International Journal of Enterprise Computing and Business Systems

ISSN (Online) : 2230-8849

http://www.ijecbs.com

Vol. 2 Issue 1 January 2012

ARCHITECTURE FOR ACCIDENT MONITORING IN BRTS CORRIDORS USING WIRELESS SENSOR NETWORK

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Abstract

In India road accidents amount to many death casualties. As urbanisation increases so does the vehicular traffic. The numbers of people using vehicles have increased tremendously. All state government are trying to provide the people with alternative, economic and better transport facilities. Bus Rapid Transit System (BRTS) is one such initiative.

The BRTS busses runs on dedicated corridors, which at times are encroached by other vehicles or objects. This tends in increase of chance of accidents, at present there is automatic system available for avoiding possibility of accidents on BRTS corridor; we have proposed a solution for it.

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This paper describes architecture of an accident monitoring system based on wireless sensor network which is helpful in reducing the occurrence of accidents on BRTS routes. The paper is divided into seven sections. Section I introduces wireless sensor network, Section II lists various applications of WSN, Section III gives information of BRTS. The proposed solution to reduce the accidents is discussed in Section IV followed by our proposed architecture in Section V. Section VI contains list of probable sensors that would be used in the application. Finally conclusion is given in Section VII.

Keywords: Accidents, BRTS, Sensors, WSN

I. INTRODUCTION TO WSN

A Wireless Sensor Network consists of spatially distributed autonomous sensors to monitor changes in physical or environmental conditions such as temperature, sound, vibration, pressure, motion, or pollution. The sensors work cooperatively to pass the data collected through the network to different locations [7]. Based on the requirement, sensors can be organized in best suitable topology viz. star, mesh, hybrid to form a network [2]. The WSN is made by two primary components, Base station and client nodes.

(i) Base station: The base station is high capacity node that performs the task of final data aggregation. It is also known as control centre. Depending on the needs of application it can be made centralized or distributed.

(ii) Client node: The client nodes play an important role in WSN. These entities gather, monitor, and transmit data across WSN.

The applications of WSN are derived from the need of appropriate topology along with the use of available infrastructure setup having Control Centre and Sensors as defined above.

II. APPLICATIONS OF WSN

WSN Applications are being extensively used in the domains of Military, Monitoring and Intelligent Transportations. A brief discussion of the same is given in next section.

Military Application

Michael Winkler et al, in [10] discussed about military application that WSN were used exclusively in the Military domain. Where sensors are usually deployed on the battle field, and sense the unauthorized vehicles and/or intruders and pass this information to its base camp. The base camp than would take appropriate action. Such applications are mission critical and security aspects become major concern in them.

Monitoring applications of WSN

WSN is being used in various specialized monitoring application areas such as forest fire monitoring, medical care, and agriculture monitoring, structural monitoring. A brief discussion of these applications is as mentioned.

Forest Fire Monitoring

Byungrak Son et al in [5] has discussed about forest fire monitoring, where sensor nodes are deployed in forest which detect the fire and pass that alert message through hop by hop communication towards the control centre. Control centre will take appropriate action. Forest fire surveillance systems have also been proposed in [12], [15].

Medical Care

William Walker et al, in [1] has mentioned about health care monitoring. In this application WSN sensors measure the vital signal of patient such as blood pressure, oxygen rate, heart pulses and according to violation of their threshold value it sends the message to nurse or doctor.

Agriculture Monitoring

N. Medrano in [8] has proposed about agriculture monitoring, sensor senses the wide cultivar area in real time and gives the precise responses to changes in the cultivar condition, which improves the product quality.

Structural Monitoring

Vivek Katiyar in [13] has mentioned that civil structure like bridges, building, and water reservation can be monitor with the help of WSN. WSN is more help full for checking condition of some critical structure at regular interval of time.

Intelligent Transportation and Traffic Management

Transportation domain is one of the areas where WSN is extensively being used nowadays. It is used for automatic traffic control, efficient multi storage parking location identification. A brief discussion of these applications is as mentioned.

Automatic Traffic Control

Malik Tubaishat in [9] has discussed a system for reducing the traffic by real time monitoring of vehicles using WSN. The intensity of the traffic is been measured, all the sensor nodes on different signals co-ordinate with each other and dynamically changes the duration of green signals. That makes help in reducing traffic in peak hours. Chen Wenjie et al in [6] have also mentioned about real time dynamic traffic control system.

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http://www.ijecbs.com

Vol. 2 Issue 1 January 2012

Multi Storage Parking Building

BI Yan-Zhong et al in [3] has mentioned that WSN is very useful in multi storage parking building where sensor nodes are deployed at each parking space. Whichever parking space is empty, appropriate sensor sends the message to control centre which will guide the vehicle to that direction.

III. BUS RAPID TRANSIT SYSTEM (BRTS)

BRTS, in Ahmedabad was launched in public domain on 14th October 2009. Currently there are 75 bus stations available between RTO and piranha having length of route is 45 km in phase one. In next phase the route is further exceeded up to 65 km. For this project total 730 buses are approved for Ahmedabad BRTS, out of them around 200 buses are currently running on road.

Gujarat Infrastructure Development board (GIDB), Government of Gujarat, in collaboration with Ahmadabad Municipal Corporation (AMC) and Ahmadabad Urban Development Authority (AUDA) took initiative for this project.

Like metro rail system BRTS too can provide superior transportation services as a part of mass rapid transit system. To achieve proper functionalities BRTS uses several elements viz. travel time saving, reliability, safety and security, and capacity. [14]

Though BRTS buses are running on its separate and dedicated routes, accidents often occur. Table 1 shows the result of survey done by the team of JANMARG in last year. It shows the number of accident occurrence per month [4]. The current year details are yet to be published.

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Accidents involving BRTS Vehicles From 15th Oct '09 to 14th June '10								
Month / Accidents	**1st**	**2nd**	**3rd**	**4th**	**5th**	**6th**	**7th**	**8th**
Total number	2	1	2	6	6	4	4	5
Fatalities	0	0	0	0	1	0	0	0
Serious injury	0	1	0	0	0	0	0	0
Minor injury	0	0	0	2	1	0	0	0

TABLE-1

Though the Table 1 does not indicate many accidents, if we are to consider the increase in number of buses from 200 to 730 the accidents rates may also increase in same proportion.

Most of the accidents that have occurred have caused minor injuries or no injury. The major cause of accidents is either due to entry of unauthorized people, vehicles, and/or obstacles in the route of BRTS or at the cross section of multiple tracks, which allow pathway for other vehicles or people.

IV. PROPOSED SOLUTION

In this section we have proposed a solution to reduce number of accidents. The obstacles mentioned above are either stationary or mobile objects or

people. A list of some of the possible obstacles which have been found on the route of BRTS is shown in Table 2.

Obstacle Type	Mobility option	
	Mobile	Stationary
Vehicle	Y	Y
Animal	Y	Y
People	Y	Y
BRTS Bus	Y	Y
Fallen Tree	N	Y
Fallen Street Light pole	N	Y
Road Railing	N	Y
Deep Pit	N	Y
Logged Water	N	Y
Uneven road surface	N	Y

TABLE-2

The obstacles listed in Table 2 may be present anywhere on the route of BRTS. So, it becomes necessary to inform the bus driver or the control station well in advance about these obstacles to prevent causing of accidents.

We plan to create an infrastructure that consists of wireless sensor network, database and mobile services. Sensor node deployed on the BRS corridors will sense an obstacle along the corridor. In case of presence of an obstacle it will then send the sensed data to control centre. The control centre will then generate a message for appropriate action. This will be delivered to appropriate object and/or subject.

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V. PROPOSED ARCHITECTURE

The system architecture for accident monitoring is a multi-tiered architecture, as shown in Figure 1.

At the lowest level of architecture, sensor nodes are deployed to sense different types of obstacle on the BRTS route. The BRTS route is divided into number of wireless sensor clusters. Individual sensor nodes within the clusters will communicate and coordinate to create a cluster.

Once the cluster is formed, sensor nodes within the cluster will transmit data using multi-hop mechanism to cluster head which acts as the gateway. The gateway serves to communicate between source sensor node and control centre which may be at far distance from the place of object. Based on the data received the control centre looks into the database and creates a message for appropriate person (security guard or BUS driver) and sends message through mobile service.

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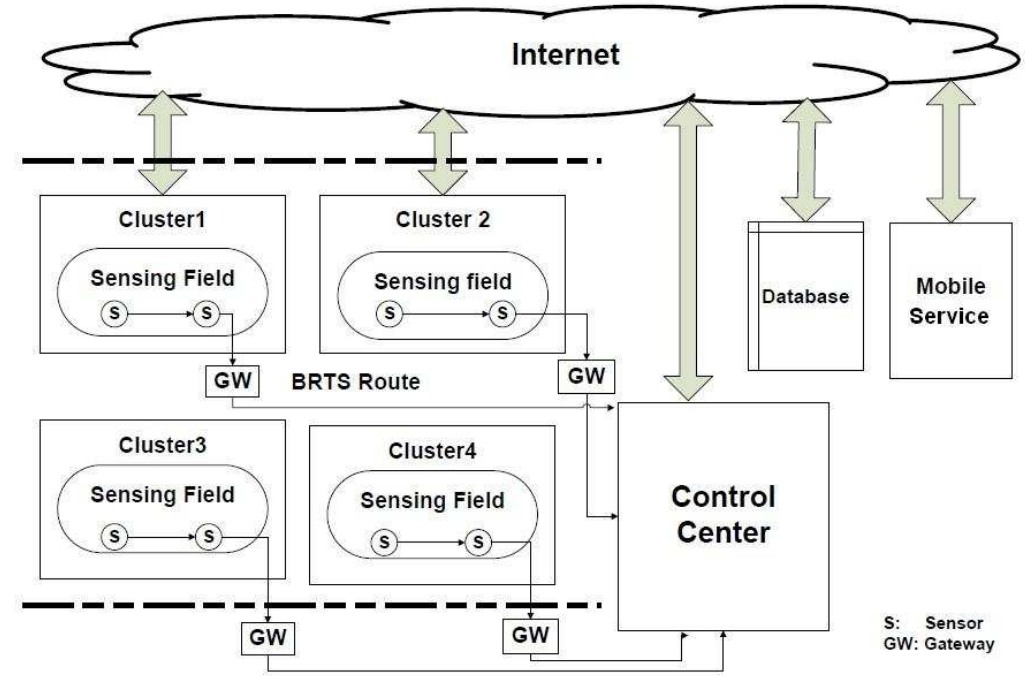

Figure 1: Architecture for accident monitoring

Bus driver who receive this message will be informed about the present obstacle and can take appropriate action to avoid the accident. In the same way a security guard that receives this message, can go to the place and take appropriate.

The gateway node may also work as an aggregator. It will aggregate the data, if multiple nodes have sensed the same obstacle, and then pass this information to control centre. Aggregation will reduce the number of message passing between the gateway and control centre. This is very helpful for

system as it will remove the redundant data and transfers the useful data only, [11].

VI. List of proposed sensor

For detecting obstacles in heterogeneous environment, the details of the proposed sensors are furnished as below.

Video Sensor (CCTV camera)

Video sensors are mostly deployed with CCTV cameras. They are used to evaluate scenes recorded by the video camera. They send recorded analogue or digital signals to a storage device such as a video tape recorder or desktop computer. Objects and their characteristics are verified and compared to the pre-set templates. When there is a match between object and model, then the frame and the objects are marked digitally. The operator can recall the digitally marked image for further use.

Motion Detector

Motion detector is a device that contains an electronic sensor or physical mechanism that quantifies motion, which can be either integrated with or connected with other device that alert the user of the presence of moving object within the field of view (range). Range of the motion detector is up to 15-25 meters.

In our system, motion detector will be placed on street light pole of the route to identify living or non living obstacle. It will detect the obstacle from their body heat and send the alert message to control centre on detection of any living or non living object on the route.

Infrared Sensor

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ISSN (Online) : 2230-8849

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Vol. 2 Issue 1 January 2012

Infrared sensor is a light sensor, which includes a light source (infrared LED), a lens to collimate the light in to beam, and a photodiode to receive the infrared beam. In the absence of any obstacle beam is continually received by receiver. But when obstacle passes through the observing field of sensor, beam will not be received by receiver and that will be indicated as obstacle.

VII. CONCLUSION

This paper addressed the system for monitoring obstacles on the route of BRTS to reduce accidents. It can be achieved by deploying different kind of sensors on the route and continually updating control centre. It is control centre's responsibility to inform bus driver about that obstacle on the route and have to take some action to move away obstacle from the route and make the journey safe for passengers. At present we are in process of identifying final hardware requirements for the architecture. On the software part we plan to use open source softwares to make the design cost effective.

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Vol. 2 Issue 1 January 2012

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