Available online at www.elixirpublishers.com (Elixir International Journal)

Electrical Engineering

Elixir Elec. Engg. 92 (2016) 38884-38887

ISSN: 2229-712X

Advanced Traffic Monitoring and Congestion Control using Embedded System

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ARTICLE INFO

Article history:

Received: 29 February 2016;

Received in revised form:

4 March 2016;

Accepted: 9 March 2016;

Keywords

Arduino UNO,
GSM SIM900,
LCD,
RFID tag,
RFID Reader,
LED,
Voice Output- Audio Ply BK BRD using APR33A3IC.

ABSTRACT

Now-a-days traffic congestion has become the biggest problem in the developing cities. This could become even worse in future, if the conventional method of traffic system is followed. So, our project focuses on a smart traffic control system. The proposed system is more efficient than the conventional system in respect of less waiting time, preventing accidents due to over speed and efficient operation during emergency mode. The proposed system makes use of sensor network and microcontroller Arduino UNO. The Arduino Uno is a microcontroller board based on the ATmega328. Portable Inductive Proximity sensors are used. There is no need to embed these sensors in the road. Instead these devices can be placed next to the roadway and measure traffic in the immediately adjacent lane. Using this sensor system, traffic signal are opened and closed depending upon the vehicle density in each lane. Vehicle counting, classification into heavy and light vehicles and detection of over speed vehicles can all be performed using this sensor system. A LCD display is used to display vehicle count. After over speed detection, an alert message can be sent to the nearby police station using GSM SIM900.All the emergency vehicles are equipped with RFID tag. We use RFID reader, NSK EDK-125–TTL and Arduino Uno to read the RFID tags attached to the emergency vehicle. So this enables the emergency vehicle to reach hospital on time without delay. A voice output is provided in the traffic signal which keeps intimating about the last few seconds left for the traffic light to turn green. This will help the impaired people in road crossing.

I. Introduction

Due to the growth of urbanization, industrialization and population, Traffic management on the road is becoming a severe problem of today's society. Due to the growth in traffic, several problems like accidents, Traffic jams, traffic congestions and traffic rule violations at the heavy traffic signals occur. Thus all these problems finally result in adverse effect on the economy of the country as well as affect human lives.

Convention method of traffic system is not density based. This is the main cause of traffic congestion. Over speed vehicles when not detected at the right time result in accidents. Ambulances face major problem due to heavy traffic. As we all know that Ambulances are the most important medical means of transport in any country as they carry patients to the nearby hospitals. But due to heavy traffic, one can often see the Ambulances stuck in traffic for long durations thus causing danger to patient's life. Therefore an increasing demand arises to solve these issues and to provide effective traffic management.

The proposed project aims to solve all these issues,

In the first use of this project, traffic density is controlled using microcontroller and embedded sensing network. The wide spread technology used for Vehicle detection and classification was based on feature extraction from camera systems. On evaluation, camera method fails to give good results during adverse weather conditions like frost, snow etc. and this method is also expensive. The proposed project describes a portable sensing system that can be placed adjacent to the road and can be used for vehicle counting, vehicle classification, and vehicle speed measurements. Sensor used in this proposed work is Inductive Proximity Sensors. Unlike strain gauges that have been used in vehicle detection and classification, the sensing system proposed in this paper does not require devices to be embedded in the roadway. The proposed sensing system is compact, portable, wireless, and inexpensive. Sensors used in this project are placed on the side of the road, and hence, there is no need to stop the traffic for their installation.[5]

In the second use of this project, over speed vehicles are being detected using embedded sensing network and timing circuit. Later alert message is being sent to the near by police station using GSM module.

This project aims to solve the problem of Ambulances also. When an Ambulance arrives, its corresponding lane traffic light becomes green and all the others become red, thus paving traffic less way for the Ambulance and thus helping it to reach the hospital swiftly. This is possible by the use of RF transmitters and Receivers. Finally voice output is also provided in traffic signal to help impaired people in road crossing.

II. Literature review

In 2015 Wenjing Xue, Linbing Wang, and Dong Wang proposed a system called "Portable Roadside Sensors for Vehicle Counting, Classification, and Speed Measurement". The sensor system consists of wireless anisotropic magnetic devices that do not require to be embedded in the roadway.

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Speed measurement is based on the calculation of the cross correlation between longitudinally spaced sensors. Vehicle classification is done based on the magnetic length and an estimate of the average vertical magnetic height of the vehicle. Vehicle length is estimated from the product of occupancy and estimated speed.

Rajeshwari S., Santhoshs Hebbar, Varaprasad Golla proposed a paper called "Implementing Intelligent Traffic Control System for Congestion Control, Ambulance Clearance and Stolen Vehicle Detection". Each individual vehicle is equipped with special RFID tag. RFID reader is used to read the RFID tags attached to the vehicle. It counts the number of vehicles that passes on a particular path during a specified duration. If the RFID-tag-read belongs to the stolen vehicle, then a message is sent using GSM to the police control room. This paper presents an intelligent traffic control system to pass emergency vehicles smoothly. When an ambulance is approaching the junction, it will communicate to the traffic controller in the junction using ZigBee modules.

III. Proposed system

The proposed system consists of Arduino Uno microcontroller to monitor and control the traffic. To collect information about the count and classification of the vehicles, proximity sensors are used. This information is sent to the microcontroller, which in turn controls the traffic signal. A GSM module is interfaced to send messages in case of over speed detection. The RFID transmitters and receivers are helpful in detecting the emergency vehicles. The block diagram of the proposed system consists of three modules:

- Density based traffic monitoring
- Over speed detection
- Emergency vehicle detection

A.Density based traffic monitoring

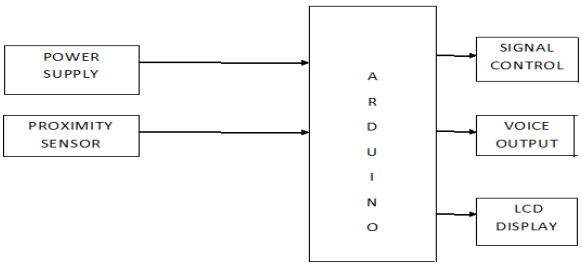

Figure 1. Block diagram for Density based traffic monitoring.

Figure 1 shows the Block diagram of Density based traffic monitoring. Arduino Uno microcontroller is used in this module. Inductive Proximity sensor is integrated with the controller. Sensors are arranged in horizontal manner on the side of the road. The sensor system is at once activated whenever any vehicle passes on road. Microcontroller controls the sensor system and counts the number of vehicles passing on road. Vehicles count is also stored by microcontroller in its memory. Based on different vehicles count, the microcontroller takes decision about which lane should be given green signal first. In the proposed system, a small time count is given in the lcd display .At the end of time count, decision making of which lane should be opened first is decided depending upon vehicle density.

B.Over speed detection

Road transport is essential to the socio economic development of any nation. However, the current level of loss of life and property associated with road accidents is on the increase. By detecting the vehicles violating the speed limit, accidents can be avoided. The over speed vehicles are detected using Inductive proximity sensors. For convenience, lets name the sensors as, (a), (b) and (c). When sensor (a) detects a vehicle, the timing circuit gets activated. It calculates the time taken by the vehicle to reach the sensor (b). If the time is equal to or greater than the pre-determined time, then the vehicle is considered to be moving with normal speed. Else, if it takes less than the pre-determined time, then the vehicle is moving with over speed. Thus we could identify the vehicles violating the rules. As soon as the over speed vehicle is detected, a message is sent to the nearby police station through a GSM module

C. Emergency vehicle detection.

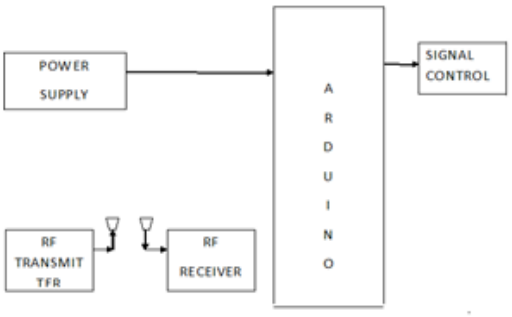

Figure 2. Block Diagram of Emergency vehicle detection.

Figure 2 shows the Block diagram of the Emergency vehicle detection. This system proposed a RFID based automatic lane clearance system for ambulance or any emergency vehicle. The focus of this work is to reduce the delay in arrival of the ambulance to the hospital by automatically clearing the lane, in which ambulance is travelling, before it reaches the traffic signal. All the emergency vehicles are equipped with special RFID tag. RFID reader is used to read the RFID tags attached to the vehicle. As soon as the RFID reader reads the data from RFID tags, it transmits data to the controller. Thus turning the traffic signal, in the path of the ambulance, to green when the ambulance is at a certain distance from the traffic junction is achieved. The use of RFID distinguishes between the emergency and non-emergency cases, thus preventing unnecessary traffic congestion. Figure 3 shows the overall block diagram for traffic monitoring and congestion system

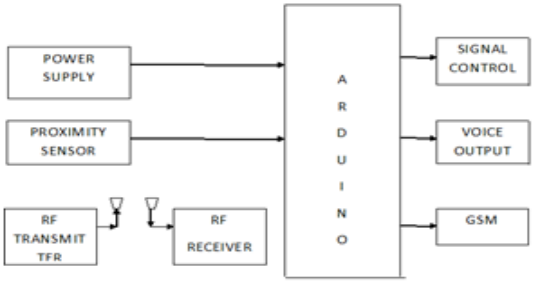

Figure 3. Overall block diagram.

IV. Software Algorithm

Programs written using Arduino Software (IDE) are called sketches. These sketches are written in the text editor and are saved with the file extension .ino. The editor has features for cutting/pasting and for searching/replacing text.

The Arduino Uno can be programmed with the Arduino software (download). Select "Arduino Uno from the Tools > Board menu .The ATmega328 on the Arduino Uno comes pre

burned with a boot loader that allows to upload new code to it without the use of an external hardware programmer.

The software algorithm for detecting presence of vehicle and over speed detection is explained below shortly:

Step1: Include header files for Interfacing LCD with the Microcontroller unit.

Step2: Initialize all the macros and variables.

Step3: Initialize digital ports for interfacing proximity sensors.

Step4: Initial sensor state is low. This indicates that no vehicle is detected . After detecting target, sensor state becomes high. Initially the value of variables TO, H, L is zero.

Step5: Configure the sensor output as input to the controller.

Step6: Initialize timer.

Step7:Over speed condition is checked initially based on sensor output.

Step8:Vehicle classification takes place depending upon the data from sensors.

Step9:After vehicle classification vehicle count gets incremented.

Step10: All the results are displayed in LCD display.

V. Experimental Results

The Advanced traffic monitoring and congestion control system consist of microcontroller Arduino Uno and Inductive Proximity sensors. These two form the principle components. Apart from these, GSM SIM900, LCD, RFID tag, RFID Reader, Voice Output are also used to perform additional features. The overall system module is shown in Figure 4.

Figure 4. Advanced traffic monitoring and congestion control system.

A. Initial Setup Description

A 5V power supply is given to Arduino Uno. It's is the operating voltage for Arduino. GSM SIM900 is interfaced with the controller. To give audio output, voice board is also interfaced with controller. To display vehicle count, and classified output, LCD display is used. Traffic signal LED is also connected to controller Proximity sensors are placed in horizontal manner on the adjacent side of the road.

Figure 5. Initial Setup

Sensor output is fed to the traffic signal. Here traffic signal is indicated using green and red LED lights. As soon as the traffic control system setup is switched on LCD displays the text "TRAFFIC CONTROL". H stands for heavy vehicles, L stands for light vehicles and TO refers to total count. Initially count of TO, H, L is set to zero.

B. Vehicle Count In Lane 1

In this condition, proximity sensor detects a vehicle in Lane1. In the proposed system, only two lanes of road are considered. Three sensors are arranged horizontally in lane 1. As soon as the first sensor detects metal target, vehicle count starts. Classification of vehicles is performed by second and third sensor. If the sensor 2 and 3 detects vehicle individually, then the vehicle is considered to be light vehicle. And if both the sensors detect the vehicle simultaneously then we call it as heavy vehicle. In this condition, lane 1 detects light vehicle and whereas lane 2 does not detect any vehicle. As soon as vehicle is detected in lane 1, green led in lane 1 glows and lane 2 shows red light indication.

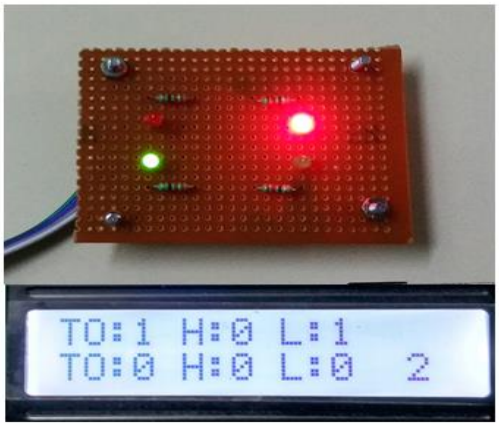

Figure 6. Vehicle count in LANE1.

C. Vehicle Count In Lane 2

In the proposed system 3 proximity sensors are arranged horizontally in lane 2.Whenever the density of vehicles is more in lane 2, green signal is shown in lane 2. In this condition, there is no vehicle in lane 1 and light vehicle is detected in lane 2. So lane 2 shows green light whereas lane 1 indicates red light in the figure7.

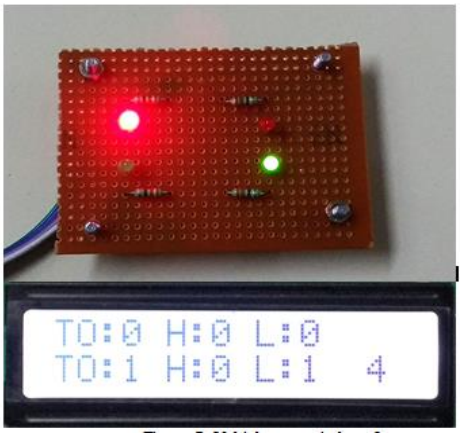

Figure 7. Vehicle count in lane 2.

D.Over Speed Detection

In this condition, sensor 1 and sensor 2 are used to detect over speed. A predetermined time delay between the sensors 1 and 2 is set initially in the timer of controller. When any vehicle takes less time than the predetermined time delay, over speed condition is detected.

Figure 8. Over speed detection.

A. Message sent to phone

As soon as over speed condition is detected, alert message is sent to the nearby police station using GSM SIM900 module. The message received in the mobile phone during over speed detection in lane1 and lane 2 is shown in the Figure 9.

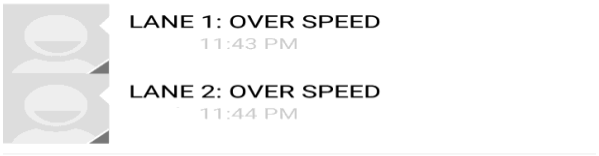

Figure 9. Message sent to phone.

Emergency vehicle detection

In this condition, all the emergency vehicles are given unique RFID tag. Here emergency vehicle passes through lane 1. As soon as the RFID reader detects the tag, it transmits tag information to the controller. As soon as the reader reads tag data, signal of that particular lane turns green irrespective of the density of that lane. Signal is turned green in lane 1 till the emergency vehicle crosses the traffic signal. Emergency vehicle detection is shown in shown in the Figure 10.

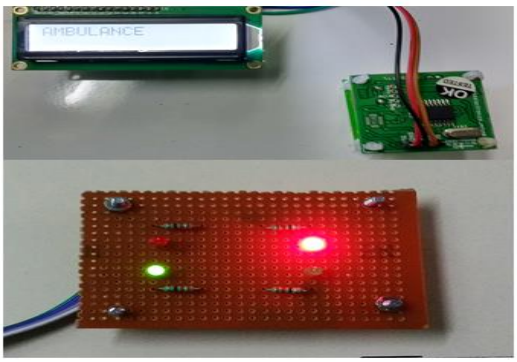

Figure 10. Emergency vehicle detection.

B. Voice output

The voice board called audio play back board using APR33A3IC is placed at the traffic junction. This will first say the name of the lane, whether lane1 or lane 2. Then it will announce the time left for the corresponding signal to turn green. This helps the people in being aware of the signal status and also helps impaired people in road crossing.

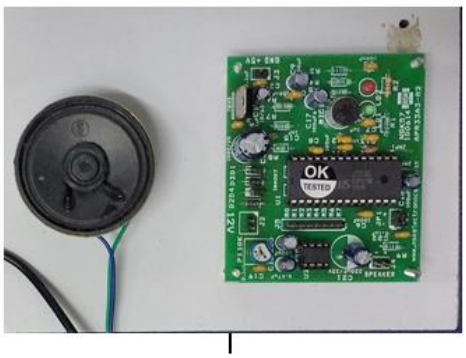

Figure 11. The Voice board

VI. Conclusion

Thus advanced traffic monitoring and congestion control is used to count the number of vehicles, classify those vehicles and control the traffic signal depending upon the density of vehicles. Portable Inductive proximity sensors are used to implement this. And through these sensors over speed vehicles are detected. After detecting, an alert message is sent to the nearby police station through GSM module. Provisions are made to give special attention to ambulance and other emergency vehicles. When an Ambulance arrives, its corresponding lane traffic light becomes green and all the others become red thus allowing ambulance to reach hospital swiftly.

Sensors used in this project are placed on the side of the road, and hence, there is no need to stop the traffic for their installation. This system paves way for over speed detection without human intervention. By giving special attention to emergency vehicles, these could reach hospital swiftly and save human lives. Voice output is provided in the traffic signal which facilitates impaired people and old age people for easy road crossing. Thus the proposed system is compact, portable, wireless, and inexpensive.

VII. Future Work

In the Advanced traffic monitoring and congestion control system, Inductive proximity sensors are placed on only one side of the lane. But in future, sensors can be placed on either side of the road. So that, multiple vehicles can also be detected. Instead of providing just a voice output for impaired people in road crossing, a separate wearable gadget can be given to the impaired people, which is capable of intimating them through a vibration, when they arrive at zebra crossing. The proposed work can be further enhanced by altering the signal delays based on the density.

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