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ENERGY GENERATION FROM PIEZO ELECTRIC MATERIAL FOR AN OPEN TRAFFIC CONTROL MODEL AND ALTERNATE ROUTING FOR AMBULANCE

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ABSTRACT

In this paper, the embedded board with interface module to implement a traffic control system. The proposed model uses an embedded board to replace a manual operation, since the embedded board has the advantage of being easily carried, a real-time operation, a low cost, and programmable. In addition users can operate this measurement system with the help of the operating system andthe GPS modules to connect to the Internet.

The design provides the step by step function to help user operate, such as traffic flow information by using embedded measurement system. This design can also show the traffic flow detailsin LCM (Liquid Crystal Monitor). GPS is mainly used to identify the vehicle state information. Vehicle state information will be send to control section and based on the information traffic light phase is changed according to the traffic by LABVIEW.Piezoelectric crystals are used to generate electrical energy for traffic light signals by applying mechanical vibration. Piezoelectric effect is used to generate the electrical energy. This system can be mainly used for real time applications.

INTRODUCTION

There has been an increasing demand for low-power and portable-energy sources due to the development and mass consumption of portable electronic devices. In this scope, piezoelectric materials become a strong candidate for energy generation and storage in future applications.
The direct piezoelectric effect is more suitable for sensor applications. Therefore, it can be stated that a material is called piezoelectric when it shows the ability to transform mechanical into electrical energy.Piezoelectric crystals are placed in the highways

near traffic signal. The power will get generated when the vehicles are passed over the crystals, since crystals will produce voltage signal when it subjects to deformation. With this generated power the entire traffic signaling system can be operated.

The system monitors traffic density of vehicles near the traffic signal and provide alternate routing system before reaching the crowded traffic signal. The system has a wireless transmitter unit to send those signal details and in the receiver side, we kept a display unit with upcoming traffic signal details, the system can respond before 200-1000 meters of distance before traffic, so that the driver can take other way to reach the destination by not using the crowded traffic. And also in the ambulance, GPS and GSM units were used to send the exact location of the ambulance to the control room. The spot and the hospital is informed in the control room and by tracking the ambulance position, can try to control the traffic signals from remote place.This is the concept of the proposed system which controls the traffic signal through wireless communication. In the control room, the proposed system is to use the LABVIEW software for the effective interface. This system controls all the traffic signals and provides an easy route for the ambulance to move.

PROPOSED SYSTEM

Piezoelectric materials are placed on the road side, so that when the vehicles pass on it more power will be generated. By using Lead Acid batteries and storing thepowerprovides energy for the whole traffic signal system in real time.

In addition to this, alternate routing technique to reduce the traffic is carried out. IR transmitter and receiver are used at different levels on the road and the traffic level is monitored, and the current traffic level will be displayed on the road 200 – 1000 meters prior to the traffic. This system helps us to know about the current traffic details before reaching the traffic, so that the ambulance can take the alternate route to avoid the traffic and further increase in traffic level will be avoided.

It mainly concerns collectingroad traffic flow information data, sending traffic flow data, receivingtraffic light phase data. Inthis module,vehiclestate information will be obtained from the GPS devices. The GPS devices cancommunicate with the control unit and thus by LABVIEW in PC can change the traffic lights.The GPS devices and sensors can communicate with each other by wireless communications; therefore, the real-time traffic flow information canbe sent to the lights. Meanwhile, the traffic control results will be sent to theGPSs, and then, drivers can know the traffic light phases in time. The purpose of the storage is to save the received traffic flow data. The traffic lights are the displays that show the control results.

In figure 1,The Transmitter section consists of Piezo electric element, Bridge rectifier, Storage battery, ADC, Microcontroller, IR Sensors, Encoder and wireless transmitter. The output from the piezoelectric crystal is having different magnitude with respect to time. At the same time, the current ratings are very less. So bridge rectifier is used to rectify the voltage and it will be handled by the capacitor and it will get stored in the battery for later use.

IR Sensors are used to find the level of traffic and the output of IR Sensors is fed to Microcontroller AT89S52. It has 8K of Program memory and 256 bytes of code memory with 32 Input and output lines. It is used to monitor the traffic flow andits corresponding traffic detailsistransmitted through the Wireless transmitterby encoding the data through encoder.

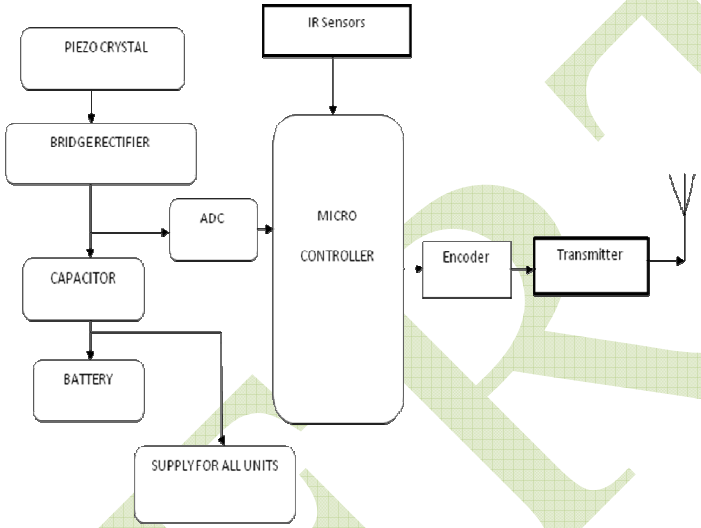


Figure 1: Transmitter Section

When mechanical stress is exerted on Piezo crystals, an applied electric field produces in these materials a linearly proportional strain. The electrical response to mechanical stimulation is called the direct piezoelectric effect and the mechanical response to electrical simulation is called the converse piezoelectric effect.

In figure 2,Receiver section consists of LCD module, Microcontroller, Decoder and Wireless receiver. The Data sent from Wireless transmitter is received through the wireless receiver. The received data is then decoded and sent to the Microcontroller AT89S52. The 2x16 character LCD module interfaced with microcontroller is used to display the current traffic information.

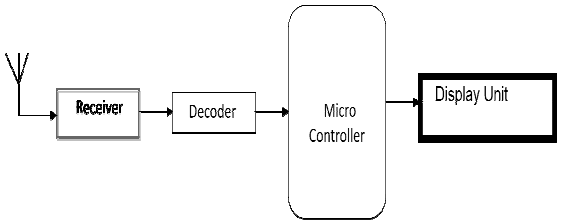


FIGURE 2: RECEIVER SECTION

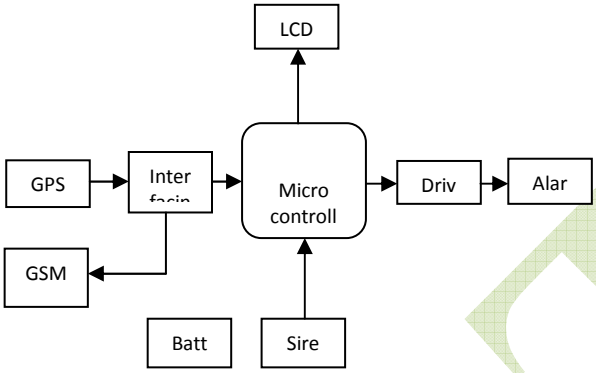


FIGURE 3. VEHICLE UNIT

Figure 3 shows the Vehicle Unit section consists of Battery, Microcontroller,Alarm,Siren switch, GSM module, GPS module and Interfacing circuit. The output of GPS module is fed to Microcontroller AT89S52. It is used to monitor the location of the vehicle. The location is sent to the control room using GSM module.

Control room section consists of Microcontroller, GSM Module, Interfacing circuit, PC or Laptop, Encoder and Wireless RF Receiver. The Location Information sent from Vehicle is received via GSM and sent to the system using the interfacing circuit. Through the LABVIEW software the location of the vehicle is continuously monitored and the control signal for the traffic signal lights is then sent to the corresponding area with the help of Microcontroller, Encoder and Wireless RF Transmitter.

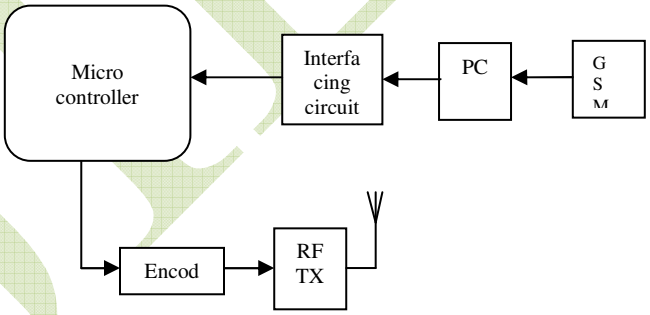


FIGURE4. CONTROL ROOM SECTION

Traffic Light Signal section consists of Traffic signal module, Microcontroller, Decoder and Wireless RF Receiver. The Data sent from Wireless transmitter is received through the wireless receiver. The received data is then decoded and sent to the Microcontroller AT89S52. The Traffic signal lights interfaced with microcontroller is used to display the signal.

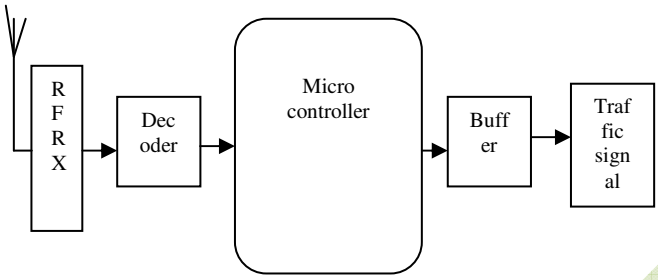


FIGURE 5. TRAFFIC LIGHT SIGNAL SECTION

1 WIRELESS TRANSMISSION

1 RF transmitter

It is an ideal for remote control applications where low cost and longer range is required. The transmitter operates from a 1.5-12V supply, making it ideal for battery-powered applications. The transmitter employs a SAW-stabilized oscillator, ensuring accurate frequency control for best range performance. Output power and harmonic emissions are easy to control, making FCC and ETSI compliance easy.
On-off keying (OOK) is a type of modulation that represents digitaldata as the presence or absence of a carrier wave.OOK is the modulation method of choice for remote control applications where power consumption and cost are the primary factors. Because OOK transmitters draw no power when they transmit a 0, they exhibit significantly better power consumption than FSK transmitters. OOK data rate is limited by the start-up time of the oscillator. The start-up time of the oscillator determines the maximum data rate that the transmitter can send.
The oscillator start-up time is on the order of 40uSec, which limits the maximum data rate to 4.8 Kbit/sec. The transmitter is basically a negative resistance LC oscillator whose center frequency is tightly controlled by a SAW resonator. SAW (Surface Acoustic Wave) resonators are fundamental frequency devices that resonate at frequencies much higher than crystals.

2 RF receiver

It is an ideal for short-range remote control applications where cost is a primary concern. The receiver module requires no external RF components except for the antenna. It generates virtually no emissions, making FCC and ETSI approvals easy. The super-regenerative design exhibits exceptional sensitivity at a very low cost.

Table: 1 RF receiver Performance

RF Frequency	915 MHz
Minimum RF Input	40µW
Load Capability	3µw / 70 µw RF input
Modulation	OOK
Data Rate	30 kbps
Leakage Current	<5µA

Super-regenerative AM detection occurs. The RF Receiver module uses a super-regenerative AM detector to demodulate the incoming AM carrier. A super regenerative detector is a gain stage with positive feedback greater than unity so that it oscillates.
An RC-time constant is included in the gain stage so that when the gain stage oscillates, the gain will be lowered over time proportional to the RC time constant until the oscillation eventually dies. When the oscillation dies, the current draw of the gain stage decreases, charging the RC circuit, increasing the gain, and ultimately the oscillation starts again.

RESULTS& DISCUSSIONS

The generated power using Piezo electric material has tested it using the LED. The Various Piezo electric crystals placed series to each other and its output connected to LED is shown in the figure 6below:

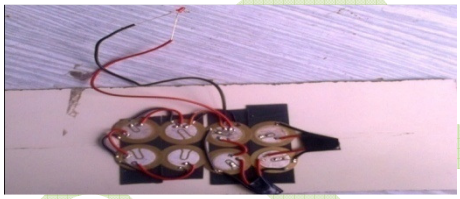


Figure 6.Piezo Electric Crystal Unit

The output of this unit is realized by punching on the crystals or providing vibration to the crystals, which in turn makes the LED to glow. The mechanism behind this power generation is that, a mechanical vibration is given to the Piezo electric crystals, the electrical output will be obtained.
These Piezo electric materials were placed on the road side, so that when the vehicles pass on it more power will be generated. By using Lead Acid batteries and storing these powers can provide power to whole traffic signal system in real time.
In addition to this, an alternate routing technique is done to reduce the traffic. The figure 6.1 and 6.2shows the Receiver and Transmitter section of the proposed system.The Transmitter section is placed in the Road side place, in which the three IR sensors shown in the above figure is placed at different distances from the traffic signal level crossing on the road The three IR Sensors are named IR Sensor1, IR Sensor2, IR Sensor3respectively

Fig 6.1 Transmitter section

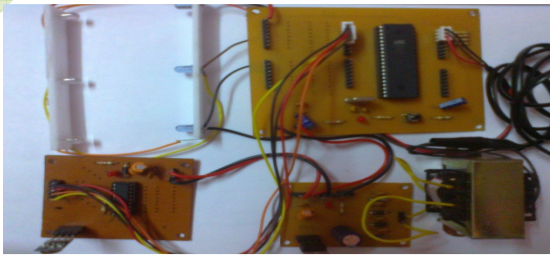
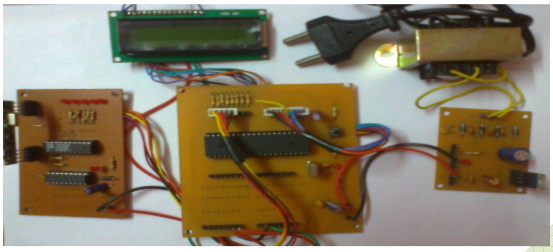


Fig 6.2 Receiver section



The IR Transmitter is placed on one side of the road whereas the IR receiver is placed on the opposite side of the road. When the vehicles are waiting till IR Sensor1 level, Interrupt occurs and IR Sensor1 output changes. Similarly IR Sensor2 and IR Sensor3 works. The outputs will be processed and transmitted through RF Transmitter.

The Receiver section is placed 200 to 1000 meters prior to the Traffic signal, on the left side of the road. The Transmitted signal from Transmitter section is received with the help of RF Receiver in the Receiver section. This unit consists of a LCD which displays the current traffic details of that particular road, according to the data received. This helps us to know about the current traffic details before reaching the traffic, so that the alternate route can be taken to avoid the traffic and further increase in traffic level will be avoided.

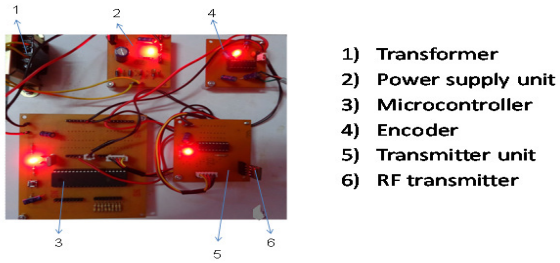


Figure 7: Transmitter section(Control Unit)

Transmitter section from vehicle unit is the module fixed in every vehicle so that when the vehicle met with an accident, the impact sensor senses it and the alarm will be activated. If any person inside the vehicle is conscious and finds accident doesn't have more impact, will press the reset switch and alarm is deactivated. If no one is conscious and accident is severe and the alarm is not deactivated within the particular time period, the location of the accident is obtained from GPS and alert will be sent along with the location to the control room via GSM. The GPS and GSM module is fixed in every ambulance vehicle, so that the exact location of the ambulance will be monitored continuously in the control room Figure 7.

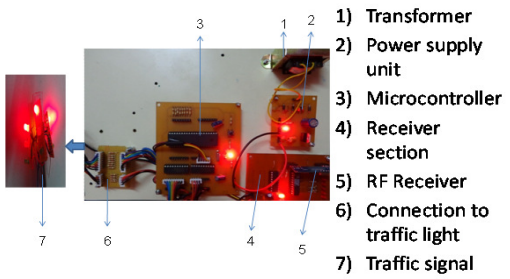


Figure 8: Receiving section in the Traffic signal light unit

Figure 8 shows the traffic signal light unit in the particular road. The data from the control room is received via RF receiver and corresponding signal change is done.

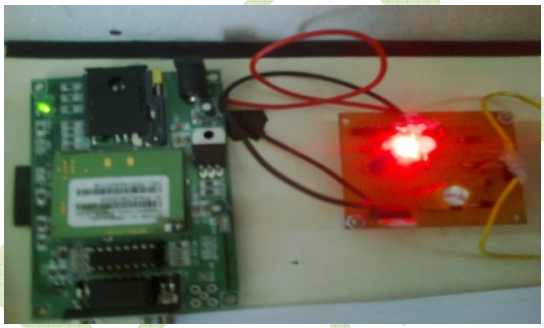


Figure 10: GSM unit to receive accident occurrence

Figure 10 shows the GSM unit connected with the PC/Laptop to receive the alert from the accident vehicle and the location of the ambulance from the ambulance vehicle.

OUTPUTS

IR Sensor1 is placed near the Traffic signal, IR Sensor2 at some distance from IR Sensor1 and IR Sensor3 at some distance from IR Sensor2.

A. LOW TRAFFIC INDICATION

In figure 11,When traffic level is till IR Sensor1, IR Sensor1 output will be enabled. Then **LOW TRAFFIC** will be displayed on the LCD as in figure 12.

IR Sensor3 IR Sensor2 IR Sensor1

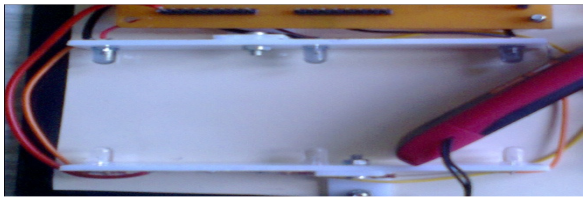


Figure 11: Low traffic indication in Transmitter side

Figure 12: Low Traffic Display in Receiver side

B. MEDIUM TRAFFIC INDICATION

In figure 13, When the traffic level is till IR Sensor2, IR Sensor2 output will be enabled. Then **MEDIUM TRAFFIC** will be displayed on the LCD as in figure 14.

It works only when both IR Sensor1 and IR Sensor2 output is enabled. In case if only one vehicle passes between IR Sensor2 alone, it will not be considered.

IR Sensor3 IR Sensor2 IR Sensor1

Figure 13: Medium traffic indication in Transmitter side

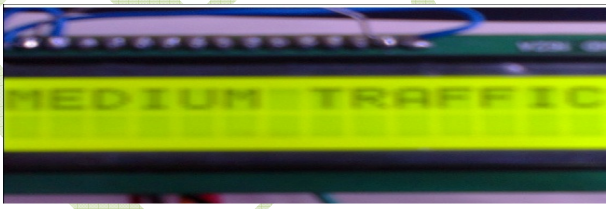


Figure 14: Medium Traffic Display in Receiver side

C. HIGH TRAFFIC INDICATION

In figure 15, When the traffic level is till IR Sensor3, all the IR Sensor1,2,3 outputs will be enabled. Then **HIGH TRAFFIC** will be displayed on the LCD as in figure 16.It works only when all IR Sensor1, IR Sensor2 and IR Sensor3 outputs are enabled. In case if only one vehicle passes between IR Sensor2 alone or IR Sensor3 alone, it will not be considered.

IR Sensor3 IR Sensor2 IR Sensor1

Figure 15: High traffic indication in Transmitter side

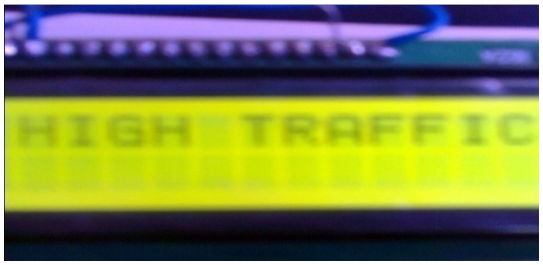


Figure 16: High Traffic Display in Receiver side

Ambulance tracking and Alternate Routing

Initially, the traffic light signals are programmed in all the areas in order to vary from red to yellow, yellow to green and green to red within particular time interval. When one face is green, all the signals in other faces are in red. The variation of those faces is shown in the figure 17 below.

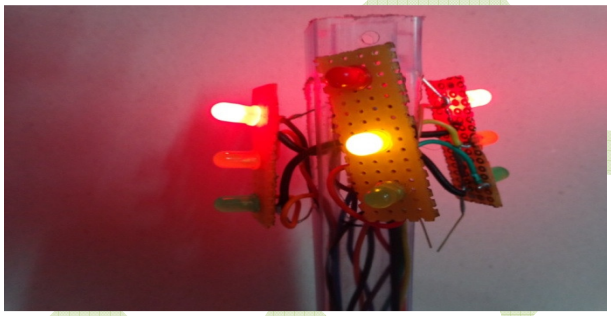


Figure 17: Traffic light signals in normal conditions

When the accident is identified, and alarm is not deactivated, the location of the accident is sent to the control room. The information is received in the control room and it is viewed in the Lab VIEW software. When the information sent to ambulance and the ambulance along with the patient is moving to the hospital, the location of the ambulance is continuously sent to the control room and it is viewed in the Lab VIEW software.

According to the location of the ambulance, the corresponding path is made free by clearing the traffic signals in that particular path. This can be done in the control room and the corresponding signal is made green as shown in the figure 18below.

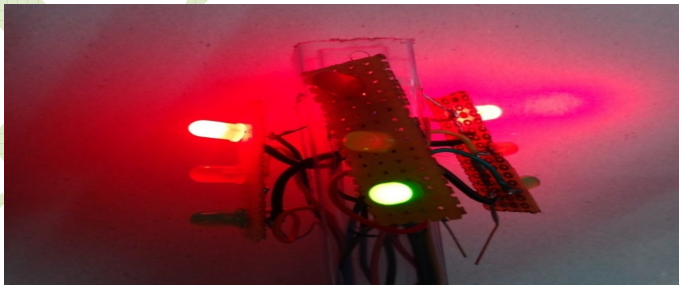


Figure 18: Clearing the traffic signals in the path of ambulance

FUTURE IMPLEMENTATION

The generated power from the Piezo electric crystal and it has been tested using LED. In future implement this system of generating power from Piezo electric crystal for providing supply to whole

traffic light signaling system. Place the crystals on the surface of the road before the traffic signals on the white level crossings or on the speed breakers so that when the vehicles pass on it, power will be obtained. Feeding this power to bridge rectifier, then stored in the Lead acid batteries. This power will be then utilized for traffic light signals. In addition to thistrack the vehicles such as VIP vehicles, Ambulance vehicles, Fire service vehicles, etc using GPS. The GPS module will be fixed on those vehicles and the vehicle's location is continuously sent to the control center using GSM. The continuous monitoring of those vehicles location is done in the control center and the corresponding road's traffic signal is made green. This system helps to provide faster transport. We are going to track the accident vehicles and Ambulance vehicles using GPS. The GPS module will be fixed on those vehicles and the vehicle's location is sent to the control center using GSM. The continuous monitoring of those vehicles location is done in the control center and the corresponding road's traffic signal is made green. This system helps the ambulance to reach the hospitals in time. This project can be effectively done by using long distance and advanced transmitters and receivers in real time. In future this systemwill be implemented with the help of high efficient transceivers.

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