An IoT Based Smart Medical Systems In Trains For Passengers

1Rani K S, 2Suguna R, 3Amal Krishna Dinesan, 4Girivash K, 5Harish Saran R and 6Kiranraj K
1, 2, 3, 4, 5, 6 Department of Electrical and Electronics Engineering
1, 2, 3, 4, 5, 6 Vel Tech High Tech Dr. Rangarajan, Dr.Sakunthala Engineering College, India
1 raniks2@gmail.com, 2 sugunaramesh2429@gmail.com, 3 amalkrishnaboys33@gmail.com
4 girivashk@gmail.com, 5 harishsaranr@gmail.com, 6 kiranraj1149@gmail.com

Abstract - The provision of health care systems for Indians is subsidized by the government and free public health care is promoted. The public sector of India encompasses 18% of total outpatient care and 44% of total inpatient care. The outpatient care is still not extended in transportation sectors due to which there’s an increased rate of fatality due to heart attacks in running train has been noticed. It is noted that around 8.92 billion and 5.65 billion passenger traffic is amounted during the year 2018 and 2019 respectively. The amounting rises the need for installing health care systems in trains. The proposed system satisfies the need and makes use of IoT platform, therefore uses various edge devices to monitor the health of the passengers. It has two modules compartment module and engine module, the compartment module monitors and detects the abnormal changes in health and communicates it to the loco-pilot who drives the train, to ensure emergency halt if needed. If any abnormal changes in heart rate are detected the health care system has automated CPR and ventilator system which is provided to the ill passengers automatically. Thus, the proposed system stands alone in modern health care in transportation which is irreplaceable.

Keywords - Train, passengers, health care, monitoring, CPR, Ventilator mechanism

1. Introduction

In India, owing to the inflation in population, a dramatic increase in transportation is highly noticeable. One of such fourth largest and second busiest mode of transportation across the world is Indian rail transport. The Indian Railways passenger traffic is amounting at least 5 billion per year. The railway network has its way along the length and breadth of the country which covers more than 7000 stations in its route. At this circumstance the express trains have elongated travelling hours. In such long travelling, a passenger may get sick. Some illness can be delayed to be consulted and treated. Some are really fatal, one of such fatal illness is cardiac arrest. A train passenger may face cardiac arrest while the train is running. Sometimes it may happen at night when there will be a lack of individuals who would be awake. In such time, the affected passenger would be pushed to death. Nowadays, the mortality rate of passengers due to cardiac arrest in running train has been increased dramatically. Now this demands the need of installing health care system in transportations. There are many subsidies provided by the Indian government for installing the health care system widely. Although the installation of health care system in transportations is not over-emphasized by the government, the undeniable need of such systems can be more effective if the portrayal of its necessity is interpreted well. Presently the health care system in public is owned by Indian Public sector which encompasses 18% of total outpatient care and 44% of total inpatient care. The proposed system signifies the health care system which emphasizes the outpatient care implemented in transportation sector mainly in express trains. The system uses heart beat sensor and respiratory sensor to monitor the heart rate and respiration of the passenger. It additionally has an emergency switch. If the sensors detect any illness or if the emergency switch is pressed then the automatic CPR and ventilator system is activated which provides basic first-aid for heart attack. Along with these, if the switch or sensor is activated a message is sent to the engine to the loco-pilot through the IoT platform involving wireless sensor networks. Thus, the proposed system provides fundamental emergency care to the patients and reduces the fatality rate due to heart attack in running trains. Besides, provision of first-aid the health status of the particular passenger is sent the cloud database therefore assessment of national health is enhanced better.

2. Proposed System

The proposed system consists of two modules namely the compartment section and the engine section. The compartment section consists of the following components such as the heart beat sensor, respiratory sensor, emergency control, microcontroller, WSN, IoT, Voice IC, speaker, driver circuit, ventilators and CPR provider. The following Figure 1 is the block diagram of the compartment section.

![Block diagram of compartment section](image)

Fig. 1: Block diagram of compartment section

The compartment section module is installed in every compartment of the train wherein the heart beat sensor and respiratory sensor is used to monitor the health of the passenger. If any abnormal changes in the health is detected or if emergency medical switch is activated then the
microcontroller activates the control signal and transfers the message to the engine section through wireless sensor network and the health data is sent the cloud through IoT platform. Along with that the emergency first-aid is provided to the passenger suffering due to cardiac arrest. The CPR and the ventilator system are provided. The engine section consists of the following such as the LCD, Buzzer, WSN, and microcontroller as shown in Figure 2. Once the wireless sensor network receives the signal from the compartment section transmitted to the WSN. The received signal is processed by the microcontroller and displayed in the liquid crystal display. It displays the details of passenger, passenger’s compartment and seat.

![Fig. 2: Block diagram of the engine section](image)

### 3. Research Background

The existing system [1] advocates the employment of intelligent health care system for remote health care monitoring. The system emphasizes the systems for self-restriction condition of individuals that’s the ones who suffering from dementia, Parkinson’s disease and wretchedness etc., the infected people are monitored by using some relevant sensors and they are linked to the cloud through IoT platform and the data is seen remotely through the mobile application [2],[3]. It also uses GSM and GPS to send details of the patient in case of emergency to doctors and patient’s relatives. Although the system is good for monitoring purposes it doesn’t provide any first-aid to the person which is a main disadvantage of this system. The paper [4] discusses about monitoring the Blood Pressure (BP) of the patient by unobtrusive monitoring and improving the efficiency of web-based care systems for such monitoring [5]. It emphasizes cuff-less BP monitoring for home-based health care [6],[7]. The system is specifically used for BP monitoring, apart from that it doesn’t respond and take appropriate action which could treat the person at the time they suffer from low or high BP. The paper also doesn’t promote this to implement the system in transportation. The paper [8] discusses about promoting telemedicine services by developing a system which uses IoT platform. The system is used in trains, busses and other transports where it is necessary. Though the system provides effective telemedicine service it lags because it needs persons at each end for providing the service effectively, since it is not automated in every aspect [9]. The paper [10],[11] focuses on robust IoT system for health care monitoring which monitors the health of passengers who travels through public transports.

As before, the system doesn’t provide enough first-aid facility to passengers. Therefore, the demerits of the existing system are noted and they are overcome in the proposed system.

### 4. Design and Implementation

The proposed system comprises of two modules namely the compartment section and engine section. The compartment section consists of heart beat sensor, respiratory sensor, IoT, Voice IC, WSN, emergency switch is shown in Figure 4- Figure 8. The following are the components of the compartment section,

**Heart beat sensor**

The heart beat sensor is a non-invasive measurement of blood pressure. It measures the heart rate of the individual by means of optical method. It measures the heart beat by shining the light into the finger and thus by measuring the amount of light that’s reflected and absorbed it can appropriately decide the number of heart beats. The sensor is used in the system due to its compactness and reliability. The sensor is mounted on every seats of the train as shown in Figure 3.

**Respiratory Sensor**

The respiratory sensor usually sensitive to stretch of the chest. It must be strapped around the individuals in order to monitor the respiration. The expansion and contraction of rib cage is converted into rise and fall of a signal. Therefore, effective monitoring of respiration can be noted. The respiratory sensor is mounted on every births of the train so that the individual while sleeping can strap the sensor around them. Thus, it can monitor the respiration the passenger while sleeping.

**Emergency switch**

The emergency switch is manually operated switches which will turn on activate the control signals in the microcontroller and therefore activates the WSN and emergency alert in the engine section. If the patient is abnormal with miscellaneous health condition the switch can be pressed to indicate the loco-pilot[12].

**WSN**

The wireless sensor network consists of small and many interconnected sensor nodes which will carry data to the end device effortlessly. Each of these sensor nodes consists of electrical and communication unit which will sense and communicate it to another node finally the data is sent to the end device. It is mounted on each compartment assuring the information passage to the engine.
**IoT module**

The IoT module consists of a small computer which allows sharing of information to the internet. The wifi module ESP8266 is used to share the data through the internet in this system. It is used for sending data to the database where all the reports are monitored each and every time.

**Driving circuit**

The ULN2003 is a monolithic high voltage and high current transistor arrays. It comprises of seven NPN Darlington pairs that renders high-voltage outputs with common-cathode clamp diode for switching inductive loads. The collector-current rating of a single Darlington pair transistor is 500mA. The Darlington pairs can be made in parallel for higher current capability. Applications of ULN2003 include relay drivers, hammer drivers, lamp drivers, display drivers (LED gas discharge), line drivers, and logic buffers. The ULN2003 has a 2.7kW series base resistor for each Darlington pair for operation directly with TTL or 5V CMOS devices. This driver is used facilitate CPR and ventilator mechanism in case of emergency.

**CPR**

The automated CPR system provides circumferential chest compressions without interruptions. The continuous and periodic compressions circulate the blood all around the body and help the heart to pump again. The CPR is mounted on the train berths. Therefore, if any illness is detected the CPR system is activated.

**Ventilator**

The ventilator system is a mechanical system which is used to move the air in and out of the lungs when the individual is unable to breathe effectively. The system is controlled by the driving circuit and the driving circuit is controlled by the microcontroller.

**LCD**

The LCD screen is used for displaying the warning or alert message transmitted from the compartment section. The LCD screen can be replaced with OLED in future enhancement. The LCD can be 16*2 or may be 20*4 which has 5*7 pixels each providing the best output results.

**Buzzer**

The buzzer is made of piezo electric crystal. It works on the principle of Hall Effect i.e., if the electric supply is provided to the terminals of the buzzer it will be subjected to orthogonal vibration which creates a sound. The buzzer here is activated through the control signals when the alert message is received from the compartment section.

**Arduino Uno**

A microcontroller board based on the ATmega328P is the Arduino Uno. It has 14 digital input/output pins, 6 analogue inputs, a 16 MHz quartz crystal, a USB link, a power jack, an ICSP header and a reset button (of which 6 can be used as PWM outputs). It contains all the microcontroller requires to support; just connect it to a device with a USB cable or power it with an AC-to-DC adapter. There are several facilities for Arduino Uno to connect with a computer, another Arduino board or other microcontroller.

**ZigBee**

ZigBee is a technological standard designed for control and sensor networks. Based on the IEEE 802.15.4 Standard Created by the ZigBee Alliance. It Operates in Personal Area Networks (PAN’s) and device-to-device networks Connectivity between small packet devices Control of lights, switches, thermostats, appliances, etc. Development started 1998, when many engineers realized that WiFi and Bluetooth were going to be unsuitable for many applications. IEEE 802.15.4 standard was completed in May 2003. Organization defining global standards for reliable, cost effective, low power wireless applications. Consortium of end users and manufacturers of solutions, mainly responsible for the development of the standard 802.15.4. Using the 802.15.4 packet delivery mechanism to build applications and network power.

**Voice IC – Apr9600**

The APR9600 device offers true single-chip voice recording, non-volatile storage, and playback capability for 40 to 60 seconds. The device supports both random and sequential access of multiple messages. Sample rates are user-selectable, allowing designers to customize their design for unique quality and storage time needs. Integrated output amplifier, microphone amplifier, and AGC circuits greatly simplify system design.

The device is ideal for use in portable voice recorders, toys, and many other consumer and industrial applications. APLUS integrated achieves these high levels of storage capability by using its proprietary analog/multilevel storage technology implemented in an advanced Flash non-volatile memory process, where each memory cell can store 256 voltage levels. This technology enables the APR9600 device to reproduce voice signals in their natural form. It eliminates the need for encoding and compression, which often introduce distortion.

**Web Server**

![Web Server Showing Sensor Values](image-url)

*Fig. 4: Web Server Showing Sensor Values*
5. Results

6. Future Enhancement

The system can be enhanced by integrating many sensors which can monitor the specific health illness. An app can be developed so that the health of the passenger is available to anyone around the world. In specific, family members can monitor the passenger’s health in any case. Therefore, if they observe any noticeable abnormality in health, they can immediately contact the medical care nearer to the passenger’s location. It will prove to be helpful for the child passengers whose health can be monitored remotely by parents in case of isolated journeys. Moreover, the model is limited to be employed in train; it can be enhanced to be used in various transportations.

7. Conclusion

The proposed model contains merits that can dramatically reduce the fatality caused due to heart attack. The model is specific to the train as the train journey is overemphasized in case of long journeys. Moreover, the rail route is mostly far apart the civilized areas. Therefore, the proposed system is more reliable and effective than other existing system in many aspects. The effective implementation of the system can reduce the fatality and health risks of an individual making it the most reliable health care system ever.

References

[2]. Toshiyo Tamura, “Connected healthcare system to monitor the blood pressure of clients with an unobtrusive device” 2019
[3]. S. Saravanan, P. Sudhakar, “Telemedicine communication system in mobile units”, 2017