



Predictive Healthcare Ambulance – AI & Human Interface Collaboration

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Abstract: The integration of artificial intelligence (AI) and advanced human-machine interfaces is transforming emergency medical services. This study proposes an intelligent ambulance system that leverages AI for predictive analytics, decision support, and real-time communication to enhance the efficiency, accuracy, and responsiveness of ambulance operations. Traditional ambulance services often suffer from manual processes, limited patient data, and delayed communication. By incorporating AI algorithms and technologies such as natural language processing, augmented reality, and automated data analysis, the proposed system streamlines emergency response, improves patient assessment, and facilitates seamless coordination between paramedics and hospitals. This innovation aims to optimize critical care delivery, reduce response times, and ultimately improve patient outcomes in emergency situations.

Keywords: Artificial Intelligence (AI), Intelligent Ambulance, Emergency Medical Services, Human-Machine Interface, Predictive Analytics, Decision Support System, Real-Time Communication, Healthcare Technology, Patient Care, Automated Response.

I. INTRODUCTION

Emergency Medical Services (EMS) are a cornerstone of pre-hospital care, particularly in time-sensitive conditions such as stroke and cardiac arrest, where rapid and appropriate response is essential for favorable clinical outcomes.

Timely and effective Emergency Medical Services (EMS) are critical for improving outcomes in life-threatening conditions such as cardiac arrest and stroke. However, traditional dispatch methods—typically assigning the nearest ambulance—are often inefficient, especially when resources are limited. Accurate triage is essential for prioritizing cases and optimizing response

Globally, EMS systems use either the protocol-driven Medical Priority Dispatch System or the symptom-based Criteria-Based Dispatch System. While widely adopted, these methods often lack accuracy, resulting in significant over-triage and under-triage rates. In Singapore, the Singapore Civil Defence Force (SCDF) manages over 190,000 emergency calls annually using a rule-based triage system based on the Patient Acuity Category Scale (PACS). Despite structured protocols, recent data show a 47% over-triage and 6% under-triage rate, indicating

room for improvement.

In Singapore, the national EMS provider—the Singapore Civil Defence Force (SCDF)—responds to over 190,000 emergency calls annually with a limited fleet of 84 ambulances. SCDF employs a rule-based dispatch model guided by the Patient Acuity Category Scale (PACS), a five-tier system ranging from P1+ (critical emergencies) to P4 (non-urgent cases). Triage decisions are made by call center specialists based on caller-reported information and 30 predefined protocols.

These specialists, while trained, are not clinically certified, and operate under strict time constraints that limit the depth of patient assessment.

This study proposes a machine learning-based triage model that leverages call data to enhance dispatch accuracy. By providing data-driven decision support, the model aims to reduce over-triage while maintaining low under-triage rates, ultimately improving EMS efficiency and patient care outcomes.

II. RELATED WORK

Blomberg SN, Folke F, Ersbøll AK, Christensen HC, Torp-Pedersen C, Sayre MR, Counts CR, Lippert FK. Machine learning as a supportive tool to recognize cardiac arrest in emergency calls. *Resuscitation*. 2019;138:322–329.

This study explores the use of machine learning algorithms to aid in recognizing cardiac arrest situations during emergency calls. The researchers investigate the potential of machine learning as a supportive tool for identifying cardiac arrest cases based on information provided during emergency calls.

Blomberg SN, Christensen HC, Lippert F, Ersbøll AK, Torp-Petersen C, Sayre MR, Kudenchuk PJ, Folke F. Effect of machine learning on dispatcher recognition of out-of-hospital cardiac arrest during calls to emergency medical services: A randomized clinical trial. *JAMA Netw Open*. 2021;4(1):e2032320.

This paper presents the results of a randomized clinical trial that examines the impact of machine learning on dispatcher recognition of out-of-hospital cardiac arrest cases. The study assesses how machine learning algorithms affect the ability of emergency medical service dispatchers to recognize cardiac arrest situations during calls, providing valuable insights into the effectiveness of these technologies in real-world scenarios.

Tollinton L, Metcalf AM, Velupillai S. Enhancing predictions of patient conveyance using emergency call handler free text notes for unconscious and fainting incidents reported to the London Ambulance Service. *Int J Med Inform*. 2020;141:104179.

This research focuses on improving predictions related to patient conveyance by analyzing free text notes provided by emergency call handlers. Specifically, the study concentrates on incidents involving unconsciousness and fainting reported to the London Ambulance Service. By leveraging natural language processing techniques, the researchers enhance the accuracy of predictions, highlighting the importance of textual information in emergency medical services.

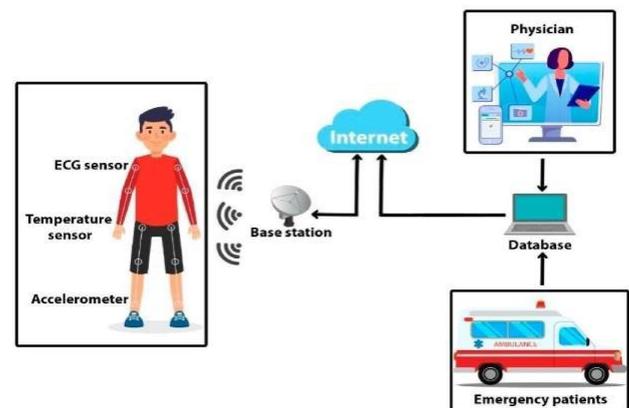
III. PROPOSED SYSTEM

To implement this initiative, two applications have been designed:

- Hospital Application: This application loads and preprocesses the dataset, trains all algorithms on the

processed data, and initiates a cloud server to receive requests from ambulances.

- Ambulance Application: In the absence of IoT sensors, this application uploads test data, representing the patient's vital signs, from a file. The application then transmits this data to the hospital server, where the patient's condition is predicted. The hospital server sends back the response to the ambulance, enabling timely and accurate medical interventions.



This advanced AI-based Ambulance system not only addresses the challenges posed by the burgeoning population but also significantly enhances the efficiency and effectiveness of emergency medical services, ultimately saving lives in critical situations. Finally, the AI-based Ambulance System represents a significant leap forward in the field of emergency medical services, offering a solution to the challenges posed by the increasing population and urbanization. By leveraging modern technologies, the proposed model ensures that every moment counts in saving lives during medical emergencies.

Advantages of proposed system

The advantages of intelligent ambulance-AI and human interface technology encompass improved efficiency, accuracy, patient care, and decision-making, ultimately leading to better outcomes for patients in emergency situations and creating a more responsive and effective emergency medical services system. The integration of intelligent ambulance-AI and human interface technology in emergency medical services offers several advantages, including:

- Enhanced Efficiency: Automation of tasks and processes leads to quicker response times, streamlined operations, and efficient allocation of resources. AI algorithms can optimize ambulance routes, ensuring the fastest possible

response to emergencies.

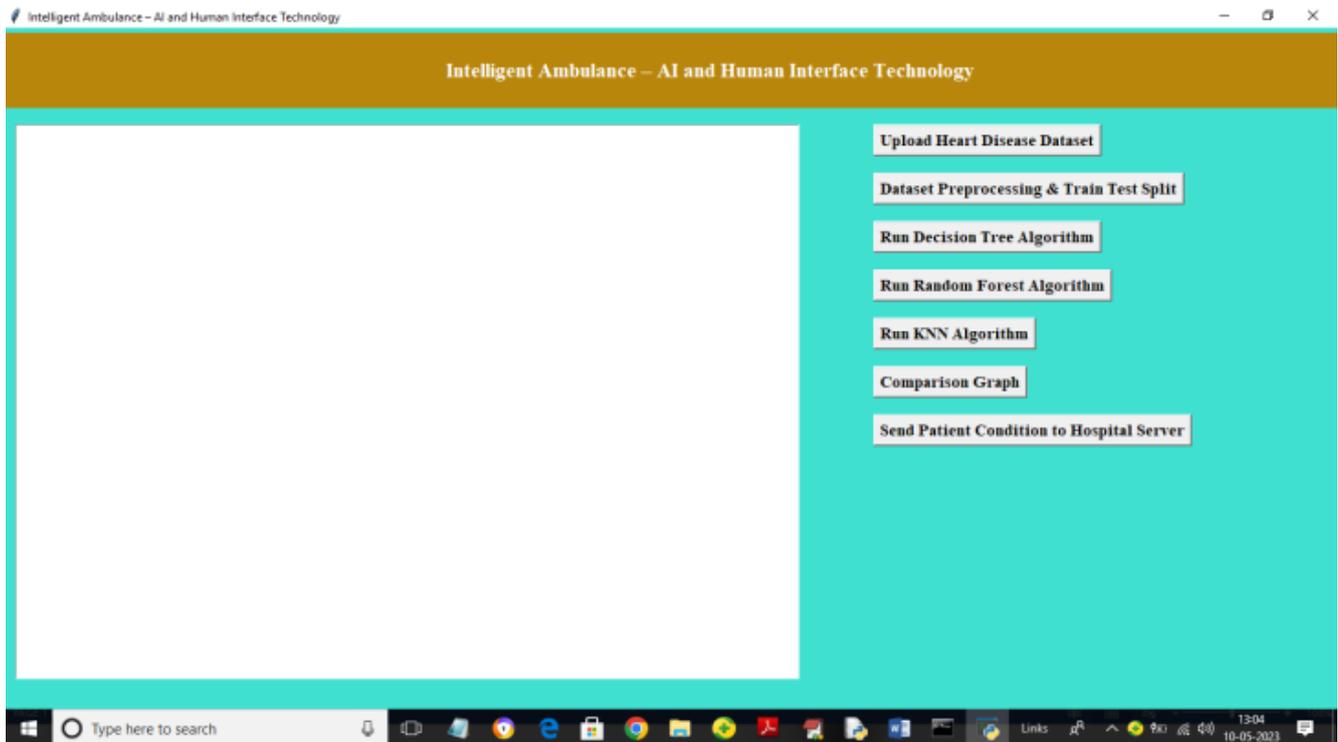
- **Improved Accuracy:** AI-driven predictive analytics and decision support systems provide accurate insights based on vast amounts of data. This accuracy can aid paramedics in making informed decisions about patient care, leading to better treatment outcomes.
- **Optimized Resource Utilization:** By analyzing data and predicting demand, the system can optimize the allocation of ambulances and medical staff.

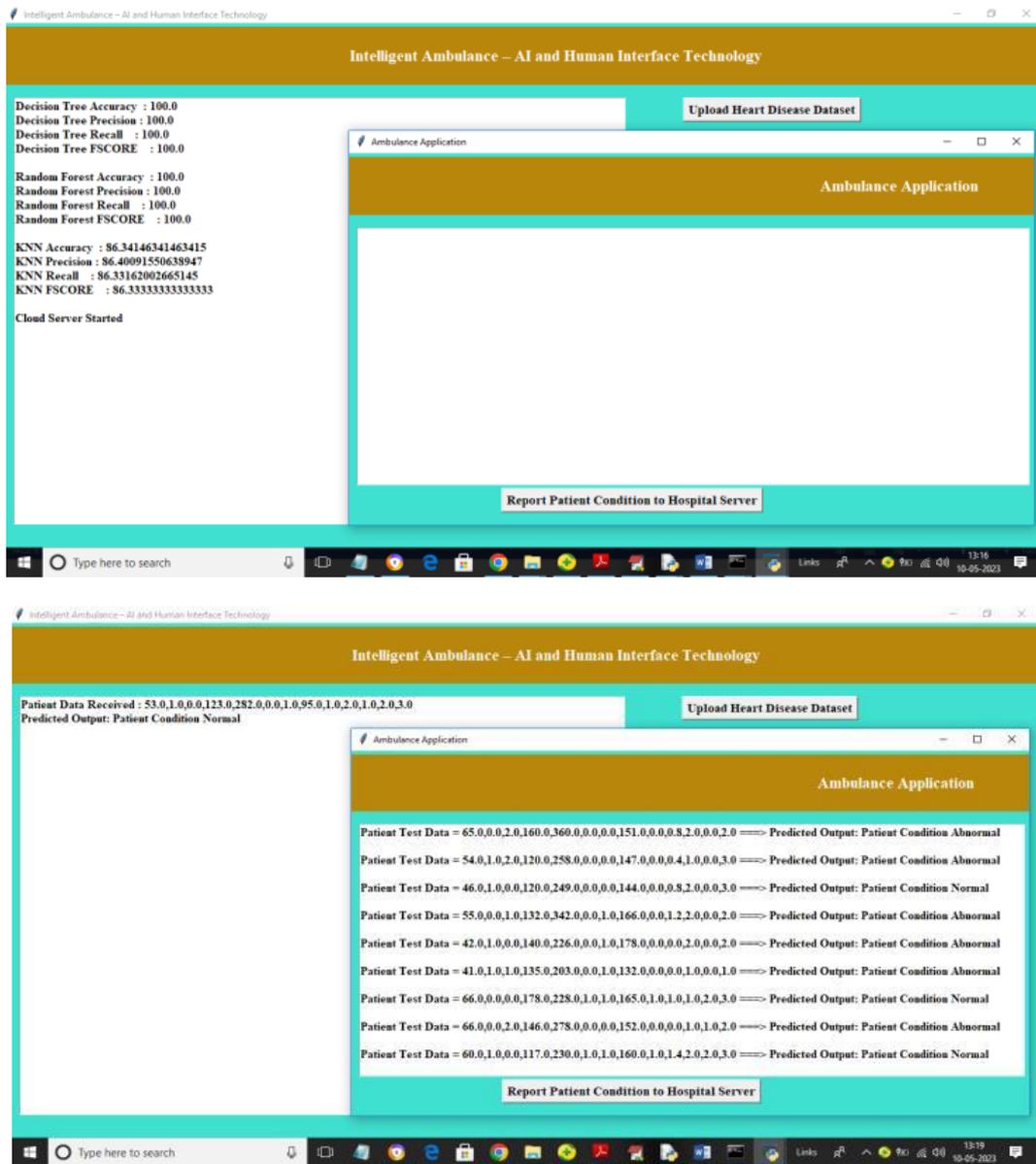
This ensures that resources are used efficiently, reducing idle time and improving overall service availability.

- **Enhanced Patient Care:** Access to real-time data and historical patient information allows paramedics to provide personalized and targeted care. They can arrive at the scene better prepared, with insights into the patient's medical history and specific conditions, leading to more effective treatments.
- **Faster Decision-Making:** AI algorithms can process information rapidly and provide instant recommendations. This speed is crucial in emergency situations, where swift decision-making can significantly impact patient outcomes.
- **Improved Communication:** Advanced human-machine interfaces facilitate seamless communication between

paramedics, emergency operators, and hospitals. Clear and instant communication ensures that vital information is relayed promptly, enabling more coordinated and effective care.

- **Reduction in Errors:** Automation reduces the likelihood of human errors, ensuring that critical information is not overlooked. This leads to safer medical practices and minimizes the risk of mistakes in emergency situations.
- **Data-Driven Insights:** The system generates valuable data that can be analyzed to identify patterns, trends, and areas for improvement. These insights can be used to enhance protocols, training programs, and overall emergency medical service strategies.
- **Resource Conservation:** By optimizing routes and resources, the system contributes to the conservation of fuel and other valuable resources, making emergency medical services more environmentally friendly and sustainable.
- **Cost Efficiency:** While initial implementation might require investment, the long-term benefits, including reduced hospitalization costs due to better initial care, streamlined operations, and optimized resource usage, can lead to significant cost savings for healthcare providers and organizations.





In above screen continuously ambulance will send patient data to server to get predicted condition and based on condition doctors will arrange medications. There have been some studies exploring machine learning on medical emergency calls. In Copenhagen, Blomberg et al. used a machine learning framework to recognize cardiac arrest in emergency calls, but the details of the machine learning framework are proprietary and, hence, was not disclosed. In their randomized clinical trial, no significant improvement in dispatchers' ability to recognize cardiac arrest was found when supported by machine learning. In London, Tollinton et al. used machine learning models to predict whether an unconscious and fainting patient would be conveyed to a hospital using the Medical Priority Dispatch System codes and

free text notes as features. However, using conveyance as a binary marker of case severity is neither accurate nor objective.

The increasing population in developing countries like India has put immense pressure on existing infrastructures, especially in the healthcare sector. The history of emergency medical services dates back to ancient times when communities devised rudimentary methods to transport the injured. Rapid urbanization and population growth have led to challenges in providing timely medical assistance during emergencies. Traffic congestion, lack of resources, and communication gaps have further exacerbated this problem, leading to avoidable loss of lives. Over the centuries, these services have evolved, but the

challenges have grown with increasing population and urbanization. With the advent of technology, especially artificial intelligence and the Internet of Things (IoT), new opportunities have emerged to revolutionize emergency medical services. Therefore, AI-based Ambulance System aims to revolutionize emergency medical response by leveraging cutting-edge technologies. By integrating IoT sensors, artificial intelligence algorithms, and real-time communication systems, this project seeks to provide a seamless and efficient method of predicting, diagnosing, and administering treatment to patients en route to the hospital. This innovative approach ensures that patients in critical conditions receive the necessary medical attention promptly, significantly improving their chances of survival and recovery.

The need for an efficient and timely emergency medical response system is crucial. With the rise in population and urban density, traditional methods of ambulance services have become inadequate. There is a pressing need for a system that can bridge the gap between patients in critical conditions and timely medical interventions, ensuring that patients receive appropriate care even before reaching the hospital.

IV. CONCLUSION

The proposed intelligent ambulance system integrating AI and advanced human-machine interfaces aims to revolutionize emergency medical services. By automating processes, utilizing predictive analytics, and improving communication between paramedics and hospitals, this system enhances efficiency, accuracy, and responsiveness. The timely and data-driven support provided ensures optimal patient care during critical situations, ultimately saving lives and reducing the strain on healthcare facilities. This innovative approach addresses the limitations of traditional ambulance systems and underscores the importance of technology in improving emergency response and medical outcomes.

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