IoT Based Vehicle Traffic Monitoring System

Aromal Balakrishnan[1], Sebastian Cyriac[2]

[1]U G Scholar, Santhigiri College of Computer Sciences,
Vazhithala, Thodupzha
aromalbalakrishnan27@gmail.com

[2]Asst. Professor, Santhigiri College of Computer Sciences,
Vazhithala, Thodupzha
sebastiancyriac@santhigiricollege.com

Abstract: ***Traffic management system is taken into account mutually of the foremost dimensions of a sensible town.With the rapid climb of population and concrete quality in metropolitan cities, traffic jam is usually seen on roads. In this paper, a smart traffic management system using the Internet of Things (IoT) is planned to trace the assorted problems for managing traffic on roads and to inform authorities and to assist in correct designing. Internet of Things (IoT) is a network which connects all the smart objects all together in the world. It is a medium that allows all things to communicate each other. A scientific approach is used to optimize traffic flow on roads and an algorithm is devised to track various traffic situations efficiently to monitor traffic based problems. For this purpose, the system takes traffic density as input from devices like cameras and sensors, then manages traffic signals. just in case of fireside on the road, Smoke sensors are a part of this method to find this example. To demonstrate the effectiveness of the planned traffic management system, a prototype is developed that not solely optimizes the flow of traffic however system connects nearest rescue departments with a centralized server. Moreover, the system extracts helpful data given in graphical formats that will facilitate the authorities in future road designing and planning.***

Keywords: Internet of things, Smart City, Traffic Congestion, Monitoring, Tracking, Communication.

1. Introduction

The traffic system is one of the important subsystem of a city. A city consists of many interdependent complex subsystems. A good traffic management system is also declared as one of the major dimensions of the smart city. Nowadays the number of vehicles on roadways is increasing consequently with the rapid growth of the population of the world. As a result, the rate of traffic jams is also increasing in the same manner. Traffic jams are not just wasting time but in some cases, it is noticed that criminal activities like mobile snatching at traffic signals also happen in metropolitan cities. On the other hand, it is not only affecting ecosystem badly but the efficiency of industries is also being affected . So it is necessary to have an active traffic management system.

In today's world internet is a global phenomenon. So many devices are getting internet friendly, due to which with the help of internet, traffic management and transportation becomes easier. As number of vehicle has been increasing at an exponential rate, more traffic issues arises. It is logical that the monitoring of speed limits, pollution checks, vehicle tracking, alcohol detection and emergency response to road accidents should also be taken care to make life easier.[3]

In the traffic management systems paradigm of the Internet of Thing (IoT) has been introduced .It is known that the present traffic management systems are centralized.Just in case of networking problems, such systems might crash. Additionally, there's less concentrate on problems in traffic flow. So, the proposed system is able to manage the traffic on local and centralized servers by using the concepts of IoT and Artificial Intelligence together. The representation of traffic data in statistical form can also be helpful to authorities for real-time monitoring and managing traffic. Moreover, it may also be helpful for future planning and improvements. The rest of the paper is structured in four different sections. Section 2 of this paper discusses on the cases of two currently working system. The proposed system is presented and discussed in Section 3 whereas a discussion on results is being carried on in Section 4. Then the section 5 of the paper concludes the research.

2. Existing System

Most of the countries within the world still follows conventional traffic management system, few traffic congested and developed cities like Los Angeles and Amsterdam have tried out big data to manage traffic lights.

Los Angeles, the Californian town, comes third within the Forbes list of most traffic affected cities within the world . This town includes a system that uses big data to manage traffic on roads. Magnetic sensors within the road at each intersection send periodic updates regarding the traffic flow through fiber-optic cables to a bunker below downtown Los Angeles. the system, that runs software package the town itself developed, analyzes the info and mechanically makes second-by-second changes, adapting to dynamical conditions and employing a hoarded wealth of past knowledge to predict wherever traffic block may occur, all happens without human involvement [1].

The system is intelligent there that it will mechanically regulate the time delay between lightweight changes whenever problems arise. So, for instance, if there's associate degree accident that causes one or additional lanes to be closed on any road within the town (thus inflicting a bottleneck), it will regulate the lights and provides longer to let cars wedged in it all submit to. as an alternative, it also can be accustomed facilitate keep conveyance running on time – if the buses are late, the system will facilitate them to submit to the lights quicker and find back on schedule.This system slightly improved the traffic within the town. Per officers, the typical time to drive five miles within the town before was

twenty minutes. These sensible traffic lights have reduced the time to simply 17.2 minutes.[1]
The Amsterdam city is one in every of the busiest regions of Netherlands. Three road managers are active, the municipality of Amsterdam , the province of North Holland and also the national government. all of them attempt to optimize the traffic flow inside their management space, however the measures they take typically conflict with one another. To boost traffic flow cooperation between all parties was necessary. The Amsterdam city currently uses TrafficLink‟s SCM system that's connected to the traffic system of the national government. each centres will see what's happening, on their screen. However the centres can put together and mechanically manage traffic inside the region. Since the initiative for regional cooperation and also the implementation of intelligent traffic management, of car loss hours within the Amsterdam space has born by ten percent. Amsterdam's sensible traffic management system will simply be ready for reference to in-car and navigation instrumentation. This way, additionally within the future, Amsterdam city will have its own fashionable digital road manager, that helps optimizing traffic flow inside the full region[1].

3. Proposed System

The proposed system, shown in Figure 1, is meant to control traffic at road networks, sensing through sensors, surveillance cameras, and RFIDs that are embedded on roadsides. The system works in a very distributed manner, it processes sensors' data at the node level and videos' data at the native server, then calculates the cumulative density to control the traffic consistent with density.In addition to this, it also tackles emergency vehicles such as ambulance, fire brigade. This system also helps the users to understand the congestion status at a road through prediction. The system is divided into three layers A) Data Acquisition and Collection layer B) Data Processing and Decision making layer C) Application and Actuation layer.

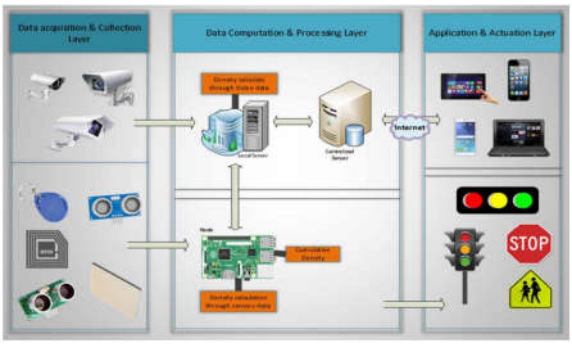

Figure 1: The System Model

3.1 Data Acquisition and Collection Layer

Many ways of traffic detection are used by the researchers within the state of the art which consists ultrasonic sensors, RFIDs, surveillance cameras and light beam. All these sources have advantages and disadvantages; the appropriate sources within the context of the planned system are surveillance cameras, ultrasonic sensors, RFIDs, smoke sensors and flame sensors.A surveillance camera is the most widely used source to detect the road traffic in this field due to efficiency and ease of maintenance. Traffic block detecting algorithmic programs are applied to the video stream at the local server due to its performance and capability of noise reduction . Once traffic is detected, local server sends the density measured through image processing to its respective microcontroller.
Apart from the cameras, this technique is additionally make use of ultrasonic sensors to reinforce the accuracy.Sensors are the important things to understand the traffic density in several traffic management system applications.[2] It measures distance by sending out a wave of a particular frequency and listening for that wave to improve.This economical sensor measures the distance 2 cm to 400 cm .

The system calculates the distance by using the following formula:
Distance = ((a x b) / 2)
a= Speed of sound
b= time taken

As shown in Figure 2, there are three pairs of sensors at a certain distance are embedded on each roadside of an intersection to calculate the traffic density. Each sensor's reading returns the values as 1 or 0 (If that particular pair of sensors detects any vehicle or not). At the node side, density is calculated by considering the readings of all the sensors embedded at that particular roadside.

$$\sum_{i=1}^{3}(Pi) = \mathbf{P}_i + \mathbf{P}_{i+1} + \mathbf{P}_{i+2}$$

P is the pair of ultrasonic sensors. Table 1. shows the states of the sensors and their results are as follow:

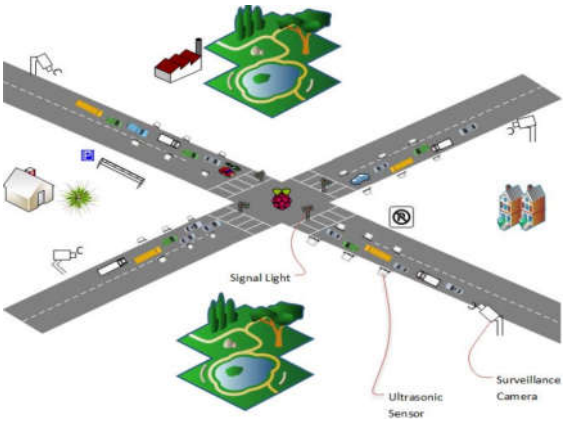

Figure 2: Sensors Network

Table 1: Traffic density states by ultrasonic sensors

Condition / Sensors	P1	P2	P3	Status
Condition 1	1	0	0	Low
Condition 2	1	1	0	Medium
Condition 3	1	1	1	High

The microcontroller receives results from sensors and video from a local server to calculate cumulative density using the received data and it is represented below in the Table 2.[2]

Table 2: cumulative density

Situations	Sensors' Result	Camera's Result	Traffic Density
Situation 1	High	High	High
Situation 2	High	Medium	High
Situation 3	High	Low	Medium
Situation 4	Medium	High	High
Situation 5	Medium	Medium	Medium
Situation 6	Medium	Low	Medium
Situation 7	Low	High	Medium
Situation 8	Low	Medium	Medium
Situation 9	Low	Low	Low

3.2 Data Processing and Decision-Making Layer

According to the traffic conditions, the system manages the road traffic. a) In the first situation, each traffic signal has a preset time that is α seconds, when there is normal traffic on road. Every signal is going for green at their turn for α seconds, and rest of signals at that time remains red until all remaining traffic signal at an intersection complete their turn. Traffic ratio is increasing day by day and our current Fixed-time signal control system is not working well in this situation, there arises a need to add a density based traffic management module which dynamically allocates time to each lane on the base of the traffic density, in second part of algorithm when the capacity of traffic is increased and flow of traffic is not in routine, the system calculates the level of density according to some conditions ,which is represented in the Table 2. And update the time β of traffic signal on the basis of traffic density. further, the system undergoes to traffic management algorithm discussed in Figure 3.[2]

Algorithm:

Part(I) When no emergency vehicle detected

```
if (Traffic Density == high)
    if (Rush Interval==Yes)
        Time= ((α e^x sinθ) + β) + γ
    else
        Time = (α e^x sinθ) + (cosθ * γ) + β
else
    if (Rush Interval==Yes)
        Time= (α e^x sinθ) + γ
    else
        Time= α
```

Part (II) When RFID tags detect emergency vehicle

```
While (vehicle Exits)
    Time != 0
```

Figure 3: Traffic Management Algorithm

Where α represents the default time slot given to a specific roadside, θ=90, x=0, β is the extra time added in case of traffic congestion occurs and γ is extra time added when there is rush interval near to approach on the road. Moreover, if the emergency vehicle is detected, and the system stops its normal operation and turns the respective signal green immediately and it remains green until that particular vehicle passes through that intersection. In addition to this, case if there is fire is detected on the road, the microcontroller communicates with the respective local server through which it goes to the centralized server and then this information goes to the respective department through a mobile application. The flow, how the system calculates the signal time according to the situation,and is represented in Figure 4.

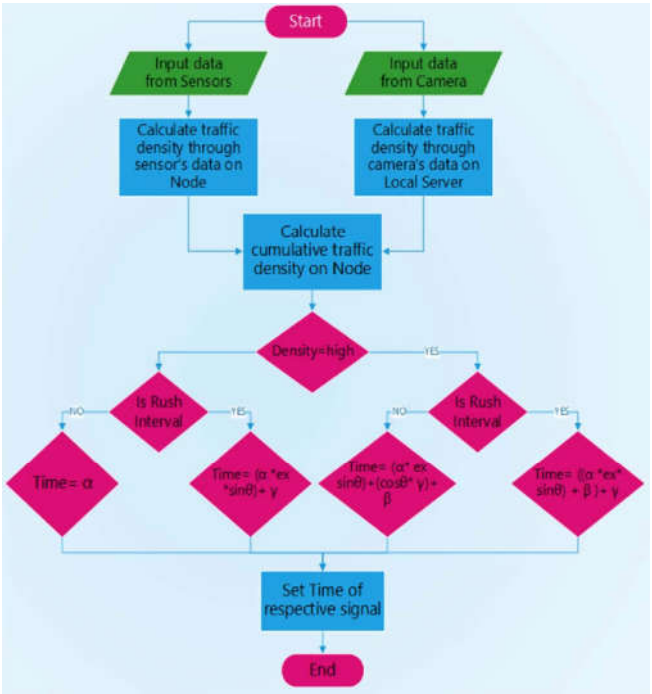

Figure 4: Flow Chart of Traffic Management System

3.3 Application and Actuation Layer

In this layer, there are two types of information delivered i)duration of a green signal from node to traffic signal and ii) daily, weekly, monthly and yearly reports provided to the administrators of the smart traffic management system through the web application from a centralized server. First of all, the system calculates rush interval by using Regression Tree algorithm the data saved at the local server and updates this report to the centralized server on the daily basis (after 24 hours).[2]

The rush interval ion the road is time span of about thirty minutes. This report is then displayed from the web application to the administration of smart traffic management system which takes data from the centralized server, and it shows daily, weekly, monthly and yearly graphs of rush intervals happened so far in the road. This graphical data is fruitful for the longer term road coming up with and resource

management. second within the feat module, whenever the rush interval is known, the native server intimates to the several microcontroller in conjunction with the road id. After receiving the rush interval intimation, the decision-making module updates the duration of the green signal to the respective traffic signal.In this modern world, wherever time is cash and wastage of your time don't seem to be cheap, there's a necessity to understand the traffic condition on the actual road before travel on it road by exploitation mobile application.Moreover, this system is also capable of managing emergency situations like if the smoke and fire are detected on the road. If the system detects fire on the road, which is detected by flame sensors and extensive smoke through smoke sensors, the system conveys to the nearby relevant department through a mobile application for further actions to take.[2]

4. Result Analysis

A prototype was developed to demonstrate the applicability of our proposed system. Many experiments are conducted on real traffic and data were collected to evaluate the efficiency of the proposed algorithm.The traffic density was monitored and calculated by vehicle detection as shown in Figure 5.
As present since the traffic density crosses the required threshold on a road, the system stops the traditional operation and keeps the green light on until situation of the road became normal. The real time information was additionally being sent to the local and central servers.[5]

Figure 5: Vehicles Detection

Besides this, a web interface was also developed for the authorities to show them the statistics of traffic on the roads so that they could make real-time and future decisions as discussed in section III. Figure 6 represents the statistical form of traffic data i.e. number of vehicles passed in a very explicit time span at a selected road. The bar graph is representing real-time traffic data. Different bar graphs representations based on real-time and historical data are produced in this application which is helpful for traffic department and other related authorities for i) managing traffic congestion's on roads ii) and future planning.[3]

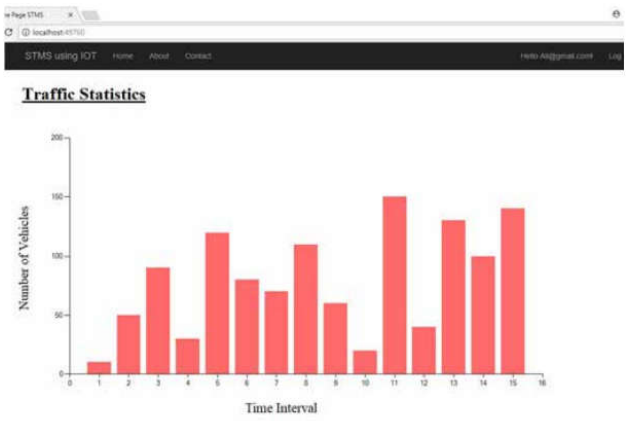

Figure 6: Statistical data on traffic

5. Conclusion

This research presents an effective solution for rapid growth of traffic flow particularly in big cities which is increasing day by day and traditional systems have some limitations as they fail to manage current traffic effectively. Keeping in view the state of the art approach for traffic management systems, a smart traffic management system is proposed to control road traffic situations more efficiently and effectively.The system updates the timing for the signal intelligently by analysing the traffic density on the particular roadside and control the traffic flow by communicating with local server more effectively than done before.[4]
The systematic approach makes the system simplified and effective as the system works even if a local server or centralized server were crashed. The centralized server of the system is able to communicate to the nearest rescue department in case of an emergency situation happened oh the road to ensure timely human safety. Moreover, a user can ask about future traffic level at particular road to avoid wastage of time in traffic jams.
The system also able to give useful information to higher authorities for road planning and to use the resources in optimal way.

References

[1] Mahesh Lakshminarasimhan, “Advanced Traffic Management System Using Internet of Things”
[2] Sabeen Javaid, Ali Sufian, Saima Pervaiz, Mehak Tanveer, “Smart Traffic Management System Using Internet of Things”
[3] Shraddha S. Kukade, Prof. U. W. Hore, “Intelligent Traffic Management System Based on Smart Internet of Vehicles: A Review”
[4] Sowmya M , Anusha P S , Ashwin S Murthy, Joy Steffi Jones, Lynette W Pinto , “IoT Based Traffic Management System”

[5] Yucheng Huang , Linbing Wang , Yue Hou , Wei Zhang , Yinning Zhang , “A prototype IOT based wireless sensor network for traffic information monitoring”

Author Profile

Aromal Balakrishnan received the BCA degrees in Computer Applications from Santhigiri College of Computer Sciences, Vazhithala in 2021.

Sebastian Cyriac received the MCA professional degree in computer science .Currently working as assistant professor in Santhigiri College , Vazhithala.