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Wireless Sensor Networks for Traffic Congestion Monitoring

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Abstract: ***Wireless magnetic sensor networks offer an attractive, low-cost alternative to inductive loops, video and radar for traffic surveillance on freeways, at intersections and in parking lots. The network comprises 5" diameter sensor nodes (SN) glued on the pavement where vehicles are to be detected. The SNs send their data via radio to the "access point" (AP) on the side of the road. The AP forwards sensor data to the Traffic Management Center via GPRS or to the roadside controller. Because such networks can be deployed in a very short time, they can also be used (and reused) for temporary traffic measurement. Vehicles are detected by measuring the change in the Earth's magnetic field caused by the presence of a vehicle near the sensor. This paper proposes a simple, yet, powerful system for real time vehicle identification. Wireless sensor nodes are used because of their low cost and the flexibility they provide during deployment.***

Keywords: wireless sensor network, intelligent traffic system

1. Introduction

Urban movement administration is an enormous issue facing the worldwide organizers. This is because of fast increment in vehicular thickness. Car influx, specifically, is a migraine for urban suburbanites, likewise bringing on incredible monetary misfortune with every passing day. ITS configuration is by all accounts a standout amongst the best ways to deal with manage such issues .One of the biggest hindrances to the usage of ITS is the non-accessibility of precise and dependable movement observation information. Right now utilized activity sensor advancements (feature, sonar, radar, inductive, attractive, and capacitive) posture issues amid establishment and consequent support furthermore cost a few a huge number of rupees .They experience the ill effects of low execution in order exactness. Here is a call for more data about velocity, inhabitance and other measurable amounts of movement or only data about vicinity or nonappearance of vehicle at a specific spot (parking garage). Movement blockage may be allayed by enhancing the proficiency of the present transportation framework through the usage of cutting edge advancements. Ongoing movement observation is a standout amongst the most vital segments of such a methodology, and continuous travel data is helpful for cutting edge tourism warning frameworks. Crisis administration organizations, for example, police, fire stations, and rescue vehicle dispatchers might likewise advantage from continuous movement data in steering their vehicles through the transportation system to spare lives. Roadway security and productivity will be essentially improved by utilizing remote detecting and correspondence advancements fit for giving minimal effort, adaptable, and disseminated information obtaining of street conditions. Such Intelligent Transportation System (ITS) applications require disseminated obtaining of distinctive movement measurements, for example, activity rate, volume, and thickness which can be acquired utilizing attractive sensors.

2. On-Road Wireless Sensor Network For Traffic Surveillance

The overall design and structure of the traffic surveillance system including system requirements will be explained.

i) Key Requirements

A traffic surveillance system using wireless sensor networks should consider the following requirements.

- Energy-efficiency on sensor networks
- Accurate vehicle detection
- Reliable and real-time data transmission on wireless communication
- Real-time sensor data processing and vehicle detection
- Efficient and intuitive management of sensor networks and services

There can be some variations on such requirements according to installation environments of the vehicle detection system. For example, some real-time properties, such as the limit time for system responses, can differ from types of real-roads, such as high-way and in-city roads.

3. WSN in ITS (Intelligent Transportation System) Environment

Globalization, liberalization and privatization took after by financial blast have put a ton of discretionary cashflow in the hands of individuals. It has prompted more number of vehicles on street. This requests more space on street. Eventually, there is more activity blockage coming about movement jams..Consequently, movement issues lead to more defers, mishaps, expanded fuel wastage and related

environment contamination. Henceforth, the requirement for more and expansive streets and extensions to moderate cloggings and jams is justified. Be that as it may, there are reasonable issues connected with accessibility of open space alongside assets preparation while broadening of existing streets and development of new ones are taken up. Subsequently, the arrangement lies in advancing utilization of existing assets. The point of ITS is to discover answers for transport related issues and enhance existing assets. Outline and execution of effective and productive ITS framework needs precise and dependable movement information. Voyager data framework, parkway and urban movement administration and stopping administration are a percentage of the ITS applications which intensely depend on exact continuous and past activity information. Vast scale sending of movement control framework is obliged to take most extreme advantages from the ITS innovations. In a matter of seconds there are different observation advancements being used, for example, circle locator, camcorder, infrared sensor, microwave radar, piezo- electric sensor, GPS and so forth. Their execution is satisfactory yet have some characteristic genuine absconds, for example, meddling attributes, high cost, viewable pathway, climate condition (ice, downpours), operation amid night or awful lights and high cost of establishment and support. WSN is the best in class innovation, which can be utilized for remote data detecting, accumulation and scattering. WSN has focal points, for example, minimal effort, little size, remote correspondence, versatility, adaptability in arrangement design, multifunctional and so forth. Enabled with such highlights WSN can be a decent contender for movement observation applications. The expansive scale organization of ITS framework is conceivable through the utilization of adaptable and savvy WSN based observation innovation.

4. Motivation and Related Work

i) Magnetic Loops: Magnetic loops are an innovation that has been utilized for vehicle identification and activity control for as long as couple of decades. These gadgets are introduced inside every movement path and go about as counters, checking vehicle disregarding them. The circle is a nonstop run of wire which is covered inside a movement path as shown in figure 1. The finishes of the circle wire are associated through a circle augmentation link to the vehicle identifier. The finder controls the circle bringing on an attractive field on the up and up range. The attractive flux connected with the circle changes at whatever point a metal article, for example, a vehicle, moves over the circle. The recognition plan of circles is in light of this standard. The adjustment in flux is detected by the finder which drives an ordinarily open hand-off to close. The transfers stay shut until the vehicle leaves the circle.

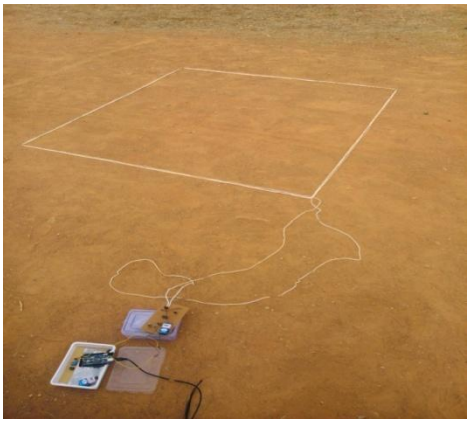

Figure 1: Magnetic loop

ii) Camera Based Systems: Cam based frameworks have the capacity to distinguish, number and arrange vehicles. These frameworks use feature picture processors to recognize vehicles and their activity stream parameters by examining symbolism supplied by camcorders. Pictures supplied by cams are digitized and after that arrangement of picture transforming calculations are connected on them. Data about vehicle entry, vicinity, and rate can be removed by utilizing different picture preparing systems. In spite of the fact that cam based frameworks are more precise than circle based frameworks and don't oblige path discipline they have a few drawbacks. Their execution is unsuitable in foggy states of poor perceivability as shown in figure 2. Other ecological conditions, for example, light reflected from wet asphalts and shadows influence the execution of Video picture processors.

Figure 2: Camera based system

iii) Ultrasonic Detectors: Ultrasonic sensors utilization sound waves (over the capable of being heard extent) to focus the vicinity or separation of an item. Ultrasonic finders transmit sound at 25 KHz to 50 Khz. A piece of the transmitted vitality is reflected back from the street or the vehicle to the recipient. By measuring the time taken for the sound reverberation to give back the separation of an item can be found. The ultrasonic Doppler indicator that additionally measures vehicle rate are a great deal more lavish than the vicinity identifier. This innovation is extravagant and is delicate to clamor and natural conditions.

5. System Architecture

Figure 3. Underneath demonstrates the general structure of the outlined activity observation framework. The activity reconnaissance framework principally comprises of three sections as per their capacities - 1) vehicle discovery layer, 2) information administration layer, and 3) checking & application layer. The vehicle discovery layer comprise of

attractive sensor hubs introduced on surface of genuine streets, entryway hubs to hand-off vehicle recognition information, and base-stations to process identification information and to ascertain velocity of vehicles. All the more particularly, the attractive sensor hubs distinguish vehicles taking into account varieties of attractive fields of earth created by moving vehicles. The attractive sensor hubs additionally exchange the vehicle identification data to door hubs or base-stations with recognition time (nearby ticks). Base-stations get the identification data from attractive sensor hubs or entryway hubs, and procedure them to concentrate more valuable information, for example, recognizable proof of vehicles. The information administration layer gives more extensive administrations in view of data transmitted from base-stations, for example, movement status of a few regions. The checking and application layer gives more redid administrations to end-clients, for example, framework observing and customized administrations. In this paper, we have concentrated on the vehicle discovery layer, particularly remote sensor system and base-stations, in light of the fact that remaining parts are identified with adaptable capacities as indicated by sorts of activity related administrations.

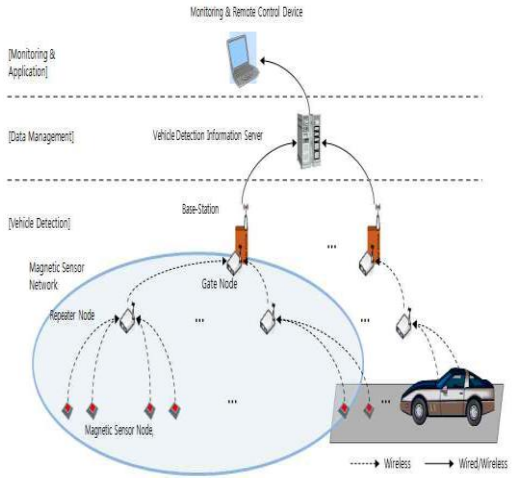

Figure 3: System architecture

6. Anisotropic Magneto-Resistive Sensor

Almost all vehicles are made-up of ferrous material such as steel, nickel, cobalt etc. Mother earth provides us with its magnetic field that permeates everything between the south and north poles. Earth's magnetic field is nearly half gauss in magnetic flux density. Also the earth's magnetic field gets disturbed by vehicles. A low field magnetic Sensor is needed to pickup this field disturbance. Figure 4 shows the lines of flux from the earth's magnetic poles and the disturbance they receive as they penetrate a vehicle.

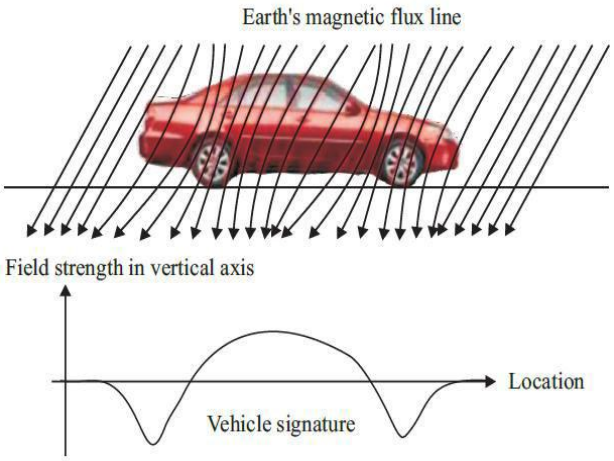

Figure 4: The disturbance of Earth's magnetic flux lines by a vehicle

The AMR sensor is able to detect such disturbance. The lines of magnetic flux get concentrated at the parts, where density of ferrous material is more, such as axles and main body,these results in distribution becoming sparser near the front and rear ends. AMR sensor is a directional sensor and provides only an amplitude response to magnetic field in its sensitive axis. By combining AMR sensors in two or three axis configuration a two or three dimensional measurement of magnetic field passing through the sensor is possible with excellent linearity. Hence such a sensor can be used in traffic surveillance applications.

7. Anisotropic Magneto-Resistive Vehicle Detection System

An AMR sensor is a sensing device that utilizes the rate of change of magnetic resistance which is affected by the strength of the external magnetic field to detect the presence of vehicles. Magnetic sensors were introduced as an alternative to the inductive-loop detector for specific applications. A magnetic sensor is designed to detect the presence or passage of a vehicle by measuring the perturbation in the Earth's quiescent magnetic field caused by a ferrous metal object (e.g., a vehicle) when it enters the detection zone of the sensor. Early magnetic sensors were utilized to determine if a vehicle had arrived at a "point" or small-area location. Modern AMR sensors are used for vehicle presence detection and counting. Unlike the inductive-loop detector, the magnetometer are usually used in places where cutting the deck pavement for loop installation is not permitted. Also, the magnetometer probe and its lead-in wire tend to survive in crumbly pavements longer than ordinary loops.

An iron or steel vehicle distorts the magnetic flux lines because ferrous materials are more permeable to magnetic flux than air. That is, the flux lines prefer to pass through the ferrous vehicle. As the vehicle moves along, it is always accompanied by a concentration of flux lines known as its "magnetic shadow" .There is reduced flux to the sides of the vehicle and increased flux above and below it. An AMR sensor installed within the pavement detects the increased flux below the vehicle.

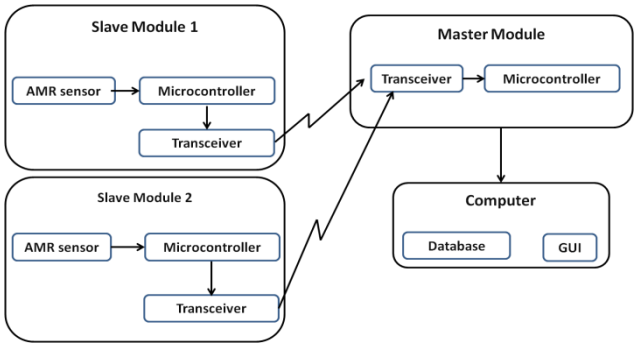

Figure 5: Block Diagram of AMR sensor Vehicle Detection System

The block diagram of the AMR vehicle detection system is show in Fig 5. The system contains two slave modules that are buried along the length of the road with a distance of two meters between them. The slave modules consist of a two axis AMR sensor and a microcontroller interfaced with a ZigBee transceiver. The modules are used for speed calculation and communicate with a master module using ZigBee protocol. The master module consists of a microcontroller interfaced with a ZigBee transceiver and is connected to the computer through UART. The sensors on the slave modules detect the presence of vehicles and send a time stamp indicating the time at which the vehicle was detected to the master module.

A flow chart for the functioning of the slave and master modules is shown in Fig 6 and 7 respectively.

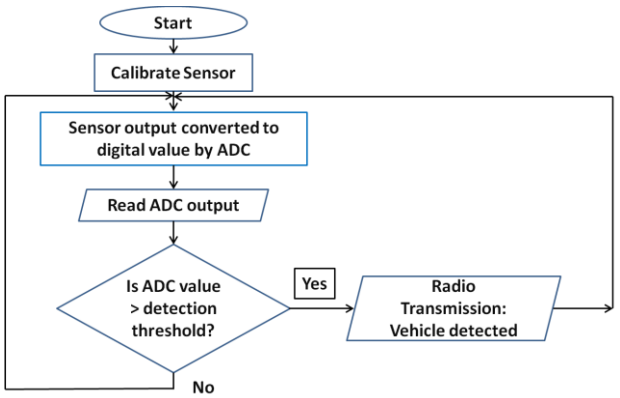

Figure 6: Flowchart for Slave Module

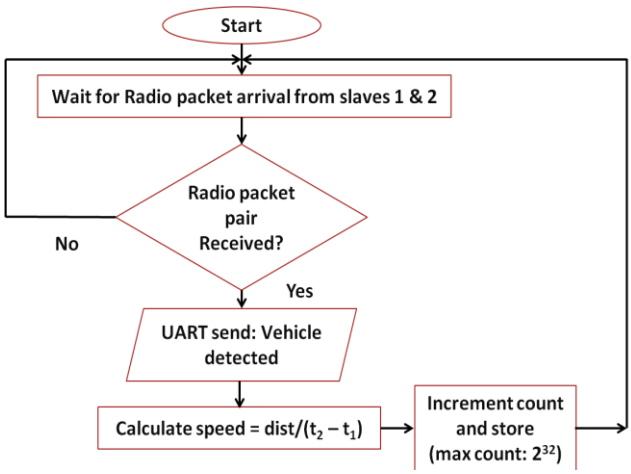

Figure 7: Flowchart for Master Module

8. Conclusion

Vehicle identification frameworks taking into account remote sensor systems are appealing in light of their ease, simplicity of establishment and adaptability of sending. It has the capacity beat the drawbacks of a large portion of alternate innovations. In this paper a reasonable, attractive sensor-based arrangement was proposed to recognize vehicles, and evaluation their pace. The proposed arrangement utilizes high-affectability attractive sensors to permit estimations from a sheltered separation (in the displayed investigations sensors were sent 5 meters from the edge of the street), subsequently permitting non-meddling, and conceivably concealed sending of the sensors.

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