Application of wireless sensor networks in Mumbai traffic control

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Abstract **- Wireless sensor network (WSN) refers to a group of spatially dispersed and dedicated sensors for monitoring and recording the physical conditions of the environment and organizing the collected data at a central location. (WSN) is an important and exciting new technology with great potential for improving many current applications in medicine, transportation, agriculture, Intelligent transportation systems (ITS) etc .We can also Use it in traffic analysis, monitoring and control. With the reduction of power consumption and cost of instruments and maintenances, it's ready to install over large-scale traffic areas and monitor roads in a much fine way, which is certain to bring some breakthroughs in the field of traffic monitoring. The aim of this paper is to study and analyze the wireless sensor network and its working and how it can be actually used in road traffic control with proposed algorithm of the paper.**

***Index Terms*— Wireless sensor network , sensors for monitoring, Intelligent transportation systems (ITS)**

I. INTRODUCTION

Essentially, traffic systems have different parameters. The traffic parameters on the different sections of the road are different, because the propagation of traffic flow is dependent on the influence of drivers' personality and skill, pedestrians crossing the roads, intersections of minor roads, accidents and so on. The precision and robustness of traditional traffic forecasting methods cannot meet the requirements of developing traffic control and guidance technologies.

Wireless sensor networks (WSN) are new emerging technologies which contains working of wireless communication and tiny sensors. WSN is a kind of monitoring networks consisting of a large number of low-cost, power-saving, highly integrative and self-organized sensor nodes and network coordinators.WSN is widely used technology now a days it is being used in military, urban management, biomedical treatment, environmental monitoring and remote monitoring of dangerous areas.

As we know vehicular traffic is constantly increasing around the world, especially in cities like Mumbai. Therefore existing traffic management solutions become inefficient. This can be clearly seen in our

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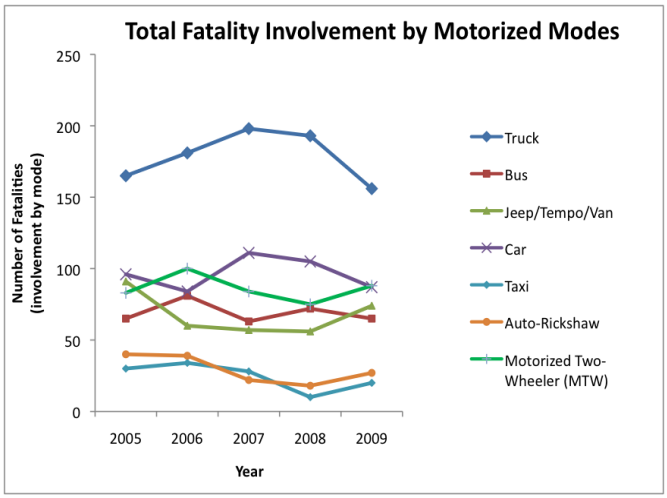
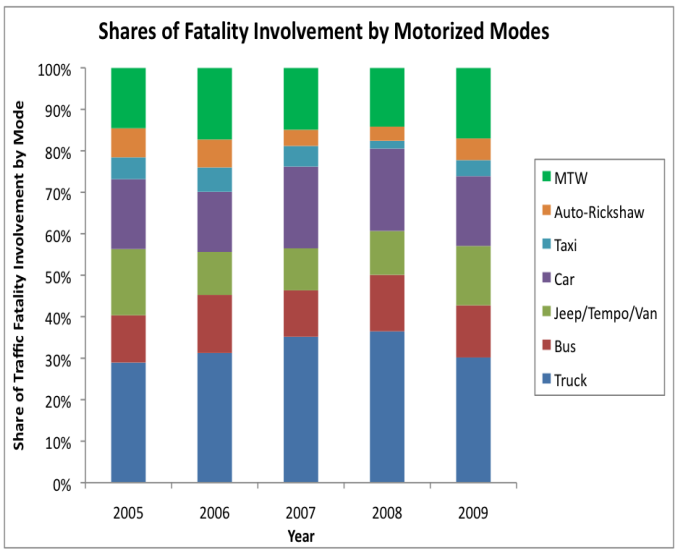
life through persistent traffic jam and rising number of accidents. Wireless sensor networks (WSN) based intelligent transportation systems (ITS) have emerged as a cost effective technology that have potential to overcome these difficulties. This technology enables a new broad range of smart city applications around urban sensing including traffic safety, traffic congestion control, road state monitoring, vehicular warning services, and parking management.

II. CURRENT TRAFFIC CONDITIONS

Discussion of the road safety issues surrounding motorized transport modes should focus not just on the safety of in-vehicle passengers (passengers using the motorized modes) but also on how motorized modes affect the safety of other non-motorized users of the roadway system, such as pedestrians and cyclists.

Mumbai Road Fatality Data: The Mumbai Traffic Police maintains records of involvement of motorized road transport modes in accidents and their contributions to fatalities. The figures below show historic trends (2005 to 2009) in the contribution of the various motorized modes in Mumbai to road traffic fatalities. This data includes all fatalities, both in-vehicle as well as pedestrians and cyclists. Since contributions to just pedestrian fatalities were not available, it was assumed for this analysis that the relative contribution of motorized modes to pedestrian fatalities would be the same as that for all fatalities. This assumption is corroborated by the fact that, in 2009, more than 70% of the road fatalities in Mumbai were pedestrians, according to traffic police data .The figures below show that auto-rickshaws and taxis have consistently had the lowest involvement in (and contribution to) road fatalities in Mumbai compared to all other motorized modes.





III . ARCHITECTURE OF WSN

Wireless sensor networks which are made of basic components like microcontroller , transceiver , external memory , power source and one or more sensors.

WSN consists of simple and cheap motes which are able to sense, preprocess and transmit defined data to nodes in which processing of data is finished and suitable action signal is generated and realized. Data

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could be sent in proper format to operator or users of transportation system as well.

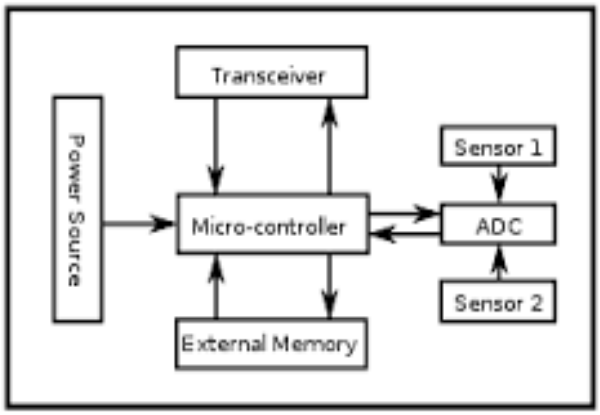

Fig 1. Architecture of WSN

Components Of WSN :

1. Controller

The controller performs controlling tasks such as processing data, calculations and controls the functionality of other components in the sensor node. There are some options for controllers. In which microcontroller is widely used. other alternatives that can be used as a controller are : A general purpose desktop microprocessor, Digital Signal Processor, FPGAs which are good for testing and ASICs are used when performance must be best . A microcontroller is often used in many embedded systems such as sensor nodes because of its low cost, flexibility to connect to other devices, ease of programming, and low power consumption. A general purpose microprocessor generally has higher power consumption than a microcontroller , therefore it is not suitable for sensor nodes. Digital Signal Processors (DSPs) may be chosen for broadband wireless communication applications, but in Wireless Sensor Networks the wireless communication is not that much complicated. Ex of microcontrollers are Texas Instruments MSP430, Atmel ATMega

2. Transceiver

Sensor nodes often make use of ISM band, which gives free radio, spectrum allocation and global availability. Options for wireless transmission media are radio frequency (RF), optical communication (laser) and infrared. Lasers require less energy, but need line-of-sight for communication and are sensitive to atmospheric conditions. Infrared, like lasers, needs no antenna but it is limited in its broadcasting capacity. Radio frequency-based communication is the most relevant that fits most of the WSN applications. WSNs tend to use license-free communication frequencies: 173, 433, 868, and 915 MHz; and 2.4 GHz. The functionality of both transmitter and receiver are combined into a single device known as a transceiver. There are some states of transceiver such as transmit, receive, idle, and sleep.

3. External memory

Two Types of memories are required for storing data and for processing the data. Therefore on-chip memory is used for microcontroller and flash memory is used for RAM for processing. Memory requirements are are always dependent on applications used.

ISSN: 2278 – 1323

4. Power source

Requirement of wireless sensor nodes are in such conditions where there is difficult to continuous mains supply to nodes. Wireless sensor nodes often used and installed in places where regular maintenance of power source or battery is difficult. In case of sensor nodes power is required for sensing conditions, communicating with other sensors and controllers, and processing of data. Between these three processes communication requires more power. The energy cost of transmitting 1 Kb a distance of 100 meters (330 ft) is approximately the same as that used for the execution of 3 million instructions by a 100 million instructions per second/W processor.

Here the power is stored in batteries and capacitors. Both rechargeable and non-rechargable batteries are main source of power supply. Current sensors are able to renew their energy from solar sources, temperature differences, or vibration.

5. Sensors

Sensors are hardware devices senses changes in physical condition such as temperature, pressure, volume, vibrations etc. and are Flexible, dependable, low-cost, the Sensors Networks wireless vehicle detection system uses magneto-resistive wireless sensors to detect vehicle presence and movement. It should be small, which can work in low energy, can operate unattended and adaptive to environment. It stores and measures physical data of parameter it is going to monitor. Sensors produces analog signals it is converted to digital signals by analog-to-digital converter and sent to controllers for processing. As wireless sensor nodes are typically very small electronic devices, they can only be equipped with a limited power source of less than 0.5-2 ampere-hour and 1.2-3.7 volts.

IV . HOW WSN CAN BE USED IN TRAFFIC CONTROL

For effective traffic control management using WSN it is very important to collect information about flows of traffic and transportation infrastructure parameter. For relevant information gathering Wireless sensor network is widely used. WSNs are becoming an integral subsystem of
most of ITS.

Wireless Sensor Networks (WSN) is an efficient technique to detect traffic and remote control management. These systems uses nodes installed at sides of roads which detect traffic using their dedicated sensor network and this information is passed to central server at the control centre .
The major advantage of using wireless sensor networks is that they have their own dedicated network for detection of traffic and transfer of information. So availability of traffic information will be fast as compared to other networks. But maintenance and implementation of these types of networks would involve considerable amount of efforts and cost. Short range wireless communications techniques are used for communication of sensors. These techniques are :

i) Bluetooth : Bluetooth is a type of wireless communication used to transmit voice and

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data at high speeds using radio waves. It is a standard protocol for short-range radio communications between many different types of devices, including mobile phones, computers, entertainment systems and other electronics. Devices need to be within approximately 10 meters of each other, and the typical data transfer rate is around 2 megabits per second (Mbps).

ii) Infrared : Infrared (IR) light is electromagnetic radiation with wavelengths that are just beyond those of visible light. The human eye can see light in the wavelengths from approximately 390-700 nanometers. Infrared light has wavelengths from 700 nanometers to 1 millimeter

iii) Zigbee : It is used for short-range, low-power digital radio communications. Compared to Bluetooth and infrared light zigbee uses very little power and low data rate. Also zigbee modules can be installed at lower cost and longer battery life.

Vehicle detection is accomplished by measuring changes in the local magnetic field by passing vehicle. Wireless Vehicle Detectors (WVDs) calculates vehicle velocity, length, type and occupy rate rapidly and send these information to wireless Access Points (WAPs).These Access points works as central control point which collects data from all WVDs and controls network. These information is processed and forwarded to central traffic management systems, remote traffic information systems, or signal controllers.

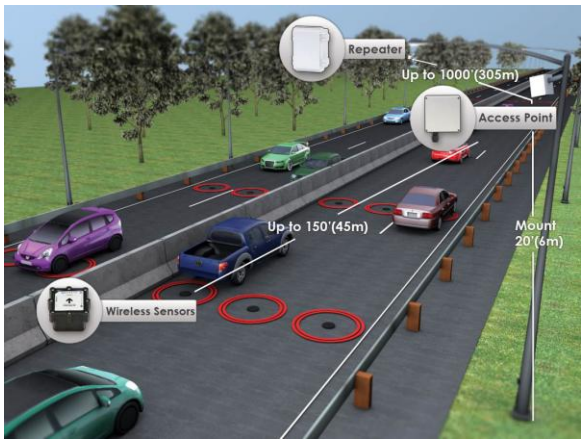

Fig 2. Installation of sensor nodes on roads

V. USE OF WSN IN INTELLIGENT TRAFFIC LIGHT SYSTEM

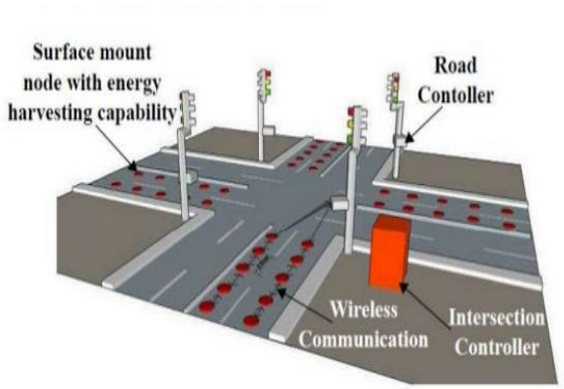

Fig 4 . System Architecture at road intersection

Proposed algorithm considers a scenario where there is road controller, intersection controller, sensor nodes places. The following algorithm is proposed on time and priority constraints.

Each intersection point has its own database to store the information regarding the vehicles that passed from it with timestamp and traffic light

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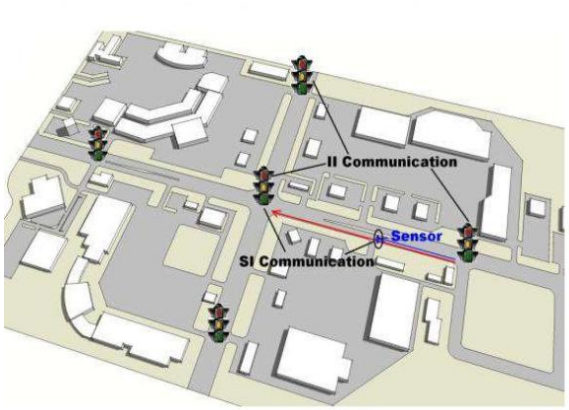

Fig 5 . Sensor detection and communication with neighbors

Entire communication is carried out wirelessly with ISM band .Each road side sensor will communicate with controller every intersection will communicate with next intersection.

Priority: In the proposed algorithm, different types of vehicles have the different priorities. The total vehicles are divided into 4 categories: First system category includes Ambulance, Fire Brigade vehicles and V.I.P vehicles. These vehicles have the highest priority. The second category includes the buses and school & college buses. These buses need to reach their destination on time so these vehicles also need a fast service. Third category includes the car, motor cycles and scooters and fourth category include the Heavy vehicles. Day time priority of 3rd category is high as compare to 4th category but during night hours the priority of the heavy vehicles high.

For deciding priority and detecting emergency vehicle we can use wireless acoustic sound sensors. As road standard rules Honk intensity of emergency vehicle is 128dB and transportation vehicle's intensity is 86 dB. Acoustic sensing is done by setting threshold value. Thus difference is made between emergency and transport vehicles.

These sensors are arranged up to 300 to 400 meters from intersections.

Algorithm:

1. Periodically status of the lane is transmitted to controller

2. Controller receives the signals and priorities are compared

3. If the Emergency vehicle is present
   3.1 Assign green light priority

4. If more than two emergency vehicle present
   4.1 Calculate their distance from intersection of road
   4.2 Give the highest priority which is closest to intersection
   4.3 Assign green light priority

5. If priorities of vehicles are same then vehicles waiting for long periods are given the priority

6. If traffic in left lane , green is given for straight direction, based on Traffic, either right side neighbor is given green for right direction, or opposite road is give green for straight direction

7. If Traffic in right lane, green is given for right and based on traffic, left side neighbor is given for straight or opposite is given green right.

ISSN: 2278 – 1323

Implementation: This system can be implemented by just installing the sensor nodes into the road sides interfacing the central microcontroller to the existing signal lights and connecting the sensor nodes to the controller. The sensed data is transferred, via the wireless network, the area of coverage of each vehicle and its distance is calculated. The area of coverage is a measurement of the quality of service of a sensor network.

VI. CONCLUSION

The main aim of this research paper is to give the basic information about rapid developing WSN technologies, By using WSN nodes presence of vehicle, velocity, distance is rapidly calculated and transferred to information system at high speed. As a result, the urban traffic network with distributed parameters will become more measurable and controllable.

VII . REFERENCES

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