Interactive Educational Robot using advanced Speech Recognition and NLP algorithms

[a] M Gnana Priya, [b]Muchakala Harshitha, [c]Yandra Advik, [d]Arusuru Keerthi Keshwari, [e] Natteti Siddarda, [f]Chinnireddy Kusuma

[a]Associate Professor, Department of ECE, Gokula Krishna College of Engineering [b-f] UG Scholar, Department of ECE, Gokula Krishna College of Engineering

Abstract: **This project involves making advanced technology a bit more accessible to a large number of students who have limited resources, along with the development of a low- cost AI-powered chatbot robot specifically made for tier-3 schools as well as colleges. The system uses a Raspberry Pi to thoroughly integrate each and every instance of voice recognition and natural language processing (NLP) with every single robotic movement, thus providing a fully interactive and quite cost-effective learning tool. It uses sentiment analysis and machine learning models with Python-based speech-to-text processing to understand users and to produce smart answers. The system also uses a fully API-based Google search to retrieve genuinely real-time information, which importantly increases its ability to provide relevant answers. The chatbot robot's AI voice commands control every motorized movement. Therefore, students can learn all about robotics, AI, and automation through personal experience. This system is budget-friendly and revolutionary, so it acts as a key educational resource for students and researchers at institutions that lack sufficient funding by providing practical experience with speech recognition, chatbot creation, and robotic automation. This project connects the technical gap, which helps many people, and it greatly increases AI and robotics education to all audiences while widely promoting skill growth and originality in new areas.**

Keywords: **AI, NLP, Machine Learning, Raspberry Pi.**

I.INTRODUCTION

Educational robotics is a rapidly expanding field that merges artificial intelligence (AI), natural language processing (NLP), and machine learning (ML) to create interactive and immersive learning experiences. As technology continues to evolve, incorporating robotics into education allows students to engage with AI-driven systems, fostering practical understanding and hands-on problem-solving skills. This project introduces an AI- powered chatbot robot that integrates voice recognition, text-based NLP, and robotic movement, offering an innovative and cost-effective learning platform. By leveraging AI-driven conversational abilities, students can interact with the robot, ask questions, and receive intelligent responses, making learning more dynamic and engaging.

The system is built on a Raspberry Pi, utilizing Python- based speech-to-text processing, sentiment analysis, and machine learning models to analyze user input, recognize intent, and generate meaningful replies. To enhance its capabilities, the robot features backend API-based Google search functionality, enabling real-time information retrieval and ensuring that responses remain accurate and up-to-date. The integration of AI-driven voice command-controlled motorized movement allows the robot to perform real-world actions, making it more than just a virtual assistant. This interactive approach helps students understand robotic automation, AI-based decision-making, bridging the gap between theoretical knowledge and practical application.

Designed specifically as an educational tool, this AI-powered chatbot robot serves as a valuable platform for students and researchers to explore speech recognition, chatbot development, and robotic automation. The system allows learners to experiment with AI algorithms, train chatbot models, and develop voice-controlled robotic behaviors, fostering creativity and innovation in STEM (Science, Technology, Engineering, and Mathematics) education. By integrating low-cost hardware with AI-based functionalities, this project aims to make robotics and AI education more accessible, especially for institutions with limited resources, encouraging broader participation in emerging technologies.

II. LITERATURE SURVEY

[1]. Ajmeera Kiran; I. Jeya Kumar; P. Vijayakarthik; S.K Lokesh Naik; T. Vinod, "Intelligent Chat Bots: An AI Based Chat Bot for Better Banking Applications", 2023, International Conference on Computer Communication and Informatics (ICCCI)

A text-based and audio-based chat and voice assistant for a banking application that is powered by artificial intelligence and does conversions that are designed to resemble human conversations. Chat and voice assistants have come a long way from their humble beginnings, with advances in machine learning and natural language processing enabling them to learn from their interactions and hold conversations in a human-like manner. Becoming more human can help with calculating loan interests and checking transaction details and savings, among other things. Chat and voice assistants have come a long way from their humble beginnings. Conversational banking is an improved method for retaining loyal customers because it enables the bank to respond more quickly to the customers' inquiries. The Stone Age was followed by the Bronze Age, and now we are in the Digital Age thanks to the advancement of technology. When it comes to customer behaviour, the transition from being a service seeker to a game-changer is happening at a very rapid rate. Those days are long gone when a company could still get away with putting the requirements of their customers lower on their priority list. Since the customer is now the person who ultimately decides whether a company will succeed or fail, it has become the top goal of any company to make certain that the needs and desires of the customer are met to the greatest possible extent.

[2]. A. Bhharathee; Sandeep Vemuri; B. Bhavana; K. Nishitha, "AI-Powered Student Assistance Chatbot", 2023, International Conference on Computer Communication and Informatics (ICCCI).

To address the issues and queries of Class 12 students while joining college, this research study has developed a chatbot to help the students with enrollment process. A chatbot (or chatterbot) is a software technology that performs an online chat discussion and is built leveraging NLP techniques and frameworks in general, rather than allowing a regular dialogue with a real human agent. Here, the bot is developed using BotPress. This study has incorporated NLU into the proposed chatbot so that it can identify the user's intent and respond appropriately. This chatbot is then deployed into a WordPress Website using Javascript. The plugin used here is the 'Header and Footer Scripts Plugin' of WordPress. Depending on the outcomes, the working of the proposed student helper chatbot system is quite remarkable in providing appropriate response to the users. The results indicate that the student helper chatbot is approximately 90.6% accurate in giving responses to users.

[3]. M. Ganesan; Deepika C.; Harievashini B.; Krithikha A.S.; Lokhratchana B., "A Survey on Chatbots Using Artificial Intelligence", 2020, International Conference on Computer Communication and Informatics (ICCCI).

The major role of today's technology is played by the artificial intelligence along with the NLP processing integrated with the machine learning algorithms. The computer program which uses artificial intelligence to imitate the behavior of the human decision making as well as providing the various kind of services forms the basis for the survey on artificial intelligence on the chatbots. Thus, the paper provides a survey based on the different platforms used to build a chatbot for providing various kind of services to different kind of users. The design techniques for building the chatbot depends on the services meant to provide for the users. The chatbot will get the experience by learning through the past experience using various algorithms. The data can be trained to the chatbot which will enable it to check with the knowledge base for providing accurate results to the query of the user through client side applications.

III. EXISTING SYSTEM

In the current technological landscape, most AI-powered chatbots and virtual assistants are designed to function as stationary systems, either in the form of voice-based software assistants or fixed-location robots. Popular virtual assistants like Siri, Alexa, and Google Assistant utilize natural language processing (NLP) to understand user commands and generate intelligent responses. These AI-driven systems have significantly improved human- machine interaction by enabling hands-free operations, automating tasks, and providing real-time information. However, they are primarily software-based entities without any physical form, meaning they can only communicate through voice or text and lack the ability to physically interact with their environment. This limitation makes them useful for digital tasks but restricts their effectiveness in applications requiring real-world

interactions, such as education, healthcare, and robotics.

Similarly, existing chatbot robots used in customer service, education, and industrial applications are often stationary, meaning they remain fixed in one place while responding to queries. These robots are programmed with predefined responses and are designed primarily for information retrieval rather than real-time physical interaction. While they provide automated responses and support, they do not adapt dynamically to human movement or perform physical tasks beyond their static positioning. This restricts their usability in interactive learning environments, where students or users could benefit from a more engaging experience involving robotic movement and real-time interactions. Additionally, most of these robots lack sensor-based awareness, which limits their ability to perceive and respond to their surroundings dynamically.

The major drawback of these stationary and software- based AI systems is their inability to bridge the gap between virtual intelligence and real-world interactivity. The lack of mobility makes them unsuitable for applications requiring movement, autonomous navigation, or interactive engagement. This opens up the need for AI-powered mobile robotic systems that can process voice commands, respond intelligently, and move autonomously to create a more immersive and practical experience. By integrating speech recognition, robotic mobility, and real-time decision-making, the next generation of AI-driven robots can enhance education, assistive technology, and automation. The development of such autonomous and interactive robotic systems would represent a significant leap forward in AI and robotics, overcoming the challenges of existing stationary chatbot models and redefining human-machine interaction.

IV. PROPOSED SYSTEM

The proposed system is an AI-powered educational chatbot robot designed to provide students with a highly interactive and engaging learning experience. By integrating natural language processing (NLP), voice recognition, and robotics, this system enables real-time interaction between students and an AI-driven robot. Unlike traditional virtual assistants that are confined to software-based interactions, this robot has physical mobility, allowing it to respond to voice commands, execute real-world actions, and enhance practical learning. Built on a Raspberry Pi, the system acts as a cost-effective and efficient educational tool, making AI and robotics more accessible, especially in resource- limited institutions such as tier-3 schools and colleges.

One of the key features of the proposed system is its speech-to-text (STT) and text-to-speech (TTS) capabilities, which enable the robot to understand spoken commands and generate voice-based responses. These functionalities allow students to communicate naturally with the robot, making learning more immersive and interactive. The system leverages Python-based machine learning (ML) models to classify user intents and perform sentiment analysis, ensuring that responses are not only accurate but also context-aware. However, the trained inputs for the chatbot are limited to predefined datasets, meaning that while it can recognize a broad range of queries, its ability to process complex, untrained inputs may require further model enhancements over time.

Unlike conventional stationary chatbot systems, which are primarily designed to respond to queries through voice or text, the proposed system incorporates physical movement using motorized components. With AI-driven voice commands, the robot can move autonomously or in response to specific instructions, enabling students to explore robotic control and automation in real-world scenarios. This feature makes the system an ideal learning tool for AI, robotics, and automation, as it bridges the gap between theoretical knowledge and hands-on application. Students can experiment with controlling robotic movements, integrating AI-driven decision-making, and programming the robot for different actions, which helps them develop critical problem-solving and programming skills.
Additionally, the system is equipped with backend API- based Google search functionality, allowing it to retrieve real-time information and provide relevant, up-to-date answers to student queries. This feature enhances its role as an educational assistant, ensuring that students can access a wide range of knowledge beyond its pre-trained responses. The integration of machine learning algorithms enables continuous improvement, meaning that with further training, the chatbot can become more intelligent and responsive over time. This scalability makes it an

ideal platform for AI research and development, allowing students and researchers to experiment with NLP, chatbot training, and voice- controlled robotics.

In conclusion, the proposed AI-powered educational chatbot robot represents a significant advancement in interactive learning technologies. By combining NLP, machine learning, voice recognition, and robotic mobility, it offers students a hands-on approach to understanding AI, automation, and robotics. Designed as a cost-effective solution, this system is particularly beneficial for tier-3 schools and colleges, where access to high-tech learning tools is often limited. With future enhancements such as improved ML training, autonomous navigation, and IoT integration, this chatbot robot has the potential to revolutionize AI-driven education and pave the way for more immersive and intelligent learning experiences.

V. PROJECT DESCRIPTION

This chapter deals with design and implementation of "IER using advance Speech Recognition and NLP algorithms". It can be simply understood by its block diagram.

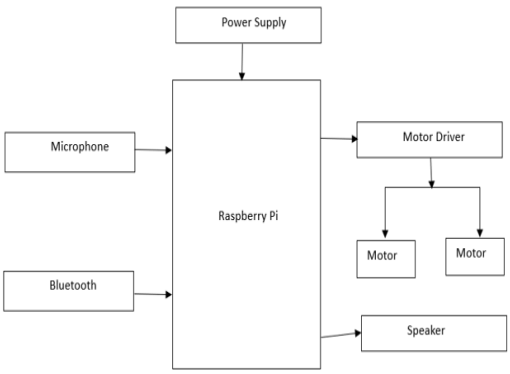


Fig: Block Diagram

This diagram appears to represent a system design for a project, likely based on a Raspberry Pi with various components interacting with each other. Here's a detailed explanation of each block:

1. Power Supply:

This block provides power to the entire system. The power supply is crucial for maintaining the necessary voltage and current for all components to function correctly. In a Raspberry Pi-based project, this typically involves a 5V DC power supply.

2. Microphone:

The microphone captures audio input from the environment. In this system, it would be used to detect voice commands or sound signals. The Raspberry Pi processes this input for further action, such as controlling motors or providing voice output.

Fig: USB Microphone

3. Bluetooth:

The Bluetooth module allows the system to communicate wirelessly with other devices, such as smartphones or computers. This could be used to send commands to the Raspberry Pi or receive data from it, depending on the design of the system.

4. Raspberry Pi:

This is the central processing unit (CPU) of the system. The Raspberry Pi handles all the data processing,

input/output operations, and decision-making based on the received signals. It processes the input from the microphone and Bluetooth module and sends appropriate commands to control the motors and speaker.

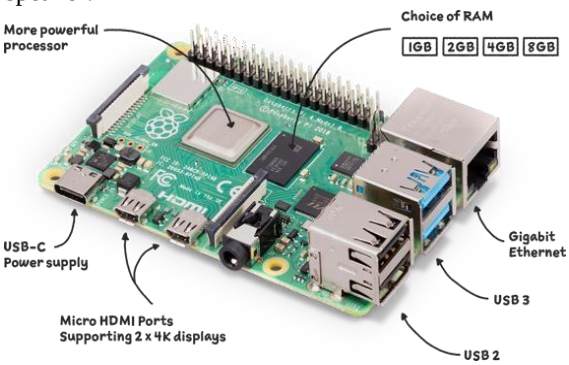


Fig: Raspberry Pi

5. Motor Driver:

The motor driver acts as an interface between the Raspberry Pi and the motors. It receives control signals from the Raspberry Pi and amplifies them to drive the motors. It also ensures that the motors receive the correct power and direction signals.

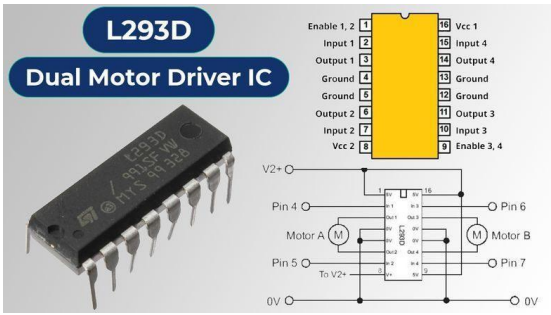


Fig: Motor Driver IC

6. Motor (x2):

These are the motors that are controlled by the motor driver. In the diagram, there are two motors, which suggests a system where motion control is involved, such as moving a robot or a vehicle. The motors will be activated or directed to move forward, backward, or turn based on commands received from the Raspberry Pi.

Fig: Motor

7. Speaker:

The speaker is used for audio output. In this system, it could be used to provide voice feedback to the user, such as confirming actions or providing instructions. The Raspberry Pi would send audio signals to the speaker, enabling interaction via sound.

Fig: Speakers for Raspberry Pi

Software:

NOOBS OS:

NOOBS (New Out Of Box Software) is an operating system installation manager for the Raspberry Pi. It is designed to simplify the process of installing and setting up an OS on the Raspberry Pi by providing a user- friendly interface. When the Raspberry Pi is first booted with NOOBS, it presents a list of supported operating systems that users can choose to install. This makes it easier for beginners to quickly start using their Raspberry Pi, as they don't need to manually flash the OS onto an SD card. NOOBS comes pre-loaded with multiple operating systems, including Raspberry Pi OS (formerly Raspbian), LibreELEC, and others, making it versatile and accessible for different use cases.

NOOBS can be run in two different modes: online and offline. In offline mode, users can download NOOBS and install the operating systems directly from the SD card without needing an internet connection. In online mode, users can download the latest versions of supported operating systems directly from the internet, ensuring they have access to the most up-to-date software. This flexibility is especially helpful for users who may not have easy access to the internet on the Raspberry Pi but still want to install a functional OS.

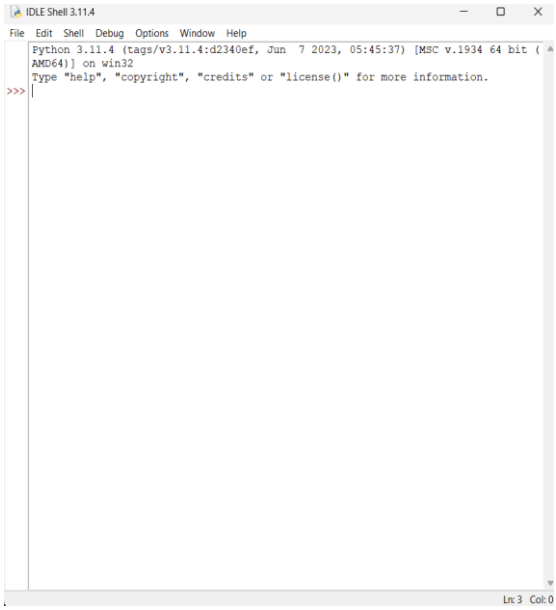
While NOOBS is excellent for beginners, it can also be used by more advanced users who want a simple way to switch between different operating systems on the same Raspberry Pi. The software allows easy multi-booting, meaning users can install several operating systems on a single SD card and select which one to boot into at startup. However, advanced users who prefer more control over the installation process may opt for flashing an OS manually to have a more streamlined and customized setup. NOOBS remains a popular tool for Raspberry Pi enthusiasts because of its simplicity and ease of use.

Python IDLE:

Python IDLE is the default editor and Integrated Development Environment (IDE) that comes pre-installed with Python. It offers a simple, lightweight interface ideal for beginners to start programming without the need for additional setup or software. IDLE consists of a Python shell, where users can directly enter Python commands and receive immediate feedback. This interactive feature is perfect for testing small snippets of code and experimenting with Python syntax in real-time. In addition to the shell, IDLE provides a basic code editor that includes syntax highlighting, which helps make the code more readable and easier to understand. It also automatically indents code, ensuring proper structure and readability. For those learning how to debug, IDLE includes a built-in debugger that lets users set breakpoints, step through the code, and inspect variables, which is a helpful tool when troubleshooting and refining Python programs.

Although IDLE may not have as many features or customization options as advanced IDEs like PyCharm or Visual Studio Code, it remains a reliable

and user- friendly environment for those starting their Python journey. Its simplicity and direct integration with Python make it an ideal tool for beginners, providing an accessible and efficient platform to learn and experiment with Python programming.



VI. CONCLUSION

In conclusion, the proposed AI-powered educational chatbot robot bridges the gap between virtual intelligence and physical interactivity, offering an advanced learning platform that integrates natural language processing (NLP), voice recognition, and robotics. By leveraging Raspberry Pi, speech-to-text (STT), text-to-speech (TTS), machine learning (ML), and sentiment analysis, the system enables dynamic interactions, making it an effective tool for students, researchers, and educators to explore AI, automation, and robotics hands-on. Unlike traditional chatbots confined to stationary operation, this system introduces real-world action execution through motorized movement, enhancing engagement and practical understanding. With applications spanning education, AI research, personalized assistance, and smart technology development, the system provides a versatile and interactive approach to modern learning, fostering innovation and deeper comprehension of intelligent systems.

FUTURE WORK

Future enhancements for this AI-powered chatbot robot can focus on improving mobility, intelligence, and connectivity to make it even more interactive and efficient. Integrating computer vision with a camera module will allow the robot to recognize faces, objects, and gestures, enabling context-aware interactions. Upgrading the NLP model with deep learning techniques will enhance speech recognition accuracy, making conversations more natural and intelligent. Implementing LoRa or Wi-Fi-based communication will improve data transmission, enabling real-time monitoring and remote control over longer distances. The addition of autonomous navigation using LiDAR or ultrasonic sensors will allow the robot to move safely and independently in complex environments. Furthermore, expanding its functionality with IoT integration can enable smart home or classroom automation, where the robot can control appliances, retrieve real-time data, and assist in various tasks. By continuously upgrading its AI, sensors, and connectivity, the chatbot robot can evolve into a more intelligent, adaptable, and versatile learning assistant, offering a richer educational experience for students in tier-3 schools and colleges.

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