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Smart Traffic Management System: Smart City

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Abstract:- *A smart city is a responsible city where every citizen contributes to the process of improvement of communication, transportation and security, continuously on a real time basis.The biggest problem what the world is facing today is traffic jams. Due to the increasing number of vehicles they are not only wasting fuel but also have effected environment badly.Take an example of delhi according to WHO every year there are 2.2 million deaths only because of the bad quality of air and the gases released by vehicles play an important role in it. Now in order to avoid this problem we can usewireless sensor network (WSN). 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. There are many methods to move smooth traffic like video data analysis, infrared sensors, inductive loop detection, magnetic detectors, acceleration detectors etc which can utilize to solve the problem of traffic congestion. Traffic surveillance systems provide data for building an efficient Intelligent Transportation System (ITS). Flexibility, ease in installation and maintenance, low cost and high accuracy of WSN gives more accurate vehicle detection and classification. ITS are widely researched to improve the traffic situation. In ITS, vehicle detection system plays a significant role. At present, vehicle detection is often conducted by inductive loops, which are very expensive and inconvenient to install and maintain. Video camera is another frequently used detector, but it needs high computing power. In order to solve these problems, this paper focuses on the development of a roadside magnetic sensor system for vehicle detection. The device is installed at the side of the road and measures traffic in the adjacent lane (the closest lane to the sensor node). The data are transmitted by the IEEE 802.15.4 communication protocol(IEEE 802.15.4 is a technical standard which defines the operation of low-rate wireless personal area network (LR-WPANs).). These wireless magnet sensors are compact and cost-effective. The devices used in this have high accuracy and are viable in urban environment.*

Keywords: *Wireless Sensor Networks (WSNs), Traffic sensing systems,Traffic congestion, Urban areas, Smart traffic management system,IEEE 802.15.4, Intelligent Transportation System (ITS).*

I. INTRODUCTION

This idea will be implemented by placing sensor nodes on both the side of road. Here i'm focusing on two-way single carriageways only, because almost 80% of all road accidents in India occur on this type of road. After deployment of theses sensors on road side they form an ad hoc radio network to exchange information about passing cars, as determined by their magnetometers, between each other. The nodes need to cooperate by means of communication to maintain consistent real-time local road-state information, which consists of the relative positions and speeds of all of the vehicles travelling along the road at a particular time and place. This information is then communicated to the vehicles, so that on-board computers can use it to infer dangerous situations. The amount of reasoning and computation that needs to be done by sensor nodes and vehicle on-board computers is to be investigated.

To make my ideas more clear I am considering a typical improper overtaking scenario that could possibly be avoided by use of this system: A vehicle is trying to overtake another vehicle on the curved road, where it cannot be seen by other vehicles travelling from the opposite direction. This situation is depicted in Figure 1. The sensor nodes located on the roadside forward the information about the vehicles they have detected along the road and drivers can be informed early enough to react safely and an unfortunate incident can be prevented.

The system should be easily deployable and robust i.e. the sensors used in it should be able to cope with errors during execution and cope with erroneous input. The nodes should be replaceable and if there is anyhow failure in any node it should not affect operation of the system as a whole, which means that node failure should have impact only on local system operation. The broken devices should be replaceable without any additional system reconfiguration. The newly installed ones should detect their neighbours and quickly find their place within the whole system i.e. it should be able to adjust itself within that system without any additional improvement.

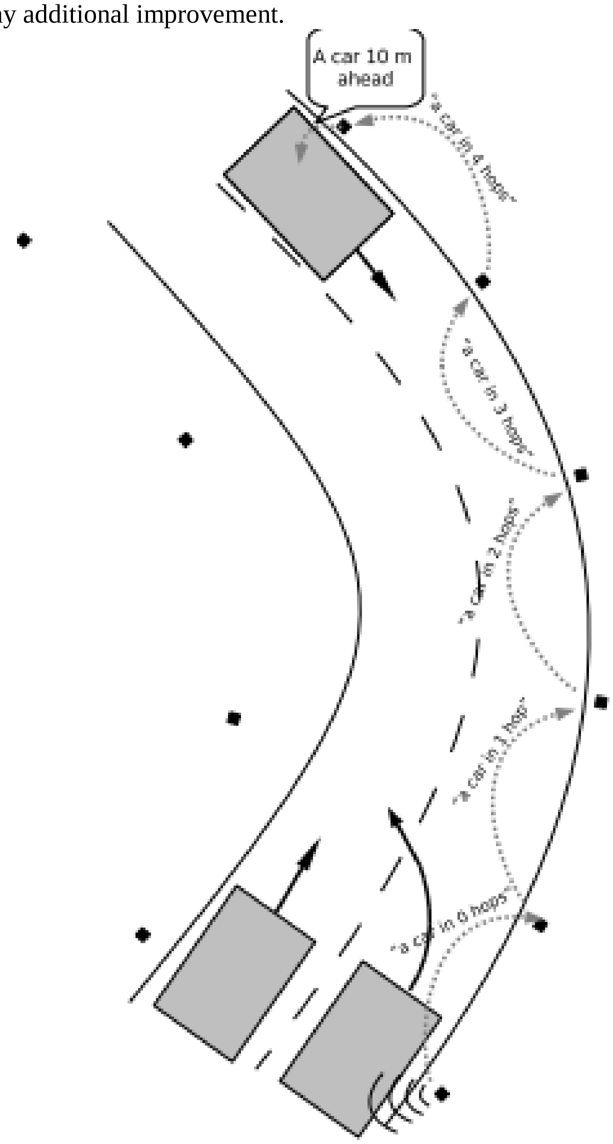


Fig1: Possible application of sensor networks to safe driving monitoring. (http://citeseerx.ist.psu.edu/viewdoc/download)

II. HARDWARE PLATFORM AND SYSTEM CONFIGURATION

Mother-earth provides us with earth's magnetic field that permeates everything between the south andnorth magnetic poles. As we know, almost all traffic vehicles have significant amount of ferrous metals in their chassis (iron, steel, nickel, cobalt, etc.). Once a vehicle passing nearby, it will cause disturbances to the magnetic field and a magnetic sensor can be used to capture these disturbances (see Fig. 2). The device is installed at the side of the road and measures traffic in the adjacent lane (the closest lane to the sensor node). The data are transmitted by the IEEE 802.15.4 communication protocol(IEEE 802.15.4 is a technical standard which defines the operation of low rate wireless personal area network (LR-WPANs).). A novel adapted threshold state machine algorithm is proposed to detect vehicles. The wireless network used in this system is Zigbee as it has lot of advantages as compared to the Bluetooth or Wi-Fi. The major advantage of using the Zigbee is that it consumes very less power as compare to the Wi-Fi or others and has also better range to transfer information from one node to other node.

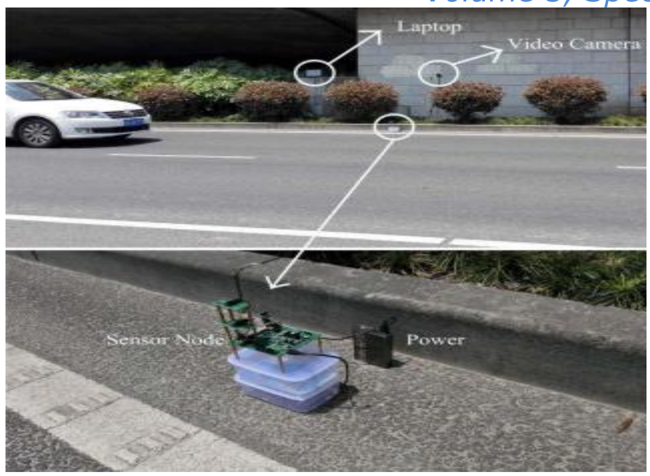
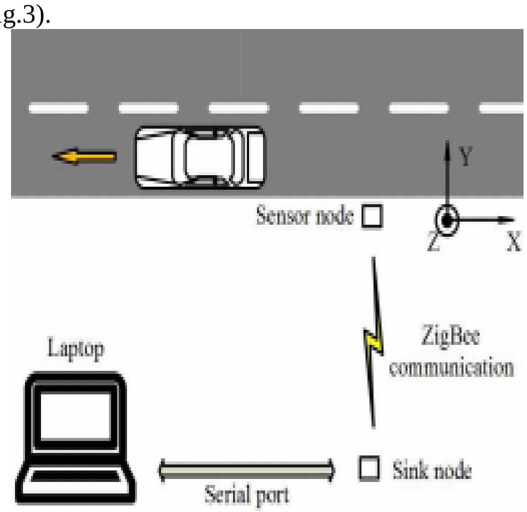


Fig 2:The scene of on-road experiment.
(http://sci-hub.cc/http://ieeexplore.ieee.org/document/8003296/)

Zigbee is a wireless communication protocol based on IEEE 802.15.4 standard. Since it uses low overhead data transmission and requires low system resources which are vitally important factors for embedded sensor networks.The technology defined by the Zigbee specification is intended to be simpler and less expensive than other wireless personal area network (WPANs), such as Bluetooth or more general wireless networking such as Wi-Fi.) Zigbee has a defined rate of 250 kbit/s, best suited for intermittent data transmissions from a sensor or input device.The sensor node will measure the magnetic field and transmit data to the sink node by Zigbee communication.The sink node will receive the data and transmit it to the laptop by serial port communication. Finally, the laptop will display and save the traffic measurements (as shown in Fig. 2 and Fig.3).



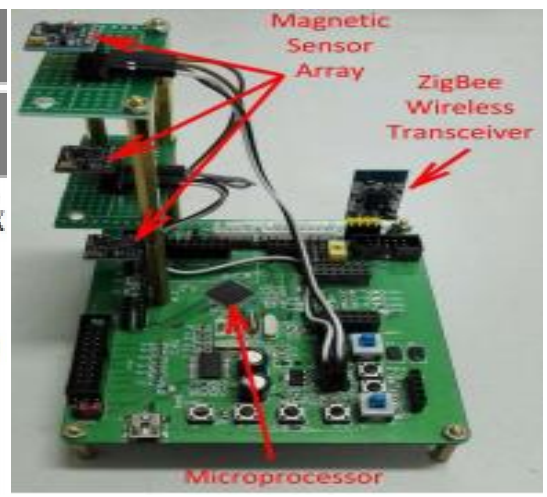


Fig 2: Sensor node configuration diagram. ***Fig 3: Developed PCB for sensor node.***

(http://sci-hub.cc/http://ieeexplore.ieee.org/document/8003296/) (http://sci-hub.cc/http://ieeexplore.ieee.org/document/8003296/)

III. EXISTING METHODOLOGY

A)Inductive Loop Detection

Inductiveloop detection works on the principle that one or more turns of insulated wire are placed in a shallow cutout in the roadway, a lead in wire runs from roadside pull box to the controller and to the electronic unit located in the controller cabinet. Whenever a vehicle passes over the loop or stops, the induction of the wire is changed. Due to change in induction, there is change in the frequency. This change in the frequency causes the electronic unit to send a signal to the controller; indicating presence of the vehicle.Inductive loop detection is useful in knowing the vehicle presence, passage, occupancy and even the number of vehicles passing through a particular area. But there are few problems with this system. These include poor reliability due to improper connections made in the pull boxes and due to application of sealant over the cutout of the road. If this system is implemented in poor pavement or where digging of the roads is frequent then the problem of reliability is aggravated.

B)Video Analysis

Video analysis consists of a smart camera placed which consists of sensors, a processing unit and a communication unit. The traffic is continuously monitored using a smart camera. The video captured is then compressed so as to reduce the transmission bandwidth. The video analysis abstracts scene description from the raw video data. This description is then used to compute traffic statistics. This statistic includes frequency of the vehicles, average speed of the vehicles as well as the lane occupancy.The problems associated with video analysis are – (a) the overall cost of the system is quite high (b) the system gets affected in case of heavy fog or rains (c) night time surveillance requires proper street lighting.

C) Infrared Sensors

Infrared sensors are used to detect energy emitted from vehicles, road surfaces and other objects. The energy captured by these infrared sensors is focused onto an infrared sensitive material using an optical system which then converts the energy into the electric signals. These signals are mounted overhead to view the traffic. Infrared sensors are used for signal control, detection of pedestrians in crosswalks and transmission of traffic information. The basic disadvantages of infrared sensors are that the operation of the system may be affected due to fog; also installation and maintenance of the system is tedious.

IV. EXPERIMENT AND RESULTS

As a vector, the magnetic field can be divided into three components in x, y, and z directions. When a vehicle passes by a magnetic sensor, the change of magnetic field caused by the vehicle can be reflected in the output of each sensor axis. Fig. 4 depicts the raw outputs of x, y, and z axis of the sensor at a height of 20 cm when a sedan passing over in the adjacent lane.

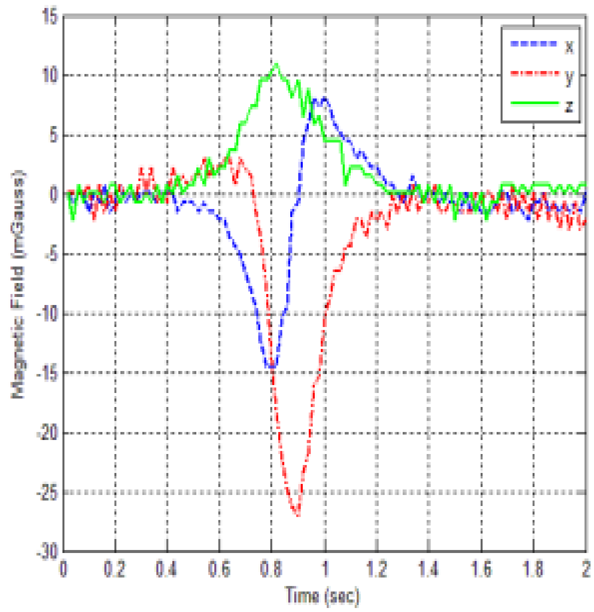


Fig 4: Magnetic field readings for a sedan
(http://sci-hub.cc/http://ieeexplore.ieee.org/document/8003296/)

V. Other Applications

Although the focus of our system is to improve driving safety, we can also consider additional applications. In further research we envision a system with enhanced functionality that comprises of a configurable number of services. The particular set of services comprising a particular system instance would be chosen at the design level, with respect to such factors as node hardware or power constrainor simply the need for particular functionality. We expect that this system, besides the basic road-state information service, would also provide:

1) Vehicle tracking over longer distances for travel-time estimation. By correlating spatial-temporal detection data, vehicles can be tracked along the road. This requires further investigation.
2) Vehicle counting at intersections. This service is of major importance in cities, where traffic volume information is used by traffic management systems.

3) Pedestrian on-road presence notification. This service can be provided assuming the use of more sophisticated sensors or pedestrians equipped with some device to announce their presence on the road.
4) Erratic driving detection and driver warning. Assuming a bigger computational capability, the sensor nodes can make use of the road-state information they generate (the vehicle tracking service) to infer dangerous driving patterns (e.g., speeding or driving in the wrong direction) and warn drivers by using some actuators, e.g., LEDs in cat's eyes. In the case of this service the reasoning would have to be done on the sensor network side.
5) Incident detection. A service similar to erratic driving detection, with the difference that the nodes try to infer an incident (e.g., a crash) and forward that information along the road to warn other drivers or to send it to a traffic management centre, by communicating it to a more powerful device capable of long-range communication.
6) Periodic traffic volume snapshot. This service counts or estimates the number of vehicles along the whole road at some particular time and sends it to a traffic management centre to make it available to other users (e.g., through the Internet). Periodic service execution would allow for real-time traffic information.
7) Road-surface condition reporting service. Equipping sensor nodes with additional sensors like temperature and humidity sensors would allow to periodically gathering information about the road-surface condition. The information could be sent to a traffic management centre, displayed on a variable message sign or communicated to passing vehicles.
8) Message broadcast service. Nodes can also forward messages along the road and broadcast them to passing cars. Their purpose would depend on the particular application, e.g., they could be warning messages generated by a traffic management centre.

VI. CONCLUSION

In this paper, a portable vehicle detection system based on magnetic sensors is proposed. Unlike the traditional inductive loop systems and video camera systems, this solution is of low installation complexity and low cost. It can be implemented at the side of the road conveniently and does not interfere the traffic during the time of installation and maintenance. In addition, the system transmits data by wireless communication. Thus, it is also scalable.

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