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DESIGN & DEVELOPMENT OF INTELLIGENT AMBULANCE CONCEPT – AI AND HUMAN INTERFACE TECHNOLOGY

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Abstract

This paper involves the review of papers related to an efficient ambulance management system in this project report we will be going through research papers related to similar topics and find information to improve the process of making an ambulance intelligent. India's population is increasing as each day is passing. The increase in population puts a lot of strain and management of resources from medical, government services and many more. The strain on the resources results in citizens not getting proper help in the time of need. The main example of this process is ambulance management system which is the first line of help process in time of need. If a patient or a victim does not get an ambulance in time then the patient's life is surely at risk. So there needs to be proper mechanism to handle this important resource and help patients in time. Latest technologies such as cloud computing, IoT, AI, ML and mobile computing can be used to improve the ambulance management and emergency help services. 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. In health monitoring system, the patient's vital health parameters such as Heart Rate, Blood Pressure and Body Temperature are monitored. These parameters are sent the hospital server using IoT and cloud technology. In the current era of technology, Artificial Intelligence (AI) is playing a vital role in the health care sector especially cardiac disease detection which is a major cause of sudden death.

Keywords : Artificial Intelligence (AI), Internet of Things (IoT), Machine Learning (ML), Cloud computing.

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1. Introduction

The rapid growth of population coupled with high rate of industrialization has resulted in unmanageable increase in traffic volume, especially in metropolitan cities and urban area. This could affect the route for emergency vehicles such as ambulance to reach their destination. There is loss of life due to the delay in the arrival of ambulance to the hospital in the golden hour [1]. The unnecessary waiting at the traffic signals in emergency services which pay the maximum price when caught in traffic jams especially the ambulance services where situations can be very critical. As the India's population increase rapidly a large set of young population is entering the working space. As the population goes out for work it also causes many mishaps like accident, fire etc. Thus, lot of emergency services are needed daily like ambulance, hospitals, police, fire brigade and volunteers.

This services or people help the concerned citizen in need and happens to save a lot of lives daily. But due to increase in population this emergency services are in a lot of stress and needs to be properly managed. In the recent researches, prevalence of various diseases such as heart attacks, diabetes has been rising day to day due to insufficient health care resources in most developing countries. In India, doctors were not available all the time to check the patients and the patients has to wait in a long queue for consultation with doctors, this also a major cause for rising diseases [2]. In today's world, wearable sensors have been used in all application areas such as health care, fitness, industry applications and all other activity areas.

Technology is developing day by day in every field of the world. Now everyone in the world got smart phones and their impact on humans has increased a lot. The benefits of patient monitoring include initial and real-time identification of diseases, the ability to fully monitor patients, prevention of diseases adversely affecting and early

deaths, time savings in hospital admissions, and providing virtual monitoring the way to efficiently improvements in healthcare services [3]. Patients with chronic diseases, individuals with mobility difficulties or even other disabilities, post-surgery patients, newborns, and older patients are among those who benefit from remote patient monitoring.

Cardiovascular diseases are a leading cause of death globally. In fact, over 12 lakh young people die of cardiac arrests every year. In the current scenario, deaths due to heart attacks have become evident, especially in India. With the increasing death rate due to heart attacks, it has become even more crucial to ensure timely medical responses for saving lives. First hour after a heart attack is usually called golden hour, timely assistance provided during this hour can save a person's life. In emergency situations, a standby ambulance with certified medical specialists and essential medial equipment can improve the chances of survival after a heart attack. During a heart attack, providing immediate and appropriate care is the only possible way to save lives.

We have come up with the idea of Intelligent Ambulance using AI and human interface technology. In this system, the ambulance is being connected with IoT and making it a smart ambulance that can monitor the health condition of the patient through sensors and forward the health status of the patient to the hospital with the help of the internet. The aim is to enhance the survival rate of the patient by stabilizing one's health condition until they reach the hospital for proper treatment.

2. Literature Survey

In 2020 Akca et al. [1] put forward a paper which mainly emphasizes on "Intelligent Ambulance Management System in Smart Cities." technique to manage ambulance and emergency services. This research is efficient to cover all the things needed to

develop a smart ambulance management framework but lacks to explain how the system can work in real time with a combination of mobile computing, cloud computing and standalone application together.

In 2021 Ganesh et al. [2] presented a study on “health machine to handle covid-19 related health emergencies” technique to manage ambulance and emergency services. This research effectively covers all the requirements for developing a smart ambulance management framework, but it falls short on describing how the system may function in real time by combining mobile, cloud, and standalone applications altogether.

Gargi Beri, Ashwin Channawar, Pankaj Ganjare, Amruta Gate, Prof. Vijay Gaikwad published, “Intelligent Ambulance with Traffic Control” [3]. This study 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. These parameters are sent to a PC in ambulance via serial communication and this data will be sent to the hospital server.

Ms. Aisha Meethian, Althaf B K, Athinan Saeed, Ligin Abraham, Mohammed Samran Hashim Proposed a study on “IoT Based Traffic Control System with Patient Health Monitoring For Ambulance” in August 2022 [4]. The proposed system optimizes the route by minimizing the transport duration to the hospital by using GPS sensor networks. The health parameter of the patient is monitored using different sensors like Heart Rate Sensor, Breath Sensor and Temperature Sensor . These parameters collected from the patient are transmitted to the hospital's database using IOT.

In [5], To provide an intelligent smart health system which sense the body condition and send the data to the collaborated hospital's website. A device in which the heart beat sensor will sense the

heart beat and temperature sensor will sense the body temperature. After sensing, sensors will send respective data to the microcontroller. After that microcontroller will sent it to raspberry-pi which will connect with the internet or IOT cloud. To reach the destination on time the driver will use google map along with accident-avoidance features to save lives.

In 2022 Timothy Malche et.al. [6] proposed a system m consists of a sensor node to track patients' vitals during different activities which patients perform. The proposed sensor node collects patients' data using the sensors attached to the nRF5340 Development Kit (DK). The connected sensors are accelerometer, microphone, pulse oximeter, heart rate sensor, and temperature sensor. The accelerometer enables monitoring different patient physical activities, including walking, sleeping, exercising, and running. By analyzing the vitals during different activities, the doctor can prescribe treatment or give suggestions to patients.

In [7], A study presents a new method for pulse detection during Out of Hospital Cardiac Arrest using the electrocardiogram (ECG) and Thoracic impedance (TI) signals. The approach uses an adaptive filter to extract the circulatory-related component from the TI referred to as impedance circulation component (ICC) and a support vector machine (SVM) classifier based on features extracted from the ECG and ICC to discriminate pulseless electrical activity (PEA) and PR interval [1].

In [8], an Enhanced deep convolutional neural network (EDCNN) has been proposed for the early detection of heart disease and diagnosis. This research has been developed on EDCNN approach to detect heart disorders in patients and to improve diagnostic precision using deep learning-based prediction models. The prediction of heart disease by processing patient data to calculate the chance of heart ailment has been mathematically computed

with distributive functions. Heart activity has been analyzed during exercise, resting, and working [2].

In [9], The proposed method use Decision Tree algorithm for feature selection method, PCA for dimension reduction and ANN for the classification. The principal component analysis (PCA) is a statistical technique that uses mathematical principles to convert a set of observations (or samples) of possibly correlated variables into a new set of observations of linearly uncorrelated variables [3]. The method used in this work involves Data Collection, Pre-processing, Feature extraction, Dimension Reduction, Classification and Result Analysis as shown in the Fig. 1 [4].

3. Problem Analysis

In India, death rate has been recorded as 7.380 in 2022 and 7.344 in 2021. This rate does not include the impacts of COVID-19 virus. Then, the number of people aged 18 to 30 years who died from heart attacks in India was 2,541 in 2021, and 2,695 in 2020. There's a delay in emergency medical services. Timely action must be taken in case of critical situation to save life of a patient [5].

Year	Death rate
2023	7654
2022	6574
2021	5463
2020	4532
2019	3421
2018	2345
2017	2100
2016	1890
2015	1001

Table 1 : Death rate recorded every year

A NITI Aayog report on emergency care in India states that 62% of deaths in India are due to non-communicable diseases. It estimates that 50% of these deaths could be

averted with pre-hospital and emergency care. Thus, the need for efficient and effective Emergency Medical Services (EMS) cannot be overemphasized. Early detection of a certain diseases cannot be seen in most of the cases, so we are proposing propose a fast, economic and efficient ambulance management control system to increase the chances of survival of a patient [7]. For patients who have been in an incident or sustained a severe injury, the time they are monitored electronically may be limited to the time they are now being transported to the hospital in an ambulance. Nonetheless, emphasis has been concentrated on ensuring a safe trip to the hospital, and virtual monitoring aids in the provision of urgent medical treatments in extremely critical situations [6]. Every second is crucial for a patient. Creating better and fast applications which will make the life of a citizen easy and safe the motivation of our project is [8]

- To develop a better and secured automatic ambulance or emergency management services.
- To use cloud computing and mobile computing technologies together.
- To keep the services simple and easy to use.
- To make the system operatable 24 x 7 without any failures.
- To help save lives in need with prompt ambulance management which is the first line of help system.
- To enhance the survival rate of the patient by providing virtual monitoring directly from the doctor in-charge.

The goal is to propose a system that increases the chances of saving the patient by using emerging technologies like Internet of Things (IoT) and Artificial Intelligence (AI) [9]. To improve the performance of the Ambulance and transform into an Intelligent Ambulance using IoT and AI to increase the chances of

survival of a patient as shown in the Fig. 2 [10].

4. Objectives

In today's world of smart cities, people are concerned on numerous issues with respect to medical problems like not getting aided on time, delay in response and facilities in health care services. The emergency services need to be handled and managed properly to help the general population. The main objective of the project aimed to transform the existing ambulance into Intelligent Ambulance to make it more efficient and also cost-effective [11].

- Online booking of nearest ambulance using mobile application.
- Suggesting the nearest hospital and shortest path along with estimated time to reach the hospital.
- Once the patient is taken into ambulance the complete health data of patient is driven using cloud technology and communicated to doctor for further instruction.
- To use Artificial Intelligence (AI) for analyzing the patient's condition precisely for early diagnosis of disease and better treatment.
- Pre-allocating the facilities physically in the hospital ahead of time and virtually monitor patient health where the instructions are performed by the assistant present in the ambulance.
- The main goal here is to bring all the three different sections i.e health parameters measured, virtual assistance by the doctor and the AI disease prediction result all in one single monitor.
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5. Coding Technology

To implement the above system, we can use a combination of web development, cloud computing, and machine learning

technologies. Here's a brief outline of the coding technology [12]

- **Web Development:** Web development is the process of developing websites or web applications that run on the internet or on a private network. We develop a web application that allows patients to book an ambulance by entering their location and other details. We can use a modern web framework like React, Angular, or Vue.js for frontend development and Node.js, Django, or Flask for backend development. The web application should be able to send the patient's location to the ambulance service provider [13].
- **Cloud Computing:** Cloud computing is the delivery of computing services, including servers, storage, databases, networking, software, and analytics, over the internet. In this system, cloud computing is used to store and process the patient's health data. Cloud functions can be used to process the data and trigger alerts if necessary. This makes the system highly scalable and ensures that it can handle a large volume of data [14].
- **Machine Learning:** Machine learning is the field of study that gives computers the ability to learn and improve from experience without being explicitly programmed. We use machine learning to analyse the patient's health data and predict the disease. We can use a supervised learning algorithm like logistic regression or random forest to classify the patient's health data into different categories. Unsupervised learning algorithms like k-means clustering can be used to group similar patients together. These algorithms can analyse large amounts of data quickly and accurately, which can help doctors make faster and more accurate diagnoses [15].

- **Virtual Monitoring:** Virtual monitoring is the use of video conferencing and other virtual communication tools to allow doctors to monitor the patient's health remotely. We use video conferencing and other virtual communication tools to allow doctors to monitor the patient's health remotely.

We can use a tool like Zoom, Skype, or Microsoft Teams for virtual communication. This enables doctors to provide real-time feedback and instructions to the assistant present in the ambulance. This can be especially useful in critical situations where immediate medical attention is needed [16].



Fig. 1 : Conceptual idea of the system.

6. Proposed Methodology

Our proposed system we are implementing Internet of Things (IoT), cloud technology and Artificial Intelligence (AI) which standalone work together to monitor the patient's health even when being carried in the ambulance to the hospital. Every second is crucial for a patient [17]. The unnecessary waiting at the traffic signals without proper and effective monitoring, they risk losing

their life even in the ambulance [18]. The goal is to propose a system that increases the chances of saving the patient by using emerging technologies like Internet of Things, Cloud computing and AI. Our system works in two sectors one is the ambulance and the other is the hospital, along with AI to predict the disease. Entire system follows the following architecture as shown in the Fig. 3 [19].

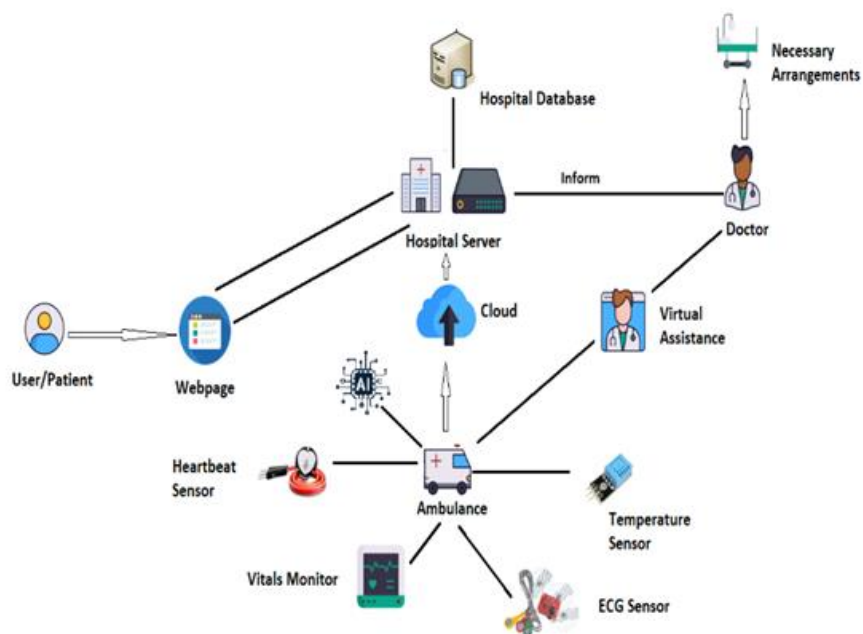


Fig. 2 : Overall Architecture of the propose system

The user or the patient books the ambulance using the webpage. which then sends one to the patient's location. Once the patient is taken into ambulance different sensors like

heart rate sensor, Temperature sensor, blood pressure sensors are used to measure the health parameters of the Patient as shown in the Fig. 3 [20].

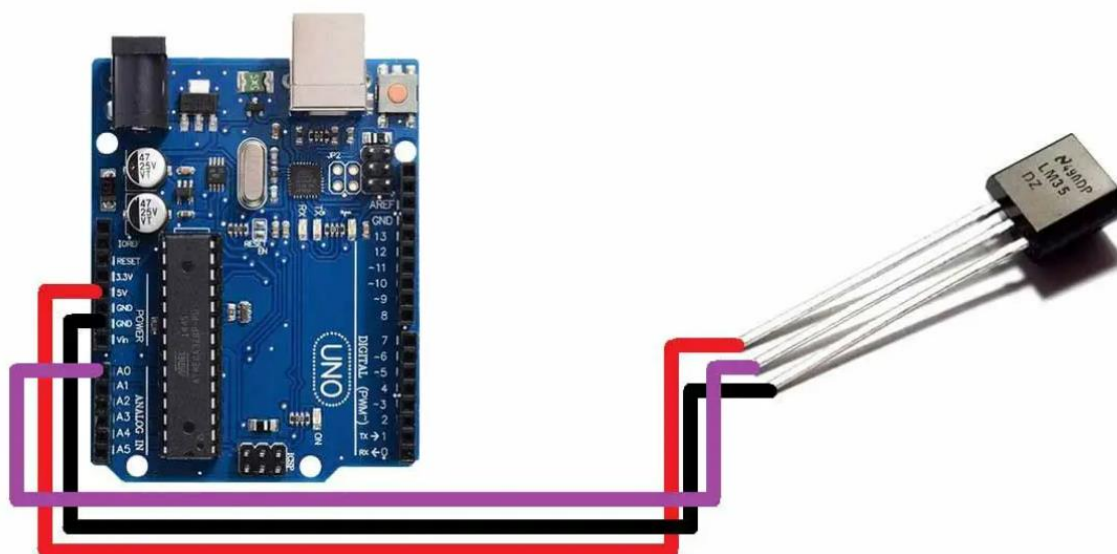


Fig. 3 : Patient's data collection using Temperature Sensor



Fig. 4 : Patient's data collection using Blood pressure Sensor

Blood pressure, pulse rate, and temperature readings are important parameters to identify a heart attack because they can provide important clues about a patient's cardiovascular health and the presence of an acute cardiac event [21]. Blood pressure readings can provide information about the patient's blood flow and the force with which blood is flowing through the blood vessels [22]. During a heart attack, the blood vessels supplying the heart with blood can become blocked, leading to a drop in blood pressure. Low blood pressure readings in combination with other symptoms like chest pain, shortness of breath, and sweating can be indicative of a heart attack as shown in the Fig. 4 [23].

Pulse rate is a measure of the heart's electrical activity and the number of times it beats per minute [24]. During a heart attack, the heart may beat irregularly or faster than normal, leading to an increase in the pulse rate. An abnormal pulse rate, along with other symptoms like chest pain and shortness of breath, can be a sign of a heart attack [25]. Temperature readings can also provide important information about a patient's cardiovascular health. During a heart attack, the body may release certain chemicals that can cause a fever, leading to an increase in body temperature. An abnormal increase in body temperature, along with other symptoms like chest pain and shortness of breath, can be a sign of a heart attack as shown in the Fig. 5 [26].

By monitoring these parameters, doctors can quickly identify the signs of a heart attack and take prompt action to treat the patient. This can help improve patient outcomes and reduce the risk of complications associated with a heart attack [27]. The complete health data of patient is driven using cloud technology. In hospital the respective doctor will continue to monitor patient and necessary arrangements are made before the arrival of the patient to the hospital as shown in the Fig. 6 [28].



Heart rate: 78BPM Temp: 94.3F status: OK

Fig. 5 : Heart rate measurement



Heart Rate: 82BPM Temp: 103F Status: Critical

Fig. 6 : Cloud driven patients health parameters

If the patient is in critical condition and needs doctor's attention, the doctor virtually monitors the patient health and give instructions which are performed by the assistant present in the ambulance as shown in the Fig. 7 [29]. These are the essential steps that should be performed to enhance the survival of the patient as shown in the Fig. 8 [30].

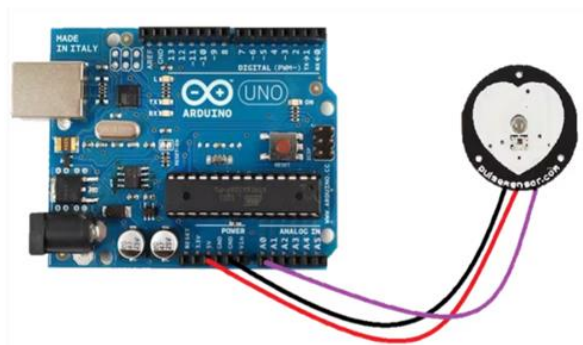


Fig. 7 : Arduino Uno board

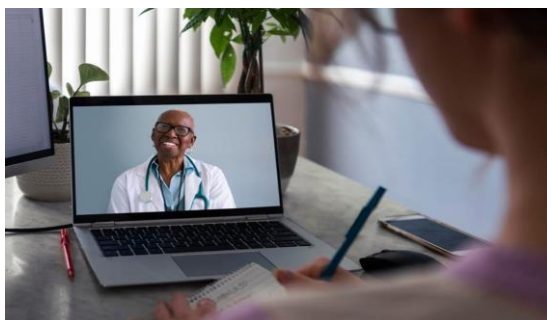


Fig. 8 : Doctor virtually monitors the patient

Artificial Intelligence is used to predict the disease the patient is suffering from by analyzing one's health parameters and suggest the suitable treatment [31]. AI is used here as an assistant to the doctor. The main goal here is to bring all the three different sections i.e health parameters measured, virtual assistance by the doctor and the AI disease prediction result all in one single monitor as shown in the Fig. 9 [32].



Fig. 9 : Vitals, Virtual monitoring and AI results in one single monitor

7. Conclusion

The system designed can be used by medical staff in real time using the facilities of a mobile phone or notebook. The main plan of the planned system is to supply higher associated economical health services to the patients by implementing a networked info cloud, so the specialists and doctors may build use of this knowledge and supply a quick and an economical resolution to the patients. The ultimate model is equipped with the options wherever doctor will examine the patient from anyplace and anytime. The health parameters monitoring system works with an accuracy and gives live results of patient's BP level, glucose level, Pulse rate and temperature level and it prevents from taking to serious stage. If the condition is critical an alert notification will be sent to the hospital monitoring website and the respective doctor will give instructions to stabilize the patient's condition through virtual monitoring. AI prediction and treatment suggestion saves time. The basic idea of this study is to get a victim with timely help like ambulance services and help avoid the complications.

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