IJCSE International Journal of Computer Sciences and Engineering Open Access
Survey Paper Vol.-8, Issue-2, Feb 2020 E-ISSN: 2347-2693

IOT Based Synchronous Smart Traffic Monitoring System with Data Sharing Capability

Hemlata Kachhavey[1*], Mubeen Ahmed Khan[2]

[1,2]Department of Computer Science, Sagar Institute of Research and Technology, Indore, India

[*]*Corresponding Author: hemlatakachhavey@gmail.com, Tel.: +91-7697026165*

DOI: https://doi.org/10.26438/ijcse/v8i2.9398 | Available online at: www.ijcseonline.org

Accepted: 08/Feb/2020, Published: 28/Feb/2020

***Abstract*—** In recent years' traffic congestion is a major problem in our country, which affects modern city's daily life routine and environments. Due to population growth, the size of cities expands, automatically the number of vehicles increases in the major scale on roads. So, traffic monitoring and controlling is the biggest challenge on traffic management authorities. In many urban areas, most of the traffic signal lights are based on a fixed cycle protocol, which is a reason for the inefficient controlling. Thus, there is an immoderate need to enhance and automate these traffic systems. We design and develop a system for real-time traffic monitoring using the Internet of Things (IoT) platform and sensing technology. Proposed work identifies the traffic conditions based on vehicle numbers on road and makes decisions for a control system with sharing their data synchronously with each other. In addition, the proposed system can send traffic signal data to other signals and people can retrieve traffic situation anywhere. This paper provides an insight into how these technologies can be applied and how it helps to overcome traffic congestion to reduce travel time.

***Keywords*—** Internet of Things (IoT), Sensors, Raspberry Pi, Pi-Camera, RFID, Synchronous Traffic Monitoring, Vehicle Counting.

I. INTRODUCTION

The goal of transportation research is to optimize the transportation flow of people and goods. As the growing population, the number of travellers constantly increases while resources provided by current Infrastructures are not sufficient for this, therefore intelligent control of traffic became a really serious issue. Traffic in the urban areas is generally based on fixed cycle traffic signal lights, which is not properly configured in many cases and causes unnecessary extra waiting times for the vehicles [1]. The traditional traffic signal monitoring techniques include fix-interval monitoring, day time monitoring, vehicle actuated and semi-actuated monitoring, green wave monitoring, area dynamic monitoring and area static monitoring. However, there is no system which we can call a capable and effective system or can be adopted in real-world effectively. This is because the traffic control system is non-linear, non-deterministic and fuzzy, and thus established methods of modelling and control cannot work very well. In order to answer the above-mentioned problem, there are numerous researchers' groups have performed a lot of studies.

In recent years the application of image processing methods in automated traffic monitoring and control system has been reviewed to optimize methodologies for traffic controls. We also have the ever-increasing problem of the traffic violation. Minimizing the number of violations brings more order and reduces the number of accidents. Currently, the monitoring approaches of traffic violation are not effective and good enough in the majority of the cases. In some other cases, radar guns are used. But these guns cannot target short-range and multiple vehicles [2]. Hence, we can use the Internet of Things (IoT) to aid humans to prevent these violations with traffic monitoring. Instead of a regular traffic cop monitoring the vehicles, we can use camera sensors, ultrasound sensors, RFID etc. to improve efficiency and decrease the dependence on humans. This provides a great scope for automation. Detecting vehicles in surveillance data is one of the most sought-after problems in sensing technology. Here we have made an attempt to analyses the number of vehicles on the intersection. These observations are not limited to a single traffic signal. We introduce a new concept of synchronous data sharing with the traffic signals that provide better results for automation and with peoples to predict their timing. It can be used to determine the peak hours and plan the traffic management layout according to the overall analysis of the system data. We receive the data from the ultrasonic sensors, RFID and cameras positioned at different places and use the data as input for calculations. Though there is an overhead of installing such sensing devices at the region of interest, it is a one-time investment and more durable. Hence IoT gives the

system great installation flexibility and increases the durability, efficiency and portability of the system.

This paper aims to propose a smart synchronized traffic signal monitoring system to improve traffic monitoring and enhance the way we are dealing with some other problems and the situations related to transportation. It will be in the smart traffic system. Thus, a smart traffic monitoring system will be formed of two segments (or subsystems): a control system and a monitoring system will able to integrated together to help the traffic system to take the smart decisions efficiently. This research will be examining the additional component (monitoring system) by using synchronous data sharing between its control system. This system will be capable to determine the crowded street case, normal street case and empty street case. A Raspberry Pi microcomputer with ultrasonic sensor, RFID and Pi-Camera is used in each intersection to calculate the traffic and based on that calculation system can operate the lane easily. While operating the lanes, traffic data are simultaneously uploaded to a website, which can be accessed by any user. This feature can be used by users to get real-time information for a given road intersection and set their route accordingly. In addition, ultrasonic sensors are also used for more accuracy and RFID sensor is used to detect the emergency vehicle. The motivation behind this approach was to create a smart traffic monitoring system that is able to reduce the congestion effectively and people can view live traffic situation on a particular intersection by which they can change their route and save their important time.

II. INTERNET OF THINGS

IoT is an innovation which uses the internet to control the physical items. Using IoT we can obtain the outcome which is more precise, quick and exact. In IoT, all database will be stored in the computer. This storage is done through internet. Later this database is used accordingly to their requirements and applications. Components can be accessed from far place by using IoT, hence it reduces human work or involvement. This makes the investment of the system less. All different protocols can be used accordingly to the respective domain in IoT.

IoT was first proposed in 1999 by Kevin Ashton, who is the co-founder of the Auto-ID Center at the Massachusetts Institute of Technology (MIT) [3]. One foundational technology of IoT is the Radio-Frequency IDentification (RFID) technology, which allows microchips to transmit the identification number of the objects to a reader through wireless communication. Through RFID technology, physical objects can be identified, tracked, and monitored automatically. Nowadays, RFID technology has been widely adopted in logistics, pharmaceutical production, retailing, and supply chain management [4,5]. Another foundational technology of IoT is Wireless Sensor Networks (WSNs), which adopt interconnected intelligent sensors to periodically sense the monitored environment and send the information to the sink (or base station), at which the gathered/collected information can be further processed for end-user queries [6]. The applications include disaster control, environment and habitat monitoring, battlefield surveillance, traffic control, and health care applications [7]. Additionally, many other technologies and devices such as Near Field Communication (NFC) [8], short-range wireless communication (i.e., ZigBee [9] and Bluetooth [10]), universal mobile accessibility (i.e., Wi-Fi hotspots [11], and cellular networks [12]), social networking [13] and cloud computing [14] support internet of things to compose an extensive network infrastructure.

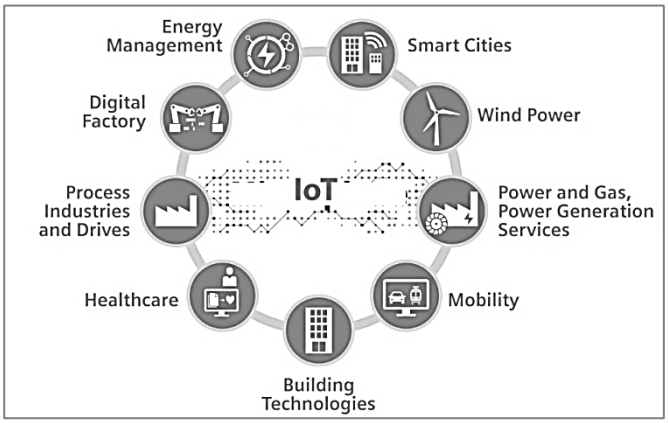

Figure 1. Applications of IoT

III. RELATED WORK

The paper [15] gives insight into the actual implementation of traffic management in terms of hardware. Gives a brief explanation of how real-time traffic flow is monitored and controlled.

The paper [16] gives an advantage of automated system implementation using RFID tags for controlling and monitoring traffic in smart cities.

The paper [17] gives us information on how to detect a vehicle which needs emergency exit or less time to reach its destination. Emergency vehicles need to reach their destinations at the earliest. If they spend a lot of time in traffic jams. With emergency vehicle clearance, the traffic signal turns to green as long as the emergency vehicle is waiting in the traffic junction. The signal turns to red, only after the emergency vehicle passes through.

In the field of IoT, many systems are proposed in order to control, manage the traffic system effectively. Each of the systems uses different types of technologies, components for managing Traffic congestion like IR Sensors, RFID's, ZigBee, Traffic warning systems, Big Data, Bluetooth etc. The following are some works that are related to our project.

In the past ten years, the Internet of Things evolution has been unprecedented. Recently, various driver assistance systems have been actively developed that use both information communication technology and on-board sensors. The invisibility of traffic signal caused by huge vehicles blocking the view, prevent traffic congestion at toll gates and give advanced collision warning to the drivers. A microcontroller with an RF module will be installed and is programmed to connect to each automobile passing by. Later it displays signal status on the traffic signal status display system installed inside the automobile. This system installed in the vehicle is also capable of giving collision warnings to the driver [18].

IoT links the objects of the real world to the virtual world. It constitutes to a world where physical objects and living beings, as well as virtual data and environments, interact with each other. Urban IoT system that is used to build an intelligent transportation system (ITS) has been developed. IoT based intelligent transportation systems are designed to support the Smart City vision, which aims at employing efficient and dynamic communication technology for the citizens. ITS uses technologies like Near field communication (NFC) and wireless sensor network (WSN) [19].

Automation combined with the increasing market penetration of on-line communication, navigation, and advanced driver assistance systems will ultimately result in intelligent vehicle highway systems (IVHS) that distribute intelligence between roadside infrastructure and vehicles and in particular on the longer term, are one of the most promising solutions to the traffic congestion problem [20].

The simulation and evaluation of a traffic congestion detection system which combines inter-vehicular communications, fixed roadside infrastructure and infrastructure-to-infrastructure connectivity and big data. To simulate and evaluate, a big data cluster was developed based on Cassandra. Big data cluster is coupled with discrete-event network simulator with the SUMO (Simulation of Urban Mobility) traffic simulator and the Veins vehicular network framework. The results validate the efficiency of the traffic detection system and its positive impact in detecting, reporting and rerouting traffic when traffic events occur [21]. In order to avoid incidents like jams, accidents and to reduce huge menace concepts like ZigBee, RFID, Bluetooth, GSM-GPS technologies were developed [22].

An Automated Highway System (AHS) represents the evolution of the current interstate highway system making use of both intelligent vehicles and smart highways. The latter would include roadside monitors that will measure traffic flow, patterns of vehicular traffic volume, vehicle speed, vehicular routes, heavily trafficked intersections, and ways to prevent gridlock in vehicle-intense urban centres. The traffic flow is evaluated at one-way, perpendicular intersections by use of paired infrared (IR) sensors, an IR LED and an IR photodetector.

The most frequently used component for traffic congestion control is IR sensors. The objective of IR sensors is that using the IR transmitter and receiver decreases delay, fuel wastage, wear and tear of vehicles, collisions, traffic jams, the frustration of passengers and drivers. An IR sensor is placed at the traffic lights. This IR sensor will detect the traffic on the road and will then label that traffic as light, normal or heavy traffic. The assumption of the traffic by the IR sensor will be taken by the microcontroller and that will be sent to the webpage through the GPRS module installed. To measure the traffic density, other than IR sensors Inductive looping as an instrument, the concept was developed. A microcontroller was programmed to receive information about traffic density on different lanes, as measured by the inductive loops [23].

There are many approaches that are followed by different countries. Each adopted Traffic management techniques have some loopholes. In the countries like the USA, San Jose, California, Portland etc. follow Adaptive Traffic Control System. This system creates more traffic towards residential streets. This system partially reduces the congestion on US arterial roadways. However, the initial cost for both field equipment and traffic management center management was high and maintenance cost was higher for the field components. Initial system setup and tuning process are more difficult. In Sydney, Oakland County, Michigan, Sydney Coordinated Adaptive Traffic System is followed. SCATS sometimes fail to manage the dynamic timing of signal phases at traffic signals, meaning that it fails in finding the best phasing for the current traffic situation if traffic is hectic. There is only an average of 7.8 % reduction in delay. Active Traffic Management system is followed in Washington state and Minnesota. It includes multiples strategies to smoothen the high traffic and leads to confusion. This technique is time-consuming. It disturbs the network by injecting artificial probe traffic into the network. Hence create traffic congestion. Split Cycle Offset Optimization Technique is followed in Dubai. The technique used requires high operational cost and mainly concerned on highways. Only delay reduction of up to 19% during special events, 8% decrease in travel time, a 17% decrease in delay 7% travel time. Optimized Policies for Adaptive Control is followed in Northern Virginia. Only 5-6% improvement in delays is obtained. Performance measure like logged measures of effectiveness, including average cycle lengths, vehicle counts by phase, and average phase green times and estimated speeds is not completely achieved.

The proposed methodology uses ultrasonic and camera sensors which load cells reduces the wastage of time, fuel consumption, traffic congestion. It also provides special

clearance of traffic for emergency vehicles that are deployed with RF transmitters in it. When an emergency vehicle, pass the RF signal, it is received by RF receiver that is placed at about 10-15 meters from emergency vehicle. Hence incidents like traffic congestion or disturbance in the traffic system are completely avoided. During the orange signal, complete details of vehicles in the specified road will be uploaded to the cloud. Information about the required time will be displayed, depending on the density of the traffic during the green signal.

IV. PROPOSED SYSTEM AND CHALLENGES

Sometimes during the overcrowding situations, signals based on hard-coded time interval technique does not provide excellent results. This is because of the fixed time interval; every street can have different traffic situation every hour even every minute which fails time-based signals and can result in traffic bottleneck. Applying automation to do this job can be very effective and reliable.

From already developed systems in the present situation, an efficient solution to the problem is not yet obtained. Hence, in order to provide an effective solution, we designed an efficient smart traffic monitoring system.

In this proposed methodology, we will provide a solution to congestion in traffic, and provide real-time traffic data to the users. One major plus point of the system is we have designed the system in automatic mode and manual mode. In automatic mode depending upon pi-camera and sensors output, the decision is taken. However, in manual mode, we can have control over traffic; an authorized person in the control room does this. The Raspberry Pi is used in the system takes controls on all that contains different modules like Pi-Camera, ultrasonic sensors, RFID. Camera used in the system captures still pics of traffic, which can be used for automation and for manual controlling by an authorized person of the control room to make decisions.

The proposed system will be a synchronized smart traffic signal monitoring which will improve the way of traffic monitoring and enhance the way we are dealing with other problems and the situations related to transportation. The proposed model will be composed of two components: a monitoring system and a control system. Both components are able to integrate together and use data of other signals simultaneously to take intelligent decisions efficiently. Figure 2 shows a simple arrangement of sensors devices in the proposed System.

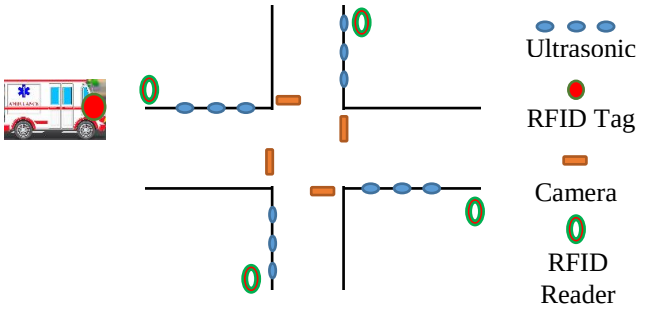

Figure 2. Proposed System Device Arrangement

Figure 3 shows the proposed model architecture.

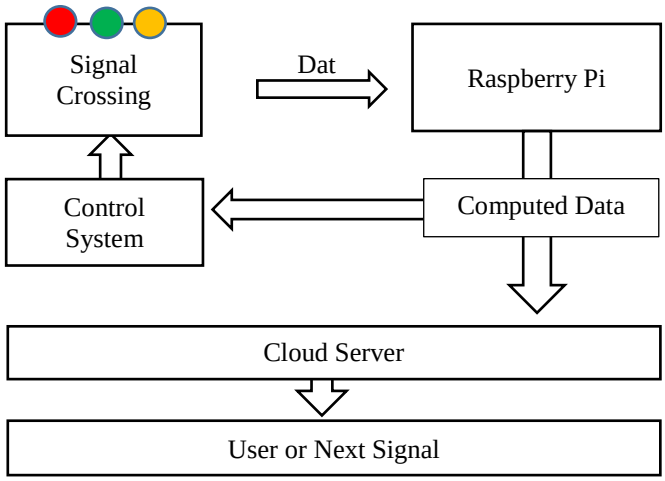

Figure 3. Proposed Model

An RFID sensor is used to detect the emergency condition. RFID is a technology in which data will be transferred without an external connection of components. We have RFID tag and reader, a passive tag that has a unique id is installed on an emergency vehicle and RFID reader on intersections. When a tag comes in the range of RFID reader, the reader receives a unique id of tag and sends an emergency condition to the monitoring system and sends it to control system that change the signal.

Ultrasonic sensors also used to detect the density of the traffic and make a decision. This mechanism is very useful in a low light condition when cameras cannot work efficiently.
The proposed model will give good results in the traffic monitoring but there are some challenges that should be discussed.

1) The initial cost of such a system will be high, right from installation to maintenance everything will require a lot of expenditure.

2) The system must be first tested on less busy streets and then only it can be implemented on busy junctions. This might take a significant amount of time.
3) Changes in road conditions, inclement weather will change the pattern in which the traffic moves. Such unexpected occurrences would directly affect the accuracy of traffic prediction.
4) Minute error in the system may cause an accident so the design of the system should be flawless as human life is on stake.

V. CONCLUSION

Traffic congestion is the biggest problem in the world that can decrease productivity and affects transportation. Therefore, there is a massy need for an effective traffic monitoring system. In a nutshell, it is possible to create a system which can solve such type of problems in an effective way by combining major developing fields of computer science. The proposed model here is expected to perform better with time, as the IoT technology and sensor devices improving daily, it will be possible to make better systems. Thus, a reliable and large set of IoT devices will help in efficient estimations. Moreover, the only use of different devices is not enough, one must be able to validate, connect and access data dynamically to extract meaningful information and implement it in real-time which will help to predict trends in traffic and regulate traffic efficiently. Thus, the most useful and powerful technology nowadays, IoT will help us to automate our traffic systems and synchronize traffic data with other traffic systems and peoples. This technique will be effective to reduce traffic congestion and improve the transportation system.

REFERENCES

[1] Emad Issa, Abdul Kaream and Aman Jantan, "Intelligent Traffic Light Control Using Neural Network with Multi-Connect Architecture", National Conference on Information Retrieval and Knowledge Management (CAMP08) in Kuala Lumpur,Malaysia, 2008.

[2] S. An, B.-H. Lee, and D.-R. Shin, "A survey of intelligent transportation systems," 2011 Third Int. Conf. Comput. Intell. Commun. Syst. Networks, pp. 332–337, 2011.

[3] K. Ashton, "That Internet of Things Thing", RFiD Journal, Vol. 22, pp. 97 114, 2009.

[4] X. Jia, O. Feng, T. Fan, and Q. Lei, "RFID Technology and its Applications in Internet of Things (IoT)", 2nd IEEE conference on Consumer Electronics, Communications and Networks (CECNet'12), pp. 1282 - 1285, 2012.

[5] C. Sun, "Application of RFID Technology for Logistics on Internet of Things", AASRI Conference on Computational Intelligence and Bioinfor- matics, pp. 106 - 111, 2012.

[6] J. He, S. Ji, Y. Pan, and Y. Li, "Constructing Load-Balanced Data Aggre- Gation Trees in Probabilistic Wireless Sensor Networks", IEEE Transactions on Parallel and Distributed Systems (TPDS), Vol. 25, No. 7, pp. 1681 - 1690, July, 2014.

[7] J. He , S. Ji, R. Beyah, Y. Xie, and Y. Li, "Constructing Load-Balanced Virtual Backbones in Probabilistic Wireless Sensor Networks via Multi- Objective Genetic Algorithm", Transactions on Emerging Telecommunica- tions Technologies (ETT), Vol. 26, No. 2, pp. 147 - 163, February, 2015.

[8] T.G. Zimmerman, "Personal area networks: Near-Field Intrabody Communication", IBM System Journal, Vol. 35, pp. 609 617, 1996.

[9] P. Baronti, P. Pillai, V.W. Chook, S. Chessa, A. Gotta, and Y.F. Hu, "Wireless Sensor Networks: A Survey on the State of the Art and The 802.15. 4 and ZigBee Standards", Computer Communication, Vol. 30, pp, 1655 1695, 2007.

[10] Bluetooth, S.I.G. Specification of the Bluetooth System, version 1.1. Available online: http://www.bluetooth.com.

[11] G. Anstasi, M. Conti, E. Gregori, and A. Passarella, "802.11 Power-Saving Mode for Mobile Computing in Wi-Fi Hotspots: Limitations, Enhancements and Open Issues", Wireless Networking, Vol. 14, pp. 745 768, 2008.

[12] M.K. Karakayali, G.J. Foschini, and R.A. Valenzuela, "Network Coordination for Spectrally Efficient Communications in Cellular Systems, Wireless Communication, Vol. 13, pp. 56 61, 2006.

[13] J. He, S. Ji, R. Beyah, and Z. Cai, "Minimum-Sized Influential Node Set Selection for Social Networks under the Independent Cascade Model", ACM MOBIHOC 2014, pp. 93 - 102, 2014.

[14] J. A. Gonzalez-Martnez, M. L. Bote-Lorenzo, E. Gomez-Sanchez, and R. Cano-Parra, "Cloud Computing and Education: A State of the Art Survey", Computers & Education, Vol. 80, pp. 132 - 151, 2015.

[15] Misbahuddin, S., Zubairi, J.A., Saggaf, A., Basuni, J., Sulaiman, A. and Al-Sofi, "IoT Based Dynamic Road Traffic Management for Smart Cities", 12th International Conference on High-Capacity Optical Networks and Enabling/Emerging Technologies, 2015.

[16] Choosri, N., Park, Y., Grudpan, S., Chuarjedton, P. and Ongvisesphaiboon, "IoT RFID Testbed for Supporting Traffic Light Control", International Journal of Information and Electronics Engineering 2015.

[17] Togrikar, P.S. "Implementing Intelligent Traffic Control System for Congestion Control, Ambulance Clearance, and Stolen Vehicle Detection", Imperial Journal of Interdisciplinary Research 2016.

[18] Nayak, R. R., Sahana, S. K., Bagalkot, A. S., Soumya M., Roopa, J., Govinda, R. M., & Ramavenkateswaran, "Smart Traffic Congestion Control Using Wireless Communication", International Journal of Advanced Research in Computer and Communication Engineering, 2013.

[19] Sherly, J. & Somasundareswari, D., "Internet Of Things Based Smart Transportation Systems", International Research Journal of Engineering and Technology (IRJET), 2015.

[20] Baskar, L. D., De Schutter, B., Hellendoorn, J., & Papp Z., "Traffic Control and Intelligent Vehicle Highway Systems: A Survey", IET Intelligent Transport Systems, pp. 38-52, 2011.

[21] Cárdenas-Benítez, N., Aquino-Santos, R., MagañaEspinoza, P., Aguilar-Velazco, J., Edwards-Block A., & Medina Cass, "Traffic Congestion Detection System Through Connected Vehicles and Big Data Sensors", International Journal of Science and Research (IJSR), 2016.

[22] Perumalla, B. K., & Sunil Babu, "An Intelligent Traffic and Vehicle Monitoring System using Internet of Things Architecture", International Journal of Science and Research (IJSR), 2015.

[23] "Integrating IR Sensors with a Microcontroller Automated Regulation of Traffic Flow", Robert H. Winston 2004.

Authors Profile

*Miss. Hemlata Kachhav*ey has been Completed her Bachelor of Engineering in Computer Science Engineering in 2016 from Rajeev Gandhi Technical University, Bhopal. She is pursuing Master of Engineering in Computer Engineering Sagar Institute of Research and Technology, Indore, India. She has a research interest in Internet of Things, Computer Networking, Machine Learning and Artificial Intelligence. She has delivered several seminars on IoT Technologies.

Mr. Mubeen Ahmed Khan has been Completed his Master of Technology in Computer Science and Engineering in 2012 from Rajeev Gandhi Technical University Bhopal. He has been Completed his Bachelor of Engineering in Information Technology in 2005 from Rajeev Gandhi Technical University Bhopal. His Area of Specialization is WiMAX Networks, Wireless Network and Sensors Network's. He is having more than 15 years of academic experience for both UG and PG Level.

