IOT based security system for smart vehicle

Girish B G[1], Akhilesh D Gowda[2], Hajira Amreen[3], Amit[4], K M Apoorva Singh[5]

[1]Asst Professor, Dept of CSE, SJCIT, Karnataka, India
[2,3,4,5] Dept of CSE, SJCIT, Karnataka, India

---***---

Abstract - *With a rising progression of brilliant technologies, the eventual fate of vehicle security frameworks (VSS) are changing into savvy frameworks for different advantages. With this constant headway, web has turned into a fundamental piece of one's life where Internet of Things (IoT) is the most recent and rising web innovation that has changed the way one takes a gander at things. Web of things is creating ordinary from little scale machines to huge scale machines that can trade information and achieve errands while people are possessed with different exercises. The primary point of the paper is to plan a keen vehicle security framework utilizing IoT, that is to turn a standard vehicle security frameworks (CVSS) to a shrewd vehicle security frameworks (SVSS) for getting to and controlling vehicles remotely utilizing a Smart telephone. SVSS are likewise called as Intelligent Anti-Theft Tracking Systems (iATTS). To be particular, we intend to outline a light-weight, minimal effort, extensible, adaptable remote keen vehicle security framework utilizing IoT which utilizes the coordination of Radio Frequency Identification (RFID), Global Positioning System (GPS), Global System for Mobile correspondence (GSM), remote correspondence, cloud organizing, and fluffy calculation that is utilized for choice tree. This savvy framework is made to give vehicle data, for example, position, time, and alert educated to the proprietor of the vehicle by either utilizing Short Message Service (SMS) or utilizing versatile application. The combination of the above advancements can be utilized synergistic-ally as a keen vehicle security key to control a vehicle (bolt or open one's vehicle with the assistance of SMS/application) from remote areas. The entire framework is outlined thinking about a wide range of vehicles by giving a straightforward, powerful simplicity of establishment, to give vehicles extraordinary security and SVSS will be a methods for forestalling, identifying and counter-estimating burglary of vehicles.*

Key words - Smart vehicle security systems; Automation; Internet of Things; IoT; Radio Frequency Identification; RFID; Global Positioning System; GPS; Global System for Mobile communication; GSM; Short Message Service; SMS; cloud networking; fuzzy algorithm.

1. INTRODUCTION

Far reaching burglary of vehicles is a proof that the security of vehicles, especially two-wheeled vehicles. The prerequisite for the additional security structure is seen as critical to keep up a vital separation from robbery of vehicles. Such conditions require vehicle proprietors to give cautious thought to vehicle security. The present circumstance needs a decent strong security structure for a wide range of vehicles.

A brilliant vehicle security framework is an implies that empower people to control vehicles shrewdly and naturally inside a worldwide or nearby condition. Numerous current, entrenched vehicle security framework systems rely upon different advancements however need security and does not bolster people totally. Responding to the delineation of the vehicle burglaries, various security apparatuses have been produced in vehicles, paying little heed to whether they are basic or they use any current advancements. Designers have effectively given standard security frameworks to vehicles, for instance, keys to the two-wheel vehicles, and ready frameworks for four-wheel vehicles. In any case, security frameworks gave by the engineers are less guaranteeing in this cutting edge innovative period; there ought to be extra security on the off chance that it is to genuinely secure. Nasir and Mansor [1] built up a programmed key for the two-wheeled vehicle by utilizing a micro-controller. Tang et al. [2] created security frameworks for four-wheeled vehicles utilizing remote sensor arrange innovation, and Sehgal et al. [3] prevailing with regards to building up a security framework utilizing SMS to track missing two-wheel vehicles.

GSM is an advanced portable communication framework that is generally utilized as a part of Europe and different parts of the world. GSM utilizes a variety of time division various access (TDMA) and is the most generally utilized of the three advanced remote communication advances (TDMA, GSM, and CDMA). GSM digitizes and packs information, at that point sends it down a channel with two different floods of client information, each time permitting opening. It works at either the 900 MHz or 1800 MHz recurrence band.
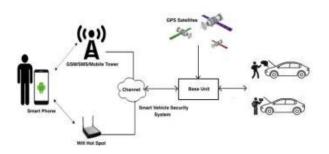

Fig. 1: The concept of the Wireless Vehicle Security System (WVSS) using IoT.

In numerous created items, Very Important Person (VIP) security display comprises of a few layers, that is the main secure point, the second secure point. This investigation utilizes two layers of security for vehicles well being: (I) Authentication technique for the primary secure point and (ii) Point Positioning for the second secure point. The confirmation strategy has been broadly connected to numerous PC security frameworks, while the Point Positioning technique is one of the strategies utilized as a part of GPS. [4] connected validation technique for remote system security framework and the analysts utilized Point Positioning strategy to think about the exactness of the information preparing of GPS-online from a portion of the GPS information Processing administration. The guideline of verification strategy is the procedure to get to specific frameworks, for example, watchword [5], unique mark, the retina of the eye [6], facial acknowledgment [7], ID number (interesting number) [8] and others. In these investigations, the validation of the ID number is the initial step and by utilizing RFID innovation, there will be no duplication of ID numbers, or there will be no same ID number. Point Positioning strategy [9], likewise called total technique, is the fundamental technique in GPS which intends to acquire a situation continuously with great exactness. The depiction of the security framework is that the main safe point utilizes a standard security framework and by applying the validation technique, the rider should first acquaint his ID number with turn on the engine vehicle. While the second security point utilizes GPS for following frameworks position by applying Point Positioning technique.

All frameworks will be controlled by a solitary part, to be specific Micro-controller, and as the control of all frameworks is Radio Frequency Identification (RFID). By applying the Authentication and Point Positioning techniques, the vehicles will be more secure, because of the rider must go through the confirmation of ID number to open the handlebar of two-wheel vehicles and turn the motor on and there is just a single ID number that will be recognized and could open the handlebar and turn the motor on. Position following framework progressively is likewise favorable position in this framework since utilizing Point Positioning strategy, the position can be recognized continuously with great precision. With the two strategies connected in the vehicles, the motor will be killed naturally if the cruisers will be stolen.

The plan of the vehicle security framework is by utilizing Arduino as the fundamental controller, the highlights of short message cautions that give data as notices and position of vehicle area is important. The framework is relied upon to be an imaginative security framework for vehicles to acknowledge intelligent security frameworks utilizing different blend of correspondence advances. Building IoTs has advanced basically finished the latest quite a while since it has added another measurement to the progression of data and correspondence advances. Web of Things (IoT) is a current correspondence

worldview that imagines a not so distant future, in which the objects of consistent day by day life will be outfitted with small scale controllers, handsets for electronic correspondence, and suitable conventions that will make them prepared to speak with each other and with clients, transforming into an irreplaceable bit of the Internet. The IoTs have added another estimation to the progression of data and correspondence technologies(ICT).

As per CISCO [10], it is surveyed that 50 billion articles/gadgets would be associated with the Internet by 2020. The idea IoT goes for making the Internet fundamentally more immersive and inescapable. In addition, by engaging simple access and association to an extensive variety of gadgets, for instance, home electrical machines, sensors, CCTVs and so forth, the IoT will encourage the change of various applications that make use of the possibly gigantic measure of information delivered by such framework to give new administrations to different associations, people, and other administration arranged parts [11]. This worldview in all actuality finds application in an extensive variety of spaces, for instance, home robotization, mechanical mechanization, restorative and social insurance, car parts, movement administration, and various others. With the quick paced increase in the quantity of clients of web over the previous decade has made Internet a fundamental piece of life, and IoT is the latest and creating web advancement. Web of things is creating regular from little scale machines to extensive scale machines that can share information and achieve undertakings while people are possessed with different exercises. Late incremental improvement in cloud innovation and information examination enables shrewd and wise frameworks to process and dissect information viably and in a more effective way.
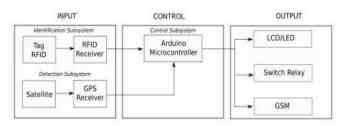
The idea of the Wireless Vehicle Security System (WVSS) utilizing IoT is appeared in the Fig. 1. This is a structure that utilization's PCs, mobiles as well as advanced cells to control vehicles adroitly, cleverly and naturally through web from wherever around the world to upgrade security frameworks in vehicles. Among numerous loT applications, keen security frameworks assume a critical part in acknowledging brilliant urban communities over the globe.

The principle point of the paper is to outline a brilliant vehicle security framework utilizing IoT, that is to turn a standard vehicle security frameworks (CVSS) to a savvy vehicle security frameworks (SVSS) for getting to and controlling vehicles remotely utilizing a Smart telephone. To be particular, we plan to outline an ease, extensible, adaptable remote shrewd vehicle security framework utilizing IoT which utilizes the joining of Radio Frequency Identification (RFID), Global Positioning System (GPS), Global System for Mobile correspondence (GSM), remote correspondence, cloud organizing, and fluffy calculation that is utilized for choice tree. This savvy framework is made to give vehicle data, for example, position, time, and

caution educated to the proprietor of the vehicle by either utilizing Short Message Service (SMS) or utilizing portable application. The blend of the above advances can be utilized synergistic-partner as a keen vehicle security key to control a vehicle (bolt or open one's vehicle with the assistance of SMS/application) from remote areas. This entire framework is composed thinking about a wide range of vehicles by giving a basic, viable simplicity of establishment, to give vehicles extraordinary security.

The different innovation exposures that the paper gives incorporate, Internet of Things (IoT), WiFi Technology, RF Transceiver, Arduino Open Source Electronics Platform, Android Application Development and Relay Switching Principle. The points of interest are clarified in the plan and usage segment.

2. DESIGN AND IMPLEMENTATION

The plan of twofold security framework in light of RFID will be connected to the foreordained vehicle show to be specific the engine made that has a sufficiently huge size of the capacity box. Twofold security framework on vehicles in view of RFID is an open-circle control framework in which the control framework alludes to the discovery yield comes about gave by the RFID location framework, and there is no input sent back to the redress procedure. The Fig. 2 speaks to the square graph of a general shrewd vehicle security framework. An intuitive twofold security framework for vehicles in light of RFID comprises of a few subsystems in particular ID, identification, controllers, and yield. subsystems.

Fig. 2:   Block diagram of an overall smart vehicle security system

Distinguishing proof Subsystem: The recognizable proof subsystem is a piece of an information subsystem. RFID location subsystem comprises of RFID labels, RFID Reader, and the primary controller Micro-controller Arduino Uno R3. RFID Reader will read the RFID label distinguishing proof information of RFID label data to be sent to the Arduino Uno R3 miniaturized scale controller as a controller. Location Subsystem: GPS identification subsystem comprises of satellites, GPS Receiver and the fundamental controller Micro-controller Arduino Uno R3. The satellite will recognize the nearness of a GPS recipient and transmit information in National Marine Electronics Association (NMEA) organize and Global Positioning System Fix/Accuracy Data (GGA). The information is then sent to Micro-controller Arduino Uno R3.

Yield Subsystem: Output subsystem comprises of Minimum Output, Relay Action and GSM Communication subsystems. There are LED and Buzzer on Minimum Output Subsystems as pointers which shows the information and a 16x2 LCD which demonstrates the information watcher yield. By utilizing a hand-off as programmed switches, activity subsystem, a subsystem that fills in as a breaker/start circuit interfacing the vehicles, can be figured it out.

Control Subsystem: Arduino Uno miniaturized scale controller is competent in giving an underlying yield of 5 volts (high condition) as a trigger to initiate the hand-off with the goal that the engine circuit start frameworks can be associated. The circuit is associated with the vehicle key switch so the vehicle start framework may be initiated when the start hand-off and the conditions are associated. GSM correspondence subsystem fills in as an instrument that backings correspondence between the miniaturized scale controller and the cell phone of the vehicle proprietor.

Correspondence subsystem is acknowledged by utilizing Link sprite ATWIN GSM Shield module good for Arduino Uno R3 small scale controller. GSM module requires ATcommand convention in the act of its capacities, so it ought to be depicted in the program code of Arduino smaller scale controller.

Likewise, the security framework introduced in vehicles can be utilized to screen vehicle area utilizing our own particular portable application "Discover my Vehicle". In this way, our application will help one to find the gadget on a guide, remotely bolt it, play a sound, show a message as well as get driving bearings to vehicle area. The satellite station gains the area subtle elements and can deliver it in Google Maps. In this framework the Base station and the Satellite station work in a Master-Slave design where the base station gives the fundamental summons to satellite stations to obtain areas. The framework is controlled by an Android Smartphone which goes about as a Client and information are sent by means of Socket programming. The App gives an interface to every one of the three stations utilizing which client approaches of controlling and checking them remotely (eg. the idea of "discover my iphone application"). There is additionally an another correspondence module, GSM module, as a reinforcement if there is no web scope for refreshes from the framework.

3. RESULTS AND ANALYSIS

Devices and frameworks test was led in stages going from the test on parts/apparatuses, subsystem test, and trial of the general framework.

3.1 Test on Component/Tools Function

Test on the capacity of segments/gadgets/apparatuses was led to dodge blunders coming about because of non-working of at least one of the segments/instruments.

The test was led utilizing computerized multi-meter estimation devices and programming for every gadget.

1.Voltage Source Test: The test was directed to decide the voltage limit from voltage source whether it can give the voltage required by the framework. The voltage sources are associated with the voltage controller circuit that comprises of a few segments of the voltage controller IC 7805, 7809, and 7812. This is directed to modify the voltage prerequisites in the framework. From the test aftereffects of the voltage source, the mistake esteems were be acquired utilizing:

Blunder = jIdealV oltage AverageM easuredV oltagej

2.Tags and RFID Reader Test: This test utilized three units of RFID labels. The test was completed by utilizing RFID Tester programming. RFID least circuit was associated with one unit of the compact PC ACER 4752G research. RFID least circuit transmit the information contained on the RFID label serially to the PC unit by means of a USB to Serial RS232. In the principal RFID label test information, the information are acquired with the card number 8803460 (tag1). In the second RFID label test, the information are gotten with the card number 8803459 (tag2). In the third RFID label test, the information are gotten with the card number 7206252 (TAG3).

3.Micro-controller Arduino Uno R3 Test: Main controller Micro-controller, Arduino Uno R3 Test, intends to decide the states of Micro-controller Arduino Uno R3 whether it is in great condition or not. Test fundamental controller Micro-controller Arduino Uno R3 was directed utilizing programming IDE (Integrated Development Environment) 1.0.5 Arduino. Arduino Micro-controller conditions can be dictated by connecting it to the PC and transfer the example program to the Arduino Uno R3 with the Arduino IDE programming.

3.2 Subsystem Test

Subsystem test was directed to guarantee that it can play out its capacity as per the requirements of the framework. Tests are completed on discovery subsystem, a control subsystem and yield subsystem at that point watching whether the yield comes about are by the framework or not.

1.Test on Identification RFID Subsystem: In the subsystems test a unit RFID Reader ID-12 LA, an Arduino Uno R3 smaller scale controller unit, a progression of least yield frameworks, and programming Arduino IDE 1.0.5 are utilized as a part of the test. This test was led to distinguish the capacity of RFID Reader for perusing RFID labels at that point transmit the ASCII information data to the miniaturized scale controller Arduino Uno R3 and showed on a progression of Arduino IDE 1.0.5 programming screen.

2.Test on GPS Detection Subsystem: A unit of U-box GPS Receiver CN-06, an Arduino Uno R3 miniaturized scale

controller unit, Arduino IDE 1.0.5 programming, PCs, and programming U-Center GPS Evaluation Software are utilized as a part of the test. Information recovery GPS (Global Positioning System) as scope and longitude information is done at a few focuses in the territory of Bangalore, India (arbitrary).

3.Test on Action Relay Subsystem: A 12-volt voltage source, hand-off circuit Activator, a unit of Micro-controller Arduino Uno R3, PCs, and programming Arduino IDE 1.0.5 are utilized as a part of the test. The test was directed to decide the execution of the circuit as a switch associating Relay movers and breaker in light of the guidelines given by the fundamental control of Micro-controller Arduino Uno R3. The order is influenced by the character input got from the PC by means of serial correspondence by utilizing a USB. Character "1" makes the transfer to be in associating position so the LED lights on, while the character "0" makes the hand-off back to be in detaching position with the goal that the LED light is off.

4.Test on GSM Communications Subsystem: The unit Micro-controller Arduino Uno R3, Link sprite ATWIN Quad band GPRS/GSM Shield module, a cell phone, a PC, Arduino IDE 1.0.5 programming and SSCOM32E programming were utilized as a part of the test. The test was directed to guarantee that the Link sprite ATWIN Quad band GPRS/GSM Shield module can understand the correspondence between the miniaturized scale controller Arduino with the cell phone.

Connection sprite ATWIN Quad band GPRS/GSM Shield is a correspondence module that is good with miniaturized scale controller Arduino Uno R3. The module underpins GSM benefit. Connection sprite Quad band GPRS/GSM Shield underpins SMS in Text arrangement and PDU (parallel). Connection sprite ATWIN Quad band, GPRS/GSM Shield, has a recurrence of 900 MHz which is extremely strong for use in India.

3.3 Framework Test

Framework test is a test directed in the wake of incorporating the current subsystems into one. The time postpone that happens in the framework is checked in this stage. It can be seen that there is a period delay for a portion of the activity given as a type of reaction to a portion of the conditions that sustain into the framework.

Planning Time delay is a period defer that happens when another framework is turned on. Time postpone transfer On is a period defer required for the info states of RFID tag is right, and the key is exchanged on so the hand-off ends up dynamic. Defer time hand Off 1 is the time postpone required for the key of the cruiser is turned off with the goal that transfer winds up idle. Postpone time hand Off 2 is the time defer required for the information states of GSM character input are met so the transfer winds up latent. The framework experienced a defer time of arrangement by a normal of 5.6 seconds in the wake of

getting power from a voltage source. The framework can give activity because of the info conditions that happen with the normal time postponement of 1.6 seconds.

Miniaturized scale controller Arduino Uno R3 gives the activity by associating Relay if the information of RFID tag is fitting. The following activity is to make telephone calls to the telephone number enrolled if the RFID label information is relating and the vehicle is On. The other framework activity is to send data about the area of the vehicle as a short message to the telephone number recorded.

4. DISCUSSION

In view of the aftereffects of the tests that have been done on the framework's for distinguishing proof, identification, activities and correspondence, the outcomes acquired is by the arrangements of the framework usefulness. The framework can recognize RFID labels protests as an entrance key to vehicle motor from ASCII information put away in the RFID tag and afterward makes a move by interfacing a progression of vehicle motors, the framework can recognize the character of approaching SMS through Link sprite GSM Shield module as info characters and after that make a move by answering to SMS giving vehicle position data so the framework can speak with the cell phones of the vehicle owner's.

The procedure of recognizable proof, location, and correspondences on the frameworks requires serial correspondence process with the primary information processor Micro-controller Arduino Uno R3. The fundamental information processor Micro-controller Arduino Uno R3 has a couple of the stick of serial correspondence of information recipient (Rx) and the information transmitter (Tx), in which it is proficient just of speaking with the way toward accepting information at once. This causes the requirements of the framework which has three serial correspondence process (RFID distinguishing proof, recognition of GPS and GSM interchanges) can't be gotten. The necessities are met by utilizing two sets of phony stick serial expansion by using the program code libraries "Delicate wareSerial" and "AltSoftSerial." Pin serial correspondence works at a similar Baud Rate that is 9600. Counterfeit stick serial has an indistinguishable working rule from the first serial stick found on the Arduino Uno R3, yet the pins work reciprocally in a brief time frame with the danger of defer time (delay) collected.

The test outcomes demonstrate that there is a period defer experienced by the framework work. The time delay is caused by a few elements, including the impact of ecological conditions, for example, building development and climate fit for disturbing the condition of signs for information interchanges and the impact of time postpone program. The execution of the GPS collector to get information from satellites and sends it to the smaller scale controller Arduino Uno R3 are profoundly influenced

by the development of structures that piece the transmission of radio waves between the GPS beneficiary and satellites. It additionally influences the execution of GSM Shield to get information as a short message or a call amid lost flag. The time delay in the program transferred to a small scale controller Arduino Uno R3 is a noteworthy time postponement of the estimation of the time delay in the framework.

5. CONCLUSION

In light of the test outcomes and talk, it can be presumed that a twofold security framework has been acknowledged between effectively on vehicles which are equipped for recognizing the RFID label in view of the ASCII information spared to turn the vehicle on and ready to give data on the area of the vehicle. The security framework is furnished with a crisis well being highlight by using GSM correspondence to kill the machine of the vehicle when it is stolen. The precision of data is influenced by ecological conditions and additionally the time postponement of the framework. The time postponement of the whole framework can be endured for the adequacy of the framework with the normal estimation of the planning defer time of 5.6 seconds and the normal postpone time of 1.6 seconds. Blunder procurement 4,067% on the source framework voltage demonstrates that the voltage source framework in great condition.

The possibility of the proposed framework is to supplant the customary security frameworks with the Internet of Things (IoT), where the vehicles are associated with the web and can be gotten to from anyplace by methods for an android advanced mobile phone which is fit for interfacing with the web through remote systems. To enhance the work, a precise assessment and a viable portrayal of segment tests will be led. Likewise, we mean to furnish an examination of existing CVSS with our proposed SVSS in an incorporated assessment. This will bolsters the general objective of our work. The connection between the approach of cloud organizing and fluffy calculations are presented only and the future work will depend on them. The planned brilliant security framework can be introduced in vehicles to screen vehicle area utilizing our own particular portable application "Discover my Vehicle". Along these lines, our application will help one to find the gadget on a guide, remotely bolt it, play a sound, show a message or potentially get driving headings to vehicle area. The satellite station secures the area points of interest and can deliver it in Google Maps.

Likewise the framework can store the spatial/transient information and the status of the vehicles in the thing talk cloud platform. The put away information is pictured in the versatile application as diagrams. The framework causes clients to dissect and screen vehicle area whenever anyplace. Our keen security framework utilizing IoT has been tentatively demonstrated to work tastefully by associating vehicles, which can be easilty controlled remotely through web. Utilizing this framework as

structure the accompanying further improvements can be accomplished [12][13][14] [15].

REFERENCES

[1] M. M. Nasir and W. Mansor, "Gsm based motorcycle security system," in Control and System Graduate Research Colloquium (ICSGRC), 2011 IEEE. IEEE, 2011, pp. 129–134.

[2] V. W. Tang, Y. Zheng, and J. Cao, "An intelligent car park management system based on wireless sensor networks," in Pervasive Computing and Applications, 2006 1st International Symposium on. IEEE, 2006, pp. 65–70.

[3] Z. Yihua, "Vip customer segmentation based on data mining in mobile-communications industry," in Computer Science and Education (ICCSE), 2010 5th International Conference on. IEEE, 2010, pp. 156–159.

[4] S. A. Hameed, S. Abdulla, M. Ershad, F. Zahudi, and A. Hassan, "New automobile monitoring and tracking model: Facilitate model with handhelds," in Mechatronics (ICOM), 2011 4th International Conference On. IEEE, 2011, pp. 1–5.

[5] B. Gurung, P. Prasad, A. Alsadoon, and A. Elchouemi, "Enhanced virtual password authentication scheme resistant to shoulder surfing," in Soft Computing and Machine Intelligence (ISCMI), 2015 Second International Conference on. IEEE, 2015, pp. 134–139.

[6] T. R. Borah, K. K. Sarma, and P. H. Talukdar, "Retina recognition system using adaptive neuro fuzzy inference system," in Computer, Communication and Control (IC4), 2015 International Conference on. IEEE, 2015, pp. 1–6.

[7] C. C. Queirolo, L. Silva, O. R. Bellon, and M. P. Segundo, "3d face recognition using simulated annealing and the surface interpenetration measure," IEEE transactions on pattern analysis and machine intelli-gence, vol. 32, no. 2, pp. 206–219, 2010.

[8] Y.-Q. Gui and J. Zhang, "A new authentication rfid protocol with ownership transfer," in ICT Convergence (ICTC), 2013 International Conference on. IEEE, 2013, pp. 359–364.

[9] N. M. Raharja, O. Wahyunggoro, A. I. Cahyadi et al., "Altitude control for quadrotor with mamdani fuzzy model," in Science in Information Technology (ICSITech), 2015 International Conference on. IEEE, 2015, pp. 309–314.

[10] CISCO, "Internet of things (iot)," http://www.cisco.com/web/solutions/trendsliot/overview.html, 2012.

[11] K. Mandula, R. Parupalli, C. A. Murty, E. Magesh, and R. Lunagariya, "Mobile based home automation using internet of things (iot)," in Con-trol, Instrumentation, Communication and Computational Technologies (ICCICCT), 2015 International Conference on. IEEE, 2015, pp. 340– 343.

[12] M. Sathiyanarayanan and K. S. Kim, "Multi-channel deficit round-robin scheduling for hybrid tdm/wdm optical networks," in Proc. of the 4th International Congress on Ultra Modern Telecommunications and Control Systems (ICUMT 2012), St. Petersburg, Russia, Oct. 2012, pp. 552–557.

[13] M. Sathiyanarayanan and B. Abubhakar, "Dual mcdrr scheduler for hybrid tdm/wdm optical networks," in Proc. of the 1st International Conference on Networks and Soft Computing (ICNSC 2014), Andra Pradesh, India, Aug 2014, pp. 466–470.

[14] M. Sathiyanarayanan and B. Abubakar, "Mcdrr packet scheduling algorithm for multi-channel wireless networks," in Proceedings of 3rd International Conference on Advanced Computing, Networking and Informatics. Springer, 2015, pp. 125–131.