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EDITORIAL

In this fourth edition of 2010, we bring forward issues from various dynamic computer science areas ranging from system performance, computer vision, artificial intelligence, ontologies, software engineering, multimedia, pattern recognition, information retrieval, databases, security and networking among others.

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As always we thank all our reviewers for providing constructive comments on papers sent to them for review. This helps enormously in improving the quality of papers published in this issue.

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We are pleased to present IJCSI Volume 7, Issue 4, July 2010, split in nine numbers (IJCSI Vol. 7, Issue 4, No. 9). Out of the 179 paper submissions, 57 papers were retained for publication. The acceptance rate for this issue is 31.84%.

We wish you a happy reading!

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TABLE OF CONTENTS

Relationship between Students' Overall Satisfaction from 3D Virtual Learning Spaces and their Individual Design Components

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Abstract
3D virtual worlds, such as Second Life, are increasingly being used for delivering e-learning for different genres of students. As part of an ongoing research to evaluate different digital design aspects of using these emergent virtual learning environments, the aim of this paper is to investigate whether the overall satisfaction of students from their 3D learning spaces is dependent on their satisfaction and contentment from specific individual architectural elements used to design these educational spaces and buildings. This is depicted through investigating the correlation between students' satisfaction from individual space design elements and overall satisfaction from diverse e-learning venues within Second Life. Furthermore this study contrasts the difference in response rates between different student categories to the perception of suitability of educational space design for conducting e-learning sessions.
Keywords: *3D virtual worlds, virtual learning environments, e-learning spaces in Second Life, 3D architectural design for educational facilities.*

1. Introduction

3D online virtual worlds have been progressively utilized over the past decade as 3D virtual learning environments (3D VLEs) by hundreds of universities and educational facilities for a variety of e-learning purposes within many fields including computer science, medicine, law, engineering, architecture, business, art, humanities and many more [1]. This existence has necessitated the erection of virtual campuses for universities and educational institutions inside these environments such as Active Worlds, Blue Mars, OS Grid, and the more prominently used Second Life [2]. While designers and builders have strived to erect assorted styles of buildings inside 3D VLEs to accommodate students in realistic, creative and imaginative constructions, there is no evidence in prior research that pinpoints presence of any architectural codes or specifications for designing 3D virtual educational spaces [3]. These are design codes and guidelines that should be incorporated in current virtual creations to provide the optimum environment for enhancing a student's e-learning experience through increased satisfaction, participation, retention, enjoyment etc. [4]. On the contrary, 3D educational facilities are currently being created on an extemporized basis according to individual perception and experience of each individual virtual world designer from designing in the "real-life" physical world [5]. This contradicts views by Bridges & Charitos [5] which state that virtual building design should not imitate physical building design to detail since virtual usability criteria of 3D buildings in general can differ to usability criteria required in the physical world [6].

It hence becomes imperative to investigate the effect of the architectural design elements of existing 3D virtual educational facilities on the students using them and their e-learning experiences in an attempt to find the most suitable design criteria for future usage. This would entail, as part of the process, examining the satisfaction percentage levels of students from a range of 3D learning spaces that contain different variations of architectural components or features.

2. Research Rationale and Methods

As part of an ongoing research to uncover the effect of different architectural design elements of 3D virtual learning spaces on a student's e-learning experience, a study was conducted to record the satisfaction level of students from different variations of specific architectural features in selected learning spaces.

Eleven university campus buildings and learning spaces were selected within Second Life (as a representative of a 3D VLE) for participant students to take short e-learning sessions inside. These spaces represented eleven different variations of each of eight specifically identified architectural characteristics for designing 3D virtual buildings. The chosen characteristics were:

- Building style (e.g. modern, classical)
- Area shape, dimensions & height (e.g. rectangular, circular, dimensions ratio)
- Environmental surrounding elements (e.g. greenery, mountain, sea)
- Seating arrangement (e.g. linear, circular rows)
- Wall design (e.g. wood, stucco, light and dark color finishing)
- Floor design (e.g. marble, carpeting)
- Window design (e.g. bow, gliding windows)
- Interior lighting & open walls percentage (e.g. 50% open walls, 20% open ceiling)

The above mentioned characteristics were specifically chosen because: i) they have been shown to have an impact on student learning in real life physical educational buildings e.g. effect of class size on discipline [7], effect of classroom colors on concentration and performance [8]. This is unlike other features, the impact of which has not been tested on students in the physical world e.g. effect of different column and arch styles. ii) The previous design features and components were also chosen since they exist in 3D virtual environments unlike other building design criteria [9] like for example, ventilation and acoustics control.

The participating sample of students for the study consisted of 65 under graduate and post graduate students from the School of Engineering and Information Sciences at Middlesex University, selected randomly and consenting to partake in the study after explaining the purpose of the research to them.

After engaging the students shortly in each of the previously mentioned 11 "inworld" sites in Second Life, the students were asked to answer the following questions using a seven degree Likert-scale (strongly agree, agree, partially agree, neutral, partially disagree, disagree, and strongly agree) to depict their degree of satisfaction from individual design components in each site and overall satisfaction from it:

1. This learning space has an attractive building style (e.g. modern, classic, baroque)
2. This learning space has attractive surroundings (e.g. greenery, lighting, water features)
3. This learning space provides a suitable seating arrangement (e.g. circular, rows, random, suspended in space)
4. This learning space provides a pleasant wall aesthetic/design (e.g. colors, texture)
5. This learning space offers a pleasant floor aesthetic/design (e.g. colors, materials)
6. This learning space provides pleasant window aesthetic/design (e.g. shapes, sizes)
7. This learning space provides sufficient lighting and open walls to the outdoors (percentage area of open to closed walls, windows and ceiling in the space)
8. This learning space offers comfortable dimensions, shape and size for an educational environment (width to length to height area ratio)
9. This learning space offers a learning environment that you would like to have classes in.

The last question was used as a benchmark or point of reference to find the overall average contentment of students from each site as a whole.

The resulting numbers for each question were then multiplied by a factor (weight), described hereafter, and an average satisfaction rate was found for each site, for each category of students (under graduate and post graduate), to give an overall percentage of satisfaction for every 3D virtual architecture design feature represented by that site. For each site in every question, the percentage overall satisfaction from each design element in that site was calculated according to equation (1) below:

$$\Big(\textit{(no. of strongly agree votes * 100\%)} + \textit{(no. of agree votes * 66\%)} + \textit{(no. of partially agree votes * 33\%)} + \textit{(no. of neutral votes * 0\%)} + \textit{(no. of partially disagree votes * -33\%)} + \textit{(no. of disagree votes * -66\%)} + \textit{(no. of strongly disagree * -100\%)}\Big) \,/\, \textit{Total number of participants * 100} \qquad (1)$$

The positive factors used in the equation above designate student satisfaction, whilst negative factors signify displeasure with the design element, where 100% denotes maximum satisfaction ("strongly agree"), 0% means indifference or "neutral" effect and -100% denotes total discontentment (strongly disagree). The 66%, 33%, -33% and -66% weights represent the even distribution of the other Likert scale values in between 100% and -100% based on importance. A similar data analysis technique was implemented by Chan et al. [10].

Diagrams illustrating the different findings were created accordingly, as demonstrated in the subsequent sections, to show the following:

- Percentage satisfaction scores for undergraduate students versus post graduate students from each architectural element in all presented sites.
- Analogy between average overall satisfaction of all students from each presented site versus all students' average satisfaction from each individually tested design component in each site.
- Correlation coefficient between overall satisfaction rate from each site and average satisfaction rate from

each individual tested architectural element in that site. The correlation coefficient was calculated according to the following equation (2) [11]:

$$\left(N\Sigma XY - (\Sigma X)(\Sigma Y) \,/\, Sqrt([N\Sigma X^2 - (\Sigma X)^2][N\Sigma Y^2 - (\Sigma Y)^2]) \right) \qquad (2)$$

where
N = Number of values or elements
ΣXY = Sum of the product of first and second set of values
ΣX = Sum of first set of values (overall satisfaction value)
ΣY = Sum of second set of values (individual element satisfaction value)
$\Sigma X2$ = Sum of square of first set of values
$\Sigma Y2$ = Sum of square of second set of values

3. Results

While the diagrams in the consequent sections show, as part of the findings, which variations of each design element were the most favorable by students or provided most satisfaction, these particular findings were elaborately described by the authors previously [12] and thus are not the main issue here. The main focus within this paper is to analogize

- The rates of response provided by under graduate students compared to post graduate students, in the first section of the results
- The illustrated relationship between the overall satisfaction of students from a 3D virtual learning space in general and satisfaction from its individual design characteristics, in the second section of the results.
- The correlation coefficients between overall satisfaction of students from a 3D learning space and satisfaction from each individually tested architectural feature within this space.

3.1 Analogy between Satisfaction Rates of Under-Graduate and Post-Graduate Students

The subsequent Figures 1 and 2 illustrate the percentage satisfaction of under graduate and post graduate students from the learning space shape and dimensions, building style, environmental features, seating arrangement, wall, floor, window design, and internal lighting as provided by percentage of open walls.

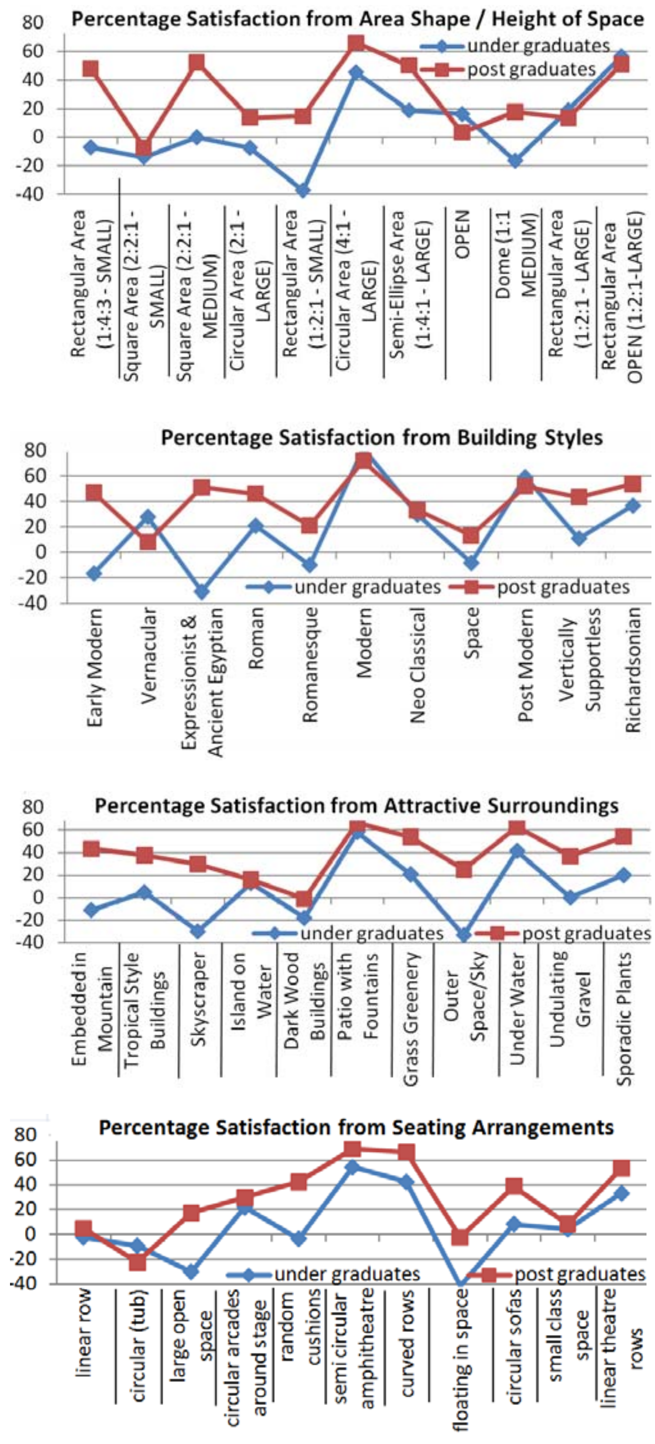

Fig. 1 Percentage satisfaction of under graduate and post graduate students from selected architectural design elements in different 3D virtual learning spaces: i) area shape & height ii) building style iii) environmental features iv) seating arrangement

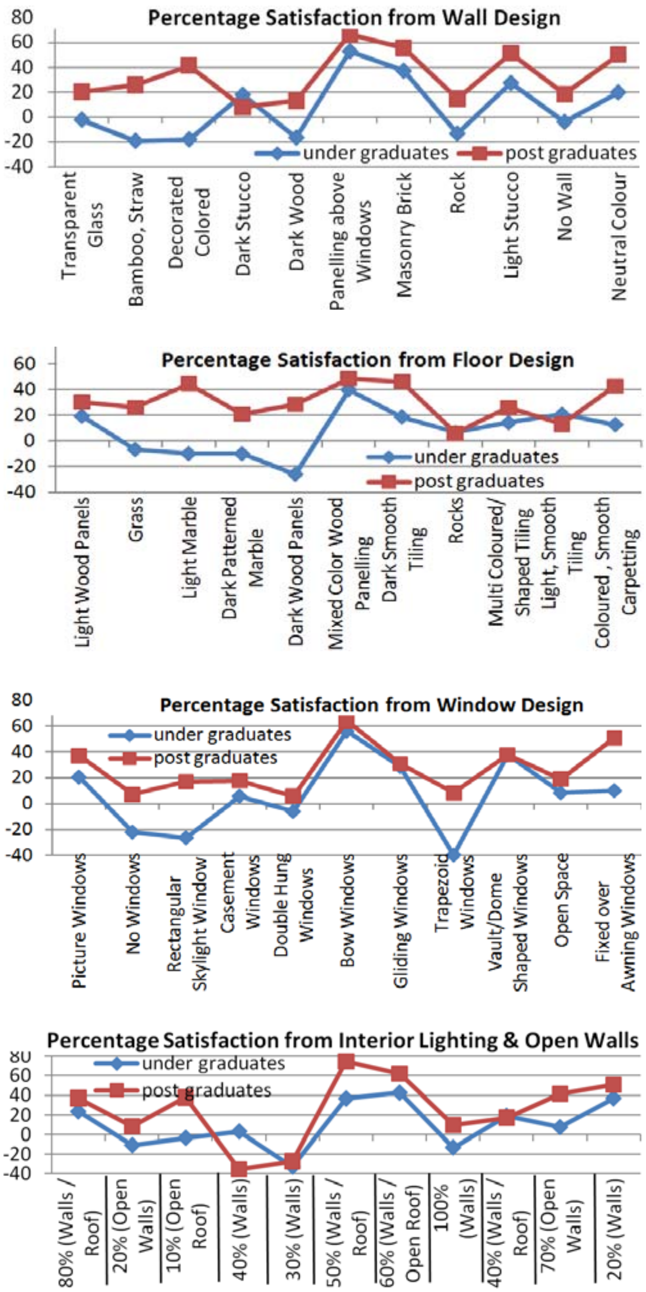

Fig. 2 Percentage satisfaction of under graduate and post graduate students from selected architectural design elements in different 3D virtual learning spaces: i) wall design ii) floor design iii) window design iv) interior lighting and open walls

General findings from the figures above provide evidence for the ensuing results:

- *While there are distinct variations between satisfaction rates of under graduate and post graduate students, the former illustrations show that both groups were always in agreement only over the most preferred variation of each architectural design component tested within this study.*

For example results of both student categories are almost identical for the most preferred building style, i.e. modern and post -modern style. They both also showed a high affection towards presence of landscaped patios with water elements in the surrounding environment and furthermore, underwater themes. In addition, all students expressed most contentment and comfort with semi circular and curved seating arrangements. Even more, the most preferred shape and dimensions of space by both under graduates and post graduates was large circular or rectangular spaces. As for wall and floor design, again results were extremely similar for highest preferences which tended towards light, colored and wood finishing. Bow paneled windows were also highly in favor and presence of approximately 50% of the surface wall and roof area of the space open for interior lighting.

- *Another significant while unexpected finding from the previous figures was the fact that satisfaction of under graduate students from all variations of all design elements in general was almost always less than the satisfaction displayed by the post graduate students for the same variations of the architectural design features.*

This was especially evident with the least preferred variations of each design element. On calculating average percentage satisfaction, of under graduates and post graduates, from each architectural design feature for all sites combined, it was seen that all results for under graduates are significantly less than those for post graduates, as presented by the table below:

Table 1: Overall percentage satisfaction of students from each design feature for all tested sites combined

architectural design feature	under graduate students	post graduate students
building style	11	38
space shape & dimensions	3	29
environmental features	5	38
seating arrangement	1	28
wall design	1	34
floor design	7	30
window design	13	28
internal lighting, open walls	5	27

Implications of the above findings are to be discussed in the subsequent conclusions section.

3.2 Analogy between Average Satisfaction Rates from 3D Virtual Learning Spaces in General and per Architectural Design Element

Another area of focus within this paper is represented by the following Figures 3 and 4. Each diagram depicts a comparison between two measures: i) the average satisfaction of both student categories from each virtual site in general and ii) their combined satisfaction from one of the eight individual design elements tested for in those sites.

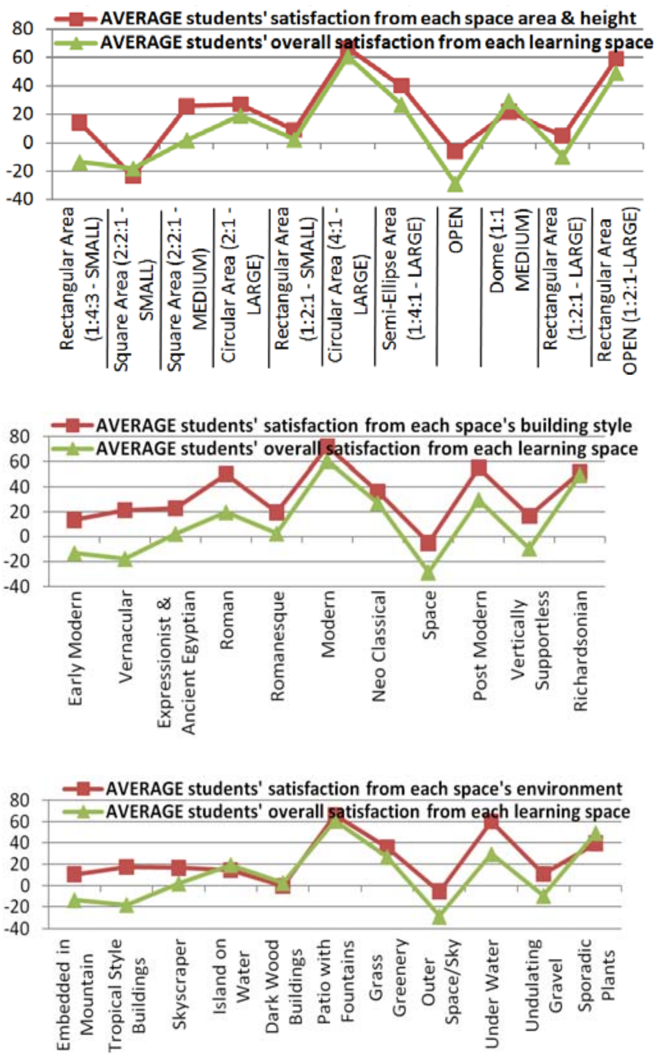

Fig. 3 Percentage satisfaction of all students combined from each 3D virtual learning space in general versus their combined satisfaction from i) space shape, area & height ii) building style iii) environmental features

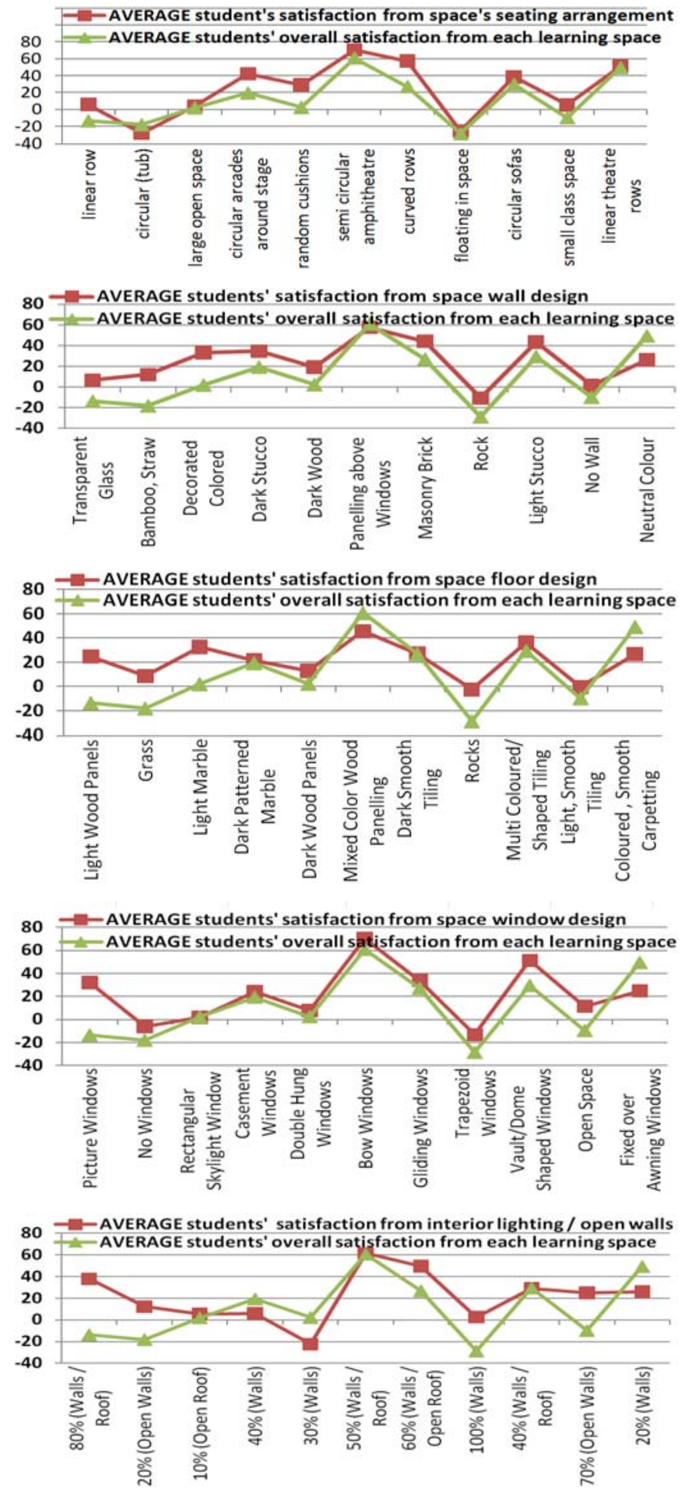

Fig. 4 Percentage satisfaction of all students combined from each 3D virtual learning space in general versus their combined satisfaction from i) seating arrangement ii) wall design iii) floor design iv) space window design v) interior lighting and percentage of open walls

The former figures 3 and 4 offer significant findings regarding the relationship between the overall satisfaction of a student from a 3D virtual learning space and his/her satisfaction from each individual architectural design component in that learning space. It can be clearly deduced that there is a striking similarity in the values and slope gradients between the overall and individual-element satisfaction percentages. This indicates that general satisfaction from a 3D educational space is highly dependent on the architectural characteristics used to design this space and satisfaction from them. This hypothesis is especially supported with the fact that it is applicable for all eight tested architectural design elements within this study, where the recorded overall percentage satisfaction of students from any given site is very similar to the percentage satisfaction from any given design element within that site. To further elucidate this finding and detect if there is a statistical association between the aforementioned factors, a correlation coefficient was calculated between the percentage satisfaction from each individual design component in every site, and the overall satisfaction from that site.

3.3 Correlation between Overall Satisfaction and Satisfaction from Individual Design Features of 3D Virtual Learning Spaces

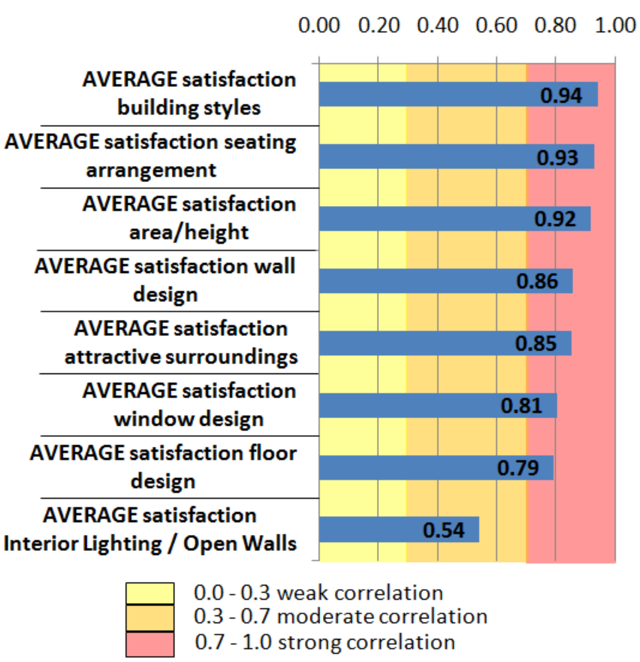

Fig. 4 Correlation coefficient between students' satisfaction from each design element and overall satisfaction from 3D virtual learning spaces

The correlation coefficient is a statistic that represents how closely two variables are related, thus expressing the amount of similarity and dependence between them. It is represented by a number that varies between -1.00 and +1.00 thus quantifying the strength of a linear association between the two variables' range of inputs and outputs [13]. The two variables under inspection within this study are i) overall satisfaction from a 3D virtual learning space ii) satisfaction from an individual design component used in a 3D virtual learning environment. Correlation coefficients between 0.00 and 0.30 signify a weak relationship; those between 0.30 and 0.70 indicate a moderate relationship and coefficients between 0.70 and 1.00 are considered high [11].

Figure 4 noticeably demonstrates that there is a high correlation or relationship between general satisfaction of a student from a 3D learning space and the satisfaction from individual design components of that space. The architectural design characteristics found to have highest association and hence most connection with overall satisfaction from a virtual learning space are the building style of the educational facility, the seating arrangement employed within the space and satisfaction from space shape and dimension ratios. Next in impact are the wall, floor, window designs and how attractive the surrounding environmental features are. However, unpredictably, the student contentment from the amount of interior lighting, represented by the percentage of open walls & ceiling surface area in the space, seems to have least impact on the overall satisfaction of students from their learning spaces. Despite that, the correlation coefficient for this design element is still moderate and thus considerable.

4. Conclusions

This paper aimed at identifying relationships between percentage satisfaction and contentment of different categories of students, and correlations between satisfaction from overall 3D virtual learning spaces and their individual design features. Recognized findings within this study have the following implications:

Only the best perceived variation from each architectural design feature of a 3D virtual site was demonstrated to be identical for both undergraduate and post graduate students. This unanimous perception can help create generalized guidelines for design and enhancement of educational facilities in 3D virtual learning environments. These guidelines, which take into consideration best practices for enrichment of a student's online e-learning experience, are currently non-existent as formerly evidenced from literature, and thus it becomes imperative to initiate such a framework of educational facility design.

Another significant conclusion uncovered within the current study shows that overall satisfaction rates provided by undergraduate students are generally lower than those displayed by post graduate students for any given 3D virtual site or its individual design components. This can be attributed to two facts: i) undergraduate students may be novice to using 3D worlds as an educational medium compared to post graduate students, and thus are more unfamiliar with their 3 D v irtual p resence in side v irtual learning spaces hence renderi ng them skeptical and less accepting or satisfied with th e e-learning experience, its venue and design characteristics i f not resem bling t he physical world classroom which they are accustomed to. ii) On t he cont rary, undergraduat e st udents m ay be t oo exposed to game playing within 3D vi rtual worlds to the extent of comparing t heir e-l earning venue t o t he stimulating, constantly changing gaming environment they are used t o. Thi s woul d consequently negatively affect their perceived satisfaction from the 3D learning spaces used in this study. iii) In contrast, post graduate students may be more flexible in accepting new ideas and new environments, hence woul d show m ore sat isfaction from their 3D virtual learni ng spaces and their design characteristics than under graduate students.

An ad ditional co nclusion attain ed with in th is stu dy concerns establishing a rel ationship and correl ation between overall contentment of students from a 3D virtual e-learning site in general, an d satisfactio n fro m its individual desi gn feat ures. Si nce a high correlation coefficient was found for all design features considered in this st udy, t his i ndicates t hat a st udent's pleasure and satisfaction from an educational space is highly dependent and rel iant on i ts archi tectural design characteristics, especially seven out of eight of the selected characteristics, namely th e b uilding style o f th e ed ucational facility, th e seating arrangem ent em ployed within the space, space shape and dimension ratios, wal l, floor, window designs and surrounding environmental features . Internal lighting denoted by the percentage of open walls & ceiling surface area in the space was also f ound to have an im pact on overall satisfaction from 3D learning spaces, but at a lower level. Thi s concl usion assert s t he choice of the architectural design elements selected within this study for testing.

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Research interests: Human issues in software engineering, focusing on their effects in software development / Distributed team working as in virtual teams and collaboration across networks / Online communities of practice / e-Business effects on society (e.g. e-portals, electronic employment contracts, privacy and security) / e-Learning focusing on computer-assisted assessment and computer-mediated communication

Localization technique in VANets using Clustering (LVC)

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Abstract

Relative location information is an important aspect in vehicular Ad hoc networks .It helps to build vehicle topology maps, also provides location information of nearby vehicles.
Due to the characteristics of VANet, the existing relative positioning techniques developed initially for Ad hoc or sensors networks are not directly applicable to vehicular networks.
In this paper, we propose a protocol of localization in VANet when no GPS information is available, based on clustering and has the advantage to use a single coordinates system. We study its impact on the performances of the network, by using the network simulator NS-2.
Keywords: *VANets, Localization, Trilateration, clustering.*

1. Introduction

Vehicular Ad hoc Network (VANets), considered as a subclass of mobile Ad Hoc networks (MANets), is a promising approach for future Intelligent Transportation System (ITS). These networks are characterized by highly mobile nodes and potentially large network. The nodes can recharge frequently, they are constrained by the road and traffic pattern.
Many researchers consider Vehicular Ad hoc NETworks as one of the most important technologies for improving the efficiency and safety of modern transportation systems, by enabling vehicles to communicate with each other via Inter-Vehicle Communication (IVC) as well as with roadside base stations via Road side-to-Vehicle Communication (RVC) [1].
A plethora of applications have emerged in this domain. For example, vehicles can inform that there is traffic accident or congestion to the nearby vehicles to avoid traffic jam near the affected areas. Also, it enables vehicles to connect by Internet to obtain real time news, traffic and weather reports.
VANET also gives the enormous opportunities in online vehicle entertainments like gaming, chatting, multimedia streaming and file sharing via the Internet or the local ad hoc networks.
One of the most promising vehicular safety applications is the development of an advanced cooperative collision warning system [2]. It is envisioned that the system will use vehicle-to-vehicle radio communications to create a cooperative collision warning system, where vehicles cooperatively share information (i. e. location, speed, heading, acceleration, etc.) for collision anticipation. Tatchitkou and al. [3] showed that sending safety warning messages containing position information can substantially reduce the probability of collision within a platoon.
The localization of a vehicle compared to an event when it's informed for the existence of an accident or an imminent danger. It's a task of great importance that can avoid pile-up of vehicles and loss of human life.
Currently, typical localization techniques integrate GPS receiver and motion sensors. However, when the vehicle passes through an environment that eclipses GPS information or creates a multipath effect, these techniques fail. Unfortunately, vehicles often travel in environments where GPS is not accessible. For these reasons, many techniques are proposed in literature to locate nodes in Ad hoc networks [4], in sensor networks [5], as well as in VANets [2, 6, 7]. Some of these techniques show how to determine the location of vehicles if only some vehicles are equipped of GPS [4], whereas others present methods to determinate position using a local and global coordinate systems which need a lot of calculates [4].
In this paper, we propose a new technique to determine the positions of nodes in a vehicular ad hoc network in the full absence of GPS information.
The proposed solution is essentially based on a technique of clustering, where a clusterhead is chosen among a group of vehicles and a technique, for the establishment of the relative positions of the nearby nodes. Every clusterhead establishes a local coordinate system and calculates the positions of all its neighbours in the group using the distances measured between vehicles. In the aim to reduce the calculate time in dangerous situation, the orientation of the coordinate system of the first clusterhead and the global system are considered the same. This new solution provides sufficient location information and accuracy to support basic network functions.
The rest of this paper will spell it out more carefully: The techniques of localization used in VANet are presented in section 2; in section 3 the relative techniques of localization are summarized; our approach is detailed in section 4.The simulation results are discussed in section 5. Finally, some concluding remarks are given.

2. Overview of localization techniques

A number of localization techniques have been proposed to determine the position of mobile nodes in classical Ad hoc. Most of them can be adapted to VANets [8]. Techniques like Map Matching, Dead Reckoning, Cellular Localization, Image/Video Processing, Localization Services, and Relative Localization are commonly discussed in VANet literature.

In this section we briefly explain each of these techniques and discuss when and how they can be used to localize vehicles in Intelligent Transport Systems.

2.1 Global Positioning System (GPS)

GPS, the Global Positioning System [9, 10], is composed of 24 satellites which can operate in orbit around the earth. Each satellite circles the earth at a height of 20.200 km and makes two complete rotations every day. The orbits have been defined in such a way, in which any region of the earth can be observed at least by four satellites.

A GPS receiver is an equipment able to receive the information constantly being sent by the satellites and using it. The GPS receiver uses the Time of Arrival technique (ToA) to estimate its distance to the four known satellites, and trilateration technique [11] to compute its position. Once these procedures have been executed, the receiver is able to know its latitude, longitude and altitude.

The main solution for VANet localization is to equip each vehicle node with a GPS receiver. This is a very reasonable solution; since the GPS receivers can be installed easily in vehicles. But as VANets advance into critical fields which are dependent on localization systems, GPS starts to show some undesirable problems such as not always available and not robust enough for critical applications.

2.2 Map matching

In the Map Matching [12] technique, several positions obtained over regular periods of time can be used to create an estimated trajectory. The estimated trajectory is then compared to the known digital map data to find the most suitable path geometry on the map that matches the trajectory. Using this technique, position information (e.g., from GPS) can be accurately depicted on the map.

2.3 Dead Reckoning

By using Dead Reckoning [13], the current position of a vehicle can be computed, based on its last known location and using such movement information as direction, speed, acceleration, distance, time, etc. The last known position, also known as a fix, can be obtained, for instance, by using GPS receivers (which are most common) or by locating a known reference (road crossing, parking lots, home, etc.) on a digital map.

Since Dead Reckoning accumulates errors rapidly over time and distance, it is considered only as a backup system for periods of GPS outage, for example, when a vehicle enters a tunnel and loses its GPS connection.

2.4 Cellular localization

Cellular localization [14] takes advantage of the mobile cellular infrastructure present in the most urban environments to estimate the position of an object. Known applications of this technology include locating mobile phones, tracking domestic animals, and vehicle localization.

In order to work properly, mobile cellular systems require the installation of a communication infrastructure composed of a number of cellular base stations distributed through the covered area.

Cellular localization is usually less precise than GPS. The accuracy depends on a number of factors such as the current urban environment, the number of base stations detecting the signal, and the positioning algorithm used, etc. Also, signals from the Cellular infrastructure have more availability in urban environments than signals from satellite (used by GPS receivers) which can be useful for indoor environments such as parking lots and even tunnels.

2.5 Image/video processing

The image and video information sources, and the data processing techniques can be used for localization purposes, especially in mobile robot guidance systems [15]. In some cases, however, cameras are already available in security systems implemented in parking lots and tunnels. Commonly, these Image/Video Processing techniques are used to feed Data Fusion algorithms to estimate and predict a vehicle's location [8]. In fact, both image and video information are actual sources from which we can compute the location parameters of a vehicle.

2.6 Localization services

A Localization Service can be implemented by using any known infrastructured localization system; such as the Cricket Location-Support System [16], RADAR [17], Ultra-Wideband Localization [18], or Wi Fi Localization [19]. In [20], Thangavelu and al. propose a system called "VETRAC", a vehicle tracking and location identification system designed for VANets that uses WiFi access points as a communication infrastructure. The proposed system can be used in tunnels, university campuses, airports, etc.

VANets can also use Wireless Sensor Networks (WSNs) as the base for a VANet localization infrastructure. The reason for doing this is that WSNs can also be used to monitor other road variables like movement, temperature, smoke, visibility, and noise.

Thus, these networks are ideal for monitoring critical environments, as well as for emergency operations, as shown by a number of works [21]. Also, the use of sensor networks as a roadside communication infrastructure is an envisioned scenario in many Intelligent Transportation Systems. A number of WSN features can also be used to improve the performance and accuracy of an infrastructured VANet localization system. For instance, movement sensors can be used to send localization packets only when vehicles are presented.

2.7 Relative localization

By the exchange of the estimated distances between the vehicle and its neighbors, a local relative position maps can be constructed. With this dynamic position map, a vehicle can locate itself relatively to nearby vehicles as well as locate the vehicles in its vicinity [8]. This type of relative localization has been used mostly in Ad Hoc and Sensor Networks [4, 5], but recently a number of solutions [2, 6, 7] have been proposed for VANets.

3. Overview of relative localization techniques

A number of distributed relative ad hoc localization systems have been proposed recently for Ad Hoc and Sensor networks, but only a few of these [4,5] can be applied to highly mobile and dynamic networks such as VANets.

A GPS-free positioning algorithm for ad hoc networks was proposed in [4], where each node runs a self-positioning algorithm, that computes the angles between the one- hop neighbors using the inter-node distance measurements to establish a local coordinate system. Once the local coordinate systems are established, the nodes orient their coordinate system to a common coordinate system however all nodes' x, y coordinates point in the same direction.

The GPS-free algorithm, as pointed out by Iyengar and Sikdar in [5], is expensive in terms of the number of messages that need to be exchanged between nodes. Iyengar and Sikdar derived an improved version of [4], to tackle these issues, by creating an algorithm that improves scalability and convergence times. For the formation of the local coordinate system, they use the method of triangulation as in [4]. However, to keep the system scalable as the number of nodes increases, this required the formation of local coordinates at only a small subset of the total nodes (which they called master nodes).

Kukshya and al.[7] made use of the results from [5] to create a scheme for localizing neighbouring vehicles based on radio range measurements. Their goal was to establish an accurate map of the relative positions of all neighbouring vehicles. Under the assumption when vehicle does not have access information from GPS or dead-reckoning system (e.g. operating in conditions where GPS did not have line of sight). They use trilateration [9] for estimating a vehicles position.

In [6], a distributed localization algorithm is proposed to assist GPS-unequipped vehicles in estimating their positions based on nearby GPS-equipped vehicles. To estimate a position for a vehicle not equipped with GPS, it needs to communicate with at least three GPS-equipped vehicles in its vicinity in order to estimate distances and gather their positions information. When the number of nearby GPS-equipped vehicles is less than three, the author shows how to estimate at least the direction of the vehicle and the distance from an event (an accident or a danger) based on the small amount of available information. The proposed algorithm can successfully estimate the position of vehicles not equipped with GPS, but it is hard to identify situations where vehicles have network cards to communicate with other vehicles but have no GPS equipment. Also, the direction of the cars can be easily estimated by exchanging digital compass or gyroscopes information.

In [2], another distributed VANet localization system is proposed, in which distances between vehicles are estimated using RSSI and the information is used by an optimization algorithm to improve the initial position estimation of the vehicles (obtained, for instance, via GPS). This technique is primarily intended to improve GPS's initial position estimations, but since nearby GPS receivers tend to have correlated errors, estimating distances using RSSI will hardly improve the position information. However, this solution can also be used to improve positions computed via the Dead Reckoning technique during GPS outages.

4. Our approach: Localization in VANets using Clustering (LVC)

In this paper we propose a new technique, which consists to determine the positions of nodes, in a vehicular Ad hoc NETwork when no GPS information is available. It based on the clustering technique and uses the trilateration method for the establishment of the relative positions of the nearby nodes. This solution can be executed in three phases:

Phase 1: Selection of the first clusterhead to be the center of the system and calculate the relative positions of all its neighbors in the group.

Phase 2: According to the first clusterhead selected in the previous step, we chose the other clusterheads (CH) and their coordinates in the system.

Phase 3: This step will execute only if the chain of clusterheads is broken.

4.1 Phase1

To select the first vehicle « M » which will be the center of the network, any vehicle detects that no GPS information is available), it waits for a fixed delay. If during this time receives a message from a clusterhead, it becomes a node member of the clusterhead group's. Otherwise, it sends a message to say " is there any clusterhead in the approximate?" If there is no response received, it broadcasts a message to say "I am the first clusterhead".

The selected vehicle in this phase becomes the center of the network with the position (0, 0), and the positions of the other vehicles in the network are calculated on the base of this selection.

To calculate the positions of the nearby vehicles of the vehicle « M », we choose two vehicles $A, B \in V_M$ (where V_M is the set of nearby vehicles of « M » in a group of radius R = 300m) (cf. Fig. 1) such as:

- The distance between vehicles «A» and «B» (d_{AB}) is already known, (where $A \in V_B$ *and* $B \in V_A$). The neighbors can be detected by sending periodically a beacon messages. Hence, we can calculate the distances between vehicles using the technique based radio RSSI 'Received Signal Strength Indication'. We choose RSSI because probably is the most well-known, and less expensive to implemented, since it does not require any specialized hardware.
- The node «A» must be on the positive x axis of the coordinate system.
- The node «B» has a positive B_y component on y axis (Fig. 1).

Thus, we obtain the positions of vehicles « M », « A » and « B » as follows:

$$M_x = 0; M_y = 0$$

$$A_x = d_{MA}; A_y = 0$$

$$B_x = d_{MB}\cos\alpha; B_y = d_{MB}\sin\alpha$$

Where « α » is the angle $A\hat{M}B$ and it is calculated by the following formula:

$$\alpha = \arccos\frac{d_{MB}^2 + d_{MA}^2 - d_{AB}^2}{2 d_{MB} d_{MA}}$$

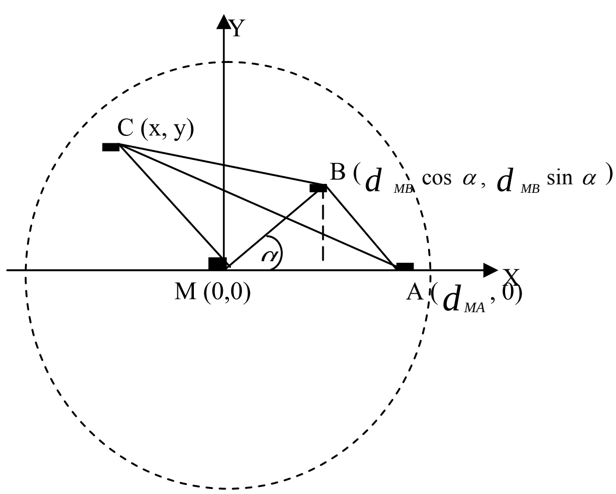

Fig.1: the calculation of the nearby positions vehicles of « M ».

To calculate the positions of the other nearby vehicles of « M » (let's take a vehicle C, $\forall C \in V_M$ *and* $C \neq A, B$) where we already know the distances d_{MC}, d_{AC} *and* d_{BC} (or $C \in V_A \cap V_B$). We use the technique of trilateration that gives the following equations:

$$x^2 + y^2 = d_{MC}^2 \quad (1)$$

$$(d_{MA} - x)^2 + y^2 = d_{AC}^2 \quad (2)$$

$$(d_{MB}\cos\alpha - x)^2 + (d_{MB}\sin\alpha - y)^2 = d_{BC}^2 \quad (3)$$

$$(1) - (2) \Rightarrow 2 d_{MA} x - d_{MA}^2 = d_{MC}^2 - d_{AC}^2$$

$$\Rightarrow x = \frac{d_{MA}^2 + d_{MC}^2 - d_{AC}^2}{2 d_{MA}}$$

To determine the coordinate « y », we use the equation (1) - (3).

The calculations above show how we can calculate the position of a vehicle « C » which is a neighbor of vehicles « A » and « B». If the vehicle « C » is not a neighbor of « A » or of « B », we can calculate its position using the position of « M » and at least two other vehicles with known positions.

4.2 Phase 2

When the center of the network (vehicle « M ») builds its coordinates system and calculates the positions of all its neighbors in the group, it starts to construct the backbone formed of clusterheads. For this reason, it selects two clusterheads (CH) among the near by vehicles. The first vehicle « M^{+1} » is for the superior level and the second vehicle « M^{-1} » is for the lower level of « M » (Fig. 2).

Both vehicles « M^{+1} » and « M^{-1} » are selected such that they verify the following conditions:

- $y_{M^{+1}} = MAX\ y_V$ *and* $D_{MV} \leq 250m$, $\forall V \in V_M$ (Due to the high mobility In VANets we choose $D_{MV} \leq 250m < R$ to avoid the fast break of the backbone)
- $y_{M^{-1}} = MIM\ y_V$ *and* $D_{MV} \leq 250m$, $\forall V \in V_M$

The two clusterheads M^{+1} and M^{-1} execute the same procedure to calculate the positions of their neighbors. So, we use the position of M^{+1} (respectively M^{-1}) calculated by the vehicle M and at least the positions of two vehicles in the range of M and M^{+1} (respectively between M and M^{-1}) to calculate the positions of the nearby vehicles of M^{+1} (respectively M^{-1}). This gives the possibility to apply the technique of trilateration.

Finally, to calculate the positions of all the vehicles in the network, the vehicle M^{+1} (M^{-1}) must select his successor M^{+2} (his predecessor M^{-2}) (Fig. 2). The procedure will be repeated until no successor (predecessor) is found.

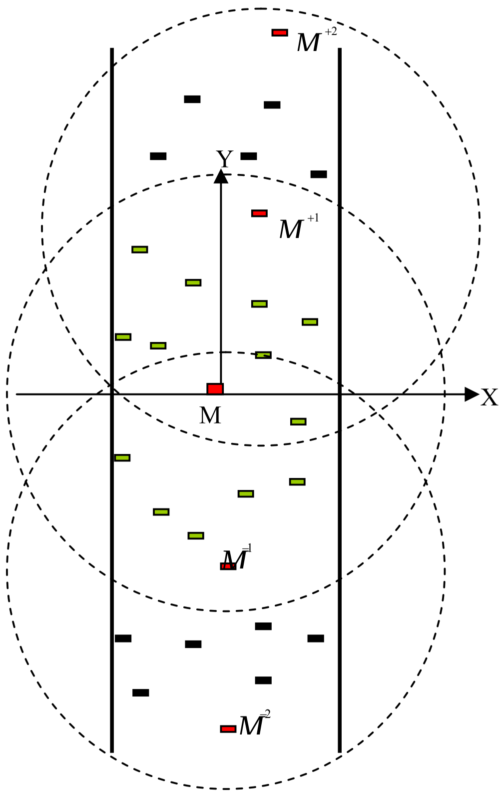

Fig. 2: The selection of master's vehicles (CHs).

4.3 Phase 3

This step can be executed in two different cases:

- As soon as the first clusterhead receives two or more than a message via the GPS, at this moment recognizes that it left the environment without GPS. Thus, it has to inform its neighbors' that it has left the tunnel (or the forest) by sending a special message. In the reception of this message, the previous clusterhead (i.e. M^{-1}) is going to take the role of the master clusterhead.
- In the second case, where the first clusterhead arrests or fails, one of its clusterhead neighbors (i.e. M^{+1} or M^{-1}) is chosen to take the role. For that purpose, each one of them starts to decrement a random timer. The vehicle sees its timer expire the first, it becomes the new center of the network.

5. Simulation results

To evaluate the performances of this technique, we use NS2 simulator [22] and the mobility generator tool IMPORTANT [23] to produce realistic mobility model. For this reason, we have to change the number of nodes in the network (20, 30, 40, 50, and 100), and the speeds. We also use two kinds of mobility. The first is a low mobility with a speed between 20 km/h and 50 km/h. The second is a high mobility with a speed between 80 km/h and 140 km/h.

The Fig. 3 shows for two cases of mobility: low and high, that the rate of positions calculated (RNP) is related to the numbers of nodes in the network.

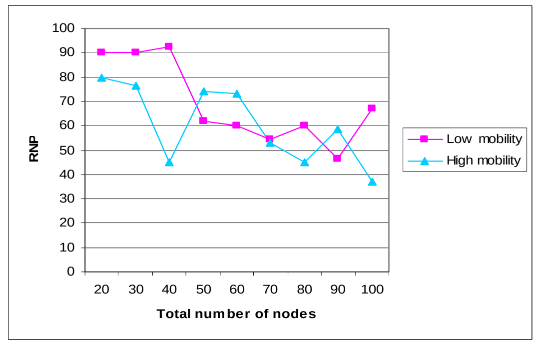

Fig. 3: Rate of positions calculated according to the total number of nodes.

For a number of nodes which varies between 20 and 40 and in the case of low mobility, we notice that RNP increases when the number of nodes increases. So, it's clear that the low variation in speed of vehicles permits the clusterhead to calculate the positions of vehicles in its domain with a low effect of the topology changes.

In the case of high mobility, the success to calculate the positions is less than the first case, due to the fast changes in topology. Generally, the rate of calculated positions decreases when the members in the group of a clusterheads change very quickly. But sometimes, we can find the opposite, for example, when the number of nodes varies between 50 and 60 the rate of success is better than a network of low mobility. We can explain that, by the fast movement of the vehicles which allows nodes to enter to another domain. Consequently, the new clusterhead can calculate their positions.

The Fig. 4 shows that RNP has an influence on the mean error and this for both cases of mobility.

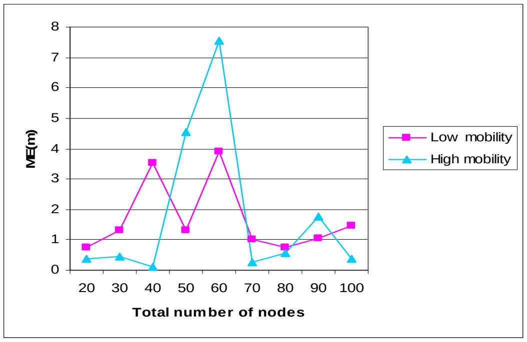

Fig. 4: Mean error according to the number of nodes.

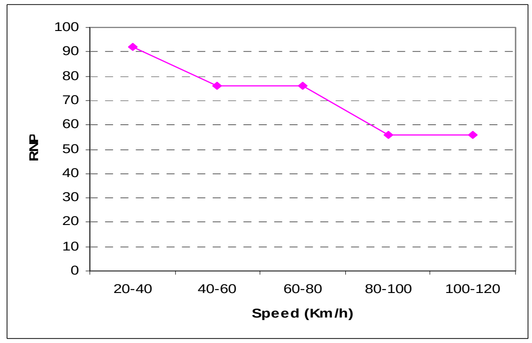

Fig. 6 Rate of positions calculated according to the speed.

In the case of low mobility, RNP reaches 92, 5 % with a mean error less than 4 m. In the case of high mobility, the rate of positions reaches 73 , 3 3 % with a mean error $\cong 8m$.

This can be explained by the fact that in the case of high mobility, when the clusterhead is in the process of calculating the position of a vehicle, the later moves quickly. Therefore, if we compare the position calculated by the clusterhead and the real position, we remark that errors are proportional to the speed. In the case of low mobility, vehicles move with an average speed that permits to decreasing the mean error.

The curves of the Fig. 5 show for both cases of mobility that the number of sent messages increases with the augmentation of the total number of nodes, in which confirms the smooth operation of our protocol.

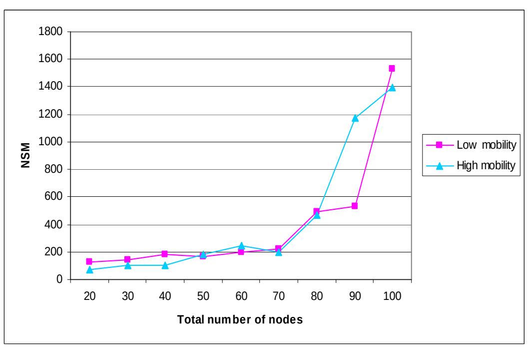

Fig. 5: Number of sent messages according to the total number of nodes.

In our algorithm, each vehicle has to broadcast a massage to calculate the distances with regarding to its neighbors. Thus, every time we increase the number of vehicles in the freeway, the number of sent messages also increases.

To evaluate the performances of LVC when the speeds change, we fixed the number of vehicles to 50 and we vary the speed between 20-40 km/h or 40-60 km/h … and 100-120 km/h.

According to the Fig. 6, we see that the speed of vehicles has an impact on the Rate of Nodes with Position (RNP). Thus, every time we increase the speed the RNP decreases, due to the fast change of topology. So, a vehicle being in a range of a clusterhead can leave to another range, consequently the clustehead does not calculate its position which reduces imperatively the RNP.

Finally, we compare the performances of our approach with the GPS-free positioning in mobile Ad hoc networks technique GPMAN [4]. According to this, we choose to present the rate of positions calculated (RNP) and the latency (The necessary time to calculate the positions). We remark that the obtained RNP using our method (LVC) is better than the GPMAN whatever the number of nodes (cf. Fig. 7). Also, the latency of LVC is widely better than the one obtained by GPMAN (cf. Fig. 8), due to the utilization of single global axes for the whole system which permits to avoid translations and rotations for calculating the positions of any node.

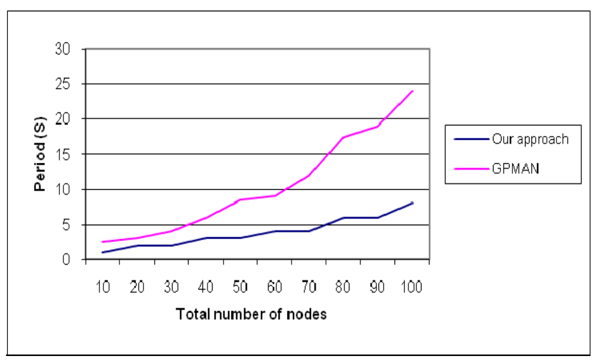

Fig. 7 Rate of positions calculated using LVC and GPMAN.

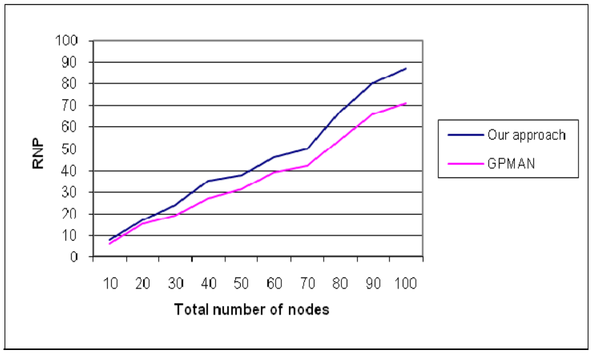

Fig. 8: The latency using LVC and GPMAN.

6. Conclusions

We have presented a novel technique of localization in vehicular networks, which permits to simplify the necessary calculations to estimate the positions of nodes.

Our solution provides certain improvements:

(i) A single coordinate system - without using the rotations and the translations of axes-, (ii) a selection of the clusterheads not random, and (iii) a technique of maintenance of the system allows changing the first clusterhead in case of failure.

We can say that the performances of our algorithm are very satisfactory and it can be useful in safety applications when GPS information is not available.

Simulation results show that the rate of calculated positions reaches at most 92,5 % with a position error does not overtake 8 m.

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Verifying ODP trader function by using Event B

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Abstract

In order to support interoperability in open distributed systems, an information service is needed that can provide dynamic knowledge about available service providers. Such a service is Trading function, identified by Basic Reference Model of Open Distributed Processing (RM ODP). RM ODP is a joint effort of ISO and ITU−T. Within the standardization of RM ODP, Trading function is developed as a component standard.
The use of formal methods in the design process of ODP systems is explicitly required. Currently there are no formal specifications of ODP concepts which are widely accepted. One interesting question concerns the suitability of event B for their use in ODP. In this paper, the use of event B for verifying ODP is investigated and evaluated. The ODP trader is chosen as case of study because it appears as a first main application of ODP.

Keywords: *RM-ODP, Trader function, event B, RODIN platform.*

1. Introduction

One property of a distributed system is that a user of the system is unaware of the differences in computers and operating systems in which their applications run. Such systems are inherently complex. Despite this, distributed processing is growing rapidly, primarily due to the computer industry's ability to produce cheaper, more powerful computers. As a result of this growth, the need for the coordinated production of standards for distributed processing has been identified.
ODP is already a major effort between the International Organization for Standardization (ISO) and International Telecommunications Union (ITU-T) which will lead to significant product development in the coming years. The ODP work identifies and attempts to provide a framework for distributed systems. This has been set out in a Reference Model of ODP (RMODP) [1].
It defines an architecture through which distribution, interworking and portability can be achieved. The RM-ODP recognizes that it cannot provide an infrastructure to meet all of the needs of distribution. Different systems will almost certainly have different demands on the infrastructure.
The RM-ODP is divided into four main parts.
Part 1 - Overview and Guide to Use : contains an overview and guide to use of the RM-ODP.
Part 2 - Descriptive Model : contains the definition of concepts and gives the framework for descriptions of distributed systems.
Part 3 - Prescriptive Model : contains the specification of the required characteristics that qualify distributed system as open, i.e. constraints to which ODP systems must conform. It defines a framework comprising five viewpoints, five viewpoint languages, ODP functions and ODP transparencies. The five viewpoints are enterprise, information, computational, engineering and technology.
Part 4 - Architectural Semantics : contains a formalization of a subset of the ODP concepts.
A trader [3] is an object that performs trading, which is an ODP common function. ODP aims to provide distribution-transparent utilization of services over heterogeneous environments. In order to use services, users need to be aware of potential service providers and to be capable of accessing them. Since sites and applications in distributed systems are likely to change frequently, it is advantageous to allow late binding between service users and providers. If this is to be supported, a component must be able to find appropriate service providers dynamically. The ODP trading function [3] provides this dynamic selection of service providers at run time.
The languages Z, SDL, LOTOS, and Esterel are used in RM-ODP architectural semantics part [1] for the specification of ODP concepts. However, no formal method is likely to be suitable for specifying every aspect of an ODP system.
Elsewhere, we used the meta-modeling approach [9] [10] to define syntax of a sub-language for the ODP QoS-aware enterprise viewpoint specifications. We defined a meta-model semantics for structural constraints on ODP enterprise language [11] using UML and OCL. We also used the same met-modeling and denotation approaches for behavioral concepts in the foundations part and in the enterprise language [12] [13].
Furthermore, for modeling ODP systems correctly by construction, the current testing techniques [21][22] are not widely accepted.
In this paper, we use the event-B formalism as our formal framework for developing trader function in distributed

systems. Event B [4] is a method with tool support for applying systems in the B method. Hence we can benefit from the useful formalism for reasoning about distributed systems given by refinement techniques and from the tool support in B. The Rodin Platform for Event-B provides effective support for refinement and mathematical proof. [5]
The paper is organized as follows. Section 2 introduces RM-ODP and trader function. Section 3, presents an introduction to event B notations. In Section 4, we use event B as refinement support to specify trader function. Section 5 presents the Rodin platform as tool of proving initial and refinement models. In section 6 we describe related works. Lastly, section 7 concludes the paper.

2. Introduction to ODP and the RM-ODP

2.1 RM-ODP

The Reference Model for Open Distributed Processing (RM-ODP) [1] provides a framework within which support of distribution, networking and portability can be integrated. It consists of four parts. The architecture part contains the specifications of the required characteristics that qualify distributed processing as open. It defines a framework comprising five viewpoints, five viewpoint languages, ODP functions and ODP transparencies. The five viewpoints are enterprise, information, computational, engineering and technology. The ODP functions are required to support ODP systems. The transparency prescriptions show how to use the ODP functions to achieve distribution transparency. RM-ODP defines a number of specific repository functions [2], concerned with maintaining a database of specialized classes of information. There are three repository functions: Type Repository, Relocator and the trader function [3].

2.2 Trader Overview

A trader [3] is a third party object that enables the clients to find suitable servers in a distributed system. Figure 1 shows the interactions of a trader and its users:
• A trader accepts service offers from exporters of services when exporters wish to advertise service offers. A service offer contains the characteristics of a service that a service provider is willing to offer. Service offers are stored by the trader in a centralized or a distributed database.
• A trader accepts service requests from importers of services when importers require knowledge about appropriate service providers.
• A trader searches its service offer database to match the importer's service request. And, if required, a trader can select the most appropriate service offer(s) (if one exists) that satisfies the importer's service request. The matched list of service offers or the selected service offer is returned to the importer.
After a successful match, the client, that requires a service, can interact with the service provider of a matched offer. The matching and selection of appropriate service at run time by a trader allows client objects to be configured into an ODP system without prior knowledge of server objects that can satisfy their requirements.

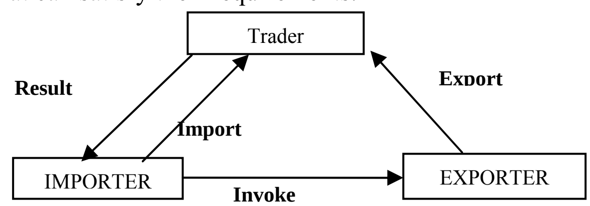

Fig. 1 Trader and Its Users.

3. EVENT B MODELLING APPROACH

The Event-B [14] [15] is formal techniques consist of describing rigorously the problem, introduce solutions or details in the refinement steps to obtain more concrete specifications and verifying that proposed solutions are correct. The system is modeled in terms of an abstract state space using variables with set theoretic types and the events that modify state variables. Event-B, a variant of B, was designed for developing distributed systems. In Event-B, the events consist of guarded actions occurring spontaneously rather then being invoked. The invariants state properties that must be satisfied by the variables and maintained by the activation of the events.
The mathematical foundations for development of event based system in B is discussed in [6]. An abstract machine consists of sets, constants and variables clause modeled as set theoretic constructs. The invariants and properties are defined as first order predicates. The event system is defined by its state and contain number strained by the conditions defined in the properties and invariant clause known as invariant properties of the system. Each event in the abstract model is composed of a guard and an action. A typical abstract machine may be outlined as below.

```
MACHINE            M
SETS               S1,S2,S3...
CONSTANTS          C
PROPERTIES         P
VARIABLES          v1,v2,v3...
INVARIANTS         I
INITIALISATION     init
EVENTS
     E1 = WHEN  G1 THEN  S1   END;
     .......                  END
```

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4. SPECIFYING THE ODP TRADER USING EVENT B

4.1 Refinement strategy

In this section, we present our strategy for constructing the negotiation scenario between trader object and its users. This will be done by means of an initial model followed by one refinement.

a) The initial model essentially presents the protocol as done abstractly of repository function of trader.

b) In the refinement model, we introduce the trader repository function. A trader needs to checks with its type repository that the service type specified in the offer is valid.

4.2 Abstract Model of trading function

The abstract model of a trader communication protocol is presented as a B machine in the Fig. 2. The PROCESS and MESSAGE are defined as sets. The brief description of this machine is given as follows.

MACHINE Trader and users communication
SETS PROCESS ={importer, exporter, trader)
MESSAGE = {import, export, result, invoke}
VARIABLES sender , receiver
INVARIANT
/* I-1*/ sender $\in$ MESSAGE $\rightarrow$ PROCESS
/* I-2*/ $\wedge$ receiver $\in$ PROCESS $\leftrightarrow$ MESSAGE
/* I-3*/ $\wedge$ ran(receiver) $\subseteq$ dom(sender)
INITIALISATION sender := Φ || receiver:= Φ
OPERATIONS
Send (pp $\in$ PROCESS , mm $\in$ MESSAGE) =
WHEN mm $\in$ dom(sender) $\wedge$ pp $\in$ dom(receiver)
THEN sender := sender U {mm $\mapsto$ pp}
END;
Receive (pp $\in$ PROCESS , mm $\in$ MESSAGE) =
WHEN mm $\in$ dom(sender) $\wedge$ (pp $\mapsto$ mm) $\in$ receiver
THEN receiver := receiver U {pp $\mapsto$ mm}
END ;
END

Fig. 2 Abstract Model of trader function.

The sender is a partial function from MESSAGE to PROCESS defined in invariant I-1. The mapping (m $\mapsto$ p) $\in$ sender indicate that message m was sent by process p. The receiver is a relation between PROCESS and MESSAGE defined in invariant I-2. A mapping of form (p $\mapsto$ m) $\in$ receiver indicates that a process p has delivered a message m. The sender and receiver are initialized as empty set.

In our model of trader communication protocol with its users, a sent message is also delivered to its sender. It may be noticed that all delivered messages must be messages whose Message Sent event is also recorded. This property is defined as invariant I-3. The events of sending and receiving of messages are modeled as Send(pp, mm) and Receive(pp, mm). When a Send event is invoked, the entry of a process and the corresponding message is made to the sender.

4.3 Refinement model: Introducing repository function of a trader

In order to match service requests with service offers, a trader interacts with the type repository function provided by the ODP infrastructure [2]. The set of all service types known to a trader is known to its type repository.

The possible interaction scenario for the trader and its environment is given below:

Interaction 1. Service Export - the trader receives a service offer from an exporter. The trader checks with its type repository that the service type (or interface type), the service properties and service offer properties specified in the offer are valid. The service offer is stored in the trader database including the offer's service type identifier (if given), interface type identifier, service and service offer properties.

Interaction 2. Service import - the trader receives a service request from a client. The trader checks with its type repository that the request contains a known service or interface type and the properties in the matching constraints are valid.

Interaction 3. Matched offers - the trader returns offers (possibly empty) to the importer that matches the importer's requirement specifications.

Finally, to use the service, the importer needs to map the service interface identifier to an interface location for the service, establish a binding with the server at the service location and, finally, invoke the service.

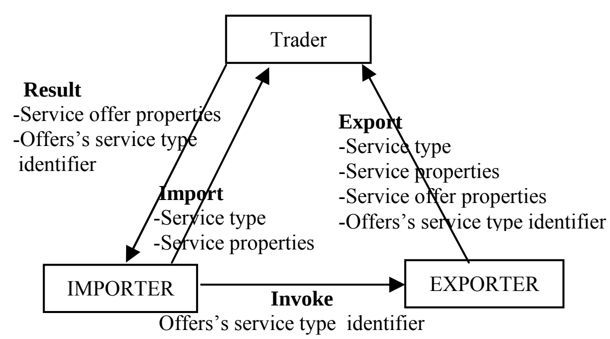

Fig. 3 Trader and Its Users taking in account the repository function.

In this refinement we introduce the repository interface of trader. The refinement of abstract model is given in Fig. 4 and Fig. 5. A brief description of the refinement steps are given below.
The abstract repository interface is represented by a variable repository. A mapping of the form $(m1 \mapsto m2) \in$ repository indicates that parameter m1 is sent with message m2 (Inv I-4). A repository on the messages can be defined only on those messages whose message sent event is recorded (Inv I-5).

REFINEMENT Repository interface
REFINE Trader and users communication
SETS PROCESS = {importer, exporter, trader);
MESSAGE = {import, export, result, invoke};
PARAMETER= {Service type, Service properties, Service offer properties, Offers' service type identifier}
CONSTANT Trader type repository
VARIABLES Sender, receiver, repository
INVARIANT
/* I-4* repository $\in$ PARAMETER $\leftrightarrow$ MESSAGE
/* I-5*/ $\wedge$ ran (repository) $\subseteq$ dom (sender)
INITIALISATION sender := Φ || receiver := Φ || repository := Φ

Fig. 4 Trader communication with users and repository: Initialization

The events send (pp, mm, param) and receive (pp, mm, param) respectively models the events of sending a message and the receiving of a message.
As shown in the operations, only exporter process can export a service offer. When the trader receives a service offer from an exporter pp, the trader checks with its type repository (Trader type repository) that the service type is valid. The service offer is stored in the trader database including the offer's service type identifier, interface type identifier, service and service offer properties.
Furthermore, only importer process can import a service. When the trader receives a service request from a client, the trader checks with its type repository (Trader type repository) that the request contains a known service or interface type and the properties in the matching constraints are valid.

Fig. 5: Trader communication with users and repository: Events

OPERATIONS

Send (pp $\in$ PROCESS, mm $\in$ MESSAGE, param $\in$ PARAMETER) =
WHEN mm $\in$ dom (sender) $\wedge$ pp $\in$ dom (receiver) $\wedge$ param $\in$ dom(repository)
$\wedge$ pp =exporter
$\wedge$ Service_type = Trader_type_repository
THEN sender := sender U {mm $\mapsto$ pp} || repository := repository U {param $\mapsto$ mm}
END;
Receive (pp $\in$ PROCESS , mm $\in$ MESSAGE, param $\in$ PARAMETER) =
WHEN mm $\in$ dom(sender) $\wedge$ pp $\in$ dom(receiver) $\wedge$ param $\in$ dom(repository)
$\wedge$ pp = importer
$\wedge$ Service_type = Trader_type_repository
THEN receiver := receiver U {pp $\mapsto$ mm} || repository := repository U {param $\mapsto$ mm}
END ;

Fig. 5 Trader communication with users and repository: Events

5. PROOFING TRADER MODELS

Rodin Platform [5] is an open tool set implemented on top of Eclipse. It is devoted to supporting the development of such systems. It has been developed within the framework of the European project Rodin. It contains a modeling database surrounded by various plug-ins: static checker, proof obligation generator, proovers, model-checkers, animators, UML transformers, requirement document handler, etc. The database itself contains the various modeling elements needed to construct discrete transition system models: essentially variables, invariants, and transitions.
The initial model of trader communication with users and its refinements models are developed by using Event-B. Each model was analyzed and proved to be correct using The Rodin Platform. The correctness of each step is proved in order to achieve a reliable protocol communication between trader, client and server objects.
The abstract and refinement models of the trader by both essentials construct of Event-B (machine and context) are illustrated below:

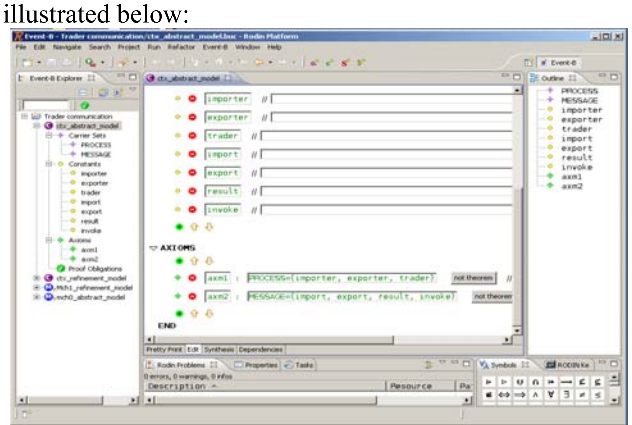

Fig. 6 A context of trader abstract model.

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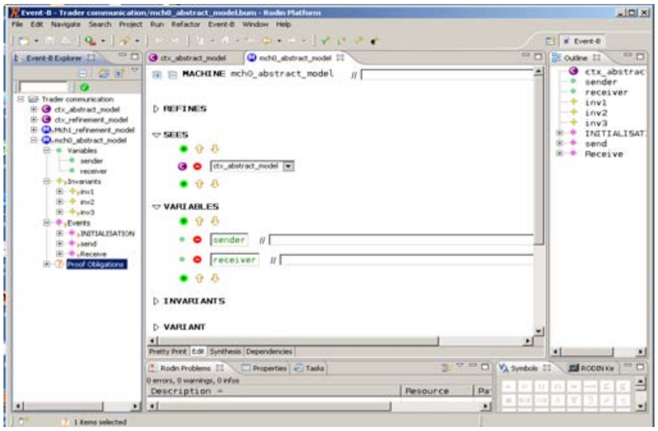

Fig. 7 A machine of trader abstract model.

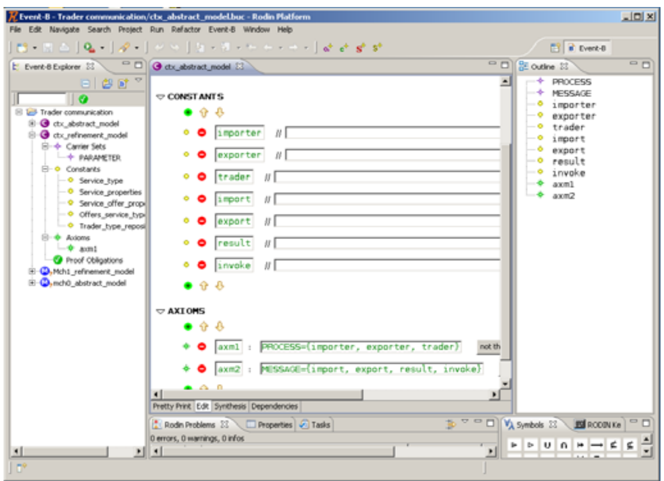

Fig. 8 A context of trader refinement model.

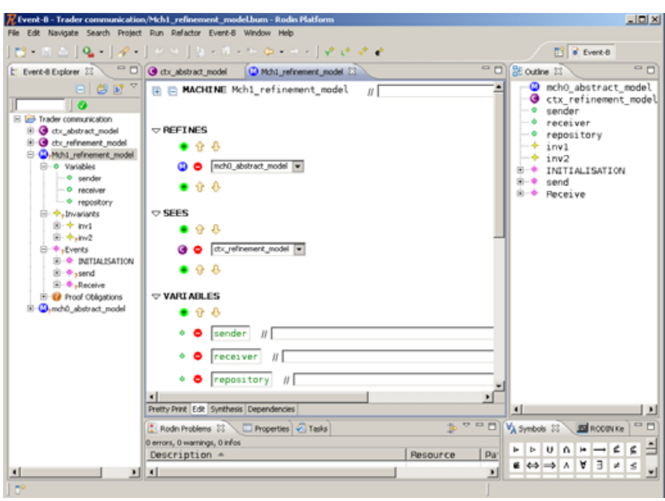

Fig. 9 A machine of trader refinement model.

6. RELATED WORK

There are related works which are using event-B to specify systems. For example, Abrial [8] introduces patterns for state-based specifications in EventB and uses informal graphical notations similar to TD to illustrate the patterns. Cansell et al. [16] introduce a time constraints pattern based on an Event-B model for distributed applications. This work uses global time which interacts with a number of active times as do our patterns. Bicarregui [17] extends Event-B notations to three linear temporal logic (LTL) operators The work proposes using three new constructs that are to replace the standard Event-B structure, WHEN…THEN…END, to represent the three LTL operators. In [18] the use of the Formal Description Techniques (FDT's) Z, LOTOS and SDL'92 is investigated and evaluated for specifying the ODP trader. KAOS [19] is a goal-oriented modeling technique for requirements specification, in which a goal defines an objective of the composite system. KAOS uses a Goal model to declare the system requirements. An attempt to combine KAOS with B is introduced by Ponsard and Dieul [20]. Our earlier works [11] [23] investigates how to translate the specification of enterprise viewpoint concepts in event-B. Our work is unique in providing techniques for verifying ODP trader specification by using the standard Event B notations provided.

7. CONCLUSION AND PERSPECTIVES

In this paper we have presented a formal approach to modeling and analyzing trading function using Event B. The abstract model of trader is done abstractly of its repository function.
In the refinement of the abstract model, we introduced the notion of a trader repository function. In fact, in order to match service requests with service offers, a trader interacts with the type repository function provided by the ODP infrastructure. The set of all service types known to a trader is known to its type repository.
The system development approach considered is based on Event B, which facilitates incremental development of distributed systems. The work was carried out on the Rodin platform. In order to verify our trader model, the initial and refinement model of trader are developed by using Event-B, Each model is analyzed and proved to be correct.
Our experience with this case study strengthens our believe that abstraction and refinement are valuable technique for modeling complex distributed system.
As for future work, we are going to generalize our approach to verify ODP common function trader from different viewpoint. This will be our basis for further investigation of using event-B in the design process of ODP systems

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Performance of Networked DC Motor with Fuzzy Logic Controller

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Abstract

In the recent years the usage of data networks has been increased due to its cost effective and flexible applications. A shared data network can effectively reduce complicated wiring connections, installation and maintenance for connecting a complex control system with various sensors, actuators, and controllers as a networked control system. For the time-sensitive application with networked control system the remote dc motor actuation control has been chosen. Due to time-varying network traffic demands and disturbances, the guarantee of transmitting signals without any delays or data losses plays a vital role for the performances in using networked control systems. This paper proposes Fuzzy Logic Controller methodology in the networked dc motor control and the results are compared with the performance of the system with Ziegler-Nichols Tuned Proportional-Integral-Derivative Controller and Fuzzy Modulated Proportional-Integral-Derivative Controller. Simulations results are presented to demonstrate the proposed schemes in a closed loop control. The effective results show that the performance of networked control dc motor is improved by using Fuzzy Logic Controller than the other controllers.

Keywords: *Networked Control System, Fuzzy Logic Controller, DC Motor.*

1. Introduction

The adaptation of communication network for information exchange between controllers, sensors and actuators to realize a closed control loop is called as Networked Control System (NCS). Networks reduce the complexity in wiring connections and the costs of Medias; provide ease in maintenance and also enable remote data transfer and data exchanges among users. Therefore, NCS is used widely in many industrial applications. Two major challenges as networked induced delay and data losses in the network affects the performance of the system. Hence the challenges have to be compensated. Thus, with a networked controlled dc motor system this paper illustrates the proposed Fuzzy Logic Controller (FLC) for the compensation of the challenges and also compares FLC simulation results with the Fuzzy Modulated Proportional-Integral-Derivative Controller (FMPID) and Zeigler Nichols tuned Proportional-Integral-Derivative (PID) Controller.

There are two approaches to utilize a data network as Hierarchical Structure and Direct Structure. The Hierarchical Structure is shown in Fig. 1 where the dc motor is controlled by its own remote controller at remote station. The central controller provides the set point to the plant (dc motor) via remote controller and the sensor measurements of the system are sent from the remote station to central controller. The remote controller controls the plant by providing the control signal in the remote unit. The set points and sensor measurements are transmitted through network. This approach has a poor interaction between the central and remote unit because of not transmitting the control signal from central controller. Whereas in the Direct Structure Fig. 2 approach the network is used for the direct transfer of the control signal and the sensor measurements between a remote unit and a central controller. The central controller is connected to the dc motor through an interface unit. Due to the transfer of control signal directly to plant this approach provided better interaction of data’s between central controller and the plant than the hierarchical structure.

Recently the stability analysis and control design for NCS have attracted considerable research interest [3], [4], [6] and [11]. The work of Nesic and Teel [2] presents an approach for stability analysis of NCS that decouples the scheduling protocol from properties of network free nominal closed-loop system. Nesic and Tabbara [3] extended [2] by stochastic deterministic protocols in the presence of random packet dropouts and inter transmission time and they also proposed wireless scheduling protocol for non-linear NCS in [6]. The networked predictive control scheme for forward and feedback channels having random network delay was proposed in [4], and [5] addresses the problems of how uncertain delays are smaller than one sampling period which affects the stability of the

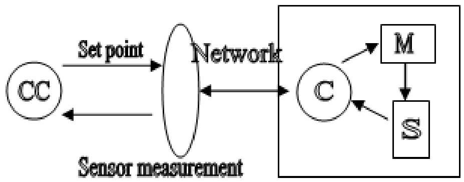

Fig. 1 Hierarchical Structure

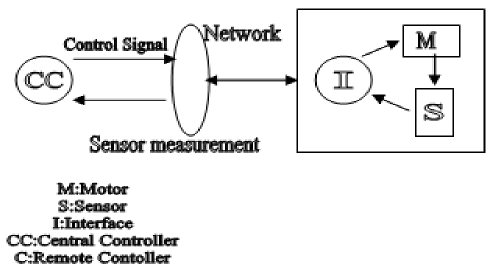

Fig. 2 Direct Structure

NCS and how these delays interact with maximum allowable transfer interval and the selected sampling period. Robust feedback controller design for NCS with uncertainty in the system model and the network induced delay has been addressed in [7]-[8], whereas [9] handles the case of state feedback stabilization of NCS with varying sampling period. Seiler and Sengupta [1] measure the networked vehicle control performance using an H infinity norm with linear matrix inequalities conditions and markovian jumping parameters in communication losses. In case of time varying transmission times, model based NCSs has been proposed for stabilization problem of NCS. The stability analysis and controller synthesis problems are investigated in [11] for the NCSs with random packet losses by using H infinity control and linear matrix inequalities. A moving horizon method was developed by Godwin et. [12], which was applied as a quantized NCS in a practical context. Since these methods transmit data specifying only a region in which the measurements lie, it will reduce the network stabilization of the NCS. However, this method could reduce the stability of the control system by introducing uncertainty in the control system. The issues of limited bandwidth, time delay and data dropouts was taken into consideration when NCSs controllers were designed in [12] – [14]. The networked control system performance depends on the control algorithm and the network conditions. Several network conditions such as bandwidth, end-to-end delay, and packet loss rate are major impacts on networked control systems. Depending upon the control algorithm and network conditions the overall performance of the networked system may vary and hence the stability of the system.

2. Modeling

A networked control system can be divided into three parts: 1) the remote unit; 2) the central controller; and 3) the data network. A general block diagram of the networked control system under investigation is shown in Fig. 3. In order to focus our discussion on the performance of networked closed loop control system with network conditions (delay, data loss), a networked dc motor control system has been illustrated as in [16].

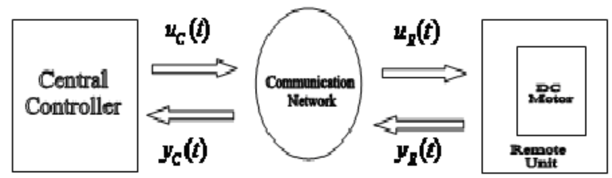

Fig. 3 An overall real-time networked control system

2.1 Remote Unit

The Remote Unit consists of the plant (dc motor), sensor and an interfacing unit. Via the network the remote unit can send measurements like motor speed, current, temperature, and local environment information, back to the central controller. Using the state-space description, the dynamics of the remote process can be described as shown in Eq. (1), where the state vector $X_R = [x_{R1} \ldots x_{Rn}]^T \in X^n$ the state space; the input vector $U_R = [u_{R1} \ldots u_{Rr}]^T \in U^r$, the input space; $S_R = [s_{R1} \ldots s_{Rq}]^T \in R^q$ are the system parameters; $t \in R^+$ is the time parameter; and $F_R \in R^n$ is the state transfer function of the remote unit

$$\dot{X} = F_R(X_R, S_R, U_R, t) \tag{1}$$

Depending on the design of the networked control system, the remote interface, G_R performs a certain task, such as regulating the performance of the plant, as described by Eq.(2).

$$U_R = G_R(\gamma_R, \cdot) \tag{2}$$

where $\gamma_R = [\gamma_{R1}, \ldots, \gamma_{Ra}]^T$ is the adjustable controller parameter vector and (·) is other appropriate information. The combination of the remote plant and remote interface is viewed as a remote unit. The remote unit dynamics can be described by a set of differential equations

$$\dot{X} = F_R(X_R, S_R, G_R(\gamma_R, \cdot), t) \tag{3}$$

For the discussion a network based controlled dc motor is used as remote unit. The electro-mechanical dynamics of the dc motor can be described by the loop equation as first order differential equations.

$$u(t) = e_a = L\frac{di_a}{dt} + Ri_a + e_b \qquad (4)$$

where $u=e_a$ is the armature winding input voltage; $e_b = K_b\omega$ is the back-electromotive-force (EMF) voltage; L is the armature winding inductance; i_a is the armature winding current; R is the armature winding resistance; K_b is the back-EMF constant and ω is the rotor angular speed. Based on Newton's law the mechanical-torque balance equation is

$$J\frac{d\omega}{dt} + B\omega + T_l = Ki_a \qquad (5)$$

J is the system moment of inertia; B is the system damping coefficient; K is the torque constant and T_l is the load torque.

By letting $x_1 = i_a$ and $x_2 = \omega$, the electromechanical dynamics of the dc motor can be described by the following state-space description:

$$\dot{x}_1(t) = -\frac{R}{L}x_1 - \frac{K_b}{L}x_2 + \frac{1}{L}u \qquad (6)$$

$$\dot{x}_2(t) = \frac{K}{J}x_1 - \frac{B}{J}x_2 + \frac{1}{L}T_l \qquad (7)$$

The parameters of the motor table 1 are used for determine the state space model of dc motor. To keep the illustration simple, the remote unit receives the data sent from the central controller as u_R, which can be mathematically expressed as

$$u_R(t) = u_c(t - \tau_R) \qquad (8)$$

where τ_R is the time delay to transmit the control signal u_C from the central controller to the remote unit. The remote unit also sends the sensors signals $y_R(t)$ of the remote system back to the central controller, $y_C(t)$, and these two signals are related as

$$y_c(t) = y_R(t - \tau_c) \qquad (9)$$

where τ_C is the time delay to transmit the measured signal from the remote unit to the central controller.

The parameters of the ½ hp dc motor which are used in this paper are shown in table 1.

Table 1. DC Motor parameter

J	Moment of Inertia	42.6 e-6 Kg-m^2
L	Inductance	170 e-3 H
R	Resistance	4.67 Ω
B	Damping Coefficient	47.8 e-6 Nm-sec/rad
K	Torque Constant	14.7 e-3 Nm/A
K_b	Back EMF constant	14.7 e-3 Vsec/rad

There are also processing delays as τ_{PC} and τ_{PR}, at the central and remote unit, respectively which could be approximate small constants or even neglected because these delays are usually small compared to τ_C and τ_R.

2.2 Central Controller

The central controller will provide the control signal $u_C(t)$ to the remote systems. Let z^{-t} be a time delay operator and the current network conditions n(t) provided by the network are defined as

$$u_R(t) = u_c(z^{-t_R}, n(t)) \qquad (10)$$

$$y_c(t) = y_R(z^{-t_c}, n(t)) \qquad (11)$$

where t_R is the time delay in transmitting a signal from the central controller to the remote unit, and t_C is the time delay in transmitting a signal from the remote unit to the central controller. The network conditions n(t) and time delays z^{-t} are functions of network variables such as the network throughput, the network management/policy used, the type and number of signals to be transmitted, the network protocol used, and the controller processing time, and the network traffic congestion condition.

The central controller will monitor the network conditions of the remote unit link and provide appropriate control signals to each remote unit. In this paper, the Fuzzy Logic Controller is proposed to be the central controller.

2.3 Data Network

There are different ways to define network conditions for point-to-point (from the central control to a specific remote unit). Two of the most popular network measures are the point-to-point network throughput and maximal delay bound of the largest data.

One factor of interest is the sampling time. In this paper, we have chosen sampling time as 0.5ms and simulations are done.

3. Controller Design for NCS

In this session the proposed Fuzzy Logic Controller for the central controller is described and the results are compared with the Fuzzy Modulated PID controller and PID controller.

3.1. Fuzzy Logic Controller

In general, fuzzy logic control is used for the control of a plant where the plant modeling is difficult. For such systems that are difficult to model, fuzzy logic controller has been successful by Mamdani. The basic principle of fuzzy logic lies in the definition of a set where any element can belong to a set with a certain degree of membership. Using this idea, the knowledge of an expert can be expressed in a relatively simple form and the inference for given inputs can be implemented very efficiently. Due to these advantages, fuzzy logic control is a very attractive method for NCS whose modeling is very difficult because of the stochastic and discrete nature of the network. Figure (4) shows the structure of FLC for a single input single output plant. In this figure, the control signal and plant output are transmitted through the network. Due to the use of the network, the control signal and feedback signal (plant output) inevitably contain the network induced delay and losses of data. In Fig.4 r(t) is the reference input, y(t) is the plant output, e(t) is the error signal between the reference input and plant output and $U_c(t)$ is the control signal.

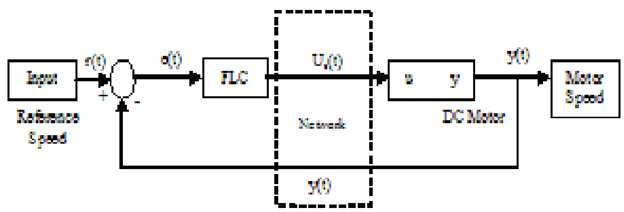

Fig. 4 Fuzzy Logic Controller for NCS

The FLC consists of three parts as 1) Fuzzifier that converts the error signal into linguistic values, 2) Inference engine that creates the fuzzy output using fuzzy control rules generated from expert experience and 3) Defuzzifier that calculate the control input to the plant from the inferred results. The input and output signals to the FLC are error signal e(t) and control signal $U_c(t)$ respectively. In this paper, the trapezoidal fuzzy members are selected for membership functions. Three fuzzy linguistic variables, i.e., Small, Medium and Large are defined. The coefficients of the membership function depend upon the set point and are determined by several trial and error experiments with the plant without the network. In order for faster execution of the fuzzy logic controller, the Mamdani's min-max inference method and the central average defuzzifier are used. The rules used in this paper are as

If e(t) is small then $U_c(t)$ is small
If e(t) is medium then $U_c(t)$ is medium
If e(t) is large then $U_c(t)$ is large

The FLC reduces the effects of network induced delays, losses and disturbance and they also reduces the effects of the disturbances in the input reference signal. The simulation results are shown in the Session 4.

3.2. Fuzzy Modulated PID Controller

The fuzzy modulated PID controller for the networked control dc motor is shown in the Fig. 5. The model is based on modulating the control signal $U_{PID}(t)$ provided by the PID controller with a single parameter β. The fuzzy modulator receives the input as the error signal e(t) which is the difference between the reference signal and the plant output signal y(t) in addition to the output from the PID controller $U_{PID}(t)$. The fuzzy modulator produces an output as modulation parameter β which is used to compensate the affects of the network induced time delay and data losses. The control signal produced by the fuzzy modulated networked PID controller is

$$U_c(t) = \beta U_{PID}(t) \tag{12}$$

Two fuzzy linguistic variables, i.e., Small and Large are defined. The coefficients of the membership functions are determined by several trial and error methods with the plant and without the network. The fuzzy logic modulator used in this paper is composed of the following rules.

If e(t) is small and $U_{PID}(t)$ is small, then β is β_1
If e(t) is large and $U_{PID}(t)$ is large, then β is β_2

Such that $\beta < \beta_1 < \beta_2 < 1$ where β_i, i=1,2 are the consequent parameters corresponding to the modulation parameter β [19].

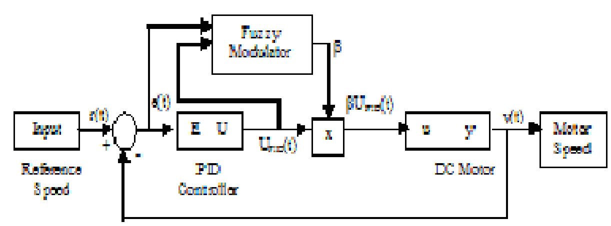

Fig. 5 Fuzzy Modulator PID Controller for NCS

3.3. PID Controller

It is used to compute the control signal to the remote dc motor for step tracking, based on the monitored system signals sent from the remote unit via the network link Fig. 6. The Proportional-Integral-Derivative (PID) controller used is

$$U_{PID}(t) = K_p e(t) + K_I \int_0^t e(t)dt + K_D \frac{de(t)}{dt} \tag{13}$$

where K_p is the proportional gain; K_I is the integral gain; K_D is the derivative gain; r(t) is the reference signal for the system to track; y(t) is the system output; and e(t) is the error function. In our case, y = ω is the motor speed, and $U_{PID}(t)$ is the input voltage to the motor system.

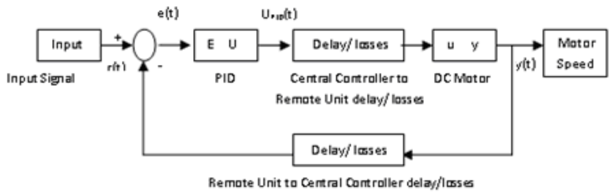

Fig. 6 ZN Tuned PID Controller for NCS

4. Simulation Setup and Results

In the simulation scenario, the direct structure of the networked DC motor control system is simulated using MATLAB/ SIMULINK under fully controlled environments for Fuzzy Logic Controller, PID Controller and Fuzzy Modulated PID Controller. The motor Eq.(4) and Eq.(5) are used as the main model, and it is controlled by the fuzzy logic controller with the insertions of network delays according to Eq.(8) and Eq.(9). The delays are varied according to different effects of interests. The disturbance and loss of input signal, control signal and the feedback signal were made for few milliseconds at each stage and the results were studied. The system setup is illustrated in Fig.4, Fig.5 and Fig.6. Using Eq.(6), Eq.(7) and table I, the state model of the dc motor is obtained. Then the results of the FLC are compared with the PID controller and fuzzy Modulated PID Controller.

Output Responses of the system are obtained for all controllers used in this paper. Figure 7 shows the comparison of the system performance for all controllers without delays and data losses.

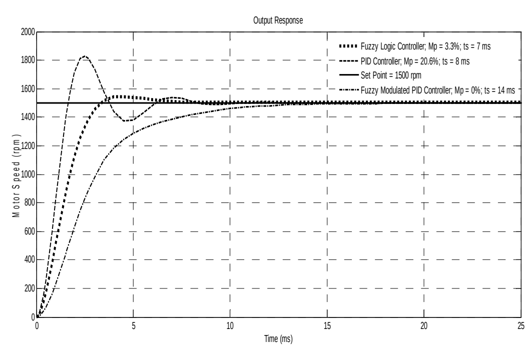

Fig. 7 Comparison of System Responses for FLC, Conventional PID Controller and FMPID Controller without delay and losses.

In Fig. 8 – 10 shows the response of the system for the controllers with different network induced delays and the comparison of these performances are tabulated in table 2. In Fig.11 and Fig. 12 the system responses of all the controllers with missing of input data and disturbances in the input data are shown respectively. Similarly the system response for missing of control signal, disturbances in control signal, missing of feedback signals and disturbance in feedback signals are shown in Fig. 13-16 respectively. Thus the system performance with data loss in the input signal, control signal and feedback signal are obtained. Finally the system responses with delay and data losses are obtained as shown in the Fig.17. From the simulation results obtained as in Fig.7-17, the overall system performance with Fuzzy Logic Controller is improved than the PID controller and fuzzy modulated PID controller.

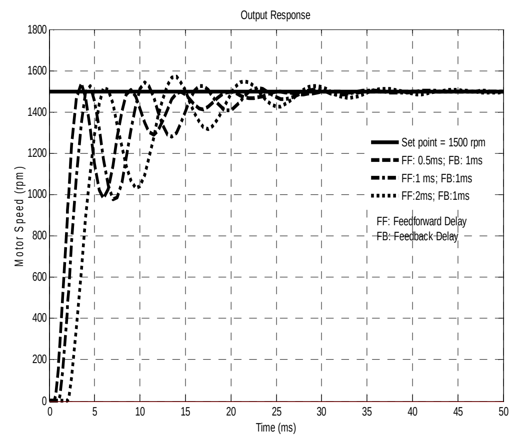

Fig. 8 Output Response of the System using PID Controller with varying delays in forward and feedback path of NCS.

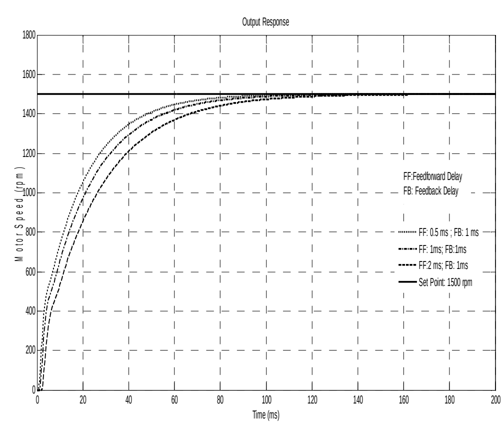

Fig. 9 Output Response of the System using FMPID Controller with varying delays in forward and feedback path of NCS.

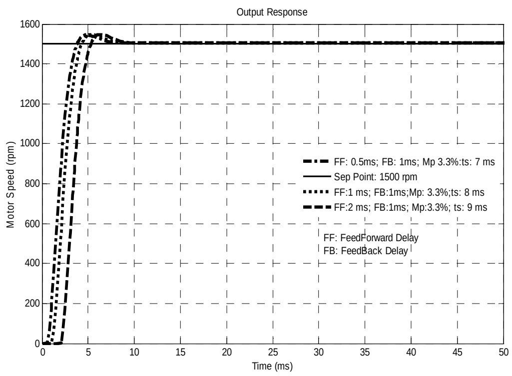

Fig.10 Output Response of the System using FLC with varying delays in forward and feedback path of NCS.

Table 2. Comparison of performance of the networked dc motor control system with delay in FLC, PID and FMPID Controller (Set point = 1500 rpm; Sampling Time = 0.5ms)

Time delay (ms)		Maximum overshoot (%)			Settling Time (ms)		
Feed forward path	Feed back path	PID	FMPID	FLC	PID	FMPID	FLC
0.5	1	3.3	-	3.3	30	100	7
1	1	3.3	-	3.3	40	110	8
2	2	6.6	-	3.3	62	150	9
2	3	8	-	3.3	70	180	9
3	2	9	-	3.3	75	190	9

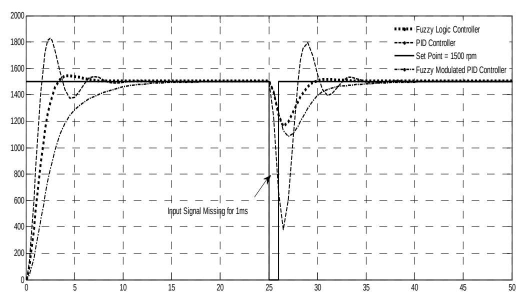

Fig.11 Comparison of system responses for missing of the input signal using FLC, PID and FMPID Controllers.

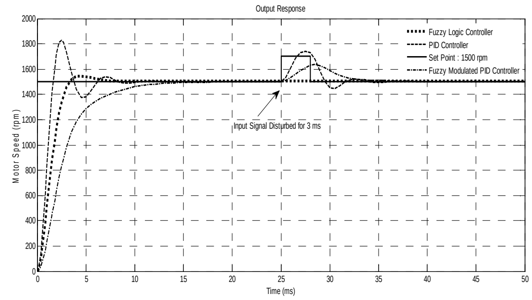

Fig.12 Comparison of system responses for disturbance in the input signal using FLC, PID and FMPID Controllers.

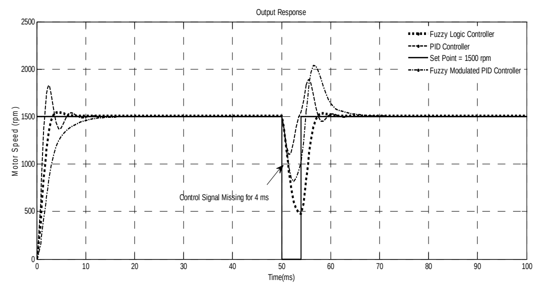

Fig.13 Comparison of system responses for missing of the control signal using FLC, PID and FMPID Controllers.

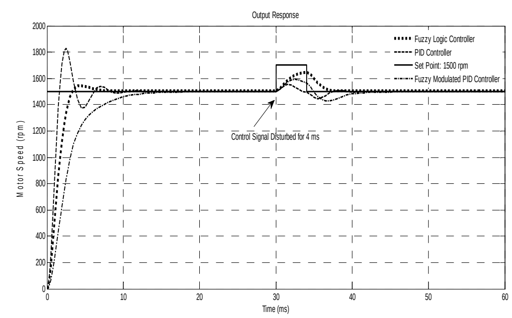

Fig.14 Comparison of system responses for disturbance in control signal with FLC, PID and FMPID Controllers.

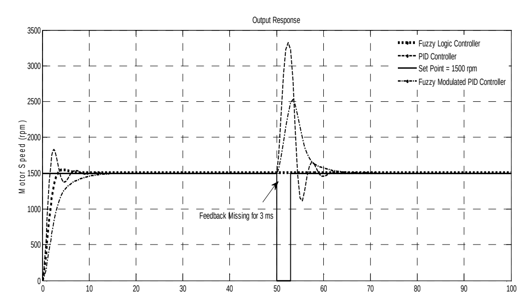

Fig. 15 Comparison of system responses for missing of the feedback signal with FLC, PID and FMPID Controllers.

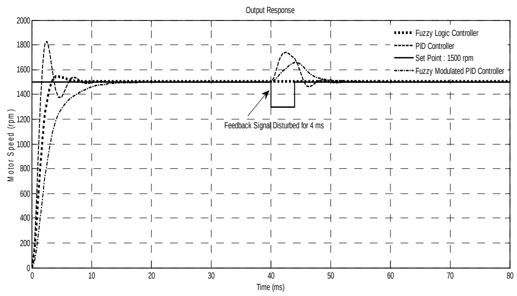

Fig.16 Comparison of system responses for disturbance in feedback signal with FLC, PID and FMPID Controllers.

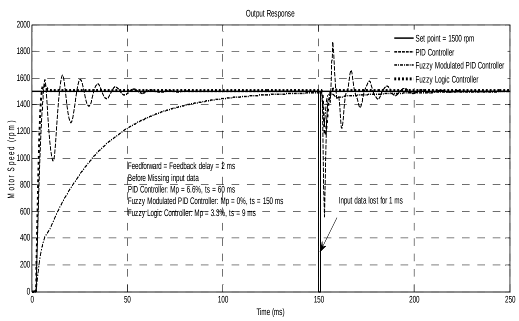

Fig.17 Comparison of system responses of FLC, PID and FMPID Controllers with delay and losses.

5. Conclusions

Networks and their applications play a promising role for real-time high performance networked control in industrial applications. The major concerns are the network induced delays and data losses that are provided by the network which affects the performance of the networked control systems. This paper has describes and formulates the Fuzzy Logic Controller in a networked DC motor control. The numerical result are obtained and compared for Fuzzy Logic Controller, Fuzzy Modulated PID Controller and PID Controller. The effective results show that the performance of networked control DC motor is improved by using Fuzzy Logic Controller than the other controllers in all network variations and deteriorations. The analysis on using intelligent controls improves and strengthens the networked control systems concepts in the future.

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Modified Rumor Routing for Wireless Sensor Networks

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Abstract

Due to the limited processing power, and finite power available to each sensor node, regular ad-hoc routing techniques cannot be directly applied to sensor networks domain. Thus, energy-efficient routing algorithms suitable to the inherent characteristics of these types of networks are needed. However highly efficient data centric model of routing will improve the longevity of the network. This paper describes a mechanism of improvisation through simulation of existing feature of Rumor routing. The improvised rumor routing algorithm handles node failures and allows for tradeoffs between setup overhead and delivery reliability.

Keywords: *Rumor routing, flooding algorithm, spanning trees, PROWLER*

1. Introduction

Rumor routing [1] allows the routing of queries to nodes that have observed an event of interest. As a result, retrieval of data is based on events and not on an addressing scheme. An event is an activity related to the phenomena being sensed (e.g. increased movement in an area being monitored). In this paper, events are assumed to be localized phenomena which occur in fixed regions of space. A query is issued by the sink node for one of two reasons, as an order to collect more data, or as a request for information. Once a query arrives at its destination, data is issued to the originator of the query. Depending on the amount of data (whether it is more or less) being issued to the originator of the query, shorter paths from the source to the sink are discovered. If flooding was to happen on a regular basis, network resources would be consumed quickly, thus Rumor routing was created to be an alternative to flooding queries and events. When a query is generated, it is sent randomly through the network until it finds the event path instead of flooding it. When the query finds the event path, it is routed directly to the event. Only if the path cannot be found, it is flooded as a last resort. Rumor routing can achieve a high delivery rate as will be shown in the performance study.

Rumor routing uses agents, which have a limited life determined by a TTL field; these agents create paths in the direction of any events they may come across. If an agent crosses a path to an event that it has not yet come across in the network, it creates a path that leads to both events.

An event is an abstraction, identifying anything from a set of sensor readings, to the node's processing capabilities. For the purpose of the simulation studies in this paper, events are assumed to be localized phenomenon, occurring in a fixed region of space. This assumption will hold for a wide variety of sensor net applications, since many external events are localized themselves. A query can be a request for information, or orders to collect more data. Once the query arrives at its destination, data can begin to flow back to the query's originator. If the amount of returning data is significant, it makes sense to invest in discovering short paths from the source to the sink. methods such as directed diffusion [2] resort to flooding the query throughout the entire network [4], in order to discover the best path.

If geographic information is available, the best path is the greedy shortest path, and does not require flooding [3][5].

2. Related Work

Here is a list of various protocols for WSN and they have been developed in the view of overcoming the draw backs of the traditional protocols.

 SPIN [6][7] : Sensor Protocols for Information via Negotiation.

- DD[2].: Directed Diffusion
- RR[1].: Rumor Routing
- GBR [8]: Gradient Based Routing.
- CADR [9]: Constrained Anisotropic Diffusion Routing.
- COUGAR [10]
- ACQUIRE [11]: ACtive QUery forwarding In sensoR nEtworks.
- LEACH [12]: Low Energy Adaptive Clustering Hierarchy.
- TEEN & APTEEN [13] :[Adaptive] Threshold sensitive Energy Efficient sensor Network.
- PEGASIS [14] : The Power-Efficient GAthering in Sensor Information Systems [27].
- VGA [21]:Virtual Grid Architecture Routing .
- SOP [15] : Self Organizing Protocol
- GAF [16]: Geographic Adaptive Fidelity.
- SPAN[17]
- GEAR[18]: Geographical and Energy Aware Routing
- SAR [19] : Sequential Assignment Routing.
- SPEED [20] :A real time routing protocol.
- GAF [16]: Geographic Adaptive Fidelity.
- SPAN[17]
- GEAR[18]: Geographical and Energy Aware Routing
- SAR [19] : Sequential Assignment Routing.
- SPEED [20] :A real time routing protocol.

It can be seen that Rumor Routing is a compromise between flooding event and flooding queries notifications. The idea is to create paths leading to each event; whereas event flooding creates a network-wide gradient field [8]. In this way, when a query is generated it can be sent on a random walk until it finds the event path; instead of flooding it throughout the network .As soon as the query discovers the event path, it can be routed directly to the event. If the path cannot be found, the application can try re-submitting the query, or as a last resort, flooding it. Under a wide range of conditions, it is possible to achieve an extremely high delivery rate [1].

3. The Algorithm Overview

The network is modeled as a set of densely distributed wireless sensor nodes, with relatively short but symmetric radio ranges. These nodes record unique events, and the application needs to be able to route queries to a node that has recorded a particular event.

A heuristic view of the rumor routing algorithm is described below:

• A 2*2 matrix is used by the nodes to maintain a list of the distances with their neighbors, as well as an events table, with forwarding information to all the events it knows. The neighbor list can be actively created and maintained as and when required. All diagonal elements are set to zero representing the distance of a node with itself.

• The nodes in an event are realized and the event path along with the length of the event path is determined and stored elsewhere. As and when a node witnesses an event, it adds it to its event table, with a distance of zero to the event.

• The number of each node constituting the event is stored in a suitable array for the agent to verify if the node encountered is an event node during query transmission.

• Any node may generate a query, which should be routed to a particular event. If the node has a route to the event, it will transmit the query. If it does not, it will forward the query in a random direction. The forwarding is done along a minimum spanning graph using a suitable algorithm, until the agent encounters an event node. As soon as the event node is encountered the remaining length of the event path is added. This continues until the query TTL (**Lq**) expires, or until the query reaches a node that has observed the target event.

• If the node that originated the query determines that the query did not reach a destination, it can try retransmitting, give up, or flood the query. Retransmission is a risk, but the chance of delivery is exponential with the number of transmissions. Hopefully only a very small percentage of queries would have to be flooded.

4. The Simulation Details

PROWLER - Probabilistic Wireless Network Simulator V1.25 was used for simulation with a test bed of 100 sensors placed in a matrix of 10X10 sq units, here the Spanning tree formation is based on randomly distributed network. The list of assumptions made while running the simulation on PROWLER-V1.25 :

1. Each node has the following fields in the routing table
   xID: The identifier of the neighbor.
   InLink: Quality of the directed link (*xID* → *ID*)
   OutLink: Quality of the directed link (*ID* → x*ID*)
   Hop: the hop-number of mote *xID*
   Note: Each node is assigned with unique ID, hop number (initially NaN except the root node where its zero)
2. Each node wakes up periodically and transmits its *ID*, hop number, and table data .Upon receipt of message from node i ,node j updates its own table
   - Updates the *InLink* property of *i*.
   - Updates the *Hop* property of *i*.
   - Updates the *OutLink* property of *i*, if the received table contains information about *j* (the *InLink* value is used).
3. Each nodes transmits the table data with certain finite probability. The transmission probability is the

function of design parameter and the content of the table.

1. Initially $p=P/8$.
2. For all the nodes with a hop-number *NaN*, $p=P/8$.
3. If the hop-number of the node changes, p is set to P.
4. If a mote *j* receives a message from node *i*, indicating that *i* has no information about *j*, but *j* has a good *InLink* property of *i*, then node *j* sets $p= P$
5. After each transmitted message $p=p/2$.

Using the above considerations the spanning tree algorithm was run on the test bed, the following are the performance graphs obtained:

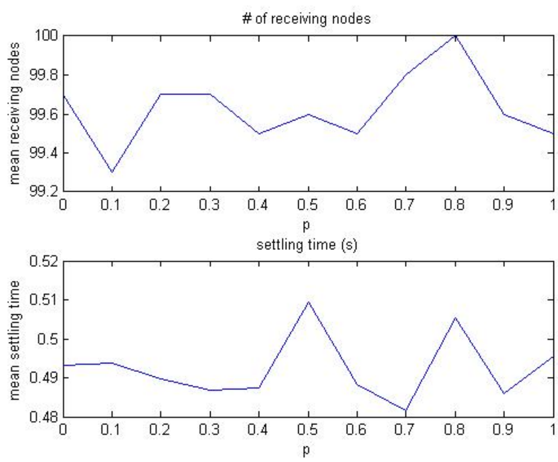

Fig 1: Performance graph for Spanning Tree Algorithm

Using the same considerations as above the flooding algorithm was simulated and the performance graph was as obtained:

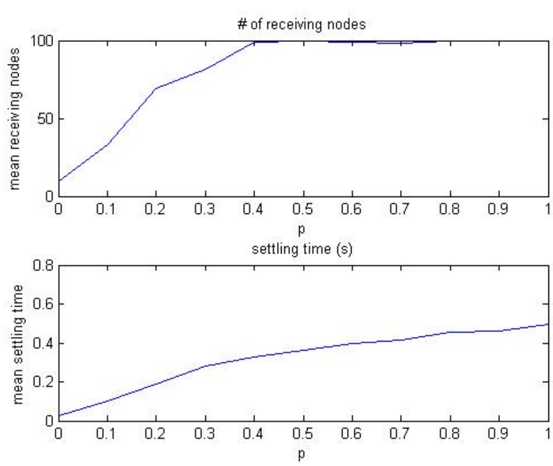

Fig 2: Performance graph for Flooding Algorithm

From the above two cases the interpretation can be made as in case of spanning tree algorithm the percentage of receiving nodes are less as compared to the flooding algorithm with respect to transmission probability. The settling time increases when the transmission probability is increased for flooding algorithm but the variation of settling time is seen for spanning tree algorithm. This condition indicates high congestion probability and power expense in flooding algorithm than spanning tree algorithm.

4. Conclusions

It may be safely concluded that the spanning tree protocol can be used for event –query information dissemination throughout the static network more efficiently than the existing flooding algorithm. Only problem with spanning tree is that the nodes farther from the root node cannot be linked to the closest nodes due to the additional constraints.

4. Scope for Future Work

The simulator PROWLER V1.5 used here never accounted for the battery model used for this WSN. Hence to obtain more detailed analysis NS-2 should be used.

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Implementation of 'Habit sensitive login system' An approach to strengthen the login security

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Abstract

Providing reliable security to the computer user without overstepping any of the privacy related issues is the biggest challenge faced by the computer technologists now a day. An attempt is made herein to tailor a solution based on the personality features of an individual as a factor of identification and authentication. The traditional approach based on verification of the username and the password is insufficient. Hence, a new approach is needed to be introduced so as to make the existing login process more secure. To achieve the goal one can use the advantages of data mining techniques as well as the algorithms similar to the apriori algorithm. The suggested method is based on detection of intrusions at the time of logon. The system so designed; not only by verifies the username and password but also verifies the user's behavior in comparison with the 'recorded normal behavior' of the user. The experiments carried herein are fruitful in recognizing the user by their 'habits as behavior'. And hence the system based on the approach is practicable in real sense.

Keywords: *security, user behavior, habit, apriori algorithm, data mining, intrusion detection.*

1. Introduction

Providing good security to the user without overstepping any of privacy related issues is the biggest challenge faced by the computer technologists now a day. Although there are many options available, the objections and the controversy follow with the invention hand in hand. A very recent issue is of the security system introduced and implemented by 'Google' based on 'Face Identification' technique. This technology is hot debated and strongly argued world wide as a move against the privacy of the user.

An attempt is made herein to tailor a solution based on the personality features of individual as a factor of identification and authentication.

1.1 Problem Definition

The present available security methods are based on the traditional login system that allows 'authentic' (normal) user to gain access to his/ her account after providing the 'username' and 'password'. The traditional approach is insufficient with reference to the security provisions. Hence, a new approach is needed to be introduced so as to make the existing login process; more secure. To achieve the goal one can use the advantages of data mining techniques as well as the algorithms similar to the apriori algorithm[2].

Research Objectives and Hypothesis

To perform the research on the issue, following objectives are decided

1) To study the present Intrusion Detection Systems (IDS).
2) Identify limitations of IDS.
3) Design and develop new logon system.
4) To test and evaluate the performance of newly designed IDS.

To implement the system following assumptions are made-

1) Hypothesis 1 H_0 – User's behavior can be detected in the forms of 'events' as a series of the activities carried by the user as a habit.
2) Hypothesis 2 H_0 – Anomaly if any, can be detected by studying the behavior of the user with the help of the Data Mining Techniques.
3) Hypothesis 3 H_0 –The system based on the new approach helps to solve problem of intrusion at

logging in process by providing more security to the authentic user.

1.3 Research Strategy-Design and Creation

According to the research methodology [1] "*Design and Creation*" is carried out in this research attempt. It focuses on developing new IT product which is also called as "*artifacts*". Types of IT artifacts such as [March & Smith, 1995] *Constructs, Models, Methods* such as Soft Systems Methodology (Checkland & Scholes, 1990) or Information Engineering (Martin, 1989), *Instantiations.*

In general, the research for the IT application focuses mainly on-

1. IT application that uses IT in a new domain, which has not previously been automated.
2. IT applications that incorporate a new theory, which may be drown from other discipline.
3. IT application that expresses or explores novel artistic ideas.

While searching for exploration of new ideas, an approach is accepted by combining various data mining techniques. For tailoring the solution to the problem of security regarding authentication and prevention from any unauthorized access techniques such as association, clustering in the Intrusion Detection System at login time are prefered.
The tools used here are the Visual Basic and the data base for the verification of the idea and to find out the feasibility of the implementation of the idea.

This activity focuses on designing of an improved Information System (IS). This kind of approach was not been taken earlier for detecting the anomaly using data mining. It is an attempt towards design and creation of new IS product to give good security to the user at the time of the user login for any system[3].

1.4 The Method suggested for the implementation of the idea:

The suggested method is based on detection of intrusions at the time of logon. To achieve this, the system designed not only verifies the username and password but also verifies the user's behavior in comparison with the recorded normal behavior of the user (or profile). The behavioral practices and the habits displayed by the user are to be recorded and stored in to the database. The database is updated time to time. The behavior refers to **"the sequence of events/actions that are performed intentionally and/or unintentionally by the user at the time logon process"**. From this, the behavioral profile, event sequence set that contains one or more of such events is obtained for the normal user.

The output of the proposed system is the sequence of events; termed as *eventsequence* detained from user at logon time. On this *eventsequence,* Apriori Algorithm is applied so as to obtain the **"strongest association rule(s) between most frequently occurring events"**. The system so designed thus makes it possible for leading to the decision **'whether or not to allow access permission to user'** for the session further. The decision is taken by comparing current user's events/actions that are generated at the time of each logon with the strongest rules produced from profile database by the algorithm. In this way, the proposed system becomes capable to detect intruder before logon into the system.

1.5 Normal User's Profile Database

Of course, to achieve the goal in this regard, one has to have proper record of the normal user's behavior. This record is treated as the profile of the user constructed using database software MS-Access. This profile of the user contains the attributes such as – **UserID**, **Username**, **Password**, **Event sequence string**, **Session time**. The very first table created for the purpose is-

Table Name: tlbUserMaster which is used **to store the information of the user** like User ID, User Name and Password. The primary on attribute UserID is applied to uniquely identify user. Following table shows the structure of *tlbUserMaster* table

Table-1: User Master Table Structure

Attribute Name	Data Type	Size/ Format	Description
UserID (Primary Key)	Number Integer		User ID to identify each user distinctly or uniquely.
UserName	Text	15	Name of the user that has to provide at Logon Time.
UserPassword	Text	10	Key (Complex String) in encrypted format used to gain access into the system.

(Source: System design suggested by Dr. N.C.Dhande)

Table Name: tlbNormalUserProfile : This table is used **to store the behavior of the normal user at logon time** for example, events/actions generated by the user (normal/anomaly) at the logon time. This table is referred by the table *tlbNormalUserProfile*

Table-2: Normal User's Behavioral Profile Structure

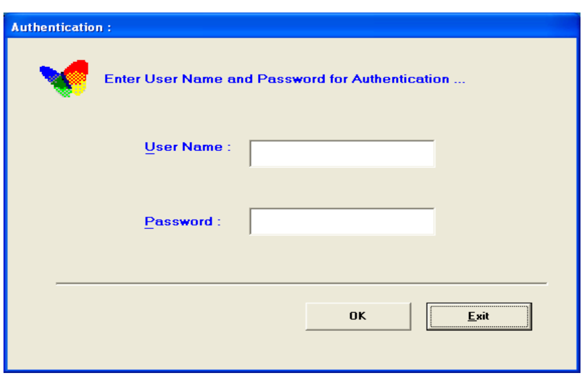
S N	Attribute Name	Data Type	Size/ Format	Description
1	UserID (Foreign Key)	Number	Integer	This field is refers the field UserID from the table **tlbUserMaster.**
2	EventSequence	Text	50	Used to store the events generated intentionally or unintentionally at logon time.
3	LogonTime	Date/ Time	Medium Time	Used to store login time of user.
4	SessionTime	Number	Integer	Used to store time (in Seconds) spend by the user at the time of logon process.

(Source: System design suggested by Dr. N.C.Dhande)

1.6 Proposed Method - Design and layout

While implementing the idea of detecting the unauthorized user, the suggested system is designed with the VB and Access combination. The prepared logon form using VB accepts the username and password inputted by the logger, the **system also simultaneously records the actions/events those are generated at logon time by the current user who may be a normal user or an anomaly**. Also it calculate the time used up by the current user in logon process.

Figure-1: Proposed Logon Form that record Normal User's Behavior



(Source: System design suggested by Dr. N.C.Dhande)

The designed logon form is provided to the user to record his/her behavior at the time of logon process. As stated in the suggested method – the behavior means, "set of events that generated purposely or accidentally when user trying to logon". While doing it, the user has to enter username and password. The application for proposed method records the events performed by the user and also calculates the time taken by the normal user to logon as a normal process.

In this way the sequential set of events is now made available in ***EventSequence*** field that is obtained from the application of the designed system. The application of the Association Rules of the Apriori Algorithm[4] on these set of events gives the output so as to establish an association.

1.7 Verification of the facts on implementation:

Description: The username, password and behavior detained by the application and are then transferred in to table. The normal user's sample behavior recorded by application is given in the following table.

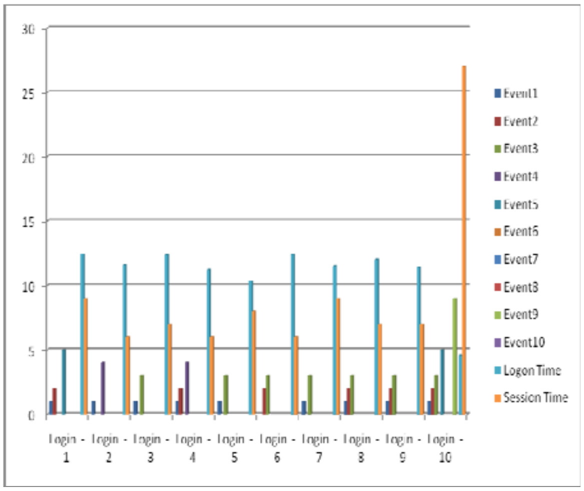
Table-3: Normal User's Recorded Behavior at Logon

User ID	User Name	User Password	Event Sequence	Logon Time	Session Time
101	Nishikant	Nishi#123	E1,E2,E5	12:45 PM	9
101	Nishikant	Nishi#123	E2,E4	11:57 AM	6
101	Nishikant	Nishi#123	E2,E3	12:35 PM	7
101	Nishikant	Nishi#123	E1,E2,E4	12:05 PM	6
101	Nishikant	Nishi#123	E1,E3	10:11 AM	8
101	Nishikant	Nishi#123	E2,E3	12:40 PM	6
101	Nishikant	Nishi#123	E1,E3	11:50 AM	9
101	Nishikant	Nishi#123	E1,E2,E3,E5	12:03 PM	7
101	Nishikant	Nishi#123	E1,E2,E3	11:42 AM	7
101	Nishikant	Nishi#123	E1,E2,E3,E10	03:00 PM	27

(Source: System design suggested by Dr. N.C.Dhande)

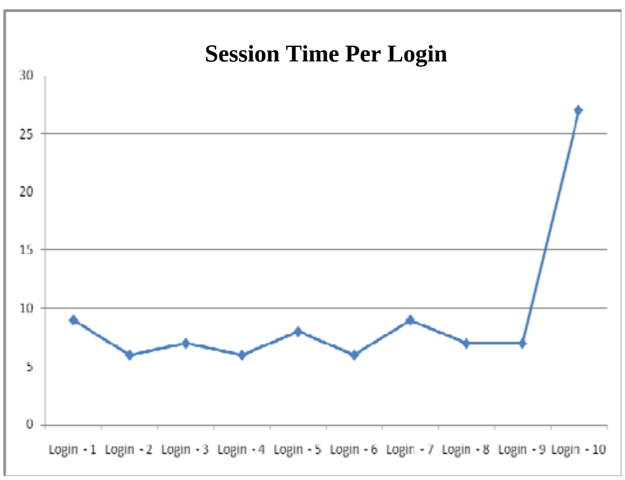
To illustrate it more the graph of the events recorded is shown in the figure given ahead. On each of the event of the logging in session, the session time is recorded and the same is further used to interpret the behavioral pattern of the user at the time of the login.

Graph 1: Graphical Representation of Normal User's behavior Recorded by the Application



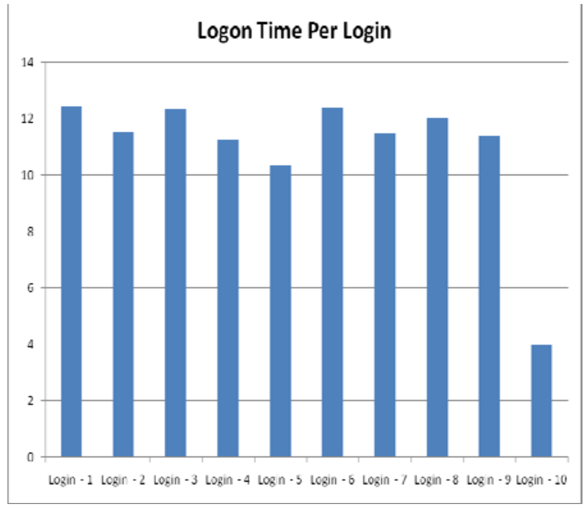
(Source: System design suggested by Dr. N.C.Dhande)

Graph 2: Graphical Representation of Normal User's SessionTime/Login



(Source: System design suggested by Dr. N.C.Dhande)

Graph 3 : Graphical Representation of Normal User's LogonTime/Login



(Source: System design suggested by Dr. N.C.Dhande)

The Graph 1 shows the Normal User's behavior at logon time with respect to session time that means time (in second) spent by the user at each logon process. From this it clears that for the first nine logon processes time taken by the user is in between 6-9 seconds hence average value for session time will be 7.22 and normal deviation ranging from -1.77778 to +1.22222. While in the last logon process user takes 27 seconds to log-on. Similarly, Figure-10 shows average logon time for first nine logon processes is 12:21 PM. While in the last logon process time will be 3:00 PM . Also **occurrences of backspace key ensure that E10 user trying to logon in the last logon process may be anomaly** up to some extent hence deviation occurred at three levels and **hence denied** current user at first level to gain access to the system. And once again has to verify the current user with some other parameters.

1.8 Conclusion:

Though it is difficult to give a total secure login procedure using traditional methods, a new approach based on identification of the user beyond the user name and password is a successful attempt towards achieving the design of a total secure logging process (TSLP). The experiments made herein are fruitful in recognizing the user on their habits as behavior. Hence it is clear that, user behavior can be detected in the forms of 'event s', 'Anomaly' can be detected by on behavior using Data Mining Techniques and a system based on the new approach can provide more security to the authentic user. The system based on the approach is practicable in real sense and can be attached as a middleware with the 'key operated interface system' like internet, ATM, etc .

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A Fast Mode Selection Algorithm Using Texture Analysis for H.264/AVC

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Abstract

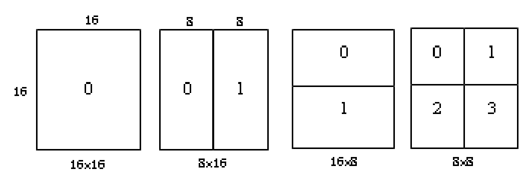
H.264/AVC, the newest international video coding standard achieves higher compression efficiency as compared to all other existing coding standard such as MPEG-4 and H.263. However this efficiency comes with a dramatic increase in computational complexity due to several advanced techniques, such as inter mode and intra mode prediction with variable size motion compensation. It adopts rate distortion optimization (RDO), while maximizing visual quality and minimizing the required bit rate. In this paper, we propose a fast inter mode selection algorithm. The aim is to reduce the number of modes in intra and inter mode prediction. Experimental results show that this algorithm reduces the total encoding time with little loss of bit rate and visual quality.

Keywords*-H.264/AVC, rate distortion optimization (RDO), inter-mode prediction, intra-mode prediction.*

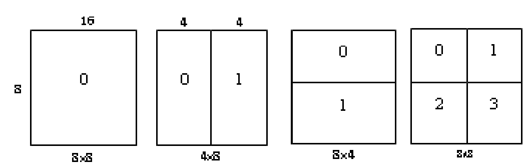
1. Introduction

H.264/AVC is a transform based, block-based, motion compensated video format jointly developed by the International standards organization (ISO) Moving Picture Expert Group (MPEG), and Telecommunication standardization Sector (ITU-T). H.264/AVC is composed of many advanced video coding techniques. The main goal of this standardization effort has been enhanced compression, provision of network-friendly video representation addressing both 'conversational' (video conferencing, video telephony) and 'non-conversational' (storage, broadcast or streaming) applications. H.264/AVC encoder has 5-10 times computation complexity compared to MPEG-2. This makes it a must to reduce the computational complexity of algorithm in H.264/AVC.

For Inter-frame prediction, the H.264 encoder performs motion estimation of blocks with variable sizes, such as 16x16, 16x8, 8x16, and 8x8, for each 16x16 macroblock[9][4]. In the case of 8x8 block, the macroblock is divided into four 8x8 blocks and each of these 8x8 blocks can be encoded into 8x8,8x4,4x8, or 4x4 blocks, as shown in fig.1.



Macroblock partitions: 16x16, 8x16, 16x8 and 8x8



Submacroblock partitions: 8x8, 4x8, 8x4 and 4x4.

Fig.1.Macroblock and Submacroblock partitions.

H.264/AVC supports various techniques among which intra-mode and inter-mode prediction mostly contribute to the coding efficiency. The Rate Distortion Optimization (RDO) mechanism is used to select the best coding mode among all of the block modes[6][7].However, the computational complexity of the RDO technique is extremely high since the encoder has to encode the target block by searching all possible modes for the best mode. Therefore there is an obvious need for reducing the amount of modes that are evaluated in order to speed up the encoding and hence to reduce the complexity of the encoder.

2. Intra-And Inter Prediction for H.264/AVC

H.264/AVC defines two coding modes which are intra-frame coding and inter-frame coding. Intra-frame coding supports two classes which are Intra 4x4(*I4MB*) and Intra 16x16(*I16MB*). Intra-prediction is based on the observation that adjacent macroblocks tend to have similar properties. When the subsequent frames of the video sequence have comparably large difference among them, Intra coding [1] is selected. For prediction of 4x4 luminance blocks, the 9 directional modes consist of a DC prediction (Mode 2) and 8 directional modes: labeled 0,1,3,4,5,6,7, and 8 as shown in Fig. 2, the block (values of pixels “a” to “p”) is to be predicted using A to Q. The pixels “A” to “Q” from neighboring blocks have already been encoded and may be used for prediction.

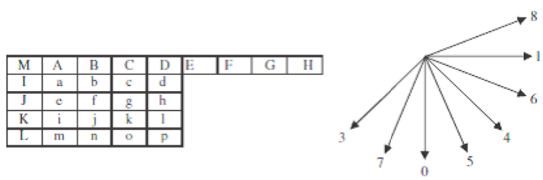


Fig.2.Labelling and direction of intra-prediction modes.

For regions with less spatial details(i.e. flat regions), H.264/AVC supports 16x16 intra-coding; in which one of four prediction modes[2] (DC, vertical, horizontal, and planer) is chosen for the prediction of the entire luminance component of the macroblocks as shown in Fig. 3.

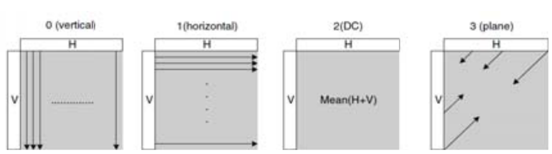


Fig.3.Intra 16x16 prediction modes.

Inter-frame selection supports the following modes: SKIP, 16x16, 16x8, 8x16, 8x8, 8x4, 4x8, and 4x4. The mode decision is made by choosing the mode having minimum RDO[10] cost.

J(s, c, MODE|QP, λmode) = SSD(s, c, MODE|QP) + λ_{MODE} R(s, c, MODE|QP) (1)

Where *QP* is the quantization parameter of the macroblock, *J(s, c, MODE|QP,* λ_{mode}*)* is the mode cost, $\lambda_{mode} = 0.85x2^{(QP-12)/3}$ is the Lagrangian multiplier[3], and *MODE* indicates a mode chosen from the set of macroblock modes: {*SKIP*, 16x16, 16x8, 8x16, 8x8, 8x4, 4x8, 4x4, Intra 4x4, Intra 16x16}, *R(.)* represents the rate i.e. the number of bits associated with chosen *MODE*, *SSD* denotes the sum of squared differences between the original block s and its reconstructed signal *c*, computed as,

SSD(s, c, MODE|QP) = [x, y]-Cy[x, y, MODE |QP])^2 [x, y]-Cu[x, y, MODE |QP]) ^{2}+ [x, y]-Cv[x, y, MODE |QP])^2 (2)

Where $c_y(x, y, MODE|QP)$ and $s_y(x, y)$ represent the reconstructed and original luminance values; c_u, c_v and s_u, s_v indicates the corresponding chrominance values.

3. The Proposed Improvement of Fast Mode Selection Algorithm

The proposed algorithm of mode decision analyzes texture of an image and the motion characteristics for choosing a group of effective predicting modes to reduce the searching modes.

The texture characteristics of the current macroblock, the definition of variable V_{ar} which is complexity level of the texture for the current macroblock can be found as:

$$Var = \sum_{x=0}^{A-1}\sum_{y=0}^{B-1}\left| f(x,y) - \frac{1}{A*B}\sum_{x=0}^{A-1}\sum_{y=0}^{B-1} f(x,y)\right| \quad (3)$$

In the above equation, *f(x, y)* is a pixel of *(x, y)*, *A* and *B* are used to calculate the block size of variable V_{ar}. A macroblock with well-proportioned texture, V_{ar} is very small. If V_{ar} is less than threshold ψ_{inter} which is a given threshold in the experiment shows that the current macroblock belongs to flat background. For which 16x16 inter-frame coding mode is selected for motion estimation and motion compensation rest of all other coding mode. If $\psi_{inter1} < V_{ar} < \psi_{inter2}$, then it shows that the macroblock belongs to complex area. So the Inter-frame coding mode such as 16x16, 16x8, 8x16, 8x8 is selected. Otherwise if $V_{ar} > \psi_{inter2}$ the current macroblock belongs to motion area, and small inter-frame mode[8] such as 8x8, 8x4, 4x8, 4x4 are selected.

The two parameters of texture direction which are horizontal texture direction D_{hr} and vertical texture direction D_{ver} are also calculated. D_{hr} and D_{ver} are calculated as follows:

$$\mathrm{D_{hr}} = \sum_{x=1}^{A-1}\sum_{y=0}^{B-1}\left[f(x,y)-f(x-1,y)\right]^2 \quad (4)$$

$$\mathrm{D_{ver}} = \sum_{x=0}^{A-1}\sum_{y=1}^{B-1}\left[f(x,y)-f(x,y-1)\right]^2 \quad (5)$$

The steps of implementation of the proposed algorithm are as follows:

1. First we compute the variable through equation (3).

2. If $V_{ar} < \psi_{inter1}$, it shows that the current macro block belongs to background area. So mode *SKIP* is selected .Then equation $V_{ar} < \psi_{inter2}$ is checked, if it is satisfied, it indicates that the current macroblock belongs to complex background area. If not satisfied then the current macroblock is motion area.

3. D_{hr} and D_{ver} is calculated using eqn. (4) and (5) respectively.

4. Mode selection should chosen according to the estimation of D_{hr} and D_{ver} ,if $D_{her}>D_{ver}$, then mode 16x16, 16x8 should be selected, otherwise mode 16x16, 8x16 should be the best choice. If $D_{hr}>D_{ver}$ and is in the motion area then mode 8x8, 8x4, 4x4, INTRA 4x4, INTRA 8x8 should be selected, otherwise mode 8x8, 4x8, 4x4, INTRA 4x4, INTRA 8x8 should be selected.

5. Rate Distortion Cost of all modes in the coding mode are calculated, and the mode which has minimal Rate Distortion Cost is selected.

4. Expected Results

H.264/AVC reference software JM 11[7] is applied to validate the efficiency of the proposed fast algorithm. The international standard sequences, which are QCIF video sequences i.e. Foreman, Salesman, Container and Coastguard, are used for simulations.

The test condition [1] is shown in Table I. For simulation we used recommended sequences with various quantization parameters, i.e. QP = 28, QP = 32, QP = 36, QP = 40.

The ΔBit, ΔTime and ΔPSNR were used for the performance evaluation.

T_{ref} is the coding times used by JM11 [7] encoder and $T_{proposed}$ be the time taken by the proposed algorithm. The ΔTime% is defined as:

$$\Delta\text{Time\%} = \frac{\text{Timeproposed} - \text{Timeref}}{\text{Timeref}} \text{ x } 100$$

Also the ΔBit value is defined as:

$$\Delta\text{Bit\%} = \frac{\text{Bitproposed} - \text{Bitref}}{\text{Bitref}} \text{ x } 100$$

$$\Delta\text{PSNR} = \text{PSNR}_{\text{proposed}} - \text{PSNR}_{\text{ref}}$$

Table I. Simulation Parameter

GOP	IPPP
Codec	JM11
MvSearch Range	16
QP	28,32,36,40
Transform	Hadamard Transform
ProfileIDC	66,30
Coding Method	CAVLC
RDO	Enabled
Size	QCIF

The experimental results are shown in Table II. From Table we can see that the proposed algorithm reduces the encoding time by 81.91% for slow motion videos and 64.2% for fast motion videos.

Table II. Simulation Results for IPPP Type Sequences

Video Sequences	***ΔTime %***	***ΔPSNR(dB)***	***ΔRate %***
Container_qcif.yuv	-82.70	-0.02	0.32
Salesman_qcif.yuv	-79.19	-0.01	0.83
Foreman_qcif.yuv	-66.45	-0.10	1.30
Coastguard_qcif.yuv	-59.63	-0.08	1.34

5. Conclusion

The algorithm of mode decision is key to image compression. The full search algorithm is too complex. A fast mode selection algorithm for H.264/AVC is proposed, which is based on image texture analysis with a simple algorithm to decrease the computational complexity. The experiment results show that the fast mode selection algorithm can increase the calculating speed of H.264/AVC coding greatly, which is helpful for real time application of H.264/AVC coding standard.

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