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# Intelligent Ambulance with Traffic Control

Gargi Beri[1], Ashwin Channawar[2], Pankaj Ganjare[3], Amruta Gate[4], Prof. Vijay Gaikwad [5]

[1]*(Department of Electronics, Vishwakarma Institute of Technology, 666, Upper Indira Nagar, Bibvewadi, Pune-411 037, India)*

**ABSTRACT:** Now-a-days many services get delayed due to traffic jams especially in large cities. Ambulance service is one of the crucial services that gets delayed. Sometimes on-sight doctors are not available, so the patient does not get medical attention immediately. To overcome this situation this paper describes a solution that is 'Intelligent Ambulance with Traffic Control' wich includes a traffic control system as well as a health monitoring system. In health monitoring system, the patient's vital health parameters such as ECG, Heart Rate and Body Temperature are monitored. For ECG measurement, a 2-lead Electrode Electrocardiogram technique is used. Heart Rate measurement is done using photoplethysmography method**.** LM-35 is used to measure the patient's body temperature. These parameters are sent to a PC in ambulance via serial communication and this data will be sent to the hospital server. In traffic control system an RF transmitter on the ambulance will communicate with the RF receiver mounted on the signal post. An algorithm is used to control the traffic signals automatically based on the key pressed by the driver from keyboard in the ambulance. The information reading the current as well as future location of ambulance, is sent from the ambulance itself. This information is used to optimally control the traffic.

**KEYWORDS-** Intelligent Ambulance, microcontroller, Traffic Control

## 1. INTRODUCTION

Now-a-days due to more luxurious living, more four wheelers have replaced 2-wheelers. Moreover, industrialization (tech-parks) and need for space have caused more congestion. This in turn increases traffic. Amidst all these frenzied life, one forgets the importance of human life [1].This is a very serious problem in case of the heart attack patients. A direct clot removal in Heart attack patients becomes possible if the electrocardiogram is analyzed by a cardiologist. This system transmits the ECG at a regular time intervals to the hospital .

Also the vehicles on the road have to make way for the ambulance. But sometimes, the ambulance gets stuck in the traffic which in turn wastes a lot of time. Hence to overcome all these situations a solution of 'Intelligent ambulance with traffic control' is proposed in this paper. This paper describes monitoring of health parameters of the patient in ambulance and transferring these to the hospital and at the same time traffic lights are controlled by the driver of ambulance to reach hospital as early as possible. Health parameters such as ECG, Heart rate, body temperatures are calculated by hardware and further using serial communication are stored in PC present in ambulance through which they are transferred to hospital. For traffic controlling purpose RF communication is used. Traffic density is also considered while designing the algorithm to control the traffic lights. Embedding of health Monitoring system and traffic controlling system may lead to save one precious life.

## 2. BLOCK DIAGRAM

The following two systems are combined in this paper. Data acquisition will take place in Health monitoring system and parameters will be sent to the hospital server via PC. The driver of the ambulance will be able to control the traffic signal from a keypad present in the ambulance.

### 2.1 Health Monitoring System

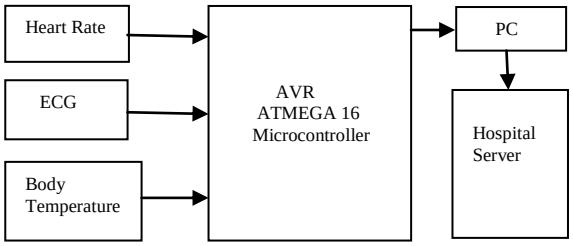


Figure 1: Block diagram health monitoring system

### 2.2 Traffic Control System

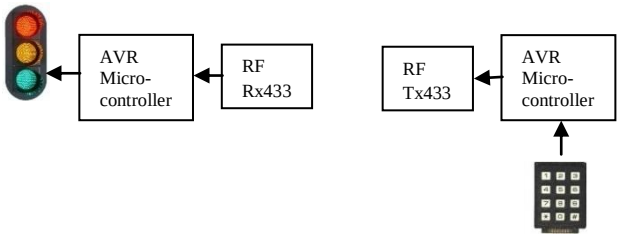


Figure 2: Block diagram of traffic control system

Both health monitoring and traffic controlling systems will work simultaneously. Patients health parameters are monitored by doctor in hospital and at the same time driver of the ambulance can manipulate the traffic signals.

## 3. HEALTH MONITORING

At this point, very little work has been done to systematically identify which biomedical signals (and signal qualities) actually are necessary for specific telemedicine procedures in EMS. More research directed to the aspect of signal delay would drastically improve the support a telemedicine system can offer to a tele- EMS physician who has to decide for a treatment method that heavily relies on the availability of biomedical signals within a certain maximum delay; this very specific maximum delay then defines real-time for the case at hand, which can automatically be assessed by the telemedicine system [2].

3.1 ECG (Eletrocardiogram)

ECG is an electrocardiogram system in which electrical activity of the heart is recorded via electrodes placed on body. Here 2-lead Ag-Cl electrodes along with conducting gel (to reduce the skin resistance) are used. ECG signal is of a very small amplitude (1mV-5mV).Electrodes measure the impulse signals (Bio-potential signals) generated by the heart which are transferred to the surface of the body. Real-time monitoring of cardiac health is helpful for patients with cardiovascular disease. Many telemedicine systems based on ubiquitous computing and communication techniques have been proposed for monitoring the user's electrocardiogram (ECG) anywhere and anytime.[3]

### 3.1.1 System Block Diagram

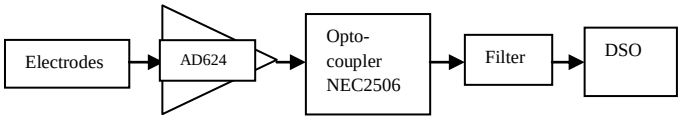


Figure 3: Block diagram of ECG

AD624AD is an analog instrumentation amplifier IC used to amplify signals generated due to contraction and relaxation of heart. The AD624 is set up with a gain of 1000, and is supplied by +9 V and -9V

power supply. Opto-coupler NEC2506 is used to isolate the input of amplifier from the rest of the circuitry. Band pass filter containing low-pass and high-pass filters are used with the RC & time constants as follows:

### 3.1.2 Filter Design

Table: Filter Design

| Parameter-> Type V | R | C | Time constant t | 3-DB Frequency |
|---|---|---|---|---|
| Low pass filter | 4MW | 1mF | 4 sec | 0.04 Hz |
| high pass filter | 10KW | 0.1mF | 0.001 sec | 159 Hz |

### 3.1.3 Result

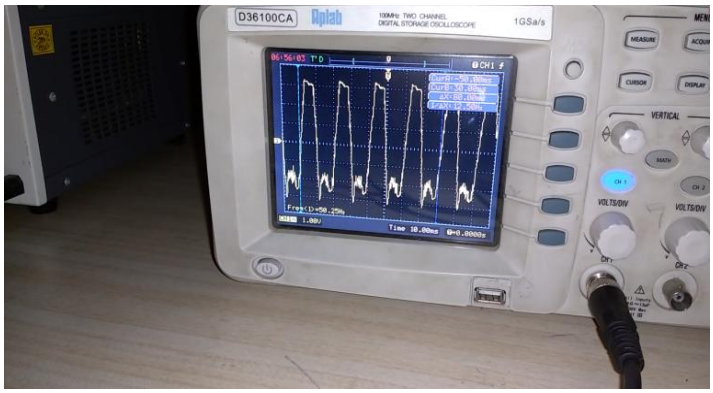


Figure 4: ECG Result

### 3.2 Heart Rate

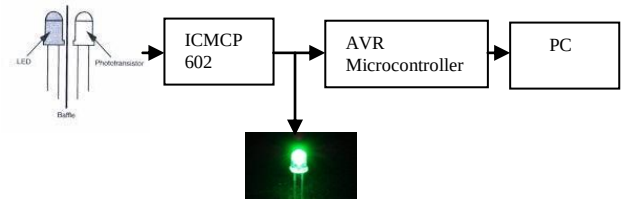


Figure 5: Block diagram of Heart Rate measurement

The activity of the heart is characterized by rhythmical contractions of ventricles and atria, allowing the oxygenation of the body organs. This regular functioning is due to electrical impulses that stimulate the muscular mass of the heart cavities to contract. With the passing of time, the cardiac activity can suffer from possible faults [4].Heart rate measurement gives the rate at which blood is pumped from the heart per minute by the human cardiovascular system. This technique demonstrates how to measure the heart rate by sensing the change in blood volume in the finger blood vessels. It consists of an infrared LED that transmits an IR signal through the fingertip of the subject, a part of which is reflected by the blood plasma. The reflected signal is detected by a photo diode sensor. The changing blood volume with heartbeat results in a train of pulses at the output of the photo diode, the magnitude of which is too small to be detected by a microcontroller. Therefore, a two-stage high gain, active lowpassfilter is designed using two Op-Amps to filter and amplify the signal to appropriate voltage level so that the pulses can be counted by a microcontroller. Heart rate is the number of heart beats per minute (bpm). In adults, a normal heart rate is about 60 to 100 beats per minute during resting condition. The resting heart rate is directly related to the health and fitness of a person. The most common sites to measure the heart rate are wrist and neck. We can count the number of pulses within a certain interval (say 15 sec), and easily determine the heart rate in bpm.

Figure 6: Result of Heart Rate

Gain of each stage is given by an equation:

$$G = (1 + \frac{Rf}{R1}) \quad (1)$$

Cut off frequency is given by an equation:

$$f = \frac{1}{2} * \pi * Rf * Cf \quad (2)$$

### 3.3 Body Temperature

IC LM35 is used as a temperature sensor with an output voltage (10mV=1°C) linearly-proportional to the Centigrade temperature. The LM35 device has an advantage over linear temperature sensors calibrated in Kelvin, as the user is not required to subtract a large constant voltage from the output to obtain convenient Centigrade scaling. The LM35 device does not require any external calibration or trimming to provide typical accuracies of ±¼°C at room temperature and ±¾°C over a full −55°C to 150°C temperature range.

Figure 7: Result of Temperature Measurement

## 4. DATA ACQUISITION

The Heart Rate and body temperature of the patient are sent to the PC by the microcontroller using serial communication. For which the serial to TTL logic converter chip CP2102 is used. This chip helps in serial to USB communication. The silab's USBXpress drivers along with the RealTerm software are used to acquire the data. The ECG of the patient is viewed on an oscilloscope; and the oscilloscope is connected to the PC using USB cable. The image of the ECG is captured by controlling the DSO virtually by using the software provided by DSO manufacturer. This data can be further sent to the hospital server with the help of internet. At the hospital, a doctor will be able to see the ECG image along with the body temperature and Heart rate on a computer. This data will help him to treat the patient immediately after the ambulance arrives.

### 4.1 Ambulance Website

The website for sending patient's basic information as well as health monitored parameters, website is designed using html.

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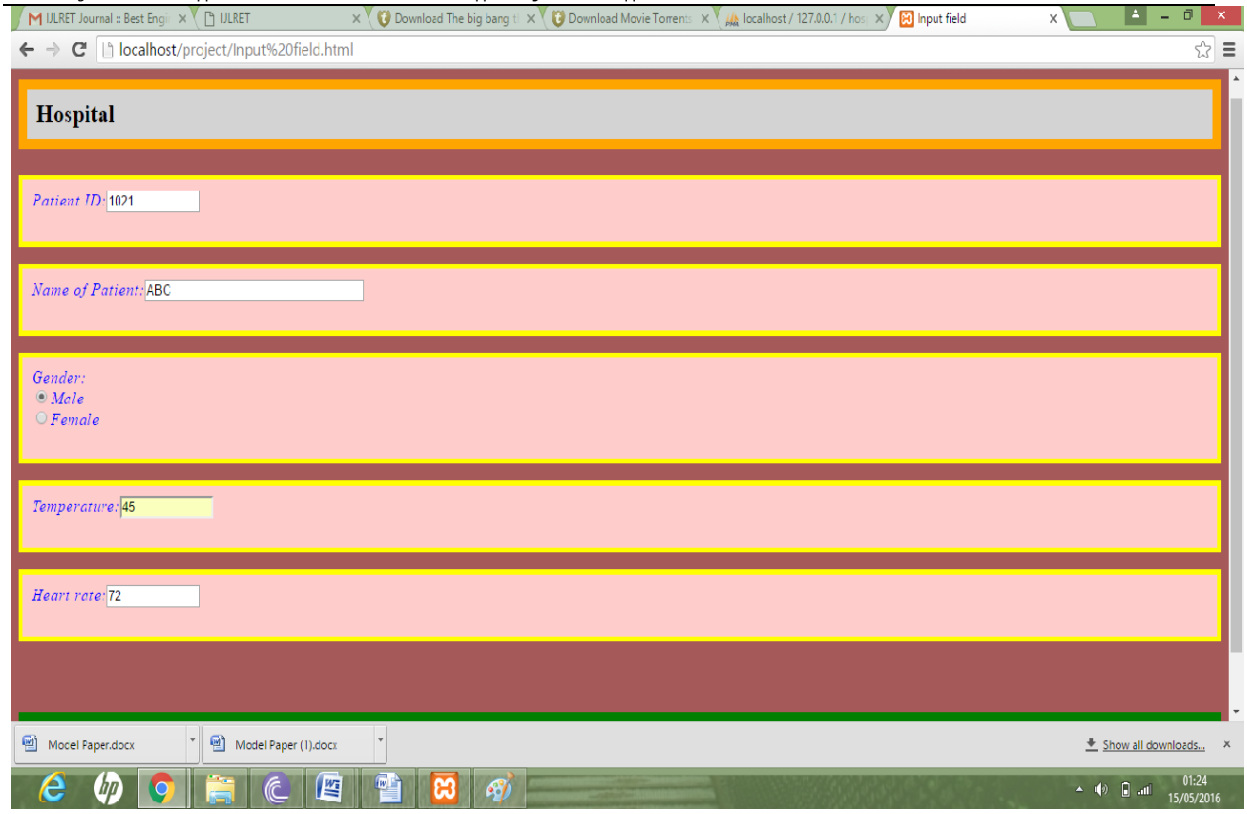


Figure 8: Ambulance Server

### 4.2 Hospital Server

Using XAMPP software as a server to receive the patient's health parameters in hospital. XAMPP is a free and open-source cross platform web server solution stack package developed by Apache Friends

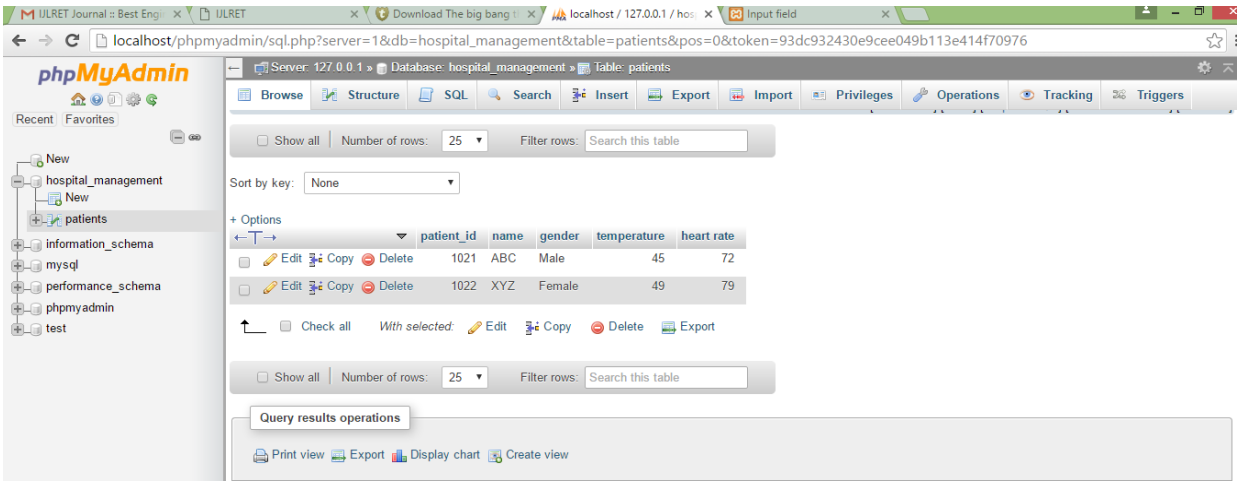


Figure 9: XAMPP Server

## 5. TRAFFIC CONTROLLING

In road networks, especially in big cities, the reaction of a TMS to create green passages for the emergency vehicles may depend on real-time traffic conditions and prediction. If the traffic congestion around the fastest route assigned to the emergency vehicle is low then traffic lights timing change and inter-vehicles coordination are sufficient to ensure short response time. If the congestion is medium then the TMS may also adapt the driving policies accordingly. Finally, in case of very high congestion level re-routing the traffic and closing some road segments may also be needed. [5]Therefore in second system a traffic controlling method is described to provide congestion free path for ambulance to reach hospital within a short time.

**5.1 Signal From Ambulance**

Every ambulance contains a navigation module for routing purpose. But as GPS signal only detects large distance displacements, instead of that a keypad which contains possible routing options is used. As the driver presses one key, a binary signal will be send to the microcontroller, which it will send to the RF transmitter via the TxD pin. This binary signal contains the current location of the ambulance, the future path, and the traffic congestion information.

**5.2 RF433 Module**

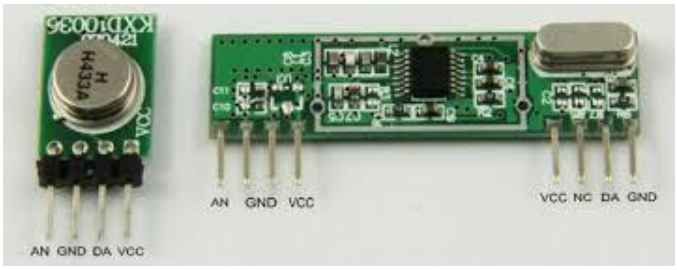


Figure 10: RF 433 Tx-Rx

A radio frequency module (RF433) is used which operates at a frequency of 433MHz. A RF transmitter placed on emergency vehicle transmits signal to receiver which is fixed on traffic lights in emergency mode. The signal received by receiver is then decoded and processed by a microcontroller. The RF module, operates at the Radio Frequency of 433MHz. The corresponding frequency range varies between 30 kHz & 300 GHz. In this RF system, the digital data is represented as variations in the amplitude of carrier wave. This kind of modulation is known as Amplitude Shift Keying (ASK). Transmission through RF is better than IR (infrared) because of many reasons. Firstly, signals through RF can travel through larger distances making it suitable for long range applications. Also, while IR mostly operates in line-of-sight mode, RF signals can travel even when there is an obstruction between transmitter & receiver. Next, RF transmission is more strong and reliable than IR transmission. RF communication uses a specific frequency unlike IR signals which are affected by other IR emitting sources. The transmission occurs at the rate of 1Kbps - 10Kbps.The transmitted data is received by an

RF receiver operating at the same frequency as that of the transmitter. The range of this RF433 module is 500 meters. As any other RF device, the performance of an RF module will depend on a number of factors. For example, by increasing the transmitter power, a larger communication distance will be achieved. However, this will also result in a higher electrical power drain on the transmitter device, which will cause shorter operating life for battery powered devices. Also, using a higher transmit power will make the system more prone to interference with other RF devices, and possibly cause the device to become illegal depending on the jurisdiction. Correspondingly, increasing the receiver sensitivity will also increase the effective communication range, but will also potentially cause malfunction due to interference with other RF devices. The performance of the overall system will be improved by using matched antennas at each end of the communication link.

The RF communication between the two modules was tested using DSO. The information transmitted by RF transmitter is encoded and a specific address is used to establish a secured dialogue. The receiver receives that signal and decodes it only if the correct address is present. These waveforms are shown below.

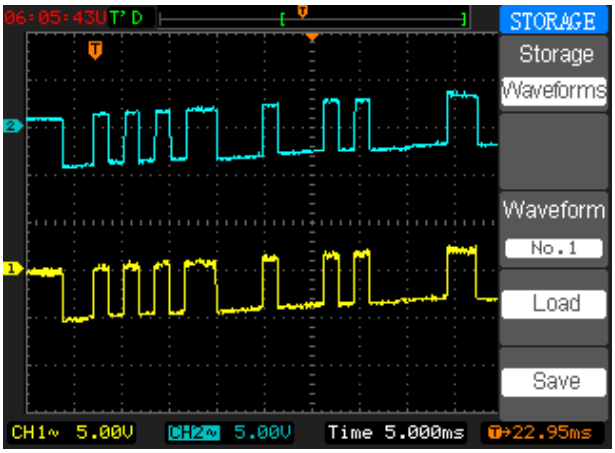


Figure 11: RF Communication waveform

**5.3 Signal Post and Signal Control Algorithm**

The receiver mounted on the signal post detects the incoming signal from RF Tx and forwards it to the microcontroller. The binary signal is used to control the traffic lights considering the information sent by the ambulance driver. Master controller pre-empts original flow sequence of traffic lights and executes emergency mode. In this mode if original signal is red then it is made green for ambulance. The driver of ambulance has a keypad for choosing path. This is implemented using keypad. A particular path or an algorithm will be selected by the controller based on the key pressed by driver in ambulance. The traffic density condition is included on the keypad itself. Based on this information, the signal will be controlled. During these operations signals from all other lanes will be red and the priority will be given to ambulance only. When ambulance crosses that lane the controller will again continue with the original sequence of traffic signals.

## 6. CONCLUSION

In this paper, a system is described which will continuously monitor the patient's health parameters and simultaneously will control the traffic signal. If the doctors do not have sufficient medical history of the patient, they may not be able to give proper treatment to the patient. This system tries to prevent just that. In health monitoring system, the patient's vital health parameters such as ECG, Heart Rate and Body Temperature are monitored. This information is sent to the hospital for analysis.

Many traffic control systems propose an autonomous solution which does not consider the future path of the ambulance. In this paper, the traffic control algorithm considers the current & destination location of the ambulance to control the traffic lights. This will help in optimization of the time taken by the ambulance to reach the hospital. Also, the monitoring of the patient will help the doctors to give him the necessary treatment for the time being.

Considering the real time scenario this system can be improved by adding an actual GPS navigation system along with a congestion detecting module for an optimized traffic control algorithm. The congestion detection part may be done using image processing or computer vision techniques. A network between consecutive signal posts may be established to control a high intensity traffic. A possible re-routing feature can be added based on traffic density, by establishing a dialogue between the ambulance and the signal post.

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