CHAPTER 2

SYSTEM DESCRIPTION

2.1 BLOCK DIAGRAM

Fig 2.1 shows the block diagram of the system, illustrating how different components interact to enable autonomous operation. This system enhances automation, efficiency, and remote accessibility, making it a smart and eco-friendly solution for modern farming. The Agri-Bot is an advanced agricultural system controlled via a mobile application (Blynk) using an ESP32 microcontroller. The mobile app wirelessly communicates with the ESP32 through a WiFi connection, allowing farmers to control the mower and its functions remotely. The ESP32 microcontroller processes these commands and operates different relays to control the mower's movement and various agricultural tasks.

A WiFi receiver ensures real-time communication between the mobile app and the ESP32. The mower's movement is controlled by Relay 1 (GPIO 15) for forward/reverse and Relay 2 (GPIO 2) for left/right navigation. Additionally, Relay 5 (GPIO 18) controls the seeding mechanism, Relay 6 (GPIO 19) operates the water pump for irrigation or spraying pesticides, and Relay 7 (GPIO 21) manages the grass cutter for trimming unwanted grass.

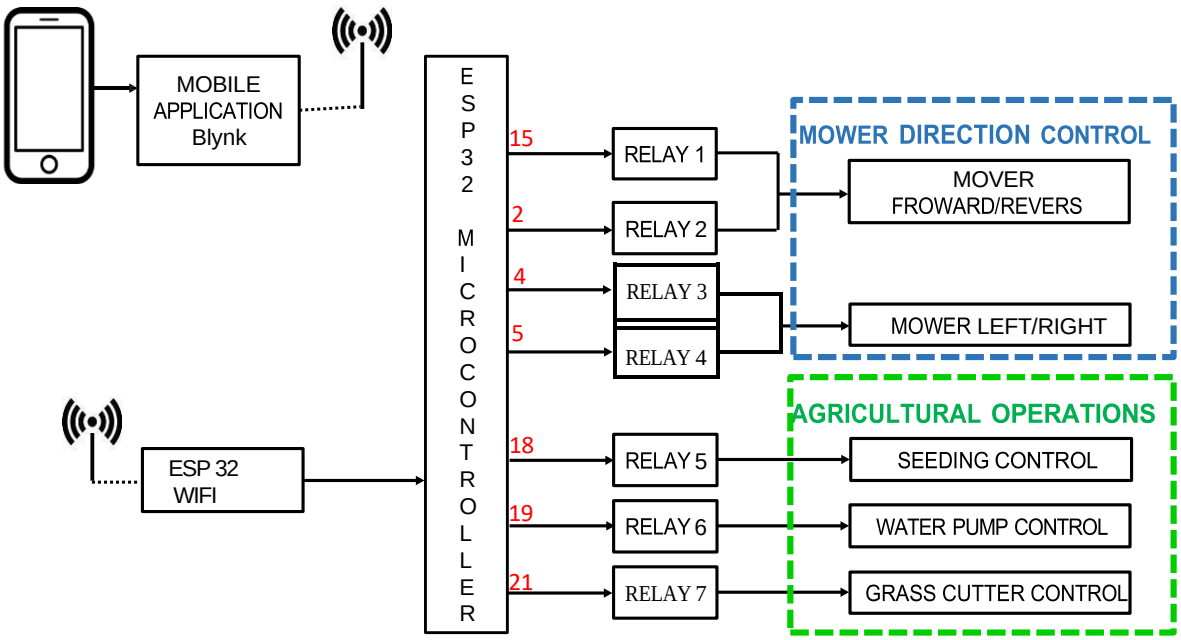

Fig 2.1 BLOCK DIAGRAM

2.2 ESP 32 MICRO-CONTROLLER

The ESP-WROOM-32 Microcontroller shown in a Fig 2.2 is a powerful and versatile Wi- Fi, Bluetooth, and BLE (Bluetooth Low Energy) MCU module designed for a wide range of applications, from low-power sensor networks to demanding tasks such as voice encoding, music streaming, and MP3 decoding. At the heart of this module is the ESP32-S chip, which features dual CPU cores that can be individually controlled or powered, with clock frequencies adjustable between 80 MHz and 240 MHz. The chip also has a low-power coprocessor that allows users to power off the main CPUs while constantly monitoring peripherals for changes or threshold crossings, optimizing energy usage.

The ESP32-S integrates a wide variety of peripherals, including capacitive touch sensors, Hall sensors, low-noise amplifiers, SD card interface, Ethernet, high-speed SDIO/SPI, UART, and I²C. Bluetooth functionality allows for phone connections or broadcasting low-energy beacons, while Wi-Fi enables a large physical range and direct internet connection via a Wi-Fi router.

The module supports data rates of up to 150 Mbps and has 22 dBm (decibel milliwatt) output power at pin PA, providing an extended range. It features 520 KB of SRAM, 4 MB of flash memory, and an on-board PCB antenna, making it highly integrated and efficient for various applications. The ESP32-WROOM-32 operates within a voltage range of 3.0V to 3.6V and consumes a typical current of 80 mA during normal operation. The processor is based on two low-power Xtensa 32-bit LX6 microprocessors, making it ideal for low-power, high-performance applications.

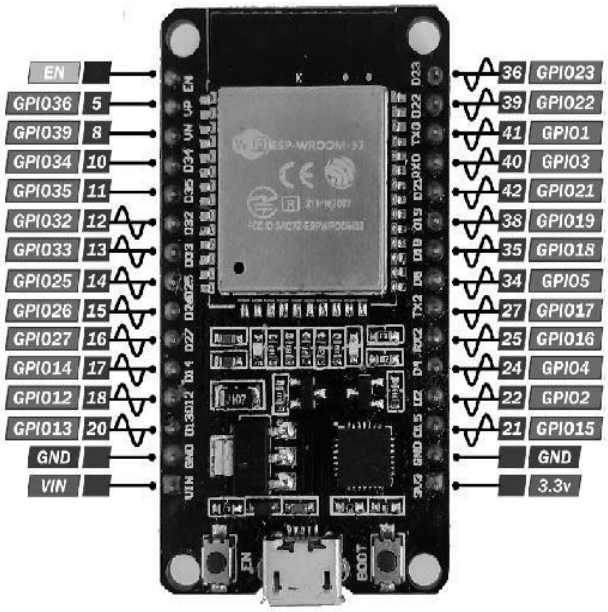

Fig 2.2 ESP-WROOM 32

2.3 12V 300 RPM DC MOTOR

DC Motor – 300RPM – 12Volt geared DC motors are typically simple DC motors with an attached gearbox, as shown in Fig. 2.3. These motors are commonly used in all-terrain robots and a variety of robotic applications. They feature a 3 mm threaded drill hole in the centre of the shaft, making it easy to connect them to wheels or other mechanical assemblies.

The shaft includes a nut and threads for easy attachment, along with internal threading to facilitate secure connections with wheels. These DC geared motors come with a robust metal gearbox designed for heavy-duty applications. They are available in a wide range of RPMs and are ideally suited for both robotics and industrial uses. The motors are user-friendly, available in standard sizes, and built for reliability and ease of integration.

Fig 2.3 12V 300 RPM DC MOTOR

2.3.1 SPECIFICATIONS OF MOTOR

- RPM = 300
- Operating Voltage = 12V DC
- Torque = 2 kg-cm
- No-load current = 60 mA (Max)
- Load current = 300 mA (Max)
- Weight = 125gm weight

2.4 12V RELAY

Relays are frequently employed as switching components in electronics. It is shown in the Fig 2.4. An essential consideration is the trigger voltage, which indicates the voltage required to initiate the relay, leading to the transition of the contact from the Common terminal to either the Normally Closed (NC) terminal or the Normally Open (NO) terminal.

The particular relay requires a 5V trigger voltage, although variants with 3V, 6V, and even 12V trigger voltages are available, allowing for selection based on the project's available voltage. Another vital factor to consider is the voltage and current rating of the load, which denotes the maximum voltage or current that the NC, NO, or common terminal of the relay can manage. For our application, it can manage up to 30V and 10A with DC. It's essential to ensure that the load being used falls within this specified range.

Fig 2.4 12V RELAY

2.4.1 FEATURES OF 12V RELAY

- Coil Activation Voltage: 12 volts DC
- Nominal Activation Current: 70 milliamperes
- Maximum AC Load Current Handling: 10 amps @ 250/125 volts AC
- Maximum DC Load Current Handling: 10 amps @ 30/28 volts DC
- Compact 5-pin configuration with plastic casing
- Activation Time: 10 milliseconds Release Time: 5 milliseconds
- Maximum Mechanical Switching Frequency: 300 operations per minute.

2.5 12V DC PUMP

Pumps are mechanical devices used to create a pressure difference that drives fluid from a storage tank through the plumbing system to a spray nozzle. The 12V DC pump, shown in Fig. 2.5, operates exclusively on a 12V DC power supply and typically features two ports—an IN port to draw water from the tank and an OUT port to discharge it. It is commonly used for water transfer and can be fully submerged, eliminating the need for extra space. This pump has a capacity to transfer water at a rate of 10 liters per minute.

Fig 2.5 12V DC PUMP

2.5.1 SPECIFICATION OF PUMP

- Rated Voltage: 12V DC
- Operating Voltage: 9V-14V DC
- Rated current: 600mA-1500Ma
- Max Water Head: 5m
- Max Flow: 10 L/Min

2.6 CUTTER MOTOR

The Cutter Motor is a high-torque DC motor specifically designed for grass cutting applications. The 12V DC Cutter Motor is shown in the Fig 2.6. It powers the rotating blades of lawnmowers, ensuring efficient and smooth cutting of grass. With reliable performance and high speed, it provides the necessary force to tackle various grass heights and densities.

Fig 2.6 12V CUTTER MOTOR

2.6.1 SPECIFICATION OF CUTTER MOTOR

- Motor Type: 775.
- Operating Voltage: 6~20Vdc. (Nominal 12Vdc)
- No Load Speed: 12,000 RPM @ 12V.
- Rated current: 1.2A @ 12V.
- Stall Torque: 79Ncm @ 14.4V.
- Cooling Fan: Internal
- Overall Size: 98x42mm.
- Shaft: Full Round Type Ø5mm.
- Mounting Screw Size: M4.
- Weight: 350g**.**

2.7 BATTERY

A battery is a device in which chemical energy is directly converted to electrical energy. It consists of one or more voltaic cells, each of which is composed of two half cells connected in series by the conductive electrolyte. Each cell has a positive terminal, shown by a long horizontal line, and a negative terminal, shown by the shorter horizontal line. In this project, two 6V batteries with a 2.5 Ah capacity shown in the Fig 2.7 are connected in series to provide the required voltage and current for the system.

Fig 2.7 6V BATTERY

2.7.1 SPECIFICATION OF BATTERY

- Rated Voltage (V) – 6V
- Rated Power: 20-Hour Rating - 5.0 AH, 10-Hour Rating - 3.8 AH, 5-Hour Rating - 2.65 AH
- Weight - ~0.6KG
- Internal resistance: approx. 30 mΩ
- Chargeable: Yes
- Maximum charge current: 1,2 A
- Maximum discharge current: 350 A (5 s)
- Self-Discharge: These batteries can be stored for approximately 6 months at 25°C (77°F) before requiring a recharge. However, at higher temperatures, the storage time will be shorter.
- Lifespan (cycles): They can endure up to 500 cycles of charging and discharging, with each cycle involving a 50% depth of discharge.

2.8 SOLAR PANEL

The solar panel shown in Fig 2.8, consists of an array of photovoltaic cells arranged within a framework for installation. These cells utilize sunlight to produce direct current (DC) electricity. These modules commonly use crystalline silicon cells or thin-film cells. The structural layer of the module can be positioned on either the top or backside, providing structural support against mechanical loads and protecting cells from physical damage and moisture.

While most modules are rigid, there are flexible options available that incorporate thin-film cells. Cells are interconnected in series to achieve the desired voltage and then in parallel to increase amperage. The power output of the module is calculated by multiplying its voltage by amperage. In this project, the solar panel used has a module voltage of 12V, a short circuit current of 0.46A, and a rated power of 5W. The frame is made of aluminium, and the panel contains 36 cells.

Fig 2.8 12V SOLAR PANEL

2.8.1 SPECIFICATION OF SOLAR PANEL

- Module Voltage: 12V
- Short Circuit Current: 0.46A
- Rated Power: 5W
- Frame Material: Aluminum
- No. of Cells: 36
- Application: Home, Outdoor and Commercial Use
- Panel Type: Polycrystalline

2.9 REGULATOR IC's

2.9.1 VOLTAGE REGULATOR IC 7805

The 7805 Regulator IC shown in Fig 2.9, is widely used voltage regulator integrated circuit (IC) that provides a stable output voltage of +5 volts. It ensures a consistent 5V supply required for powering to ESP 32 microcontroller. By maintaining a fixed output, the 7805 protects the microcontroller from voltage fluctuations.

Fig 2.9 7805 VOLTAGE REGULATOR

2.9.2 VOLTAGE REGULATOR IC 7812

The 7812 Regulator IC shown in Fig 2.10, is a widely used voltage regulator integrated circuit (IC) that provides a stable output voltage of +12 volts. It ensures a consistent 12V supply required for powering the system components. By maintaining a fixed output, the 7812 protects the system from voltage fluctuations. Connected at the output of the booster circuit, it provides a fixed 12V output to the battery, ensuring that the battery is efficiently charged.

Fig 2.10 7812 VOLTAGE REGULATOR

2.10 12V BOOST CONVERTER

The 12V Boost Converter is a device that steps up the voltage from a lower voltage source to a stable 12V output. It is shown in Fig 2.11. It is connected to the output of the solar panel to boost the voltage to 12V, ensuring a consistent power supply. This converter efficiently increases the voltage while maintaining current flow to power various components. The input voltage range is from 2.5V to Vout-0.5V, and the output voltage can be set to 5V, 8V, 9V, or 12V. With a maximum output current of 1A and low power consumption, the boost converter optimizes the overall system's efficiency and performance, making it ideal for solar- powered systems.

Fig 2.11 12V BOOST CONVERTER