

# EMBEDDED SYSTEM BASED SMART HIGHWAY

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**Abstract**—Smart Highway Technology is the term for number of different proposals to incorporate technologies into roads for generating energy, for improving accident detection, for automating street lights and traffic lights, etc. The purpose of Smart Highway is to develop safer and more convenient highways by means of converging the highly advanced road technologies, IT communication technologies and automobile technologies for the next generation. This paper illustrates the various technologies that make smart roads by using automated lights, energy and communication that interact with traffic situations.

**Index Terms**—Bluetooth Module, Roadside unit, Vehicle Unit

## I. INTRODUCTION

An embedded system is a special-purpose computer system designed to perform one or a few dedicated functions, sometimes with real-time computing constraints. It is usually embedded as part of a complete device including hardware and mechanical parts. In contrast, a general-purpose computer, such as a personal computer, can do many different tasks depending on programming. Embedded systems have become very important today as they control many of the common devices we use.

Since the embedded system is dedicated to specific tasks, design engineers can optimize it, reducing the size and cost of the product, or increasing the reliability and performance. Some embedded systems are mass-produced, benefiting from economies of scale.

In the last few decades the total number of vehicles around the world has experienced a remarkable growth. The effect of this situation is the increase of traffic accidents on the road, consumption of more energy and traffic congestion.

The proposed system is designed to improve the traffic safety, achieving a reasonable reduction of road death, effective management of energy resources. The applications in Smart Highway Technology includes: Automated Street Light, Density Based Traffic Light, Intelligent Accident Detection and Ambulance Rescue System, Driver Information System, Energy Generation using piezoelectric material. In Automated Street Light System, street lights are switched on depending on the intensity of the Sun light as well as the vehicle movement. In Density Based Traffic Light system, the traffic light is managed depending upon the density of vehicles. Intelligent Accident Detection system and Ambulance Rescue System reduces the loss of life due to accidents and time taken by the ambulance to reach the hospital. Here we will implement the system in which automatic detection of accident through sensors provided in the vehicle, a main server unit houses the data bases of all hospital in the city, a GPS and GSM module in the concerned vehicle will send the location of accident to main server which will rush in ambulance from nearest hospital to accident spot along with this there would be a control of traffic light signals in

the path of ambulance using RF communication. Driver Information System is another important application in smart highway technology, it consists of a portable unit placed inside the vehicles and it communicates with the roadside systems at all times and a voice notification is given to the driver about the hurdles. Additionally, once implemented the system can be used for applications like driver drowsiness detection using accelerometers and automatic voice alerts, to alert the driver using GPS receiver placed in the vehicle, detecting the health status of driver, check drunk and drive and also accident detection can be done. Energy Generation using piezoelectric material is another application in smart highway. In this piezoelectric materials are used for the construction of pavements which generate electricity when pressure is applied. The electricity generated is used for lighting street lamps, traffic light etc.

## II. LITERATURE SURVEY

### A. Piezoelectric Experiments

Brenda Ou, et al. scientists of Japan has installed piezoelectric tiles in Tokyo's busiest stations. They noted that the footstep of an average person whose weight is 60 kg is able to yield 0.1 watt/sec. It has also been reported that there is a 3×5 feet panel a product of Digital Safari Greenbiz Company which is capable of producing 17.5 watts/step<sup>[14]</sup>. Scientist at the Hull University worked on convert on to motion in to electrical energy.

### B. Street light based on the light intensity

Apurv Ekansh et al.<sup>[13]</sup> proposed automatic street lighting system based on low cost LDR circuit and 555 timer. The main objective is to design energy efficient based controller for controlling the Light Emitting Diode (LED) based street lamp via appropriate lighting levels control. This system consists of a simple light detecting resistor, sunlight detecting sensors and LEDs. While, the controlling and managing of the system is based on the number of traffic and five different level of street light

brightness has been used for lighting up the street and proportional to the number of traffic. The system was programmed to automatically turn off during the hours of daylight and only operate during the night and heavy raining or bad weather. The main problem of this system is that street light glows even in the absence of vehicle.

### C. Image Processing Based Intelligent Traffic Controller

Vikramaditya Dangi et al.<sup>[11]</sup> proposed a system in which Traffic congestion problem can also be reduced to greater extent through the process of image processing. In this technique a camera is used which is fixed on either poles or some other tall structure in such a way that they can cover the whole traffic scene. Images extracted from the video is then analyzed and used to detect the vehicle and for counting them and thus depend upon the density, the time is allotted to each side. The disadvantage of this system is high cost.

### D. Road Traffic Congestion Monitoring and Measurement using Active RFID and GSM Technology

Koushik Mandal et al.<sup>[12]</sup> proposed a system in which active RFID tag, wireless Coordinator, wireless router, GSM modems and monitoring station Software are used. Here the wireless devices are mounted on either sides of the road and they collect the data from the active RFID tags. Through GSM, monitoring station will collect all the data and respond to the corresponding traffic signal. The system is complex system.

### E. Automatic emergency alert system

In E. Davila, et al. the author present an automatic emergency alert system for two-wheeled. This system has features like crash detector and an eCall box, which can be connected over a wired or wireless link which was developed only for two wheelers. The box provides the notification (emergency call) service, which sends eCall's minimum Set of Data to the Public Safety Answering Point. Early experimental results showed systems reliability of the detector-box wireless communication, and detection of frontal, lateral and roll-over crash types. This system alerts the driver of the vehicle about accidents on the coming roads and also advices to control the speed i.e. acceleration and braking.

## III. PROPOSED METHOD

Automation, Power consumption and Cost Effectiveness are the important considerations in the present field of electronics and electrical related technologies. The Proposed work is to minimize the accidents, traffic congestion, power consumption etc. The technologies used in proposed systems are;

### A. Automated Street Light System

The proposed system consists of Atmega8 microcontroller, LDR (Light Dependent Resistor), PIR (Passive Infrared Radiation) sensor and LCD.<sup>[6]</sup>

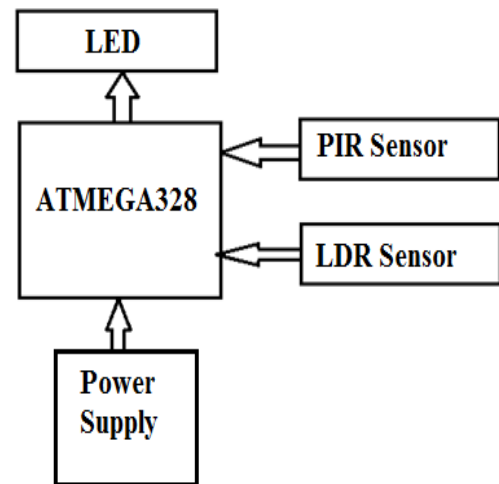


Fig. 1. Block diagram of Automated Street Light System

Street lights are switched on depending on the intensity of the Sun light on LDR. If the intensity of Sunlight on light dependent resistor is low, its resistance value becomes high. This value increases and becomes high when it is completely in dark. This resistance value decides when the street lights are required to switch ON. Once the street light gets active it remains ON for 10 sec and goes to OFF state. Now the PIR sensor comes into play.<sup>[5]</sup> When there is any vehicle on the road, it is detected by the PIR sensor. Whenever PIR sensor is detected it just indicates the microcontroller to switch ON the street lights. Then lights are switched on for 2 to 3 minutes and switched off automatically.

### B. Density Based Traffic Light System

The aim of our study is to reduce the problem of traffic congestion which is becoming a very severe problem nowadays. As we all know that the present traffic light system consists of a predefined hardware which has a fixed time for green light and red light. To optimize this problem we have made a framework for an intelligent traffic control system.

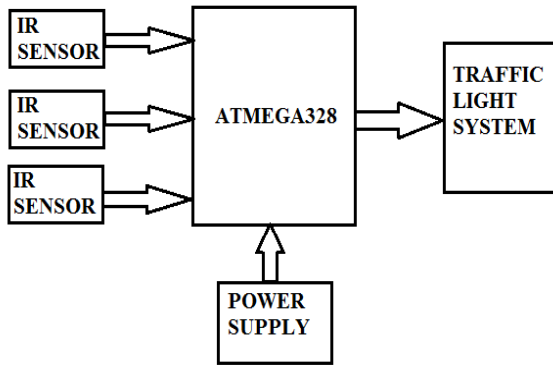


Fig. 2. Block diagram of Density Based Traffic Light System.

Generally we have seen that the conventional traffic light system is not depends upon the density of the traffic. So we proposed a scheme in which the time period of green light and red light is assigned on the basis of the density of the traffic present at that time. This can be done by using IR sensors. Once the density is calculated, the glowing time of green light is assigned by the help of the microcontroller. The sensors which are present on either sides of the road will detect the presence of the vehicles and sends the information to the microcontroller. On the basis of that information, micro-controller will make a decision and then assign the glowing time of green light and red light. It means that the timing of the traffic lights is set according to the density of the vehicles. This is going to be very helpful in the reduction of the traffic congestion and it has a scope for further expansion in future.

C. Intelligent Accident Detection and Ambulance Rescue System

The system consists of three main units<sup>[1]</sup>, which coordinate with each other and make sure that the ambulance reaches the hospital without any time lag. Thus our system is divided into following four units:

1. *Vehicle Unit:* For implementation of this work, vehicle unit should be installed in every vehicle .It consists of microcontroller along with the accelerometer, GPS and GSM module and sensors to sense the accident. On impact on the vehicle, information about accident is send to the main server. This information consists of the location of accident detected by GPS module installed in vehicle. The GPS system finds out current position of vehicle (latitude and longitude) which is the location of accident spot and gives that data to GSM module. This information to the main server is conveyed by GSM module.<sup>[8]</sup>

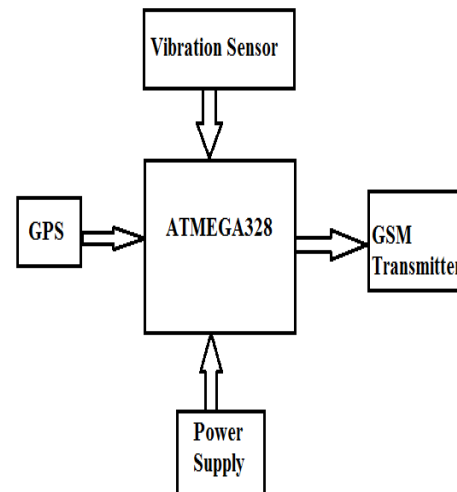


Fig. 3. Block Diagram of Vehicle unit

2. *Control Unit:* Control unit is the brain of our system. Practically, the control unit will house all the database of all the nearest hospitals in order to send an ambulance to the accident spot. It receives the message about accident location from the GPS and GSM module installed in vehicle unit and responds accordingly.

3. *Ambulance Unit:* The ambulance section consists of an RF transmitter and the traffic unit will consist of the RF receiver. The RF transmitter on the ambulance will communicate with the RF receiver of the signal section and make the signal green whenever it is within a 100m radius. As a result of which the ambulance will have a clear path all along its way to the hospital without any traffic congestion.<sup>[2]</sup>

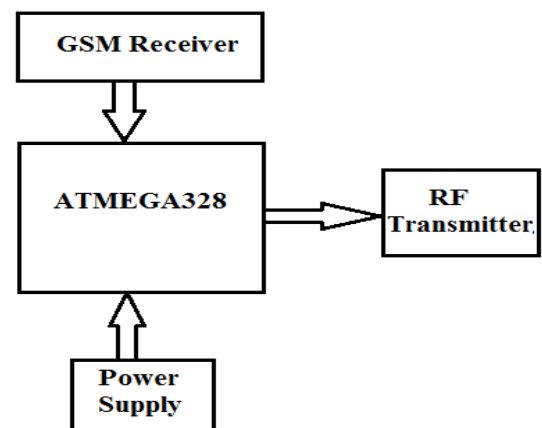


Fig. 4. Block Diagram of Ambulance unit

4. *Traffic Junction Unit:* Whenever the ambulance reaches to the traffic signal (approximately 10m) the traffic signal will be made to green through RF communication. Thus the ambulance will have clear path to reach the hospital without any traffic congestion along the way. This system is fully automated, thus it finds the

accident spot, controls the traffic lights, helping the victim to reach the hospital in time.

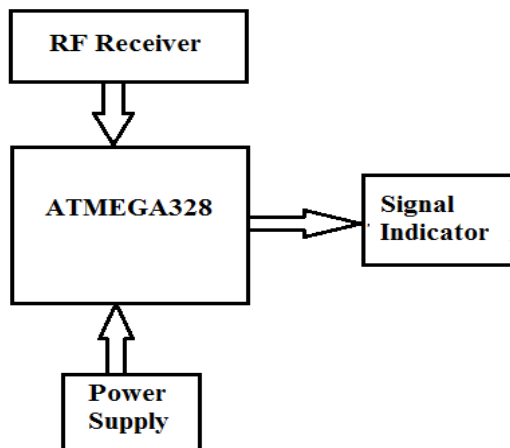


Fig. 5. Block Diagram of Traffic unit

Thus this system detects accident automatically and gives a clear way to emergency purpose vehicle on road so they can reach their destination in least time without stopping at traffic intersection.<sup>[7]</sup>

D. Driver Information System

A portable unit is placed inside the vehicles and it communicates with the roadside systems at all times. So the position of each vehicle can be very easily known by the roadside system and also the system has all the details of roads and emergency station such as hospitals stored in it. So whenever the information is needed such information is automatically passed on to the vehicle from roadside system and the driver in the vehicle can get a clear idea of the contents received.

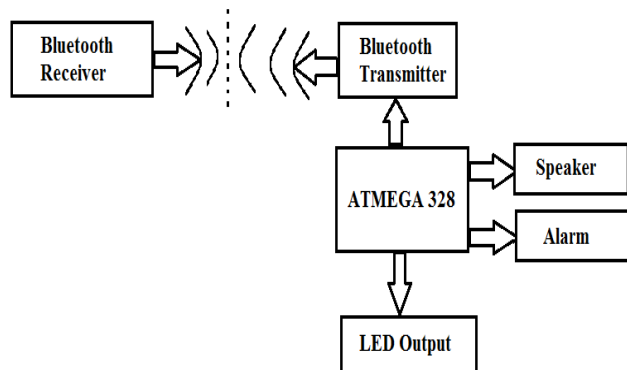


Fig. 6. Block Diagram of Driver Information System

A Bluetooth module is placed along with the microcontroller. The microcontroller at all times receives the information and displays the information using the dedicated LCD display. Further the same is used to announce to the driver about the hurdles such as speed breakers. This voice alerting system helps the drivers to concentrate on the road without even worrying about the sign boards near the road.

E. Energy Generation Using Piezoelectric Material

The main aim of this work is to generate the energy through the pressure generated by footsteps. This micro controller setup is placed at foot path when a person walking along the foot path the footsteps of the person generates some pressure and that pressure generated by the person is noted down by the pressure transducer connected to the micro controller the pressure generated at the transducer is converted into the electrical energy and that energy is stored into the battery connected to it.<sup>[3]</sup>This energy can be used to power street light and traffic lights. By using this we can develop extra energy without wasting the other resources.<sup>[4]</sup>

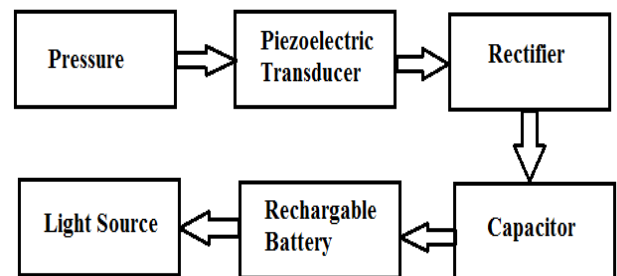


Fig. 7. Block Diagram of Energy Generation Using Piezoelectric Material.

V RESULTS

The results obtained from the proposals mentioned in the paper are as follows, the street light glows by detecting the presence of vehicle as sensed by PIR sensor, Traffic congestion in city which is detected by sensor array and traffic signal is controlled automatically, the accident is detected by vibration sensor and location of accident is received using GPS and GSM and the traffic light is adjusted automatically to pay way for the ambulance to reach the accident spot and then to nearest hospital, the voice notification about the hurdles in the road is passed to the driver using Bluetooth technology, when pressure is applied to the road having piezoelectric pavements energy is generated and this energy is used for lightning purposes.

VI CONCLUSION

Thus we have presented a smart system which can be implemented in our highways to automatically control the street lights and traffic lights, to generate electricity efficiently, intelligently control accidents and to give a clear way to emergency purpose vehicles on road so that they can reach their destination in least time without stopping at traffic intersection. This system can be effectively implemented for an entire city or countries with large population like India for better results

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