

An-Najah National University
Department of Computer Engineering



Faculty of Engineering & Information Technology

Hardware Graduation Project

AI Robot

Done By

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Disclaimer Statement

This report was written by students: Mostafa Irshaid and Majed Kawa at the Computer Engineering Department, Faculty of Engineering, An-Najah National University. It has not been altered or corrected, other than editorial corrections, as a result of assessment and it may contain language as well as content errors. The views expressed in it together with any outcomes and recommendations are solely those of the students. An-Najah National University accepts no responsibility or liability for the consequences of this report being used for a purpose other than the purpose for which it was commissioned.

Abstract

Our project aims to develop an intelligent robot that has multiple features such as mobility, voice interaction, and emotional expressions controlled by ChatGPT language model using prompt engineering.

The importance of this project lies in the integration of hardware and advanced language processing. Enabling the robot to understand and interact with the surrounding environment achieving a more natural human-robot interaction. This has the potential to be used in various fields from personal assistance to educational applications.

The design and implementation of the hardware components, including mobility features, is the first step in the project development process. At the same time, the ChatGPT language model is integrated. To create a balanced and effective intelligent robot, the development approach places a strong emphasis on iterative testing and improvement.

While there are a lot of intelligent robots, the combination of mobility, voice interaction, emotional expressions, and the specific use of the ChatGPT language model through prompt engineering distinguishes this project. Some of the projects that we have seen are Alexa from Amazon, and Loona from KEYi.

Chapter 1: Introduction

1.1 General background:

Robotics is a fast-evolving field that combines hardware and software in order to help us with a specific task or make our lives easier.

1.2 Project Objective:

The project aims to build a robot that we can interact with, has the ability to do some moves like moving in four directions, turning left and right, waving and this project can be used as a starting block to more specific aspects or jobs using the items needed for that specific job.

1.3 Project Significance:

Market demand for the advancement of robotics has grown exponentially in recent years. The global mobile robotics market was valued at USD 7.472 billion in 2023 and is anticipated to reach USD 22.96 billion by 2030. Industries such as healthcare, education, engineering, and manufacturing are increasingly relying on robotics. [\[2024-2030\] Mobile Robotics Market Demand, Growth](#)

Building a robot that has features such as voice interaction, movement, and using the AI to control it, is an exciting idea that we think will be used in the future so we wanted to try and build it.

1.4 Report Organization:

The report is divided into six chapters and these chapters are:

Chapter 1: Introduction to the problem, the objectives and significance.

Chapter 2 : Theoretical background and previous work.

Chapter 3 : Standards, constraints, tools and methods.

Chapter 4 : Results and analysis.

Chapter 5 : Discussion.

Chapter 6 : Conclusions and Recommendations.

Chapter 2: Theoretical Background and Previous Work

Before starting with our project we saw multiple examples of how AI and robotics can be used in different aspects.

For example, voice assistants like Amazon's Alexa and Apple's Siri which have shown just how capable voice-driven systems can be.

“Spot” - The Agile Mobile Robot from Boston Dynamics which uses a form of AI, which they call “athletic intelligence,” which allows Spot to walk, climb stairs, avoid obstacles, and autonomously follow preset routes with little or no input from users.(“FAQ”)

“Loona” - PetBot by KEYi, A new kind of robot with emotional intelligence that brings up a higher level of social interactions between humans and robots

3.1.2 ESP8266:

We used the ESP8266 microcontroller to connect the sensors, and send their values to the database.

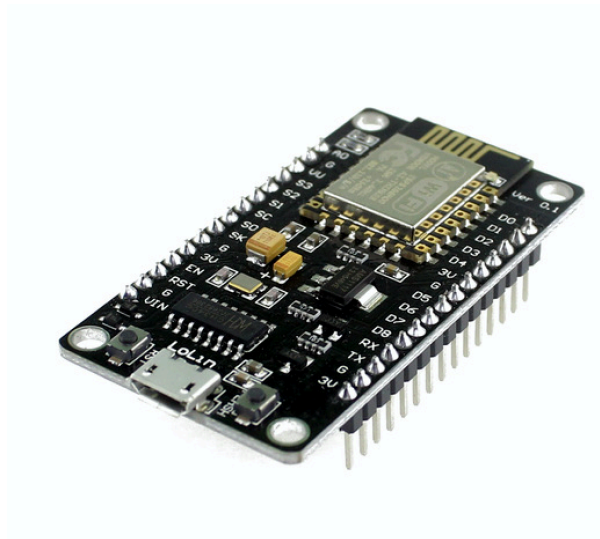


Figure 2: ESP8266

3.1.3 DC Motors with Encoders:

We used two dc gear motors with encoders, to move the robot in all directions, here are some specifications of the motors:

Voltage: DC 6V

Speed: 210 rpm

Stall torque: 10kg.cm 3.2A



Figure 3: DC motor with encoder

3.1.4 Servo motors:

We used servo motors as simple arms of the robot to make it wave as a simple example.



Figure 4: Servo motor

3.1.5 Ultrasonic sensor:

We used an ultrasonic sensor to detect the objects in front of the robot, and stop its movement.



Figure 5: Ultrasonic Sensor

3.1.6 Webcam(Philips spz2000):

We used this webcam to stream real-time video, and interact with it using AI



Figure 6: Webcam(Philips spz2000)

3.1.7 H-bridge Dual Motor Controller(L298N):

We used a DUAL MOTOR CONTROLLER MODULE-L298N in order to control the speed and direction of the motors.

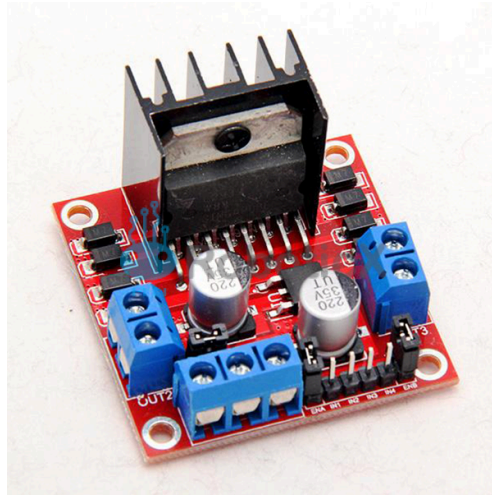


Figure 7: DUAL MOTOR CONTROLLER MODULE-L298N

3.1.8 Oled display:

We used two oled screens as eyes for the project, we used i2c for communication between the raspberry and the oled screens.

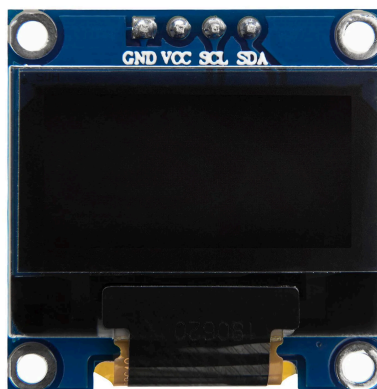


Figure 8: Oled 128x64

3.1.9 Speaker:

The response of the query is outputted from the speaker



Figure 9: Speaker

3.1.10 Power bank and li-batteries:



Figure 10: PowerBank



Figure 11: Li-batteries

Used a 20000mAh power bank to provide power for the raspberry, and the Oled screens.

Used 2 lithium ion batteries to provide the required power the motors

3.1.11 DHT Sensor:

Used a DHT-11 sensor to measure temperature and humidity

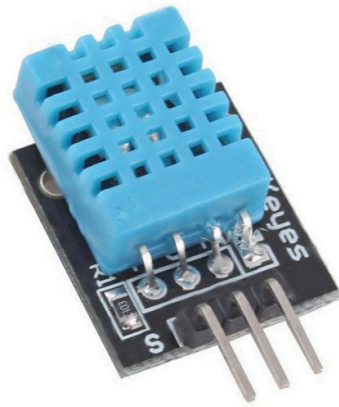
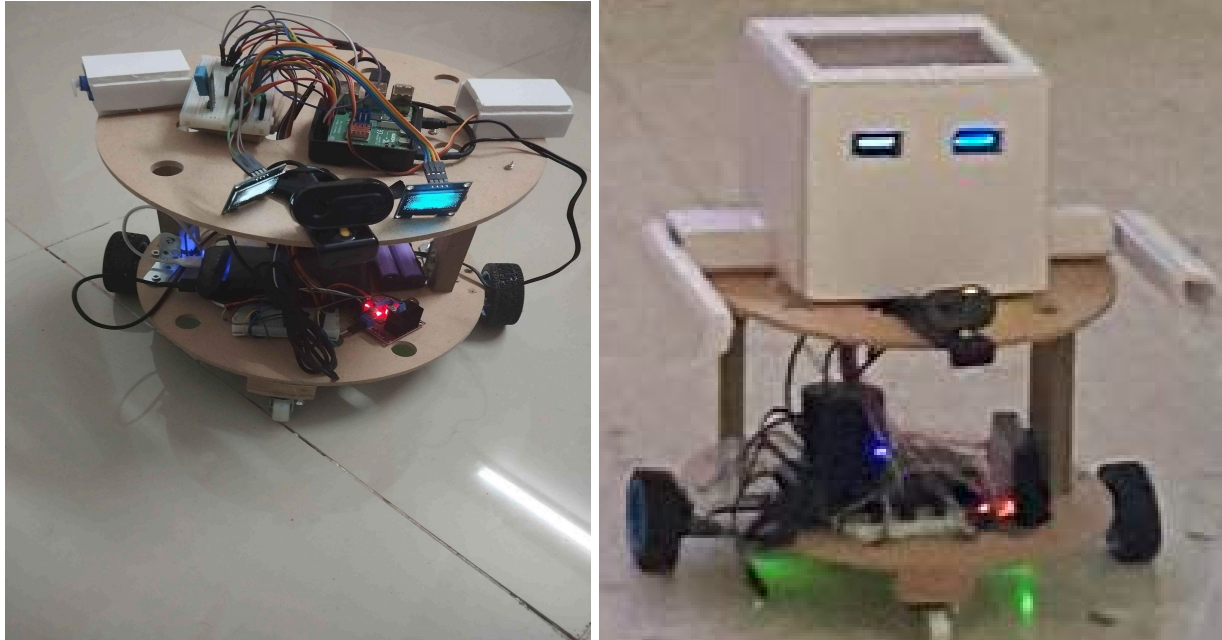


Figure 11: DHT-11 Sensor

The ROBOT



3.2 Constraints

Processing Power:

- Limited computational power of the Raspberry Pi and ESP microcontrollers for running complex AI models and real-time video processing.
- Constraints on running advanced machine learning models due to hardware limitations.

Battery Life and Power Consumption:

- Limited battery life of the robot, requiring frequent recharging or a more efficient power management system.

High power consumption by sensors, motors, and processing units.

3.3 Tools, Methods and Programming Languages

3.3.1 Tools

- Visual Studio Code
- Firebase
- Arduino IDE
- VNC Viewer

3.3.2 Programming Languages

- Python
- TypeScript

Chapter 4: Results

4.1 Database

Used Firebase realtime database, to send and receive data from the pi, esp and the web application

4.2 Web Application

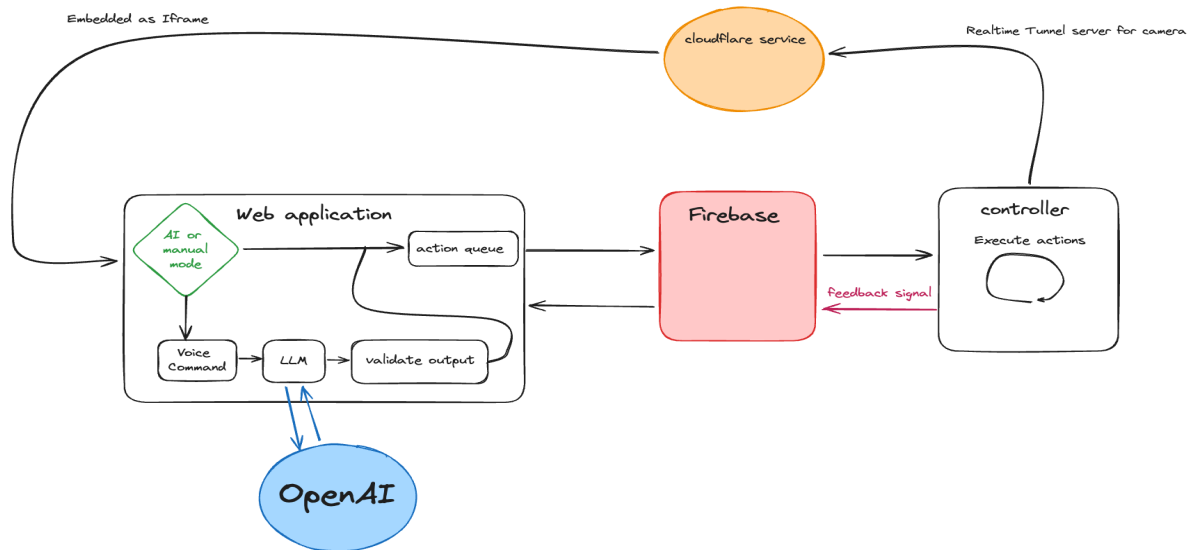
4.2.1 Web Application

Now we will present the web application:

In this section, we present our web application. We utilized React as the framework and integrated it with Firebase for backend services. Additionally, we

employed prompt engineering techniques to optimize AI responses. We implemented output validation to ensure the AI returns valid JSON output, adhering to a predefined schema.

Upon receiving the AI results, we send the movement commands to our robot using a queue system. This allows the web application to act as the controller, significantly enhancing the robustness and reliability of the robot's operations.



Chapter 5: Discussion

We have developed an AI hardware project that integrates ESP microcontrollers and Raspberry Pi with advanced AI models from OpenAI. The project includes a robot capable of moving, speaking, and streaming live video through a web application. Despite the impressive functionality, there are some limitations due to the current stage of AI technology.

Expected Capabilities and Current Limitations

Expected Capabilities

One of our goals for this project was to enable the robot to analyze a 5-second video clip and decide the best move based on the content of the video. This feature would have added a significant level of intelligence and adaptability to the robot, making it capable of dynamic decision-making.

Current Limitations

Unfortunately, this advanced capability is beyond the reach of current AI technology. The AI models we have access to are still in the early stages and do not yet possess the ability to analyze video content in real-time and suggest optimal actions based on that analysis. This limitation highlights the evolving nature of AI and the potential for future advancements.

Applications

Despite these limitations, the project has numerous applications:

- **Education:** Serves as an engaging tool for teaching programming, robotics, and AI concepts.
- **Surveillance:** Useful for real-time monitoring with live video feeds.
- **Entertainment:** The robot's interactive features provide entertainment and engagement.

Chapter 6 : Conclusions and Recommendations

Conclusions:

Our AI hardware project showcases the integration of AI with IoT devices using ESP microcontrollers and Raspberry Pi. The robot can move, speak, and stream live video, demonstrating the potential of current technology. Although we aimed to incorporate video analysis for dynamic decision-making, this remains a future goal due to the early stage of AI capabilities. This project highlights both the achievements and the limitations of AI in its current form, paving the way for future innovations in AI-driven robotics.

Future Work:

- 1- Develop and integrate more advanced AI models capable of analyzing video content in real-time.
- 2- Implement algorithms that allow the robot to make dynamic decisions based on video input, enhancing its interactivity and adaptability.
- 3- Use more sensor data to provide contextual responses and actions. like GPS
- 4- Add more movements to the arm of the robot

References:

[React Library](#)

[Firebase Documentation](#)

[GitHub Docs](#)

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