Smart Traffic Management and Control system Based on IoT

Dominic Abuga (abugah.dominic@gmail.com)
VLSI & Embedded Systems, Delhi Technological University

Nallanthighal Raghava
VLSI & Embedded Systems, Delhi Technological University

Short Report

Keywords: NTSA, Traffic jams, Internet of Things, greenhouse gases

Posted Date: March 17th, 2021

DOI: https://doi.org/10.21203/rs.3.rs-314224/v1

Abstract

Over the last two decades, there has been an exponential increase in population in many cities globally, posing a challenge in managing and controlling traffic. According to the National Transport and Safety Authority of Kenya, in the year 2020, 134,000 crashes led to 3600 fatalities. During peak hours of traffic, Kenya's average city resident wastes two litres of fuel in traffic daily. Traffic jams result in wastage of time with an average motorist using almost an hour daily. They cause fuel wastage and environmental pollution as a result of the emission of greenhouse gases that cause global warming. Pollution has a devastating effect on human beings, animals, and plants around us. IoT technology is best suited for tackling the problem of traffic management and control in the city. This paper will focus on the design and development of IoT based real-time monitoring framework for the city that also incorporates the use of remote sensing technology. The proposed system has an advantage over other existing methods because it is easy to design, develop and implement; it will reduce the amount of time spent in traffic, will lower the consumption of fuel and the number of fatalities and accidents on the roads.

I. Introduction

The major problem cities face having an effective real-time traffic monitoring system. IoT technology can monitor and learn the patterns of traffic in specific areas such as cities. RFID and RSU can be used to collect information about traffic density from various lanes on the highways, and this data which is in real-time, is stored in a central database. RSU is a dedicated short-range communication unit (DSRU) that is strategically placed on the sides of highways. DSRC serves as a gateway between the communication infrastructure and OBU (on-board Unit). The RSU contains of a microcontroller with an IP smart camera affixed to it. The IP camera takes the photo images of the vehicles in real-time, then through the process of image processing, it takes the information on the running time of the traffic lights and eventually computes the vehicles speed. The information about the speed at which a vehicle should move at in order to pass the traffic lights without any further delay is provided by a mobile interface developed using HTML5.

Ii. Experimental

According to [1], a system based on real-time intelligent vehicle monitoring using IoT is implemented. The system also provides for real-time tracking of vehicles using IoT, RFID, and cloud computing. This system is accountable for the provision of real-time information about the traffic timings. This helps in calculating the distance covered by using Global Positioning System technology and hence the speed of the vehicle can be calculated. This system is essential because it minimizes road fatalities and accidents by notifying all the drivers when they have exceeded certain speed limits.

According to [2], Traffic status queries in real-time for intelligent traffic systems were modelled using PEPA, IoT, and TOPSIS. By using performance evaluation process algorithm methods, a real-time query

status in the intelligent traffic system can be processed, and performance analysis can also be done. The status of traffic in real-time is obtained and can be used to optimize the process.

According to [3], the authors have focused on an Intelligent Traffic Management System (ITMS) and the graph theory. The model proposed here has many nodes that are used in collecting information from all the city roads. The ITMS helps motorists reach their destinations safely by using the shortest optimal routes with less traffic.

According to [4], they have proposed a smart traffic lights management and control mechanism based on distributed multi-agent Q learning. The system will use both non-motorized and motorized to optimize the traffic lights control within a city. The system also provides solutions for pedestrians' queue length and the waiting time at highway intersections.

According to [5], an urban intelligent traffic management mechanism using both IoT and cloud-computing has been used to solve the problem traffic congestion problems that have limited cities' development. The system manages the traffic situation in the cities intelligently by use of ISR (intelligent service request) and RSS (response scheduling strategy.

According to [6], they have proposed a model of tackling the issue of traffic jams and making roads free from vehicle obstruction. This makes roads clear to pave the way for emergency vehicles such as police vehicles, ambulances, and fire brigades. The model proposed includes the management of traffic signals using RFID tag and reader, Raspberry Pi, and Node MCU. When there is an incoming emergency vehicle, the traffic light signal changes instantaneously by accurately communicating with the vehicle's sensors.

According to [7], an intelligent traffic management system based on IoT is implemented with the RSU, central database, mobile interface, and environmental sensors. The system is crucial in providing information on all the traffic light signals that are far ahead and the minimum speed at which the vehicles should accelerate in order to pass the traffic lights faster with minimal or no further delay. The proposed system helps in reducing fuel consumption, prevent accidents, and saves on time.

According to [8], a system on intelligent parking system based on IoT that uses image processing algorithms has been proposed. The system is accountable for all the information that concerns image processing of all images that are captured by the roadside unit and then sent to the central server. The proposed system helps in reducing vehicle theft, ensures efficiency in parking, and decongest the city roads.

According to [9], an intelligent vehicle monitoring system based on IoT framework, machine learning, correlation methods, and emergency detection is proposed. The proposed system provides a review on selection filters that are based on fast based correlation feature algorithm and correlation measurements which are widely used in increasing industrial facilities by intelligent networks based on IoT.

According to [10], a secure traffic management and control system for all emergency vehicles using

he system entirely uses hacking traffic signals. IoT helps

maintain the steadiness of the traffic signals using intelligent transport systems for all the incoming emergency vehicles, it also aids at least all the emergency vehicles to reach their preferred destination without any delay. The system also helps reduce traffic jams.

Iii. Methodology

Road Side Unit has been commonly used to make communication much easier between transportation infrastructure, vehicles, and other physical devices. The data is transferred to the RSU by complying with the industry standards. Besides the roadside unit, the vehicles are also equipped with other sensors used to measure the vehicle's external surroundings. The system basically involves collecting data from the vehicles and the road side unit and then provides information to all end users by the use of a mobile interface.

The roadside unit is deployed on all major roads of the city. The RSU comprises a microcontroller that has an IP smart camera affixed to it. This IP camera takes real-time image photos of the traffic lights and their respective timers. Thereafter, the RSU performs a quick scan in accordance with a specified algorithm in the embedded microcontroller and then sends the generated traffic data to a centralized database. Radio frequency identification unit will be deployed to each vehicle and equally, the RFID tags will also be installed at every traffic signal. Active RFID tags will be used because they can communicate wirelessly. The RFID tags are used to precisely identify the vehicles. The readers automatically detect the active RFID tags that are placed in the vehicles, then the traffic data collected is sent to the database.

The following happens at the central database server; the scanned images from the roadside unit are first received. The traffic lights timings are extracted, and a processing time of between five to ten seconds is added to the extracted time before being updated and stored sequentially in a central database server.HTML5 is used to develop a mobile interface that all end-users will use in accessing all the real-time information about the city's traffic lights status. The mobile interface has the capacity to show all the locations where the RSU has been deployed in every traffic signal. The information is shown in a pattern of dots. An end-user who wants to recognize the traffic light situation on a particular road has to click a specific dot. The dot will pop-up and provide the required information to the end-user. When a vehicle using HTML5 Interface needs to access information on a distinct traffic signal, a timestamp affixed to every vehicle helps the vehicle find the actual distance between the traffic signal and the vehicle by use of the Global Positioning System technology.

Since the proposed system can provide the required real-time information regarding the traffic light signal, the PEPA algorithm helps track real-time traffic information, and the exact distance will be computed using the Global Positioning System technology. Once the distance and time has been obtained, the speed can be calculated using this formula $speed = \frac{distance}{time}$, this provides the speed at which the vehicle can accelerate to cross a highway junction without any delay. The speed also helps to determine the time-based optimal shortest path or distance-based optimal shortest path, and the end-users have the

neans the proposed system provides these three crucial

information; the speed required to accelerate to cross the highway junction, information regarding the traffic light signals, and alerts to end-users when to slow down on a highway.

The proposed system also aids in finding the traffic density of the vehicles on roads and highways; this is done by retrieving all the information from the installed radio frequency identification units. The highway or road with higher vehicle density will be marked colour red; this will depend entirely on the traffic data from the central server that the RFID unit has collected. The active RFID tags that the RFID readers have captured will specify the roads with more traffic density. The images captured by the smart camera and regularly updated to the central system will also indicate the traffic density of a particular road or highway. This collected information from both the RFID and camera is stored as a dataset. Machine learning algorithms can be used to detect and predict any road's traffic density by using the collected dataset anytime an end-user requires the information.

These are the components required for the proposed system

- Central database server
- Sensors and active RFID tags
- GPS technology
- Roads Side Unit

Iv. Discussion

Many city residents have to endure traffic jams, which results in numerous hours spent on the road during peak hours. Traffic jams also cause unnecessary consumption of fuel that leads to wastage. Accidents that occur in the traffic signals are majorly caused by human negligence and motorists' urgency to ignore the traffic signals. The RSU module is used to collect information on the existing road conditions and the weather conditions in the area where it is deployed. The RSU also captures the information showing the traffic density patterns across major roads and stores the information in the central database server. By using the PEPA algorithm, the system can be modelled to expedite the processing of the real-time status of any traffic query in an intelligent transport system (ITS). All end-users using HTML5 mobile interface can access the required information about the road conditions and the weather pattern on a particular day. In the proposed system HTML5 mobile interface has the sole purpose of displaying real-time information showing the traffic lights signals' status to all road users.

V. Conclusion

The Smart traffic management and control system based on IoT enables many end-users to access real-time information on the roads' traffic density status. The system has a roadside unit with a microcontroller with an IP smart camera affixed to it. The proposed system uses the current technology that is cost-effective, consistent, and reliable. The system is also scalable and can be modified in the near [illegible] ting this system will cause rapid changes in the management

and control of traffic by reducing traffic jams on the roads. The system will reduce road fatalities and accidents, and finally, the system will help motorists in efficient use of fuel due to reduction in traffic jams.

Declarations

DATA AVAILABILITY

Data sharing not applicable to this article as no datasets were generated or analyzed during the current study.

CONFLICTS OF INTEREST

The authors declare that they have no conflict of interest.

AUTHORS' CONTRIBUTION

Dominic was involved in writing of the manuscript, which included the introduction, literature review, discussion, conclusion, and acknowledgment.

Nallanthighal Raghava was involved in conceptualizing the methodology, review, editing, and final approval of the manuscript.

ACKNOWLEDGMENT

We will like to acknowledge Delhi Technological University for the access they gave us to the IEEE repository to acquire related papers for this proposed system.

References

[1] Sarika B. Kale, Gajanan P. Dhok "Design of Intelligent Ambulance and Traffic Control", International Journal of Innovative Technology and Exploring Engineering (IJITEE) ISSN: 22783075, Volume-2, Issue-5, April 2013.

[2] B. Jan, H. Farman, M. Khan, M. Talha, and I. U. Din, "Designing a smart transportation system: an internet of things and big data approach," *IEEE Wireless Communications*, vol. 26, no. 4, pp. 73–79, 2019.

[3] Laisheng Xiao, Zhengxia Wang*, Internet of Things: a New Application for Intelligent Traffic Monitoring System* JOURNAL OF NETWORKS, VOL. 6, NO. 6, JUNE 2011.

[4] L. Foschini, T. Taleb, A. Corradi, and D. Bottazzi, "M2M based metropolitan platform for IMS-enabled road traffic management in IoT," *IEEECommunicationsMagazine*,vol.49, no. 11, pp. 50–57, 2011.

[5] ShaoHuaGang, ChengJin, WangHui, etc. "The system and middleware design face to IOT," in Computer engineering, vol. 4, 2010,pp: 84-86.
[6] Intelligent Traffic Light System to Prioritized Emergency Purpose Vehicles based on Wireless Sensor Network", by Amnesh Goel, Sukanya Ray, Nidhi Chandra International Journal of Computer Applications, 2012.

[7] L. Da Xu, W. He, and S. Li, "Internet of Things in Industries: A Survey," IEEE Trans. Ind. Informatics, vol. 10, no. 4, pp. 2233–2243, Nov. 2014.
[8] Ni, W. Wu, K. Li," A message efficient intersection control algorithm for intelligent transportation in smart cities," Future Generation Computer Systems, 2016.

[9] Laisheng Xiao, Zhengxia Wang*, Internet of Things: a New Application for Intelligent Traffic Monitoring System* JOURNAL OF NETWORKS, VOL. 6, NO. 6, JUNE 2011.
[10] B. Jin, D. Zou and Y. Gan, "Research and design of traffic detection based on GPS", IEEE conf. on advanced computer control (ICACC), (2010) March.

[11]The system architecture https://github.com/apoorvt95/SMTS

Figures

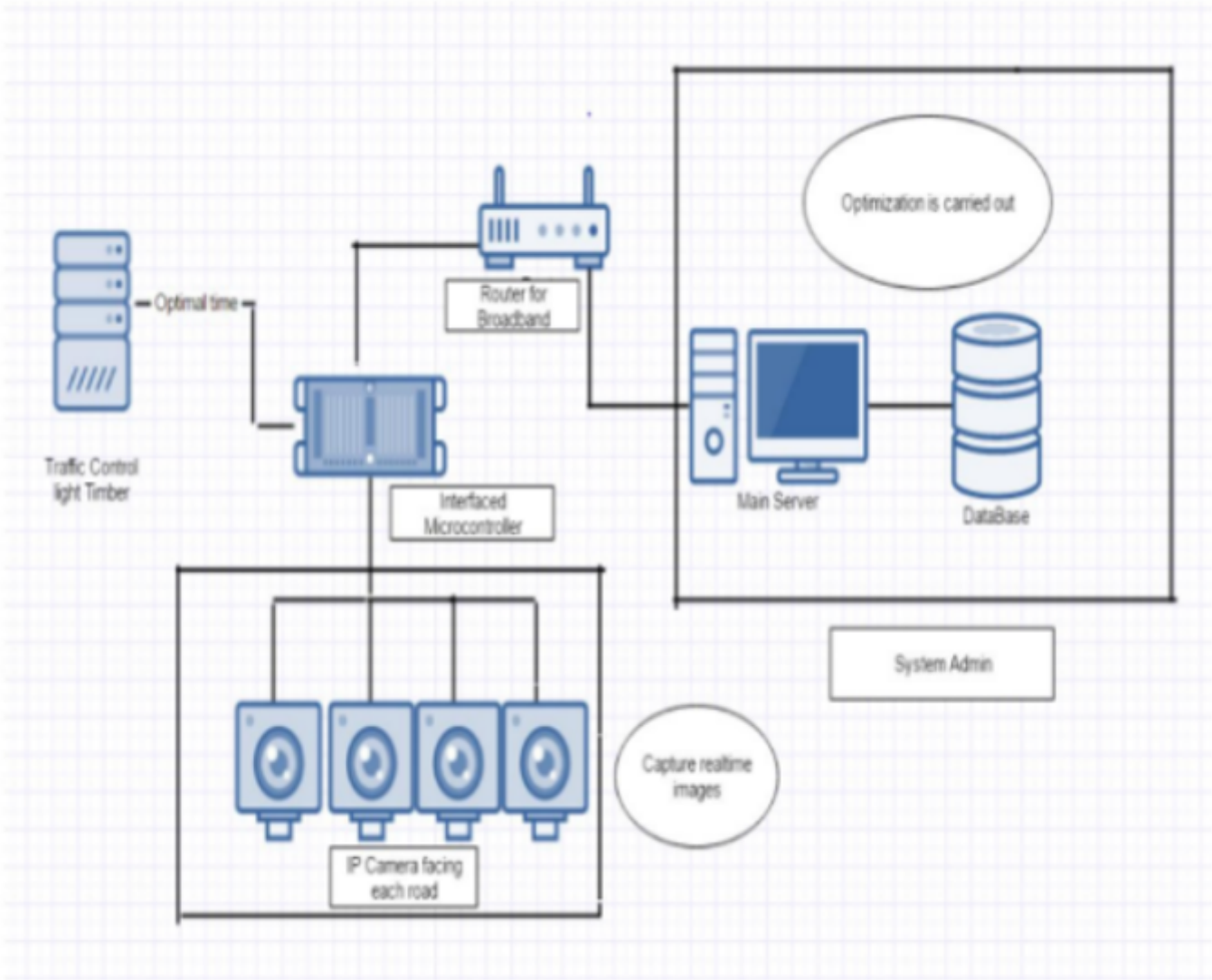

Figure 1

The system architecture (adapted from github.com)

Loading [MathJax]/jax/output/CommonHTML/jax.js