	14.49
DI	54	11	12.90	83	11	13.24
TRI	51	11	12.19	276	11	12.38
TETRA	29	11	11.91	203	11	12.13
PENTA	65	14	15.27	100	14	15.41
HEXA	42	17	18.74	145	17	19.70

Based on the results in Table 4, we have further tried to find repeats in chloroplast genomes that have exceptional tract lengths. Interestingly, we found 10 repeats in chloroplast with tract lengths 100bp or more; out of those, two repeats have tract lengths 200bp or more. Two significant tract lengths of 276 and 203 have been reported for genomes with IDs NC_020321, NC_008117 respectively.

IV. Conclusion

In this paper, we have presented a brief description about the distribution of microsatellite repeats in all sequenced chloroplast genomes of Plants. This study forms the first comprehensive analysis of microsatellite repeats in chloroplast genomes and the statistics of this study can be a useful resource for biologists.

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- Present a background, such as by describing the question that was addressed by creation an exacting study.
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- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or in manuscript form.

What to stay away from

- Do not discuss or infer your outcome, report surroundings information, or try to explain anything.
- Not at all, take in raw data or intermediate calculations in a research manuscript.
- Do not present the similar data more than once.
- Manuscript should complement any figures or tables, not duplicate the identical information.
- Never confuse figures with tables - there is a difference.

Approach

- As forever, use past tense when you submit to your results, and put the whole thing in a reasonable order.
- Put figures and tables, appropriately numbered, in order at the end of the report
- If you desire, you may place your figures and tables properly within the text of your results part.

Figures and tables

- If you put figures and tables at the end of the details, make certain that they are visibly distinguished from any attach appendix materials, such as raw facts
- Despite of position, each figure must be numbered one after the other and complete with subtitle
- In spite of position, each table must be titled, numbered one after the other and complete with heading
- All figure and table must be adequately complete that it could situate on its own, divide from text

Discussion:

The Discussion is expected the trickiest segment to write and describe. A lot of papers submitted for journal are discarded based on problems with the Discussion. There is no head of state for how long a argument should be. Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implication of the study. The purpose here is to offer an understanding of your results and hold up for all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of result should be visibly described. Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved with prospect, and let it drop at that.

- Make a decision if each premise is supported, discarded, or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."
- Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work
- You may propose future guidelines, such as how the experiment might be personalized to accomplish a new idea.
- Give details all of your remarks as much as possible, focus on mechanisms.
- Make a decision if the tentative design sufficiently addressed the theory, and whether or not it was correctly restricted.
- Try to present substitute explanations if sensible alternatives be present.
- One research will not counter an overall question, so maintain the large picture in mind, where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

- When you refer to information, differentiate data generated by your own studies from available information
- Submit to work done by specific persons (including you) in past tense.
- Submit to generally acknowledged facts and main beliefs in present tense.

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Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

INDEX

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ISSN 9754350