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Exploration of IOT based Intelligent Traffic Management System

Iwin Thanakumar Joseph S*, Department of Computer Science and Engineering, Karunya Institute of Technology and Sciences, Coimbatore, India.
C Sorna Chandra Devadass, Department of Civil Engineering, Samskruti College of Engineering and Technology, Hyderabad, India.
Arul Xavier V M, Department of Computer Science and Engineering, Karunya Institute of Technology and Sciences, Coimbatore, India.
Mythily M, Department of Computer Science and Engineering, Karunya Institute of Technology and Sciences, Coimbatore, India.

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Abstract:
The utilization of private vehicles increased in the past few years due to the advancement of technology and life style of the civilians causes hectic traffic complexities in the cities as well as rural areas across the globe. Huge traffic leads to an environmental pollution, unavoidable accidents and wastage of time due to traffic blocks and congestions. In recent years, the concept of Internet of Things (IoT) provides an excellent automated solution to all major applications. Thes technology provides an efficient traffic management system by means of its automated tracking, monitoring, processing and management. This research paper gives the complete overview of various intelligent traffic management system developed based on IoT to reduce the traffic congestions.

Keywords: *Internet of Things (IoT), Traffic Management, Intelligent Traffic, Traffic congestions.*

I. INTRODUCTION

In the past few years, urban traffic becomes more complicated and crowded due to the popularity and utilization of private vehicles among the civilians all over the world. This result in a huge traffic congestion during the peak times and also paves the importance of effective traffic management system in order to avoid undesirable accidents, environmental pollution, time waste etc. Internet of Things (IoT) appears to be new trend setter for an intelligent traffic management due to the advancement of data communication through internet, cloud utilization and appropriate monitoring using various machine learning methodologies.

Effective traffic management system will help to reduce the traffic tensions among all kind of civilians such as

1. Vehicle drivers
2. Elderly peoples
3. Ambulance (Emergency situation)
4. Shipping services

The main advantage of utilization of IoT for an intelligent traffic management describes below

1. Release of traffic pressure among civilians
2. Dynamic traffic information to travelers
3. Optimized route to reach the destiny
4. High reliability
5. Traffic safety
6. Traffic control and solutions independent of weather conditions.

January - February 2020
ISSN: 0193 - 4120 Page No. 4651 - 4658

These kinds of intelligent traffic management system based on IoT leads to smart city management in the future. The IoT system includes all the details of the traffic elements like bridges, roads, tunnels, traffic signals, vehicles, drivers through gadgets etc. All the elements are connected to an internet for an effective management of the traffic system in the entire urban area. It includes effective traffic information acquisition, suitable processing, analyzing various conditions and categories of bulk traffic information in the crowded area leads to the modern traffic management. The rest of the research paper gives the details of various IoT based intelligent traffic management systems, its advantages and limitations, finally concludes with the future scope.

2. INTELLIGENT TRAFFIC MANAGEMENT SYSTEM

An IoT based intelligent traffic management system is broadly classified into three categories as mentioned in the overall block diagram given below:

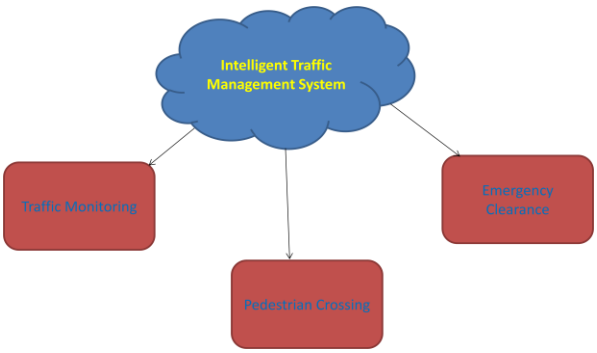

Figure 1 : Overall view of Intelligent Traffic Management System

Traffic Monitoring System

Traffic monitoring is one of the major factors in the smart or intelligent traffic management system. It deals with vehicle to vehicle communication and vehicle to various infrastructure communications for enhancing the availability of road ways to the user instead of construction of new road ways that needs major financial budget from the government for construction and maintenance. Here we discuss few IoT based traffic monitoring system architecture put forward by several researchers.

Figure 2 : a) Traffic Monitoring b) Traffic Congestion
Source : Wikipedia

Pampa Sadhukhan and Firoj Gazi (2018) [1] put forward an IoT based intelligent traffic congestion control system for road crossing to reduce the urban areas road congestions. This architecture has two major modules

1. Traffic Density Monitoring Module (TDMM)
2. Traffic Management Module (TMM)

The major work of traffic density monitoring module is to measure the distance of the vehicle crowd created from the cross over point to fix the traffic congestion density. The three different traffic congestion measures are

- High
- Medium
- Low

The main work of traffic management module is to set the traffic signal timings based on the traffic density measured during the traffic density monitoring module.

Senthil Kumar Janahan et al (2018) [5] proposed a clustering algorithm based on KNN based model for an effective management of traffic signals in the urban areas in order to reduce the crowded traffic in the peak times. The architecture for traffic monitoring system built with number of infra red sensors, micro controllers connected with android application for effective traffic management and also used KNN algorithm to predict the traffic density and based on that increase or decrease the traffic

January - February 2020
ISSN: 0193 - 4120 Page No. 4651 - 4658

signal timings to flow the smooth traffic in the peak areas. This architecture has three basic modules

1. Android application
2. Server side communication
3. User communication

Manikanta et al (2018) [3] proposed a novel IoT based intelligent traffic information system using integration and agent technology to reduce the traffic congestions. The framework consists of three layers

1. Application layer
2. Network layer
3. Acquisition layer

The main functionality of the application layer includes collection, storage and process of traffic data to give the visualizations like

- Analyze the dynamic information received from acquisition layer for different conditions
- Present the traffic interface to users

Application layer has following modules:

1. Intelligent driver management subsystem
2. Vehicle guidance and road information management subsystem
3. Intelligent traffic management subsystem
4. Information collection and monitoring subsystem
5. Information service subsystem

The network layer consists of various private networks, wired and wireless network, WiFi, WiMax, GPS, GPRS, corporate networks. This layer is used for transmission of high reliable and secure data.

The future work mainly concentrates on the security of IoT objects in the traffic management system and another way is analyzing and processing of diverse data to provide efficient dynamic traffic management system.

Thiyagarajan et al (2014) put forward an internet of things based intelligent transportation system to provide an intelligent traffic management. It consists of three modules:

1. Sensor system
2. Monitoring system
3. Display system

The major role of the sensor system is to get the informative data and transfer it to the monitoring system. It is further classified into three subsystems

- Location subsystem
- Commuter subsystem
- Ambience subsystem

The use of the display system is to display the result obtained from the context data to the public for the further decision of the users.

Guangquan Fu et al (2015) [4] proposed an architecture of intelligent traffic control based on the internet of things. Here the traffic signal timing is optimized. System architecture has three layers

1. Data collection layer
2. Network layer
3. Application layer

Data acquisition is carried out by RFID, radar, other infrared detection method and the data is carried to other terminal using network transport layer and application layer is used for processing huge amount of data and build the intelligent display system.

The main intension of traffic signal control is to enlarge the intersection efficiency usage and to satisfy the transportation need of intersection. Here vehicle delay is an important parameter of measuring the traffic signal controlso that each module extract the data and minimize the average delay due to road conditions by using appropriate adaptive genetic algorithm. The enhanced method is used to reduce the drawbacks of traditional genetic algorithm in terms of convergence and the possibility of increasing the global optimization.

The steps of adaptive genetic algorithm is as follows

January - February 2020
ISSN: 0193 - 4120 Page No. 4651 - 4658

- Chromosome encoding
- Fitness function
- Genetic operator
- Stop condition

Megha H N and R H Goudar (2017) proposed next generation intelligent traffic management system and analysis for smart cities. The proposed architecture analysed where the traffic congestion in the city and also check the cause for that congestion and the intelligent algorithm identify the person who create the traffic congestion and intimation given to various officials to smoothening the traffic.

The algorithm works in the following basis

- Fix the cameras and sensors in the identified crowded places of the city for traffic monitoring
- Collect the datas from sensors and cameras and separate the data. The sensor datas are digital datas and the camera datas are images / videos.
- Once the data is separated, the sensor data is further analyzed since it is in the digital format.
- If there is heavy traffic i.e more than 100 meters vehicle queue is there at a particular signal point, the vehicle reaching the particular place will get the alternate path to travel towards the destiny.
- If there is any traffic violation notified, the camera data is checked for the vehicle number, type of vehicle, owner of vehicle for further intimation to higher officials for proper action.

Yangxin Lin et al (2017) [6] proposed the concept of intelligent transportation system, its challenges and further opportunities. Intelligent transportation system consists of

1. Physical layer
2. Communication layer
3. Operation layer
4. Service layer

Physical layer contains all major objects of transportation system including user, vehicle and infrastructure. It has the following functions

- Have a look of entire environment
- Control over functions of object in the environment
- Proper interaction with other objects.

Due to these functionalities, it has the information about traffic data and it react to the environment changes.

Communication layer gives the exact information to other subsystems connected in the architecture.In this architecture, communication layer works on four basic modules

1. Field – vehicle communications
2. Fixed point – fixed point communications
3. Vehicle – vehicle communications
4. Wide area wireless communications

Operation layer works as a backbone of the system and it collects the data, process it and translates it into useful information which can be utilized for further actions. It works on three major modules

1. Advanced Transportation Management System
2. Advanced Traveler Information System
3. Advanced Vehicle Control System

Service layer provides basic services to the users.

The major challenges and opportunities for future enhancement in the intelligent transportation system is given below

- Future inclusion of Internet of Vehicle (IoV)
- Handling multi source data in the environment
- Initiation of automated driving
- Security aspects in terms of data, device and vehicle

January - February 2020
ISSN: 0193 - 4120 Page No. 4651 - 4658

P Pyykonen et al [8] proposed IoT for intelligent traffic system during different weather conditions such as wet, dry, icy conditions etc. The entire system is categorized into four modules

1. Road side unit
2. Vehicle
3. Database
4. Mobile interface

The implementation of the entire intelligent transportation system includes following subsystems

- Tampere IoT ITS pilot
- Communication
- Friction monitoring

Aneesa Saleh et al (2017) [9] put forward an intelligent traffic control system which worked on the basis of image processing techniques to find out the traffic density. Canny edge detection algorithm is used to detect the vehicle. The architecture includes the following components for the data acquisition

- Traffic density camera
- Red light camera
- Red light camera sensor
- Infra red proximity sensor
- Traffic lights

This algorithm is implemented in real time smart traffic management of Nigerian transportation sector.

Pedestrian Crossing

One of the major consideration in the intelligent traffic management system is an efficient pedestrian crossing monitoring in order to reduce the hectic traffic issues in the urban areas and also to support the elderly peoples to walk without dependant on others to cross the major roads. There are several researches put forward to implement an efficient pedestrian crossing management using IoT support.

Figure 3 : Pedestrian Crossing

Source : Wikipedia

K Wang Eun An et al (2018) [12] proposed a pedestrian safe smart crossing system based on IoT with object tracking for the safe pedestrian crossing over roads. The architecture is built on three major modules

1. Preventing
2. Detecting
3. Rescuing pedestrian

It includes various sensors and CCTV for the effective identification of pedestrian crossing and initiate the system to stop the vehicle for few seconds until the civilians crossed the path way. The algorithm worked on the principle of background subtraction and if the resulted image is beyond the threshold, it initiates the system to take further action for the smooth pedestrian crossing.

Giovanni Pau et al (2018) [13] put forward smart pedestrian crossing management at traffic light junctions through a fuzzy based approach for an effective smart city traffic management. Author used fuzzy based solution coupled with dynamic traffic light management for pedestrian crossing. Real time decision can be efficiently performed by fuzzy logic even with partial knowledge about the situation. In past few years, lot of researches put forth for an enhancement of traffic light control. The utilization of intelligent setting and tuning methods enhance numerous intelligent transportation system based approaches for smart cities.

Hazarathaiah et al (2018) [14] proposed smart crossing for pedestrians using IoT for a smart crossing. The module includes IoT, node MCU, piezoelectric sensor, blynk cloud for a complete architecture.

The main advantage of this system is

January - February 2020
ISSN: 0193 - 4120 Page No. 4651 - 4658

1. Restriction of happening of accidents
2. Quick decision making during emergency situation
3. Use of low energy.

K Wang Eun An et al (2017) [15] put forward smart crossing system using IoT to reduce the number of accidents due to pedestrian crossing. The new architecture named smart crossing uses sensors, CCTV, illuminator and IoT devices to make the cross walk safe in the crowded urban areas. It provides the vehicle drivers for safe driving and the intimation about pedestrian crossing so that they can reduce their speed at appropriate time to reduce the possibility of accident. Even any accident happens, the system immediately inform to the control centre and it gives alarm to the concern for the rescue operation to save the lives. Smart crossing system reduces the wastage of energy in high factor.

Emergency Clearance

Life is precious in this world. Saving a life is equivalent to god's work. It is really a challenge for emergency vehicles like ambulance to cross the hectic traffic to reach the hospital to save the life of the patient in the crowded urban areas. This leads to lot of researches to pave optimized way to the ambulance during the emergency situations in the traffic areas.

Usha N S et al (2018) proposed a research article titled make a way for ambulance using IoT to provide an appropriate way of making path to emergency vehicles to pass through the crowded traffic. The system uses GPS module to monitor the ambulance arrival and use of sound sensor to find out the frequency of ambulance sieren. These modules are connected to the node MCU for making adjustment in the traffic light to make ambulance to pass the crowded traffic.

Ashit S Chitta and Dinesha P proposed priority management of emergency vehicles using IoT approach to deal effectively in an emergency situation. This algorithm efficiently worked for the prevention of emergency vehicles like ambulance, police vehicles, fire brigades got struck in the crowded traffic areas. Manual control or pre determined timers in the traffic light will not be able to support to clear the emergency vehicles if they struct in a heavy traffic crowd. It leads to an automated emergency vehicle clearing system for an intelligent traffic management. This system works with the RFID tag which installed in the dashboard of the vehicle during manufacturing. Based on the reading of RFID tag, the system prioiritize the vehicle and give separate way for the emergency vehicle to pass the heavy traffic areas without any delay in order to reach the destination at the right time to avoid losses.

S. Sasikala and Mohamed Nazeer (2018) proposed an article titled traffic signal management of emergency vehicle and health monitoring of in patient. This architecture works on two modules :

1. Intelligent traffic control unit
2. Health care monitoring unit

The following table gives the overall view of few recent research articles in the intelligent traffic management system based on internet of things (IoT).

Table 1 : Future Enhancement in Intelligent Traffic Systems

S.No	Author	Title	Future Enhancement
1	Pampa Sadhukhan (2018)	An IoT based Intelligent Traffic congestion control system for road crossings	Application in real time environment
2	C Manikanta (2018)	A novel IoT based Intelligent Traffic Information using Integration and Agent Technology	ensure the security against cyber attack or other infrastructure attack
3	Thiyagarajan (2014)	An Internet of Things based Intelligent Transportation System	NIL

January - February 2020
ISSN: 0193 - 4120 Page No. 4651 - 4658

4	Hasan Omar (2015)	Intelligent Traffic Information System based on Integration of Internet of Things and Agent Technology	Security of data and privacy of users
5	Guangquan Fu (2015)	The Intelligent Traffic Control based on the IoT	Peak time traffic congestion
6	Megha H N (2017)	Next Generation Intelligent Traffic Management System and Analysis for Smart Cities	system improvement to find validity of vehicle, pollution control etc
7	Senthil Kumar (2018)	IoT based smart traffic signal monitoring system using vehicle counts	communication of ambulance model with other base station to get free lane
8	Yangxin Lin (2017)	Intelligent Transportation System :Concept, Challenges and Opportunity	Transportation safety and mobility
9	P Pyykonen (2013)	IoT for Intelligent Traffic System	implementation of proper alert system
10	Aneesa Saleh (2017)	An Intelligent Traffic Control System	regulating revenues by connecting with government traffic regulating bodies
11	Aditi Avadhani (2017)	IoT based dynamic road traffic management for smart cities	Minimize the traffic accident
12	Harshini Vijetha (2017)	IoT based Intelligent Traffic control System	Accident alert message for rescue operation

3. CONCLUSION

This research paper gives the complete overview of the intelligent traffic system based on Internet of Things (IoT), its advantages and limitations with regard to the real time analysis of traffic congestion, pedestrian crossing and free path availability for emergency vehicles in urban cities and its future enhancement towards the intelligent traffic regulations and alert systems for the vehicles in the smart cities.

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January - February 2020
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