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Real time traffic accident detection system using wireless sensor network

Real Time Traffic Accident Warning System using Wireless Sensor Network

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Abstract—Deaths due to traffic accidents became a major problem that expenses governments billions of Pounds. In case of highway accidents, acknowledgment to the proper authorities is highly needed. The main objective of this paper is to create a Real Time Traffic Accident Warning System (RTTAWS) using Wireless Sensor Network (WSN) and Radio-Frequency Identification (RFID) Technologies. This paper explains the hardware prototype setup for RTTAWS, the algorithms used, the advantages and the limitations of the entire system. Also the configuration of the setup and application software is elaborated. Sensors installed in a vehicle detect the accident's location, the vehicle's speed just before the accident and the number of passengers in the vehicle. The sensors then send an alert signal to a monitoring station. The monitoring station, in turn, tracks the location where the accident has occurred and directs casualty alert to the authorities concerned.

Keywords: Real Time Traffic Accident Warning System (RTTAWS); Sensor; Wireless Sensor Network (WSN); Radio-Frequency Identification

I. INTRODACTION

Wireless sensor networking is an emerging technology that has a wide range of potential applications including environment monitoring, smart spaces, medical systems and robotic exploration [1, 2]. Each node in the WSN has one or more sensors, embedded processors, and low-power radios; and is normally battery operated. Typically, these nodes coordinate to perform a common task [1, 3].

Wireless Sensor Networks (WSN) Terminology could be summarized as follows: Sensors make discrete, local samples (measurements) of the phenomenon, i.e. in this approach we will have heterogeneous topology as the measurements include different types of phenomenon. These sensors communicate over wireless medium forming a wireless sensor network. Finally these sensors disseminate information about the phenomenon to the observer [3].

The radio frequency identification (RFID) technology allows automatic identification of objects with RFID tags. These objects' data stored in RFID tag can be accessed by RFID readers. Hence objects in real world can link to a digital identification through the RFID technology. These identifications can be connected to each other in the cyber space, forming a connection mapping of the corresponding real objects. Consequently, the RFID technology is a key technology that enables the internet of things [4]. The rest of the paper is organized as follows: Section 2 explains the motivation of the proposal; section 3 presents the related work; section 4 introduces the proposed algorithm components; section 5 explains the Real Time Traffic Accident Warning System (RTTAWS) Schema; section 6 explains the intended application; section 7 explains the Hardware Implementation; section 8 explains the software implementation; the conclusion section, and finally the references.

II. Motivation

Although different governmental and non-governmental organizations all around the world

carry out workshops and other training programs to make people aware of the effect of careless driving, yet this whole process has not been very successful till the day we live. In Our Country, deaths due to traffic accidents became a major problem adding to those emergency actions by hospitals or police that are not provided at the place of accident at required time, ignoring the fact that these people's lives could have been saved. Basically, in the event of a road accident, the Real Time Traffic Accident Warning System (RTTAWS) proposed can intelligently inform the site of accident through a wireless interface, reporting it to the proper authorities. Also, informing the type and the amount of emergence services needed, and approximately the number of injured people.

III. Related works

Reference [5] is a traffic flow control system that uses Wireless Sensor Networks (WSN) to control the traffic flow sequences. WSN is used as a tool to instrument and control traffic signals while an intelligent traffic controller is developed to control the operation of the traffic infrastructure supported by the WSN. Conventional vehicular sensor systems for accident detection, such as (ACDS) system and discussed in [6] Wireless Vehicular Accident Detection and Reporting System notify emergency responders immediately by utilizing in-vehicle sensors, such as accelerometers and airbag deployment monitors to detect car accidents. In reference [7] the proposed model has aimed for the real time traffic control using the traffic lights. Wireless sensors are deployed on the lanes and can detect vehicles' number, speed etc, and communicate to the nearest control station to forward any information. In [8] is a document regarding automatic vehicle identification and managing traffic using RFID.

IV. Proposed Algorithms

In the proposed system, three main components are needed to facilitate the delivery of the accident report. In other words, we need three algorithms which are stated as below:

A. Node algorithm

The main task of node algorithm is to prepare the "help" message if an accident occurs, otherwise it repeatedly sends "I'm here" message to send the last location of the vehicle. Figure 1 illustrates the steps of the node algorithm.

B. Router algorithm

Its task is to distinguish the type of message and take the appropriate actions (buffer it for "I'm here" message and send it to coordinator for "help" message). Figure 2 illustrates the steps of the router algorithm.

C. Coordinator algorithm

The coordinator has two tasks; the first one is to send scan order message sequentially to all routers stored in its database to locate vehicles. While the second task is to receive the "help" messages and prepares the accident report. Figure 3 illustrates the steps of the coordinator algorithm

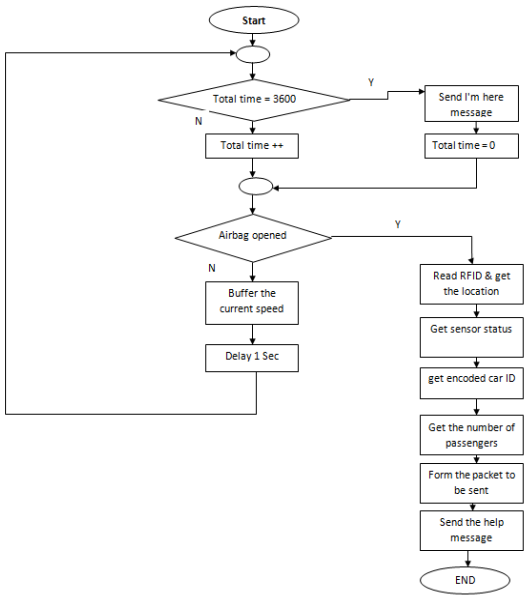

Fig. 1 Node algorithm

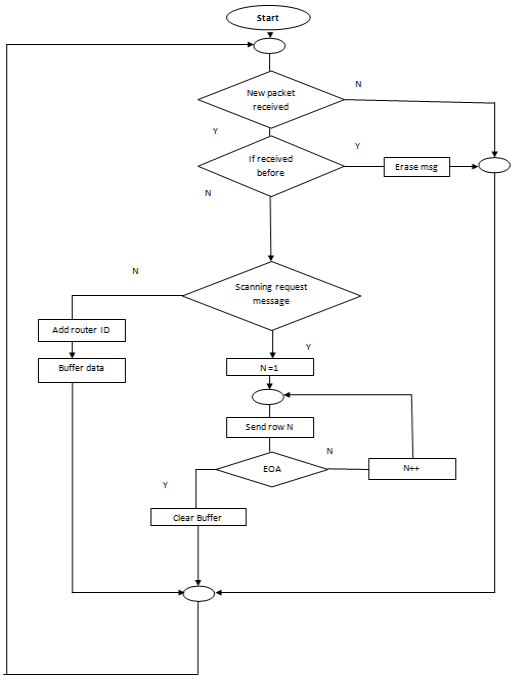

Fig. 2 Router algorithm

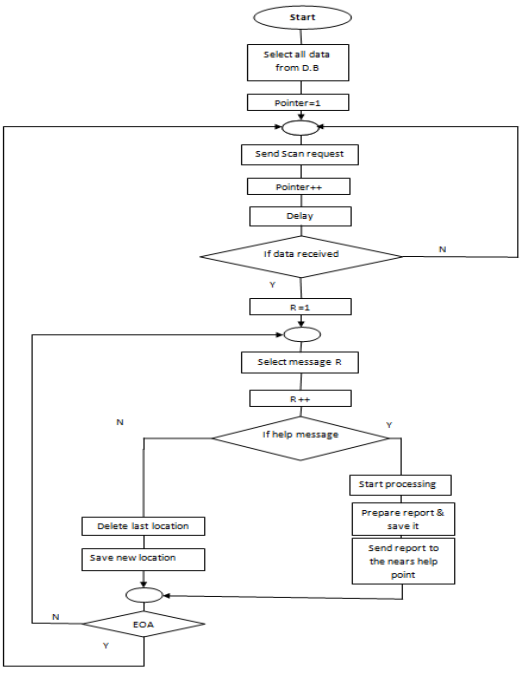

Fig. 3 Coordinator algorithm

V. Real Time Traffic Accident Warning System (RTTAWS) Schema

To explain the proposed system clearly, we will discuss a scenario of an accident in details and the function of each element previously introduced. When an accident occurs, we use the airbag impact sensor to interrupt the node board then the interruption signal occur, the node board starts to prepare the packet to be sent encoding the vehicle plate number (three letters and four numbers), accident location (Street and the sector), the vehicle speed(rollover sensor). Just before the impact, the sensors become activated stating the number of passengers in the vehicle crash sensors which had been activated (front, back, right side and left side) as shown in Figure 4. Also a fire alarm sensor can be activated in case of fire. In the case of an accident occurrence, the "help" message can be sent to the router. Figure 5 illustrates packet frame (Help message) which contains all information and status about the car.

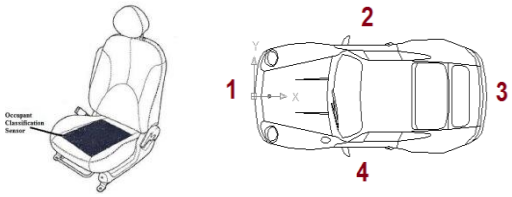

Fig. 4 Distribution of Sensors inside car

Router ID	ID	Location	#P	Speed	Status	Message type
5	29	2	2	9	6	2

Fig. 5 Help message frame

When the router receives a message, it distinguishes whether it is a "help" message, where the router sends the message immediately to the coordinator where the coordinator receives starts to process it and prepare the accident report. Otherwise, in normal mode of operation (no accidents happened) the node repeatedly send other type of message "I'm here" message that informs the system the last location of the vehicle. When the router receives this type of message, it simply buffers it and waits for the scan process completion of the received message

from the coordinator to batch all buffered messages.

VI. Intended Application

As shown in figure 6, to implement the proposed system we need to install four main components. The first component is an embedded system board; which should be attached to each car. This board will represent the remote data acquisition node. It exquisites the data from the vehicle and sends it with wireless module to next network item (Router).

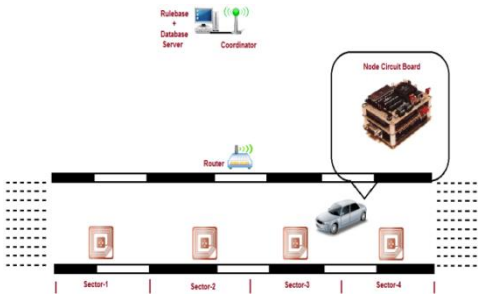

Fig. 6 main components of the proposed system

The Second and third components are wireless modules. The first component is called router and the other one is called coordinator. In the proposed system, we need one router for each coverage area placed along to the road. All these routers communicate with the coordinator and each router communicates with all nodes (embedded boards attached to the vehicle) in its coverage area. The forth and last component is the RFID tags. In our proposed system, we need to locate which sector in the router's coverage area has the accident's event. That's why we need to attach four RFID tags one for each sector.

VII. Hardware Implementation

Our proposal's hardware mainly consists of three parts (Node, Router and Coordinator). The node as shown in figure 7 is the electrical circuit that is to be installed in the vehicle. It consists of EPROM which contains the encoded vehicle ID , speed sensor , Microcontroller (Pic16f877a) , four Weight Sensors one for each vehicle set , four impact sensors one for each side of vehicle (front , back , right side and left side) , RFID reader that reads distributed tags on the road (each router coverage area has four tags one for each sector) , microcontroller with program that exquisites data and form the packet to be sent and finally the RF module .

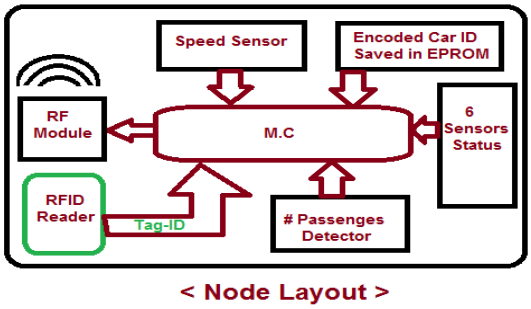

Fig.7 Node layout

The router has a simple task which can be achieved by using a very simple program in microcontroller and RF module. Finally the Coordinator's hardware is RF module, as shown in figure 8, is attached to the main server where the rule base, database and the administrator interface are located. The coordinator then communicates with all routers and sends them sequential requests to send all buffered data (polling scan method). On the other if an accident occurs, the router immediately sends "help" message to the Coordinator (interrupting method).

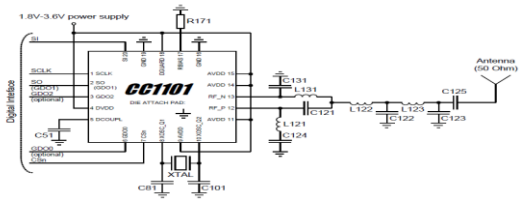

Fig. 8 RF Module

VIII. Software Implementation

To demonstrate our idea, we made a proof-of-concept demo which was applied on four streets where every street has its installed router and four tags divided into four segments are on those numbered streets. Tags are from one to four, from left to right. forbid I change the parameter basic two car number, speed and sensors when

an accident occurs and is pressing on the letter Q From the keyboard It represents the open Air bag send the car order assistant to the router adds router to the message router ID then Coordinator sends a request to examine the router is then extracted a report of the incident and the available place following the incident - State sensors- the nearest hospital - the nearest point of fire if necessary . System can also be queried for another place for the car by a certain number. We used SQL Server as our database server and Visual basic.net to build our demo. It also has been used Rule based Are as follows:

R3: IF SPEED (>=90) THEN CAR SPEED IS HIGH

R4: IF CRASH SENSOR 1 ACTIVE THEN INNER EFFECT FACTOR 4

R5: IF CRASH SENSOR 2 ACTIVE THEN INNER EFFECT FACTOR 2

R6: IF CRASH SENSOR 3 ACTIVE THEN INNER EFFECT FACTOR 1

R7: IF CRASH SENSOR 4 ACTIVE THEN INNER EFFECT FACTOR 5

R8: IF CRASH SENSOR 5 ACTIVE THEN INNER EFFECT FACTOR 3

R9: IF CRASH SENSOR 6 ACTIVE THEN INNER & OUTER EFFECT FACTOR 5

R10: IF CAR SPEED IS LOW THEN (INC OUTER EFFECT 1)

R11: IF CAR SPEED IS NORMAL THEN (INC OUTER EFFECT 2 & INC INNER EFFECT 3)

R12: IF CAR SPEED IS HIGH THEN (INC OUTER EFFECT 5 & INC INNER EFFECT 5)

R13: R9: IF CRASH SENSOR 6 ACTIVE THEN WE NEED FIRE TRUCK

INNER EFFECT FACTOR =(X/25)

OUTER EFFECT FACTOR =(Y/10)

Number of injured persons= (outer effect factor * street population) + (inner effect factor * number of passengers) =AMBULANCE CAR NEEDED

X. CONCLUSIONS

Our system makes use of the built-in vehicle sensors to detect an accident. But the interfacing part with the service provider is done in a simple and cost effective manner compared with Wireless Sensor Network for Vehicle Speed Monitoring and Traffic Routing System [9], and Performance Evaluation of Road Traffic Control using a Fuzzy Cellular Model [10] which describes an intelligently detector of an accident based on accident detection system. Reporting about the over speeding vehicles are sent to Police Stations, medical departments in case of accidents and reports detecting traffic jams. Our proposal can detect an accident on real time system and inform the supervisory program with accident location, the vehicle's speed just before the impact sensor are activated, the number of passengers in the vehicle crash sensors which had been activated (front , back , right side and left side), rollover sensor status and finally fire alarm sensor status. In our proposal, rule-based system is used which scans the predicted number of ambulance cars needed for injured people and whether we need fire truck or not.

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