Traffic Management Using Sensors

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ABSTRACT

As amount of vehicles increasing on roads, problems like traffic congestion, pollution, accidents also increasing. Traffic congestion is a problematic situation that has been seen worldwide. Improper management of traffic increase the waiting time of vehicles due to which the motorist has to wait in lane for a long time which also causes problems like fuel consumption and air pollution. To solve all these traffic related problems, traffic need to be managed smoothly and smartly. The method that can help to solve these traffic related issues is called Smart Traffic Management System. This new method provide computing platform to the existing Traffic Management Technology. Many researches are going on and there are many existing Smart Traffic Management Systems. These Smart Traffic Management System use traffic flow sensors like IR Sensor, Induction loop, video processing, RFID's for managing traffic. This Paper offers general information of the traffic flow sensors that are mostly used in traffic management system for traffic monitoring. Each sensor has its specialization, characteristics and drawbacks. In this paper, our aim is to provide qualitative analysis of different traffic flow sensors. The Study also provides a way for selection of best technology for monitoring traffic intersections in real time.

Keywords: Induction loop, IR Sensor, RFID's, Traffic management system, video processing.

1. INTRODUCTION

Traffic is mainly refers to vehicles or transportation medium that are moving along the road in the particular area. Increase in population means more need of transportation, results in more traffic or congestion on the road. In modern society everyone wants quick mobility that required a proper management of traffic flow. Traffic management basically concerns the planning, controlling and routing of transport services. This management could be manual and automatic.

A. Traffic Management System

Traffic management Systems is a mean to regulate the flow of traffic. In order to avoid traffic congestion in urban areas and to improve the overall traffic efficiency, Smart Traffic management Systems is required. Smart Traffic management system is a traffic controlling tool to sense, integrate, analyze and process the information which takes some action with the goal of improving traffic flow. Traffic management Systems help to increase efficiency of transport system, improve safety, enhance mobility, increase economic productivity, reduces fuel consumption and environmental problems. Traffic control began in the early 18th century, in London (England). As early as 1722, across the London Bridge traffic control measure were taken to ensure instant movement of carthorse. At that time, crossing the bridge was seemed inconvenient due to the disorganized nature of the traffic activities. Three men were employed as public servants to monitor and direct individuals by Lord Mayor on the bridge. In early, 1860's New York City's Police Department was appointed to manage the reckless driving of horse-drawn buses within the city[1]. With the increase in population and needs of people, police officers were replaced by traffic signals. Over time with the advancement in technology, introducing advanced traffic control systems. There are mainly two ways by which traffic could be managed i.e. manually and automatically.

1) Manual Management

Manual Traffic Management requires man power to control the traffic. In manual traffic control strategy a trained personnel uses some informatory signs, regulatory signs, warning signs and road making to regulate the traffic flow. Basically traffic police law enforcement officers appointed for the above purpose. They use things like sign board, sign light and whistle to control the traffic. It will difficult for a single person to handle the traffic, when it is coming from every direction at once. Here we need more man power in manual traffic management which is highly inefficient and vulnerable to congestion and its related problems. Hence we need a better solution to control the traffic. Table (1) encapsulates the Advantages and Disadvantages for Manual Traffic management.

Table (1): Advantages and Disadvantages of Manual Traffic management System

Advantages:	Disadvantages:
• An officer can control of an individual corner better than any other means. • An officer is best at allocating time appropriately at any given instance. • An officer can give priority to emergency and public transportation vehicles. • An officer can use common since judgments at a moment notice. • An officer can handle varying left hand turn volumes better than any other signal control system.	• An officer must perform police duties. • A rookie officer is subject to a learning curve. • A veteran officer will have bad days on occasion. • An officer is much more expensive than an automated signal controller. • An officer is subject to being asked questions by the public. • An officer can be distracted easily. • An officer can become complacent over time. • It can be difficult to see an officer standing at the corner of the intersection. • An officer cannot coordinate his actions with officers at neighboring intersections.

2) Automatic Management

Automatic traffic signaling is based on electronic sensors and timers. Whereas traditional traffic signaling is based on fixed time cycle in which signal changes automatically as the value of timer changes. Since, Fixed Cycle traffic light system is very prone to traffic congestion hence an intelligent traffic light system is needed i.e. density-based traffic system.

It is very helpful to install traffic monitoring equipment's on road that can collect much more detailed information about traffic flow. The most common mechanism is usage of electronic sensors embedded on the road. There are different sensors technologies like Induction loop technology, IR sensors, RFID's, Image processing for monitoring traffic flow i.e. density count, prioritize emergency vehicle, detect stolen vehicles etc. There are mainly four components of Smart Traffic management Systems to control the congestion:

- First, Traffic detectors buried on road to collect the traffic data.
- Second, Central node to process the traffic data.
- Third, Traffic lights to manage the traffic flow.
- Forth, communication module provides communication between all components.

The array of traffic detectors collect the traffic data and tell to the central node the state of traffic flow on the road. The central node system in turn controls the lights to maintain flow of traffic. Fig (1) shows general of automatic traffic management system.

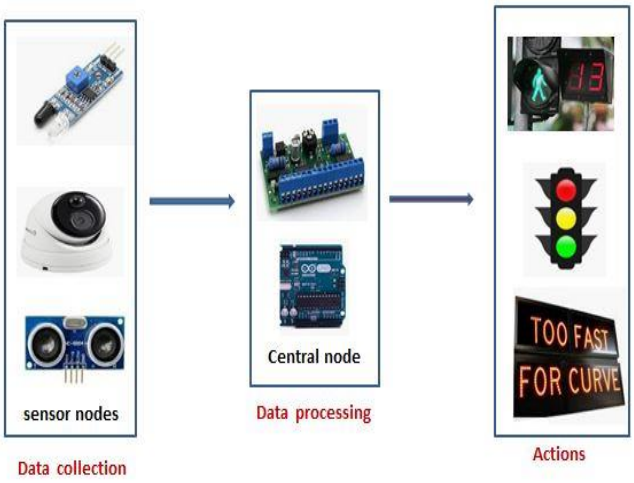


Figure 1: Automatic Management

Advantages for Automatic Traffic management system:

- Less expensive and easy to locate and understand.
- Reduces accidents on roads.
- More than one lane coverage is possible.
- Provides features like capacity, appearance, tenancy, movement and speed of vehicles etc.
- Can work day and night.
- Reduce accidents, decrease waiting time of vehicles while they are waiting in traffic and also reduce environment problems.

B. Need of Smart Traffic Management System:

Increase in population means more needs of goods and services. Population growth is most obvious reason of demand for transportation services which results in traffic congestion. Traffic congestion has great impact on the social and economic lives of the people due to time wasted while they are waiting in traffic. More congestion on roads will slow down the speed of vehicles, increases the waiting time and enlarge the vehicles lining. Emergency Vehicles are also affected by the congestion which may result in loss of lives. Hence Traffic management is becoming major challenge in cities and urban areas of India.

1) Heavy Traffic on road:

With the increase in traffic on road, congestion has increased over time in urban area. This is often seen at cross-road which mainly wasting time of people on road. The solution to this problem is to create the program-based traffic management system with different settings for particular lane. The lane that has high density should be setting longer time than the lane that has low traffic density.

2) There is no traffic on road, but still have to wait:

Despite having no vehicle on road, people have to wait for signal to be green which increases waiting time of vehicles and expand the vehicles lining. The reason behind this is that the traffic light remains red for the current time period because it is based on fixed time cycle. The solution to this problem is to create a traffic light control system that is based on vehicles density and synchronizes the signals accordingly.

3) High priority vehicle jammed in traffic jam:

Vehicular traffic increases rapidly which cause traffic congestion. Mostly the traffic control systems today are working on fixed time sequence and could not detect presence of emergency vehicles. During traffic jam, the High Priority Vehicle like fire brigade, ambulance and police stuck in traffic jam especially at the junction and delayed in reaching their destination. The solution to this problem is to make a traffic light control system that is based on vehicles volume and synchronizes the signals accordingly.

4) Air pollution and fuel wastage:

Due to large traffic congestions difficult situations like environmental damage and wastage of fuel also arises. The consequences and effects of traffic congestion range from Air pollution to Fuel consumption which slowdown the economic and health growth. The primary source of air pollution is Motor Vehicles. Every year 2 million premature deaths are caused by air pollution. With all these listed consequences the rapid motorization needs an efficient traffic monitoring and management system.

Section 2 described sensor technologies that are widely used in traffic management system. Section 3 discussed some past year research experiences of research judges on traffic management systems. Section 4 proposed a methodology for qualitative analysis of traffic management system. In the last Section 5 concluded all the aspects that are discussed in this paper.

2. TECHNOLOGY USED

Traffic management started with manual control, police officers were first traffic managers who control traffic flow on road. With the increase in population and needs of people, police officers were replaced by traffic signals. Over time with the advancement in technology, introducing advanced traffic control systems.

A. FIXED TIME CYCLE BASED TRAFFIC MANAGEMENT SYSTEM:

In order to improve the traffic management automated traffic control scheme was suggested. The automated traffic control system includes simple three colors i.e. red, yellow and green to control traffic flow. It is based on fixed time cycle. The time fixed to each lane remains constant throughout the day. However, automated signal control is less expensive, reduced traffic accidents, could operate 24-7 service do not affected by weather conditions, but automated signal control cannot detect emergency vehicles, stolen vehicle, cannot adjust to the current traffic volume which increase congestion. The consequences and effects of traffic congestion range from air pollution to fuel consumption which slowdown the economic and health growth.

B. SMART TRAFFIC MANAGEMENT SYSTEM:

The smart traffic management system is embedded with information and communication technology. The array of traffic sensors collect the traffic data and transmit it to the central node by using communication technologies. The central node system in turn controls the lights to maintain flow of traffic. Smart traffic management system can detect emergency vehicles, stolen vehicles, can adjust traffic lights on the basis of traffic volume. It can also reduce fuel consumption and air pollution by reducing waiting time of vehicles while they are waiting in lane. In smart traffic management system traffic monitoring is done by various sensor technologies like induction loop, IR sensors, video processing, RFID's etc.

1) INDUCTION LOOP:

Induction loop detectors are installed under the road i.e. Installation requires pavement cut. The main components of an induction loop detector are a detector oscillator that serves as a basis of energy for the detector, a lead-in cable, and single or multiple turns of insulated wire across the pavement.

Three types of loop detectors exist:

- Saw cut loop installation involves cut the roadway according to shape of loop, placing the loop wire in cutting area, cover-up the cutting area and shielding the wire.
- Trenched-in loops are installed under the roadway.
- The preformed loop is not fixed in roadway. The loop wires are sheathed in PVC pipe to hold their shape and guard them from harm caused by vehicles.

It Provides features like capacity, appearance, tenancy, movement and speed of vehicles etc. When vehicles move over a loop or wait on loop area, decrease inductance of loop and increase oscillator frequency. Existence of vehicles is detected when frequency change exceed the threshold set by the sensitivity setting [2].

2) IR SENSORS:

The IR sensor use light sensor to transmit the low powered energy in targeted area and detects reverberated energy from vehicles. The energy returned from targeted area is absorbed by an IR sensitive material which converts the returned and irradiates pulses into electrical signals. These electrical signals are analyzed and processed to obtain the occurrence and location of vehicles.

There are two types of infrared (IR) detectors:

- Active infrared sensors

Operate by transmitting energy using light sensor in targeted area.

- Passive infrared sensors

Detect energy emitted by objects and extract the desired information.

3) ULTRASONIC SENSOR:

The ultrasonic sensor release sound waves and sense reverberated signals from the object. The sensor measures the travel time of waves between the detection zone and the sensor. It uses the time gap between the emitted and returned sonic waves to detect the location of vehicles. Ultrasonic sensor can monitor multiple lanes. Ultrasonic detectors can detect density, classification, occurrence and speed of vehicle [2].

4) VIDEO PROCESSING:

Video image processors can monitor vehicles and provide more than one lane coverage. A video image processor system made up of:

- Single or multiple lenses to collect vehicular data.
- A microprocessor based system for processing the image data.
- Software for conversion of images into traffic flow data.

VIP's can classify vehicles by their length and report vehicle existence, density, lane coverage, and speed for each class of vehicles. VIP's have ability to record turning, movements of vehicles [2] Also ease of add, adjust and modify targeted area.

5) RFID'S:

Abbreviation for RFID is radio frequency identification, describes a system that use radio signals to detect an objects. RFID tags are easily found on rear windshield of vehicle. RFID is automatic object detection and data computing technology make the use of radio waves. Sensors plays main role to improve traffic management, RFID systems are used to track the status of objects like location, temperature, movements etc. sensor network act as a bridge between physical and digital world. RFID systems are of very small size and cheap, their lifespan is not limited by the battery duration. RFID sensor network has sensing, computing, and communication capabilities in a passive system[3].Data related to vehicles stored on an RFID tag which is a programmed silicon chip. RFID tags activated when come in contact with RFID reader. Once activated it send data back to reader. RFID tags are of two types, active and passive. Active RFID tag has its own power supply where passive RFID tags activated when come in contact with RFID reader. RFID system basically composed of three components.

- Programmable Silicon chip attached to vehicles.
- RFID reader having scanner with an antenna to transfer and collect signals.
- A controller that can be a host computer with microprocessor which collect the input and process the data.

Table (2): Strengths and Weaknesses of commonly use sensor technologies [4]

Technology	**Description**	**Strengths**	**Weaknesses**
Inductive loop	Induction loop detectors are installed under the road. When a vehicle cross over a loop or waits in a loop area, decrease the loop inductance and increase oscillator frequency. A presence of vehicles is detected when frequency change go over the threshold.	• Flexibility in design and easy to understand. • Experience based. • Provides features like capacity, appearance, tenancy, movement and speed of vehicles etc. • Not affected by bad weather conditions like rain, dust, smoke and snow. • Offers better precision for counting of vehicles when compared with other commonly used methods.	• Installation requires roadway cut. • Improper installation drops accuracy and roadway lifetime. • Installation and maintenance of induction loop system require lane near. • Wire loops affected by heavy traffic and high temperature. • No multiple zone detection feature is available • Accuracy drops when there is large number of vehicle classes.

IR Sensor (laser radar)	IR sensors consist of IR transmitter and receiver. Whenever the vehicle passes between sensors, the IR sensors can be activated.	**Active IR**	• Emits multiple light signals for correct accuracy about vehicle position, speed, and class. • Can detect more than one lane simultaneously.	• Sensitive to bad weather condition like fog, dust, smoke and heavy rain when visibility is less than =20 ft. or 6 m • Installation and maintenance, including regular sensor cleaning, require lane near.
		Passive IR	• More than one lane coverage is possible.	• Cannot sense vehicle in downpour, snow and dense fog. • Some models not suggested for detect occurrence of vehicle.
Video image processor	A video image processor system made up of single or multiple lenses, a microprocessor based system to process image data, and software for interpretation of the images and converting them into traffic flow data.	• More than one lane coverage is possible. • Easy to add, adjust and modify targeted area. • Enormous data availability. • Provides large area coverage when information collected by single camera can be connected to another.		• Installation and maintenance including regular lens cleaning, require lane near when camera is mounted over roadway. • Accuracy dropped by bad weather, vehicle projection into adjacent lanes, occlusion, and cobwebs on camera lens. • Necessity of street lights at night • Requires 30-50ft camera height for monitoring vehicular data. • Camera position is easily affected by gale.
RFID	RFID is radio frequency identification technology. RFID tags are easily found on rear windshield of vehicle. RFID is automatic object detection and data computing technology make the use of radio waves.	• Not affected by weather conditions like rain, dust, smoke and snow. • Offers better precision for counting of vehicles when compared with other commonly used methods. • Easy installation and cost effective. • No line of sight problems, waves can pass through solid walls. • Simple commands used in RFID tags. • Priority vehicle		• Security issue, may easily intercepted even after encryption. • Active RFID are expensive.

		detection. • Can work over longer distance. • Battery independent lifespan.	
Ultrasonic	The ultrasonic sensor release sound waves and senses reverberated signals from the object. The sensor measures the travel time of waves between the detection zone and the sensor to find out the location of vehicles.	• More than one lane coverage is possible. • Over height vehicle detection.	• Performance affected by bad environmental conditions such as temperature change and extreme air turbulence. • Few models are developed with Temperature compensation. • Large pulse repetition periods may decrease possession measurement.

C. COMMUNICATION TECHNOLOGY:

In smart traffic management system communication technologies are used to provide communication between all components. Communication module helps in the transmission of data and information from one module other. Table (3) summarizes some wireless communication technologies used in smart traffic management system.

Table (3): Wireless Communication Technologies[4].

Communication Medium	**Introduction**	**Characteristics**	**Frequency**	**Range**	**Throughput**
Wi-MAX **IEEE802.16**	Broadband wireless technologies use radio waves for data transmission.	High speed and serve number of users.	2to11GHz	<10 km	<75 Mbps
ZIGBEE **IEEE802.15.4**	ZIGBEE is an open worldwide Comm. Medium used in low-cost, low-power wireless IoT networks.	Mesh networks, Multiple protocol availability.	2.4GHz	<75 m	250Kbps
Bluetooth	Used for exchanging	High speed and Low power	2.4GHz	Class 1: 100m	v. 1.2:1 Mbps v. 2.0:3 Mbps

IEEE802.15.1	data between fixed and mobile devices over short distances using safe and free radio waves.	version available. No line of sight problem and supports one to one communication.		Class 2: 15to20m Class 3: 1m	UWB: 53–480 Mbps
UWB (Ultra-wideband) **IEEE802.15.3a**	It is radio technology that uses electronic waves with a very low power spectral density.	Very fast transmission of data between servers and handy devices. Can operate on low signal even if there is a noise ratios.	3.1to10.6GHz	10 m2 m	110Mbps 480Mbps
GPRS	Packet-based data communication technology.	Resource Utilization is high and less access time.	850/900/1800/1900 MHz	Dependent on service provider	56to144 Kbps
Wi-Fi (wireless fidelity) **IEEE802.11a; 802.11b/g/n**	System of wireless data broadcast that uses radio waves to provide wireless high-speed Internet and network connections.	High speed and ubiquity. Completely safe and it will not interfere with any network	5.8GHz 2.4GHz	100 m	11/54/300 Mbps
GSM	Digital cellular technology used for communication via mobile phones.	Large coverage, offer good spectral efficiency, High capacity and transmission quality.	850/900/1800/1900 MHz	Service provider Dependent	9.6Kbps
RFID	Uses radio waves for detection of objects carrying RFID tags.	No line of sight problems, waves can pass through solid walls. Low cost.	125KHz, 13.56MHz, 902 to 928MHz	Up to 3 m	9.6to115Kbps

3. RELATED WORK

In the last few years, many research judges have researched a lot on traffic monitoring technologies to make traffic systems good. Some more used technologies are discussed in this paper to provide an understanding of the level of research interest in traffic management technologies.

Purpose of paper [5] is to provide density based traffic control system. Inductive loop sensor is used for monitoring traffic flow. A prototype of multiple loop sensing system has been developed and tested by author. Test results shows, prototype successfully detected all type of vehicle and counted correctly. Stability of the proposed sensor system for any type of traffic has been established. The proposed system is suitable for road with any type of traffic. [6] Presented the use of inductive loops as an instrument to measure traffic density. Purpose is to find out solution of congestion related problem. Density based traffic control system proposed use induction loop as instrument to measure the traffic density. Microcontroller is programmed to receive information about traffic density.

[7] Proposed a system which is based on PIC microcontroller, evaluates the traffic density using IR sensors and accomplishes dynamic timing slots with different levels, ZIGBEE wireless system is used for secure communication. The system is complemented by portable controller for the emergency vehicles stuck in the traffic, the portable controller triggers the traffic master controller to the emergency mode and provides an open path until the stuck emergency vehicle traverses the intersection.[8] concerned with the development and implementation of Sensor based Traffic Light System with Dynamic Control which in turn decreases the waiting time of vehicles, when they are waiting in traffic. The system made up of IR sensors Low Power implanted controllers, comparators and storage device. The execution of Automatic Traffic Light system provides efficiently control monitor vehicles. Main feature of this system is that it is favorable to both environment and economy.

[9] Designed a traffic control system with the purpose to clear the traffic with density of vehicles by counting on the lane. System composed of IR transmitter, IR receiver and raspberry-pi. Model contains IR transmitter and IR receiver are placed in the possible direction on the roads. The vehicle count produced from raspberry data. Based on the number of vehicles density, the raspberry-pi decides and controls the traffic light signal time duration. [10]Goal is to make traffic management system work dynamically using IOT. Author provides automated IR sensor-based solution that makes traffic signals to shift lights automatically. Paper includes IR sensor WIFI transceivers and raspberry pi microcontroller. The denseness of the traffic is calculated and the timer display is shift dynamically, decreases the waiting time for the vehicles in the more crowded region and reduce the chance of congestion.

In this paper [11] author proposed a method for determining traffic congestion on roads using image processing techniques and a model for controlling traffic signals based on information received from images of roads taken by video camera. Model use MATLAB for image processing, ATMEGA8 microcontroller for controlling traffic lights and USART (Universal Synchronous Asynchronous Receiver Transmitter) module for sending control information to the microcontroller. Paper [12] Demonstrate about the project that design a smart traffic control system based on image processing. TLS is based on density count. Image processing is done in MATLAB with GUI using GUIDE. Project shows that image processing is efficient than traditional technologies and no need of extra hardware such as sound sensors. [13] Implement IOT based traffic control system in which signal timings are updated on the basis of density of the vehicle on particular lane. WIFI module is used for the transmission of vehicle count. Image processing is done in MATLAB with STIMULINK support. The whole vehicle counting is performed by raspberry pi. System is suitable for real time vehicle management, provide good performance and help to reduce traffic congestion.

Goal of this paper [14] is to design a smart and fully automatic system that will detect the congestion in real time, and subsequently manage it efficiently to ensure smooth traffic flow with the use of Active RFID devices. In this paper we have adopted the active RFID technology to automatically detect and

manage road traffic congestion in near real-time since it is cost effective, easily manageable and reliable. Moreover, this method provides comprehensive way of congestion detection and management as a whole while most other methods are restricted only to congestion detection. In this paper [15] author Proposed an efficient method for road traffic management which is automatic and use RFID technology for collection of vehicular data. The decision-making algorithm is used to detect and control the congestion which determines how the traffic light works. The system can function even in case where a reader in any path fails.. The paper [16] is intended to design a smart traffic control system interfaced with RFID and ZIGBEE module. The system can control the traffic based on the density of the vehicles present in each of the four lanes of the junction and thus green signal is given to the lane with highest density. The density of each lane is calculated by counting the number of vehicles, can detects the presence of emergency vehicles and will give immediate allowance to the emergency vehicle, Any stolen vehicle can be tracked, information of stolen vehicle updated through the server, it can also detect the information of the vehicle which jumps the signal during red light present in each lane by means of RFID. As this system is equipped with ZIGBEE transceiver module it is completely wireless .All the information generated at the system can be monitored through the server. [17] presented a design of a traffic monitoring system using RFID and implementation of system on a small scale is done by using a Raspberry Pi 3 micro-controller. Radio Frequency Identification (RFID) technology is used for automatically identify vehicle, collect data about them, and enter the data directly into databases.

Table(4): Summary of related work.

Author	**Proposed Approach**	**Sensor Technology**	**Communication technology**
Roy, Bandyopadhyay, Das, Batabyal, & Pal, (2010) [14]	• Traffic congestion detection and management	RFID	GSM technology
Sheik Mohammed Ali, George, Vanajakshi, & Venkatraman, (2012) [5]	• Sensing and counting of all kind of vehicles	inductive loop	Twisted pair wire cable
Chellani & Tahilyani, (2013) [15]	• Smart and automatic system that can detect congestion in real time and then manage it.	RFID	
Hasan, Saha, Hoque, & Majumder,(2014) [11]	• Dynamic traffic management system based on density count.	image processor	USART (Universal Synchronous Asynchronous Receiver Transmitter)
Ghazal, Elkhatib, Chahine, & Kherfan,(2016) [7]	Traffic control system: • Evaluate the traffic density. • Emergency vehicles detection. • Dynamic timing slots.	IR Sensors	ZIGBEE transceivers
Jagadeesh, Merlin Suba, Karthik, & Yokesh, (2016) [8]	• Provide density-based traffic lights control system	IR Sensors	Wired medium
Chitragar & Ramesh, (2016) [12]	• Traffic control system based on density count of vehicles.	image processor	

Shinde & Powar, (2017) [6]	Traffic control system: • Measure traffic volume. • Emergency vehicles detection. • vehicle Detection when it jump red signal	IR Sensors, inductive loop, radio transmitter-receiver	
K. K. Kumar, Durai, Vadivel, & Kumar, (2017) [9]	• Count density of the vehicles.	IR Sensors	
P. N. Kumar, Sasank, & Kranthi, (2017) [16]	• Vehicle density count. • Track stolen vehicle. • To detect emergency vehicle.	RFID	
Rani, Kumar, Naresh, & Vignesh, (2018) [10]	• IOT based Dynamic traffic management system.	IR Sensors	Wi-Fi transmitter
Basil & Sawant, (2018) [13]	• IOT based traffic control system based on density count	image processor	WI-FI transceiver module

This paper discussed the work of many researchers, who have presented many models of traffic control systems. These systems make the use of different types of sensor technology for vehicle monitoring. The ultimate goal of researchers is to reduce traffic related problems that people face on the road.

4. METHODOLOGY

Each technology has its own characteristics and flaws , due to which it is capable of doing some task and is unable to do some. No single technique can be perfect for all applications. The success of any application depends on choosing the right technique. The ability and performance of technology is based on lot of facts such as installation, reliability, durability, cost, maintenance etc . It is impossible to tell exact accuracy of any technique[18]. However, the comparison in Table (6) provide useful information for selecting a detector technology

A. Criteria for comparison:

To implement proper Intelligent Transportation System, we have different sensor induction loop, IR sensors, image processing, RFID's etc. The comparison of the sensor will depend on certain criteria. In order to implement proper Intelligent Transportation System, from above knowledge we have select some criteria for comparison of traffic flow sensor. Table (5) summarizes different criteria for comparison of traffic flow sensor.

Table (5): Criteria for comparison of traffic flow sensor

	Criteria	**Description**
1	**Capability**	Capability of sensors to collect some information like vehicle count, multiple lane detection (Coverage), communication bandwidth.
2	**Accuracy**	• ccuracy in normal weather condition. • ccuracy in bad weather condition.

3	**Emergency vehicle detection**	Detect presence of priority vehicle in lane if any.	
4	**Installation**	Orientation of sensor, placement of sensor, time cost equipment and manpower required for installing a sensor.	
5	**Maintenance**	Time cost equipment and manpower required for Maintenance of sensor.	
6	**durability**	Life span of the traffic flow sensor.	
7	**cost**	**Installation cost**	Investment on Installation of the traffic flow sensor.
		Maintenance cost	Investment on Maintenance of the traffic flow sensor.
8	**Power supply**	Power consumption of the traffic flow sensor.	

Smart Traffic light management system should be designed to enhance transportation system. In order for Traffic light management system to be effective, it should satisfy all the above listed criteria such as Capability, Accuracy, Emergency vehicle detection, Installation, Maintenance, cost etc.

B. Performance Comparison of Sensor Technology:

The sensor technologies used in Traffic Light Management System are compared with each other. Comparison is based on some criteria, shows how one technology different from other. Table (6) shows comparison between Induction loop, IR Sensors, Video processing, RFID's

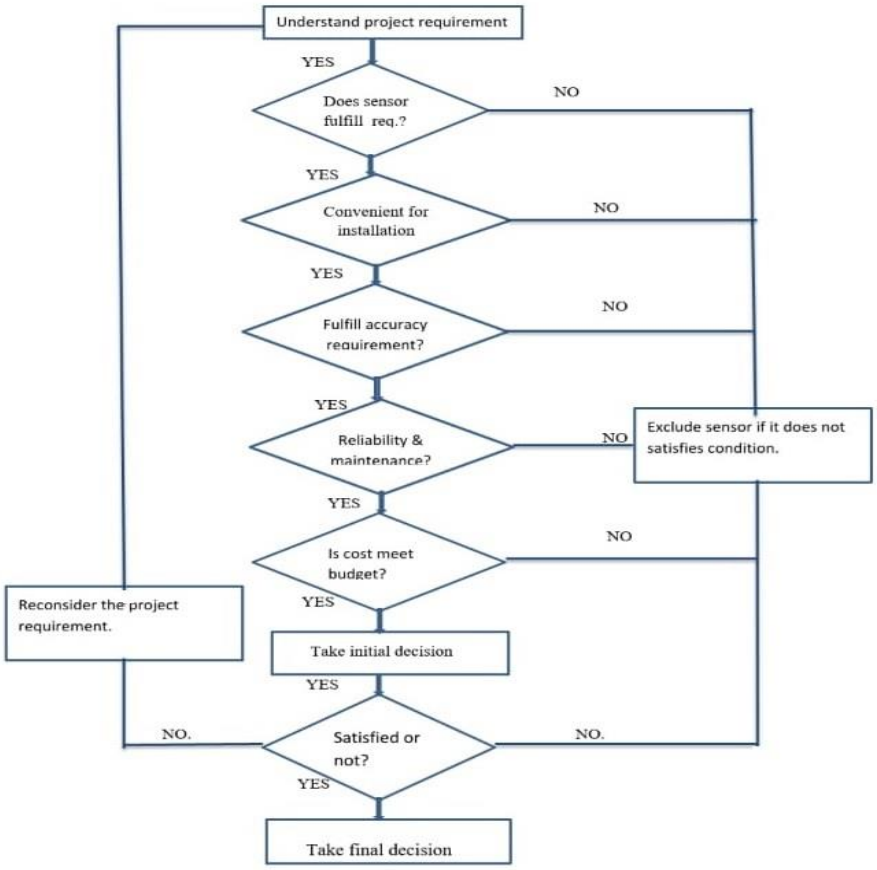
Table (6): Performance comparison of sensor sub-systems.

Technology / **Criteria**	**Induction loop**	**IR Sensors**	**Video processing**	**RFID's**
Capability	**Medium**	**Low**	**High**	**High**
Accuracy	**Medium** Improper installation decreases accuracy and pavement life	**Low** Sensitive to bad weather condition like fog, dust, smoke and heavy rain when visibility is less than =20 ft. or 6 m, installation and maintenance, including regular lens cleaning. Line of sight problem	**Low** Regular lens cleaning, Accuracy dropped by bad weather. Necessity of street lights at night etc.	**High** No effect of unpleasant weather. No line of sight problems, waves can pass through solid walls.

Emergency vehicle detection	**Low** Cannot prioritize vehicles.	**Medium** Can detect stolen vehicle.	**High** Priority vehicle detection.	**High** Priority vehicle detection.
Installation	**High** Installation requires roadway cut. Improper installation drops accuracy and roadway lifetime. .	**Low** Installation is easy but requires lane closure	**Medium** Installation is easy but requires lane closure. Requires 30-50ft camera height for monitoring vehicular data.	**Low** Installation is easy but requires lane closure.
Maintenance	**High** Require high maintenance because of roadways cracking, fault in wire insulation, poor application, poor electrical connections, also smashed by construction activities, Electronics unit failure. Wire loops affected by heavy traffic and high temperature.	**Low** Maintenance, including regular lens cleaning.	**Medium** Maintenance, including regular lens cleaning, Camera position is easily affected by gale.	**Low** Dose not Require high maintenance.
Durability	**Low** 5 to 15 years.	**Low** 8 to 10 years	**High** 20 to 30 years	**Medium** 20 years.
Cost	**High**	**Low**	**Medium**	**Low**
Environmental effects	**Low** Not affected by bad weather conditions like rain, dust, smoke and snow.	**High** Sensitive to bad weather condition like fog, dust, smoke and heavy rain when visibility is less than =20 ft. or 6 m.	**High** Accuracy dropped by bad weather. Necessity of street lights at night etc.	**Low** No effect of unpleasant weather like rain, fog, and snow.

C. Selection procedure

The Sensors technologies used in Traffic Light Management System, each has its specialization, strengths and weaknesses. Hence selection of best technology for Traffic Light Management System is an important task. Here selection is based on the performance of the sensor technology. In Fig. (2) Flow chart shows a methodology for the selection of best technology for Smart Traffic Management System.



Figure(2): Procedure for the selection of sensor technology.

5. CONCLUSION

With the huge increase in population, demand for transportation also increases day by day. Road traffic is the major issue worldwide, smart traffic management system will be a great tool for dynamic solutions of the modern-day traffic problems. Manual traffic management requires more man power and subsequently subject to more risks. The automatic traffic management overcomes all the bane of traditional approach and provides an effective solution to traffic problems. The need of smart traffic systems is because of the problems like heavy traffic jams, long waiting time, emergency vehicle stuck in traffic jam and air pollution and fuel wastage. These management systems included utilization of IR Sensor, Induction Loop, Ultrasonic sensor, Video Processing, RFID's tag and RFID readers. The techniques of "Internet of Things" has been used in data collection, which provides Real time data and information about congestion, emergency vehicles, stolen vehicles etc. Application, strength and weakness were discussed in table 2.1. The communication technologies used in smart traffic management systems such as Wi-MAX, ZIGBEE IEEE, Bluetooth device etc. are explained with feature, frequency, range and throughput. The comparisons of the sensor technologies are done in order to see the efficient working of technologies. The selection procedure for the best technology is well interpreted with the help of a flowchart. The aim of these techniques is to reduce congestion, to decrease waiting time of vehicles, to reduce vehicular air pollution caused by the smoke emanating from the vehicles when vehicles are stuck in the leave at cross road junction, reduce rate of accidents, priority for energy vehicles can also be assigned through smart traffic systems.

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