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Research Paper

IMPLEMENTATION OF GREEN WAVE SYSTEM FOR VEHICLES

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Traffic congestion management was recognized as one of the major problems in modern urban area, which has caused much frustration and loss of many hours. During rush, emergency vehicles like Ambulances, Police cars and Fire Brigade trucks get stuck in jams. Due to this, these emergency vehicles are not able to reach their destinations in time, resulting into a loss of human lives. This can be avoided with the help of "GREEN WAVE SYSTEM". A 'green wave' is the synchronization of the green phase of traffic signals. With a 'green wave' setup, a vehicle passing through a green signal will continue to receive green signals as it travels down the road. Through this, we can provide a smooth flow for the emergency vehicle and also a theft vehicle is identified. The information regarding the vehicle has to be updated in the system database. So, it is an autonomous 2-tier system which will help in the identification of emergency vehicles or any other desired vehicle.

Keywords: Green wave, Low cost, Emergency Vehicle Clearance, Tracking, Detection of stolen vehicles

INTRODUCTION

Emergency occurs anywhere at any location, at any time, and in various ways will make one at risk. These situations require a speedy response. So, it is very crucial and important to establish direct, fast and efficient software without delay. With the increasing number of population in the metropolitan areas already existing problem of poor traffic congestion has grown to an alarming event. This problem has to be properly analyzed and the appropriate measures have to be taken. Often rural areas are devoid of the traffic

congestion. The proper care is to be given to the urban areas mainly focusing on to the metropolitan cities. Even if each and every vehicle passing through the traffic has its own need, the prior importance is given to the Ambulance and other emergency vehicles which needs to wait longer time on the traffic thereby increasing the probability of risk. Transportation of a patient to hospital in emergency seems quite simple, but in actual it is pretty difficult during peak hours. Optimum utilization of the time after an accident is actually the golden hours as a measure of

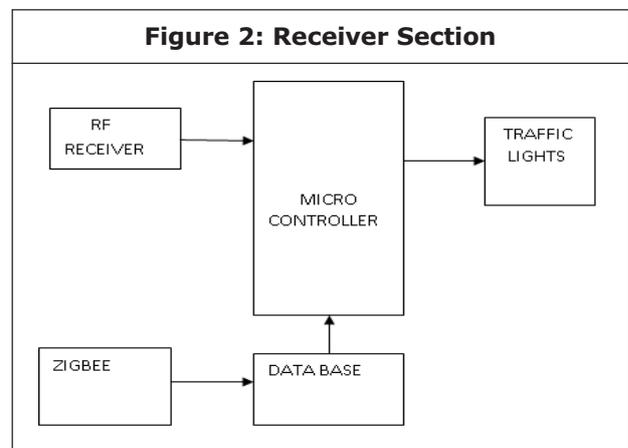
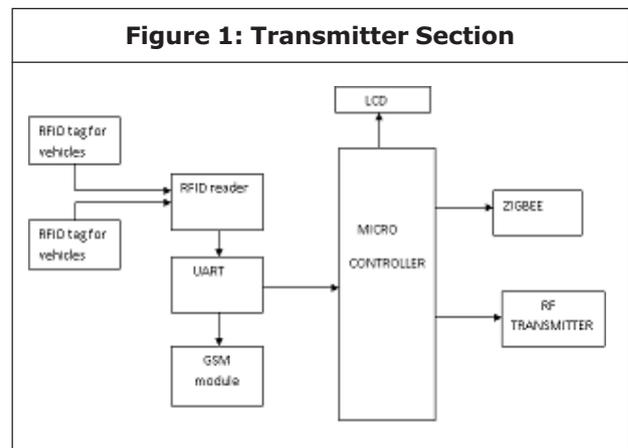
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effectiveness of an emergency response service provider system. Recovery action should be taken immediately without any time lag. Conventional technologies use image processing systems to identify the emergency vehicle. But these systems have a drawback during bad weather conditions. Due to wind, rain, fog, etc., the image received by the camera is distorted by noise and it becomes difficult for the system to identify the desired vehicle. To overcome this we developed a system by using RFID transponders (Subramanian *et al.*, 2005) and readers. The advantage of RFID is that it is a cost effective system which will provide uninterrupted communication in our network even in bad weather conditions.

SYSTEM STRUCTURE AND BLOCK DIAGRAM

The basic block diagram of the system is illustrated in Figure 1 and 2. The system comprises of a RFID reader and a RFID tag or transponder. We will use a high frequency reader which will provide long range to the system. During the manufacturing of vehicles, passive tag or transponders (Chong Hua, 2010) are embedded inside the dash board of the vehicle such that it is not easily visible to human eyes. During the registration of the vehicle, each vehicle gets a unique license plate number. In our system a database is maintained, in which table comprises of information like Unique ID of tag against which the vehicle license plate number and its category is stored. Readers are installed on every junction of the city, on top of the roads. The reader reads the unique ID present on the tag or transponder and sends the information to the main system to check its category and priority in the database and take the desired action

accordingly. For immediate update of category of vehicle and also its priority level the database is connected to the GSM module (Steel *et al.*, 2001). The RTO database is also connected to the main database, so that regular updating of the system database can be done. As soon as the vehicle is registered with Regional Transport Office (RTO), the vehicle is registered with our system as well. The microcontroller unit is



connected to the police control room, to send the alert signals of any stolen vehicle detected.

SYSTEM HARDWARE

The complete system consists of following parts.

RFID Readers

High frequency RFID readers are installed above

the roads prior to every traffic light system in all directions in such a manner that the entire area comes under the range of RFID reader.

RFID Transponders

Passive RFID transponders are installed inside every vehicle at the time of manufacturing. RFID transponders consist of unique ID. Once the vehicle is registered and gets the license plate number, its data is stored in the database along with the category of the vehicle, either 'Normal' or 'Emergency', which could be changed to any other category as per the requirements.

Base Station

The Base station is equipped with a microcontroller unit connected to the database consisting of all the information. The database is connected to the GSM module which helps in immediate update of the database. However the database can be updated manually as well. The RFID readers are connected to the base station with the help of XBEE (Riaz Ahmed, 2005-2009) transceivers. The readers will keep on sending the unique identification (UID) of the vehicle from every traffic light to the Microcontroller Unit (MCU). The MCU will then check for the category and the priority of vehicle in the database and will accordingly send outputs to the traffic lights and Police Control Room.

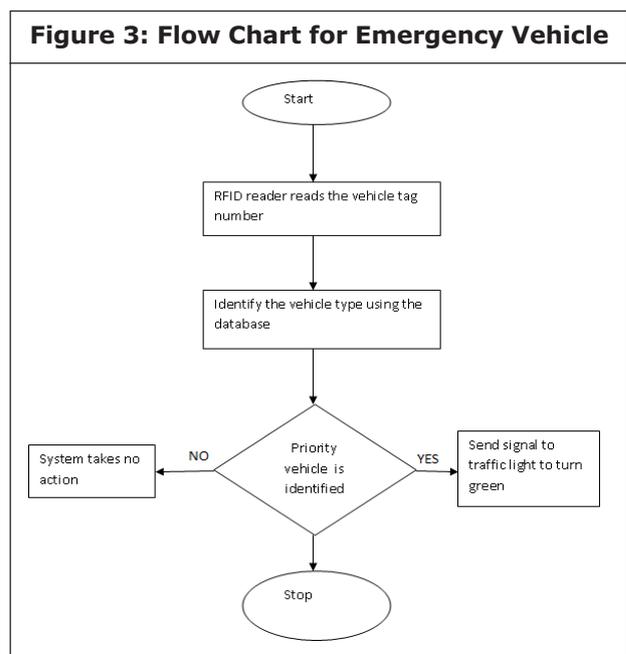
User interface for Emergency Vehicle

An interactive interface for user vehicle is also available, in which the driver of the emergency vehicle will update the priority of vehicle. As in most cases, if there is no patient in the ambulance, its default priority level will be set to low. This interface also helps the driver to select the junctions through which the emergency vehicle will pass. The priority of the vehicle, location and the total no. of junctions

to be passed through are sent to the system with the help of a GSM module. This data is received by the GSM module of the system and the database is updated.

FLOW CHART OF SYSTEM SOFTWARE

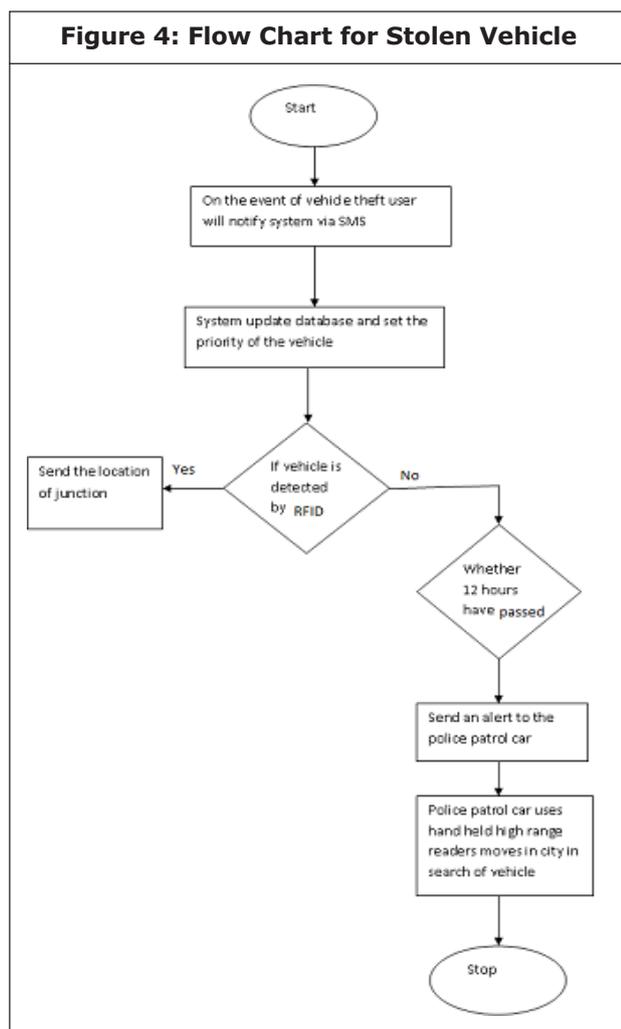
The below flow charts gives the basic algorithm of the software developed for the entire system. In Figure 3, When the category of the vehicle is emergency vehicle like ambulance the RFID reader sends the signal to the traffic light to turns on green. If the category vehicle is theft vehicle the RFID reads the vehicle UID and by using GSM module a message is send to the nearest police station. On an event of two vehicles approaching towards a traffic light junction simultaneously from opposite directions, the priority will be given to the vehicle whose priority is defined as highest. If both the vehicles have registered for the highest priority, the system will serve the vehicles on first come first serve basis. The GSM module will update the priority of vehicle to and will also



update the number and position of junctions to be passed through. The system then identifies the emergency vehicle before its arrival on the first junction with the help of the reader, installed 200 m away from the junction. Now, the priority of vehicle is checked. Depends on priority then the system sends signals to turn the traffic light to green on the Nth junction and N is decremented by one. Now, if N is less than zero, it means that the vehicle has reached the destination. If N is not less than zero, the system waits for the vehicle to arrive the next junction on the basis of average calculation, assuming the speed to be 60-80 km/h, and verifies its arrival with the help of RFID reader. The arrival of vehicle on that junction is

verified with the help of reader installed 200 m before the junction. Then, again, signals are sent to the traffic light to turn green on Nth junction and again the process continues till N becomes less than zero.

For detection of stolen vehicles (Figure 4), the user will notify the system about the vehicle theft via SMS. The system will update the database and set the priority of the vehicle as checked whether the vehicle is detected by RFID reader. If yes, then it sends the location of junction where RFID reader detects the vehicle. If RFID reader is did not detect, it will be checked whether 12 h have passed or not. If not, then again it is checked if the vehicle is detected by RFID reader or not and this continues. If yes, then it will send an alert to police patrol car. The police patrol car uses hand held high range readers and moves in city in search of vehicle and the vehicle is detected, if it is present in the city.



PROTOTYPE IMPLEMENTATION

In our prototype we have used PIC 16F877A(<http://www.atmel.com/Images/doc2545.pdf>) microcontroller along with low frequency RFID reader (125 kHz) (Harpal Singh, 2012) and passive transponders based on EM4102. Three different categories are emergency, stolen and normal. In our coding section, three different UIDs of tags are stored in the program. A 16 x 2 (Liquid crystal display) LCD is interfaced with the microcontroller to display the category of the vehicle with the traffic light model. The traffic light model is shown by red and green Light Emitting Diode (LEDs) in the model. The code written is compiled in AVR Studio 5 and burned on microcontroller using Universal serial bus (USBASP) programmer. The prototype structure is same as shown in Figure 1. The RFID transponders are fitted in four manually driven toy

cars. The RFID readers read the information from the tag; this information is fed into the microcontroller unit for the further processing. The information read is UID. Once the vehicle is in the range of the RFID reader, the reader reads the UID on tag and compares it with UIDs stored in the database. If it corresponds to any of the category defined, then the LCD displays the category of the vehicle. If the vehicle category is 'emergency', the traffic light module is activated (Faubion, 2011). Assuming the average speed of the emergency vehicle, the red light is turned to green and the process goes on for all the junctions through which the emergency vehicle shall be passing. The timing of the red lights is such that the red light turns to green only when the vehicle is 300 m away from the junction, so that a green wave is given to the emergency vehicle only. Now, if a stolen vehicle passes from any of the junctions and its information is already updated on the system, the system will send the information to the microcontroller present at the junction by using zigbee. It give an alert signal using red LED indicating that a stolen vehicle has passed from the junction. If a normal vehicle is passed, no action is taken by the system. In that case, the reader just detects it and that data can be used for data monitoring purposes. The drawback of the prototype is that if one or the other vehicle approaches, the LCD goes blank and it does not detect any of the vehicles, hence it does not support anti-collision feature for passive tags. The system uses low frequency tags and readers. Hence, we get a low range of operation that is just 4 to 5 cm. To resolve all these issues which are mentioned above we used readers with anti collision features. To increase the overall range of the system, we used high frequency readers.

By using the above mentioned techniques, the major drawback of the prototype was resolved. A highly efficient prototype is finally developed.

CONCLUSION

A new system was developed with the advanced technologies including the ZIGBEE and RFID which may proceed the ambulance to pass through the traffic without any time delay in the junction or node. This novel idea can be used for controlling the traffic signals in emergency situations, so that even if there is congestion in junction we can handle it very easily. As GSM is used, it sends the information about the theft vehicle when the database is updated. On the whole this system proves to be very successful and can be easily implemented in real time. The experimentation result shows that the system is very efficient and cost effective.

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