AGRO SPIDER BOT

PROJECT REPORT

Proposed by

Rio Roy S4 EC

Varghese Selestin S4 EC

Athul KS S4 EC

Mohammed Shan S4 EC

June 2024

ABSTRACT

Designed to mimic the movement of arachnids, this eight-legged spider robot builds upon the ingenuity of the Theo Jansen Mechanism. This system uses a dual motor setup paired to six gears which in turn actuate the eight legs in synchrony. Its Wi-Fi control operation enables the operator to control this robot wirelessly. This system also has several other features.

System Features

- Inbuilt weed cutter
- Actuator to safeguard the sensor attached to it
- Can be connected to any sensor and readings will be displayed
- Solar panel to recharge itself
- Indicator led
- Temperature sensing
- Worldwide control using a mobile app.

The spider robot makes use of a kinematic motion that is run by theo jansen linkages. This allows to turn the rotational motion of a Stepper motor motor into a step motion that mimics animals. The robot makes use of 2 x Stepper motos to drive the mechanism. The motors are mounted on 2 opposite sides of the robotic chassis or main frame. The drive produced by the motors are used to drive a gear which in turn is connected to 2 more hears. The 3 gears are used to drive a combination of 8 legs.

CHAPTER 1

INTRODUCTION

The idea of mechanization (usage of automated equipment and robots) of agriculture was most obvious in recent years and there are many success stories of robotic agriculture. The reasons for usage of robots in agriculture are to improve food quality and productivity, reduce labour costs and time. One more important reason for robotic agriculture is the unavailability of sufficient skilled man power in agricultural sector and it affects the growth in the agricultural sector of developing countries. Robots have successfully been used in agricultural activities like seeding, harvesting, weed control, grove supervision, chemical applications, etc. In India, about 70% of population is dependent on agriculture. Therefore, if the farmers are empowered with support of robots, the agricultural output of the nation can improve radically.

Here we are discussing about a rover that is intelligent enough to work the tasks that are involved in farming. The AGRO SPIDER BOT is a rover that uses different sensors to come out with different results that helps in the growth of the crops. This rover takes place of the already existing techniques. The review paper discusses all the problems, existing techniques and the remedies to all these problems.

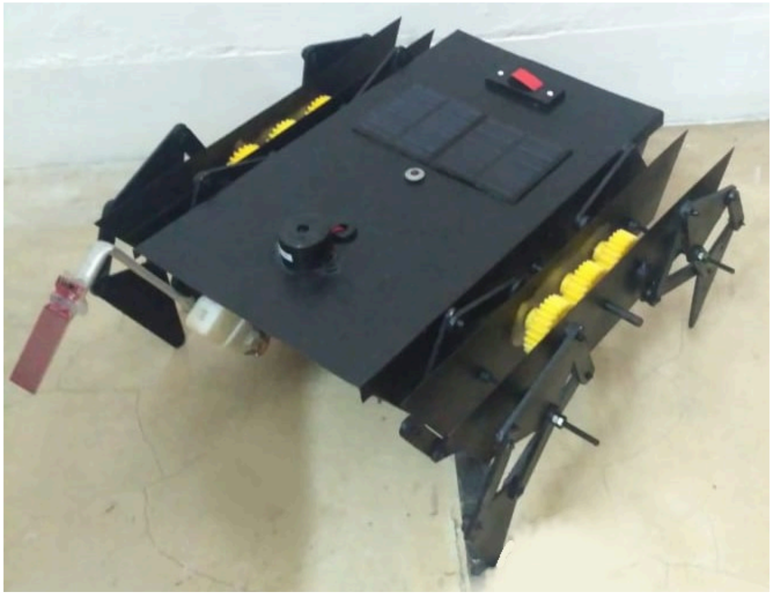


Fig.1.1: The Agro spider bot

CHAPTER 2

LITERATURE REVIEW

2.1 PROBLEMS FACED BY THE AGRICULTURE INDUSTRY TODAY

2.1.1 Lack of water control

Fig.2.1: Lack of water control

Water is an irreplaceable part in agriculture. It is required to promote the growth of the crops and also to beat the high temperatures from the sun. The amount of water required for each plant may vary on the type of plant, climate and soil characteristics. Water is distributed across land by raising the water table, through a system of pumping stations, canals, gates, and ditches. Managing of water level is sometimes difficult. Drawbacks to surface irrigation include potential overwatering and wasteful runoff. If soil lacks proper sloping or doesn't absorb readily, water can't move through the garden. Standing water damages plants and reduces yields for edible crops. Sometimes it is difficult to water the plants in the summer time or when the water shortage is present. The water shortage will also bring out a big problem in farming drying out the crops.

2.1.2 Inefficient or Dangerous methods of pest control

Fig.2.2: Poor pest control

Pest control is an important factor to be taken in consideration, since no matter how well the crops are growing, pest attacks can significantly affect the yield of the crops. Pest attacks are common around the world and farmers have different approaches to defend their crops from the pests.

Some of them use an inefficient and labor-intensive way of making loud sound by bashing plates and beating drums to make loud noises in the hopes of scaring away pest. This method can be very disturbing to the residents in the premises.

Others however takes a highly efficient but dangerous way of spray pesticides and insecticide all over their crops. This method makes sure the crops are safe but can cause significant health problems due to high dosages of dangerous chemicals.

2.1.3 Physically monitoring the crops

Fig.2.3: Field monitoring

Crop monitoring can be a hassle especially when your field is far away from your home. Travelling back and forth from your house to the field everyday can be expensive and also exhausting. Also, navigating through mud and monitoring crops can be inconvenient and tiring.

2.1.4 Weed Infestation

Fig.2.4: Weed infestation

Weed infestation can pose significant challenges and problems in farming. Here are some of the key issues caused by weed infestation:

1. Competition for Resources: Weeds compete with crops for essential resources such as sunlight, water, nutrients, and space. They can quickly overtake crops, depriving them of these vital resources and affecting their growth and productivity. Weeds are generally fast-growing and aggressive, leading to reduced crop yield and quality.

2. Reduced Crop Quality: Weeds can have a negative impact on crop quality. They may contaminate harvested crops, making them unsuitable for sale or consumption. Weeds can also reduce the market value of crops by altering their appearance, taste, or nutritional composition.

3. Decreased Crop Yield: Weed infestation can result in reduced crop yield. Weeds consume resources that would otherwise be available to crops, leading to decreased growth and development. They can also impede harvesting operations by interfering with machinery or causing difficulties in manual harvesting.

4. Disease and Pest Vectors: Weeds can serve as hosts for pests and diseases that can then spread to cultivated crops. They can harbor insects, fungi, bacteria, and viruses, acting as reservoirs and facilitating the transmission of these pests and diseases to nearby crops. This increases the risk of crop damage and reduces overall plant health.

5. Increased Costs and Labor: Controlling and managing weed infestations require additional resources, including labor, machinery, and herbicides. Farmers may need to invest more time, effort, and money into weed control practices such as manual weeding, mechanical cultivation, or chemical treatments. These added costs can significantly impact the profitability of farming operations.

6. Weed Resistance: Over time, weeds can develop resistance to commonly used herbicides. This poses a challenge for farmers as the effectiveness of herbicides decreases, requiring alternative control strategies. Weed resistance management becomes crucial to maintain effective weed control and prevent further spread and development of resistant weed populations.

7. Soil Degradation: Certain weed species can contribute to soil degradation. They can disrupt soil structure, compete with crops for nutrients, and increase soil erosion due to their aggressive growth habits. Invasive and perennial weeds, in particular, can be difficult to eradicate and may have long-lasting impacts on soil health and productivity.

To mitigate the problems caused by weed infestation, farmers employ various weed control strategies. These include integrated weed management techniques such as crop rotation, mulching, hand weeding, mechanical cultivation, biological control methods, and judicious use of herbicides. Implementing preventive measures, such as proper sanitation and weed seed bank management, can also help reduce future weed infestations. Additionally, promoting healthy crop growth through optimal planting practices and nutrient management can help crops better compete against weeds.

2.2 CURRENT SOLLUTIONS FOR STATED PROBLEMS

2.2.1 GSM controlled water supply

A GSM controlled water sprayer is a device that allows you to remotely control the spraying of water or other liquids using the Global System for Mobile Communications (GSM) network. It enables you to operate the water sprayer from a distance using your mobile phone.

Here's a brief explanation of how a GSM controlled water sprayer typically works:

1. Water Sprayer Mechanism: The water sprayer itself consists of a tank or reservoir for holding the liquid, a pump or motor for pressurizing the liquid, and a spray nozzle for dispensing the liquid in a controlled manner.

2. GSM Module: The GSM controlled water sprayer incorporates a GSM module, which acts as the communication interface between the sprayer and your mobile phone. The GSM module is connected to the electronic control circuitry of the water sprayer.

3. SIM Card and Mobile Network: The GSM module requires a SIM card, similar to the ones used in mobile phones, to establish a connection with the GSM network. The SIM card allows the sprayer to send and receive commands and data via SMS (Short Message Service).

4. Control Commands: To operate the water sprayer, you send specific control commands as SMS messages from your mobile phone to the GSM module in the sprayer. These commands can be predefined or customized based on the features and capabilities of the sprayer.

5. Processing and Actuation: Upon receiving the SMS command, the GSM module processes the message and extracts the relevant information. The control circuitry of the

sprayer interprets the command and triggers the appropriate actions. For example, it may activate the pump to start spraying water or stop the pump to cease spraying.

6. Confirmation and Feedback: After executing the command, the GSM module can send a response or confirmation message back to your mobile phone, indicating the status of the operation. This feedback helps you monitor and verify the actions performed by the water sprayer.

7. Power Supply: The GSM controlled water sprayer requires a suitable power supply, typically through batteries or a direct connection to an electrical source, to operate the pump, GSM module, and control circuitry.

GSM controlled water sprayers find applications in various fields, such as agriculture, gardening, and industrial automation. They provide convenience and flexibility, allowing you to remotely activate or deactivate the water sprayer as needed, saving time and effort.

It's worth noting that the actual design and features of a GSM controlled water sprayer can vary depending on the specific product or project requirements. The GSM module, control circuitry, and other components may differ, but the fundamental principle of remote control via the GSM network remains consistent.

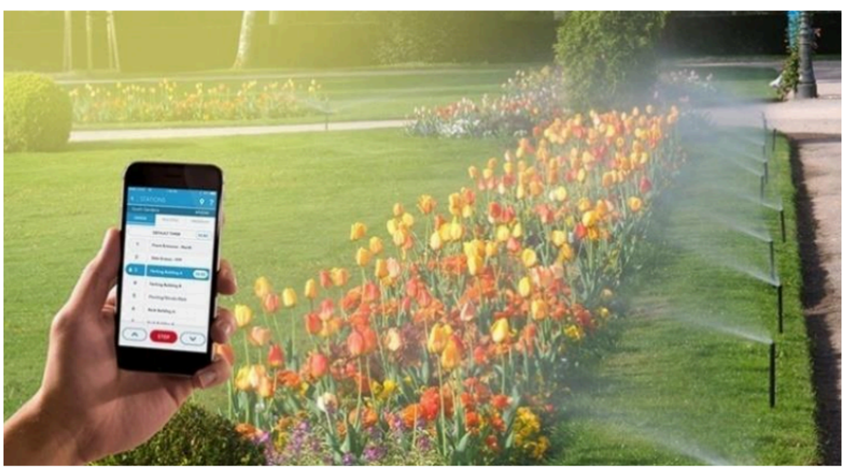


Fig.2.5: GSM controlled sprayer

Fig.2.6: GSM schematic

2.2.2 Ultrasonic pest repeller

These days when technology rise, new gadgets are entering the market to help the farmers in their hardship. One such tool is the above shown. Both the images shown above are different models of the pest Repeller used by farmers. They are either one time battery supply or solar powered. These produce ultrasonic sound to repel the pests for good. These are a helpful tool for the farmers so they good sit happily knowing the animals or pests won't attack their crops.

An ultrasonic pest repellent is an electronic device designed to deter pests, such as rodents, insects, and other small creatures, using ultrasonic sound waves. These devices are based on the concept that certain frequencies of sound are highly unpleasant or irritating to pests, causing them to avoid the area where the sound is emitted.

Ultrasonic pest repellents typically come in the form of small electronic devices that can be plugged into a power outlet or operated using batteries. They emit ultrasonic waves, usually in the range of 20 to 60 kHz, which is beyond the range of human hearing but within the hearing range of many pests. The sound waves are emitted at regular intervals, creating an environment that pests find uncomfortable or disturbing.

The ultrasonic waves generated by these devices are believed to disrupt the pests' communication, feeding patterns, and nesting behaviors, making the area inhospitable and unattractive to them. The goal is to create a deterrent effect, encouraging pests to seek alternative locations away from the area protected by the device.

It is important to note that the effectiveness of ultrasonic pest repellents can vary depending on factors such as the type of pest, the size of the area, and the specific device being used. Some pests may be more sensitive to ultrasonic waves than others, and certain species may be less affected by these repellents.

Ultrasonic pest repellents are often marketed as a non-toxic and environmentally friendly alternative to chemical pesticides. They are commonly used in homes, gardens, and commercial spaces where pests can be a nuisance. It is important to follow the manufacturer's instructions regarding the placement and coverage area of the device for optimal results.

While some users report positive results with ultrasonic pest repellents, it is also worth noting that scientific studies on their effectiveness have yielded mixed results. Some studies have shown promising effects in certain scenarios, while others have found limited or no evidence of their efficiency. Therefore, it is recommended to use ultrasonic pest repellents as part of an integrated pest management strategy, combining them with other preventive measures such as proper sanitation, sealing entry points, and removing attractants to enhance overall pest control efforts.

Fig.2.7: Pest Repeller

2.2.3 Collecting data through sensors

The latest technology uses Wi-Fi to connect with different sensors to collect data from the farm. All these data are sent to a database for the use of monitoring by a farmer. He/she gets the complete details of a plat at a particular time without going in to the farm. The sensors are places in different spaces in regular intervals to read the data and all are synced to communicate with the internet database.

Fig.2.8: Sensor motored field

2.2.4 Labor intensive weed removal

Fig.2.9: Manual weed removal

Weed removal is a very labor intensive and expensive process. This is not feasible to do every time here is a weed infestation. The agro spider bot is equipped with an electric weed cutter that creates zero carbon footprint compared to the regular gas-powered brush cutter. It also makes less noise and also can be controlled autonomously removing the need of extra labor and does not put your health at risk.

CHAPTER 3
SOFTWARE USED

3.1 ARDUINO IDE

The Arduino IDE (Integrated Development Environment) is a software platform designed to simplify the process of programming and developing projects for Arduino boards. It provides a user-friendly interface and a set of tools that enable users to write, compile, and upload code to Arduino microcontrollers.

- User-Friendly Interface: The Arduino IDE features a simple and intuitive interface that is accessible to beginners and experienced developers alike. Its user-friendly design makes it easy to navigate through the various features and functionalities, allowing users to focus on writing and editing their code.
- Code Editor: The IDE includes a built-in code editor where users can write and edit their Arduino code. It offers syntax highlighting, auto-indentation, and code suggestions to assist users in writing error-free and well-structured code. The editor also supports multiple tabs, enabling users to work on multiple files simultaneously.
- Library Management: Arduino libraries are pre-written code modules that provide ready-made functions and features, simplifying the development process. The Arduino IDE includes a library manager that allows users to easily install, update, and manage libraries. This makes it convenient to add functionality to Arduino projects without having to write code from scratch.
- Board and Port Selection: The IDE provides a straightforward board and port selection feature, enabling users to choose the appropriate Arduino board they are working with and the corresponding serial port to establish communication between the IDE and the Arduino device. This selection is crucial for compiling and uploading the code to the Arduino board.
- Compilation and Upload: The Arduino IDE incorporates a compiler that translates the written code into machine-readable instructions. It then facilitates the uploading of the compiled code to the connected Arduino board, allowing users to execute their programs and see the results in real-time.

- Serial Monitor: The IDE includes a serial monitor tool that enables users to communicate with the Arduino board and receive data from it during runtime. This feature is particularly useful for debugging and monitoring the behavior of the Arduino program, as it allows for the display of text messages, sensor readings, and other data transmitted through the serial interface.
- Example Sketches: The Arduino IDE offers a collection of example sketches that provide ready-to-use code for various Arduino functionalities and components. These examples serve as valuable resources for beginners, as they demonstrate how to implement different features and can be used as a starting point for building more complex projects.
- Cross-Platform Compatibility: The Arduino IDE is designed to be cross-platform, supporting Windows, macOS, and Linux operating systems. This allows users to develop Arduino projects using their preferred operating system without any compatibility issues.
- The Arduino IDE has played a significant role in popularizing Arduino development by providing a user-friendly and accessible platform for programming Arduino boards. Its simplicity, extensive documentation, and large community support have made it a preferred choice for both hobbyists and professionals working on Arduino-based projects..The Arduino IDE is used to compile and upload the code required for establishing Wi-Fi connection and also the logic of the bot.

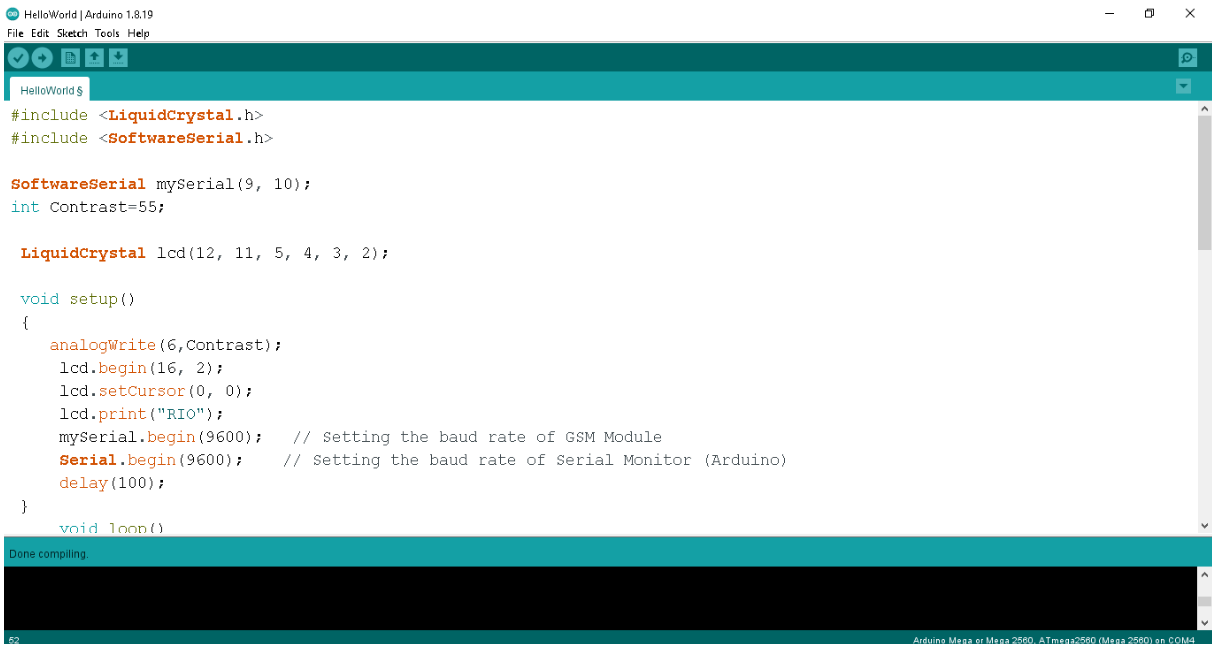


Fig.3.1: Arduino IDE

Althougth the ESP 32 boards library has to be installed to the Arduino ide.For that the following steps were taken:

- The link below is provided in “Additional Board Manager URLs” field of the preference menu for providing an address from which the libraries are downloaded

https://raw.githubusercontent.com/espressif/arduino-esp32/gh-pages/package_esp32_index.json

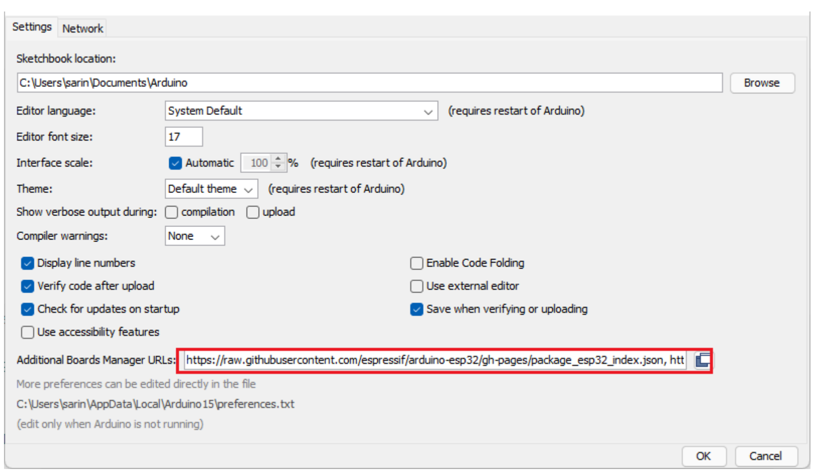


Fig.3.2: Preference menu

- Open the Boards Manager. Go to Tools > Board > Boards Manager…

- Search for ESP32 and press install button for the "ESP32 by Espressif Systems"

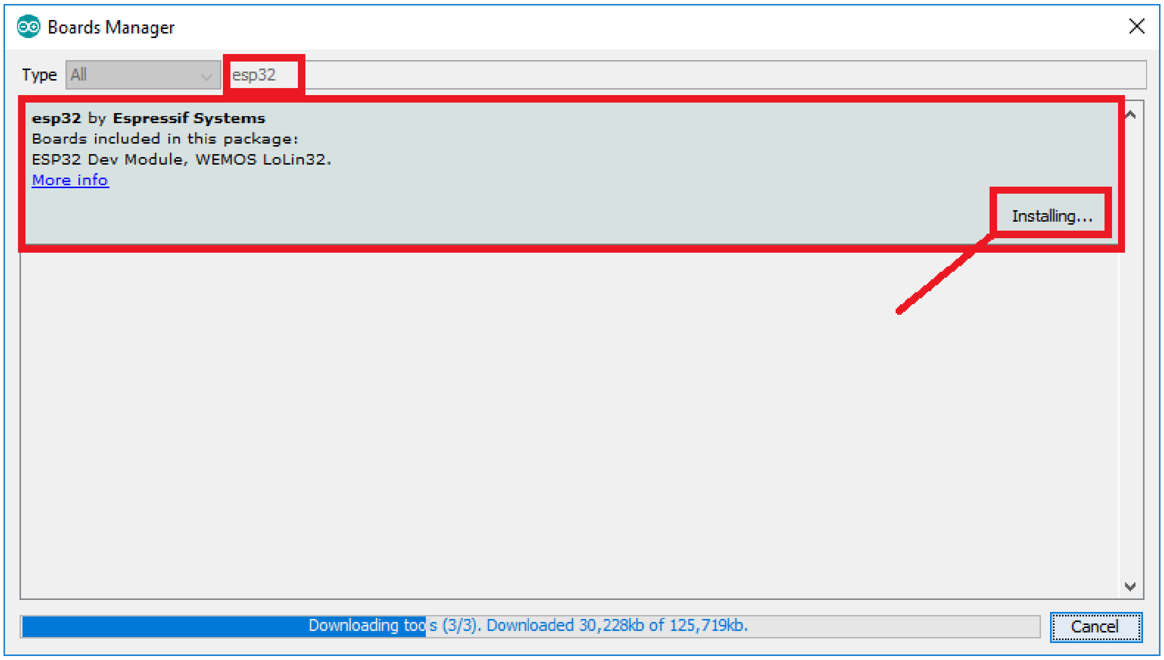


Fig.3.3: Installing ESP boards

- Select your Board in Tools > Board menu (in my case it's the DOIT ESP32 DEVKIT V1

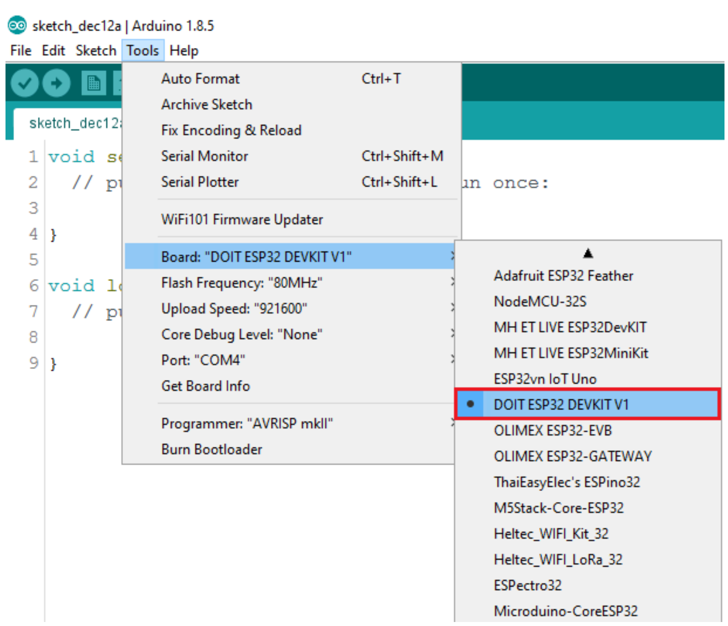


Fig.3.4: Selecting boards

- Select the Port (if you don't see the COM Port in your Arduino IDE, you need to install the CP210x USB to UART Bridge VCP Drivers):

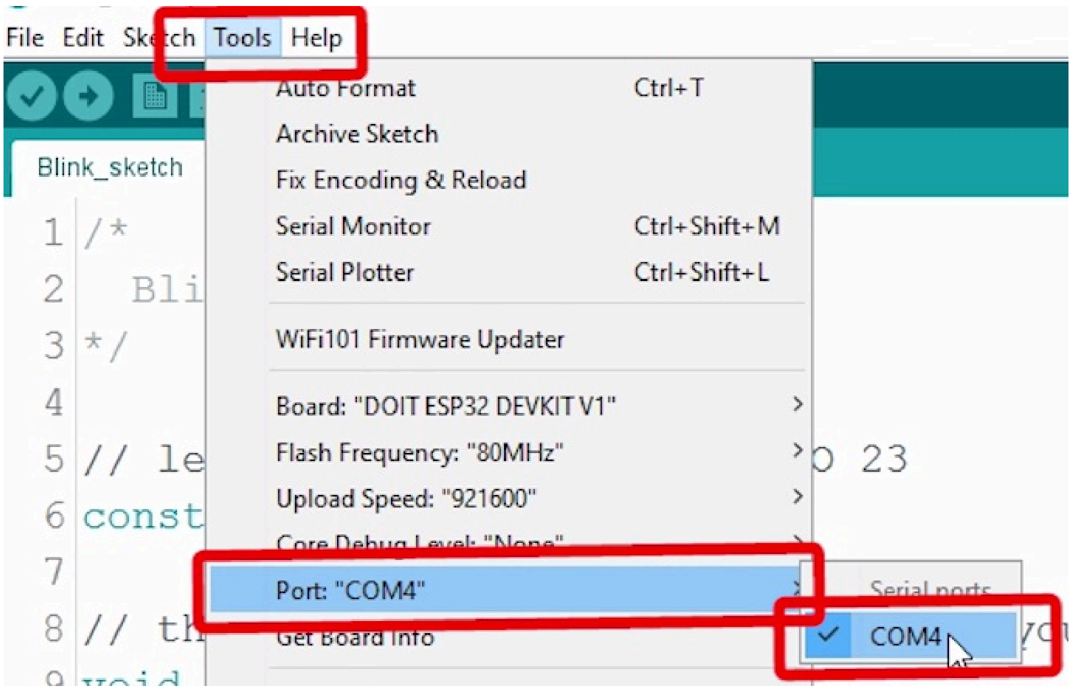


Fig.3.5: Selecting uploading port

Now the required sketch can be uploaded to the ESP 32 via USB connectors after compiling it. The boot button on the ESP 32 has to be pressed for 5 seconds while uploading the code.

3.2 BLYNK IOT

Blynk IoT is a powerful and versatile platform that enables the development of Internet of Things (IoT) projects with ease. It offers a comprehensive set of tools and features for connecting, controlling, and monitoring IoT devices remotely. Here's a description of Blynk IoT:

- IoT Project Development: Blynk IoT provides a framework for developing IoT projects by connecting hardware devices to the cloud. It supports a wide range of popular hardware platforms such as Arduino, Raspberry Pi, ESP8266, and more. This versatility allows developers to choose the hardware that best suits their project requirements.

- Drag-and-Drop Interface: Blynk IoT features a user-friendly and intuitive drag-and-drop interface, which allows users to create custom user interfaces (UI) for their IoT projects without the need for extensive programming knowledge. With simple drag-and-drop widgets and pre-built UI components, users can quickly design interactive and visually appealing dashboards for controlling and monitoring their devices.
- Cloud Connectivity: Blynk IoT leverages cloud connectivity to establish a seamless connection between IoT devices and the Blynk server. This allows users to remotely access and control their devices from anywhere in the world, as long as an internet connection is available. Cloud connectivity also enables data logging, real-time notifications, and remote firmware updates.
- Widget Library: Blynk IoT offers a rich library of customizable widgets that can be added to the UI. These widgets include buttons, sliders, gauges, graphs, and more, providing an extensive range of options for interacting with IoT devices. Users can configure these widgets to send commands, receive sensor data, and display real-time information.
- Data Visualization and Logging: Blynk IoT enables the visualization of sensor data collected from IoT devices through graphs, charts, and other visual representations. This helps users understand trends, patterns, and changes in the data over time. Additionally, Blynk allows for data logging, allowing users to store and analyze historical data for further insights.
- Remote Control and Notifications: With Blynk IoT, users can remotely control their IoT devices through the mobile app or web dashboard. They can send commands, change settings, and trigger actions on the connected devices. Blynk also supports real-time notifications, enabling users to receive alerts and updates based on predefined conditions or events.
- Integration and APIs: Blynk IoT provides integration with popular third-party services and platforms, allowing for seamless integration with other applications and systems. It offers APIs and webhooks that enable developers to extend the functionality of their IoT projects and integrate them with existing workflows and systems.

- Community and Support: Blynk IoT boasts a vibrant and supportive community of developers, makers, and enthusiasts. The community actively shares projects, tutorials, and resources, making it a valuable source of inspiration and knowledge for users. Blynk also provides extensive documentation, tutorials, and a support forum to assist users in their IoT development journey.

Blynk IoT simplifies the process of developing IoT projects by offering an intuitive interface, cloud connectivity, customizable dashboards, and a rich set of features. With its extensive library of widgets, data visualization capabilities, and remote-control functionality, Blynk empowers users to create powerful and interactive IoT applications without the need for extensive coding expertise. Blynk IOT is a cloud supporting software used in several IOT application. Blynk support most of the ESP Series chips and also helps create a front-end user interface for controlling the Agro

spider bot with minimal programming. The Blynk IOT support cloud storage that can be useful for future modification for preparing analytics for the sensed data and creating future prediction for crop growth

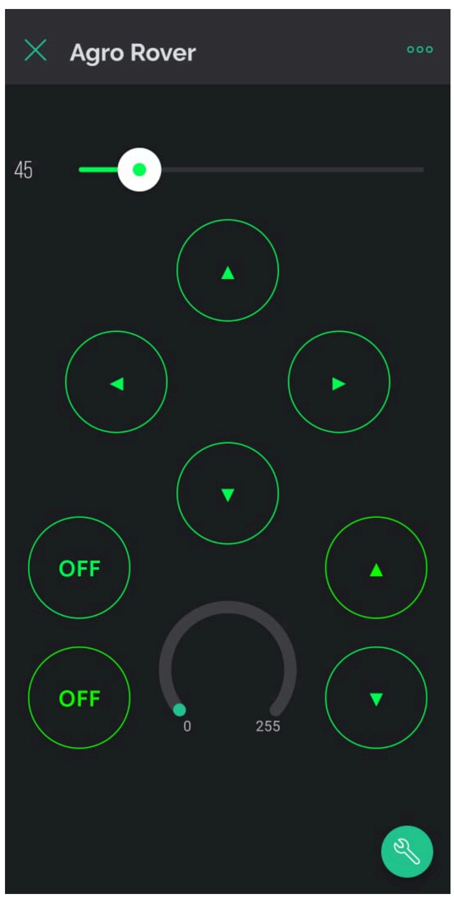


Fig.3.6: Blynk IOT

CHAPTER 4

COMPONENTS USED

4.1 ESP 32

ESP32 is a series of low-cost, low-power system on a chip microcontrollers with integrated Wi-Fi and dual-mode Bluetooth. The ESP32 series employs either a Tensilica Xtensa LX6 microprocessor in both dual-core and single-core variations, Xtensa LX7 dual-core microprocessor or a single-core RISC-V microprocessor and includes built-in antenna switches, RF balun, power amplifier, low-noise receive amplifier, filters, and power-management modules. ESP32 is created and developed by Espressif Systems, a Shanghai-based Chinese company, and is manufactured by TSMC using their 40 nm process. It is a successor to the ESP8266 microcontroller.

This module is used for the processing and the transmitting purpose trough Wi-Fi. This is taken and used as the main processor in the rover. All the sensor data, rover movement communication, actuator movement, speaker control is done using this module.This works in sync with the blynk server to enable seemless WiFi control.

Fig.4.1: ESP 32

The ESP32 is a versatile and widely used microcontroller development board that offers a powerful combination of features for IoT (Internet of Things) projects. Here's a description of the ESP32: The ESP32 is based on the ESP-WROOM-32 module, which integrates a dual-core Tensilica Xtensa LX6 processor, Wi-Fi and Bluetooth connectivity, and a wide range of peripherals. It is designed to provide a low-cost and efficient solution for building connected devices and IoT applications.

Key Features:

1.Microcontroller: The ESP32 is powered by a dual-core 32-bit Xtensa LX6 processor, clocked at up to 240 MHz, offering high computing power for handling complex tasks.

2.Wi-Fi and Bluetooth: It features built-in Wi-Fi 802.11 b/g/n/e/i connectivity, allowing devices to connect to local networks and the internet. Additionally, it supports Bluetooth Classic and Bluetooth Low Energy (BLE), enabling seamless communication with other devices and sensors.

3.GPIO Pins: The ESP32 offers a large number of General-Purpose Input/Output (GPIO) pins, which can be configured as digital inputs or outputs, analog inputs, PWM (Pulse Width Modulation) outputs, or specialized interfaces such as I2C, SPI, UART, and more. This allows for the connection and control of various sensors, actuators, and peripherals.

4.Memory: It provides a generous amount of onboard memory, including up to 520 KB of SRAM (Static Random-Access Memory) for program execution and data storage. Additionally, it offers external SPI flash memory for storing larger amounts of data.

5.Power Management: The ESP32 incorporates efficient power management features, allowing for low-power operation to conserve energy. It supports multiple sleep modes, wake-up triggers, and offers fine-grained control over power consumption.

6.Development Environment: The ESP32 is widely supported by popular development tools such as Arduino IDE, PlatformIO, and ESP-IDF (Espressif IoT Development Framework). These tools provide a familiar and easy-to-use platform for programming and debugging ESP32-based projects.

7.Wide Application Range: With its powerful features and connectivity options, the ESP32 is suitable for a wide range of applications, including home automation, smart devices, industrial automation, wearables, robotics, and more.

The ESP32 has gained significant popularity in the maker and IoT communities due to its affordability, versatility, and extensive documentation and support.

4.2 L298N DRIVER MODULE

The L298N is a popular motor driver integrated circuit (IC) that provides a convenient and efficient solution for controlling DC motors and stepper motors. The L298N driver is a dual H-bridge motor driver IC, which means it can control two motors independently or a single motor bidirectionally. It is commonly used in robotics, automation, and various motor control applications.

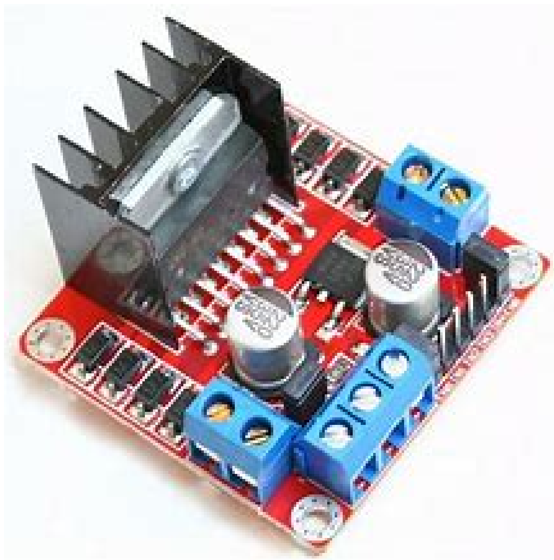


Fig.4.2: L298N Driver

Key Features:

1. Motor Control: The L298N driver is designed to control both DC motors and stepper motors. It can handle a wide range of motor voltages (up to 46V) and currents (up to 2A per channel). With its H-bridge configuration, it enables forward, reverse, and braking operations for DC motors, as well as precise control of stepper motors.

2. H-Bridge Configuration: The L298N incorporates two integrated H-bridges, allowing independent control of two motors. Each H-bridge consists of four power MOSFETs (Metal-Oxide-Semiconductor Field-Effect Transistors) that can switch the motor's direction and control its speed. This configuration provides bidirectional control, enabling the motor to rotate clockwise or counterclockwise.

3. Built-in Protection Mechanisms: The L298N offers built-in protection features to prevent damage to the IC and the connected motors. It includes internal diodes for flyback voltage protection, which are important for driving inductive loads such as motors. Additionally, it has thermal shutdown protection to prevent overheating during prolonged use.

4. Enable and Control Pins: The L298N driver has separate enable pins for each motor, allowing individual motor activation. It also provides control inputs that accept PWM (Pulse Width Modulation) signals to control the motor speed. By modulating the PWM signal, the motor's speed can be adjusted smoothly.

5. Simple Interface: The L298N driver offers a straightforward interface, making it easy to integrate into various projects. It uses logic-level inputs for control signals, and the motor connections are made through screw terminals, making it convenient to connect and disconnect motors.

6. Widely Available and Documented: The L298N is a widely available motor driver IC, and it is supported by numerous resources, including datasheets, application notes, and example code. This makes it easier for both beginners and experienced engineers to utilize the driver effectively.

The L298N driver is a versatile and reliable motor driver IC that provides efficient motor control for a range of applications. Its dual H-bridge configuration, high voltage and current capabilities, along with built-in protection mechanisms, make it a popular choice among hobbyists, students, and professionals working with motor control projects.

4.3 LITHIUM ION BATERY

A lithium-ion is a type of rechargeable battery which uses the reversible reduction of lithium ions to store energy.6 cells are used to make a total voltage of 6V.This pack is used to power the Agro Spider Bot.

Fig.4.3: Lithium-ion Battery cells

Lithium-ion cells, often referred to as Li-ion cells, are rechargeable energy storage devices widely used in various electronic devices, portable electronics, electric vehicles, and renewable energy systems. Here's a description of lithium-ion cells:

1. Chemistry: Lithium-ion cells are based on a specific type of rechargeable battery chemistry known as lithium-ion technology. They typically use lithium cobalt oxide ($LiCoO_2$), lithium iron phosphate ($LiFePO_4$), lithium manganese oxide ($LiMn_2O_4$), or lithium nickel cobalt aluminum oxide ($LiNiCoAlO_2$) as the cathode material. The anode is usually made of graphite.

2. High Energy Density: One of the key advantages of lithium-ion cells is their high energy density. They provide a higher energy-to-weight ratio compared to other rechargeable battery technologies, making them lightweight and suitable for portable devices that require long battery life.

3. Rechargeability: Lithium-ion cells are rechargeable, allowing them to be used repeatedly by recharging the cell's energy through an appropriate charging mechanism. This feature makes them more cost-effective and environmentally friendly compared to single-use disposable batteries.

4. Low Self-Discharge: Lithium-ion cells have a lower self-discharge rate compared to other rechargeable batteries, such as nickel-based batteries. This means they can retain their charge for a longer period when not in use, making them ideal for applications that require longer shelf life.

5. Voltage and Capacity: A typical lithium-ion cell has a nominal voltage of 3.6 to 3.7 volts, which remains relatively constant until it reaches the end of its charge. The capacity of a lithium-ion cell is usually measured in milliampere-hours (mAh) and determines how long the cell can power a device before requiring recharging.

6. Charging and Discharging: Lithium-ion cells require specific charging and discharging protocols to ensure safe and efficient operation. Overcharging or discharging below a certain voltage threshold can lead to reduced performance, shortened lifespan, or even safety hazards. Therefore, dedicated battery management systems (BMS) are commonly used to monitor and control the charging and discharging processes.

7. Safety Considerations: While lithium-ion cells are generally safe when used correctly, mishandling or improper charging can result in overheating, fire, or even explosion. To enhance safety, manufacturers implement various safety features such as thermal

protection, overcurrent protection, and built-in circuitry to prevent overcharging or short circuits.

8. Environmental Impact: Lithium-ion cells are considered more environmentally friendly than disposable batteries due to their reusability. However, their production and disposal require proper management to minimize potential environmental impacts, including the responsible handling of hazardous materials.

Lithium-ion cells have revolutionized portable electronics and energy storage systems, providing efficient, lightweight, and rechargeable power solutions. Ongoing research and development continue to improve their performance, lifespan, and safety, making them an essential component in the advancement of modern technology.

4.4 BUZZER

Fig.4.4: Buzzer

A buzzer or beeper is an audio signaling device, which may be mechanical , electro-mechanical, or piezoelectric (piezo for short). Typical uses of buzzers and beepers include alarm devices, timers, train and confirmation of user input such as a mouse click or keystroke.

A piezoelectric buzzer is a type of audio transducer that converts electrical energy into sound waves through the piezoelectric effect. It is a compact and widely used device known for its simplicity, efficiency, and reliability. Here's a description of a piezoelectric buzzer:

1. Piezoelectric Effect: The operation of a piezoelectric buzzer is based on the piezoelectric effect exhibited by certain materials, such as quartz, ceramic, or some

polymers. When an electrical voltage is applied to these materials, they undergo mechanical deformation or vibrations, producing sound waves.

2. Construction: A piezoelectric buzzer typically consists of a piezoelectric element or disk sandwiched between two metal plates or electrodes. The piezoelectric element is usually made of a ceramic material, and the electrodes serve to apply an electrical voltage across the element.

3. Operating Principle: When an alternating current (AC) voltage is applied to the electrodes of the piezoelectric buzzer, the piezoelectric material experiences rapid expansions and contractions due to the polarity changes of the voltage. This mechanical deformation creates pressure waves or vibrations in the surrounding medium, generating audible sound waves.

4. Sound Generation: The rapid oscillation of the piezoelectric element produces high-frequency sound waves, typically in the range of a few kilohertz to several tens of kilohertz. The specific frequency and intensity of the sound generated depend on factors such as the material used, the shape and size of the piezoelectric element, and the applied voltage.

5. Efficiency and Reliability: Piezoelectric buzzers are known for their high efficiency in converting electrical energy into sound. They offer a wide frequency range, fast response times, and low power consumption. Additionally, they have no moving parts, making them more durable and resistant to environmental factors such as shock, vibration, and temperature variations.

6. Mounting Options: Piezoelectric buzzers are available in various form factors, including through-hole mount, surface mount, or panel mount configurations. This versatility allows for easy integration into different electronic devices, appliances, alarms, or notification systems.

7. Applications: Piezoelectric buzzers find applications in a wide range of fields, including consumer electronics, automotive systems, medical devices, industrial equipment, security systems, and more. They are commonly used for audible alarms, timers, alerts, notifications, and feedback signals in various devices and systems.

8. Control and Driving Circuitry: Piezoelectric buzzers require a driving circuit to provide the appropriate voltage and frequency for sound generation. The driving circuit ensures

that the AC voltage applied to the buzzer matches its resonance frequency for optimal performance.

In summary, a piezoelectric buzzer is a compact and reliable audio transducer that utilizes the piezoelectric effect to generate sound waves. Its efficiency, durability, and wide frequency range make it suitable for various applications where audible alerts, alarms, or notifications are required. Whether in consumer electronics or industrial applications, piezoelectric buzzers play a vital role in providing clear and distinct sound signals.

4.5 LM2596 VOLTAGE REGULATOR

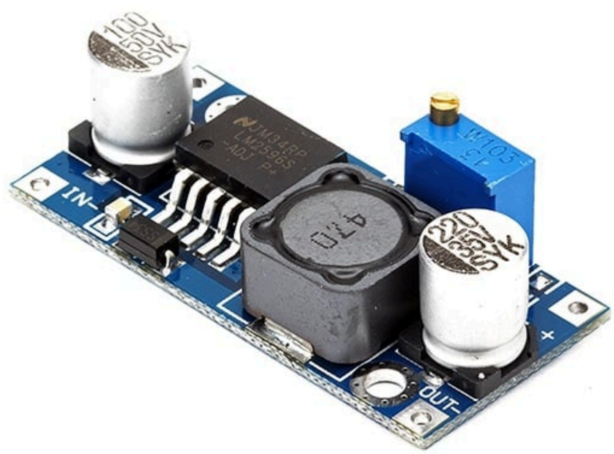


Fig.4.5: LM2596 Voltage Regulator

The LM2596 is a popular voltage regulator integrated circuit (IC) that provides a reliable and efficient solution for step-down (buck) voltage regulation.The LM2596 voltage regulator is a versatile and widely used IC designed to convert a higher input voltage into a lower output voltage with minimal power dissipation. It is commonly used in electronic devices, power supplies, battery chargers, and various other applications requiring stable and regulated power.

Key Features:

1. Step-Down Voltage Regulation: The LM2596 is specifically designed for step-down voltage regulation, allowing it to convert higher input voltages into lower output voltages. It operates as a buck converter, which means it efficiently reduces the voltage difference between the input and output.

2. Adjustable Output Voltage: The LM2596 offers adjustable output voltage, allowing users to set the desired output voltage level based on their specific requirements. This adjustable feature makes it highly flexible and suitable for a wide range of applications.

3. Wide Input Voltage Range: The LM2596 can accept a wide range of input voltages, typically from 4.5V to 40V. This broad input voltage range makes it compatible with various power sources, including batteries, power adapters, and automotive power systems.

4. High Efficiency: The LM2596 is known for its high efficiency in converting power. It achieves this efficiency through its switching regulator design, minimizing power dissipation and heat generation. This makes it an ideal choice when power efficiency is a concern.

5. Current Limit and Thermal Protection: The LM2596 includes built-in current limit and thermal protection mechanisms to ensure safe operation. The current limit protects against excessive current draw, while the thermal protection prevents the IC from overheating by reducing the output current if the temperature exceeds a specified threshold.

6. Simple Design and Low Component Count: The LM2596 requires only a few external components to operate effectively, making it relatively easy to integrate into electronic circuits. This simplicity of design, along with its wide availability and extensive documentation, contributes to its popularity among engineers and hobbyists.

7. Multiple Package Options: The LM2596 is available in different package options, such as TO-220, TO-263, and SMD packages. This provides flexibility in choosing the most suitable package for specific application requirements and PCB design considerations.

The LM2596 voltage regulator is a reliable and efficient solution for step-down voltage regulation. Its adjustable output voltage, wide input voltage range, high efficiency, and built-in protection features make it a popular choice for a wide range of electronic projects and power supply applications.

4.6 DRV 8825 STEPPER MOTOR DRIVER

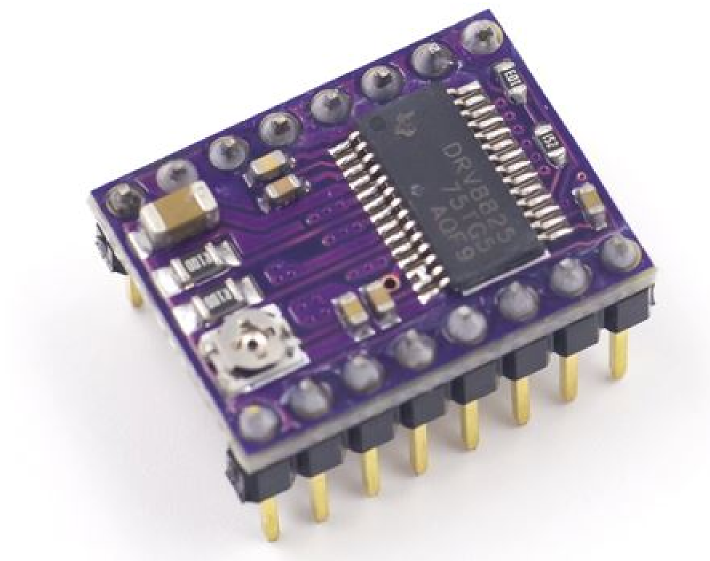


Fig.4.6: DRV 8825 Driver

The DRV8825 is a popular stepper motor driver integrated circuit (IC) that provides precise and efficient control for bipolar stepper motors. The DRV8825 is a versatile and widely used stepper motor driver IC designed for controlling bipolar stepper motors. It offers high performance and advanced features, making it suitable for various applications, including 3D printers, CNC machines, robotics, and automation systems.

Key Features:

1. Microstepping Control: The DRV8825 driver supports microstepping, allowing for finer motor control and smoother motion. It offers up to 1/32-step resolution, enabling precise positioning and reduced vibration compared to standard full-step or half-step operation.

2. Current Control: The DRV8825 provides adjustable motor current control, allowing users to set the desired current limit based on the specific motor and application requirements. This feature ensures optimal motor performance and prevents excessive current draw, protecting the motor and driver from damage.

3. High Current Handling: The DRV8825 is capable of driving stepper motors with high current requirements. It can handle continuous motor currents up to 2.5A (with proper cooling) and peak currents up to 3.2A, making it suitable for driving a wide range of stepper motors.

4. Thermal Protection: The DRV8825 includes built-in thermal shutdown circuitry to prevent the IC from overheating. If the temperature exceeds a certain threshold, the driver

automatically reduces the current to protect itself from thermal damage. This feature ensures safe and reliable operation even under demanding conditions.

5. Simple Step and Direction Interface: The DRV8825 offers a straightforward step and direction interface, making it easy to integrate into stepper motor control systems. It accepts step and direction signals from a microcontroller or other control circuitry to determine the motor movement and direction.

6. Full Fault Protection: The DRV8825 driver incorporates comprehensive fault protection features to ensure system reliability. It includes protection against short circuits, overcurrent, and undervoltage conditions, safeguarding the motor, driver, and other connected components.

7. Compatibility and Availability: The DRV8825 is widely compatible with various microcontrollers, development boards, and control systems. It is available in a convenient and compact package, making it easy to use and integrate into different electronic projects.

The DRV8825 stepper motor driver offers precise control, high current handling, and advanced features for driving bipolar stepper motors. Its ability to support microstepping, adjustable current control, and built-in protection mechanisms make it a popular choice among hobbyists, makers, and professionals working with stepper motor-driven applications.

4.7 NEMA 17 STEPPER MOTOR

Fig.4.7: NEMA 17 Stepper motor

The NEMA 17 stepper motor is a widely used and popular type of stepper motor known for its compact size, high torque, and precise control. The NEMA 17 stepper motor belongs to the National Electrical Manufacturers Association (NEMA) standard series of stepper motors. It has a square-shaped flange with dimensions of approximately 42.3mm x 42.3mm, hence the "17" in its name, which refers to the 1.7-inch flange size.

Key Features:

1. Compact Size: The NEMA 17 stepper motor is known for its compact form factor, making it suitable for applications where space is limited. Its small size allows for easy integration into various devices and machinery.

2. Bipolar Configuration: The NEMA 17 stepper motor typically operates in a bipolar configuration, which means it requires an H-bridge or dedicated stepper motor driver to control its movement. It has four wires, with two coils that can be energized independently, enabling precise control over its rotation.

3. High Torque: Despite its compact size, the NEMA 17 stepper motor offers relatively high torque output. The torque can vary depending on the specific model and winding configuration, but in general, NEMA 17 motors are capable of delivering enough torque to drive small to medium-sized loads effectively.

4. Step Angle: The NEMA 17 stepper motor typically has a step angle of 1.8 degrees per step. This means it requires 200 steps to complete one full revolution (360 degrees). The 1.8-degree step angle allows for precise positioning and control, making it suitable for applications that require accuracy.

5. Holding Torque: The NEMA 17 stepper motor has a holding torque that helps it maintain its position when not rotating. Holding torque refers to the amount of torque the motor can generate to resist external forces, such as friction or load torque, when the motor is stationary.

6. Versatility: The NEMA 17 stepper motor finds applications in a wide range of industries and projects. It is commonly used in 3D printers, CNC machines, robotics, automation systems, camera gimbals, and other applications that require precise and controlled motion.

7. Availability: The NEMA 17 stepper motor is widely available from various manufacturers and suppliers. It is compatible with a range of stepper motor drivers and control systems, allowing for easy integration into different projects.

The NEMA 17 stepper motor's compact size, high torque, and precise control make it a popular choice for various applications where accurate positioning and controlled motion are required. Its versatility and availability, along with its compatibility with stepper motor drivers, have made it a preferred choice among hobbyists, makers, and professionals working with motion control systems.

4.8 WATER LEVEL DETECTOR

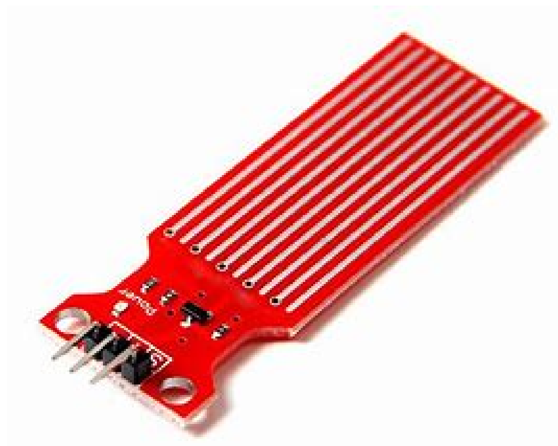


Fig.4.8: Water level detector

Water sensor water level sensor is an easy-to-use, cost-effective high level or drop recognition sensor, which is obtained by having a series of parallel wires exposed traces measured droplets or water volume in order to determine the water level. Easy to complete water to analog signal conversion and output analog values can be directly read Arduino development board to achieve the level alarm effect.

Operating voltage: Dc3-5v operating current:

Less than 20ma

sensor type: Analog

detection area: 40mmx16mm

production process: Fr4

double-sided has operating temperature: 10 and #x2103; -30 and #x2103;

humidity: 10 percent -90 percent non-condensing

product dimensions: 60mmx20mm

package include: S: 1 x sensor module.

4.9 DC MOTORS

A mini DC motor, also known as a miniature DC motor, is a small-sized electric motor that operates on direct current (DC) power. It is designed to convert electrical energy into mechanical motion, making it useful in a wide range of applications where compact size and low power consumption are important factors.

Here's a description of the key features and components of a typical mini DC motor:

1. Construction: A mini DC motor typically consists of several components, including a rotor (armature), a stator, magnets, brushes, and a housing. The rotor is the rotating part of the motor, while the stator provides a stationary magnetic field. The magnets are often located on the rotor or the stator to create the necessary magnetic forces for motor operation.

2. Commutation: Mini DC motors use a commutation system to control the flow of electric current and maintain continuous rotation. This is typically achieved through the use of carbon brushes and a commutator. The carbon brushes make contact with the commutator, which consists of copper segments connected to the rotor winding. As the rotor spins, the brushes change contact from one segment to another, reversing the current flow and ensuring the motor's rotation.

3. Power Supply: Mini DC motors are designed to operate on DC power, which can be supplied from batteries, power supplies, or other DC sources. The voltage and current requirements of the motor depend on its design and intended application. It is important to provide the motor with the appropriate voltage to ensure efficient and safe operation.

4. Speed and Torque: The speed and torque characteristics of a mini DC motor depend on its design parameters, including the number of windings, magnet strength, and overall construction. By adjusting the input voltage or using additional control mechanisms, such as motor controllers or PWM (Pulse Width Modulation), the speed and torque of the motor can be regulated according to the application requirements.

5. Applications: Mini DC motors find applications in various fields, including robotics, electronics, model making, toys, automation, and more. Due to their small size, they are suitable for projects and devices where space is limited or weight constraints exist. They

are often used for tasks such as driving small mechanical components, propelling mini vehicles, operating actuators, or providing rotational motion for various mechanisms.

6. Control and Protection: Depending on the specific application, mini DC motors may require additional control and protection mechanisms, such as motor drivers, encoders for position feedback, and thermal overload protection. These features enhance the motor's performance, reliability, and safety in different operating conditions.

Mini DC motors offer a compact and efficient solution for low-power motion applications. Their simplicity, versatility, and wide availability make them popular among hobbyists, engineers, and designers who require small-scale motion systems in their projects.

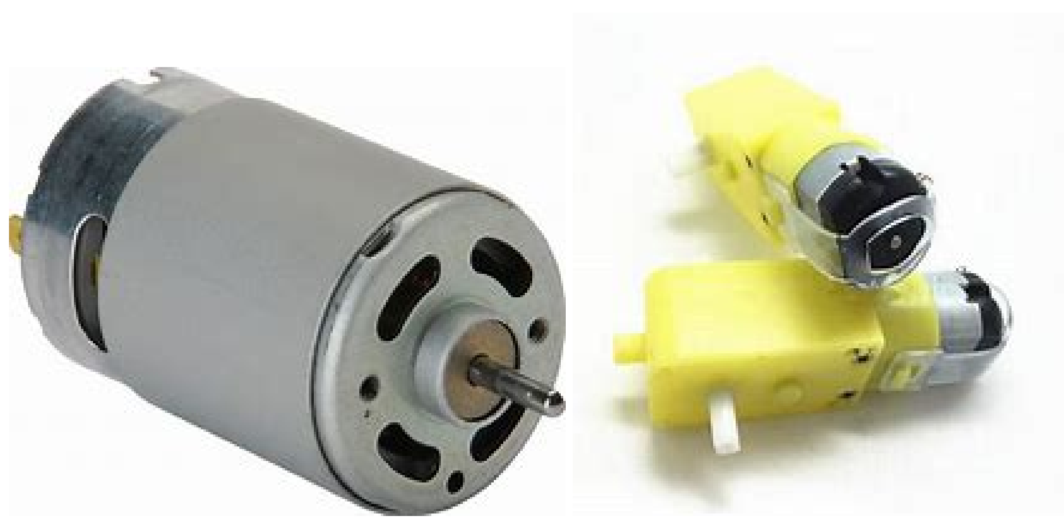


Fig.4.9: DC motors

DC geared motors are used as the actuator of the senser and the weed cutter.

A DC motor is any of a class of rotary electrical motors that converts direct current (DC) electrical energy into mechanical energy. With metal material torque dc motor is lightweight, resistant abrasion and tough features making it durable and reliable for a longer time.

- High Torque Rated Voltage Current-DC 12V
- No Load Current-0.2Amps (Max ~1.2 Amps)
- Used in numerous applications: this 12v to 24V torque gear motor perfectly fits for toys DIY, massage device, game device, game controller, cellphone etc

4.10 SOLAR PANEL

Fig.4.10: Solar panels

2 panels each of 6V are used to provide power to charge the 12v li-ion battery. A 6V solar panel is a photovoltaic module that converts sunlight into electrical energy with a maximum output voltage of 6 volts. It is commonly used in small-scale applications where low voltage is required, such as powering small electronic devices, charging batteries, or providing energy for outdoor lighting systems.

Key features and components of a typical 6V solar panel:

1. Photovoltaic Cells: The solar panel is comprised of multiple photovoltaic cells, also known as solar cells. These cells are made of semiconductor materials, such as silicon, that can generate electricity when exposed to sunlight. When sunlight strikes the cells, it creates an electric field, causing the electrons to move and generate a direct current (DC).

2. Encapsulation: The photovoltaic cells are encapsulated within a transparent, protective layer, usually made of tempered glass, to provide durability and protection against weather elements. The encapsulation also enhances the efficiency of light absorption by reducing reflection and preventing damage to the cells.

3. Electrical Contacts: The solar panel has electrical contacts attached to the photovoltaic cells. These contacts allow the generated electricity to be collected and channeled out of the panel. The contacts are typically made of conductive materials, such as metal ribbons or grids, that efficiently collect the electrical current.

4. Junction Box: A junction box is present on the back of the solar panel. It serves as a connection point for the electrical wires that are used to link the panel to external devices or to other solar panels in an array. The junction box also contains diodes that prevent reverse current flow and protect the solar panel from damage.

5. Power Output: A 6V solar panel is designed to produce a maximum output voltage of 6 volts. However, the actual output voltage can vary depending on factors such as sunlight intensity, temperature, and the load connected to the panel. It is important to consider these variations when designing a system that uses a 6V solar panel.

6. Applications: 6V solar panels are commonly used in low-power applications, such as small solar-powered gadgets, electronic circuits, battery charging, and outdoor lighting systems. They are compact and portable, making them suitable for remote locations or situations where grid power is unavailable.

When using a 6V solar panel, it is important to consider the energy requirements of the intended application and select the appropriate charge controller or battery system to ensure proper utilization and storage of the generated solar energy.

Overall, a 6V solar panel offers a convenient and environmentally friendly solution for harnessing solar energy and can be utilized in various small-scale applications that require low voltage power.

CHAPTER 5

WORKING

5.1 BLOCK DIAGRAM

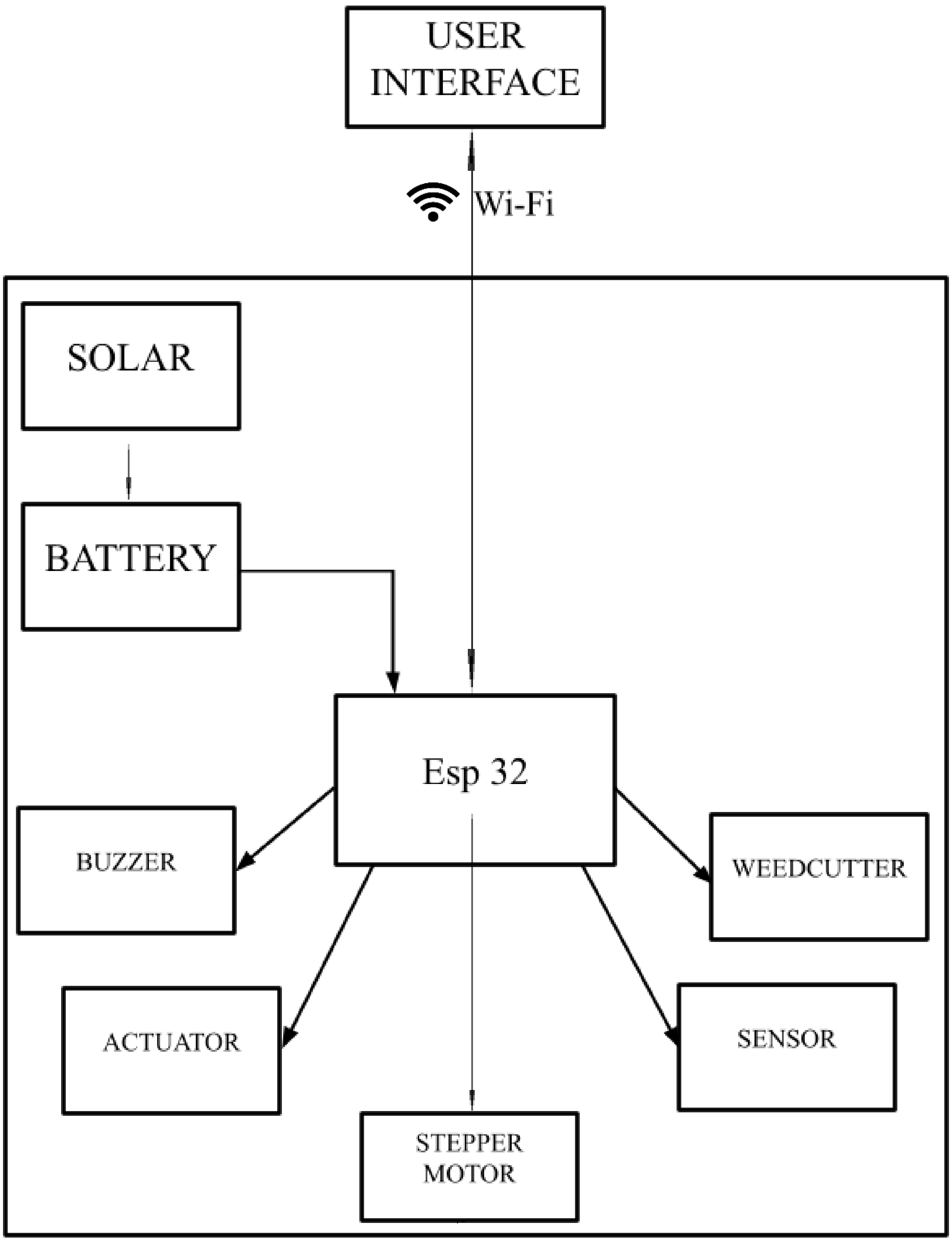


Fig.5.1: Block diagram of the Agro spider bot

These above said modules are used as processors and communicators. The ESP 32 chip have the ability to communicate through Wi-Fi to connect to the IoT platform. It is connected to Blynk App through Wi-Fi. The user has different commands in the form of virtual switches to control the rover as well as the motor relay. The main processor used here is the ESP. It is commonly used only as a Wi-Fi communicator but it also has the ability to process data with 4mb of internal RAM. All the sensor data is sent to this ESP after reading it through the sensor. The user can control the bot through the virtual switches in the app and decide the path of the bot. When using the switches, signals are sent to the ESP that activates the motor driver module. This driver module drives the eight legs of the rover.

When the user needs to know the water level of a particular place, he/she just have to press a switch in the app that makes the actuator go down so that the sensor is in contact with the ground to measure the water level. The sensor data is fed to the ESP and then from there to the mobile interface. After getting the data we can press the other switch to retract the actuator arm to its original place. Now the sensor is safe and the rover can be moved again. These actions are controlled by an L298N Driver IC that is supervised by the ESP. There is also a switch that can control a speaker on it to produce an ultra-sonic sound to scare the pests away from the crops. This can be controlled manually by the app or has a timed switch on & off function in the program. This automatically switches on & off the speaker in particular time intervals.

The rover works according to the data given by the user through their mobile interface which is interpreted by the ESP 32 and moves the motor accordingly. The ESP 32 can be considered as the brain or processor of the whole project. This is what enables the Wi-Fi connectivity between the bot and the mobile. When a signal is given to the mobile (say move forward), the data I received in the ESP 32. The ESP 32 then decides the necessary motors that needs to be energized to fulfil the command. The steps and the direction of the motor can be specified by altering the signal frequency given to the DRV8825 driver from ESP 32. The ESP 32 is also connected to several other devices such as buzzer, actuator, senser, and weed cutter. These devices can be controlled and monitored via the mobile interface.

6.2 CONNECTION DIAGRAM OF THE AGRO SPIDER BOT

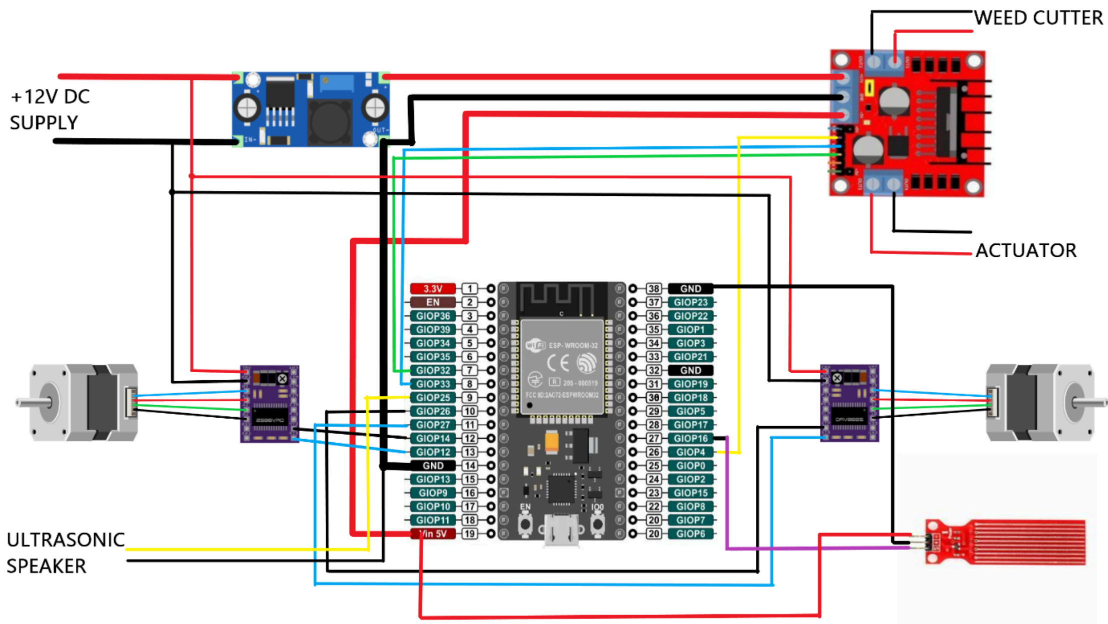


Fig.5.2: Connection Diagram of the Agro spider bot

The above is the connection diagram of the Agro spider bot. The incoming 12v supply is regulated to 7v dc using LM2596 voltage regulator an is supplied to the L298N motor driver to drive the actuator and the weed cutter. This chip also regulates the incoming voltage to 5V DC which is supplied to the ESP 32. Output pins from ESP 32 are connected to he L298N motor driver to control the motors. Pins are also connected to the ultra-sonic speaker(buzzer). The stepper motor drivers are given signals from the ESP 32 for controlling the steps and direction of the respective stepper motors but is powered directly from the 12V DC voltage.

A solar panel is also mounted on top of the lid to charge the battery from solar energy when the battery level reaches a least threshold. Then the bot goes through standby mode and charges the battery. It can also be charged externally.

The bot has a weed remover in front of the front of the bot. It is a blade that cut the weeds between the crops.

The rover also has ultrasonic sound speakers which scare away the pest. This sound is above the frequency 65khz and is inaudible to the human ear, thus it is not disturbing to nearby residents. The speaker is switched ON and OFF periodically or also can be manually switched ON or OFF by user straight away.

There are actuators in the rover which help in moving up or down the sensors which help in sensing the soil status. This up and down movement is needed in-order to safe keep the sensors while not in use without touching the soil. All the control is by the BLYNK app controlled by the user. The Blynk app is programmed with all the necessary virtual buttons for the rover and motor relay function

6.2 MECHANICAL COMPONENTS

The Agro spider bot uses spider like legs instead of round tyres to reduce the footprint on the ground to reduce the disturbance on the crop. It also allows to climb rough terrain that was impossible for tyres to scale

The body of t is made of sheet metal and is folded to make its shape.

The Agro spider bot works on the principle called Theo jansen mechanism to convert the stepper motor drive into the leg like motion that mimics that of the movement of an animal

The Theo Jansen mechanism, also known as the Strandbeest mechanism, is a captivating and innovative mechanical linkage system designed by Dutch artist and engineer Theo Jansen. This mechanism is inspired by the locomotion of animals and aims to create lifelike walking movements in large-scale kinetic sculptures. Theo Jansen's mechanism is primarily constructed using a series of interconnected rods, levers, and joints. The mechanism imitates the walking motion of animals, particularly those found in the arthropod family, such as insects and crabs. It employs a unique combination of rotational and translational motions to achieve its remarkable locomotion.

Key Features:

1. Kinetic Walking Motion: The primary objective of the Theo Jansen mechanism is to create lifelike walking motion. By utilizing a complex arrangement of linkages, it achieves a coordinated movement resembling the legs of a walking creature. This intricate motion is driven by the transfer of energy from one linkage to another, generating an impressive and captivating display.

2. Artistic Design: The Theo Jansen mechanism is not merely a functional system; it is also an artistic creation. Theo Jansen has utilized his engineering skills to design large-scale sculptures that incorporate the mechanism, resulting in stunning and visually appealing kinetic art installations. These sculptures can be seen gracefully traversing beaches and other outdoor environments.

3. Wind-Powered Locomotion: One of the distinguishing features of the Theo Jansen mechanism is its ability to harness wind energy for locomotion. By incorporating large wind-catching sails or propellers, the sculptures can capture the force of the wind and convert it into rotational motion, propelling the mechanism and enabling its walking action.

4. Self-Sustainability: The Theo Jansen mechanism exhibits a self-sustaining behavior due to its wind-driven locomotion. The captured wind energy not only powers the movement but can also be used to charge internal storage systems, such as pneumatic or hydraulic systems, enabling the sculpture to continue its motion even when the wind subsides.

5. Evolutionary Adaptability: Theo Jansen's vision for his creations goes beyond static sculptures. He envisions a form of artificial life, where the mechanisms evolve and adapt over time. His sculptures incorporate mechanisms that respond to changes in their environment, such as avoiding obstacles or adapting to changing wind conditions, showcasing a remarkable blend of engineering and biology.

The Theo Jansen mechanism represents a unique fusion of engineering, art, and nature-inspired design. Its intricate linkages and complex motion capture the imagination of viewers, showcasing the possibilities of combining mechanical engineering with artistic expression. The Theo Jansen mechanism has garnered worldwide acclaim for its beauty, ingenuity, and ability to evoke a sense of wonder and fascination..

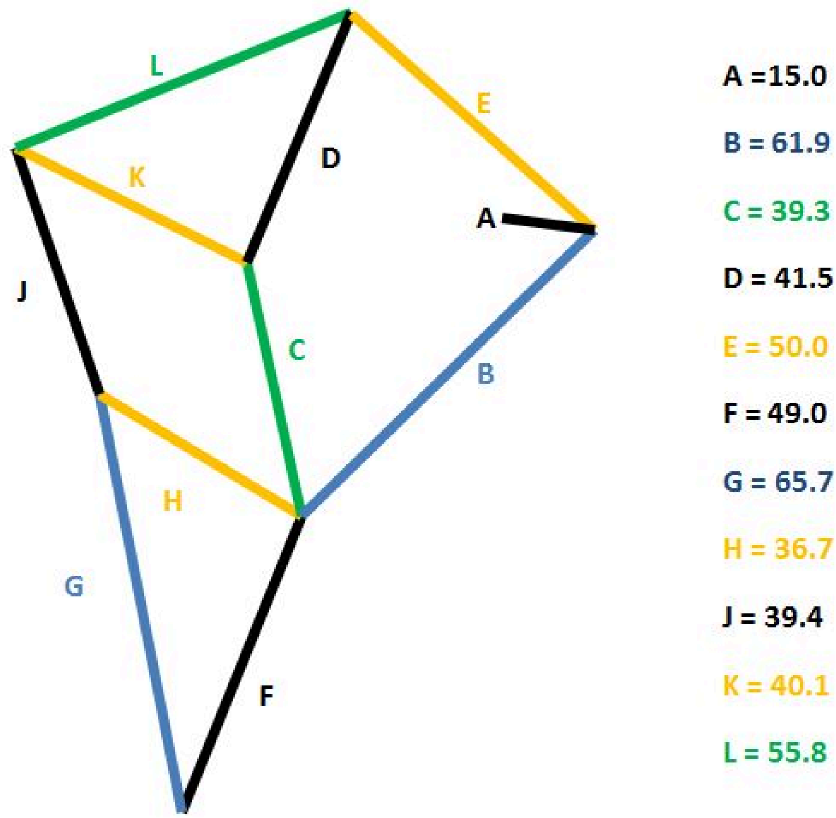


Fig.5.3: Theo Jansen Dimension

The central 'crank' link moves in circles as it is actuated by a rotary actuator such as an electric motor. All other links and pin joints are unactuated and move because of the motion imparted by the crank. The limbs of the Theo-jansen mechanism is made up of a material called aluminium composite , since it is lighter and easy to use. A stud bolt was used to fix the centre of each leg and fastened in place using bolts.

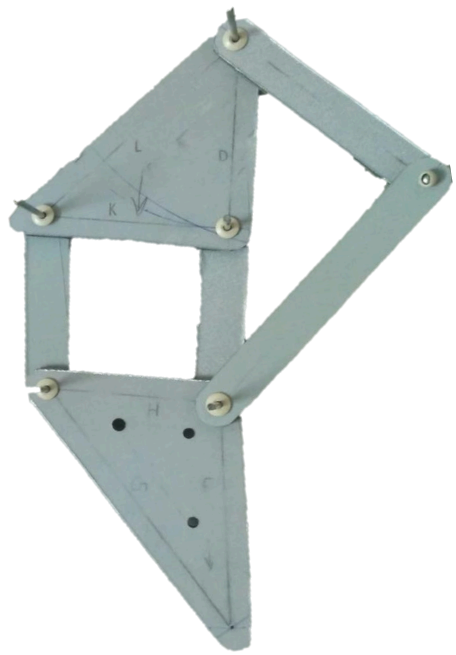


Fig.5.4: First prototype of the leg

The limbs are kept in place by using aluminium rivets since the limbs require to move freely. The drive from the stepper motors is transferred to the rotary part of the legs using 3 plastic gears.

CHAPTER 6

IMAGES OF THE AGRO SPIDER BOT

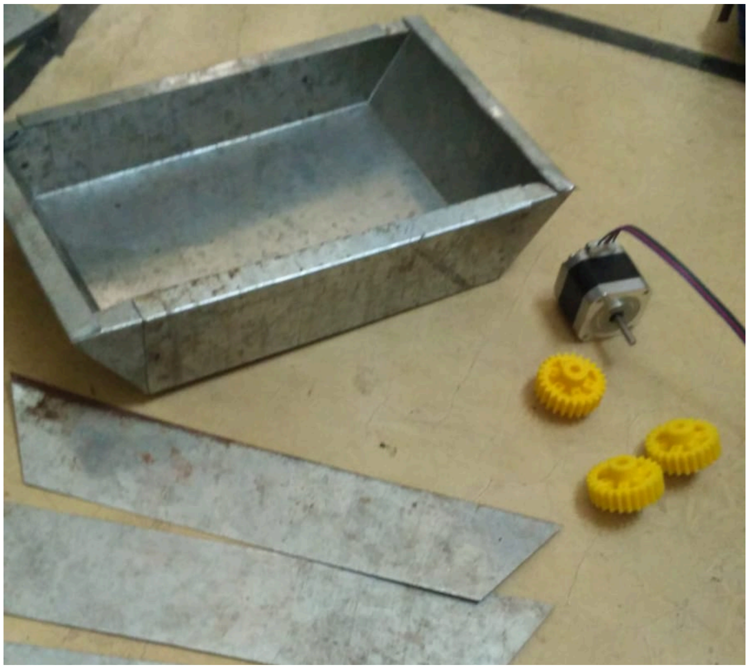


Fig.6.1: Parts before assembling

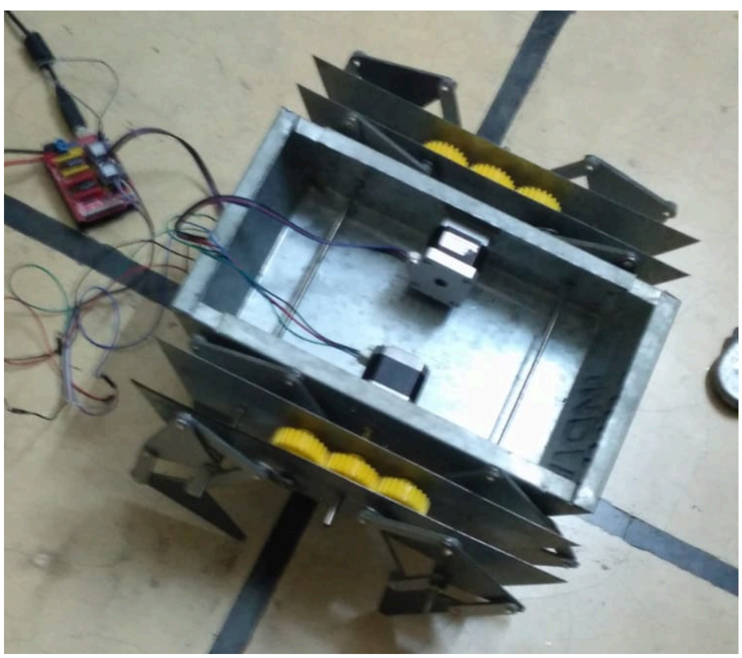


Fig.6.2: After assembling legs

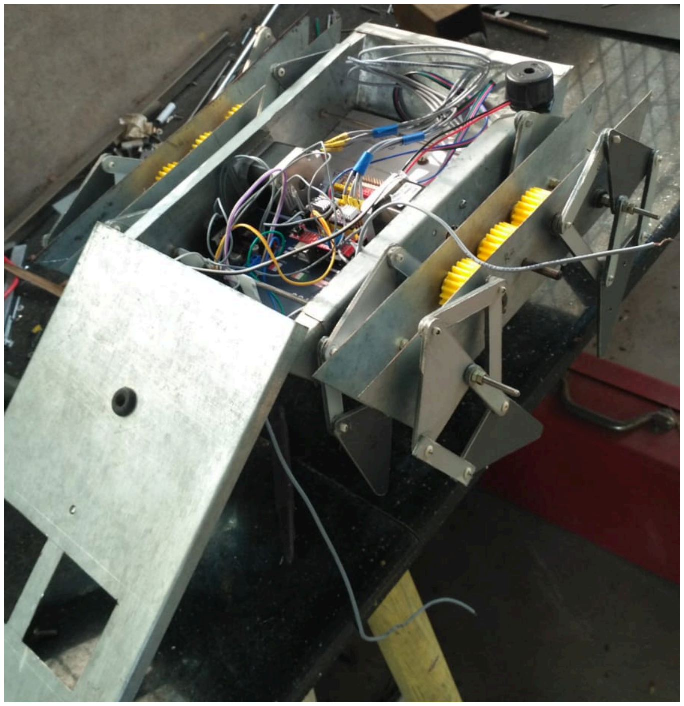


Fig.6.3: After assembling the electronic components

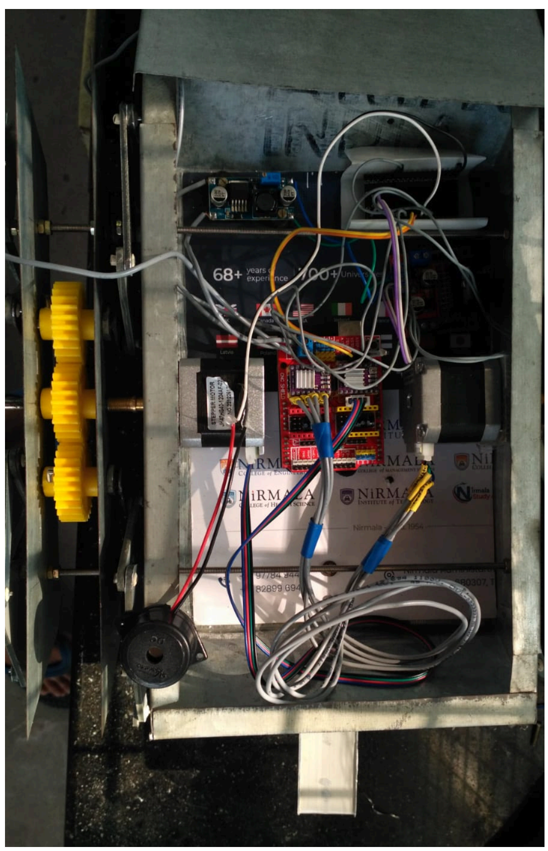


Fig.6.4: Top view of the bot

Fig.6.5: Finished picture of Agro spider bot

CHAPTER 7

TOTAL BUDGET

Table.7.1: Total budget

Sl No.	COMPONENTS	QUANTITY	COST (in rupees)
1	ESP 32	1	600
2	NEMA 17 STEPPER MOTOR	4	2800
3	DRV 8825 STEPPER MOTOR DRIVER	4	800
4	SPUR GEAR	6	300
5	CNC DRIVER BOARD	1	150
6	LI-ION BATTERY	1	1500
7	LI-ION CHARGER	1	1500
8	LM2596VOLTAGEREGULATOR	1	200
9	DC MOTOR	2	150
10	LM298N DRIVER	1	200
11	BUZZER	1	35
12	WATER LEVEL SENSOR	1	50
13	SOLAR PANEL	2	250
14	JUMPER WIRE AND OTHER CONNECTORS	-	100
15	ALUMINIUM COMPOSITE BOARD	1	500
16	RIVET	70	70
17	BODY	1	6000
18	SS ROD AND NUTS	1	400
19	TAP SET	2	200
20	MISCELLANEOUS EXPENSES	-	3395
	TOTAL		19,200/-

Several product used in the project was purchased from online shopping websites such as the following:

- www.amazon.in
- www.robu.in
- https://sharvielectronics.com

And some other parts were bought locally.

CHAPTER 8

FUTURE MODIFICATION

Like any other project there can be endless modification and features that can be integrated into the bot. However we have a couple of ideas on future modifications. Few of them are listed below:

8.1ADDITION OF ESP 32-CAM

The usage of the ESP 32 cam module integrates the feature of getting a live video feed from the Agro spider bot straight to the Blynk app. This enables the user to control the robot without actually being near the field. We can also use the bot just for monitoring purposes

The ESP32-CAM is a versatile and compact development board based on the ESP32 system-on-a-chip (SoC) with integrated Wi-Fi and a camera module. It combines the power of the ESP32 microcontroller with the convenience of a camera, making it an excellent choice for a wide range of applications that involve image and video processing. Here's a description of the ESP32-CAM:

1. ESP32 Microcontroller: At the heart of the ESP32-CAM is the ESP32 SoC, which features a powerful dual-core processor, ample memory, and built-in Wi-Fi and Bluetooth capabilities. The ESP32 offers excellent processing power, allowing for complex tasks such as image recognition, video streaming, and real-time processing.

2. Camera Module: The ESP32-CAM comes with a small yet capable OV2640 camera module. The camera supports a maximum resolution of 2 megapixels and can capture both still images and videos. It allows for various camera configurations, such as adjusting exposure, white balance, and image quality.

3. Storage Options: The ESP32-CAM offers different storage options for saving captured images or videos. It includes a microSD card slot, allowing you to easily expand the storage capacity and store a large number of files. Additionally, the ESP32 SoC itself provides onboard flash memory for program storage.

4. Connectivity: One of the key features of the ESP32-CAM is its built-in Wi-Fi and Bluetooth connectivity. It can connect to Wi-Fi networks, enabling wireless communication and data transfer. This connectivity is beneficial for applications

involving remote control, cloud integration, or real-time streaming of video or images.

5. GPIO Pins: The ESP32-CAM provides a set of general-purpose input/output (GPIO) pins that allow for flexible hardware interfacing. These pins can be used to connect external components, sensors, or actuators to expand the capabilities of the board. They provide digital input/output, analog input, and support for various communication protocols such as I2C and SPI.

6. Programmability: The ESP32-CAM is programmable using the popular Arduino IDE (Integrated Development Environment). The ESP-IDF (Espressif IoT Development Framework) provides a rich set of libraries and tools to facilitate the development of applications for the ESP32 platform. It allows for easy integration of the camera module and provides functions for capturing images, recording videos, and performing image processing tasks.

7. Application Possibilities: The ESP32-CAM finds applications in various domains, including surveillance systems, home automation, robotics, remote monitoring, and IoT projects. It can capture images or videos and transmit them wirelessly, making it suitable for applications involving video streaming, image recognition, or real-time visual feedback.

8. Open-Source Community: The ESP32-CAM benefits from a large and active open-source community. This community contributes libraries, examples, and tutorials, making it easier for developers to get started and leverage the full potential of the board. The community support also ensures ongoing development and improvement of the ESP32-CAM ecosystem.

In summary, the ESP32-CAM is a powerful development board that combines the capabilities of the ESP32 microcontroller with an integrated camera module. It offers extensive connectivity options, storage capabilities, and a wide range of applications. Whether you're building a surveillance system, an IoT device, or a project that involves image processing, the ESP32-CAM provides a versatile and convenient solution.

Fig.8.1: ESP 32-CAM

8.2 AUTONOMOUS TERRAIN MAPPING

This version of the bot requires the commands of the user to move around the field. Making an autonomous terrain mapping system that renders a 3d image and move accordingly will reduce the human hardship thus further automating agriculture. This enables the bot to automatically navigate around the field without human assistance.

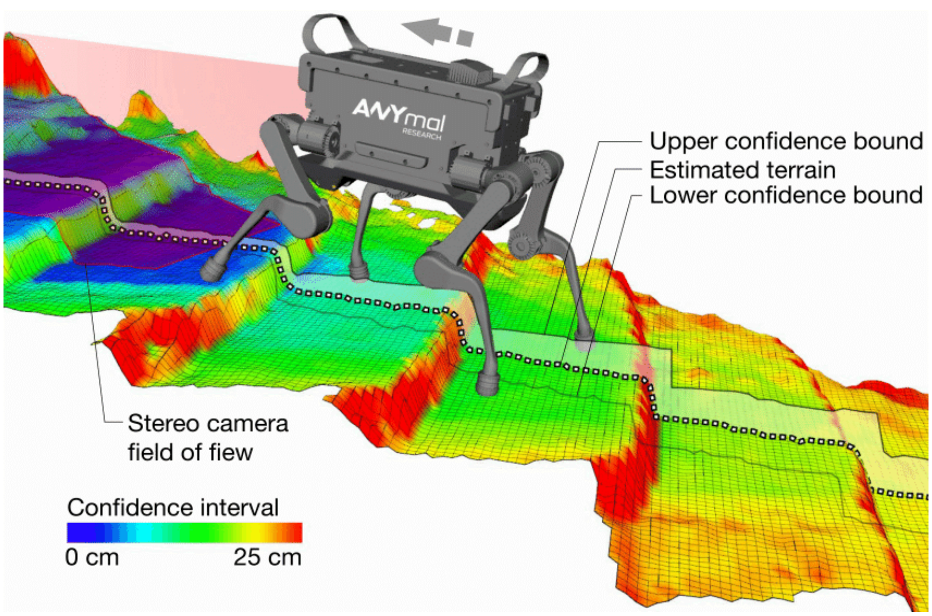


Fig.8.2: Terrain Mapping

- Terrain mapping in quadruped walking robots involves the process of collecting data about the terrain and creating detailed maps while the robot traverses over different surfaces. Quadruped robots, with their four-legged locomotion capabilities, can navigate challenging terrains and gather valuable information for various applications such as exploration, reconnaissance, and disaster response. Here's an overview of terrain mapping in quadruped walking robots:

- Sensor Systems: Quadruped walking robots are equipped with a range of sensors to perceive and gather data about the terrain they are walking on. The specific sensors used may vary depending on the robot's design and application, but common sensors include:
    - Contact Sensors: Quadruped robots often have contact sensors, such as force/torque sensors or tactile sensors, in their legs or feet. These sensors provide information about the forces and pressures exerted by the legs on the terrain, helping in detecting surface irregularities or obstacles.
    - Inertial Measurement Unit (IMU): An IMU typically consists of accelerometers, gyroscopes, and magnetometers. It provides data on the robot's orientation, motion, and acceleration, which can be used to estimate the robot's position and analyze its movement on different terrains.
    - 3D Depth Sensors: Depth sensors like LiDAR or stereo cameras are used to capture detailed 3D information about the environment. These sensors help in creating point clouds or depth maps, which can be used to generate terrain models.
    - Visual Cameras: Quadruped robots may incorporate cameras to capture visual images and videos of the terrain. These images can be used for mapping, obstacle detection, or scene understanding purposes.
- Data Acquisition and Processing: As the quadruped robot walks over the terrain, the onboard sensors collect data in real-time. The data acquired from different sensors is processed and fused together to obtain a comprehensive understanding of the terrain.
    - Sensor Fusion: Sensor fusion techniques are employed to combine data from multiple sensors, allowing for a more accurate representation of the terrain. For example, the information from the contact sensors, IMU, and depth sensors can be integrated to estimate the terrain roughness, identify obstacles, or detect changes in the terrain elevation.

- Mapping Algorithms: Various mapping algorithms, such as simultaneous localization and mapping (SLAM), can be employed to create a map of the terrain. These algorithms utilize the collected sensor data to estimate the robot's position and orientation, while simultaneously reconstructing a map of the terrain it traverses.

- Terrain Mapping and Visualization: The processed data is used to create terrain maps and visualizations that provide valuable insights into the characteristics of the environment.

  - Elevation Models: The collected depth data or point clouds can be used to generate digital elevation models (DEMs) representing the terrain's height and elevation variations. DEMs can provide valuable information about the terrain's shape, slopes, and contours.

  - Textured Maps: Visual images captured by the onboard cameras can be used to create textured maps that provide a realistic visual representation of the terrain. These maps can aid in understanding the surface texture, vegetation, or other visual features.

- Applications: Terrain mapping in quadruped walking robots finds applications in various fields. Some examples include:

  - Exploration and Reconnaissance: Quadruped robots equipped with terrain mapping capabilities can be deployed in unknown or hazardous environments to explore and map the terrain for scientific research, mapping missions, or search and rescue operations.

  - Disaster Response: These robots can be used to assess the terrain conditions in disaster-stricken areas, helping rescue teams plan their operations, identify safe paths, or locate survivors.

  - Agricultural Monitoring: Quadruped robots with terrain mapping capabilities can aid in precision agriculture by mapping fields, monitoring crop health, or detecting irrigation needs based on the terrain

8.3 SELF-BALANCING ALGORITHM

The 8 legs design provides ample support to the bot. But reducing the number of legs creates lesser footprint but compromises I the balancing. This calls for a self-balancing mechanism.

Self-balancing capabilities in quadruped robots refer to the ability of these robots to maintain stability and balance while navigating and moving on various terrains. Just like their biological counterparts, quadruped robots need to adjust their body posture and make real-time adjustments to prevent falls and maintain stability. Here's an explanation of self-balancing capabilities in quadruped robots:

1. Sensory Feedback: Quadruped robots rely on a combination of onboard sensors to gather information about their body orientation, position, and the environment. These sensors may include gyroscopes, accelerometers, inclinometers, force/torque sensors, or proprioceptive sensors embedded in the robot's joints. The sensors continuously measure relevant data and provide feedback to the robot's control system.

2. Control System: Quadruped robots utilize sophisticated control algorithms to process the sensory feedback and generate appropriate control signals. These control systems typically employ a combination of closed-loop feedback control and feedforward control techniques.

3. Posture Adjustment: To maintain balance, quadruped robots adjust their body posture by actuating their leg joints. By dynamically controlling the joint angles and leg movements, the robot can shift its center of mass and maintain stability. For example, when the robot senses a deviation from the desired orientation, it can selectively extend or retract its legs to counteract the imbalance and restore stability.

4. Gait Adaptation: Quadruped robots employ adaptive gait patterns to navigate different terrains while maintaining stability. The control system adjusts the gait parameters, such as step length, step frequency, or leg coordination, based on the terrain conditions and the robot's stability requirements. This allows the robot to dynamically adapt its locomotion to prevent tipping or stumbling.

5. Real-Time Adjustments: Self-balancing quadruped robots continuously monitor their stability and make real-time adjustments to prevent falls. The control system actively corrects deviations from the desired posture by modulating the leg forces, joint torques, or body position. This responsiveness enables the robot to react quickly to external disturbances or changes in terrain conditions.

6. Feedback Control: Quadruped robots employ feedback control mechanisms to maintain

stability. The control system compares the desired posture or orientation with the actual sensor measurements and applies corrective actions based on the error between them. By iteratively adjusting the control signals, the robot achieves stable and balanced locomotion.

7. Dynamic Stability: Quadruped robots utilize their actuated joints and sophisticated control algorithms to maintain dynamic stability during locomotion. The control system takes into account the robot's dynamic model, the terrain characteristics, and the desired trajectory to optimize control commands and maintain balance even during dynamic movements or sudden perturbations.

By integrating sensory feedback, advanced control systems, and adaptive gait patterns, self-balancing quadruped robots can navigate challenging terrains while maintaining stability and preventing falls. These capabilities enable them to perform tasks in various applications, such as exploration, inspection, or assistance in environments where bipedal or wheeled robots may face limitations.

CONCLUSION

Sensors and digital imaging capabilities give farmers a richer picture of their fields. Additionally, the bot can survey the crops for the farmer periodically to their liking. The benefits of using this bot include increased crop production and monitored crop growth, high placement accuracy, autonomous outdoor and indoor function, and reduced production costs.

This bot helps in controlling the water by giving direct commands to the motor starter using wi-fi modules according to the data's received from the water level sensor. And it eliminates the weeds in between the crops. Integrating all these into a single rover helps in reducing the cost and increasing the user friendly approach towards farming.

The main advantage of this bot is its capability to incorporate all the sensors into a single rover and function as a whole thereby decreasing the cost and increasing the overall profit. We will see a drastic change of growth in automation in agriculture in the future years. Bringing up automation to agriculture will boost the profit level. All the existing techniques cost the farmer a huge investment making only a few to continue farming in a profitable way. Introducing the bot into the farms will bring out the best out of a farmer and continue their farming in a more profitable way. By implementation of this project the farming works which are considered to be tedious will be eliminated making it easier for everyone including women to pursue farming.

REFERENCE

- ESP32 Wi-Fi & Bluetooth MCU I
- Systems
- ESP32 - Wikipedia
- DRV8825 data sheet, product information and support | TI.com
- Stepper Motor with DRV8825 and Arduino Tutorial (4 Examples) (makerguides.com)
- LM2596 data sheet, product information and support | TI.com
- L298N Motor Driver Module Pinout, Datasheet, Features & Specs (components101.com)
- Interface L298N DC Motor Driver Module with Arduino (microcontrollerslab.com)
- Jansen's linkage - Wikipedia
- Dynamic Analysis and Modeling of Jansen Mechanism - ScienceDirect
- Jansen Mechanism : 7 Steps - Instructables

APPENDIX

ESP 32

ESP32 is a single 2.4 GHz Wi-Fi-and-Bluetooth combo chip designed with the

TSMC low-power 40 nm technology. It is designed to achieve the best power and RF performance, showing robustness, versatility and reliability in a wide variety of applications and power scenarios.

ESP32 is a highly-integrated solution for Wi-Fi-and-Bluetooth IoT applications, with around 20 external components. ESP32 integrates an antenna switch, RF balun, power amplifier, low-noise receive amplifier, filters, and power management modules. As such, the entire solution occupies minimal Printed Circuit Board (PCB) area. ESP32 uses CMOS for single-chip fully-integrated radio and baseband, while also integrating advanced calibration circuitries that allow the solution to remove external circuit imperfections or adjust to changes in external conditions. As such, the mass production of ESP32 solutions does not require expensive and specialized Wi-Fi testing equipment.

Wi-Fi Key Features

- 802.11b/g/n
- 802.11n (2.4 GHz), up to 150 Mbps
- WMM
- TX/RX A-MPDU, RX A-MSDU
- Immediate Block ACK
- Defragmentation
- Automatic Beacon monitoring (hardware TSF)
- 4 × virtual Wi-Fi interfaces
- Simultaneous support for Infrastructure Station, SoftAP, and Promiscuous modes Note that when ESP32 is in Station mode, performing a scan, the SoftAP channel will be changed.
- Antenna diversity

Bluetooth Key Features

• Compliant with Bluetooth v4.2 BR/EDR and Bluetooth LE specifications

• Class-1, class-2 and class-3 transmitter without external power amplifier

• Enhanced Power Control

• +9 dBm transmitting power

• NZIF receiver with –94 dBm Bluetooth LE sensitivity

• Adaptive Frequency Hopping (AFH)

• Standard HCI based on SDIO/SPI/UART

• High-speed UART HCI, up to 4 Mbps

• Bluetooth 4.2 BR/EDR and Bluetooth LE dual mode controller

• Synchronous Connection-Oriented/Extended (SCO/eSCO)

• CVSD and SBC for audio codec

• Bluetooth Piconet and Scatternet

• Multi-connections in Classic Bluetooth and Bluetooth LE • Simultaneous advertising and scanning

CPU Features

• Xtensa® single-/dual-core 32-bit LX6 microprocessor(s)

• CoreMark® score: – 1 core at 240 MHz: 504.85 CoreMark; 2.10 CoreMark/MHz – 2 cores at 240 MHz: 994.26 CoreMark; 4.14 CoreMark/MHz

• 448 KB ROM

• 520 KB SRAM

• 16 KB SRAM in RTC

• QSPI supports multiple flash/SRAM chips

1.4.2 Clocks and Timers

- Internal 8 MHz oscillator with calibration
- Internal RC oscillator with calibration
- External 2 MHz ~ 60 MHz crystal oscillator (40 MHz only for Wi-Fi/Bluetooth functionality)
- External 32 kHz crystal oscillator for RTC with calibration
- Two timer groups, including 2 × 64-bit timers and 1 × main watchdog in each group
- One RTC timer
- RTC watchdog

1.4.3 Advanced Peripheral Interfaces

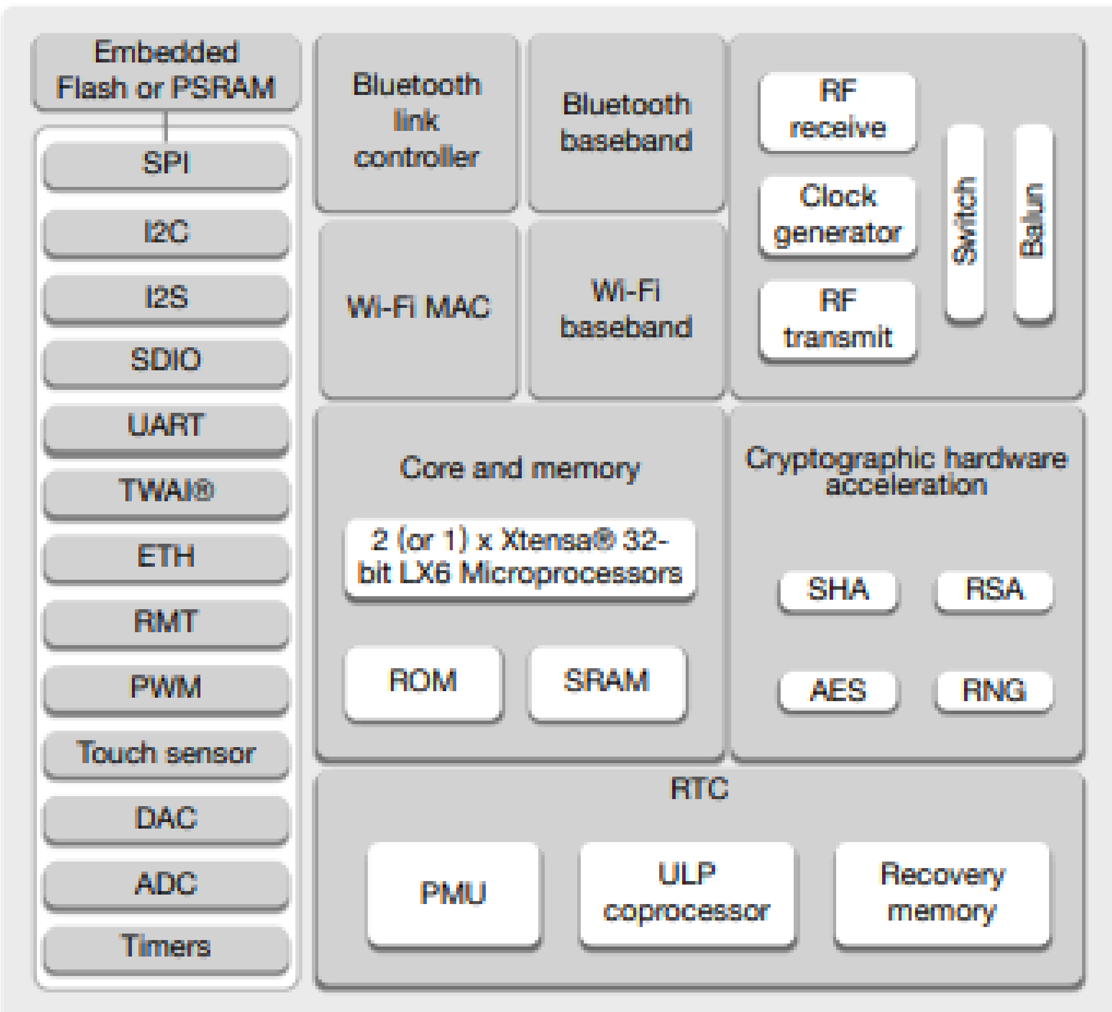
- 34 × programmable GPIOs
- 12-bit SAR ADC up to 18 channels
- 2 × 8-bit DAC
- 10 × touch sensors
- 4 × SPI
- 2 × I2S
- 2 × I2C
- 3 × UART
- 1 host (SD/eMMC/SDIO)
- 1 slave (SDIO/SPI)
- Ethernet MAC interface with dedicated DMA and IEEE 1588 support
- TWAI®, compatible with ISO 11898-1 (CAN Specification 2.0)

• RMT (TX/RX)

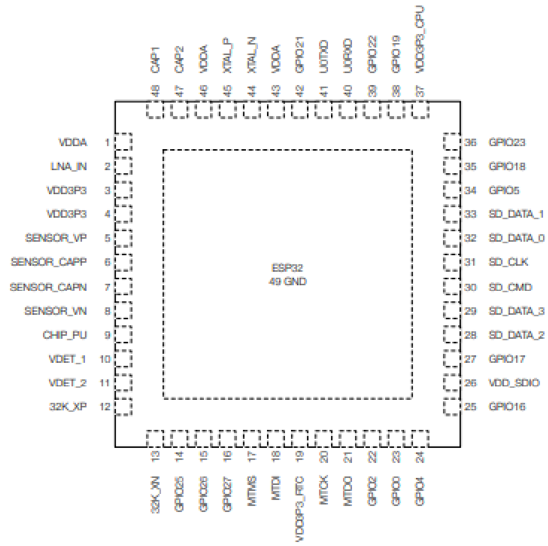
• Motor PWM

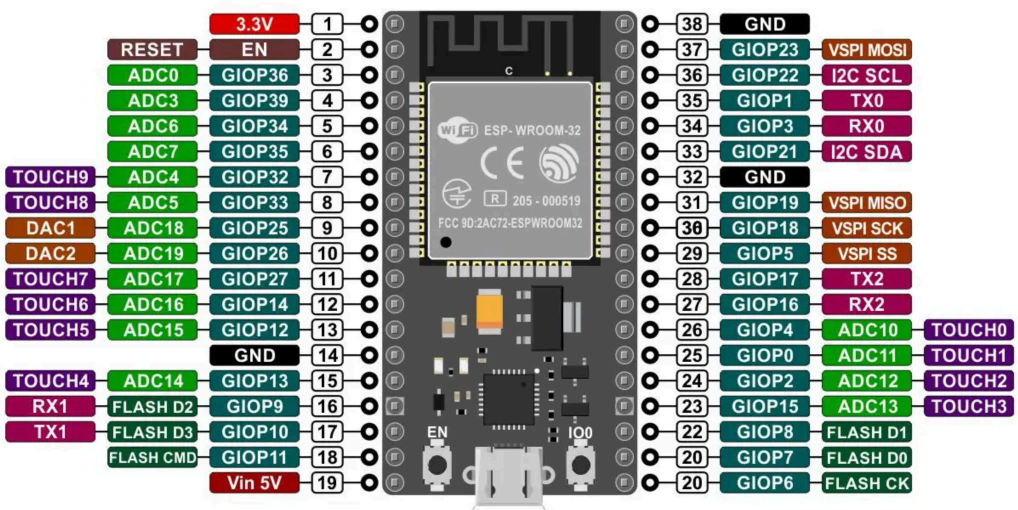
• LED PWM up to 16 channels

BLOCK DIAGRAM



PIN LAYOUT





L298N DRIVER

The L298N is a dual H-Bridge motor driver which allows speed and direction control of two DC motors at the same time. The module can drive DC motors that have voltages between 5 and 35V, with a peak current up to 2A. Let's take a closer look at the pinout of L298N module and explain how it works. The module has two screw terminal blocks for the motor A and B, and another screw terminal block for the Ground pin, the VCC for motor and a 5V pin which can either be an input or output.

This depends on the voltage used at the motors VCC. The module have an onboard 5V regulator which is either enabled or disabled using a jumper. If the motor supply voltage is up to 12V we can enable the 5V regulator and the 5V pin can be used as output, for example for powering our Arduino board. But if the motor voltage is greater than 12V we must disconnect the jumper because those voltages will cause damage to the onboard 5V regulator. In this case the 5V pin will be used as input as we need connect it to a 5V power supply in order the IC to work properly. We can note here that this IC makes a voltage drop of about 2V. So for example, if we use a 12V power supply, the voltage at motors terminals will be about 10V, which means that we won't be able to get the maximum speed out of our 12V DC motor. Next are the logic control inputs.

The Enable A and Enable B pins are used for enabling and controlling the speed of the motor. If a jumper is present on this pin, the motor will be enabled and work at maximum speed, and if we remove the jumper we can connect a PWM input to this pin and in that way control the speed of the motor. If we connect this pin to a Ground the motor will be disabled. Next, the Input 1 and Input 2 pins are used for controlling the rotation direction of the motor A, and the inputs 3 and 4 for the motor B. Using these pins we actually control the switches of the H-Bridge inside the L298N IC. If input 1 is LOW and input 2 is HIGH the motor will move forward, and vice versa, if input 1 is HIGH and input 2 is LOW the motor will move backward. In case both inputs are same, either LOW or HIGH the motor will stop. The same applies for the inputs 3 and 4 and the motor B.

Brief Data:

• Driver: L298N Dual H Bridge DC Motor Driver

• Power Supply: DC 5 V - 35 V

• Peak current: 2 Amp

• Operating current range: 0 ~ 36mA

• Control signal input voltage range :

• Low: -0.3V ≤ Vin ≤ 1.5V. • High: 2.3V ≤ Vin ≤ Vss.

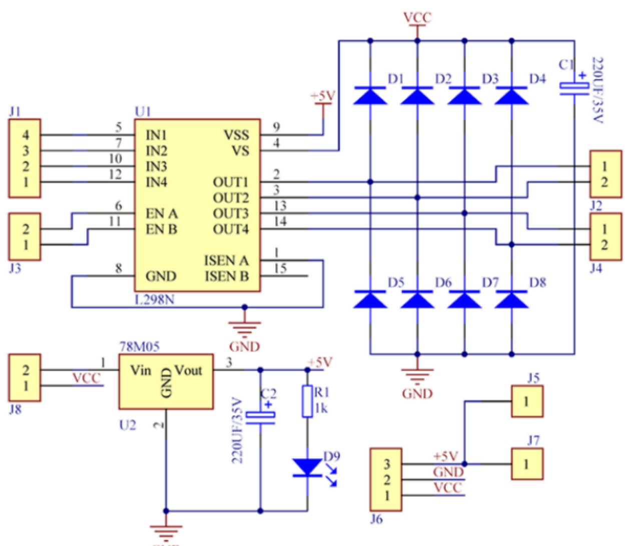
• Enable signal input voltage range : o Low: -0.3 ≤ Vin ≤ 1.5V (control signal is invalid). o High: 2.3V ≤ Vin ≤ Vss (control signal active).

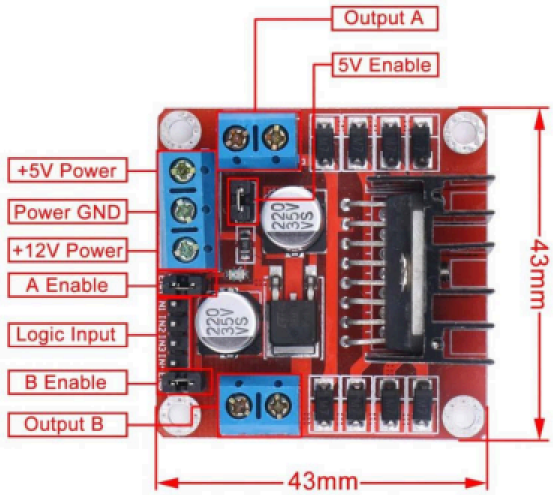
• Maximum power consumption: 20W (when the temperature T = 75 ℃).

• Storage temperature: -25 ℃ ~ +130 ℃.

• On-board +5V regulated Output supply (supply to controller board i.e. Arduino).

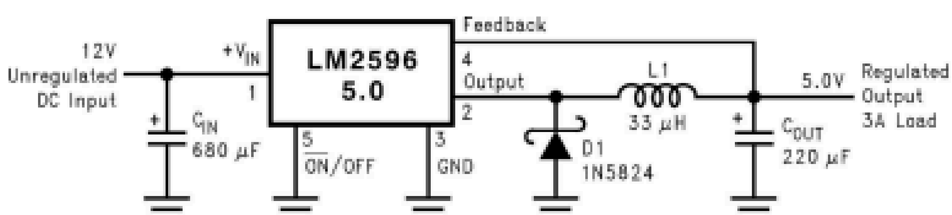
• Size: 3.4cm x 4.3cm x 2.7cm





LM2596 Voltage regulator

The LM2596 series of regulators are monolithic integrated circuits that provide all the active functions for a step-down (buck) switching regulator, capable of driving a 3-A load with excellent line and load regulation. These devices are available in fixed output voltages of 3.3 V, 5 V, 12 V, and an adjustable output version.



Requiring a minimum number of external components, these regulators are simple to use and include internal frequency compensation, and a fixed-frequency oscillator.

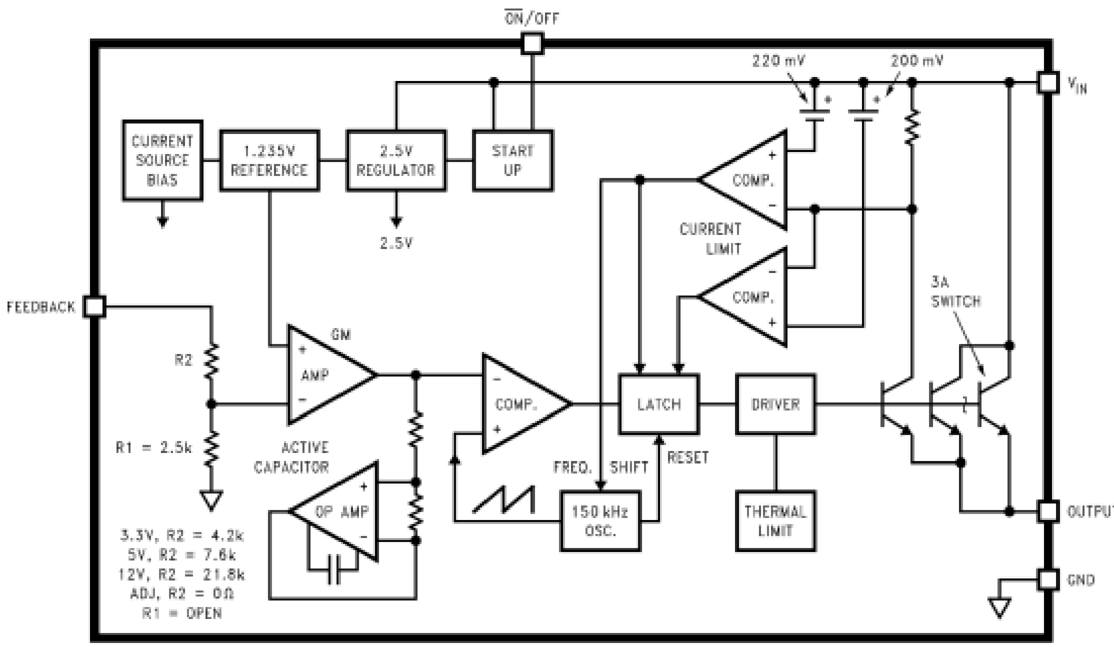
The LM2596 series operates at a switching frequency of 150 kHz, thus allowing smaller sized filter components than what can be required with lower frequency switching regulators. Available in a standard 5-pin TO-220 package with several different lead bend options, and a 5-pin TO-263 surface mount package.

A standard series of inductors are available from several different manufacturers optimized for use with the LM2596 series. This feature greatly simplifies the design of switch-mode power supplies.

Other features include a ±4% tolerance on output voltage under specified input voltage and output load conditions, and ±15% on the oscillator frequency. External shutdown is included, featuring typically 80 µA standby current. Self-protection features include a two stage frequency reducing current limit for the output switch and an overtemperature shutdown for complete protection under fault conditions.

Features

- 3.3-V, 5-V, 12-V, and adjustable output versions
- Adjustable version output voltage range: 1.2-V to 37-V ±4% maximum over line and load conditions
- Available in TO-220 and TO-263 packages
- 3-A output load current
- Input voltage range up to 40 V
- Requires only four external components
- Excellent line and load regulation specifications
- 150-kHz fixed-frequency internal oscillator
- TTL shutdown capability
- Low power standby mode, I Q, typically 80 µA
- High efficiency
- Uses readily available standard inductors
- Thermal shutdown and current-limit protection



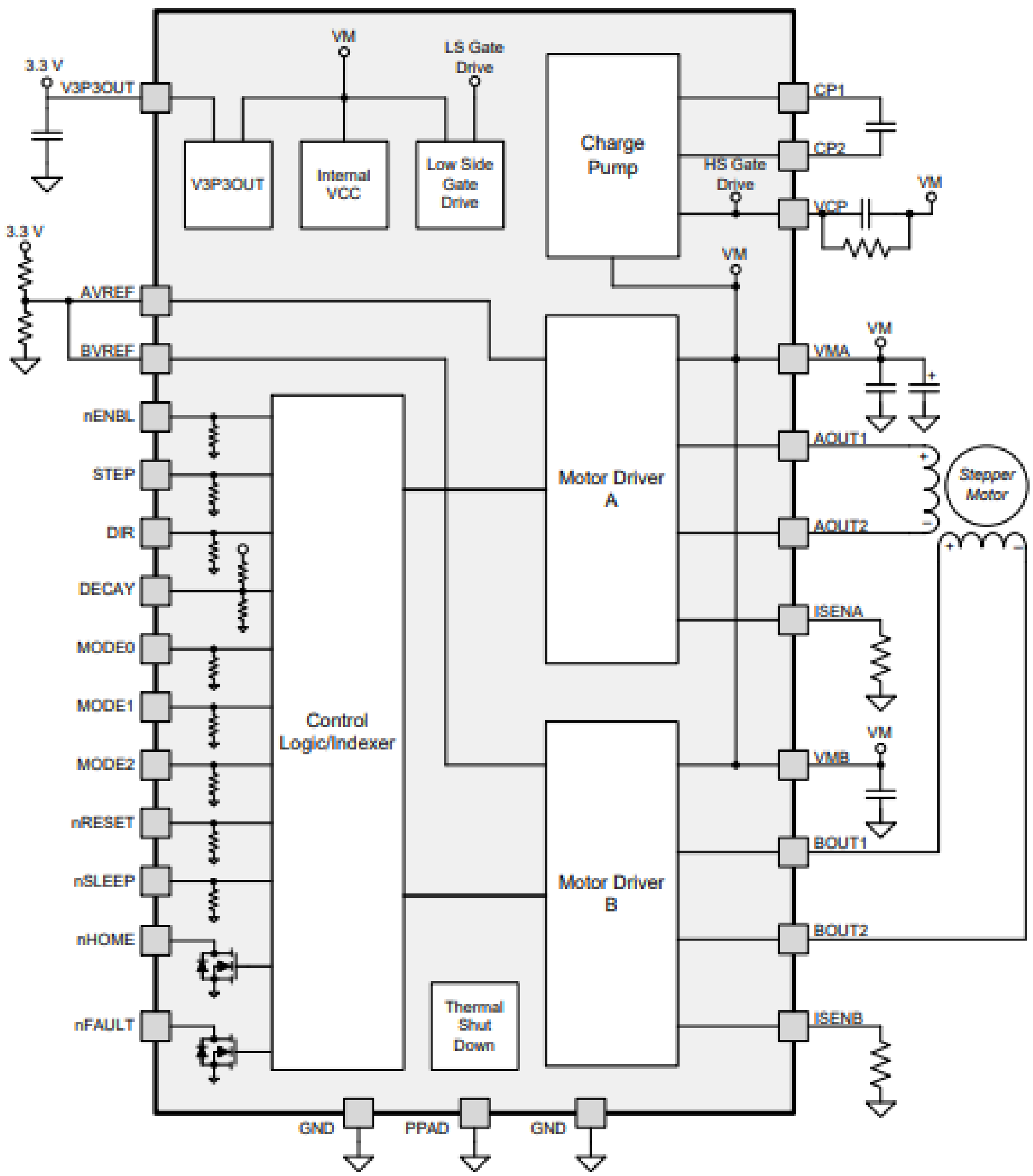
DRV 8825 STEPPER MOTOR DRIVER

The DRV8825 provides an integrated motor driver solution for printers, scanners, and other automated equipment applications. The device has two H-bridge drivers and a microstepping indexer, and is intended to drive a bipolar stepper motor. The output driver block consists of N-channel power MOSFET's configured as full H-bridges to drive the motor windings. The DRV8825 is capable of driving up to 2.5 A of current from each output (with proper heat sinking, at 24 V and 25°C).

A simple STEP/DIR interface allows easy interfacing to controller circuits. Mode pins allow for configuration of the motor in full-step up to 1/32-step modes. Decay mode is configurable so that slow decay, fast decay, or mixed decay can be used. A low-power sleep mode is provided which shuts down internal circuitry to achieve very low quiescent current draw. This sleep mode can be set using a dedicated nSLEEP pin.

Internal shutdown functions are provided for overcurrent, short circuit, under voltage lockout and over temperature. Fault conditions are indicated via the nFAULT pin.

FUNCTIONAL BLOCK DIAGRAM



Features

- PWM Microstepping Stepper Motor Driver

    - Built-In Microstepping Indexer
    - Up to 1/32 Microstepping
- Multiple Decay Modes
    - Mixed Decay
    - Slow Decay
    - Fast Decay
- 8.2-V to 45-V Operating Supply Voltage Range
- 2.5-A Maximum Drive Current at 24 V and T_A = 25°C
- Simple STEP/DIR Interface
- Low Current Sleep Mode
- Built-In 3.3-V Reference Output
- Small Package and Footprint
- Protection Features
    - Overcurrent Protection (OCP)
    - Thermal Shutdown (TSD)
    - VM Undervoltage Lockout (UVLO)
    - Fault Condition Indication Pin (nFAULT)

Arduino Sketch

An Open-source software called Arduino-IDE in programming language called Arduino C. The program is uploaded to the ESP 32 microcontroller.

```
#define BLYNK_TEMPLATE_ID "TMPLoJQxUo4a"

#define BLYNK_TEMPLATE_NAME "Agro Rover"

#define BLYNK_AUTH_TOKEN "jizEBkW2ZK42bxFUPZ7yMwOSKSgaAmX_"


#define BLYNK_PRINT Serial


#include <WiFi.h>

#include <WiFiClient.h>

#include <BlynkSimpleEsp32.h>


char auth[] = "jizEBkW2ZK42bxFUPZ7yMwOSKSgaAmX_";


// Your WiFi credentials.

// Set password to "" for open networks.

char ssid[] = "RR";

char pass[] = "1234567890";


const int DIR1 = 12;

const int STEP1 = 14;
```

```
const int DIR2 = 27;

const int STEP2 = 26;


const int M1 = 32;

const int M2 = 4;


const int SPEAKER = 25;


int weedcutter = 33;


bool forward = 0;

bool backward = 0;

bool left = 0;

bool right = 0;

bool Speaker = 0;

bool Mc = 0;

bool Ma = 0;

int Speed;

bool weedcutte = 0;



BLYNK_WRITE(V1) {

  forward = param.asInt();
```

```
}

BLYNK_WRITE(V4) {
  backward = param.asInt();
}

BLYNK_WRITE(V3) {
  left = param.asInt();
}

BLYNK_WRITE(V2) {
  right = param.asInt();
}
BLYNK_WRITE(V5) {
  Speed = param.asInt();
}
BLYNK_WRITE(V7) {
  Mc = param.asInt();
}
BLYNK_WRITE(V9) {
  Ma = param.asInt();
}
BLYNK_WRITE(V8) {
```

```
  Speaker = param.asInt();
}
BLYNK_WRITE(V10) {
  weedcutte = param.asInt();
}
void smart(){
  Serial.println("carforward");
}


void setup()
{
  // Debug console
   Serial.begin(115200);
  pinMode(DIR1, OUTPUT);
  pinMode(STEP1, OUTPUT);
  pinMode(DIR2, OUTPUT);
  pinMode(STEP2, OUTPUT);
  pinMode(M1, OUTPUT);
  pinMode(M2, OUTPUT);
  pinMode(SPEAKER, OUTPUT);
  pinMode(weedcutter, OUTPUT);
```

```
  Blynk.begin(auth, ssid, pass, "blynk.cloud", 80);


}


void loop()

{

  if (forward == 1) {

    carforward();

    Serial.println("carforward");

  }else if (backward == 1) {

    carbackward();

    Serial.println("carbackward");

  }else if (left == 1) {

    carturnleft();

    Serial.println("carfleft");

  }else if (right == 1) {

    carturnright();

    Serial.println("carright");

  }else if (forward == 0 && backward == 0 && left == 0 && right == 0) {

    carStop();

    Serial.println("carstop");

  }

  if(Mc == 1){
```

```
  motorclockwise();
  Serial.println("motorclockwise");
}else if(Ma == 1){
  motoranticlockwise();
  Serial.println("motoranticlockwise");
  //motorclockwiseoff();
  //Serial.println("motorclockwiseoff");
}

if(Speaker == 1){
  digitalWrite(SPEAKER,HIGH);
  Serial.println("Speaker");
}else if(Speaker == 0){
   digitalWrite(SPEAKER,LOW);
  Serial.println("Speakeroff");
}
if(weedcutte ==1){
  digitalWrite(weedcutter,HIGH);
}else{
  digitalWrite(weedcutter,LOW);
}
Blynk.run();
```

```
}
void carforward() {

  digitalWrite(DIR1, HIGH);
  Serial.println("M1 Forward...");
  digitalWrite(DIR2, HIGH);
  Serial.println("M2 Forward...");

    digitalWrite(STEP1, HIGH);
     digitalWrite(STEP2, HIGH);
    delayMicroseconds(7000);
    digitalWrite(STEP1, LOW);
    digitalWrite(STEP2, LOW);
    delayMicroseconds(7000);

}
void carbackward() {
  digitalWrite(DIR1, LOW);
  Serial.println("M1 Backward...");
  digitalWrite(DIR2, LOW);
  Serial.println("M2 Backward...");
```

```
    digitalWrite(STEP1, HIGH);
    digitalWrite(STEP2, HIGH);
    delayMicroseconds(7000);
    digitalWrite(STEP1, LOW);
    digitalWrite(STEP2, LOW);
    delayMicroseconds(7000);
}
void carturnleft() {
  digitalWrite(DIR1, HIGH);
  Serial.println("M1 Forward");
  digitalWrite(DIR2, LOW);
  Serial.println("M2 Backward...");


    digitalWrite(STEP1, HIGH);
     digitalWrite(STEP2, HIGH);
    delayMicroseconds(7000);
    digitalWrite(STEP1, LOW);
    digitalWrite(STEP2, LOW);
    delayMicroseconds(7000);
```

```
}
void carturnright() {
  digitalWrite(DIR1, LOW);
  Serial.println("M1 Backward...");
  digitalWrite(DIR2, HIGH);
  Serial.println("M2 Forward...");



  digitalWrite(STEP1, HIGH);
     digitalWrite(STEP2, HIGH);
    delayMicroseconds(7000);
    digitalWrite(STEP1, LOW);
    digitalWrite(STEP2, LOW);
    delayMicroseconds(7000);



}
void carStop() {


}
void motorclockwise() {
  digitalWrite(M2,LOW);
  digitalWrite(M1,HIGH);
```

```
  delay(100);
  digitalWrite(M1,LOW);
  delay(500);
}

void motoranticlockwise() {
  digitalWrite(M1,LOW);
  digitalWrite(M2,HIGH);
  delay(100);
  digitalWrite(M2,LOW);
  delay(500);
}

void Speak(){
  digitalWrite(SPEAKER,HIGH);
}
void Speakoff(){
  digitalWrite(SPEAKER,LOW);
}
```