

Internet of Everything: Transformation of Transport Infrastructure of Pakistan

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Abstract—Pakistan is the 5th country with the most population in the world. With the daily explosion of population and enhancement of mobility, the gridlock of traffic is often seen on the road. The gridlock of traffic reduces the efficiency of daily routine work by putting pressure on account of more fuel consumption and wastage of time. This is caused by signal failures or unprofessional ways of traffic management. Traffic management is the main attention to solve this problem. Many solutions were provided from which the techniques like video data analysis, wireless sensor network, infrared sensors, etc. that somehow solves the problem but it is too costly and time-consuming. The study has the objective to reduce traffic gridlock with the help of Internet of Everything Technology (IOE). IOE is the pattern of sense and response. Object detecting sensors can be used at traffic signals, direction boards, and streetlights to detect the presence of vehicles. RFID can be used to read the unique code from RFID tags attached at vehicles to detect the vehicle type. The data will be stored in the database using a network of connections. The data in graphical form can be perceived by Traffic Inspectors to judge the more gridlocked area and flow of traffic. In case of infringement of traffic rules, a fine will be charged. The engagement of this technique will be reliable, effective, and intelligible.

Keywords— Intelligent Traffic System, Internet of Everything, Connectedness, Smart City, Traffic Signal Management.

INTRODUCTION

With the daily increase in population, traffic congestion principally in peak hours is becoming a major problem in Pakistan. Pakistan is the fifth most population-wise country in the world and 2nd in Muslim countries. The blockage of traffic when someone of higher authority visits the city is the main problem. Traffic is congested for multiple hours. These factors had overwhelmed the growth of the economy. It is also dangerous when emergency vehicles such as ambulance have to move from congested areas as described by [1]. Recent research shows that 30% of air pollution is caused by fuel that is used in the vehicle. According to researches, business losses 32 lakh business hours per day [2]. The smart transport

system is not introduced in Pakistan till now. In Pakistan, traffic is controlled with the help of cameras but it flops in severe weather conditions like rain, fog. The authors of [2] predicted that In India, a micro-controller coding-based system is used with cameras but it is too costly. Several researchers have introduced many techniques to overcome this problem but they were costly or harder to implement. Neither one proposed a solution to control higher traffic to reroute to bypass instead of entering into city nor they proposed a solution that if any higher authority i.e. Prime Minister or Chief Minister wants to visit the specific area, then how to reroute the general traffic.

To overcome this problem, we can use The Internet of Everything (IOE) technology. It was introduced by Cisco. It is a networked connection of people, things, processes, and data. [3] negotiates that it is the future of connection. It is the enhancement of the Internet of Things technology. IOE is the concept of connecting the device with the internet and able to identify with other devices themselves [4]. In the modern era, everyone wants to be connected to the Internet or anywhere to make life easier. The objective of this study is to transform the transportation infrastructure of Pakistan. [5]

OBJECTIVES

The key objectives of this study are following

- To lessen the traffic gridlock
- Automatic working of traffic signals in the presence of vehicles and to turn off the in the absence to vehicles to lessen the energy charges

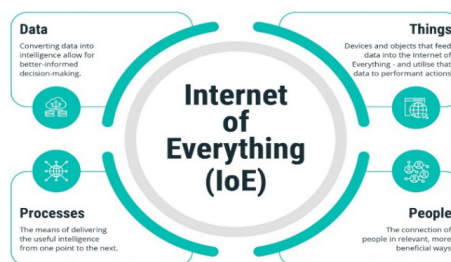


Figure 1. Process Diagram of Internet of Everything

- Provide priority to emergency vehicles like ambulance or firefighter etc.
- Reroute the high traffic vehicles (HTV) to bypass instead

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- of coming into the city
- Reroute the general traffic if Prime Minister wants to visit a specific area of the country.
- E-Challan generation if any person violates the rule

MOTIVATION

The population especially in the urban area is increasing daily. With the increase of population, urban mobility is also increasing which affects transportation very brutally. The countries like Pakistan, India, Bangladesh, Nepal is using the traditional transport system. According to a United Nations report by 2050, 90% of the world will reside in Urban areas [6]. According to researches, 30% of air pollution is due to traffic congestion of vehicles. The contaminated air is unhealthy to people as well as to animals. To overcome this problem, a smart transportation system should be built in Pakistan and other countries also.

LITERATURE REVIEW

Researchers [7] suggested a green wave system in which the signal light can turn on the green when an emergency vehicle is crossing the signal. Image processing and real-time sensors are used for distinguishing emergency vehicles. The vehicle cannot find out any hurdle on its way to reaching its destination. It's another benefit is that any stolen vehicle can be caught on camera if it crosses the point. But this system breaks out in severe conditions like rain, fog, etc. since the camera can have caught wrong or multiple images. It makes a lot of mistakes to detect the correct image which can cause improper traffic density [8] It is only applicable to areas where the weather condition is not to worry. RFID tags can serve for proper service because they are not overblown by the weather. Scientist [9] explores the study of distinguishing vehicles using wireless sensor networks (WSN) that uses real-time magnetic sensors. The sensors after observing the vehicle are sent to the traffic management department. The helps the system to manage traffic density, correct lane occupancy, and visualize the speed of vehicles. One of the drawbacks of this system is Signal to Noise ratio that differentiates the outcome signal from background noise. It can send false signals of increased rates due to poor system performance. This system has low security so that is easy to crash. It is useful because Wi-Fi and Artificial Intelligence are future technologies for real time performance. A team[10] suggested another system to reduce gridlock is by using a mobile phone. This system allows to control and manage traffic moving on roads. This allows the mobile application to receive information about the traffic on roads. The proposed application then calculates the time that may be delayed by traffic and then it suggests the alternative routes with low congestion. The main drawback of it is that a cell phone is not connected to internet or had a dead battery. It is very useful because everyone even a donkey cart man also has a mobile phone. The location of a mobile phone provides information about the traffic density. Another system of navigation of

traffic with the help of a passenger's cell phone to navigate to the correct area is described by [11]. A group of researcher[12] describes a method to lessen the traffic gridlock by using infrared sensors. Most of the traffic light systems are equipped with infrared transmitters that are further combined with infrared receivers. Vehicles are detected by sensors with the help of frequency or density and traffic lights work according to them. The drawback of this technique was that it only detects a small number of vehicles. RFID has a greater ability to detect more vehicles accurately. Authors in [13] proposed a real-time smart traffic management system. It deploys traffic indicators to update the rapidity of traffic. It is embedded in the middle of the road for every 500 to 1000 meters. Internet of things (IoT) is used to collect data and send it for processing. The real time data is sent to big data analytics. They developed a mobile phone application to develop a user interface so that alternative ways should be given for managing the traffic. This approach is cost-effective and easy to use. The cons of this technique are that thousands of sensors would be used. It takes too much time to implement. [14] suggested a future research area that automatic vehicles working without the help of drivers can help to reduce gridlock of traffic and accidents. Scientist [15] negotiates that inductive loops can be used to detect the availability of vehicles and counts them. When a vehicle passes through it, the magnetic field changes and it counts it by the counting device. It repeats its work as a loop. The cons of this method are that it requires a large number of loops to work. It is cheap and free of any maintenance.

METHODOLOGY

We proposed a system that works in a dispensing manner. It contains sensors and video cameras that take data and send it to a local server for processing. It turns on traffic signals to green when it encounters the presence of an emergency vehicle like an ambulance, fire brigade, etc. The system is divided into three layers.

Gathering layer

Ultrasonic sensors, smoke sensors, flame sensors, and video cameras are used to gather information about vehicles. Blob detection algorithms and ultrasonic sensors are utilized for video cameras for good result due to their flexibility and performance. Ultrasonic sensors send a sound wave of required frequency and calculate the distance to the object from its destination. The system computes the distance by the following formula

$S=VT$ where s = distance, v =speed and t =time.



Figure 2. Sensor Data Calculation Scheme

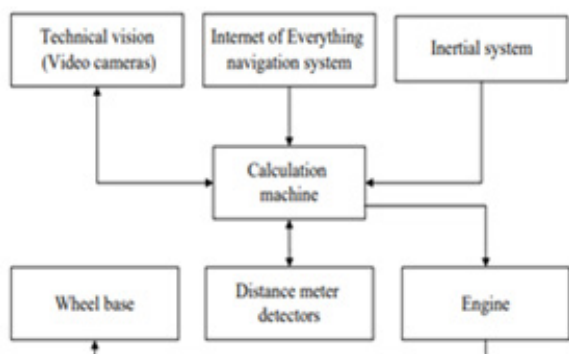


Figure 3. Deployment of sensor nodes in the field

Figure 3 shows three pairs of sensors are deployed to get the density of vehicles. The sensors have a value of 0 or 1 (0 shows no vehicle and 1 shows vehicle). Then the total value of vehicles is calculated by the following formula

$$\text{Sum of All sensor values} = S_i + S_{i+1} + S_{i+2} + \dots S_n$$
 Table 1 shows the assumed value of sensors and gives them an ordinal value like normal, peak, low.

Table1 Traffic Density Calculated By Ultrasonic Sensors

Sensor Detection	S1	S2	S3	Remarks
1	1	1	1	Peak
2	1	0	1	Normal
3	0	0	1	Low

Data Layer

The system after gathering the data from the gathering layer process the information based on sensor data. It compares the data of all sides and gives the priority to side with high sensor detection and turns on signal green for it. Some value is set in “i” by the administrator so that signal can work for that specified value if all sensor data is low.

When traffic is at a peak, then the data from sensors is updated in “j”. When an emergency vehicle is detected then it turns on the signal green for all sides of traffic signals so that it can move without any stumbling block. If any fire is detected by smoke sensors, then data is forwarded to the traffic department for further necessary action.

Presentation Layer

In this layer, the processed data of sensors are delivered to the traffic department with the help of a mobile application. The Regression Tree algorithm” is used to find out the rust time and upgrade the data daily into the local server. Then, the system turns off or on the signal concerning that data. This information is helpful for the future organization of management. A user can also get information about the congested road.

RESULTS AND DISCUSSIONS

Several strategies were proposed to lessen the gridlock of urban traffic mobility. Neither one proposed a solution to control higher traffic to reroute to bypass instead of entering into city nor they proposed a solution that if any higher authority i.e. Prime Minister or Chief Minister wants to visit the specific area, then how to reroute the general traffic. Some procedures were costly and some were time-consuming and some break off in grievous weather conditions. A sample prototype is made to view the proposed system. As the vehicle passes through the sensor, the data is carried from sensors and transmitted to the local server where it is processed and saves into the database.

The green wave system successfully detected emergency vehicles with the use of microcontroller and video cameras. When a stolen vehicle is detected, it is shown on LCD. The system is flexible and efficient. It is implemented to lessen the gridlock of urban mobility. The overall discussed system is less costly than traditional system. It doesn’t require any dynamic updating in the system. In traditional system, GPS is used to detect the presence of vehicles. The cost of integrating the GPS system is high as compared to this system. These microcontrollers are also in small. GPS can be removed easily but microcontrollers are harder to find and difficult to hack. There is an option to update the system through SMS very easily. Its drawback is that it doesn’t work in severe weather conditions. It provides 24*7*365 working time. This system is very helpful in building the city. This system can also be helpful in detection of stolen vehicles. It will reduce the consumption of fuel as well as less polluted environment will be provided to people. Traffic will find out a clear way to move on without gridlock of traffic

The following table shows the several mechanisms preferred by different researchers and their cons that why they are onerous to implement.

Table1 Comparison Of Various Techniques

Technique	Description	Cons
Green Wave System	Real-time detection of vehicles with the help of a camera. It turns on all the signals to green for emergency vehicles. It lessens traffic gridlock	Not work in severe weather conditions. Failure of this system can cause severe traffic congestion
Wireless sensor networks	Vehicles are detected through magnetic sensors; the data of passing vehicles are sent to the transmitter. It can be applied on large scale.	Easy to hack
GSM	An embedded controller is used to detect vehicles through the geolocation of mobile phones. It works with a 3G connection	Not work when no network connection or when the battery of a mobile phone is dead
Infrared sensors	Use of infrared sensor in traffic signals to detect vehicles. Sensors starts working when a vehicle cross through traffic signals. The data collected from sensors enables traffic signals to turn on green or red.	Expensive and only for a limited area. Emergency vehicles cannot be prioritized and it requires human intervention.
Traffic indicators	Use of traffic indicators to update the velocity of vehicles	Time disposable and many indicators are to be used
Nameplate	Vehicle recognition with the help of nameplates. The data can be collected with the help of camera vision.	Bicycle and donkey cart doesn't have nameplates
Inductive loops	Works in loops to detect vehicles with the help of a magnetic field. It is cheaper to use.	Requires a large number of loops. It is helpful only for few vehicle detections.

CONCLUSION

The traditional system has many constraints in managing the traffic properly. In this paper, several intelligent traffic management systems were reviewed. These included different techniques like traffic controlling through Green Wave System, Wireless Sensor networks, GSM technology, infrared sensors, etc. The study proposes a low-cost method of traffic controlling using Internet of Everything technology in which object sensors and RFID technology is used to collect real-time data to a cloud server through the use of Internet Connection. It also works as a clean route for an emergency vehicle. It charges a fine who violates the traffic rules. All of it is done by RFID tag which is installed in vehicles. This system also provides information of traffic department that can be used in further improvement in Traffic management.

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