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Learn Buddy : Path Following Lab Assistant Robot

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ABSTRACT

In this paper, we introduce a dynamic educational tool that seamlessly blends robotics and interactive technology. The system harnesses the power of intelligent algorithms and voice-enabled interfaces to create an immersive learning experience for students in lab environments. A smart robotic platform navigates predefined paths, responding intelligently to its surroundings, while a voice-enabled chatbot engages users in natural language, providing assistance and information. The synergy of these technologies not only enhances the hands-on learning experience but also offers a glimpse into the future of educational robotics. This paper unveils the intricacies of our design, highlighting the potential impact on student engagement and knowledge acquisition in the realm of robotics education.

This integration represents a significant step towards fostering a holistic learning environment. Students can interact seamlessly with the robotic system through voice commands, enabling a novel approach to both control and communication. The marriage of path-following capabilities and voice-enabled interactivity opens up new possibilities for exploring robotics concepts and programming intuitively and engagingly. This paper delves into the technical details of our implementation, shedding light on the design philosophy and experimental results. Through this work, we aim to inspire educators, researchers, and enthusiasts to embrace innovative technologies to enrich the educational landscape.

Keywords: ESP32, ESP8266, STEM, IR Sensor, ChatGPT.

I. INTRODUCTION

In the ever-evolving landscape of robotics and artificial intelligence, the integration of advanced technologies has given rise to innovative solutions catering to diverse applications. Our project, "Learn Buddy," stands at the intersection of cutting-edge robotics and interactive AI, presenting a novel approach to lab assistance through a path-following robot.

Embarking on the journey of merging hardware and software seamlessly, our project employs an array of components, including two motors, a motor driver, two IR sensors, and the ESP8266 module. The integration of these elements forms the backbone of a sophisticated robotic system designed to navigate through predefined paths autonomously.

Moreover, in a bid to enhance the user experience and foster interactive learning environments, we introduce ChatGPT, a language model powered by OpenAI's GPT-3.5 architecture. This AI assistant is seamlessly integrated into the rover, utilizing an ESP32 module to facilitate communication via a microphone and speaker. This dynamic addition transforms Learn Buddy into a comprehensive lab assistant, capable of not only navigating physical spaces but also engaging in meaningful conversations.

As you delve into the intricacies of our project report, you will witness the seamless synergy between hardware and AI, each component contributing to the overall functionality of Learn Buddy. The fusion of path-following capabilities and intelligent interaction opens up new avenues for practical applications in educational settings, research labs, and beyond.

II. METHODS AND MATERIAL

Hardware Implementation:
ESP8266 Microcontroller: The ESP8266 serves as the brain of LearnBuddy, orchestrating the overall functionality of the robot. It controls the line-following algorithm, processes data from the IR sensors, and communicates with the L298 motor driver for precise motor control. The ESP8266 interacts with the IR sensors, receiving real-time data about the surface beneath the robot. It also communicates with the L298 motor driver to adjust motor speeds based on the line-following algorithm.
IR Sensors: Positioned underneath the robot, the IR sensors detect the contrast between the line/path and its surroundings. This data is crucial for the line-following algorithm, enabling the robot to make real-time adjustments to stay centered on the path. IR sensors continuously provide feedback to the ESP8266, influencing the robot's movements as it follows the designated path.

L298 Motor Driver: The L298 motor driver interprets signals from the ESP8266, providing precise control over the motors. It determines motor speed and direction, ensuring the robot moves smoothly along the predefined path. The L298 motor driver receives commands from the ESP8266, translating them into specific motor movements that allow the robot to navigate turns and corners.

ESP32 with ChatGPT: The ESP32 hosts the ChatGPT model, enabling the robot to respond to audio inputs. It processes spoken queries, generates responses, and facilitates dynamic conversations, adding an interactive dimension to the learning experience. The ESP32 interacts with the ChatGPT model, receiving audio inputs from the microphone and sending output to the speakers. It also communicates with the ESP8266 for coordinated control of the robotic system.
Audio Input and Output: The microphone captures audio inputs, allowing users to interact with LearnBuddy through spoken queries. The speaker's output responses are generated by ChatGPT, enabling dynamic and engaging conversations with the robot.
Interactions: The audio input is processed by the ESP32 and ChatGPT, influencing the robot's responses. The output is then conveyed to the user through the speakers.

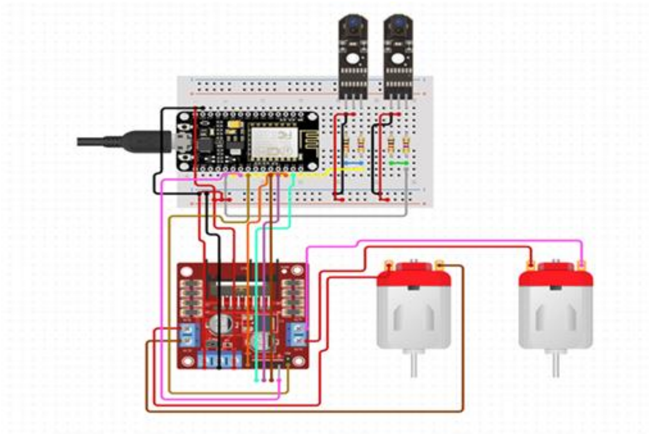

Fig. 1 Circuit diagram of Rover

Here, figure 1 shows the circuit diagram of the rover which was designed in Tinkercad. In this circuit diagram two IR sensor, two motors, a motor driver, and one microcontroller is used. Following are the pin configurations of the above circuit diagram.

D0 connected to IR Sensor 1
D1 connected to IR Sensor 2
D2 Connected to ENA of Motor Driver
D3- Motor Driver 1
D4- Motor Driver 2
D5- Motor driver 3
D6- Motor Driver 4
D7- Motor Driver 5
D8- Motor driver ENB

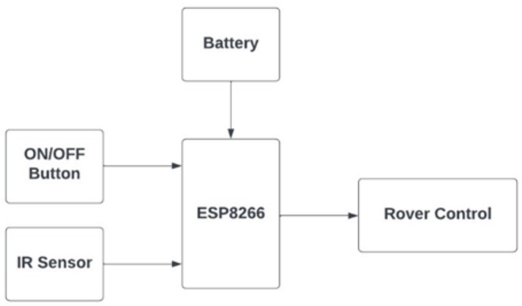

Fig.2 Block diagram of Rover

Figure 2. Represents the working of the rover as the battery powers the ESP8266, motor driver, and motors. The ESP8266 is a microcontroller that controls a robot. It receives input from the IR sensors and sends output to the motor driver and motors. The motor driver is used to control the two motors that drive the robot. The IR sensors are used to detect obstacles in the robot's path.

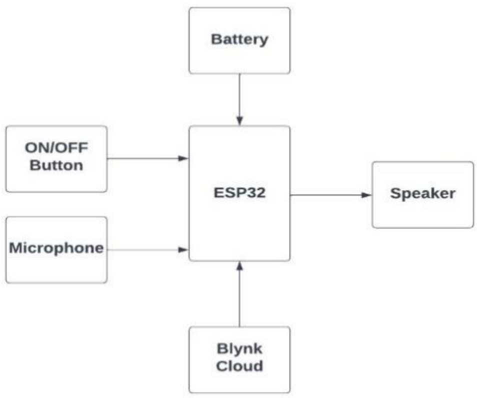

Fig. 3 Block diagram of assistant

Here, figure 3 shows the block diagram assistant which has several components and software as follows:

1. Battery: Powers the entire system.
2. ON/OFF Button: Turns the system on or off.
3. ESP32: Microcontroller that controls the robot.
4. Microphone: Captures user's voice input.
5. Speaker: Plays back audio responses.
6. Blynk Cloud: Server for remote control and data visualization.

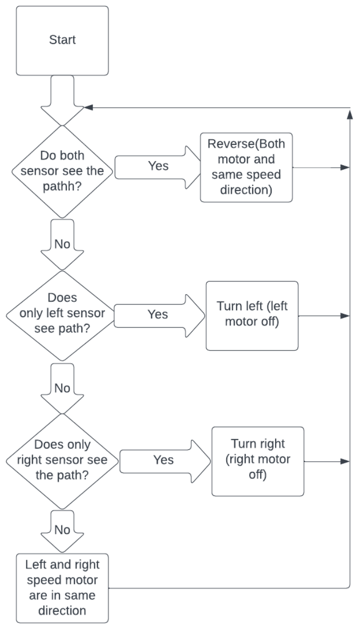

Fig. 4 Flow chart of Rover

Figure 4 shows the flowchart of the rover that represents a workflow. Also, it helps us in a better understanding of the system.

III. RESULTS AND DISCUSSION

Figure 5, it shows the final model of the path following the rover which is constructed with the help of the ESP8266 microcontroller, two IR sensors, two motors, an L298 motor driver, 4 wheels, and metal plates and wires. ESP8266 microcontroller takes input from IR sensors which is used to detect the path and the microcontroller sends signals to the motor driver for precise control of the rover.

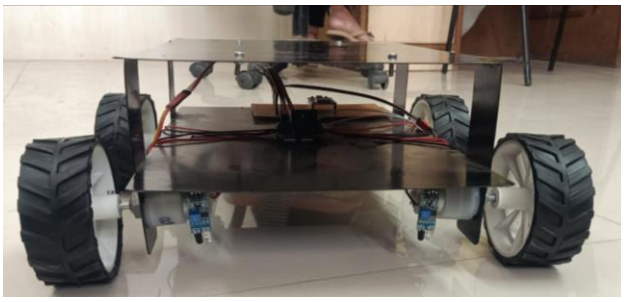

Fig.5 Output on Serial Monitor

Figure 6 shows the output of the asked question on the serial monitor of Arduino IDE. It's not possible to show voice input and output on paper so we use a serial monitor to show the output of our project and it's successfully working.

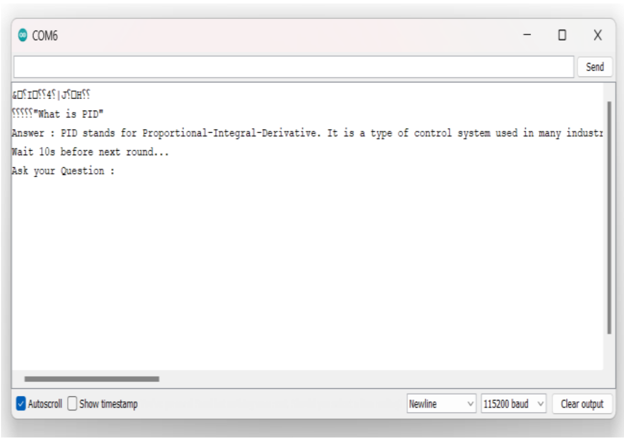

Fig.6 Real-time Question Answering.

IV. CONCLUSION

In conclusion, the LearnBuddy project stands out as an innovative and interdisciplinary exploration into robotics, artificial intelligence, and STEM education. By integrating various hardware components and incorporating advanced conversational AI through ChatGPT, LearnBuddy offers a distinctive learning experience. It surpasses traditional educational methods by providing hands-on experiences that bridge theory and practice, teaching programming, robotics, and fostering problem-solving skills. Encouraging an interdisciplinary approach, the project combines elements of electronics, programming, and AI, reflecting the real-world integration of technology domains and preparing learners for modern industries' complexities. LearnBuddy strategically aligns with current technological trends, showcasing advancements in motor control systems, and underscores the increasing relevance of conversational AI in diverse applications. The incorporation of audio input and output, along with ChatGPT's conversational abilities, transforms LearnBuddy into an interactive companion, enhancing the overall learning experience and fostering creativity and curiosity among users.

The future of the Path Following LearnBuddy robot holds promise for advancements in various areas. This includes implementing more sophisticated path-following algorithms using machine learning, enhancing sensor integration for improved navigation, and incorporating simultaneous localization and mapping (SLAM) for real-time environmental mapping. Collaborative learning capabilities and cloud connectivity offer opportunities for efficient knowledge sharing and remote updates. Additionally, expanding educational modules ensures LearnBuddy remains a versatile tool for learners of diverse backgrounds and ages.

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