RESEARCH ARTICLE OPEN ACCESS

Traffic Management System – A Comparative Study

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ABSTRACT
This paper presents an insight on the different methodologies used for traffic congestion management. Traffic congestion is a problem faced across India, which leads to unnecessary delays, especially to the emergency vehicles. The regular timer based signals fail to solve this issue. Many attempts have been made to solve this issue using GSM, Infrared Sensors, etc. This paper analyses few such attempts. Power, cost, feasibility, efficiency are parameters considered in this paper.
Keywords - Traffic Management, GSM, LoRa, Proximity Sensors, Cloud.

Date of Submission: 25-02-2020 Date Of Acceptance: 05-03-2020

I. INTRODUCTION

Traffic congestion is a common problem faced across the world, especially in India. This becomes an obstacle for the Emergency Vehicles, where each second counts. Traffic congestions affect the quality of life, environment and our economy. Due to urbanization, number of vehicles are increasing in India, leading to increased traffic density on roads, which has to be dealt with in an efficient way. Timer based signal systems fail to operate efficiently when the traffic density across a lane is more or less as it allocates the same time in all traffic conditions. Many Traffic Management Systems have been designed to solve this problem, but they have one or the other disadvantage. Various papers based on Traffic Management System have been surveyed in this paper. The paper is structured as follows. Section II deals with the literature review where various papers have been reviewed. Section III has a table of the papers surveyed in this paper. Section IV consists of the conclusion which can be drawn from this paper.

II. LITERATURE REVIEW

"An IoT based Intelligent Traffic Congestion Control System for Road Crossings" by Pampa Sadhukhan , Firoj Gazi, IEEE 2019 : In this paper, the authors have made an attempt to measure the traffic density at a particular junction using Ultrasonic Proximity Sensor and set the signal operation time based on the measured value of traffic congestion density. The components used are Wi-Fi module, Microcontroller, Ultrasonic sensors Node (USN), Signal LEDs. Here two modules are used - Traffic Density Monitoring Module (TDMM) & Traffic Management Module (TMM). The TDMM measures the length of the traffic queue to determine the density of traffic congestion and TMM adjusts the operation time of the traffic signal, based on the density of traffic congestion. The TDMM contains a microcontroller which collects data from the sensor node & from Wi-Fi module and sends data to TMM. TDMM are placed at certain distances such as 50,100 & 150 meters away from signal crossing. The USN is used to detect the presence or absence of nearby standing vehicles by measuring distance. The result shows that the authors have been successful in measuring the traffic density using Ultrasonic Proximity Sensors. [2]

"An Internet of Things (IoT) based Smart Traffic Management System: A Context of Bangladesh" by Abdul Kadar Muhammad Masum, Md. Kalim Amzad Chy, Iaamanur Rahman, Mohammad Nazim Uddin, Khairul Islam Azam, IEEE 2019 : In this paper, the authors have attempted to design a smart traffic management system (TMS) using IOT, which was done with respect to Bangladesh. Here the vehicles are controlled by the help of traditional traffic light along with the combination of sensors and artificial intelligence. The hardware components used are HC-SR04 Ultrasonic sensors, Arduino Mega 2560 controller, RFID module, ESP 8266 Wi-Fi module, LED's signal. The Arduino Mega takes the input from ultrasonic sensors & RFID sensor and ESP8266 Wi-Fi module gives the output which helps in transferring the data to cloud server & LED's at signal light. The HC-SR04 ultrasonic

sensors measures traffic density at roads and can detect vehicles at range from 2cm to 400cm. This system is useful for the emergency vehicles like ambulance, fire brigade etc. The drawback of this system is that WiFi is not available at all junctions and it consumes high power. [3]

"Low Cost Traffic Control System for Emergency Vehicles Using ZigBee" by M.E. Harikumar, M. Reguram, Prathyush Nayar, IEEE 2019: This paper presents a system designed specifically for the emergency vehicles which are in lane filled with traffic. The authors are using Zigbee for vehicle to vehicle communication and can provide information about the presence of ambulance or any emergency vehicle. The system will solve the problem of ambulance clearing the lane due to traffic congestion. The information about vehicle is send to the signal control unit at intersection. The information about the usage of lane by emergency vehicle is transferred by Zigbee protocol using Zigbee transmission. The emergency vehicles will get highest priority that are near to the junction according to the distance in between the lane intersection & the emergency vehicle. The signal transmission starts as soon as the patient is boarded on the ambulance & placed on the stretcher, since the stretcher contains the pressure sensors. The drawbacks of this system is that it is not cost efficient and traffic density is not monitored here. [4]

"Traffic Management System Using IoT Technology - A Comparative Review" by Omid Avatefipour, Froogh Sadry, IEEE 2018 : In this paper, the authors have compared the various Traffic Management Systems available. It describes various traffic controller systems like Green Wave System, RFID Systems, WSN Systems, GSM Systems, IR Systems. Applications, advantage and disadvantages of each system is described. Green Wave system is useful for detecting stolen vehicles, but fails to perform as expected during severe weather conditions. RFID Systems are weather friendly, but it consumes more power and can be cloned. Wireless Sensor Network (WSN) systems processes large scale data quickly, but it is easy to hack and is prone to interferences. GSM Systems are easy to develop but it consumes more power and many vendors are phasing out GSM technology to accommodate 5G. IR Sensor based systems is easy to develop, but it fails to work when it is exposed to sunlight. The results show that all of the above mentioned systems have one or the other drawbacks. [5]

"Android and Cloud based Traffic Control System" by Mpho K. Madisa, Meera K. Joseph, IEEE 2018 : In this paper, the author have attempted to design a traffic control system which helps in preventing traffic congestion and provide way for the emergency vehicle especially in urban cities.

This project is based on Android and cloud server based system. This system comprises of different stages IoT, Arduino IDE, GSM module, Android mobile devices. In this project all the traffic signal are connected with the Arduino Uno microcontroller and the GSM module is use to connect the mobile devices to the microcontroller. As the vehicle reaches the signal, the microcontroller measures the number of vehicle based on the android devices present at the signal, mobile and the microcontroller is connected via cloud server with help of the MQQT cloud server and GSM module. Based on the android mobile devices present, the congestion of traffic is measured and signal changes on priority. Advantage of this paper is that it is cost effective, it is easy to implement and MQQT is more efficient in information distribution. The drawbacks of this paper is that GSM is phased out by many vendors to accommodate 5G and it is not power efficient. [6]

"Dynamic Traffic Management System Using Infrared (IR) and Internet of Things (IoT) " by L. Paul Jasmine Rani, M. Khoushik Kumar, K. S. Naresh, S. Vignesh, IEEE 2018 : In this project the authors have attempted to develop a traffic management system based on IoT technology using IR sensor and GSM module. In the first step, the IR sensor measures the traffic level on the road and transmits data to the microcontroller. In the second step, the microcontroller transmit the data to cloud server. Based on the received data, controller algorithm dynamically changes the traffic signal light. Their idea was not efficient as IR Sensors are not efficient in sunlight and GSM module is not efficient as many operators are phasing out GSM services to upgrade to 5G. [8]

"Intelligent traffic control system using GSM technology" by S. S. Ramaprasad, K. N. Sunil Kumar, IEEE 2018 : In this paper, the authors have come up with an Intelligent Traffic Control system at the junctions using GSM. An IR sensor is deployed in four ways of the junction which helps in the number counts of vehicles in all four ways based on the traffic density in all four ways. Microcontroller helps in controlling the traffic signals at the junction. DC motor is used for implementation, will act as a barrier gate and the transceiver acts as a transmitter and the receiver. Since two transceiver is used, one at the junction which acts as base station and the other as moving transceiver on ambulance or any emergency vehicle. A 12V power supply has been used for DC motor & LCD, & 5v power supply for microcontroller. GSM module microcontroller sends the alert message to emergency vehicles. The main disadvantage of this project is that IR Sensors are not efficient in sunlight, GSM consumes more power and many vendors are phasing out GSM. [11]

"Smart Traffic Control System Using ATMEGA328 Microcontroller and Arduino Software" by Vahedha, B, Naga Jyothi, IEEE 2017 : This paper presents an idea to design the traffic management system which help in preventing traffic congestion and provide way for the emergency vehicle when there is a traffic congestion. The components used in this project are RFID Module, ATMEGA328 microcontroller, 16*2 LCD Display, GSM Module, RF Module. RFID system is installed on the sides of the road and each vehicle is provided with unique RFID tag, when the vehicle reaches near the signal the RFID radar count the numbers of vehicle as the radar crosses its limit it sends signal to the controller and controller will decide how much time is required for smooth flow of the traffic. This RFID tag also helps us to find the stolen vehicle, as the stolen vehicle reaches the signal, the RFID module will send the data to the controller and signal will turn red and notification is given to the owner of the car. The advantage of this system is that unique RFID tags help not only during traffic congestion, but also in finding of stolen vehicle and for the emergency vehicle. The drawbacks of this system is that GSM Module consumes more power and various vendors are planning to phase out GSM to for 5G and it is not cost efficient. [12]

"Smart Traffic Light for Congestion Monitoring using LoRaWAN" by Ruhaizan Fazrren Ashraff Mohd Nor, Fadhlan H. K. Zaman, Shamry Mubdi, IEEE 2017 : In this paper, the authors have attempted to develop a smart traffic light system which automatically monitors traffic congestion based on which signal light changes to reduce the traffic. The main technology used in this project are LoRaWAN and IoT. LoRaWAN is a low power high range communication device, whose range of communication is up to 12-15 km which uses Chirp based Spread Spectrum technology. IoT is used for storing the data gathered form the sensor and the controller. Various components used here are LoRaWAN, IR Sensor, GY-271 3-axis magnetic electronic compass, Raspberry Pi 3, and SX1276 transceiver. Multiple sensor are placed along the road side to measure the traffic. Data received from the sensor is given to LoRaWAN gateway, transceiver is used for data communication between cloud storage and LoRaWAN system. The advantages of this model is that electromagnetic sensor are extremely sensitive to metallic object, LoRaWAN require very low power. The result of this paper is that LoRaWAN is an efficient solution for traffic management. [13]

"LoRaWAN - A Low Power WAN Protocol for Internet of Things: a Review and Opportunities" by Jonathan de Carvalho Silva1, Joel J. P. C. Rodrigues, Antonio M. Alberti, Petar Solic, Andre L. L. Aquino, IEEE 2017 : In this project, the authors have reviewed LoRaWAN technology, compared it with other Low Power Wide Area technologies and has described two practical applications of LoRaWAN. Firstly, the author has described the challenges for MAC Protocol in IoT – bandwidth must be reasonable, battery life must be good, range must be high, latency must be low and throughput must be high. The author then describes various other low power wide area technologies available like Bluetooth, DASH7 and Sigfox. Next, the author explains the LoRaWAN architecture, network establishment, battery life, network capacity, device classes and security. Two examples of LoRaWAN use cases are described – Renewable energy and healthcare solutions in South Korea to monitor pollution and autonomous cars and Cattle Traxx project to track cattle in large fields. In the last part of the paper, the author compares LoRaWAN with Sigfox, NB-IoT and LTE based on Modulation, Data Rate, Link Budget, Battery Lifetime, Power efficiency, Security, Range, Interference immunity, Scalability and Mobility. The results show that LoRaWAN is one of the most efficient LPWA technology which can be used IoT in the near future. [14]

"Implementing Intelligent Traffic Control System for Congestion Control, Ambulance Clearance, and Stolen Vehicle Detection" by Rajeshwari Sundar, Santhosh Hebbar, Varaprasad Golla , IEEE 2015 : This paper present an intelligent traffic system for the emergency vehicles to pass smoothly. Each & every vehicle will be equipped with special RFID tag which is not possible to remove or destroy. Here they are using RFID reader, NSK EDK-125-TTL and PIC16F877A SoC to read the RFID tags attached on the vehicle. If the RFID-tag read belongs to a stolen vehicle, then a message is sent using GSM SIM300 to the police control room. There are mainly three models: Automatic signal control system, Stolen Vehicle Detection system, Emergency Vehicle Clearance system. There are two parts in this Emergency Vehicle Clearance System: First part which is the Zigbee transmitter placed in emergency vehicle and the second part is the receiver, which is placed at traffic pole. It also contains PIC16F877A microcontroller and Zigbee module. The advantages are the manual effort on the part of the traffic policeman is saved. It requires very less human intervention. Stolen vehicle can be detected. The disadvantage of this system is that RFID tags can be cloned or blocked using special covers, GSM is phased out by many vendors and it is not power efficient. [16]

III. TABLE

AUTHOR	YEAR	TECHNIQUE	SCOPE
Pampa Sadhukhan , Firoj Gazi	2019	An IoT based Intelligent Traffic Congestion Control System for Road Crossings	Ultrasonic sensor can be used to measure traffic density.
Abdul Kadar Muhammad Masum, Md. Kalim Amzad Chy, Iaamanur Rahman, Mohammad Nazim Uddin, Khairul Islam Azam	2019	An Internet of Things (IoT) based Smart Traffic Management System	Ultrasonic sensor can be used to measure traffic density but WiFi is not available everywhere.
M.E. Harikumar, M. Reguram, Prathyush Nayar	2019	Low Cost Traffic Control System for Emergency Vehicles Using ZigBee	Simple design but not cost efficient and consumes more power.
Omid Avatefipour, Froogh Sadry	2018	Traffic Management System Using IoT Technology - A Comparative Review	Ultrasonic sensor can be used to measure traffic density.
Mpho K. Madisa, Meera K. Joseph	2018	Android and Cloud based Traffic Control System	App can be used by Emergency vehicles to send live location but GSM cannot be used.
L. Paul Jasmine Rani, M. Khoushik Kumar, K. S. Naresh, S. Vignesh	2018	Dynamic Traffic Management System Using Infrared (IR) and Internet of Things (IoT)	Simple but IR Sensors cannot be used.
S. S. Ramaprasad, K. N. Sunil Kumar	2018	Intelligent traffic control system using GSM technology	Simple but GSM cannot be used.
Vahedha , B, Naga Jyothi	2017	Smart Traffic Control System Using ATMEGA 328 Controller and Arduino Software	Can be used for locating stolen vehicles.
Ruhaizan Fazrren Ashraff Mohd Nor, Fadhlan H. K. Zaman, Shamry Mubdi	2017	Smart Traffic Light for Congestion Monitoring using LoRaWAN	LoRaWAN is more efficient and consumes less power.
Jonathande Carvalho Silva1, Joel J. P. C. Rodrigues, Antonio M. Alberti, Petar Solic, Andre L. L. Aquino	2017	LoRaWAN - A Low Power WAN Protocol for Internet of Things: a Review and Opportunities	LoRaWAN is an efficient, low power consuming technology with good range.

Rajeshwari Sundar, Santhosh Hebbar, Varaprasad Golla	2015	Implementing Intelligent Traffic Control System for Congestion Control, Ambulance Clearance, and Stolen Vehicle Detection	Stolen vehicles can be detected but consumes more power.

IV. CONCLUSION

Various papers on Traffic Management Systems have been surveyed here. This includes system using DIP, IR Sensors, Ultrasonic Sensors, WSN, GSM, LoRaWAN, GSM and RFID. It can be concluded that the combination of LoRaWAN, Ultrasonic Sensor and Cloud can make an effective Traffic Management System.

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Prof. Swathi Somayaji B, "Traffic Management System – A Comparative Study " *International Journal of Engineering Research and Applications (IJERA*), vol.10 (03), 2020, pp 36-41.