

Automated Robot for Healthcare Applications

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Abstract—The "Automated Robot with Healthcare Applications" project aims to revolutionize healthcare by integrating cutting- edge robotics technology into medical environments. The proposed automated robot is designed to perform various tasks, ranging from patient assistance to logistical support, enhancing overall efficiency and patient care. The robot is equipped with advanced sensors, obstacle detection and path finding algorithms, and a versatile mechanical platform, allowing it to navigate and carry medi-kits for providing healthcare facilities autonomously. Its capabilities include patient monitoring, medication delivery, and assistance in routine tasks, thereby alleviating healthcare professionals' workloads and improving the quality of patient care. In addition to its caregiving functions, the robot contributes to infection control by minimizing human contact and ensuring adherence to hygiene protocols. The project emphasizes the seamless integration of the robot with existing healthcare systems, promoting collaboration between human healthcare providers and robotic assistants. Key features of the automated robot include real-time data collection, analysis, and communication capabilities, providing healthcare professionals with valuable insights for decision-making. The project also addresses ethical considerations, data security, and user acceptance to ensure the successful adoption of the automated robot in diverse healthcare settings. This report discusses the design, development, and testing phases of the automated robot, showcasing its potential impact on healthcare delivery. Through this innovative solution, the project aims to enhance healthcare efficiency, improve patient outcomes, and contribute to the ongoing evolution of technology in the medical field.

Index Terms— Healthcare Robotics, Autonomous Patient Care, Robot-Assisted Healthcare.

I. INTRODUCTION

In modern healthcare, critical challenges include the need for rapid response to various healthcare emergencies, limited accessibility to equipment's such as Medical Kit, healthcare inefficiencies, inadequate telemedicine services, and data management hurdles. Robotic systems are one of the key solutions for providing smart services. It can be seen with many of today's occupations have been replaced by automation in order to help prevent manual handling injuries in the workplace. Increasing population density in urban environments demands adequate provision of services and infrastructure. The healthcare landscape is evolving rapidly, marked by the increasing demand for innovative solutions to address the challenges posed by an aging population,

chronic illnesses, and the ongoing global health crises. In response to these complexities, our project focuses on the creation of an advanced automated robot that goes beyond traditional robotics applications. This robot is meticulously designed to perform a spectrum of tasks, ranging from patient assistance to logistical support, with the overarching goal of enhancing overall efficiency and quality of care [1][2].

The key features of this automated robot include a sophisticated sensor suite, obstacle detection and pathfinding algorithms, and a versatile mechanical platform, empowering it to navigate complex healthcare environments autonomously. By integrating these capabilities, the robot becomes adept at patient monitoring, medication delivery, and routine task assistance, thereby alleviating the workloads of healthcare professionals and contributing to improved patient outcomes. Central to the project is the commitment to infection control. The robot minimizes human contact, adheres to stringent hygiene protocols, and ensures a safer healthcare environment. Furthermore, the seamless integration of the robot with existing healthcare systems underscores its collaborative nature, positioning it as a valuable assistant working in tandem with human healthcare providers [3][4].

Real-time data collection, analysis, and communication capabilities form the backbone of the automated robot's functionality. By providing healthcare professionals with valuable insights, the robot becomes an invaluable tool for informed decision-making, further emphasizing its potential to elevate the standards of healthcare delivery. This paper delves into the intricacies of the design, development, and testing phases of the automated robot, offering a comprehensive exploration of its potential impact on healthcare efficiency. Through this innovative solution, our project strives to contribute significantly to the ongoing evolution of technology in the medical field, ushering in a future where advanced robotics becomes an integral component of patient-centric and technologically enriched healthcare systems [6][7]

II. LITERATURE SURVEY

In the paper written by Görer, B., Cacace, J., Karadogan, M., & Kuru, I. (2022): "Development of a humanoid robot for health care applications." This study focuses on the development of a humanoid robot specifically designed for healthcare applications. It is essential to explore the technical aspects of the humanoid robot, such as its design features, sensors, and capabilities.

In the paper written by He, H., Wu, D., & Shi, H. (2020): "Robot- assisted healthcare for elderly people." This research delves into the use of robots in healthcare, particularly focusing on assisting elderly individuals. Understanding the challenges in elderly care is crucial for gaining insights into the practical applications and implications of this technology.

In the paper written by Khedekar, A. and Sabet, S. (2019): "Robotics in healthcare: An overview of technologies and automation systems." This overview provides a comprehensive look at the various technologies and automation systems in robotics for healthcare. Understanding the breadth of technologies in robotics for healthcare is essential for contextualizing the specific focus of the project.

In the paper written by Serap, G., & Baris, G. (2018): "Robots in healthcare: An overview." This overview serves as a foundational piece in understanding the broader landscape of robots in healthcare. It is crucial to identify common themes, challenges, and advancements in the use of robots within healthcare to inform the development and its application.

III. OBJECTIVES & MOTIVATIONS

The main objectives and motivation behind this project were as follows [8][9][10]

- **Carrying Life: Saving Treatment:** The primary objective is to provide immediate treatment using Medical Kits which contain portable technologies such as Pulse Oximeter or Glucometer to individuals.
- **Reducing Response Time:** To reduce the response time in these situations, which is often delayed due to obstructions in the dispatch process of ambulances, thus increasing the chances of timely medical assistance.
- **Medical Kit Useability:** Any person nearby the patient can use the Medical Kit to operate and thus give immediate assistance to minimize the life threat of the patient.
- **Efficient Patient Monitoring:** Implementing robotic systems for continuous patient monitoring, such as vital signs, medication adherence, or disease progression, to improve the quality of care and ensure timely intervention when needed.
- **Accessibility:** The lack of readily accessible healthcare equipments in public spaces and the challenge bystanders face in locating them during health related emergencies, contributing to delayed life -saving interventions.

- Increasing population density in urban environments demands adequate provision of services and infrastructure. It can be seen with many of today's occupations have been replaced by automation in order to help prevent manual handling injuries in the workplace.
- Our robot is preferred for an immediate treatment using Medical Kit containing Pulse Oximeters, Glucometer to analyse the victim by facilitating various modes of operation from manual to autonomous functioning. The prototype with biomedical sensors are used for monitoring the patient health continuously.[2],[4]

IV. METHODOLOGY ADOPTED

The proposed automated robot provides the service of ambulance with Medical Kit to help someone having a healthcare related concerns. An emergency message and current position of victim will be generated. It can be operated in auto or manual mode [11][12][13].

V. CENTRAL PROCESSING UNIT (CPU)

The Arduino Uno board serves as the brain of the system, receiving inputs from various sensors and controlling the output to different components [14][15][16].

VI. INPUT SENSORS

- Pulse Sensor: Captures the pulse rate data and sends it to the Arduino MEGA for processing [17][18].
- Temperature Sensor: Measures the temperature and provides this data to the Arduino MEGA. Both sensors serve as input devices to the system, enabling real-time health monitoring [19][20].

VII. OUTPUT DEVICES

- Bluetooth terminal HC-05: A software interface for feeding preprogrammed instructions through a H6 module and to display the data received from the pulse and temperature sensors after being processed by the Arduino MEGA [21]-[22].
- DC Motor (30 rpm): Operates the robot to traverse through the designated and a recalculated path due to an obstacle, presumably to dispense medication or perform a related action, controlled by the Arduino MEGA based on the input from the sensors [23][24].
- Motor for Robot: Drives the robotic mechanism, which could be for mobility or other actions, under the command of the Arduino MEGA [25][26].

VIII. MOTOR DRIVER

- A H bridge by L293D which acts as an intermediary between the Arduino MEGA and the motors, facilitating the control signals to operate the motors based on the programmed logic [27][28].

IX. POWER MANAGEMENT

- Power Supply: Provides the necessary power to the Arduino MEGA and possibly to other components.
- Voltage Regulators: Ensure that all components receive the correct voltage, protecting them from damage due to power surges or improper supply voltage [29][30].

These components are crucial for the reliable operation of the system, managing the electrical power distribution as shown in the Fig. 1 [31].

X. COMMUNICATION MODULE

- H6 Bluetooth module: Enables wireless communication capabilities for the system, which could be used to send instructions, data, or receive remote commands [32].

XI. OBJECT DETECTION

- The ultrasonic sensor is used for object detection in the robot while navigating. It can detect an object within the close proximity of 20 cm [33].

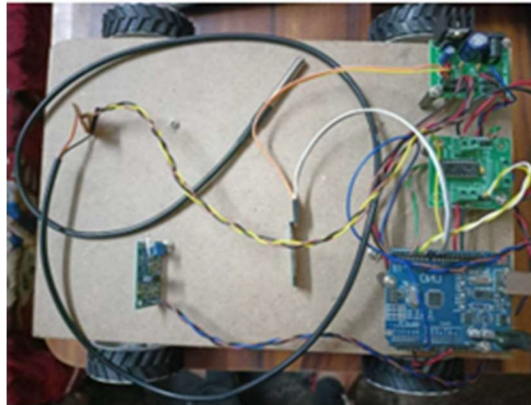


Fig. 1: Circuit Diagram

- Once an object is detected, the robot will stop its navigation, alert the bystanders and the controller to remove any obstacle in its path. Afterwards it will continue its moving in the designated path towards the destination [34].

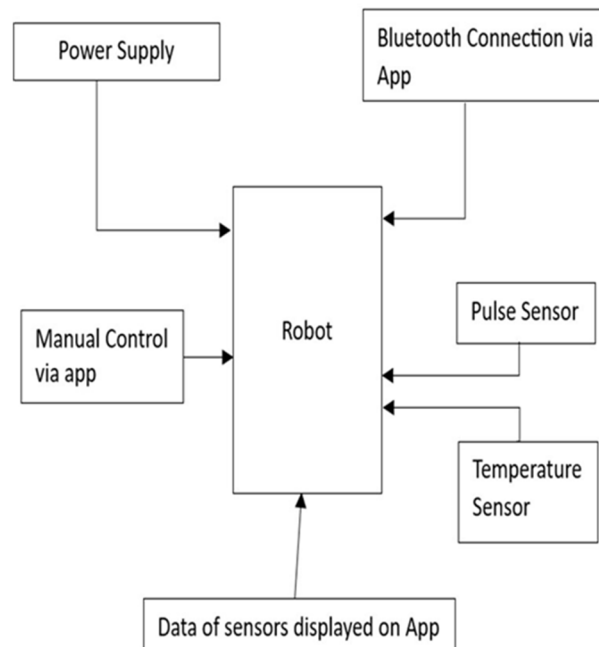


Fig. 2: Overall block diagram developed

XII. METHODOLOGY OVERVIEW

- The system begins by initializing all components and setting up communication protocols, the overall block diagram of the work is shown in the Fig. 2 [35].
- The pulse and temperature sensors continuously monitor and send data to the Arduino Uno. The Arduino processes this data and updates the display on the Bluetooth terminal with the current readings periodically in real-time.
- Depending on the logic programmed into the Arduino, it may also control the DC Motor attached to the robot which is responsible for its navigation, by executing preprogrammed actions denoted by commands in the form of strings or characters.
- By using the ultrasonic sensor - we have implemented object detection and using ESP32.
- Camera - we have made available live feed for ease in manual operations.
- Power is managed through a dedicated supply and voltage regulators to ensure all components operate within

their required voltage ranges. This methodology allows for a system that can monitor health parameters and perform actions based on those readings, while also having the capability to communicate with external devices and users. It can be applied in contexts such as telemedicine, patient monitoring, or robotic assistance in healthcare settings [4],[6].

XIII. ADVANTAGES

- Remote Patient Monitoring:
- Enables healthcare providers to remotely monitor patients' vital signs, enhancing the ability to manage chronic conditions and respond to emergencies promptly.
- Efficient Healthcare Delivery:
- Optimizes the use of healthcare professionals' time by automating routine monitoring tasks, allowing them to focus on more complex aspects of patient care.
- Continuous Monitoring:
- Provides continuous monitoring of patients' vital signs, offering a comprehensive view of their health status over time.
- Reduced Risk of Infection Transmission:
- Minimizes the risk of spreading infections by utilizing a robot for tasks like medication delivery and sample collection, reducing the need for direct human contact [3]

XIV. APPLICATIONS

- Quarantine and Isolation Management:
- Assists in monitoring and providing care for individuals in quarantine or isolation, reducing the risk of exposure for healthcare professionals.
- Nursing Homes and Elderly Care:
- Supports healthcare professionals in monitoring the health of elderly residents in nursing homes, providing assistance and responding to emergencies.
- Hospital Settings:
- Augments healthcare services by automating routine tasks, enabling nurses and physicians to focus on critical patient care in hospital environments.
- Home Healthcare:
- Facilitates remote monitoring of patients with chronic illnesses, allowing them to receive medical attention without frequent hospital visits.

XV. CONCLUSIONS

The project involves developing an autonomous robot equipped with sensors to measure a victim's body temperature and heart rate. This information is crucial in assessing whether the victim is suffering from a healthcare emergency. If detected, the robot is designed to autonomously locate and deliver first aid using a portable device (which is carried in a Medical Kit). The integration of information technology enhances the efficiency and speed of delivering life-saving assistance to victims. The confined scope of operation to a particular floor of a building indicates a targeted approach to addressing emergencies within a defined space. While the robot may have limitations in terms of geographical coverage, its specificity makes it highly relevant for applications in office buildings, residential complexes, or healthcare facilities where quick response times are critical. Furthermore, the project's restriction of the autonomous robot to a specific floor of a building reflects a strategic decision that may offer advantages in terms of response time and resource allocation. In densely populated environments where multi-story structures are common, having a robot dedicated to a particular floor ensures a prompt and focused response to emergencies within that specific zone.

This targeted approach aligns with the practical considerations of optimizing the robot's movements, allowing it to navigate efficiently and swiftly within the designated space. While the robot's reach may be limited, its ability to operate autonomously on a particular floor underscores the potential for tailored solutions that cater to specific emergency scenarios in confined settings. The project's emphasis on leveraging information technology contributes to the overall efficiency and speed of emergency assistance. The real-time data collection, autonomous operation, and integration of portable medical devices showcase a holistic solution that aligns with the demands of modern emergency response scenarios. As technology continues to evolve, it is conceivable that

similar autonomous robots could be deployed across multiple floors or integrated into larger emergency response systems. The current project serves as a foundational step toward future advancements in robotics and healthcare, demonstrating the potential for autonomous systems to play a vital role in enhancing the safety and well-being of individuals in specific environments.

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