INCREASING SAFETY AND ROBUSTNESS IN TRAFFIC CONTROLLING CIRCUMSTANCES USING WSN

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***Abstract*: Vehicular Traffic is increasing rapidly which leads the traffic management system inefficient. This is realised with the steady increase in Traffic Congestion and rising number of daily road accidents. WSN based Traffic control system has emerged as a best way to monitor traffic, Traffic Safety, Vehicular Warning System, Road State Monitoring services etc.WSNs are very trendy due to their faster transfer of information, easy installation, less maintenance, compactness and for being less expensive compared to other network options.This paper presents a review of current Traffic management schemes for priority-based signaling, and reducing congestion. The main objective of this proposed research is to provide taxonomy of different traffic management schemes used for avoiding congestion and existing Traffic management schemes for the avoidance of congestion, increasing robustness and providing priority to emergency vehicles increasing Safety of Traffic Controlling circumferences.**

***Keywords*: Wireless Sensor Networks (WSNs), emergency vehicle priority, traffic congestion, Priority-based Signalling, Robustness of Traffic Control System.**

[1] INTRODUCTION:

Over the years vehicle usage has increased exponentially worldwide. Due to this, road traffic conditions have become complicated and chaotic. By improving the operations in traffic management systems, safety and efficiency of transportation systems will increase. A common traffic control system utilizes static signalling times at intersections and does not provide priority to emergency vehicles such as ambulances, fire-fighters and police cars, possibly causing a loss of lives, damage or destruction of property, and increased fuel costs, pollution and congestion. An Intelligent Traffic Management System aims at managing traffic effectively during emergencies through the use of cutting-edge communication and processing technologies and appropriate intelligent system algorithms.

In the present state-of-the-art, a wireless sensor network is a promising technology that offers a solution for the design and development of a good deal of traffic control system applications. The sensor network consists of a sensor and gateway nodes. The duty of the sensor node is to monitor traffic in an allocated area, utilizing different devices that can measure several physical traffic parameters like flow, density, volume, headway, waitingtime, throughput, as well as pollution. The gateway node collects the traffic information from all the nodes and directs the same to the base station.

The WSNs have attracted wide interest from academic and industrial researchers due to their lower maintenance, low price, and usage in a wide-ranging application areas, such as health, the military, industry and the home. The exclusive characteristics of WSNs include the mobility of sensor nodes, the ability to withstand harsh environmental conditions, node failures, low power and scalability.Advances in embedded systems and wireless technology give birth to wireless sensor networks (WSNs), which are composed of cheap and tiny devices that communicate wirelessly and sense the surrounding environment. Each device node contains sensors, a processor, a memory, a radio, and energy source as depicted in Figure.[1].With WSN, different types of motes can be used to sense, process and transmit data tooptimally manage complex situations and enabling real-time adaptive traffic control systems

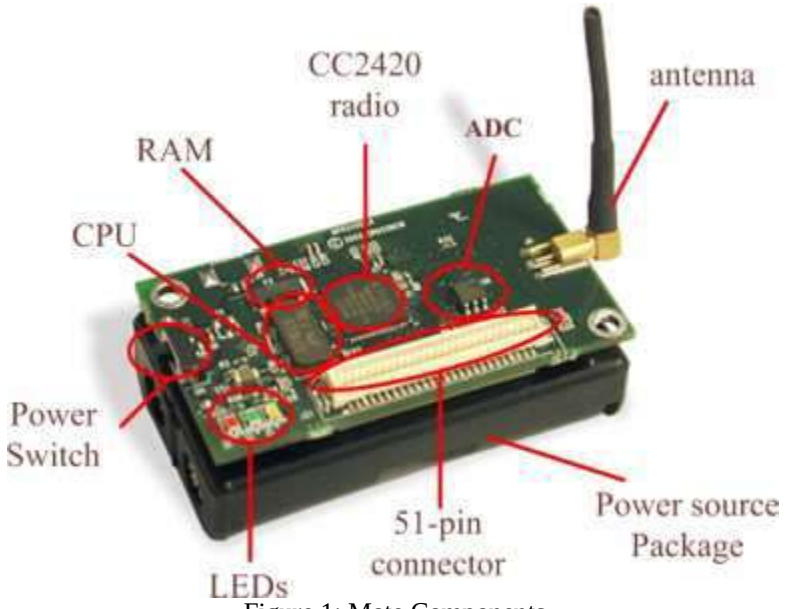

Figure 1: Mote Components
Source:Mohamed Amine Kafi et al. / Procedia Computer Science 19 (2013) 617 – 626

This Paper gives a review of WSN based ITS(Intelligent Traffic System) for both on-road and/or in-vehicle sensors. The ITSs attempt to manage optimally the urban traffic by enhancing safety, reducing travel time and fuel consumption at the aim of improving our daily life. It works as a control loop system where it senses traffic and road conditions using surveillance or detection system. The gathered information is communicated to the decision system to be organized and analysed in order to take appropriate decisions.WSN based ITS can be deployed in many application scenarios and may fit into many categories or diverge slowly from existing ones. So, applications' categorization has to be flexible because answering the needs of the operators and end users is the first goal of tracing classification.
As the purpose of ITS is traffic monitoring and management to improve life quality, ITS applicationsclassification can include:

1. **Drivers' safety:** Its principle is to transmit information related to accidents and weather in order to reduce the number and severity of crashes that lowers the number of deaths and injuries. It can be also used to guide ambulances and fire trucks.
2. **Traffic Management:** the goal of such system is to minimize congestion of the whole traffic network and optimize the use of road capacity. This is done through traffic optimization and real-time traffic light control.

[2] METHODOLOGY:

Traffic congestion is a burning issue in many cities due to an exponential growth of running vehicles. There are basically two types of traffic congestion. The first one is recurring traffic congestion, which appears at the same place during the same time every day. The second one is non-recurring traffic congestion, which occurs randomly like an unplanned event. This non-recurring effect can cause a sudden traffic volume increase. Detection of non-recurring traffic congestion is critical compared to the recurring type, because it requires real-time traffic information and evaluation thereof with appropriate traffic management decisions.Congestion is mainly due the inadequate capacity of the roadways to efficiently move the number of travelling vehicles on them.

A typical WSN-based Traffic Management System is depicted inFigure[2]. A scattered W-TMS application achieves four functions: (i) information collection; (ii) data diffusion; (iii) processing of data to plan the required activities; and (iv) implementation of the suitable actions. To carry out these functions autonomously, the TMS is equipped with wireless sensors, a Traffic Management Centre (TMC), a Road Side Unit (RSU) and On Board Units (OBUs) on vehicles. Sensors collect the real-time traffic information, like vehicle density, type of vehicle, average waiting time and pollution and relay the traffic data to the RSU. When an emergency vehicle approaches the intersection, the OBU directs that information to the RSU. The RSU gathers the data from all sensor nodes and OBUs and forward the same to the TMC. The schematic of a typical TMC is presented inFigure[3].

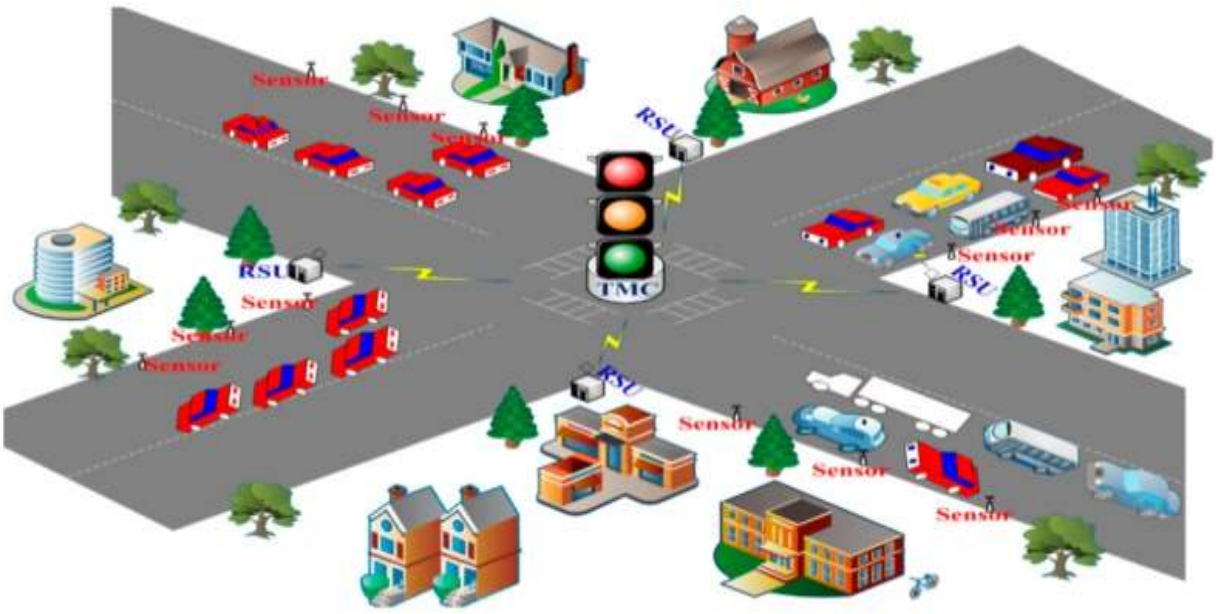

Figure 2: WSN-based Traffic Management System

Source: www.ncbi.nih.gov/articles/PMC4801535

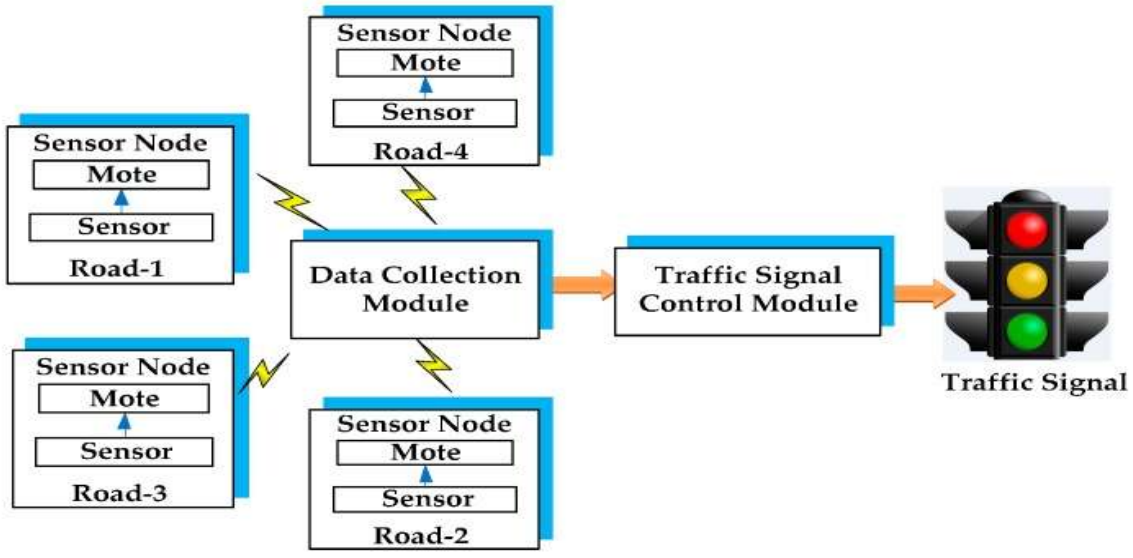

Figure 3: Schematic Diagram of Traffic Management System

Source: www.ncbi.nih.gov/articles/PMC4801535

This section provides an overview of the sensing evolution, traffic sensing technologies, the characteristic of the general sensor node and the hierarchical functionality of a WSN-based urban traffic management system.

2.1. Sensing Evolution

The Sensor is a key element of any smart system and a course of action is taken based on its location. The control system gathers the data from a group of sensors and uses different variables to distinguish its location and modifies its actions consequently. The accessibility of a massive amount of various sensors and endlessly growing technology facilitates applications that were unfeasible in the earliest because of high prices and restricted handiness. Technological developments have driven the improvement behind sensors and also powered the small-scale devices by making use of the sensors at a low price. From the

viewpoint of the desires of smart traffic management, an extensive handiness of the technology transforms to a great amount of chances in the sensing.

2.2. Traffic Sensing Technologies

The safe and efficient operation of a traffic management system relies largely on the application of advanced technologies. As a result, the past decade has witnessed the wide application of communication, sensing and computing technologies in traffic management, event detection, emergency response, fleet management and travel assistance. There is a requirement for effective traffic organization, to avoid congestion and optimize traffic flow at intersections. An approach to control traffic flow is to make use of sensor technologies .

2.3 General Sensor Node

A sensor is a transducer which transforms the physical nature parameters like light, temperature, velocity, pressure, moisture, etc. to an electronic signal. This electronic signal can be understood by humans or fed into a control system. A traffic monitoring sensor node typically comprises of four main modules as given below:

- A sensing module—This module acquires data.
- A processing and storage module—This module process the local data and stores it.
- A radio module—This module is for wireless data communication.
- A power module—This module is for energy supply.

A general sensor node normally includes a radio module for wireless data communication. The transmission range of wireless communication depends on the communication technology, which can be a few meters (Bluetooth, Zig Bee, Wi-Fi, etc.) to thousands of kilometres (Wi-MAX, GSM, etc.). The wireless communication has numerous technologies and standards, including Zig Bee, Bluetooth, GPRS, GSM, Wi-Fi and Wi-MAX.

2.4 Hierarchy of Traffic Management Systems

The Traffic management system is mainly divided into three subsystems, namely the sensor network subsystem, the traffic control subsystem and the safety subsystem. The sensor network subsystem collects real-time traffic information and quickly directs that to the traffic control subsystem, which manages the traffic congestion for normal and emergency vehicles at intersections by using adaptive traffic algorithms. The last subsystem provides security to the wireless traffic control system against jamming and violation attacks. We can classify the functions of TMS into three categories, i.e., congestion avoidance, prioritizing emergency vehicles and reducing Average Waiting Time.

2.5. Congestion Avoidance Schemes

Traffic congestion is a situation on roads that is characterized by slower vehicle speeds, queuing, and longer trip times. To reduce congestion, several WSN-based schemes and techniques have been developed and described in the literature.

There are two methods of Traffic Monitoring: circuit patrol and greedy patrol control algorithms to improve the performance of matrix completion (MC) based traffic monitoring. Simulation results have shown that the proposed algorithms reduced the traffic estimation error from 35% to 10% compared with the random patrol method. Vehicle-to-vehicle communication also helps in reducing traffic congestion

There is a congestion avoidance model for traffic control over a vehicular ad-hoc network created between the sensors and cars in traffic. The road side wireless equipment (also called wireless traffic lights, WTLs) collects the data from cars in different road segments and accumulates it to form a road map and its costs. They evaluated the proposed model using a VNSim simulator. Their evaluation results showed that the average time desired for the vehicle to reach its endpoint recorded a significant decrease of up to 40%.

There is a test bed for the evaluation of traffic signal control algorithms using a microscopic traffic simulator (SUMO) and AVR micro-controller. They implemented four scheduling algorithms, i.e., the shortest remaining processing time (SRPT), the Fair SRPT, the minimum destination distance first (MDDF) and minimum average destination distance first (MADDF) in SUMO, studied their effect on traffic networks and measured their execution times. Their experimental results indicated the execution time is constant and independent of traffic intensity for SRPT, decreases with increase in traffic intensity for Fair SRPT, increases rapidly with traffic intensity for MADDF and increases with traffic intensity for MDDF, but not as rapidly as MADDF.

There is the use of Programmable Logic Controllers (PLCs) and supervisory control and data acquisition (SCADA) systems in traffic control applications. ZigBee technology is used for communication between the PLC and SCADA systems. The master SCADA unit processes the collected data and synchronize traffic lights for the smooth flow of vehicles. The results from their study showed that the traffic lights can be synchronized by the PLC/SCADA system. There is a Traffic Random Early Detection (TRED) algorithm for real-time traffic scheduling and to solve congestion problems.

2.6Priority-Based Traffic Management Schemes

An emergency vehicle is any vehicle that is designated and authorized for emergency service (such as police, ambulance and fire). Priority-based signalling will give priority to emergency vehicles and can thus save lives and property. Several WSN-based traffic management schemes and methodologies have been designed and developed to prioritize emergency vehicles and have been reported in the literature. It can be found that most of the efforts are related to intelligent traffic control system design for smooth passage of emergency vehicles The sensors placed on traffic signals will detect the RF signal and the code transmitted from the vehicles. The sensor sends the data to the traffic light controller. The controller checks for priority and manages the signalling. After the passage of an emergency vehicle, the traffic control system reverts back to its normal operation. If two emergency vehicles of the same priority arrive at the intersection point at the same time, then signalling of the green light is given based on distance measurements of emergency vehicles from the intersection point. A vehicle with less distance from the intersection point will be given priority .

There is an approach for the management of traffic systems and altering it for emergency vehicles. They presented IR and GPS methods for estimation of the traffic density and classification of an emergency vehicle. The proposed system consists of two parts: The Smart Traffic Light Control system (STLC) and the Smart Congestion Avoidance (SCA) system. The STLC system is responsible for the signalling at intersections and gives priority to emergency vehicles. The SCA system provides the best and shortest route to avoid congestion.

MAC layer in WSNs can also be investigated. There is a real-time data acquisition scheme (improved back-off selection scheme for the IEEE 802.15.4 protocol) for the faster notification of emergency events to the traffic management system. By the quick response of TMS, collision of vehicles, loss of human lives and traffic congestion are mitigated. They evaluated the end-to-end transmission delay of an incident report by using an NS-2 simulator. The simulation results proved the effectiveness of the proposed scheme in terms of faster transmission of incident messages.

[3] RESULT AND DISCUSSION:

This paper proposes various traffic control system schemes for safety and robustness purposes using the WSN technology. The advantages of the proposed system include: 1) accurate monitoring and measurement of the vehicle number and vehicle speeds in real time due to the introduction of the WSN technology; 2) it is easy to append more functions to this system since the system not only know the statistical information but also the information of a special vehicle as well and the roadside system can communicate with the vehicles. This paper also proposes a traffic control algorithm for the signal control in an intersection. Since the vehicle state is monitored dynamically, the phase time is determined exactly instead of by forecasting usingvarious algorithms. Here the two objectives, that are, first, calculating the density of the vehicle on the road for the flow of the traffic smoothly without congestion and second, developing SMS Based Signalling which will help to when accident occurred at the traffic junction. This Traffic Signal Management approach when properly designed, operated and maintained yields significant benefits like less congestion, saving fuel consumption. The proposed approach will consider not only the priority of the vehicles but also the density of the vehicles on the road and also will control the traffic light sequence efficiently and more accurately and the accuracy of the GPS is more than that of a Camera. This system aims at saving a large amount of man-hours caused by traffic problems and accidents, where prevention can save lives and property. It is able to manage priority emergency tag vehicles. In Future Traffic Safety can be encountered on a certain algorithm proposing methods about how to find out priority of vehicles and density allowing safety crossing of vehicles. It can also be proposed that how using WSN Technology Drivers as well Traffic Controlling Management will know about the Congestion and sensors will show alternate direction to the Drivers and will inform about congestion due to any Accidents etc from a certain distance.

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