WSN APPLICATIONS: Traffic monitoring using AMR sensors

Rashid hussain, Dr.J.L.Sahgal,Anshul Gangwar,Md.Riyaj

ABSTRACT:

In today's scenario, the road network is very busy due to increasing traffic day by day.As a result major problems like congestion & safety becomes a major issue.To overcome these problems ,we need some advanced techniques of sensor. Sensor based traffic monitoring has several applications in traffic safety,law enforcement and illegal parking. To monitor road network various sensors are installed . An integrated approach of WSN is used. Some of these sensors are camera based sensor,laser sensor,ultrasonic sensor,AMR sensor etc.

In this paper an approach of auto-resistive magnetic sensor & wireless sensor nodes are used. The sensor nodes is capable of gathering information from different sensors and communicate with other nodes in network.On the other hand AMR sensors monitors the magnetic behavior of the vehicle.It identifies the position ,speed & direction of vehicle so that a better traffic management is to be done.

IndexTerms*:congestion,sensors,WSN,AMRsensors,trafficmanagement,sensornodes,trafficmonitoring*

INTRODUCTION:

In today's scenario, we know that the traffic road network is increasing day by day [2]therefore the two main concerns regarding traffic on the roads i.e. congestion and safety are two major issues. Due to increasing number of vehicles, to monitor urban road network is really a big task therefore to resolve this major issue regarding traffic monitoring the technique of wireless sensor network is to be deployed on urban road ways. Now a day's traffic congestion is also a major issue which is caused by large red light delays. If we talk about country like INDIA this is a major issue. This congestion not only results in economic loss but also pollutes the environment of urban cities as the vehicles emit more carbon dioxide at a lower speed.

Rashid Hussein, Associate Professor, E&C, Suresh Gyan Vihar University, Jaipur, India,(hussain1992@gmail.com.) **Dr. J L Sahgal,** Chairman, Institute of Engineers(rajasthan), India **Anshul gangwar,** M.Tech Scholar-VLSI, Suresh Gyan Vihar University, Jaipur, India(anshul.2456@gmail.com).,**Md.Riyaz,** M-Tech Scholar-VLSI, Suresh Gyan Vihar university,jaipur,India

In order to solve this major issue an approach of road monitoring through wireless sensor network is described.An integrated sensor network is deployed along a road network in order to detect traffic flows ,speed,position & direction.This will help in envision of smart road network where the total trip time will be minimum as compared to average waiting time. Now sensor network such as surveillance system,inductive loop detector ,microloop probes etc.are used.

Today due to heavy road network,to obtain an information about roads is becoming more challenging therefore the use of wireless sensor network has proved to be very beneficial in order to design adaptive and dynamic traffic light monitoring system.This will minimize the waiting time of vehicles and also manage the traffic load.

ADVANTAGES OF WIRELESS SENSOR NETWORK TRAFFIC MONITORING[1]:

1.WSN can monitor and sense the roads with automatic and continuous technique with little human effort.

2.It can work at night time as well as in drastic conditions such as fog or dust.

3.Ability to record the data with accuracy for the further analysis.

WHY IT IS REQUIRED:

1.low cost

2.life time usable.

3.flexible and scalability.

4.fault tolerance.

5.High quality of service.

APPLICATIONS OF WIRELESS SENSOR BASED TRAFFIC MONITORING[3]:There are several applications of wireless sensor based traffic monitoring but main applications are defined in three categories:

1. **Application based on traffic** safety:This application deals in order to prevent accidents.Sensor devices work in active mode to instruct the driver about the presence of obstacles,animals and about adverse conditions of roads. These sensors also proactively works when the driver drives in opposite direction(fig.3),overtaking(fig-1) and driving in a wrong way(fig-2).

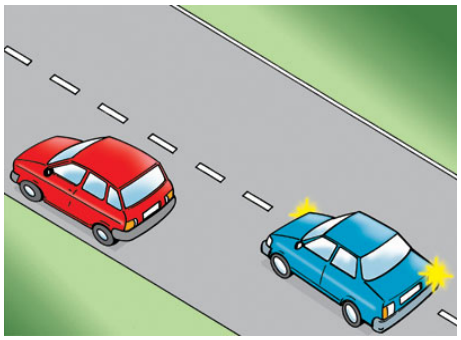

Fig1 :overtaking

2.**Applications based on law enforcement** : In a current scenario traffic law violations results in heavy accidents therefore there is a great need to employ wireless sensor

Fig2:illegalparking
fig 3 : moving in a unauthorised lane

WSN detects the over speed violations with the help of high precision cameras which are installed over the roads.These infrared cameras

takes the photograph of car and this image is sent to traffic management centre(TMC) where they are stored and ready to be processed.

Besides all these additive values,variable message signals(VMS) is sent to the driver mobile. Illegal parking is also detected by using wireless sensor network.

Above all these applications can be deployed by using WSN.

3.APPLICATIONS BASED ON SMART PARKING: This is a major issue in metropolitan cities that there is no enough space of parking . Due to unavailability for parking leads to illegal parking therefore in order to reduce this problem various parking sensors are deployed which guides the driver for a vacant position and parking slot(fig.4) WSN gives the information about vacant parking slot at each floor(fig.5).

network. This technique of wireless sensor network offer a permanent monitoring of each location of the traffic. Some common laws such as over speed, illegal parking ,travelling through a red traffic light, moving in a unauthorized lanes etc.are some violations of traffic rules.

Fig4 : smart parking

Fig5 : smart parking

PRESENT TECHNOLOGIES FOR TRAFFIC MANAGEMENT :

1.**MAGNETIC LOOP TECHNIQUE(fig-6)**: It is a technology which is in consideration for several years for detection of vehicles and traffic control.These loops are installed at each lane of traffic and works as a binary counter which counts the number of vehicles passing over them.When a vehicle enters the loop the relay circuit of sensor makes the loop closed and gives the information about vehicle.This technique identifies the position ,speed ,direction of the vehicle.

Fig6: magnetic loop sensor

2.**SYSTEM BASED ON CAMERA**:The infra red cameras installed over the lane or roads will detect and will locate the vehicle position.These cameras takes a picture of vehicle and sends this image to base station unit where this image is stored and accordingly the actions

can be taken, if there is any violations of road rules.

3.**SYSTEM BASED ON LASER(fig-7)**: These are installed overhead position .They are employed for counting and detecting speed of vehicles.These systems are more durable and authentic as compared to camera based technique.

fig7:laser sensor

4.**ULRASONIC WAVES DETECTOR**: These detectors(fig.8) use the sound waves which determines the presence of nearby object .ultrasonic detectors works in the range of 30khz to 60 khz. This technique also determine speed and relative velocity as compared to other vehicle. Above technique is costly and very sensitive to environmental conditions.

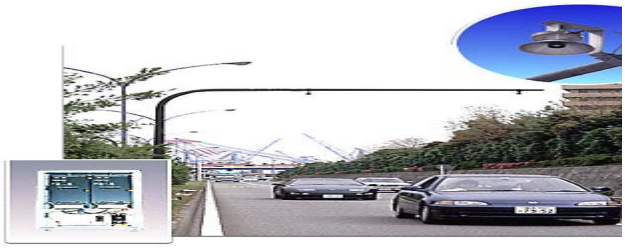

fig8: ultra-sonic detector

5.**AMR MAGNETIC SENSORS[7]**:

Anisotropic magneto-resisitive magnetic sensor is able to sense the magnetic fields which is produced by a earth when a car moves or remain stationary over the earth.To monitor traffic network we are using HMC1022 IC(8). The disturbances produced when a car moves over earth is recorded by AMR magnetic sensor(fig 9) .The overall change in magnetic field is recorded and used to judge speed ,location,directionofvehicle.

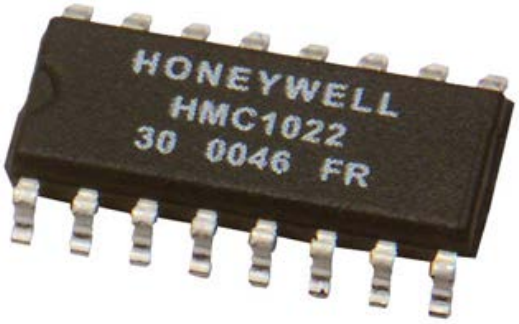

Fig9 :HMC AMR SENSOR1022

There are various advantages of AMR sensors i.e.cost is low,small size,high sensitivity, high reliability.

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6.**ACCLEROMETER**:Acclerometer is a device that sense the vibrations caused by roads when any vehicle passes nearby. In countries likeJAPAN,U.S.A,FRANCE,GERMANY,CANADA these are deployed for detection and classification of vehicle.

The main disadvantage of this technique is that they have very high sampling rate due to which the signals are not able to sampled.

7.**PIR SENSORS**: passive infrared sensor measures the infra red waves coming from heated bodies .It is used to track people and vehicles passing nearby. These are best suitable for detection of multilane roan network. These are installed at the side ways or mounted overhead

8.**IR SENSOR WITH MICROCONTROLLER INTERFACE TECHNIQUE[4]**:

In this system infrared transmitter and infrared receiver are deployed at both the sides of road .When a vehicle passes through these receiver then both systems are activated. Here microcontroller acts as counter which counts the infrared system And accordingly it takes the decision due to which it updates traffic light delay.

PURPOSED ARCHITECTURE[5]

The purposed architecture for traffic estimation will comprises of wireless sensor nodes and AMR magnetic sensors. Wireless sensor nodes and AMR magnetic sensors combined to form a single sensing unit. sensing unit will be mounted on polespresent on oth sides of road. A different software and hardware element involved in our purposed architecture. For road estimation here we are using AMR sensors and sensor nodes.

Sensor nodes(fig.10): T-Mote sky

A sensor node is also known as Mote .sensor nodes is capable of performing some processing ,gathering sensory information and communicating with other attached nodes in the network.

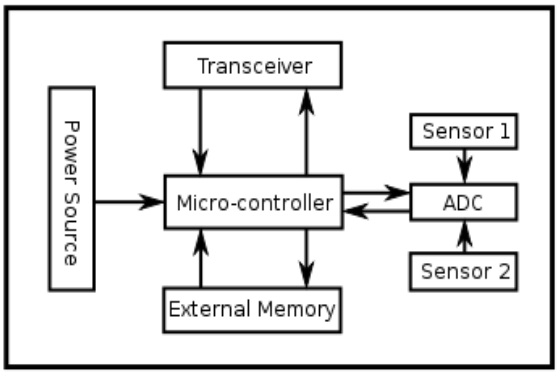

Fig 10:block diagram of sensor node

For our purposed architecture we will use ***T-Mote sky.*** it is a reliable low power wireless sensor .

Salient features of ***T-Mote sky.***

- 8 MHZ Texas instrument MSP 430 microcontroller(fig.11)(10k RAM,48K flash)
- Integrated ADC ,DAC,supply voltage supervisior and DMA controller.
- Integrated on board antenna with 125m range outdoors/50m range indoors.
- 250 kbps 2.4 GHZ IEEE 802.15.4 chipcon wireless transceiver.
- Optional integrated humidity, temperature and light sensors.
- Ultra low current consumption(fig.12).
- 16 pin(fig.13) expansion support and optional SMA antenna connector.
- Tiny OS support.

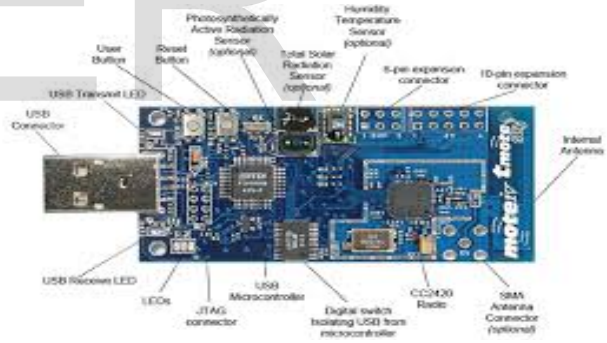

Fig 11:Front of the T mode sky module

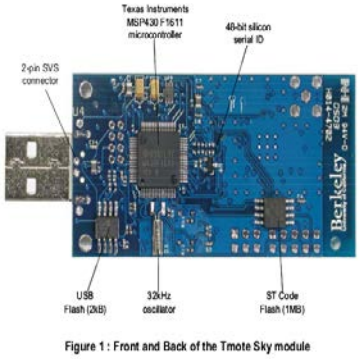

Figure 1 : Front and Back of the Tmote Sky module

Fig 12:back of the T-mode sky module

Fig13:T-mode for programming &communication

Fig 14:T-mode sky

The T-mode sky(fig.15) module consist of on chip wireless transceiver CC2420, microcontroller MSP 430 microcontroller ,anreena,ADC .and DAC. The CC2420[6] is present in the T-Mode sky module for wireless communication.The CC2420 is designed for low voltage and low power wireless communications in the 2.4 GHZ unlicensed ISM band. The low power operation of this module is due to the MSP 430 microcontroller. The microcontroller has internal DCO(digitally controlled oscillator). It can be operate upto 8 MHZ .

AMR SENSORS (ANISOTROPIC MAGNETO-RESISTIVE SENSOR):

William Thomson first observed the magneto-resistive effect in ferromagnetic materials. Later on this sensor started in monitoring of vehicles on the road. AMR sensor can sense the dc static field and strength and direction of field. This sensor consist of nickel-iron on which silicon is deposited and patterned.Whenever there is a change in magnetic field of sensor ,the resistance(fig.16) also changes. It consist Of four resistors which are connected in form of wheatstone. The bandwidth of AMR sensor is 2-8 mhz range. These sensors are excellent means of measuring linear position as well as angular position of magnetic field of earth.

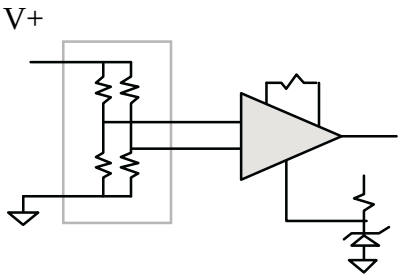

Fig16:AMR SENSOR CIRCUIT

AMR sensors which are available today do an excellent work of sensing the magnetic fields below 1 gauss. The three important parameters which a AMR sensor performs to locate the vehicle so that a clear position of vehicle is sensored in order to monitor the traffic in a proper manner.

1.VEHICLE DETECTION[9](fig.17) : Whenever a car moves on a road ,the pressure exerted by the car produces magnetic field perpendicular to the earth. We know that:

P=F/A

The pressure will be exactly equal to force per unit area.This force will be equal to magnetic field by a relation :

F=BQVSIN90

Hence the magnetic field produced due to an equivalent force will be recorded by an AMR sensor .It can detect the change in earth field due to vehicle disturbance. The change in earth field

will detect whether the vehicle is present or not. The sensing disturbance is upto 15 meters away on its ferrous content.

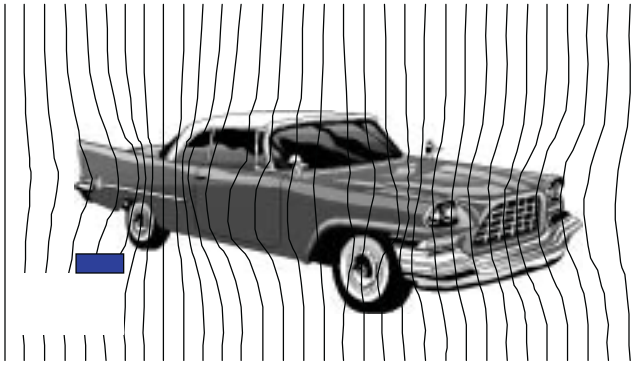

Figure17 –Vehicle disturbance in earth's field

2. Vehicle classification: The magnetic disturbances will be used to describe different vehicles such as cars, trucks, buses, vans, motor bikes etc. Whenever any vehicle will pass lose to magnetic sensor(fig.18) , it will detect all the possible dipole moments of different parts of vehicle.

The three axis of AMR sensor will detect the horizontal, vertical and curvilinear axis . The field location is described by:

FIELD LOCATION(X,Y,Z)=(FIRST VALUE, SECOND VALUE, THIRD VALUE)

Vehicle classification will be done by pattern recognition and matching algorithm. Vehicle length, breadth, height will be measured by an AMR sensor.

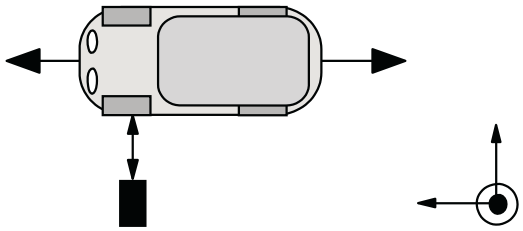

Figure18 –Vehicle and magnetic sensor orientations for drive-by tests.

3.VEHICLE DIRECTION AND ITS PRESENCE: Another important approach which is judged by a AMR sensor is to identify vehicle direction(fig.18).The AMR sensor will check the vehicle in all the three axis x,y,z. It may be useful technique for safety purpose on highways or lanes. The three axis along which the car is travelling will be used to determine the direction of vehicle.At a time when there will be no car present , the sensor will sense the same flux generated by the earth's magnetic field . As the car will approach the field lines of earth 's magnetic field will flow towards the car.Due to this there will be change in magnetic flux which will be recorded by AMR sensor.

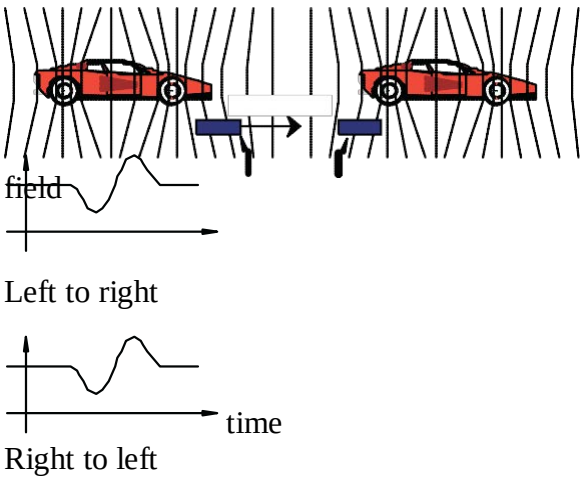

Figure18–Direction sensing for vehicles driving over magnetic sensor.

If the positive axis of magnetic sensor point direct to the right direction and the car is also moving towards left to right then AMR sensor will note a decreasing field because more flux lines move towards incoming car.When the car leaves the magnetic flux, the sensor moves to it's initial value.

To detect the presenceof vehicle ,the magnitude of vehicle's position is to be considered.

MAGNITUDE=(X^2 + Y^2 + Z^2)

CONCLUSION:

In this paper, we addressed the approach of ANISO-TROPIC MAGNETIC SENSOR (AMR) which is used to implement an efficient and intelligent traffic monitoring system for the safety while travelling on roads.

To monitor a heavy road network there is a need of smart sensors like AMR sensors in ITS for detecting a vehicle position ,speed and direction .If all these three factors are configured then there will be a NO problem of monitoring a heavy traffic network. The AMR sensors into two or three axis configurations, a two or three dimensional measurement of the magnetic field passing through sensors is possible with excellent linearity .Traffic monitoring through AMR sensors is an excellent technique of intelligent traffic monitoring system.

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