A SMART TRAFFIC SIGNAL TRAPPING SYSTEM

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ABSTRACT

A Smart traffic control system is presented to pass emergency vehicles smoothly. Each individual vehicle is connected with a special radio frequency identification (RFID) tag (placed in a strategic location), which makes nobody can remove or destroy the unit placed. Here RFID reader, NSK EDK-125–TTL, and PIC16F877A system-on-chip to read the RFID tags which is attached to the movable unit. The RFID is used to count the number of vehicles that passes on a particular path during a specified duration. It determines the network congestion and hence the green light duration for that path is enabled or disabled. If the RFID-tag-read belongs to the stolen vehicle, then intimation is sent using GSM SIM300 to the police control room. In addition to that an ambulance arriving towards to the junction, it will communicate with the traffic controller in the junction to turn ON the blue light. This module uses ZigBee modules on CC2500 and PIC16F877A system-on-chip for wireless communications between the ambulance and traffic controller.

Keywords: PIC16F877A, ZigBee, GSM & RFID

1. INTRODUCTION

Traffic congestion is a major issue in the cities of developing Countries. The vehicle flow in cities is high when compared it with the rural area. The population grows day-by-day increases and the middle-class segment contributes significantly to the rising number of vehicles in the cities. These factors determine the congestion on roads eventually results in slow moving traffic, which increases the time of travel, thus stands-out as one of the major issues in metropolitan cities. In, green wave system was discussed, which was used to provide clearance for any emergency vehicle by turning all the red lights to green on the path of the emergency vehicle, hence providing a complete green wave to the desired vehicle. 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. In addition to the green wave path, the system will track a stolen vehicle when it passes through a traffic light. The biggest disadvantage of green waves is that, when the wave is disturbed, the disturbance can cause traffic problems that can be exacerbated by the synchronization. In such cases, the queue of vehicles in a green wave grows in size until it becomes too large and some of the vehicles cannot reach the green lights in time and must stop. This is called over-saturation.

For transportation systems, concepts of intelligent agents may be used in different parts of the system such as traffic lights[8], vehicles[3] and pedestrians[14], as well as to model the behavior of the traffic system to describe the norm violation and critical situation detection[5]. A real traffic network is non-stationary environment because traffic flow patterns are dynamically changed over the time[6]. The main problem is defined, are insufficient to handle the problems of related to congestion, emergency vehicle clearance, stolen vehicle detection, etc. In the proposed design, the main is to implement our Intelligent Traffic Control System. It mainly consists of three parts. The First part contains automatic signal control system. Here, each vehicle is equipped with an RFID tag.

When it comes in the range of an RFID reader, it will send the signal to the RFID reader. The RFID reader will track how many vehicles have passed through for a specific period and determine the congestion volume. Accordingly, it sets the green light duration for that path. Second part is for the emergency vehicle clearance. Here, each emergency vehicle contains ZigBee transmitter module and the ZigBee receiver will be implemented at the traffic junction.

The buzzer will be switched ON when the vehicle is used for emergency purpose. This will send the signal through the ZigBee transmitter to the ZigBee receiver. It will make the traffic light change to blue. Once the ambulance passes through, the receiver no longer receives the ZigBee signal and the traffic light is turned to red or green. The third part is responsible for stolen vehicle detection. Here, when the RFID reader reads the RFID tag, it compares it to the list of stolen RFIDs. If a match is found, it sends SMS to the police control room and changes the traffic light to red, so that the vehicle is made to stop at the traffic junction and local police can take appropriate action. List of components used in the experiment is CC2500RF module, Microchip PIC16F877A, RFID Reader–125KHz–TTL and SIM300 GSM module.

Regarding the use of machine learning methods, in collaborative reinforcement learning has been presented to provide an adaptive traffic control based on traffic pattern observed from vehicle location data. For an overview of applications and challenges regarding multi-agent learning in traffic signal control, the reader is referred to[4].

2. ZigBeee: ZigBee is a high-level communication protocol standard IEEE 802.15.4-based specification. It is used to create personal area networks with small, low-power digital radios. The technology defined by the ZigBee specification is intended to be simpler and less expensive than other wireless

personal area networks (WPANs), such as Bluetooth or Wi-Fi. Applications include wireless light switches, electrical meters with in- home-displays, traffic management systems, other consumer and industrial equipment that require short- range low-rate wireless data transfer.

Its low power consumption limits transmission instances to 10–100 meters line-of-sight, depending on power output and environmental characteristics. ZigBee devices can transmit data over long distances by passing data through a mesh network of intermediate devices to reach more distant ones. ZigBee is typically used in low data rate applications that require long battery life and secure networking (ZigBee networks are secured by 128bit symmetric encryption keys.) ZigBee has a defined rate of 250 Kbit/s, best suited for intermittent data transmissions from a sensor or input device.

3. Literature Survey

A. Violation detection method of vehicular ad-hoc networking

Every hour, nearly 40 people under the age of 25 die in road accidents around the world. According to the World Health Organization, this is the second most important cause of death for 5- to 29-year-olds.

In India, drunk driving and inefficient law enforcements are major contributing factors. The current system of visual identification of traffic violation, conducted by the traffic authorities, cannot work every where and every time[7]. There is a great demand for simple and cost-effective solutions to a traffic safety problem. In this project, a traffic violation detection technique for vehicular ad hoc networks to detect crossing speed limits and analyzing the behavior of the driver is proposed. In this work, sensor, device is used, a digital map and GPS-based system for an area of 1000m x 1000 m.

B. Traffic light control in non-stationary environments based on multi agent Q-learning

In many urban areas where traffic congestion does not have the peak pattern, conventional traffic signal timing methods does not result in an efficient control. One alternative is to let traffic signal controllers learn how to adjust the lights based on the traffic situation. However, this creates a classical non-stationary environment since each controller is adapting to the changes caused by other controllers. In multi-agent learning, this is likely to be inefficient and computationally challenging, i.e. the efficiency decreases with the increase in the number of agents (controllers). Q-learning is employyed, where the average queue length in approaching links is used to estimate states[2].

A. novel approach to implement the green wave system and detection of stolen vehicles

The Green wave systems are most suitable to provide clearance for emergency vehicles during rush hours. Many systems are used to implement the green wave systems. We have developed a cost-effective system using Radio frequency identification (RFID) Technology, Global system for mobile communication (GSM) modules and latest high-speed microcontrollers to achieve the desired results. The primary objective is to identify the emergency vehicle and track its location so that we can provide a green wave to the emergency Vehicle. Often criminal or terrorist vehicles have to be identified.

In addition to the green wave path, the system will track a stolen vehicle when it passes through a traffic light. So, it is an Autonomous 2-tier system which will help in the identification of emergency vehicles or any other desired vehicle. It is a novel system which can be used to implement the concept of the green wave.

D. Traffic light priority control for emergency vehicle using RFID: The problem of traffic light control can be solved by RFID based system. With this system, we can consider the priority of different type of vehicles and also consider the density of traffic on the roads by installing the RF reader on the road intersections. Radio frequency identification is a technique that uses the radio waves to identify the object uniquely. RFID is a technique that is widely used in the various application areas like medical science, commerce, security, Electronic toll collection system, access control etc. There are three main components of RFID: RFID tag, RF Reader and Database. Various types of tags are available, but we can mainly divide them into two categories: passive tags and active tags. The passive tags don't contain any internal power source. There are three parts of the tag: antenna, semiconductor chip and some form of encapsulation. The life of the passive tag is very long.

E. RFID and GPS based automatic lane clearance system for the ambulance

The exponential growth of the metropolitan cities of the country has generated and magnified urban sprawl into problematic proportions. Lack of efficient traffic control and management has many a times lead's to loss of lives due to ambulances getting stuck in traffic jams. To overcome this problem, we propose an RFID and GPS based Automatic Lane Clearance System for Ambulance. The focus of this paper is to reduce the delay in the arrival of the ambulance to the hospital by automatically clearing the lane in which ambulance is travelling, before it reaches the traffic signal. This can be achieved by turning the traffic signal, in the path of the ambulance, to green when the ambulance is at a certain distance from the traffic junction.

F. Limitation

The drawback of this arrangement is that the Government ambulances, like the 108s, do not have a place from which they regularly leave to pick up the patients. Hence, the implementation of this system is difficult for Government ambulances. However, the proposed system can be easily implemented for the ambulances in service of the hospital.

4. Smart Traffic Signal Trapping System: Wire less networks are widely used in the road transport as they provide more costeffective options Technologies such as RFID, ZigBee and GSM can be used in traffic control to provide cost effective solutions. The RFID is one of the wireless technologies that use radio frequency electromagnetic energy to carry information between the RFID tag and the RFID reader. Some RFID based systems will only work within the ranges of inches or centimeters, while others may work for 100 meters or 300 feet or more. A GSM is a modem specialized type of modem, which accepts a SIM card and operates over a mobile operator which is subscribed just like a mobile phone. AT commands are used to control modems.

The ZigBee operates at low-power and can be used at all the levels of work configurations to perform predefined tasks. It operates in ISM bands (868 MHz in Europe, 915 MHz in USA and Australia, 2.4 GHz in the rest of the world). Data transmission rates vary from 20 Kilobits/second in the 868 MHz frequency band to 250 Kilobits/ second in the 2.4 GHz frequency band. The ZigBee uses 11 channels in case of 868/915 MHz radio frequency and 16 channels in case of 2.4 GHz radio frequency. It also uses 2 channel configuretions, CSMA/CA and slotted CSMA/CA.

4.1 Automatic Signal Control System: In this module, for experimental purpose, we have used passive RFID tags and RFID reader with frequency 125KHz. RFID tag, when the vehicle comes in the range of the receiver will transmit the unique RFID to the reader. The microcontroller connected to the RFID reader will count the RFID tags read in 2minute duration. For testing purpose, if the count is more than 10, the green light duration is set to 30 seconds, if the count is between 5 and 9, the green light duration is set to 20 seconds. If the count is less than 5, the green light duration is set to 10 seconds. The red-light duration will be for 10 seconds and orange light duration will be for 2 seconds.

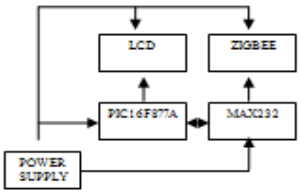

Figure 1. Transmitter

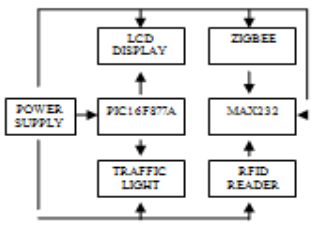

Figure 2. Receiver

Figure 1 shows the implementation for the automatic signal control and stolen vehicle detection system at the transmitter side. Figure 2 shows the receiver side of the detection system

4.2 RFID: RFID is a tracking technology used to identify and authenticate tags that are applied to any product, individual or animal. Radio frequency Identification and Detection is a general term used for technologies that make use of radio waves in order to identify objects and people.

4.3 ZigBee: The explosion in wireless technology has seen the emergence of many standards, especially in the industrial, scientific and medical (ISM) radio band. There have been a multitude of proprietary protocols for control applications, which bottlenecked interfacing. Need for a widely accepted standard for communication between sensors in low data rate wireless networks were felt. As an answer to this dilemma, many companies forged an alliance to create a standard which would be accepted worldwide. It was this ZigBee Alliance that created ZigBee, Bluetooth and Wi-Fi should not be confused with ZigBee. Both Bluetooth and Wi-Fi have been developed for communication of large amounts of data with complex structure like the media files, software, etc. ZigBee on the other hand has been developed considering the needs of communication of data with simple structure like the data from the sensors.

4.4 GSM: The GSM/GPRS module is used to establish communication between a computer and a GSM-GPRS system. Global System for Mobile communication (GSM) is an architecture used for mobile communication in most of the countries. Global Packet Radio Service (GPRS) is an extension of GSM that enables higher data transmission rate. A GSM/GPRS module consists of a GSM /GPRS modem assembled together with power supply circuit and communication interfaces (like RS-232, USB, etc.,) for computer. The MODEM is the soul of such module

Software Description

4.5 MPLAB Setup: MPLAB Integrated Development Environment (IDE) is comprehensive editor, project manager and design, desktop for application development of embedded designs using Microchip PIC micro MCUs and DSPIC DSCs. To create code that is executable by the target PIC micro MCU, source files need to be put into a project. The code can then be built into executable code using selected language tools (assemblers, compilers, linkers, etc.). In MPLAB IDE, the project mana-ger controls this process.

All projects will have these basic steps:

1. **Select Device:** The capabilities of MPLAB IDE vary according to which device is selected. Device selection should be completed before starting a project.
2. **Create Project:** MPLAB IDE Project Wizard will be used to create a Project.
3. **Select Language Tools:** In the Project, Wizard

the language tools will be selected. For this tutorial, the built-in assembler and linker will be used. For other projects, one of the Microchip compilers or other third-party tools might be selected.

4. **Put Files in Project:** Two files will be put into the project, a template file and a linker script. Both exist in sub-folders within the MPLAB IDE folder. It is easy to get started using these two files.
5. **Create Code:** Some code will be added to the template file to send an incrementing value out an I/O port.
6. **Build Project:** The project will be built. Causing the source files to be assembled and linked into machine code that can run on the selected PICmicro MCU.
7. **Test Code with Simulator:** Proteus is best simulation software for diverse designs with a microcontroller. It is mainly popular because of availability of almost all microcontrollers in it. So it is a handy tool to test programs and embedded designs for electronics hobbyists. You can simulate your programming of microcontroller in Proteus 8 Simulation Software.

5. Simulation Results

In this simulation, for testing purpose, the comparisons are made with respect to the unique RFID tag read by the RFID reader to the stolen RFIDs stored in the system. If there is any match in the ID then it quickly processes the signal to the control room that is the traffic signal is immediately turned to red for duration of 30 seconds. Also, an SMS is sent specifying the RFID number by using SIM300 GSM module. The LCD display will indicate that stolen vehicle is present as shown in Fig 3.

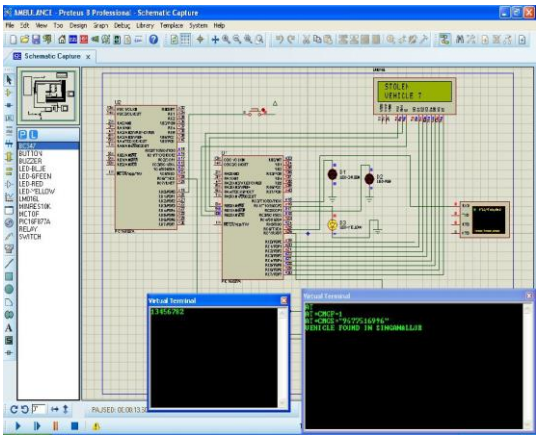

Figure 3. Stolen Vehicle Detection

In this simulation, for experimental purpose, the passive RFID tags are used and RFID reader with frequency 125 KHz is considered. RFID tag detects when the vehicle comes in the range of the receiver will transmit the unique RFID to the reader. The microcontroller connected to the RFID reader will count the RFID tags read in 2 minute duration. For testing purpose, if the count is more than 10, the green light duration are set to 30 seconds, if the count is between 5 and 9, the green light duration is set to 20 seconds. If the count is less than 5, the green light duration is set to 10 seconds. The red light duration will be for 10 seconds and orange light duration will be for 2 seconds. Fig 4 implementation for automatic signal control.

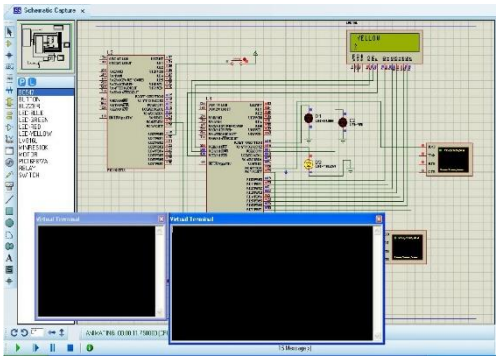

Figure 4. Automatic Signal Control

In this simulation, there are 2 parts, first part which is ZigBee transmitter is placed in the emergency vehicle. When the switch is pressed, it will transmit the signal. The signal contains unique id and security code. The transmitter contains a PIC16F877A microcontroller and ZigBee module. The microcontroller sends the commands and data to the ZigBee via serial communication. Second part is the receiver, which is placed on traffic pole. It also contains a PIC16F877A microcontroller and ZigBee module. The receiver compares the security code received for the security code present in its database. If it matches, then it will turn the blue light on. The figure 5 shows the emergency vehicle, movable unit simulation model.

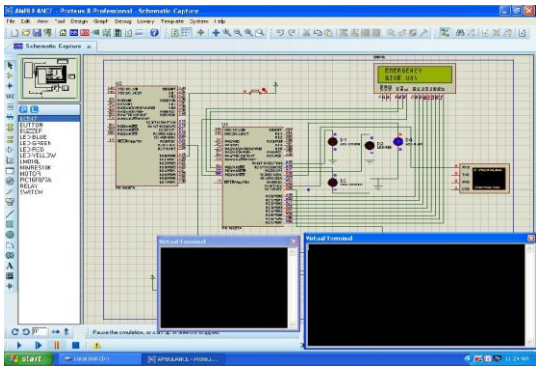

Figure 5. Emergency Vehicle

6. CONCLUSION

The automatic traffic signal control based on the traffic density in the route is considered; hence the manual effort on the part of the traffic policeman is eliminated. As the entire system is automated, then it requires very less human intervention. With stolen vehicle detection, the signal automatically turns to red in the junction hence, the police officer can take appropriate action, if he/she is present at the junction. Also, SMS will be sent so that the person is ready to capture the stolen vehicle at the next possible junctions. The Emergency vehicles such as ambulance and fire trucks were needed to reach their destinations at the earli-

est as soon as possible. To avoid the dangerous hazard or any other external damages to the society is avoided. With emergency vehicle clearance, the traffic signal turns to blue if the emergency vehicle is waiting at the traffic junction. The signal turns to red, only after the emergency vehicle passes through. Further enhancements can be done to the prototype by testing it with long range RFID readers. The GPS can be placed inside the stolen vehicle detection module; so that the processing will be exact location of the stolen vehicle is known. Currently, I have implemented a system by considering one road of the traffic junction. It can be improved by extending to all the roads in a multi-road junction

7. Future Enhancement

In the future, with the help of GPS we can able to monitor the stolen vehicle while moving. The monitoring and controlling the vehicle with fuel theft will be noticed based on ZIGBEE communication protocol, it is easy to identify the vehicle location and transfer

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