VOL. 3, NO. 4, April 2012 ISSN 2079-8407
Journal of Emerging Trends in Computing and Information Sciences
©2009-2012 CIS Journal. All rights reserved.

http://www.cisjournal.org

Wireless Sensor Networks: A Solution for Smart Transportation

[1]Rahat Ali Khan, [2] Shakeel Ahmed Shah, [3] Muhammad Abdul Aleem, [4] Zulfiqar Ali Bhutto, [5] Asad Ali Shaikh, [6] Muhmaad Aslam Kumbhar

[1, 4, 5, 6] Institute of Information and Communication Technology, University of Sindh Jamshoro Pakistan
[2] College of Computer Science, PAFKIET KHI Pakistan
[3] College of Engineering, PAFKIET KHI Pakistan
[1] rahataliikhan@yahoo.com, [2] okrajag@yahoo.com, [4] zulfiqaralibhutto2012@gmail.com, [5] dr.asadshaikh@yahoo.com, [6] aslamiit@usindh.edu.pk

ABSTRACT

Wireless Sensor Networks recently have come into importance due to the fact that they have the prospective to revolutionize many segments of our financial system and life - from automation in shipping, environmental monitoring, transportation and healthcare industries.

Transportation information collection and communication plays a key role in Intelligent Transportation System (ITS). Unfortunately, most conventional ITSs can only detect the vehicle in a fixed position, and their communication cables and power cables elevate the cost of construction and maintenance. Because of the advantages of the wireless sensor network (WSN) such as low power consumption, wireless distribution, and flexibility without cable restrictions., the usage of WSN in ITSs is expected to be able to overcome the above difficulties.

Such networks are often deployed in resource-constrained environments, for instance with battery operated nodes running untethered. These constraints dictate that sensor network troubles are the best approached in a holistic manner, by jointly considering the physical, networking, and application layers and making major design trade-offs across the layers.

Keywords: *WSN, ITS, VANET, IVHW*

1. INTRODUCTION

The significant advances in hardware manufacturing technology and the advent of the Micro-Electro-Mechanical-Switches (MEMS) paved the way for building smart sensor nodes that are capable of performing three important functions: sensing, processing, and wireless communication. These wireless sensor nodes are characterized by being intelligent, small-sized, low in cost, battery-driven, and easy to install and repair. These characteristics opened wide doors for a broad range of applications attained by deploying wireless sensor nodes in a dense, distributed manner to form specialized Wireless Sensor Networks (WSNs). The main objective of WSNs is to monitor physical or environmental phenomena like temperature, sound, vibration,relative humidity, pollutants, etc. They also collect data to be reported to a central processing unit that analyses the gathered data and take certain measures accordingly. Starting withcritical military applications like battlefield surveillance, WSNs eventually entered enormous number of civil applications such as motion tracking, traffic monitoring, fire detection, seismic sensing, home automation, to mention only few. The different aspects of WSNs attracted extensive research activities and a large body of studies is now available [1] [2].

An interesting field where the use of WSNs proves effectiveness is the field of Intelligent Transportation Systems. An Intelligent Transportation System uses technological advances in computers and information technology to improve the efficiency of both new and existing transportation systems [3]. By providing surveillance and tracking services, traffic conditions, in both urban and rural areas, can be monitored continuously. A direct consequence of that is resolving the congestion problem by properly directing the traffic away from the highly crowded and congested roads. Moreover, ITSs can be used to manage parking lots, report emergency situations, navigate destinations, and propagate traffic conditions on highways, provide traveler information, avoid vehicle collisions, and enhance driver's safety. ITSs depended on traditional monitoring sensors including inductive loops, video cameras, ultrasonic sensors, radar [4]. However, these sensors suffered from major drawbacks that affected the sole purpose behind incorporating astuteness in transportation systems. In particular, these sensors are bulky, power-hungry, expensive to connect, maintain and overhaul, and connected through wires to central data processing locations. These characteristics subvert the scalability of ITSs and affect their major objectives, like traffic nursing or collision evasion. Integrating WSNs into ITSs can be enticing due to their special topographies that overcome the problems associated with traditional wired sensors. Wireless sensor nodes are small-sized, inexpensive, simple to install, densely deployed, power-efficient, and can be effectively self-configured to cope with sudden failures in nodes [1]. The fact that a single WSN is constituted by a

©2009-2012 CIS Journal. All rights reserved.

large number of sensor nodes solved the scalability problem of traditional ITSs. Wireless sensors provide enhanced coverage of the transportation organization and thus better pronouncements in the controlling of the traffic can be attained.

Vehicular Ad-hoc Network (VANET) is an important component of Intelligent Transportation Systems. The major advantage of VANET communication is in safety systems, which increases safety of passengers by exchanging of warning messages between vehicles.

VANETs are visualized to look after the growth of broad and new attractive applications V2V (Vehicle to Vehicle) and V2I (Vehicle to Infrastructure) infrastructures are to be deployed throughout using IVHW (Inter-Vehicle Hazard Warning) system to generate a warning that is displayed on the display screen built in the vehicle so that better warning can be monitored efficiently.

VANET is a form of Mobile Ad-hoc network (MANET), for communicating between vehicles and between vehicles with fixed roadside equipment, sometimes called fixed infrastructure. This type of network is gaining attention because of communication between vehicles without any infrastructure and without costly cellular network to be deployed.

The field of telecommunications and Information Technology have developed a lot so that they can be implemented almost every where. WSNs are being introduced. This type of network is self-configured and comprising of vehicles and some components on the roadside without a fixed network.

Onboard units (OBUs) frequently broadcast routine traffic related messages with information about current time, position, direction, speed, acceleration/deceleration, traffic events, etc. By periodically broadcasting and receiving traffic-related messages, drivers can get an enhanced knowledge of their driving environment. They may take early action to respond to an abnormal/dangerous situation to avoid any possible damage or to follow a less congested route.

Almost everyone is vulnerable to different disasters that could be either natural or man-made disasters. In larger cities where there is a lot volume of traffic then that can be nuisance daily. The solution is to invest on the safety of roads and traffic efficiency. Pakistan being underdeveloped country has minimum resources to implement costly equipment all over. A cost effective solution is provided so that ITS can be implemented using VANETs.

2. ROAD DEATHS AND INJURIES ARE PREVENTABLE

There are solutions which can be implemented for overcoming the problems of road safety. The traffic system to be considered as a whole and there should be interactions between road users, vehicles and road side infrastructure for disaster safety.

Traffic congestion is a main problem that is of a major concern. This problem is increasing seriously day by day and accidents occur much more than common. According to statistics taken from different regions of the country hundreds of people are injured and died in highways/roads. This causes a traffic blockage. Traffic density has wasted a significant amount of time and fuel due to this. [5]

An intelligent traffic system (ITS) uses recent technologies like communications and information technology for traffic flow management. It also encourages vehicle drivers to use alternate forms of transport, and provides information for driving safely, for avoiding traffic jams. This implementation helps in traffic congestion, accidents and their impact afterwards that they create and also it helps in saving time and more important the drivers/passengers have peace of mind while they are travelling.[5]

The question is that can the vehicles be made intelligent so that they are able to guide their drivers in conditions like traffic congestion and accidents? [6]

The solution is Wireless Sensor Network to be deployed. Vehicular Ad-hoc network is also referred to as vehicle-to-vehicle communication. Because here the nodes or routers are the vehicles i.e. cars, motorcycles, trucks, buses etc. It means that the movement of the node is going to be restricted by the factors like road course, traffic jams or traffic rules and regulations. If this happens that the node is stopped/ restricted then VANET has to be deployed in a fixed environment. This fixed network can be deployed on that locations which are critical and well known for dangerous weather conditions, dangerous intersections etc. The major aim of VANET is to maximize the safety on the roads. In this network the vehicles act as sensors and will exchange information and warnings to other nodes (vehicles), and this information enables the vehicle drivers to concentrate in a correct manner as they are not able to react early in abnormal conditions like accidents or traffic jams.[5][6]

The information that the vehicles or the system provides will help out the other coming vehicles to keep away from that point and authorities like police or firefighters can be sent a alarm signal and also the instructions that to clear the road or to stop other vehicles that are rushing towards that area.

©2009-2012 CIS Journal. All rights reserved.

3. ITS [VANET] ARCHITECTURES

Vehicle-to-vehicle architecture [7]

Vehicle-to-Infrastructure architecture [7]

3.1 Vehicles-to-Vehicle Communication

In this type of communication vehicles communicate with each other to make sure that if there is traffic jam problem or mishap has occurred then they should opt for alternate path. As shown in figure 1[8].

Figure 1: Vehicle to vehicle communication [9]

3.2 Vehicle-to-Infrastructure

Vehicle-to-Road Communication/ Road-to-Vehicle Communication

In this type of communication there is base station (Roadside Unit) that is located alongside the road which acts as a base station to transmit/receive messages that are being generated by the network when any sort of incident occurs.

The vehicles will be connected through on-board sensors and will communicate at 5.9 GHz Dedicated Short Range Communication (DSRC) technology. The WiFi can communicate to road side antennas using Vehicle-to-infrastructure (V2I) or to vehicles. [8]

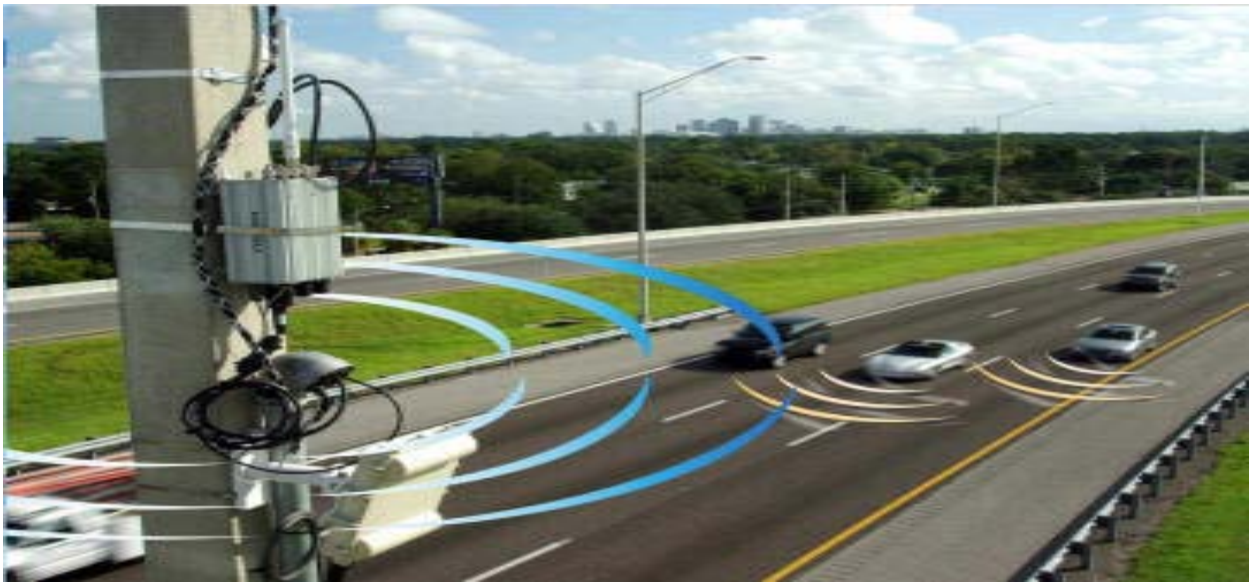

Figure 2: Vehicle to road communication [10]

VOL. 3, NO. 4, April 2012 ISSN 2079-8407
Journal of Emerging Trends in Computing and Information Sciences
©2009-2012 CIS Journal. All rights reserved.
http://www.cisjournal.org

The complete architecture that is required to be implemented to make the travelling safer and to make sure that passengers remain safe if there accident occurs, weather condition are not clear to travel, traffic jam or any other incident is shown in Figure 3.

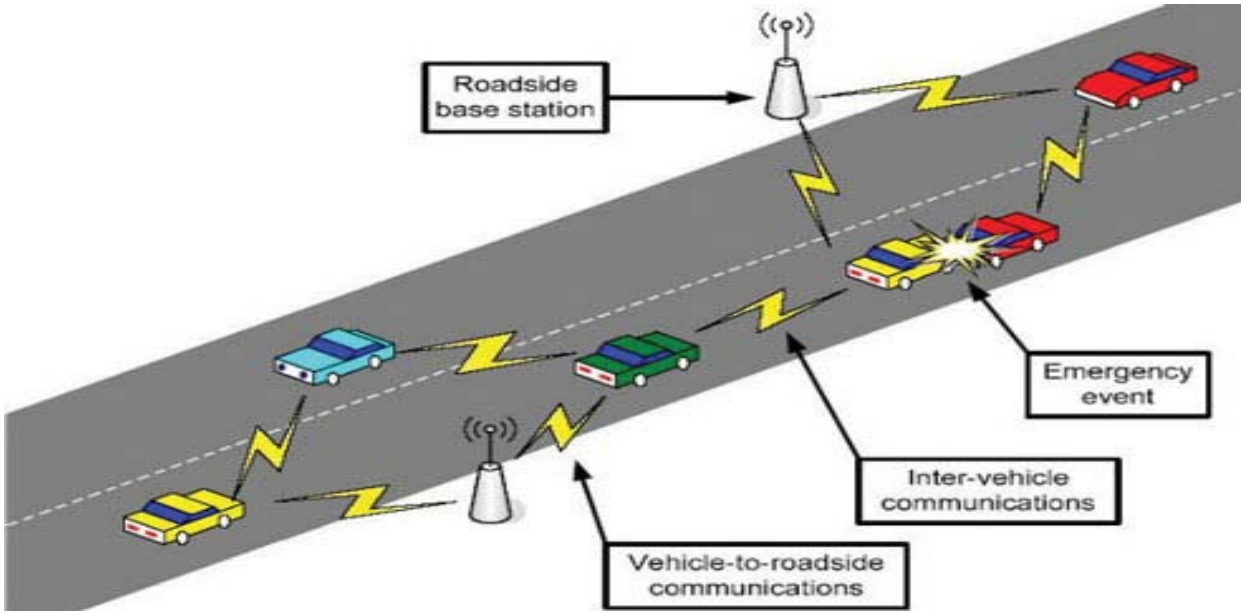

Figure 3: Schematic Representation of a Vehicular Ad-hoc Network Vehicle to Vehicle signaling, vehicle to base station signaling and base station t vehicle signaling [6]

In above figure it can be observed that the traffic flow is moving and there is an accident that has occurred between two cars. The information of this accident is transmitted to other vehicles and to base station that is located on the road side in the range and in this manner network is made and information is moved through to other vehicles which in response will become conscious and opt for alternate path. Additionally the ambulance services can be notified to make sure that there is no fatal injury.

4. WIRELESS COMMUNICATIONS FOR ITS

There are several from of wireless technologies that are proposed for ITS. Some of them are listed below as:

4.1 Radio modem can be used. Radio modem is the one which transfers the data wirelessly. It uses UHF (300 MHz to 3GHz) or VHF (30MHz to 300 MHz). Its range is up to tens of kilometers.

4.2 Short Range Communications can be achieved through IEEE 802 protocols especially Dedicated Short-Range Communications (DSRC). It is one way or two way communication channel precisely designed for automotive purpose. Its range can be or less than 500 yards. [11]

4.3 WiMax (802.16), GSM, 3G technologies are consisted for proposing Long Range Communications. They require very costly equipments and also infrastructure deployment. [12]

5. INTER VEHICLE HAZARD WARNING (IVHW) SYSTEM

The concept to IVHW is that to communicate between a network that could be vehicle to vehicle and vehicle to infrastructure for the warning of hazard. There could be various reasons like bad visibility or that can cause accidents [13]. The characteristics/Features of IVHW are as follows:

5.1.1 Risk of queue and collision

When the vehicles are going in parallel lanes then there is s possibility that there might be a collision so that to reduce that possibility this system warning in implemented. [13]

5.1.2 Vehicle breakdown

If there is a vehicle that is moving fats and goes out of control and comes to other lane or gets down from the road then there is a warning generated to other vehicles coming to be intimated. [13]

©2009-2012 CIS Journal. All rights reserved.

Warning from the base station situated road side

Figure 4: Example of Inter Vehicle Hazard Warning [13]

In figure 4 it can be observed that the IVHW system generated warning has been displayed on the display for the driver to be cautious and get an alternate path.[13]

6. WSN IMPLEMENTAION

6.1 Sanctuary Implementation

Applications belong to this class share a common attribute: the significance to life-critical conditions where the availability or lack of a service may cause fatal injuries. Therefore, the safety measures for this class are compulsory. Major applications in this class include: collision avoidance, accommodating driving, traffic optimization, assistance for lane changing, warning for traffic signs violations and warnings about road conditions in case of any construction or damaged road condition. Applications in this class generally require direct vehicle-to-vehicle (V2V) communication due to strict delay requirements. In the following figure it can be observed that base station (Roadside Unit) located near the place where the incident has occurred receives the message from the vehicle which generates automatically that there is an accident that has occurred now the RSU as well as the vehicle transmits the message to other vehicle so that they might not rush towards the place.

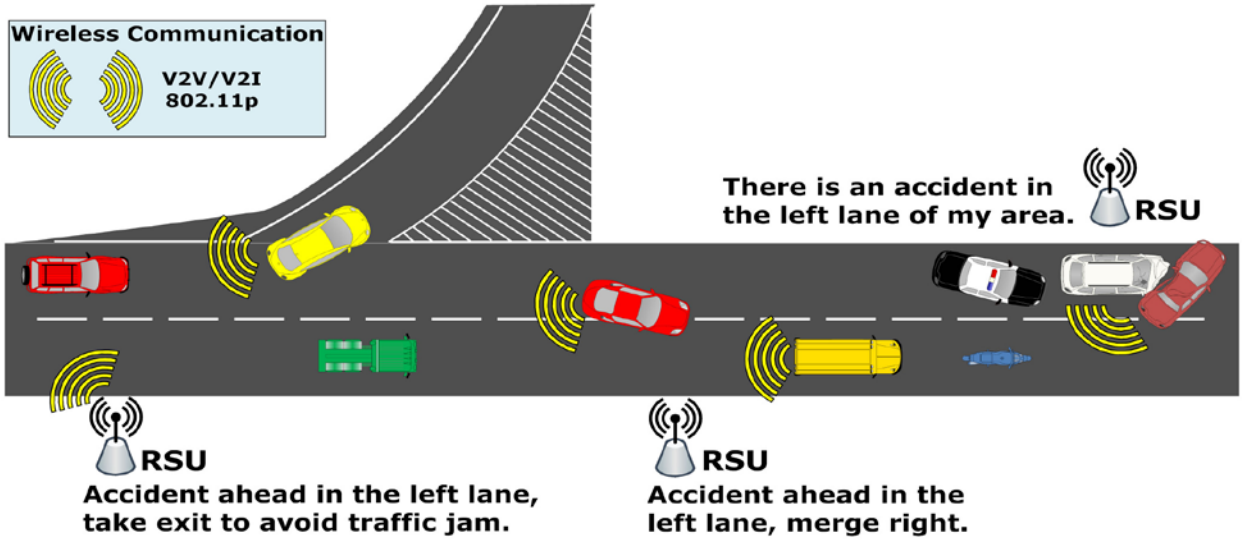

Figure 5: A safety related example of VANET based application (Source: www.cs.siu.edu)

©2009-2012 CIS Journal. All rights reserved.

6.2 Traffic Management System

ITS become important in road congestions and suggest the optimized route to vehicles with updated information about the road conditions. This may utilize road side equipment e.g., intelligent traffic signals and electronic sign boards etc. Information about any blocked road ahead can positively assist in reducing the jamming condition and improving the capacity of roads. Few more applications may also be visualized like automated call to emergency services, on the way and before trip traffic assistance etc.

7. CONCLUSION

The Intelligent Transportation System is that which utilizes the information technology and Communication can be a perfects system. ITS has a lot of future that can encourage the investors to work through it and make the travelling more secure and safe. Some of the applications of ITS, are mentioned below which also can be used in future after implementing VANETs in Pakistan:

- Automatic road enforcement through monitoring
- Variable speed limits at different conditions
- Dynamic Traffic Light Sequence

ITS is a promising and emerging wireless communication technology to improve highway safety. In this paper we propose a framework and the requirements of VANET applications are taken into account. We also study several enabling technologies for the design framework. We believe that our study can provide a guideline for the design of a VANET Network to be deployed in Pakistan. This will help travelling to be safe as there will be warning that will be generated through IHVW system whenever any incident occurs.

REFERENCES

[1] J. Yick, B. Mukherjee, and D. Ghosal, “Wireless Sensor Network Survey”, Computer Networks: The International Journal of Computer and Telecommunications Networking, vol. 52, no. 12, pp.: 2292-2330, Aug. 2008.

[2] I.F. Akyildiz, W. Su, Y. Sankarasubramaniam, and E. Cayirci, “A Survey on Sensor Networks”, IEEE Communications Magazine, vol. 40, no. 8, pp. 104–112, 2002.

[3] H. Benouar, “Deploying the ITS Infrastructure in California”, Proceedings of IEEE Conference on Intelligent Transportation Systems, pp.: 1012-1017, Aug. 2001.

[4] CALM: www.calm.hu

[5] Behin Alipour. Intelligent transportation systems: Past, present and look to future by using Grid technology. 5th Symposium on Advances in Science and Technology May 2011. Mashhad, Iran

[6] Mainak Ghosh & Sumit Goswami, IIT, Kharagpur. Intelligent Transportation using VANET

[7] Hassnaa Moustafa and Gilles Bourdon Vehicular networks deployment view: applications, Deployment architectures and security means.

[8] Richard Gunstone. Advances in Inter-Vehicle Communications Systems and Potential Military Applications. Codex Issue 5 Winter 2009.

[9] BMW Studies Car-to-Car Communication. http://blogs.cars.com/kickingtires/2009/02/bmwstudies-car-to-car-communication.html

[10] 18th World Congress on Intelligent Transport Systems. http://www.dailywireless.org/2011/10/14/world-congress-on-talking-cars/

[11] Harvey J. Miller and Shih-Lung Shaw (2001). Geographic Information Systems for Transportation. Oxford University Press. ISBN 0195123948

[12] "WiMAX™ operators and vendors from around the world announce new deployments, growing commitment at the 2nd Annual WiMAX Forum® Global Congress". News release (Wi-MAX Forum). June 4, 2009. Retrieved August 20, 2011.

[13] Benoit Maissew. IVHW: An Inter Vehicle Hazard Warning System