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Health Monitoring System for Ambulance

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Abstract: ***According to statistics, at least a dozen people, especially those in road accidents, lose their lives while on the way to hospitals. As per the 'Golden Hour' theory, a patient of road mishap has to be brought to a hospital within an hour, which increases chances of survival. By considering the current heavy traffic conditions in India, in emergency situations like road accidents, cardiac arrests etc., ambulance services get highly affected. People die due to improper and untimely treatment which is a serious issue. The proposed system aims at collecting and sending the patient's information to the hospital prior to the ambulance reaching the hospital so that suitable arrangements can be made at the hospital for better and efficient treatment of the patient. Apart from the basic equipment present inside most of the ambulances like emergency medical kit, two types of stretchers, defibrillator, portable oxygen cylinder, glucometer, ECG and ventilator our health monitoring system (HMS) for ambulance will also continuously monitors the patient's vital health parameters using various sensors.***

Keywords: HMS, Golden Hour, Cardiac arrest, Sensors.

I. INTRODUCTION

India being one of the most populated countries in the world, road traffic congestion and delayed provision of medical attention are critical problems. According to statistics, every minute a life is lost due to heart attack. Saving a life is precious to both the patient's family and hospital's reputation. Adding on to this precious time wasted in unavoidable traffic congestion, the ambulance tends to reach the hospital late and further time is wasted in fulfilling hospital formalities. To overcome this an inbuilt Health Monitoring System for the Ambulance can prove to be beneficial. Patients like accident victims, pregnant women or people suffering from serious health issues deserve immediate medical attention. There is a need for the hospital authorities to be aware of the patient's biomedical conditions, so that relevant and timely treatment can be provided to the patient which means there should be a wireless communication between the hospital authorities and ambulance in charge.

This requirement is met by the proposed Health Monitoring system (HMS). This consists of various sensors integrated with the Arduino Mega microcontroller. The HMS is mainly divided into,

1) *Mode Selection:* An appropriate mode is selected upon bringing the patient into the ambulance by the ambulance in charge to indicate the patient's medical scenario.
2) *Display:* The above selected mode is displayed along with other essential details regarding the biomedical condition of the patient.
3) *Extracting the Patient Details:* Upon being brought into the ambulance the patient's fingerprint is scanned and their basic information like name, age, blood group, contact number etc., are extracted from previously created medical database.
4) *Sending Mail:* The above mentioned three processes are buffered and sent in the form of a mail to the monitoring unit (hospital).

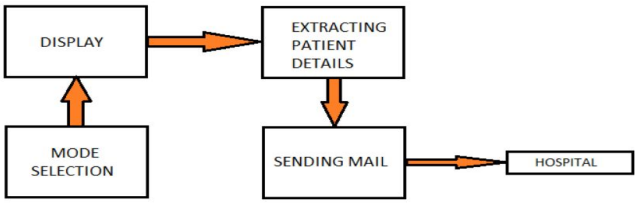

Fig.1 Basic block diagram

On completion of the above-mentioned procedure the patient's information is made available to the hospital in prior and suitable doctors can be appointed according to their availability and patient's medical condition.

For this system to be functional the following components have been used, Arduino Mega, Fingerprint sensor, OLED display, pulse sensor, 1x4 membrane keypad, BP sensor, NODE MCU microcontroller, Wi-Fi source.

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II. LITERATURE SURVEY

Previously conducted researches on health monitoring system have shown several variations over the decades, a few of which are reviewed here. One of the already existing system [1] uses an ARM7 processor module for the emergency transportation of the patient. They enable monitoring of the ambulance using google maps. They have also incorporated wireless technology like GPS, GSM modems to provide medical care as soon as possible. It also includes pulse sensor and temperature sensor and the information is sent in the form of an SMS.

There is also a proposed mobile health monitoring system for the elderly [6] which deals with smart phones and wireless body sensors and monitors the health of the elderly. In case of emergency the smart phone with the elderly person will give an alert to the people who are preassigned so that they can arrange for an ambulance. This system creates a platform for communication between the elderly person's health condition and their family members irrespective of the distance.

The work in [2] proposes a system which has the ability to monitor various physical parameters of numerous patient bodies. The signals from the wireless sensors are collected on the patient's body through a coordinator node which further sends to a base station. Other than just measuring the physical parameters the system can also measure abnormalities in them and alerts the physician accordingly.

A few advancements are seen in [3] regarding the alert system used. When the health parameters of the patient exceed the peak value which is allotted, then the microcontroller sends an alert message through the means of GSM to the pre-determined mobile number.

Another system aims at creating a low cost and effective means of monitoring patients using wireless sensor network called remote mobile monitoring system. This system can be used by bicycle rider and it can capture the environmental information. The system revolves around the concept of remote mobile monitoring system, body sensor network, and ZigBee technology [7]. It is used to constantly relay the patient details in real time to the hospital. Since it is a remote system, it has the ability to monitor patient outside the hospital premises. It helps to provide service and reach out to larger masses of people, reduces their frequency of hospital visits and enable a faster emergency service.

III. PROPOSED SYSTEM

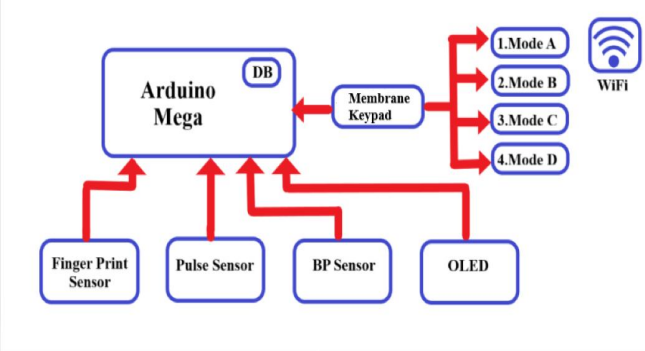


Fig.2 Detailed block diagram of HMS

As soon as the patient is admitted inside the ambulance the further process takes place with the help of the HMS. This HMS is mounted with bio-medical sensors, display, 1x4 membrane keypad; all of which are used to collect the basic information of the patient. Few of the sensors which are used in the proposed system are: Finger Print Sensor, Blood Pressure Sensor, Pulse Sensor. An OLED is used to display the selected mode.

Once the patient is brought into the ambulance, the patient may or may not be accompanied with a family member/guardian. There might be emergency cases where in the patient may be unconscious due to which the basic information of the patient might not be accessible. To overcome this issue the HMS uses a fingerprint sensor. The patient's fingerprint is scanned and his/her basic information like name, age, contact number, blood group etc., are extracted from the previously created database. The 1x4 membrane keypad, consists of four distinct modes namely, Mode 1 – Accidents, Mode 2 – Breathing problems, Mode 3 – Cardiac Arrests, Mode 4 – Other emergency cases. On examining the patient, the helper in the ambulance draws a conclusion regarding the patient's emergency condition and clicks one of above-mentioned modes. The selected mode is displayed on the OLED display to give a re-assurance to the helper regarding the mode that was clicked.

All these information will be buffered in one mail, and it is further sent to the hospital. So that the hospital officials can facilitate for further treatment and make necessary arrangements.

In severe emergency cases, the patient's pulse might vary rapidly because of which it becomes necessary for the helper to constantly monitor it and keep the doctor informed through the means of mail. It is at the helper's discretion to update the doctor with multiple mails at regular intervals of time. In accordance with the mail received, if the doctor senses emergency he can guide the helper present in the ambulance through a call.

IV. HARDWARE IMPLEMENTATION

A. Arduino Mega Board

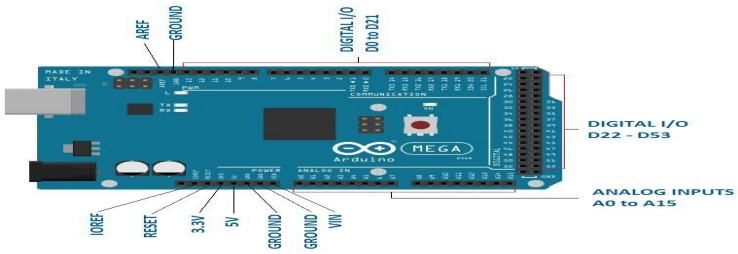


Fig.3 Arduino Mega Board

Our system mainly revolves around Arduino Mega 2560 microcontroller board. The various bio medical sensors used to measure the vital body parameters are connected to this board. The Finger print sensor is connected to Digital input/output pins of the board. The various other sensors like the pulse sensor and blood pressure sensor are also connected to the digital i/o pins. The SDA of the OLED is connected to the SDA of the Arduino board, the SCA of the OLED is connected to the SCA of the Arduino board and further the VCC and GND connections are made. The four connections coming from the 1x4 membrane keypad are going to the digital pins available on the board. After these connections are made, a program is written in the Arduino IDE platform and executed for the combined functioning of the components while providing power supply from the CPU to the power jack of the Arduino board. The TX and RX pins are removed from the Arduino while compilation is in process.

B. Node MCU ESP8266

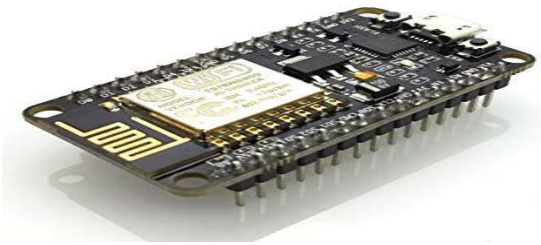


Fig.4 NODE MCU

The NODE MCU is an open source platform, which allows us to edit, modify, build programs and algorithms. The embedded ESP8266 inside the node MCU makes it a WIFI enabled chip available at a comparatively low cost. This NODE MCU is connected to the Arduino, to make provision for 'mail sending'. The D6 pin of NODE MCU is connected to the TX0 pin of MEGA and a common ground connection is established between the two. A program for sending mail is written, which has details about the sender and recipient mail ID, the SSID and password of the WIFI to which it is supposed to be connected. After the execution of this program the selected modes regarding the patient's health scenario, and his/her basic details are integrated into a mail and sent to the recipient's mail ID which can be any intended hospital incharge.

C. Pulse Sensor

The pulse sensor is an attachable heart rate sensor customized for the Arduino. It may be very well utilized by sports personnel, students and game and versatile engineers who need to effectively consolidate live pulse information into their activities. It is a sensor which eliminates the circuit noise and hence acts as an Amplifier. This sensor which is placed on the Arduino board can be clipped to the patient's fingertip or ear lobe and the heart rate can be detected.

D. Blood Pressure Sensor

It is a non-obtrusive sensor intended to quantify human circulatory pressure. This equipment can automatically compress and decompress and provides the reading with high clinical accuracy. Regular checking of blood pressure is significant for individuals particularly in the events that involve hypertension. Hypertension can lead to severe situations like heart stroke or create kidney problems. As there are not many symptoms for high B.P the only solution is regular checkups. The output readings of the sensor consist of an 8-bit value in ASCII format fixed digits.

E. Finger Print Sensor

Using the fingerprint sensor, detection of the fingerprint and its verification is made simpler. The sensor is easy to use and it has a straight-forward windows software using which the module testing can be made less complex. This equipment can also be used for fingerprint enrolling and the image of the enrolled fingerprint can also be made visible on the monitor screen. The flash memory of the fingerprint sensor can store upto 162 fingerprints. It can be connected to any system or microcontroller and helps in capturing images, hash and search, and further detection of fingerprints by sending data in the form of packets. In this HMS system the fingerprint sensor scans the onboarded patients fingerprint and extracts the preexisting basic information of the patient by matching the fingerprint. Once this procedure is completed the information is buffered into a mail and is sent to the respective hospitals.

F. OLED

The OLED is used to display the images, exhibit the texts and patterns for which it has been programmed. The HMS uses an OLED with 128x64 resolution, and it is an I2C based module. There are modules which support different color texts and this module supports text and patterns in blue. It has 4 pins, VCC, GND, SDA and SCL. The VCC supply can be both 3.3V or 5V. The connections of the respective pins are explained in the Arduino mega section. The programming is done for the text display on OLED and Adafruit's library is installed for the further execution of the designed program. The HMS makes use of the OLED to display the selected modes of the 1x4 membrane keypad according to the patient's health condition. Soon after the scanning of the patient's fingerprint, their respective ID is displayed on the OLED screen. Hence, the functioning of the OLED makes the work simpler and easy to understand for the medical representative who is present in the ambulance.

G. 1x4 Membrane Keypad

1x4 key matrix membrane switch keypad is an excellent product which is available at a minimal price requiring little to no effort for its application needs. This keypad has 4-buttons and it can be interfaced easily with any available microcontroller. It does not contain any moving parts which makes it portable. The HMS uses this keypad to showcase the different modes available such ad mode 1 for accidents, mode 2 for breathing problems, mode 3 for cardiac arrests, and mode 4 for others. Depending on the patient's health condition one of these modes are selected. The mode which is chosen is displayed on the OLED screen and also buffered in the form of a mail which is to be sent to the hospital.

V. SOFTWARE IMPLEMENTATION:

Arduino software (IDE) consists of a text editor where in codes can be written, area for message display, a console window, a toolbar which has a series of icons for basic functioning of the program. The program is written in the Arduino IDE content tool also called as an editor tool and are recorded with an extension of ".ino" . It also has features like searching, pasting, cutting, replacing the existing code. The message region gives indications during saving and exporting the file and further more shows if any errors are present.

Fig.5 Arduino IDE platform

The configured serial port and board is displayed on the bottom corner of the window. The verification and transfer of the programs is done on the available buttons on the toolbar.

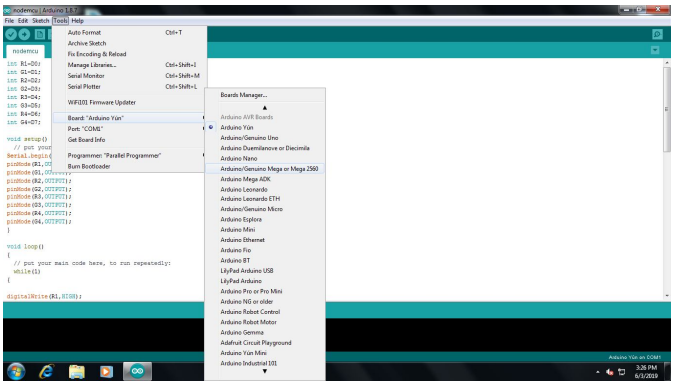


Fig.6 Board selection

For the proposed HMS system, the source codes were executed on Node MCU 1.0 (ESP-12E Module). We should ensure that the COM port is detected and connected to the selected board. The program has to be created and compiled for errors. Once this procedure is completed, it has to be dumped onto the Arduino Mega, which allows the functioning of the various sensors connected to the board.

A. Fingerprint Enrollment And Matching

After installing the required libraries like Adafruit, click on the file icon → Example → Adafruit fingerprint sensor → Fingerprint → Run the fingerprint program.

After compiling the program and dumping it, open the serial monitor and check if the fingerprint sensor is blinking, if not cross check the transmitter receiver connections and restart the Arduino if needed.

Now enroll the fingerprints of as many patient's as desired. Assign a unique ID number for each patient so that it can be useful for syncing and matching with the identified fingerprint of the intended patient.

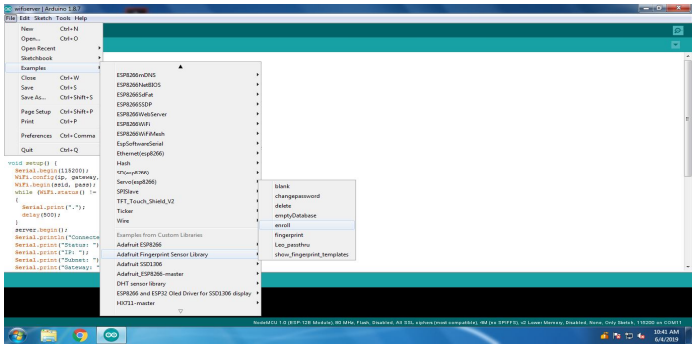


Fig.7 Fingerprint Enrollment

VI. FUTURE SCOPE

Other bio medical sensors like blood glucose sensor and temperature sensor can also be integrated into the proposed system to make it more functional and autonomous.

Adding on to the already implemented HMS, automatic traffic clearance for the ambulance will help serve our stated objective even better.

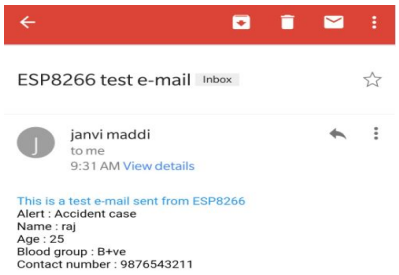
This traffic clearance for the ambulance can be brought about by using existing technology like RFID technology, IOT, obstruction-based IR sensors, density-based sensors etc.

Along with this the ambulance can be fully GPS enabled so that the live location of the ambulance can be accessed by both the patients and hospital authorities. Using google maps or by re-routing the ambulance with the inbuilt HMS, one can reach the nearest hospital through the shortest path.

If the project can be implemented on a larger scale, we can create a common data base of the patients exclusively for medical purposes and can be accessed from any hospital.

VII. RESULTS AND CONCLUSION

The patient details as sensed by the sensors will be displayed on the OLED screen, meanwhile all this information is stored in NODE MCU memory and is sent in the form a mail.



The OLED shows a message when a finger print match is found. Also, the 4 different emergency modes are displayed on it. Upon selection of one of the modes all the above details are sent to the respective hospital in the form of a mail.

Fig.8 OLED display

This remote patient health monitoring will diminish the time devoured in gathering the patient's information. The data gathered from the assembled sensors is more exact than the typical information gathering. The proposed framework can be used in emergency vehicles while on the move. This framework can be additionally improved to screen more parameters of the patient's health.

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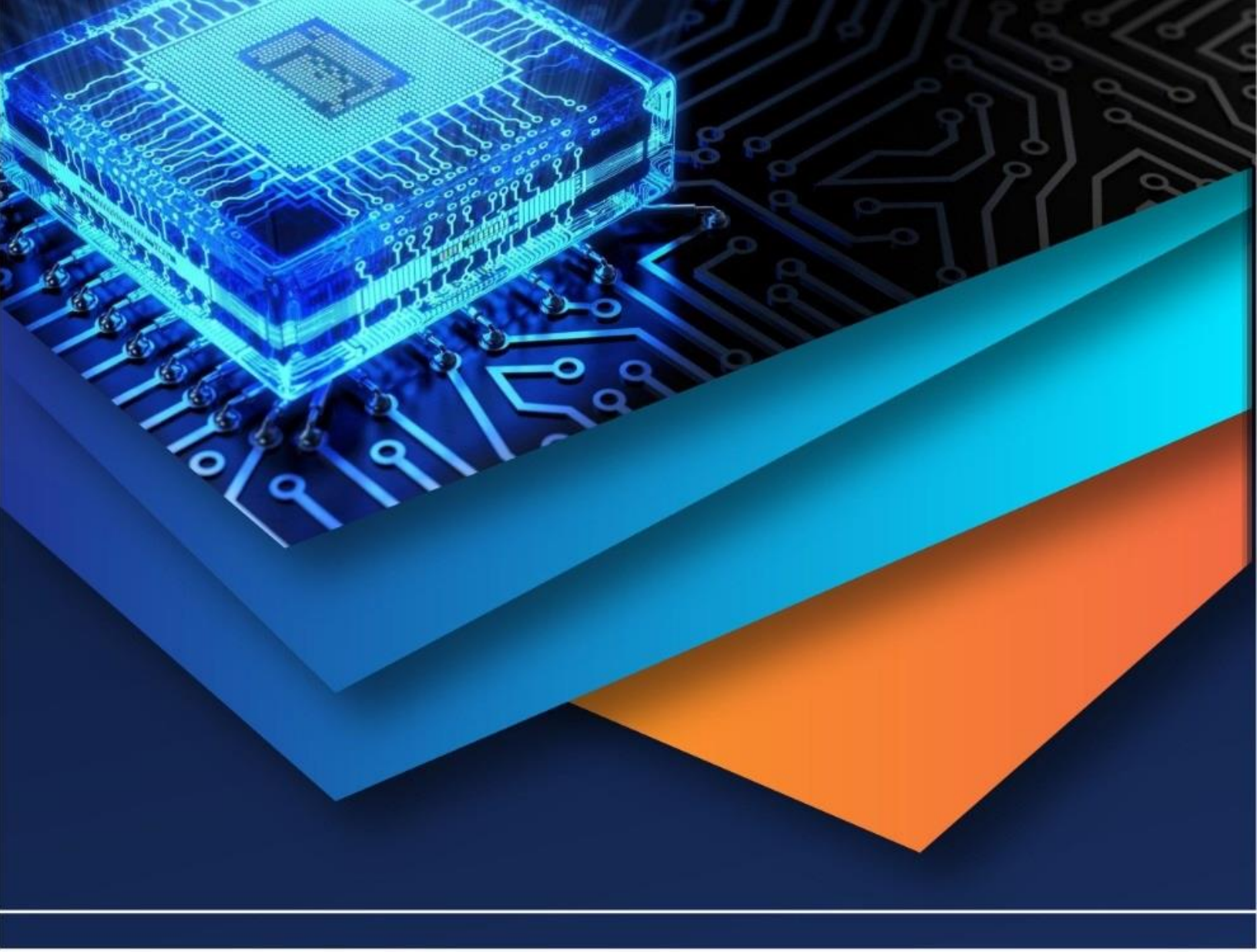

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