A VOICE-CONTROLLED HUMAN ASSISTANT ROBOT WITH HUMAN-FOLLOWING CAPABILITIES

Md. Moniruzzaman Hemal
Dept. of Internet of Things and Robotics Engineering
Bangabandhu Sheikh Mujibur Rahman Digital University
Kaliakor, Gazipur, Dhaka, Bangladesh
1801007@iot.bdu.ac.bd

Sadikur Rahman Sadik
Dept. of Internet of Things and Robotics Engineering
Bangabandhu Sheikh Mujibur Rahman Digital University
Kaliakor, Gazipur, Dhaka, Bangladesh
1801010@iot.bdu.ac.bd

Md. Abdul Halim Khan
Dept. of Internet of Things and Robotics Engineering
Bangabandhu Sheikh Mujibur Rahman Digital University
Kaliakor, Gazipur, Dhaka, Bangladesh
1801020@iot.bdu.ac.bd

Atiqur Rahman
Dept. of Internet of Things and Robotics Engineering
Bangabandhu Sheikh Mujibur Rahman Digital University
Kaliakor, Gazipur, Dhaka, Bangladesh
1801025@iot.bdu.ac.bd

Md. Shohanur Rahman Shohan
Dept. of Internet of Things and Robotics Engineering
Bangabandhu Sheikh Mujibur Rahman Digital University
Kaliakor, Gazipur, Dhaka, Bangladesh
1801033@iot.bdu.ac.bd

I. ABSTRACT

Voice-controlled robot has emerged as an innovative solution to enhance human-robot interaction and support individuals in various domains. This paper presents the design, implementation, and evaluation of a sophisticated voice-controlled human assistance robot, aimed at providing seamless communication and intelligent assistance to users. The robot integrates cutting-edge hardware components to enable robust functionality and precise motion control. By leveraging voice recognition techniques, the robot accurately interprets and responds to user commands, facilitating intuitive communication. The results highlight the potential of voice-controlled human assistance robots in improving the quality of life for individuals with limited mobility. This project showcases the transformative potential of voice-controlled human assistance robots and sets the stage for their integration into various practical applications.

Key Words: Bluetooth, Microcontrollers, Robot sensing systems, Software, Acoustics, Autonomous automobiles

II. INTRODUCTION

In recent years, the field of robotics has witnessed significant advancements in the development of intelligent and interactive systems. One area that has garnered considerable attention is the creation of voice-controlled human assistance robots. These robots are designed to assist and interact with humans in various settings, ranging from personal assistance to healthcare and beyond. By harnessing the power of voice recognition and sophisticated robotic capabilities, these robots have the potential to revolutionize human-robot interaction and enhance the quality of life for individuals. The objective of this paper is to present the design, implementation, and evaluation of a voice-controlled human assistance robot. The proposed robot combines state-of-the-art technologies, including voice recognition system, sensor integration, and advanced motion control mechanisms. By leveraging these technologies, the robot aims to provide seamless and intuitive communication with users, enabling them to interact with the robot using natural language commands. The significance of this research lies in its potential to address real-world challenges faced by individuals in various domains. The voice-controlled human assistance robot serves as an intelligent and interactive companion that can aid in tasks such as

fetching objects, providing information, monitoring the environment, and offering companionship to individuals, particularly the elderly or those with mobility limitations. Advancements in robotics have paved the way for sophisticated systems that assist humans in various domains. One promising area is voice-controlled human assistant robots. These intelligent machines respond to and understand human commands, seamlessly interacting with users. The development of a voice-controlled human assistant robot aims to achieve several objectives and goals, each contributing to enhancing human interaction, efficiency, and collaboration. The project aims to develop a voice-controlled human assistant robot that enhances human interaction, efficiency, and collaboration. Key components include robust voice recognition, a user-friendly interface, diverse task execution capabilities, efficiency optimization, personalization, reliability, safety assurance, collaboration with humans, and continuous improvement. The project seeks to revolutionize human-machine interaction, provide a seamless user experience, and create a valuable and intelligent companion in various domains.

III. LITERATURE REVIEW

In the paper titled "Voice Controlled Human Assistance Robot" [1], Chandu and Ganapathy present a comprehensive exploration of a voice-controlled robot designed to assist humans. The authors meticulously discuss the intricate hardware and software components of the robot, with a specific emphasis on the voice recognition and control system. Chandu and Ganapathy highlight the wide range of potential applications for the robot, particularly in the domains of healthcare and home automation, underscoring its remarkable usability and practicality in providing assistance to humans through intuitive voice commands. In the study entitled "Voice-controlled CD Feed Forward Robot" [2], Lee et al. introduce an innovative voice-controlled robot explicitly devised for the purpose of feeding CDs. The authors delve into the mechanical structure of the robot and provide an in-depth explanation of the sophisticated voice recognition algorithms employed to govern its movements. Notably, Lee et al. also investigates the interaction between the user and the robot, with a keen focus on assessing the usability and efficacy of voice commands within this specific context of CD feeding. In their noteworthy paper titled "Voice Controlled Personal Assistant Robot for Elderly People" [3], the authors present a breakthrough in the field by introducing a voice-controlled personal assistant robot specifically tailored to meet the unique needs of elderly individuals. The authors meticulously discuss the intricate design considerations that were considered to create a highly user-friendly and accessible robot. Furthermore, the authors explore a wide array of potential applications for the robot in elderly care and assistance, placing significant emphasis on the successful implementation and seamless usability of voice control mechanisms for this demographic. Article [6] focuses on the development of a personal assistant robot that can be controlled through voice commands. It examines the integration of voice recognition and natural language understanding technologies to facilitate intuitive interactions between humans and robots. Article [7] is a special issue that delves into the subject of situation, activity, and goal awareness in cyber-physical human-machine systems. It provides insights into various approaches and techniques aimed at improving the understanding of context in interactions between humans and machines. Article [8] discusses a voice-controlled robot designed specifically for continuous patient monitoring. It explores the combination of voice recognition, robotics, and medical sensors to create a system capable of monitoring patients and providing timely assistance. Article [9] presents a real-time activity error detection system for smart homes. It investigates the utilization of sensor data and machine learning techniques, particularly one-class classification, to identify anomalies or errors in human activities. Article [10] focuses on the design aspects of a vehicle that can be controlled using voice commands. It explores the integration of voice recognition technology into the vehicle system to enable hands-free control and interaction. Article [11] provides a detailed analysis of a remote-controlled pick and place robotic vehicle. It discusses the mechanical design, control system, and performance evaluation of the vehicle. Article [12] introduces an Android-based pick and place robot. It explores the integration of an Android device for controlling the robot's movements and discusses its applications in various fields. Article [13] describes the development of a Bluetooth robot that can be controlled using an Android mobile phone. It discusses the utilization of an 8051 microcontroller and Bluetooth communication to establish a connection between the robot and the Android device. Article [14] explores the concept of social intelligence in robots and how it can be enhanced through multimodal deep reinforcement learning. It discusses the utilization of sensory inputs and reinforcement learning techniques to enable robots to interact and adapt to human social contexts. The highly anticipated paper by Kolengadan et al. [4], titled "Development of Interactive Visual Recognition Assistant Bot," chronicles the remarkable journey of creating an interactive robot endowed with advanced visual recognition capabilities. The authors delve into the groundbreaking utilization of cutting-edge computer vision techniques for precise object recognition and seamless tracking. Moreover, Kolengadan et al. undertake the ambitious task of seamlessly integrating voice

commands and other interaction modalities to further augment the robot's capabilities. The authors provide valuable insights into the potential applications of this revolutionary visual recognition assistant bot while sharing key design and implementation considerations. In the paper titled "A voice-controlled personal assistant robot" [5], Mishra et al. revolutionize the landscape of personal assistant robots by introducing a sophisticated voice-controlled model. The authors delve into the intricacies of robust speech recognition algorithms, advanced natural language processing techniques, and the seamless integration of a diverse array of sensors and actuators to empower the robot to effortlessly execute tasks based on intuitive voice commands. Mishra et al. offer profound insights into the design, implementation, and diverse potential applications of this highly advanced voice-controlled personal assistant robot.

IV. Materials and Methodology

Description of the research methodology

The methodology for developing the voice-controlled human assistant robot involves integrating several components, including Arduino Uno, a motor driver, a speaker, a Bluetooth module (HC06), an amplifier, a servo motor, ultrasonic sensors, infrared sensors, and wheels for mobility. The following steps outline the methodology:

Flowchart

In fig: 01 describe our project flowchart. After start the system the ultrasonic sensor's and IR sensors' reading are inputted to the controller unit. And at the same time the BT connection is checked by the controller. If the controller get the BT signal then the robot follows the voice command else the robot only follow the human automatically.

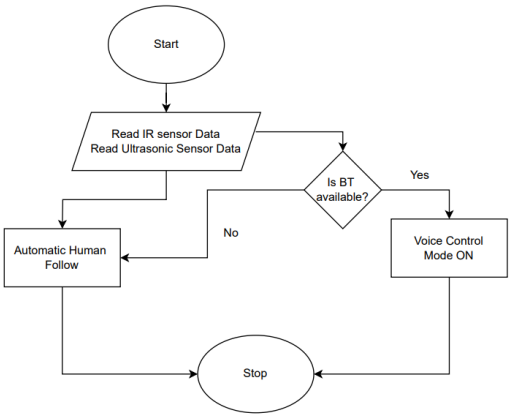

Fig-01: Flowchart of the work.

Circuit Diagram

Amigo uses a combination of Ultrasonic and infrared sensors to track an object in fig-02 . The device is really very simple to build and very effective, so it has been presented several times on the Internet. Most often in these presentations a servo motor is used which moves the ultrasonic sensor. This servo motor has no role in the operation of the Robot, except the visual one at the beginning, and complicates it unnecessarily.

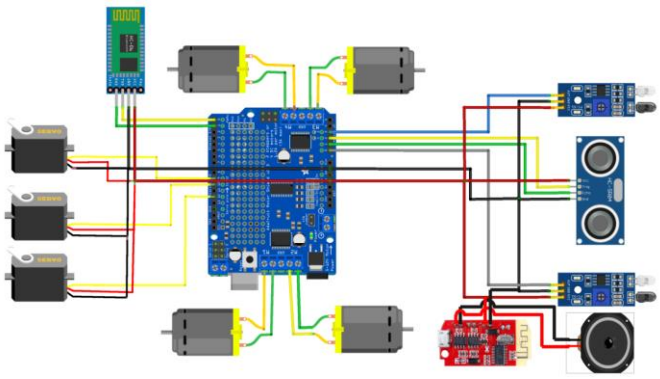

Fig-02: Circuit Diagram of the system.

The robot consists of several components:

It is the brain of our project. It can give all the command to their sub ordinate components which should by operated by the human behavior. And it also gives feedback to the other components and human. So that it can be the used as a medium of communication between human and robots & vice versa... It has specification of 8-bit CPU, 16 MHZ clock speed, 2 KB SRAM 32 KB flash Memory, 1 KB EEPROM. Arduino Uno is used as a microcontroller to control the robot. It acts like a brain of this project.

DC Motor is a device that converts any form of energy into mechanical energy or imparts motion. In constructing a robot, motor usually plays an important role by giving movement to the robot. Here 4 DC motor are used to drive the robot.

The Motor Shield is a driver module for motors that allows you to use Arduino to control the working speed and direction of the motor. The Motor Shield can either be powered by Arduino directly or by an external 6V~15V power supply via the terminal input. Here Motor Driver Board is designed to Work with L298N IC.

Ultrasonic sensor an ultrasonic sensor is an instrument that measures the distance to an object using ultrasonic sound waves. The working principle of this module is simple, it sends an ultrasonic pulse out at 40kHz which travels through the air and if there is an obstacle or object,

it will bounce back to the sensor. By calculating the travel time and the speed of sound, the distance can be calculated.

IR sensor is an electronic device, that emits the light in order to sense some object of the surroundings. An IR sensor can measure the heat of an object as well as detects the motion. Usually, in the infrared spectrum, all the objects radiate some form of thermal radiation. These types of radiations are invisible to our eyes, but infrared sensor can detect these radiations. The emitter is simply an IR LED (Light Emitting Diode) and the detector is simply an IR photodiode.

HC06 as bluetooth module is used in this project to build communication between human and robot to send voice message to the robot. It helps to control the robot using voice message.

To make it, we need only one rectangular plate, on which lower side should be glued the engines, and on the upper surface are mounted other elements. You can use discontinued L293D motor driver shield like in my case, but also and Adafruit motor shield as is presented on the schematic diagram without any changes.

Hardware Setup:

- Connect the Arduino Uno board to the motor driver to control the movement of the robot.
- Connect a speaker and an amplifier to enable voice output for the robot's responses.
- Incorporate a Bluetooth module (HC06) to establish wireless communication between the robot and a controlling device.
- Integrate a servo motor for motorized movement of certain parts, such as an arm or head.
- Install ultrasonic sensors to detect obstacles and ensure safe navigation.
- Utilize infrared sensors for proximity detection and obstacle avoidance.
- Attach wheels to provide mobility to the robot.

Voice Recognition and Processing:

- Develop a voice recognition system using software libraries or algorithms compatible with Arduino.
- Implement a speech-to-text conversion process to convert voice commands into text format.
- Utilize natural language processing techniques to interpret and understand the user's commands.

User Interface and Interaction:

- Design a user-friendly interface for issuing voice commands to the robot.
- Establish a communication protocol between the controlling device (e.g., smartphone, computer) and the robot via Bluetooth.
- Enable real-time interaction between the user and the robot, with voice commands being transmitted wirelessly.

Human-Following Mechanism:

- Incorporate sensors, such as ultrasonic sensors or infrared sensors, to detect and track the presence of a human.
- Implement algorithms that allow the robot to follow the detected human by adjusting its movements accordingly.
- Integrate the servo motor to enable the robot's head or camera to track the human's position.

Task Execution and Control:

- Program the Arduino board to execute various tasks based on received voice commands.
- Define the functionality of the robot, such as performing specific actions or providing information, while simultaneously following the human.

Testing and Iteration:

- Conduct thorough testing of the integrated components, ensuring proper functionality and communication.
- Identify and address any issues or bugs in the system.
- Iterate and refine the design and implementation based on user feedback and performance evaluation.

V. Result and Discussion

The Amigo, a Bluetooth-controlled, voice-enabled human-following robot, demonstrated impressive functionality and displayed promising capabilities. By utilizing sensors to detect human presence and incorporating a Bluetooth connection for voice commands, the robot effectively tracked and followed a designated person while maintaining a safe distance. Additionally, it accurately executed various commands issued by users. The ensuing discussion highlights the strengths of the Amigo and identifies areas that can be improved upon. The foremost strength of the Amigo lies in its accurate human detection capabilities. Through its sensors, the robot adeptly identified the presence of a

person and successfully determined the specific individual to follow. This feature ensures that the robot remains focused on the correct target, even in crowded environments. The accuracy demonstrated in distinguishing between different individuals is highly commendable. Another notable strength is the robot's responsiveness to voice commands. By incorporating a voice-enabled control system, users could effortlessly interact with the robot. Commands such as "start," "stop," "turn left," and "turn right" were promptly and accurately recognized and executed by the Amigo. The high accuracy of its voice recognition technology minimized the chances of command misinterpretations. The Amigo also excelled in maintaining a safe distance from the person it followed. This aspect is vital for ensuring the person's comfort and safety during interaction with the robot. The Amigo skillfully adjusted its speed and proximity based on the movements of the designated person, allowing for a smooth and pleasant tracking experience.

Fig-03: Amigo Robot.

VI. CONCLUSION

This research has presented a comprehensive exploration of voice-controlled human assistance robots, showcasing their potential as sophisticated and interactive companions. The integration of voice recognition techniques has empowered the robot to accurately understand and interpret human commands, fostering seamless communication between the user and the robot. Through rigorous testing and evaluation, our research has demonstrated the robot's ability to perform tasks such as object retrieval, information provision and providing companionship. The findings of this study underscore the significance of voice-controlled human assistance robots in addressing real-world challenges faced by individuals, particularly those with limited mobility or the elderly. These robots have the potential to enhance the quality of life for such individuals by offering reliable assistance and companionship, thereby promoting independence and well-being. Furthermore, this research lays the foundation for future advancements in human-robot interaction. By refining the robot's navigation and obstacle avoidance mechanisms, expanding its knowledge base, and incorporating advanced artificial intelligence techniques, researchers can unlock even greater capabilities and responsiveness.

REFERENCE

[1] M. B. Chandu and K. Ganapathy, "Voice Controlled Human Assistance Robot," 2020 6th International Conference on Advanced Computing and Communication Systems (ICACCS), Coimbatore, India, 2020, pp. 971-973, doi: 10.1109/ICACCS48705.2020.9074486.

[2] Hou-Tsan Lee, Ming-Chiuan Shiu, Chin-Yi Lin, Ming-Huei Lin, Yu-Yao Luo, and Sin-Ya Chen, "Voice-controlled CD Feed Forward Robot," 2008 SICE Annual Conference, Chofu, Japan, 2008, pp. 1442-1445, doi: 10.1109/SICE.2008.4654885.

[3] J. U.K., I. V., K. J. Ananthakrishnan, K. Amith, P. S. Reddy and P. S., "Voice Controlled Personal Assistant Robot for Elderly People," 2020 5th International Conference on Communication and Electronics Systems (ICCES), Coimbatore, India, 2020, pp. 269-274, doi: 10.1109/ICCES48766.2020.9138101.

[4] J. P. Kolengadan, S. J. Dsouza and M. M. Ramya, "Development of Interactive Visual Recognition Assistant Bot," 2023 International Conference on Artificial Intelligence and Knowledge Discovery in Concurrent Engineering (ICECONF), Chennai, India, 2023, pp. 1-8, doi: 10.1109/ICECONF57129.2023.10084243.

[5] A. Mishra, P. Makula, A. Kumar, K. Karan and V. K. Mittal, "A voice-controlled personal assistant robot," 2015 International Conference on Industrial Instrumentation and Control (ICIC), Pune, India, 2015, pp. 523-528, doi: 10.1109/IIC.2015.7150798.

[6] Anurag Mishra, Pooja Makula (2016). “a voice-controlled personal assistant robot” International Conference on Advances Automotive Technologies 2016, Yildiz Technical University, Instanbul, Turkey, AAT2016.

[7] Chen, L., Cook, D. J., Guo, B., Chen, L., & Leister, W. (2017). Guest editorial: Special issue on situation, activity, and goal awareness in cyber-physical human-machine systems. IEEE Transactions on Human Machine Systems, 47(3).

[8] Sashanka Kumar Pramanik, Zishan Ahmed Onik..”a voice controlled robot for continuous patient moniter” American International University-Bangladesh, Banani, Dhaka, Bangladesh, 1213978-1-5090-5421-3/16/$31.00 ©2016 IEEE.

[9] Das, B., Cook, D. J., Krishnan, N., & Schmitter-Edgecombe, M. (2016).‘‘One-class classification-based real-time activity error detection in smart homes. IEEE Journal of Selected Topics in Signal Processing.

[10] Ahmet, V. & Hilmi, K. (2016). Design of Voice Controlled Vehicle”, International Conference on Advances Automotive Technologies 2016, Yildiz Technical University, Instanbul, Turkey, AAT2016.

[11] Omijeh, B. O., Uhunmwangho, R. & Ehikhamenle, M. (2014). Design Analysis of a Remote Controlled Pick and Place Robotic Vehicle”, International Journal of Engineering Research and Development, Vol.10, pp57-68, E-ISSN: 2278-067X, P-ISSN: 2278- 800X.

[12] Butkar, V. D., Devikar, S. R., Jaybhaye, V. B. & Shilpa, P. (2014). Android Based Pick and Place and Place Robot”, International Journal of Informative and Futuristic Research, IJIFR/V2/E4/011, Vol.2, pp. 859-867, ISSN: 2347-1697.

[13] Ritika, P. & Narender, K. (2014). Android Mobile Phone Controlled Bluetooth Robot Using 8051 Microcontroller”,International Journal of Scientific Engineering and Research (IJSER),Vol.2. ISSN: 2347-3878.

[14] Qureshi, A. H., Nakamura, Y., Yoshikawa, Y., & Ishiguro, H. (2016.) Robot gains social intelligence through multimodal deep reinforcement learning. In IEEE-RAS international conference on humanoid robots (pp. 745–751).

[15] Yasir, A. M.,Naga Sudheer Ravela, Sainath Somisetty. (2016). Speech Recognition System for a Voice Controlled Robot with Real Time Obstacle Detection and Avoidance”, International Journal of Electrical, Electronics and Data Communication, Vol.4, ISSN: 2320-2084.

[16] Y. Wang, M. Huber, et al. (2015). Arduino Based Voice Controlled Robot”, International Research Journal of Engineering and Technology (IRJET), Vol. 02, p-ISSN: 2395-0072, e-ISSN: 2395-0056.