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AI-Driven Pre-Triage System for Ambulance and Hospital Coordination

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***Abstract*—Emergency medical services often face delays and miscommunication between ambulance teams and hospitals, which can slow down treatment and affect patient outcomes. This research proposes an AI-driven pre-triage system designed to improve coordination and communication during emergency patient transportation. The system allows paramedics to report patient vital signs and symptoms using voice commands, which are converted into digital data through speech recognition and processed using machine learning algorithms to predict possible medical conditions. The analyzed information is automatically transmitted to hospitals before the patient arrives, allowing medical staff to prepare necessary resources in advance. Proposed system improves the speed and accuracy of patient data collection, reduces the need for manual data entry, and enhances hospital preparedness. The system demonstrates the potential to reduce treatment delays, improve communication between emergency teams and hospitals, and support faster and more effective emergency medical care.**

Keywords*—Artificial Intelligence, Emergency Medical Services, Pre-Triage System, Speech Recognition

I. Introduction

Emergency medical care is one of the most important parts of any healthcare system. When a person experiences a serious illness or injury, quick medical attention can mean the difference between life and death. In many emergency situations, patients are transported to hospitals using ambulance services. During this time, medical staff in the ambulance try to stabilize the patient and collect important health information. However, many healthcare systems still rely on manual communication methods between ambulance teams and hospitals.[1] This can lead to delays, miscommunication, and inefficient patient handling.

One of the biggest challenges in emergency healthcare is the lack of coordination between ambulance services and hospitals. When an ambulance transports a patient, the hospital may not always have accurate or timely information about the patient's condition before arrival. Because of this, hospitals may not be fully prepared to treat the patient immediately. Doctors and nurses often need to collect patient information again when the patient reaches the hospital. This repetition wastes valuable time, especially in critical situations where every second matters.

In many countries, emergency medical services receive a large number of emergencies calls every day. Ambulance teams must make quick decisions about patient care while traveling to the hospital. They need to assess vital signs such as blood pressure, heart rate, oxygen level, and body temperature. These measurements help medical staff understand the patient's condition and determine the severity of the situation. However, documenting and communicating this information quickly and accurately is not always easy.

Traditional ambulance communication systems usually depend on radio calls, phone calls, or manual data entry. These methods can be slow and sometimes unreliable. For example, paramedics may need to stop their clinical work to type information into a device or make phone calls to hospital staff. This increases their workload and may reduce the time they can spend caring for the patient. Additionally, human errors can occur when information is recorded manually, leading to incorrect or incomplete data.

Another major issue is the lack of early triage information at the hospital. Triage is the process of determining the priority of patients based on the severity of their condition. In emergency departments, triage helps doctors decide which patients need immediate treatment and which patients can wait. When hospitals do not receive accurate pre-arrival information from ambulances, the triage process may be delayed. As a result, critical patients may not receive immediate attention.

Recent advancements in artificial intelligence (AI), machine learning (ML), and speech recognition technologies have opened new possibilities for improving emergency healthcare systems. AI-based systems can analyze medical data quickly and assist healthcare professionals in making better decisions. Speech recognition technology allows users to interact with systems using voice commands, reducing the need for manual typing or complex data entry. These technologies can help improve efficiency, accuracy, and communication in emergency medical situations.

Integrating AI technologies into ambulance services can significantly enhance patient care during transportation. For example, paramedics can use voice-based systems to report patient vital signs while continuing to monitor and treat the patient. The system can convert spoken information into digital data using speech-to-text technology.[2] This data can then be processed by machine learning models to predict possible medical conditions and assess the severity of the patient's situation.

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An intelligent pre-triage system can also automatically share patient information with hospitals before the ambulance arrives. This allows hospital staff to prepare necessary medical equipment, allocate beds, and arrange medical teams in advance. As a result, the patient can receive faster treatment upon arrival. Such systems can improve hospital readiness and reduce waiting times in emergency departments.

Another advantage of AI-based emergency support systems is their ability to assist in disease prediction. Machine learning models can analyze patient symptoms and vital signs to identify potential medical conditions. For example, abnormal blood pressure, heart rate, or oxygen levels may indicate serious health problems. By analyzing these indicators in real time, the system can provide earlywarnings to medical staff and help them make faster decisions.

Voice-enabled systems are especially useful in emergency environments because they allow hands-free interaction. Paramedics often have limited time and must focus on patient care while traveling in a moving ambulance. Typing information into a device can be difficult and unsafe in such situations. Voice-based reporting allows paramedics to communicate patient information quickly without interrupting their clinical tasks.

In addition to supporting ambulance staff, an intelligent pre-triage system can improve communication with hospital personnel. Once patient data is collected and processed, the system can send the information to the hospital through a centralized platform.[3] Doctors and nurses at the hospital can review the patient's condition before arrival and prepare appropriate treatment plans. This improves coordination between emergency medical teams and hospital staff.

Another important aspect of modern healthcare systems is data management. Digital healthcare solutions allow patient information to be stored securely and accessed easily by authorized medical personnel. By maintaining a structured digital record of emergency cases, hospitals can also analyze historical data to improve emergency response strategies. This can help healthcare authorities identify common emergency conditions and improve resource allocation.

The proposed research focuses on developing an AI-driven pre-triage system designed to improve ambulance and hospital coordination during emergency situations. The system integrates several technologies, including speech recognition, machine learning-based disease prediction, and automated hospital notification.[4] It enables paramedics to verbally report patient vital signs and observations while the ambulance is traveling to the hospital. The system converts this speech input into digital data, analyzes it using machine learning models, and provides early predictions about possible medical conditions.

Furthermore, the system can automatically send patient information to hospitals so that medical staff can prepare in advance for the patient's arrival. This approach aims to reduce delays in treatment and improve the overall efficiency of emergency healthcare services. By minimizing manual tasks and improving communication, the system can support paramedics in providing better patient care.

The proposed solution is particularly relevant in countries where ambulance services handle a large number of emergency cases daily. For example, emergency ambulance services must often respond quickly to accidents, heart attacks, strokes, and other life-threatening conditions. In such situations, faster communication and accurate data sharing can significantly improve patient survival rates.

Another important benefit of this system is reducing the workload of medical staff. Emergency healthcare professionals already work in highly stressful environments. By automating certain tasks such as data recording and communication, the system allows medical staff to focus more on patient treatment rather than administrative work.

The use of artificial intelligence in healthcare is growing rapidly, and many researchers are exploring ways to apply AI technologies in emergency medicine. AI-based systems can analyze large amounts of medical data quickly and provide useful insights to healthcare professionals. When combined with real-time data collection and communication technologies, these systems have the potential to transform emergency healthcare services.

This research aims to demonstrate how an AI-driven pre-triage system can improve the efficiency of emergency patient management. By integrating voice-enabled data collection, machine learning-based analysis, and automated hospital coordination, the system provides a smarter and faster approach to emergency care. The proposed solution focuses on reducing treatment delays, improving data accuracy, and strengthening communication between ambulance teams and hospitals.

II. LITRATURE REVIEW

Emergency healthcare systems play a vital role in saving lives by providing rapid medical assistance to patients in critical situations. Effective communication and coordination between ambulance teams and hospitals are essential to ensure that patients receive timely treatment. However, many healthcare systems still experience several challenges such as delays in information sharing, lack of real-time patient monitoring, and inefficient triage processes. These limitations can slow down emergency response and negatively affect patient outcomes. To address these issues, researchers have increasingly explored the use of advanced technologies such as Artificial Intelligence (AI), Machine Learning (ML), speech recognition, and Internet of Things (IoT) devices to improve emergency medical services. This literature review examines previous research related to emergency triage systems, AI-based healthcare technologies, ambulance communication systems, and voice-based medical data collection.

Triage is a key process in emergency healthcare that helps medical professionals prioritize patients based on the severity of their condition. According to Iserson and Moskop (2007), [5] triage systems ensure that patients who require urgent medical care receive treatment first, especially during emergencies or disasters where medical resources are limited. Traditional triage methods mainly rely on manual assessments performed by healthcare professionals. While this method has been used for many years, it can sometimes lead to delays and inconsistencies because decisions depend heavily on human judgment and experience.

To improve the triage process, several digital solutions have been proposed. Gilboy et al. (2011) [6] introduced the Emergency Severity Index (ESI), which is one of the most widely used triage tools in emergency departments. The ESI categorizes patients based on the urgency of their condition and the number of medical resources they may require. This system helps hospitals organize patient flow more effectively. However, the ESI system still depends on manual data entry and clinical judgment, which can slow down the process during busy emergency situations. Because of these limitations, researchers are exploring automated or AI-assisted triage systems that can support faster and more consistent decision-making.

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Emergency department overcrowding is another major challenge faced by healthcare systems. Sun et al. (2013) [7] highlighted that overcrowding often leads to delays in patient assessment and treatment. Their research showed that delays in triage and hospital admission can significantly impact patient outcomes. As a result, improving the efficiency of triage systems is essential for maintaining patient safety and reducing waiting times in emergency departments. Integrating digital technologies into triage processes can help healthcare professionals make faster and more accurate decisions.

Artificial Intelligence has become an important technology in modern healthcare systems. AI systems can analyze large volumes of medical data and support healthcare professionals in making better clinical decisions. According to Topol (2019) [8], AI has the potential to transform healthcare by improving diagnostic accuracy, predicting diseases, and supporting clinical decision-making. AI-based technologies are increasingly being applied in many areas of healthcare, including medical imaging, patient monitoring, and disease prediction.

Machine Learning, which is a subset of AI, has shown significant potential in analyzing medical data. Machine learning algorithms can identify patterns in patient information and predict possible health conditions. For example, Esteva et al. (2017) [9] demonstrated that deep learning models could achieve diagnostic performance comparable to medical experts in certain tasks. This research highlights the ability of AI systems to support healthcare professionals in making faster and more accurate medical decisions.

In emergency medical services, AI can be used to analyze patient vital signs and predict possible medical emergencies. Jiang et al. (2017) [10] reviewed several applications of AI in healthcare and concluded that AI technologies can support disease prediction, patient monitoring, and treatment planning. AI systems can also help reduce the workload of medical staff by automating routine tasks such as analyzing patient data, identifying abnormal patterns, and generating alerts for healthcare providers. This capability is particularly useful in emergency situations where quick decisions must be made.

Machine learning techniques have also been widely used to predict diseases based on patient symptoms and clinical data. Rajkomar et al. (2018) [11] explained that machine learning models can analyze electronic health records to identify patterns that indicate potential medical conditions. These predictive models allow healthcare providers to detect diseases at an early stage and provide appropriate treatment quickly.

Several studies have focused on using machine learning algorithms to analyze patient vital signs such as heart rate, blood pressure, oxygen saturation, and body temperature. These vital signs provide critical information about a patient's health condition. When combined with machine learning models, this information can help predict serious medical emergencies such as heart attacks, respiratory failure, or severe infections. For example, Clifton et al. (2012) [12] used machine learning techniques to detect early signs of patient deterioration in hospital environments.

In ambulance services, machine learning models can analyze patient data collected during transportation and provide early predictions about potential medical conditions. This information can be transmitted to hospitals before the patient arrives so that medical teams can prepare the necessary equipment and treatment plans. Such predictive systems can significantly improve the efficiency of emergency medical care and reduce treatment delays.

Communication between ambulance teams and hospitals is another critical aspect of emergency healthcare.Traditionally, paramedics use radio communication or phone calls to inform hospitals about incoming patients. However, these communication methods are often slow and may not provide sufficient medical information. According to Cone and Murray (2002) [13], effective communication between emergency medical services (EMS) and hospitals is essential for improving patient outcomes. When hospitals receive patient information in advance, they can prepare resources and respond more efficiently.

Langabeer et al. (2016) [13] emphasized the importance of real-time communication systems in ambulance services. Their research showed that digital communication platforms could improve coordination between ambulance teams and hospital emergency departments. Real-time data sharing enables hospitals to manage patient admissions more effectively and reduce delays in treatment.

Speech recognition technology is also becoming increasingly important in healthcare environments. Voice-enabled systems allow healthcare professionals to record medical information using spoken language rather than typing. According to Zhou et al. (2018) [14], speech recognition systems are widely used in clinical documentation and medical reporting. These systems reduce administrative workload and allow healthcare providers to focus more on patient care.

In emergency situations, voice-based systems can be particularly useful for paramedics. Entering patient data manually while treating a patient in a moving ambulance can be difficult and time-consuming. Voice-enabled systems allow paramedics to report hands-free patient information, which improves efficiency and safety. Patel and Lam (2020) [15] found that voice-assisted technologies can improve data entry accuracy and reduce documentation time.

The Internet of Things (IoT) has also become an important technology in healthcare systems. IoT devices such as wearable sensors and medical monitoring equipment can collect real-time patient data and transmit it to healthcare providers. Islam et al. (2015)[16] explained that IoT-based healthcare systems enable continuous monitoring of patient vital signs and support remote medical services. In ambulance environments, IoT sensors can monitor vital signs such as heart rate, blood pressure, oxygen levels, and body temperature during patient transportation. This information can be transmitted to hospitals in real time. Mehmood et al. (2018)[17] proposed a smart ambulance system that uses IoT sensors to monitor patient conditions and send data to hospitals. Their study showed that such systems can improve emergency response and patient management.

However, IoT-based systems often require complex hardware infrastructure and reliable network connectivity. In some regions, these requirements may be difficult to maintain. Therefore, combining IoT technologies with AI-based software solutions can create more flexible and efficient healthcare systems.

Several researchers have also investigated AI-based systems for pre-hospital emergency care. Pre-hospital care refers to the medical treatment provided before the patient arrives at the hospital. According to Raita et al. (2019), AI algorithms can analyze emergency call data and predict the severity of medical conditions before ambulance arrival. This allows emergency responders to allocate appropriate resources and improve response times.

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Despite these advancements, many existing solutions focus mainly on hospital-based decision-making rather than ambulance-based data collection. There is still limited research on integrated systems that combine ambulance data collection, AI-based analysis, and hospital coordination. Many systems focus on patient monitoring or hospital management but do not address the challenges faced by paramedics during emergency transportation.

Paramedics often struggle to document patient information while simultaneously providing treatment in emergency environments. Manual data entry methods can slow down the process and increase the risk of errors. Therefore, there is a strong need for systems that allow paramedics to report patient information quickly and accurately.

To address these challenges, the proposed AI-driven pre-triage system integrates speech recognition technology, machine learning-based disease prediction, and automated hospital notification. By allowing paramedics to report patient vital signs using voice commands and enabling real-time data analysis, the system can improve communication between ambulance teams and hospitals. This approach can enhance emergency healthcare efficiency and support faster medical decision-making

III. METHODOLOGY

This research proposes an AI-driven pre-triage system designed to improve coordination between ambulance services and hospitals during emergency medical situations. The methodology focuses on developing an intelligent system that allows paramedics to collect and report patient information using voice commands while the ambulance is in transit. The system automatically converts the spoken information into digital data, analyzes the patient's condition using machine learning algorithms, and sends real-time notifications to hospitals before the patient arrives. By providing early medical information to hospital staff, the system aims to reduce treatment delays, improve communication between ambulance teams and emergency departments, and enhance the accuracy and efficiency of the triage process.

Emergency healthcare environments require rapid decision-making and efficient communication. In many traditional systems, paramedics must manually record patient data or communicate information through radio or phone calls. These methods can lead to delays, incomplete data transmission, and increased workload for emergency medical personnel. The proposed methodology addresses these challenges by integrating multiple technologies such as speech recognition, natural language processing (NLP), machine learning, and cloud-based communication systems into a single intelligent platform. The integration of these technologies allows patient information to be captured quickly, analyzed automatically, and shared instantly with hospitals.

The proposed AI-driven pre-triage system follows a structured methodology consisting of several stages: patient data collection, voice-based data input, speech-to-text conversion, data processing, machine learning-based disease prediction, and hospital notification. Each stage plays a critical role in ensuring that patient information is accurately captured, processed, and transmitted in real time. The overall system architecture is illustrated in Figure 1, which shows the interaction between the ambulance module, the AI analysis module, and the hospital coordination module.

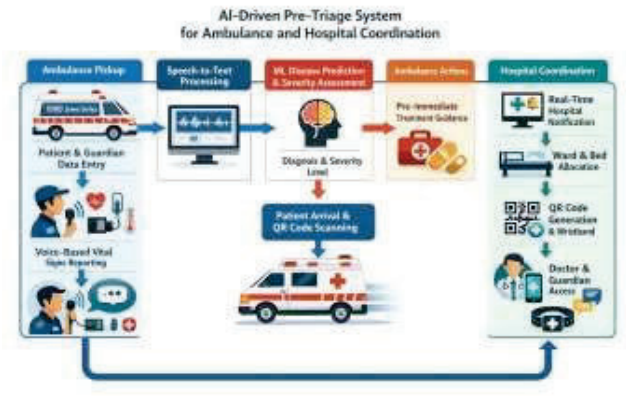

Fig 1. System Architecture

The architecture of the proposed system is designed to support seamless communication between ambulance teams and hospital emergency departments. The system consists of three main components: the ambulance module, the AI analysis module, and the hospital coordination module. Figure I illustrated in the system architecture diagram.

The ambulance module is responsible for collecting patient data during transportation. This module includes medical monitoring devices, a voice input interface, and a data transmission system. Paramedics assess the patient's condition using medical equipment that measures vital signs such as heart rate, blood pressure, oxygen saturation, respiratory rate, and body temperature. These vital signs provide essential information about the patient's physiological condition and help identify potential medical emergencies.

The AI analysis module performs data processing and predictive analysis. Once patient information is collected and converted into digital form, it is transmitted to this module for analysis. The AI module uses machine learning algorithms to analyze patient symptoms and vital signs. Based on the analysis, the system predicts possible medical conditions and determines the risk level associated with the patient's condition.

The hospital coordination module ensures that patient information is delivered to the hospital's emergency department before the patient arrives. This module sends notifications that include patient vital signs, reported symptoms, predicted medical conditions, and risk classification levels. By receiving this information in advance, hospital staff can prepare medical resources, allocate treatment spaces, and assemble appropriate medical teams.

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AI-driven pre-triage system integrates different technologies such as speech recognition, machine learning, cloud communication, and hospital information systems. The system consists of three main components: the ambulance module, the AI analysis module, and the hospital coordination module.

Collecting patient information during ambulance transportation. When an emergency occurs, paramedics assess the patient and measure several vital signs using medical monitoring devices. These measurements provide important information about the patient's health condition and help identify possible medical emergencies. The system focuses on collecting the most used vital signs in emergency healthcare. These vital signs include heart rate, blood pressure, oxygen saturation level, respiratory rate, and body temperature. In addition to vital signs, paramedics may also report patient symptoms such as chest pain, breathing difficulty, unconsciousness, or severe bleeding. The collected patient information serves as the input for the AI-driven analysis system. The data is structured so that it can be easily processed by machine learning algorithms. Table 1 shows the main patient parameters collected by the system.

TABLE I. PATIENT VITAL SIGNS COLLECTED BY THE SYSTEM

Parameter	Measurement Unit
Number of heart beats per minute	Beats per minute (BPM)
Pressure of blood in arteries	mmHg
Percentage of oxygen in blood	%
Number of breaths per minute	Breaths/min
Patient body temperature	°C

These parameters are widely used in medical diagnosis and provide important indicators of patient health conditions. By analyzing these values, the system can detect abnormalities that may indicate serious medical problems.

A key feature of the proposed system is the voice-based data input mechanism. In traditional ambulance systems, paramedics must manually enter patient data into electronic devices or communicate information through phone calls. This process can be time-consuming and may distract paramedics from patient care.

To address this issue, the proposed system uses a voice interface that allows paramedics to report patient information verbally. For example, the paramedic can say, "Patient heart rate is 110 beats per minute, oxygen saturation is 92 percent, and the patient is experiencing chest pain." The system captures the voice input using a microphone installed in the ambulance. The recorded speech is then processed using speech recognition technology to convert the spoken words into text format.

The use of voice input provides several advantages. It allows paramedics to interact with the system without using their hands. And it reduces the time required to record patient information.

Once the voice input is captured, the next step is speech-to-text conversion. This process uses natural language processing (NLP) and speech recognition algorithms to transform spoken words into structured digital data.

The speech recognition system analyzes the audio signal and identifies individual words based on trained language models. After recognizing the words, the system converts the speech into text that can be processed by the AI model. The core component of the proposed system is the machine learning prediction model. This model analyzes the patient's vital signs and symptoms to identify possible medical conditions. Machine learning algorithms are trained using historical medical datasets that contain examples of patient symptoms and corresponding diagnoses.

The model processes the input data and calculates the probability of different medical conditions. For example, abnormal heart rate, low oxygen levels, and chest pain may indicate a possible cardiac emergency. The model evaluates the relationships between these parameters and generates predictions based on learned patterns.

After the machine learning model analyzes the patient data and determines the risk level, the system automatically sends a notification to the hospital. The hospital notification module transmits patient information through a secure communication network to the hospital's emergency department system.

The notification includes the patient's vital signs, reported symptoms, predicted medical condition, and risk level classification. This information allows hospital staff to prepare in advance for the patient's arrival.

For example, if the system predicts a high-risk cardiac emergency, the hospital can immediately prepare cardiology specialists, emergency equipment, and treatment facilities. This reduces the time required to start treatment once the patient arrives.

The development of the proposed system follows several implementation steps. The speech recognition component is integrated with the voice input interface. The data processing module structures the recognized text into numerical values suitable for machine learning analysis. The machine learning model then processes the data and generates predictions. The hospital notification module transmits the results to the hospital system.

The implementation process ensures that each module functions independently while communicating with other modules through secure data channels. This modular approach improves system reliability and scalability.

IV. RESULS AND DISCUSSION

The implementation of the proposed AI-driven pre-triage system demonstrates significant improvements in communication and coordination between ambulance teams and hospital emergency departments. The system successfully integrates voice-based data input, speech-to-text conversion, machine learning analysis, and automated hospital notification into a unified platform. During testing, paramedics were able to verbally report patient vital signs and symptoms while continuing to monitor and treat the patient, allowing hands-free interaction with the system. The speech recognition component effectively converted spoken medical information into structured digital data, which was then processed by the machine learning model for disease prediction. This approach reduced the need for manual data entry and minimized interruptions in patient care during transportation.

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The machine learning module analyzed the collected patient vital signs, including heart rate, blood pressure, oxygen saturation, respiratory rate, and body temperature, to identify potential medical conditions and assess patient risk levels. The results indicate that the system can rapidly process patient data and generate early predictions about possible emergencies such as cardiac or respiratory conditions. By identifying abnormal patterns in vital signs, the system provides paramedics and hospital staff with early warnings, allowing them to make faster and more informed medical decisions. This predictive capability enhances the triage process by providing hospitals with preliminary information about patient severity before arrival.

Another important outcome of the system is the improvement in hospital preparedness. Once the machine learning model analyzes the patient data, the system automatically transmits a notification to the hospital containing the patient's vital signs, reported symptoms, predicted medical condition, and risk level classification. This early notification allows hospital staff to prepare necessary medical resources such as emergency equipment, specialist teams, and treatment facilities before the ambulance arrives. As a result, treatment delays can be significantly reduced, and patients can receive immediate medical attention upon arrival at the hospital. This improvement in coordination between ambulance services and hospitals enhances the overall efficiency of emergency healthcare services.

The use of voice-enabled technology also plays a critical role in improving the usability of the system in emergency environments. Paramedics often operate in stressful and time-sensitive situations where manual data entry can be difficult and unsafe. The voice-based reporting mechanism allows paramedics to communicate patient information quickly without interrupting clinical tasks. This not only reduces the documentation workload but also minimizes the possibility of human error associated with manual recording of patient data. Therefore, the system contributes to both improved efficiency and higher data accuracy during emergency medical operations.

In addition, the proposed system currently focuses primarily on analyzing vital signs and basic patient symptoms. While these parameters provide important information about patient conditions, more complex medical assessments may require additional clinical data such as medical history, laboratory results, or imaging data. Future improvements could integrate additional data sources and advanced AI models to enhance the system's diagnostic capabilities.

AI-driven pre-triage system can significantly improve the speed, accuracy, and coordination of emergency medical services. By combining speech recognition, machine learning-based disease prediction, and automated hospital communication, the system provides a practical solution for addressing the limitations of traditional ambulance communication methods. The integration of these technologies supports faster decision-making, improves hospital readiness, and ultimately contributes to better patient outcomes in emergency healthcare situations.

V. CONCLUSION

AI-driven pre-triage system provides an effective solution for improving communication and coordination between ambulance services and hospitals during emergency situations. By integrating speech recognition, machine learning-based analysis, and automated hospital notification, the system enables paramedics to report patient information quickly while focusing on patient care. The results indicate that the system can analyze patient vital signs, predict potential medical conditions, and notify hospitals in advance, allowing medical teams to prepare appropriate treatment resources before the patient arrives. This approach reduces manual workload, improves data accuracy, and enhances the efficiency of emergency healthcare services. Therefore, the proposed system has the potential to significantly improve emergency response times and patient outcomes by supporting faster decision-making and better collaboration between pre-hospital and hospital medical teams.

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