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# DESIGN & DEVELOPMENT OF INTELLIGENT AMBULANCE CONCEPT USING AI-ML-IOT & HUMAN INTERFACE TECHNOLOGIES

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## Abstract

This paper aims to explore and analyze various research papers related to an efficient ambulance management system. By investigating similar topics, this project report seeks to gather valuable insights to enhance the process of making ambulances intelligent. With India's population constantly increasing, the strain on resources in the medical and government sectors has become a pressing concern. Insufficient support during emergencies hampers citizens' ability to receive timely help. The ambulance management system serves as the primary lifeline during critical situations. Failure to provide prompt ambulance services puts patients' lives at risk. Therefore, it is crucial to establish a robust mechanism to efficiently handle this vital resource and ensure timely assistance. This paper proposes leveraging state-of-the-art technologies such as cloud computing, IoT, AI, ML, and mobile computing to improve ambulance management and emergency response services.

When the Challenges in Ambulance Service Delivery is considered, the following points can be reiterated as follows. The delay in ambulance services is a significant challenge that needs to be addressed. In certain cases, on-site doctors may not be readily available, causing patients to experience delayed medical attention. To mitigate this issue, a health monitoring system can be implemented to continuously track vital health parameters, including heart rate, blood pressure, and body temperature. These parameters can be transmitted to a hospital server using IoT and cloud technology, enabling healthcare professionals to remotely monitor patients' health conditions.

Considering the Role of Artificial Intelligence in Healthcare, the following could be arrived at. In the current era of technology, Artificial Intelligence (AI) plays a vital role in various aspects of the healthcare sector, particularly in cardiac disease detection. Sudden cardiac deaths pose a significant threat to individuals, making early detection crucial. AI algorithms can analyze large volumes of medical data to identify patterns and markers indicative of cardiac diseases. By employing AI-powered systems, healthcare providers can enhance their diagnostic capabilities and implement preventive measures to reduce the risk of sudden cardiac deaths. Efficient ambulance management is imperative for providing timely assistance to individuals in need. The growing population and strain on resources necessitate the adoption of advanced technologies to enhance emergency response systems. This paper highlights the potential of cloud computing, IoT, AI, ML, and mobile computing in improving ambulance management and emergency services. By incorporating a health monitoring system that utilizes IoT and cloud technology, vital health parameters can be continuously monitored, ensuring prompt medical attention. Moreover, leveraging Artificial Intelligence can significantly contribute to the detection and prevention of cardiac diseases, reducing the occurrence of sudden deaths. It is crucial for stakeholders in the healthcare sector to embrace these technological advancements and work towards implementing intelligent ambulance management systems that prioritize the well-being and safety of patients.

**Keywords:** AI, IoT, ML, DL, Cloud Computing.

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## **1. Introduction**

The exponential growth in population and industrialization has led to an uncontrollable surge in traffic volume, particularly in urban areas and metropolitan cities. This surge in traffic poses a significant challenge for emergency vehicles, such as ambulances, to reach their destinations promptly. The delayed arrival of ambulances to hospitals during the critical "golden hour" can result in loss of life [1]. Emergency services face the brunt of traffic congestion, particularly at intersections, where waiting times can be detrimental, especially for ambulance services dealing with life-threatening situations. India's rapidly growing population includes a significant proportion of young individuals entering the workforce. Unfortunately, this also contributes to an increase in accidents, fires, and other mishaps. Consequently, there is a constant need for emergency services such as ambulances, hospitals, police, fire brigades, and volunteers to cater to the daily emergencies arising from these incidents.

Emergency services and personnel play a crucial role in assisting citizens in need, saving numerous lives on a daily basis. However, the increasing population has put immense stress on these emergency services, necessitating effective management strategies. Recent research has highlighted the escalating prevalence of various diseases, including heart attacks and diabetes, primarily attributed to inadequate healthcare resources in many developing nations. In India, the scarcity of available doctors and long queues for consultations have contributed significantly to the rise in diseases [2]. In the present era, wearable sensors have gained prominence across various domains, including healthcare, fitness, and industrial applications. These sensors offer valuable insights into individuals' health conditions, enabling continuous monitoring and timely interventions. By leveraging wearable

sensor technology, healthcare providers can gather real-time data on patients' vital signs and symptoms, facilitating early detection of health issues and promoting proactive healthcare management.

In the context of emergency services, wearable sensors can play a vital role in providing crucial information about patients' health status to medical professionals, even before their arrival at the scene. This advanced technology can enhance the efficiency of emergency response teams, allowing them to prioritize and allocate resources based on the severity of patients' conditions. Furthermore, the utilization of wearable sensors can contribute to preventive healthcare measures, as they empower individuals to monitor their own health and make informed decisions regarding their well-being. By promoting a proactive approach to healthcare, wearable sensor technology has the potential to reduce the burden on emergency services by mitigating the occurrence of avoidable medical emergencies.

In conclusion, the increase in population has placed emergency services under significant strain, necessitating effective management strategies. Wearable sensor technology offers promising solutions in healthcare, providing continuous monitoring capabilities and empowering individuals to take control of their well-being. By leveraging these technological advancements, emergency services can improve their efficiency, prioritize critical cases, and potentially reduce the incidence of preventable emergencies.

With each passing day, technology continues to advance in every sector worldwide. The widespread adoption of smartphones has significantly amplified their impact on human lives. Patient monitoring has emerged as a notable area where smartphones have proven to be transformative. The advantages of patient monitoring encompass the timely and real-time detection of diseases, comprehensive

patient monitoring, prevention of adverse effects and premature deaths caused by diseases, reduction in hospital admission durations, and the facilitation of virtual monitoring, leading to substantial improvements in healthcare services [3]. Remote patient monitoring is particularly beneficial for individuals with chronic illnesses, limited mobility, disabilities, those recovering from surgery, newborns, and the elderly.

Cardiovascular diseases stand as a leading global cause of mortality, with cardiac arrests claiming the lives of over 12 lakh young individuals annually. Particularly in India, the prevalence of heart attacks has become alarmingly evident. Given the escalating death toll resulting from heart attacks, ensuring prompt medical responses has become increasingly critical. Referred to as the "golden hour," the first hour after a heart attack is crucial, as timely assistance during this period can be instrumental in saving lives. In emergency situations, having a readily available ambulance staffed with certified medical professionals and equipped with essential medical tools can significantly enhance the chances of survival following a heart attack. When a heart attack occurs, immediate and appropriate care becomes the sole avenue for preserving lives.

We have developed a concept for an Intelligent Ambulance that combines AI and human interface technology. This innovative system involves connecting the ambulance to the Internet of Things (IoT), transforming it into a smart ambulance capable of monitoring the patient's health condition using sensors. The gathered health data is then transmitted to the hospital in real-time via the internet. The primary objective is to improve the patient's survival rate by maintaining their health stability until they reach the hospital for the necessary 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.

In their publication titled "Intelligent Ambulance with Traffic Control" [3], Gargi Beri, Ashwin Channawar, Pankaj Ganjare, Amruta Gate, and Prof. Vijay Gaikwad present a comprehensive study that incorporates both a traffic control system and a health monitoring system. The health monitoring system focuses on tracking vital health parameters, including ECG, heart rate, and body temperature of the patient. These parameters are transmitted to a PC located within the ambulance through serial communication. Subsequently, the collected data is forwarded to the hospital server for further analysis and monitoring.

Aisha Meethean, Althaf, Athinen Saewd, Ligen Abraham, Md. Samran Hashem 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. The parameters collected from the patient are

transmitted to the hospital's database using IOT.

In reference to [5], the aim is to establish an intelligent and smart health system capable of sensing the body condition and transmitting the collected data to a designated hospital's website. This system incorporates a device equipped with a heart rate sensor to monitor the heartbeat and a temperature sensor to measure body temperature. Once the sensors detect the respective parameters, the data is relayed to a microcontroller. Subsequently, the microcontroller sends the data to a Raspberry Pi, which is connected to the internet or an IoT cloud platform. To ensure timely arrival at the destination, the driver utilizes Google Maps along with accident-avoidance features, thus contributing to saving lives.

In a study conducted by Timothy Malche et al. in 2022 [6], a system is proposed that involves a sensor node for tracking patients' vital signs during various activities. The proposed sensor node employs the nRF5340 Development Kit (DK) along with several connected sensors, including an accelerometer, microphone, pulse oximeter, heart rate sensor, and temperature sensor. The accelerometer facilitates the monitoring of different physical activities performed by the patients, such as walking, sleeping, exercising, and running. By analyzing the vital signs obtained during these activities, doctors can prescribe appropriate treatment or provide relevant suggestions to the patients.

In reference to [7], a study introduces a novel approach for pulse detection during Out of Hospital Cardiac Arrest utilizing electrocardiogram (ECG) and Thoracic impedance (TI) signals. The method involves the utilization of an adaptive filter to extract the circulatory-related component known as impedance circulation component (ICC) from the TI. Additionally, a support vector machine (SVM) classifier is employed, using features extracted from the ECG and ICC,

to differentiate pulseless electrical activity (PEA) and PR interval [1].

In [8], an Enhanced Deep Convolutional Neural Network (EDCNN) is proposed for the early detection and diagnosis of heart disease. This research focuses on developing an EDCNN-based approach to improve diagnostic accuracy and predict heart disorders in patients using deep learning-based prediction models. Mathematical calculations with distributive functions are applied to process patient data and estimate the likelihood of heart ailments. The analysis covers heart activity during exercise, rest, and work [2].

In [9], the proposed method employs the Decision Tree algorithm for feature selection, Principal Component Analysis (PCA) for dimension reduction, and Artificial Neural Networks (ANN) for classification. PCA is a statistical technique that utilizes mathematical principles to transform a set of potentially correlated variables into a new set of linearly uncorrelated variables. The method encompasses data collection, pre-processing, feature extraction, dimension reduction, classification, and result analysis, as depicted in Figure 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 no. of people aged 18 - 30 years who died from heart attacks in India was 2,542 in 2022, and 2,696 in 2021. 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

According to a report by NITI Aayog on emergency care in India, non-communicable diseases account for 62% of all deaths in the country. The report suggests that 50% of these deaths could be prevented with adequate pre-hospital and emergency care. This underscores the crucial need for efficient and effective Emergency Medical Services (EMS). In many cases, early detection of certain diseases is not possible, which is why we propose a fast, cost-effective, and efficient ambulance management control system to enhance the chances of patient survival [7]. For patients who have been involved in an incident or sustained severe injuries, their electronic monitoring may be limited to the duration of their ambulance transport to the hospital. Nevertheless, efforts have been focused on ensuring a safe journey to the hospital, and virtual monitoring assists in the provision of urgent medical interventions in highly 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 the era of smart cities, people are increasingly concerned about various issues related to medical problems, such as receiving timely aid, experiencing delays in response, and lacking adequate facilities in healthcare 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.

## 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].

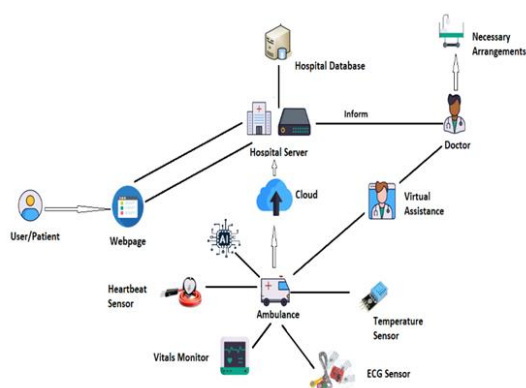


Fig. 2 : Overall Architecture of the propose system

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].

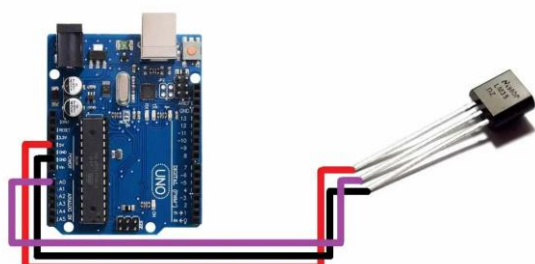


Fig. 3 : Patient's data collection using Temperature Sensor



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].

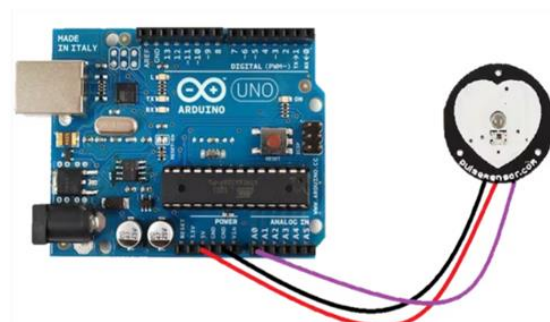


Fig. 7 : Arduino Uno board

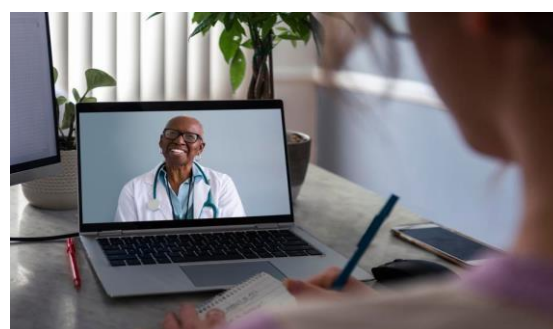


Fig. 8 : Doctor virtually monitors the patient

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 developed enables medical staff to access real-time information using mobile phones or notebooks. The primary objective of this system is to provide enhanced and cost-effective healthcare services to patients by implementing a networked information cloud. This enables specialists and doctors to utilize the available data and offer quick and efficient solutions to patients. The final model incorporates features that allow doctors to examine patients remotely from anywhere and at any time. The health parameter monitoring system operates with high accuracy, providing live results of essential metrics such as blood pressure, glucose level, pulse rate, and temperature. This proactive monitoring helps prevent conditions from reaching critical stages. In cases where the patient's condition is critical, an alert notification is sent to the hospital's monitoring website. The respective doctor can then provide instructions for stabilizing 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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