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WIZBOT: IoT Based Medical Assistant Humanoid Robot

Abdul Sameeh, Mohammad Thasleem, Mohammed Shadil, Adnan Abdul Rahman, Mariyamath Rifaina, and Adnan Abdul Rahman

Department of Artificial Intelligence and Machine Learning, P.A College of Engineering Mangaluru, Karnataka, India

E-mail:

Abstract

The integration of Internet of Things (IoT) and humanoid robotics has opened new frontiers in the healthcare sector, offering innovative solutions for patient care, monitoring, and clinical assistance. This paper presents the development of an IoT-based medical assistant humanoid robot designed to support healthcare professionals and improve patient outcomes, especially in environments with limited human interaction. The system incorporates real-time health monitoring sensors (such as heart rate, temperature, and SpO_2), autonomous navigation, and interactive features to perform tasks such as delivering medication, collecting vital signs, and assisting during basic medical procedures. Drawing from recent advancements in robotics, the proposed humanoid leverages teleoperation, RFID-based logistics, and AI-powered communication to enhance its role as both a functional and emotional support system. This research builds upon existing robotic healthcare systems by emphasizing contactless service delivery, companionship for isolated patients, and remote communication with medical staff. The findings underscore the potential of

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IoT-enabled humanoid robots to transform hospital workflows, reduce caregiver burden, and provide safe, intelligent, and responsive healthcare support.

1 Introduction

The healthcare sector is increasingly integrating Internet of Things (IoT) and robotics, creating new opportunities for patient monitoring and care automation. One such innovation is the IoT-based humanoid robot, designed to assist in tasks like monitoring vital signs, delivering medications, and supporting medical staff in hospitals. These robots, equipped with IoT sensors, can facilitate real-time health tracking and improve efficiency by reducing human intervention, especially in high-risk environments [1].

As healthcare systems face increased pressure, especially post-pandemic, humanoid robots help address staffing shortages and reduce the risk of infections through contactless operations [2]. Despite the benefits, challenges such as ensuring data accuracy, robot dexterity, and continuous connectivity remain [3]. Advancements in AI and 5G technology promise to enhance these robots' capabilities, enabling more effective and adaptive care [4].

Moreover, the potential for humanoid robots extends beyond hospitals to elder care facilities, rehabilitation centers, and even home care, offering companionship and improving the quality of life for patients with limited mobility or social isolation. By combining AI-powered communication with IoT-based health monitoring, these robots can provide personalized care, assist with daily routines, and offer support in emergency situations, ensuring more comprehensive and humane care for vulnerable populations

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2 Methodology

2.1 Data Collection

The IoT-based medical assistant humanoid robot relies on a variety of sensors to collect real-time data for patient monitoring and interaction. Vital signs such as heart rate, blood pressure, temperature, and SpO_2 are continuously measured using embedded sensors within the robot, which send this information via wireless protocols like Bluetooth or Wi-Fi to the central processing unit (CPU) for analysis and storage. This data is crucial for tracking the patient's health and notifying healthcare providers in case of emergencies [1]. In addition, the robot captures interaction data using microphones and cameras to understand verbal and non-verbal cues, helping it adapt to patient needs, such as offering emotional support or adjusting care routines [2]. Environmental sensors monitor room conditions such as temperature and air quality to ensure a comfortable atmosphere for the patient [3]. Moreover, the robot can access patient medical histories securely through integrated healthcare APIs, offering personalized care based on previous treatments and medication schedules [4]. User feedback is also gathered through touch interfaces or voice commands, providing insights into the patient's satisfaction and areas for improvement [5]. All collected data is processed in real-time, analyzed through AI and machine learning algorithms to make informed decisions, and securely stored to comply with healthcare privacy regulations like HIPAA [6].

Furthermore, data from the robot's sensors and interactions can be integrated into healthcare systems for remote patient monitoring and telemedicine applications. By transmitting the collected data to cloud-based platforms, healthcare professionals can access the data remotely, facilitating continuous monitoring even when patients are at home or in remote areas. This integration ensures that critical health information is readily available, enabling timely interventions and reducing hospital readmissions. AI-based analytics can be used to predict health trends and proactively alert doctors if patients show signs of deteriorating health, improving overall patient outcomes and the efficiency of healthcare

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delivery [7]. The ability to collect and analyze large amounts of data in real time is crucial for developing personalized treatment plans and ensuring the quality of care.

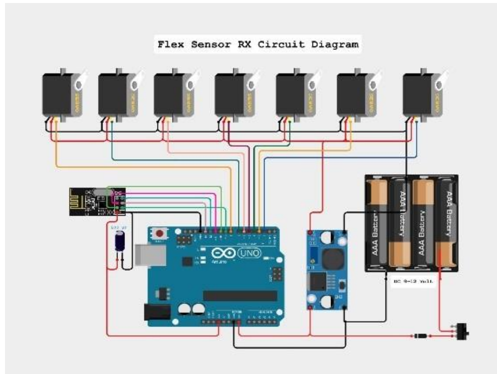

Figure 1:

2.1.1 Flex Sensor circuit diagram

2.2 Analysis Framework

The framework for an IoT-based medical assistant humanoid robot involves the integration of various technological components to enable efficient patient monitoring, interaction, and healthcare delivery. At its core, the framework includes IoT sensors for collecting vital signs, environmental data, and interaction cues, which are processed by the robot's central processing unit (CPU) or cloud-based systems. These systems use AI algorithms for real-time analysis, identifying trends or anomalies in the patient's health, and sending alerts to healthcare providers when necessary [1]. The robot also incorporates natural language processing (NLP) and computer vision to understand and respond to patient needs, whether through speech, gestures, or facial expressions [2]. Security and privacy protocols, such as encryption and secure APIs, ensure that patient data remains confidential and compliant with healthcare regulations like HIPAA [3]. Additionally, the framework facilitates remote patient monitoring, allowing healthcare professionals to track patient data from a distance and make proactive decisions based on AI-driven predictions [4]. This comprehensive framework enables personalized care, real-time decision-making, and improves overall patient

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outcomes through continuous, automated, and accurate health management

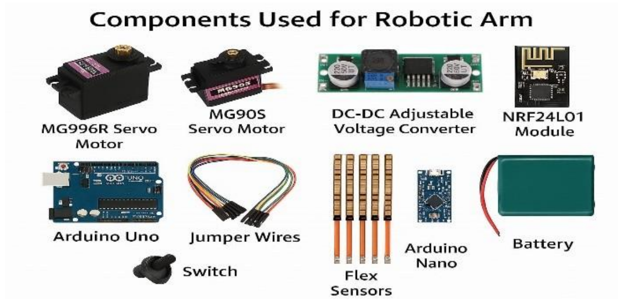

Figure 2:

2.2.1 Components of Robotic Arm

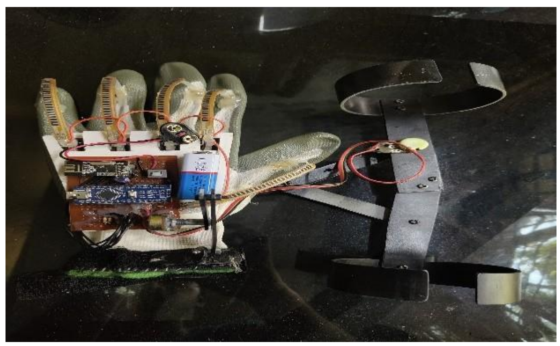

Figure 3:

2.2.2 Hard flex sensor model

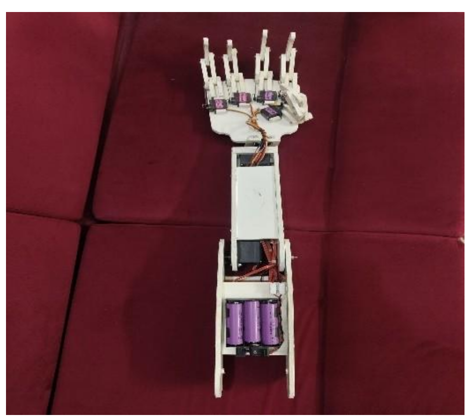

Figure 4:

2.2.3 Robotic Arm

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2.3 Comparative Analysis

A comparative analysis of various frameworks for IoT-based medical assistant humanoid robots reveals differences in the integration of technologies, data processing, and patient care functionalities. While some systems emphasize sensor-based health monitoring (e.g., heart rate, blood pressure) and environmental data collection, others incorporate advanced features like natural language processing (NLP) and computer vision to facilitate patient interaction and care [1]. Data processing methods also vary, with some systems relying on edge computing for real-time analysis, while others transmit data to the cloud for remote monitoring and storage, offering scalability but raising concerns about latency and data security [2]. Moreover, frameworks differ in their AI integration, with some leveraging machine learning for proactive care and early medical condition detection, while others focus on reactive monitoring and alerting healthcare providers only when issues arise [3]. Security measures also vary, with some frameworks emphasizing data encryption and secure API integration to comply with healthcare regulations like HIPAA, while others explore blockchain for enhanced transparency and security [4]. Ultimately, these frameworks present various trade-offs in terms of processing speed, security, and proactive healthcare delivery [5]

2.3.1 Flow chart

3 Proposed model for WIZBOT

3.1 Technical Implementation Analysis

The technical implementation analysis of an IoT-based medical assistant humanoid robot involves evaluating the integration of various technological components to achieve effective patient monitoring and interaction. The robot integrates IoT sensors such as heart rate monitors, blood pressure sensors, and temperature sensors to collect real-time vital sign

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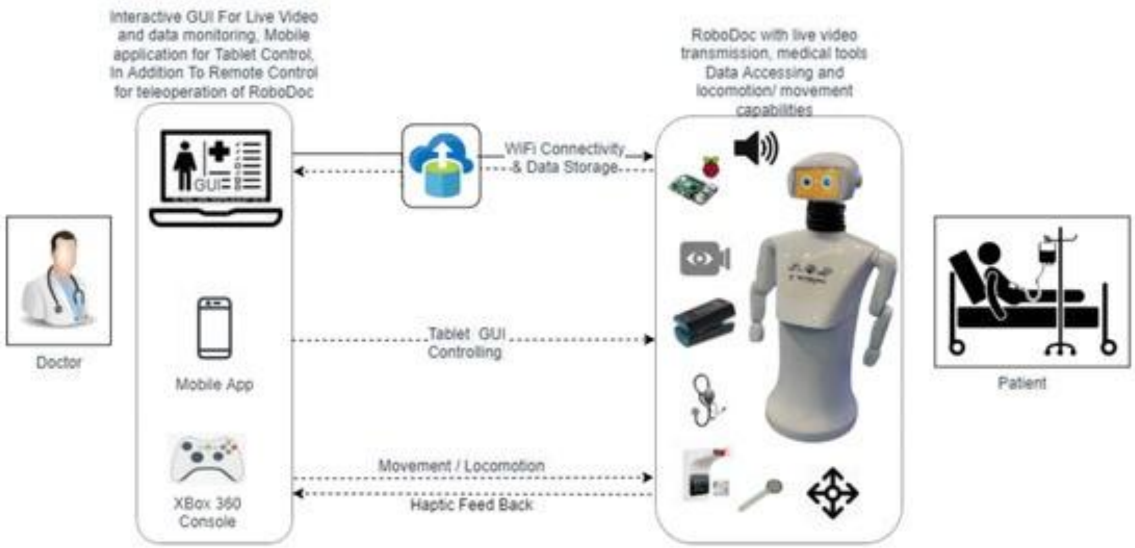

Figure 5:

Table 1:

Feature/Capability	**WizBot (Proposed Model)**	
Primary Function		Clinical assistance + Monitoring + Communication
Clinical assistance + Monitoring + Communication		
AI Communication (NLP)	Multilingual NLP, emotional support	
Health Data Collection	Real-time patient vitals via sensors	
Autonomous Navigation	Dynamic path planning with obstacle avoidance	
Medication Delivery	Secure compartment-based delivery	
Remote Doctor Communication	Video/audio interface with health staff	
Use of 5G/High-Speed Comms	Real-time data sync & low-latency control	
Emotional Companionship	AI-generated responses, mood detection	
Application Scope	Hospitals, elderly care, isolation wards	

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Table 2:

Clinical assistance + Monitoring + Communication

data. These sensors communicate wirelessly via Bluetooth or Wi-Fi to the robot's central processing unit (CPU), where the data is processed and analyzed using AI and machine learning algorithms. The use of edge computing allows for faster decision-making by processing data locally, which is crucial for real-time health monitoring, while cloud storage offers scalability for larger data sets, providing a more comprehensive view of patient health over time. The robot's natural language processing (NLP) and computer vision systems enable it to interpret voice commands and facial expressions, facilitating more intuitive patient interactions. To ensure data security, encryption methods are applied during data transmission, while compliance with HIPAA and other regulatory standards ensures patient privacy. Additionally, the robot can integrate with electronic health record (EHR) systems via secure APIs, enabling healthcare providers to remotely access patient data and make informed decisions. The technical challenges in this implementation lie in ensuring the accuracy of the sensor data, latency in real-time processing, and maintaining data security in a highly interconnected environment. The combination of AI, IoT sensors, and real-time analytics provides a robust framework for improving healthcare delivery by offering personalized, proactive care [1][2][3][4].

4 Results and Discussions

4.1 Performance of IoT Sensors in Health Data Acquisition

IoT sensors embedded within the robot enable the continuous collection of health data, such as heart rate, blood pressure, temperature, and oxygen levels. It would discuss the accuracy, reliability, and real-time capabilities of these sensors, along with any challenges in ensuring their precision in a clinical or home setting. Additionally, the discussion could cover how

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these sensors contribute to the IoT-based ecosystem, facilitating effective data transmission to the robot's central system for processing and analysis. The performance of these sensors is crucial for providing accurate, actionable data to healthcare providers and ensuring that the robot can respond promptly to patient needs or emergencies [1].

4.2 Patient Interaction and AI Integration

The robot's ability to interact with patients using natural language processing (NLP) and computer vision, enabling seamless communication through voice commands, gestures, and facial expressions. The robot can recognize patient emotions and needs, enhancing the overall user experience and improving care delivery. Additionally, AI algorithms play a critical role in processing these interactions and adapting the robot's behavior based on the patient's preferences and health conditions. By integrating AI-driven decision-making, the robot can offer personalized responses, provide guidance, and make health recommendations based on real-time data analysis. This integration facilitates not only improved patient engagement but also supports autonomous healthcare delivery, where the robot can act as both a caregiver and a health assistant, complementing medical professionals' roles [2]

Figure 6:

3.2.1 Taking Model

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4.3 Challenges and Limitations

The implementation of IoT-based medical assistant humanoid robots holds significant promise, several challenges remain in achieving seamless integration and performance. One of the primary concerns is the accuracy of IoT sensors in real-world environments, as factors such as sensor calibration and environmental interference can lead to discrepancies in data collection [1]. Additionally, the latency involved in real-time data transmission between the robot, sensors, and cloud-based systems can impact decision-making speed, which is crucial in emergency healthcare scenarios [2]. Data security and patient privacy also pose substantial challenges, as IoT-based systems are vulnerable to cyberattacks, and stringent security protocols need to be in place to ensure HIPAA compliance and safeguard sensitive health information [3]. Furthermore, AI algorithms require continuous updates and validation to maintain their predictive accuracy, and the integration of human-robot collaboration is still in its nascent stages, with limitations in fully autonomous healthcare delivery. These challenges highlight the need for ongoing research to refine sensor technologies, improve security measures, and optimize AI systems for better healthcare outcomes

4.4 Technical Platform Analysis

The technical platform of an IoT-based medical assistant humanoid robot integrates a combination of hardware, software, and communication protocols designed for real-time health monitoring and patient interaction. The robot utilizes IoT sensors such as heart rate monitors, thermometers, and blood pressure cuffs, which collect vital health data. These sensors are connected to the robot's central processing unit, where the data is processed in real-time. The robot's AI algorithms—including machine learning and natural language processing (NLP)—allow it to interpret and respond to patient interactions, making the system more personalized and efficient. The data collected is securely transmitted to cloud-based systems or processed locally through edge computing, which reduces latency and supports real-time decision-making. Cloud platforms offer scalable storage and analysis,

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ensuring healthcare providers can remotely monitor patient data and receive alerts.

The robot relies on robust communication protocols like Wi-Fi, Bluetooth, and 5G to ensure secure and efficient data transmission. It also integrates with electronic health records (EHR) to maintain continuous care. While the system offers advanced capabilities, challenges remain, including sensor calibration, network latency, and ensuring data security to meet HIPAA compliance. Moreover, maintaining the accuracy and reliability of AI models is crucial for delivering safe and effective healthcare. Future improvements in hardware, sensor reliability, and AI accuracy will be key to overcoming these challenges and optimizing the robot's performance in diverse medical environments [1][2][3]

Figure 7:

4.4.1 Components of Robotic Leg

3.4.2 Robotic Leg

5 Conclusion

The integration of IoT-based humanoid robots in healthcare presents a promising advancement in patient care, offering real-time health monitoring, personalized interaction, and enhanced healthcare delivery. By leveraging IoT sensors, AI algorithms, and cloud-based platforms, these robots are capable of continuously collecting vital health data, processing it, and responding to patient needs in real-time. The ability to interact with patients through

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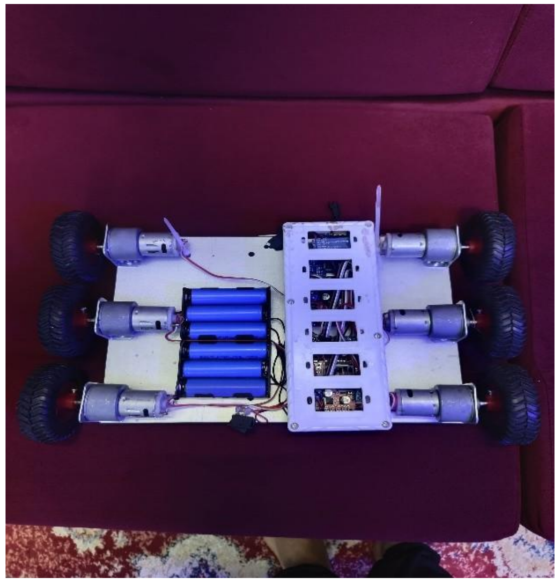

Figure 8:

natural language processing (NLP) and computer vision adds a layer of empathy and user-friendliness, which is essential for improving patient comfort and compliance.

However, several challenges remain, particularly in terms of sensor accuracy, network latency, and data security, which need to be addressed for the system to achieve full-scale deployment in clinical settings. Despite these hurdles, ongoing research and improvements in AI models, sensor technology, and communication protocols will likely enhance the performance and reliability of IoT-based medical assistant robots. With continued advancements, these systems have the potential to revolutionize healthcare by providing personalized care, supporting remote patient monitoring, and ensuring proactive healthcare management.

6 Acknowledgement

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