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Autonomous Farming Robot with Real-Time Environment Analysis

Mr. G. Chandrasekar, Anas Rahuman S, Ben Bernard, Ebin B Thomas, Pranav S Nair
Department of Robotics and Automation
Dhanalakshmi Srinivasan Engineering College (Autonomous), Perambalur

Abstract: *The purpose of this project is to develop an autonomous mobile platform which can minimize the labor of farmers in addition to increasing the speed, accuracy and yield of the farming. The robot is designed in such a way that it performs the elementary activities involved in farming such as weed removal, spraying pesticides etc which are notoriously difficult to remove and are capable of even becoming resistant to weed killers over time. Nowadays modern agriculture is an important aspect of farming because it improves the yield rate, reduces the environmental impact, increases precision and efficiency, saves money and energy during the production. Considering this, the robot is designed to perform various testing and analysis works such as soil nutrient analysis to determine the composition, characteristics or nutrient levels of the soil, soil moisture testing, temperature and humidity monitoring etc.It also helps in the efficient use of manpower and elevates productivity and improves the quality. The robot is also equipped with artificial intelligence which can identify weeds from crops as well as detect diseases in crops by analyzing leaves. To make the robot autonomous in its tasks we have introduced a unique navigation system based on rfid which can be easily implemented, at the same time convenient to use at large scale. The entire purpose of agriculture robots is to ease the physical burden on farmers, allowing them to use their intellectual capabilities and maximize abilities. This allows farmers to strategize better with their space and eventually bring down the food shortage crisis for the global population.*

Keywords: Autonomous Farming Robot, Weed Cutting, Soil Moisture Testing, Fertilization, Artificial Intelligence, RFID Based Navigation System

I. INTRODUCTION

Agriculture is the backbone of India as well as the livelihood for a majority of the population and can never be underestimated. It also provides large and ample employment opportunities to the people. India is blessed with large arable land with 15 agro-climatic zones as defined by ICAR, having almost all types of weather conditions, soil types and capable of growing a variety of crops. India is the top producer of milk, spices, pulses, tea, cashew and jute, and the second-largest producer of rice, wheat, oilseeds, fruits and vegetables, sugarcane and cotton.

Despite such gains, the average productivity of many crops in India is quite low. The country's population in the next decade is expected to become the largest in the world and providing food for them will be a very prime issue. It is alarming that India is moving towards a point of no return, from being a self-reliant nation of food surplus to a net importer of food. One of the biggest issues facing the agricultural sector in India is low yield. India's farm yield is 30-50% lower than that of developed nations. Average farm size, poor infrastructure, low use of modern farming techniques, decreasing soil fertility due to over fertilization and sustained pesticide use etc are leading contributors to low agricultural productivity. All these trends indicate that the agricultural sector in India is facing a crisis today.

To overcome all these problems, next generation reforms like automation technologies, adoption of environmentally sustainable and climate resistant farming, improvement in yield practices are required. Here comes the purpose of our project, which solves all these issues with modern farming techniques such as, using robotics to automate various labor intensive and time consuming tasks, reducing water wastage by precision irrigation, controlled use of pesticides and analyzing soil constituents for effective fertilization. This inturn helps in increasing the yield of farming drastically at the same time reducing the labor of farmers.

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II. EXISTING SYSTEM AND ITS LIMITATIONS

When it comes to the modern times, automation has been the driving force around the world. Many industries from small scale to large scale are rapidly moving towards automated production in one way or the other and agricultural industry has also been a part of it. Most of the agriculture related automated systems we see are generally multi purpose robots. Their features may include tasks such as sowing, sprinkling, weed cutting etc, to reduce the pressure on farmers while preparing the land for cultivation. These modern technologies can be introduced into the farming sector for cutting down the additional costs and labor involved in the process. This robot is a manually controlled multi-purpose system that can be adapted to the requirements of the farmer. As the robot is equipped with a weed cutting system, a sprinkler system and the ability to sow the seeds, this could be of more value for the money farmers spend, with all the convenience of controlling the robot with the help of a controller. The addition of soil moisture sensors help the farmer to get the soil moisture level and other details without involving third parties.

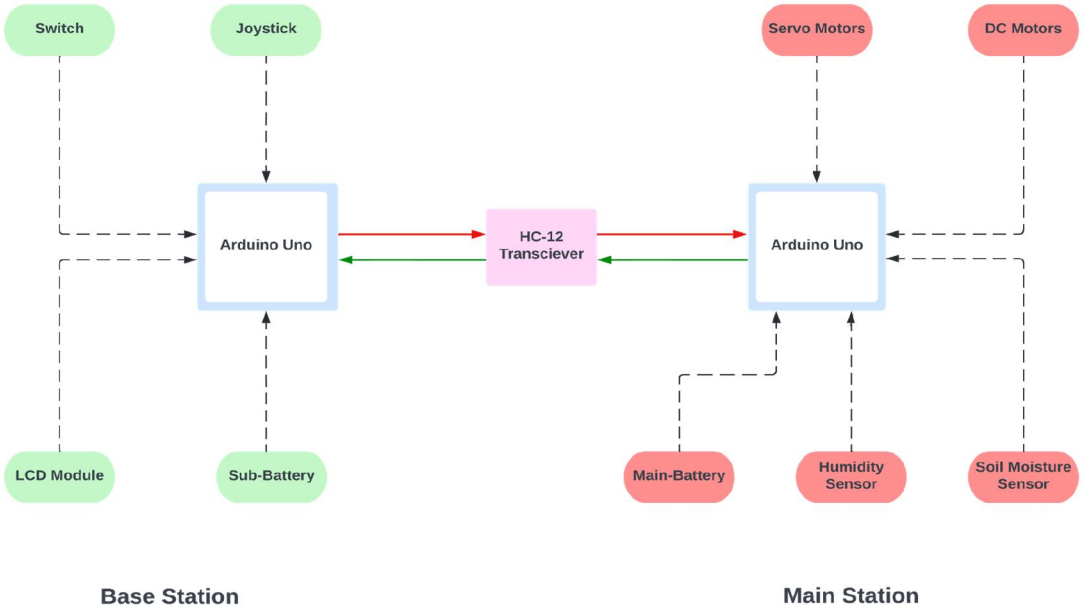

Fig: BLOCK DIAGRAM OF AN AGRICULTURE ROBOT

Limitations

But most of these automated systems are not fully capable of doing these tasks properly. This can be attributed to many reasons and below are some important points.

- Use of single bladed design for cutting weeds.
- They only have a single sprinkling unit.
- Resources are not properly utilized.
- Slow rate of data transmission.
- Harder to gain insights as real time data is not available.
- Analyzed data is not properly utilized.
- Image processing is very limited.
- Poorly designed, usually having just a frame and often too bulky.
- No proper integration within the system.
- Complex nature leads to difficulty in maintenance.

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III. PROPOSED SYSTEM

Based on the factors accumulated in the existing system, we try to change those factors into a modernized and revolutionary type of system which can be both beneficial and efficient. After these aspects are applied to the model we name it as the proposed system which denotes the finalized operations and the working of the system.

3.1 System Architecture

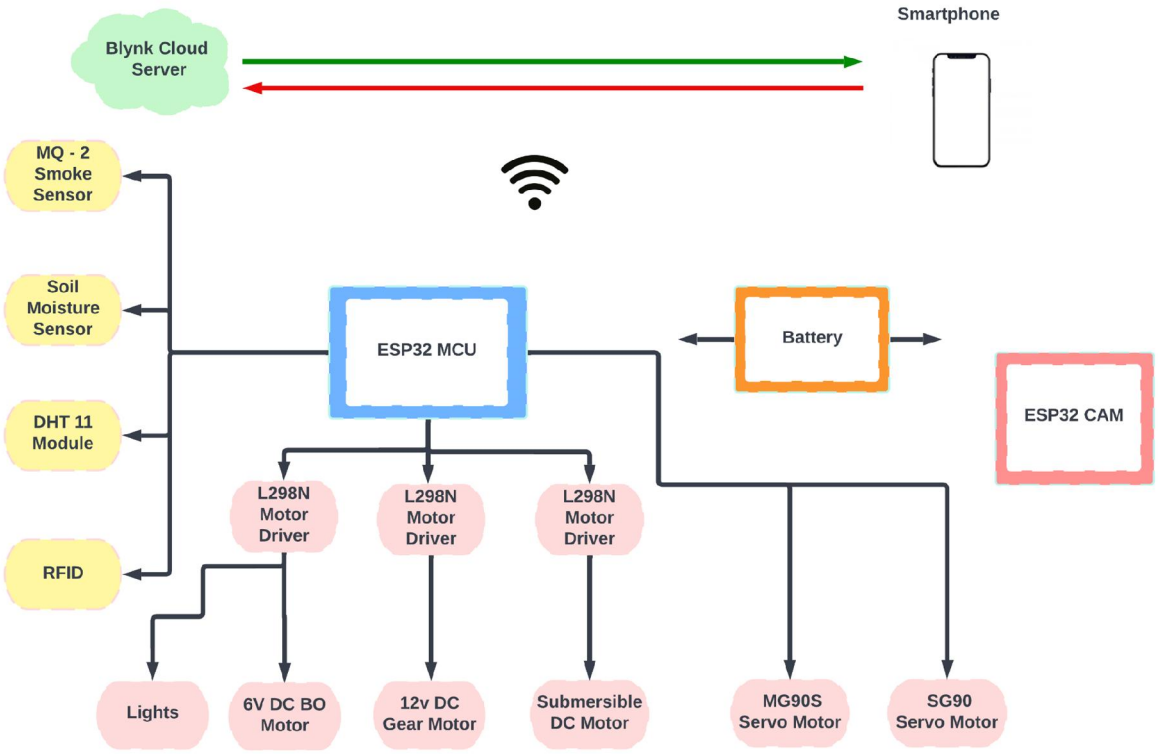

Fig: SYSTEM ARCHITECTURE

3.2 Weed Control

As the name suggests, Weed Control is the procedure where we have to limit the weeds and unwanted plants generated in the agricultural area so that it does not interfere with the growth of the crops. Weed has been a trouble and time consuming since the early times due to its unwanted growth and if left idle reducing the crop yield. So in order to control the weeds that are being generated in the farm, we have designed an autonomous, self- retractable, rotary blade which cuts the weed when it is directed to by the information provided to the system. These weed cutters are placed in such a way that the cutters do not interfere with the movement of the model. By making these cutters retractable makes the model to incur less field of space and to reduce its unwanted collisions while the model is at work.

3.3.1 Irrigation

For irrigation we provide an integrated storage tank to store water necessary for irrigation purposes. The flow of water from the tank to the outlets are controlled by two submersible pumps. The pumps are operated in such a way that when the system instructs the robot to provide irrigation to crops, the pumps are turned on accordingly and the water runs out through the outlet provided in the robot body. These outlets are placed in such a way that the water reaches individual crops equally.The benefit of using this type of feature is that every crop will be given an equal amount of water and external factors are also considered on how the crops should be irrigated like climate, moisture etc.

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3.3.2 Fertilization

Fertilization is carried out in the similar way as irrigation, we provide a separate tank for the mixing composition of the fertilizer and water in a predetermined percentage. This composition is adjusted using a single submersible pump we have placed, that determines the percentage at which the composition is mixed. The pumps are operated in such a way that when the system instructs the robot to provide fertilization to the crops, the valves open accordingly and the water with the fertilizer composition gets mixed in the tank. The outlet then sprays the thus obtained composition to the individual crops equally. The benefit of using this type of feature is that the farmer doesn't need to mix the fertilizers manually which can help him from the poisonous effects of the fertilizers and carry out the fertilization more efficiently.

3.4 Plowing

Plowing is carried out by providing a plowing linkage at the rear end of the robot, making it spot ready whenever the plowing operation is required. This linkage is placed in a horizontal manner, which moves in the vertical direction to the soil contact whenever the use of plowing is required. After the plowing is carried out the plow mechanism is retracted back to its orientation above the soil level so as to not interfere with the other operations. And hence the integration is within the model we don't require extra work labors and gasoline costs.

3.5 Soil Moisture Analysis

Soil moisture analysis is carried out by analyzing the moisture level of the soil with the help of a capacitive moisture sensor and feeding the data back to the system.

Soil Moisture sensor is placed at the bottom of the robot for easy retraction and analysis without interfering with other components. The slot is specially assigned for the sensor for the proper retrieval of data after analyzing, which is helpful throughout the area the robot works as different areas might contain different levels of moisture.

3.6 Artificial Intelligence

In our robot, we mainly use AI in the form of image processing for diagnosing plant diseases, pests, and identifying weeds.Machine Learning is used to train large data sets to give a clear way to detect the disease present in plants as well as to identify weeds from crops. The machine learning-based approaches, which will be used for detecting and classifying the diseases on agricultural products including various plants, fruits and vegetables.

We can control the flow of information in the form of signals transmitted in the form of live video from the ESP32 CAM. The live video recorded by the module is first sampled and processed, then it is hosted as a web server by the module itself, which can be accessed by an IP address created by the module. The live feedback is then analyzed by algorithms for the recognition of weeds and the crop thus helping in the proper feedback and implementation of weed cutters.An accurate and fast method to detect disease in crops based on the images of leaves will help to introduce a suitable treatment that will ultimately reduce economic cost and prevent loss in productivity.

3.7 RFID Based Navigation System

RFID is used for autonomous navigation purposes. When the RFID module detects the RFID tag, it first identifies if the tag is one of the tags that's linked with the system or not. If it's not linked with the system then it will avoid and continue on its path. But if it identifies that the tag is linked, then it reads the command that's specified on the tag and performs the task, which is motioned, ie LEFT, RIGHT, FLIP and STOP. The interface is controlled by the blynk app and using the blynk app the user can add a new tag or remove an existing tag that's previously added. This provides an extra layer of convenience to the user, as they don't have to purchase the specific cards for a specific purpose, but a universal card to assign a new task.

4.8 Solar Recharging

The solar panel placed on top-panel provides enough power to recharge the battery on the go. The top panel consists of a group of 6 solar panels. Each can output upto 6V and 100mAh. So the total combined can produce up to 600mAh when connected in parallel or upto 36V 100mAh connected in series. But as per the rating of the battery, a pair of three panels are connected in series and then connected in parallel to obtain the required output as 12V 300mAh. This power could be used to charge the battery, with the help of inbuilt BMS in the battery.

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IV. HARDWARE COMPONENTS

4.1. ESP32 MCU

ESP32 is a low-cost System on Chip (SoC) Microcontroller from Espressif Systems, the developers of the ESP8266 SoC. It is a successor to ESP8266 SoC and comes in both single-core and dual-core variations of the Tensilica's 32-bit Xtensa LX6 Microprocessor with integrated Wi-Fi and Bluetooth.It has integrated RF components like Power Amplifier, Low-Noise Receive Amplifier, Antenna Switch, Filters and RF Balun.

4.1.1 SPECIFICATION

- Number of cores: 2 (dual core)
- Wi-Fi: 2.4 GHz up to 150 Mbits/s
- Architecture: 32 bits
- RAM: 512 KB
- Peripherals: Capacitive touch, ADC, DAC, I2C etc.

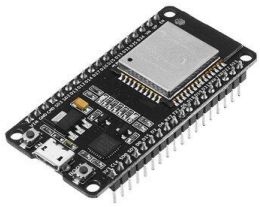

Fig: ESP32 MCU

4.2 ESP32 CAM

The ESP32-CAM is a very small camera module with the ESP32-S chip. Besides the OV2640 camera, and several GPIOs to connect peripherals, it also features a microSD card slot that can be useful to store images taken with the camera or to store files to serve to clients.This module adopts a DIP package and can be directly inserted into the backplane to realize rapid production of products, providing customers with high-reliability connection mode, which is convenient for application in various IoT hardware terminals.

4.2.1 SPECIFICATION

- Input Voltage: 5
- SPI Flash: Default 32Mbit
- RAM: 520 KB SRAM + 4MB PSRAM
- Wi-Fi: 802.11 b/g/n/
- Image Format: JPEG(OV2640 support only), BMP, GRAYSCALE
- Spectrum Range: 2412 ~2484 MHz

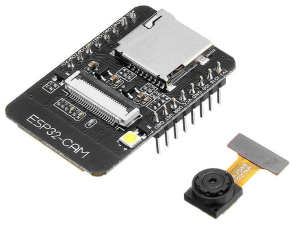

Fig: ESP32 CAM

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4.3 XL4005 BUCK CONVERTER

The XL4005 Power supply module is based on the XL4005 Dc-Dc converter IC. The module can step-down and regulate a voltage. The Potentiometer used here is a 25-turn potentiometer that provides easy adjustment of the output of the module to exactly the voltage application needs. It works with fixed 300 kHz frequency and uses a PWM buck feature where the maximum duty cycle is 100%. A built-in current limiting feature along with the thermal shutdown is also available in this module.

4.3.1 SPECIFICATION

- Input voltage: 7- 40V
- Output voltage: 1.2-35V
- Output Current: 8A
- Output Power: Maximum power is about 300W
- Protection: The built-in thermal shutdown function

Fig: XL4005 BUCK CONVERTER

4.4 L298N MOTOR DRIVER

This L298N Motor Driver Module is a high power motor driver module for driving DC and Stepper Motors. This module consists of an L298 motor driver IC and a 78M05 5V regulator. L298N Module can control up to 4 DC motors, or 2 DC motors with directional and speed control. The L298N Motor Driver is a controller that uses an H-Bridge to easily control the direction and speed of up to 2 DC motors.

4.4.1 SPECIFICATION

- Logical voltage: 5V
- Drive voltage: 5V-35V
- Logical current: 0-36mA
- Drive current: 2A (max. single bridge)
- Max power: 25W
- Motor Supply Voltage (Maximum): 46V
- Motor Supply Current (Maximum): 2A

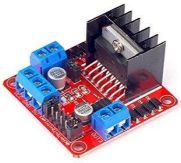

Fig: L298N MOTOR DRIVER

4.5 GEARED DC MOTOR

A geared DC Motor has a gear assembly attached to the motor. The speed of the motor is counted in terms of rotations of the shaft per minute and is termed as RPM. The gear assembly helps in increasing the torque and reducing the speed. These

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motors have a 3 mm threaded drill hole in the middle of the shaft thus making it simple to connect it to the wheels or any other mechanical assembly.

4.5.1 SPECIFICATION

- RPM: 45.
- Torque: 2 kg-cm
- Operating Voltage: 12V DC
- Gearbox: Attached Metal(spur)Gearbox
- No-load current = 60 mA(Max)
- Load current = 300 mA(Max)

Fig: GEARED DC MOTOR

4.6 SERVO MOTOR

A servo motor is a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity and acceleration. It consists of a suitable motor coupled to a sensor for position feedback. Features include good torque, holding power, and faster updates.

4.6.1 SPECIFICATION

- Recommended voltage : 5V
- Stall torque : 1.8 kg/cm (4.8V)
- Max stall torque : 2.2 kg/cm (6V)
- Gear type : Metal
- Rotation : 0°-180°

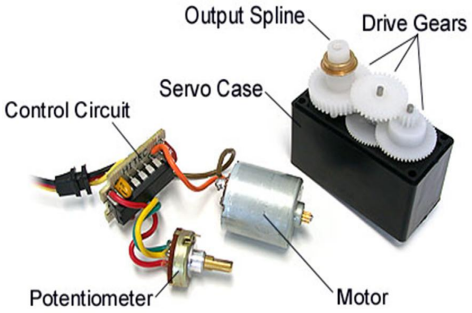

Fig: SERVO MOTOR

4.7 SUBMERSIBLE DC MOTOR

A submersible pump, also called an electric submersible pump, is a pump that can be fully submerged in water. The motor is hermetically sealed and close-coupled to the body of the pump. A submersible pump pushes water to the surface by converting rotary energy into kinetic energy into pressure energy.

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4.7.1 SPECIFICATION

- Operating Voltage: DC 5V
- Flow Rate : 80 ~ 120 L/H,
- Maximum Lift : 40 ~ 110 mm
- Maximum Flow Rate: 120 L/hr

Fig: SUBMERSIBLE DC MOTOR

4.8 MQ2 GAS SENSOR

MQ2 is one of the commonly used gas sensors in MQ sensor series. It is a Metal Oxide Semiconductor (MOS) type Gas Sensor also known as Chemiresistors as the detection is based upon change of resistance of the sensing material when the Gas comes in contact with the material. Using a simple voltage divider network, concentrations of gas can be detected.It works on 5V DC and draws around 800mW. It can detect Smoke levels anywhere from 200 to 10000 ppm.

4.8.1 SPECIFICATION

- Operating voltage: 5V
- Sensing Resistance: 10 KΩ – 60 KΩ
- Concentration: Scope: 200 – 10000 ppm
- Preheat Time: Over 24 hour

Fig: MQ2 GAS SENSOR

4.9 SOIL MOISTURE SENSOR

The soil moisture sensor measures soil moisture levels by capacitive sensing rather than resistive sensing like other sensors on the market. It is made of corrosion-resistant material which gives it excellent service life. Insert it into the soil around your plants and monitor the real-time soil moisture data.It is an analog capacitive soil moisture sensor which measures soil moisture levels by capacitive sensing, i.e capacitance is varied on the basis of water content present in the soil. The capacitance is converted into voltage level basically from 1.2V to 3.0V maximum.

4.9.1 SPECIFICATION

- Interface: 3-Pin Sensor
- Output Type: Analog
- Operating Voltage: DC 3.3-5.5V
- Output Voltage: DC 0-3.0V

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Fig. SOIL MOISTURE SENSOR

4.10 WATER LEVEL SENSOR

The sensor has a series of ten exposed copper traces, five of which are power traces and five are sense traces.These traces are interlaced so that there is one sense trace between every two power traces.Also these traces are not connected but are bridged by water when submerged.The series of exposed parallel conductors, together acts as a variable resistor (just like a potentiometer) whose resistance varies according to the water level. The change in resistance corresponds to the distance from the top of the sensor to the surface of the water.

4.10.1 SPECIFICATION

- Operating voltage: DC3-5V
- Operating current: less than 20mA
- Sensor Type: Analog
- Operating temperature: 10℃-30℃
- Humidity: 10% -90% non-condensing

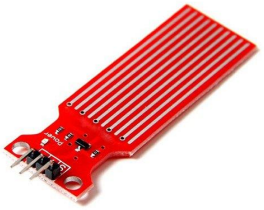

Fig. WATER LEVEL SENSOR

4.11 DHT11 SENSOR

DHT11 is a low-cost digital sensor for sensing temperature and humidity. It consists of a capacitive humidity sensing element and a thermistor for sensing temperature. The humidity sensing capacitor has two electrodes with a moisture holding substrate as a dielectric between them. Change in the capacitance value occurs with the change in humidity levels. The IC measures, processes these changed resistance values and changes them into digital form.

4.11.1 SPECIFICATION

- Operating Voltage: 3.5V to 5.5V
- Operating current: 0.3mA
- Temperature Range: 0°C to 50°C
- Humidity Range: 20% to 90%

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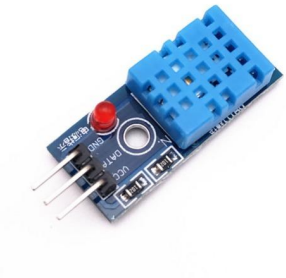

Fig. DHT11 TEMPERATURE HUMIDITY SENSOR

4.12 MINI SOLAR PANEL

Solar power is harnessed using Solar Photovoltaic (PV) technology that converts sunlight (Solar radiation) into electricity by using semiconductors. Solar panels use sunlight as a source of energy to generate direct current electricity. A collection of PV modules is called a PV panel, and a system of PV panels is called an array. Arrays of a photovoltaic system supply solar electricity to electrical equipment.

4.12.1 SPECIFICATION

- Output Current : 100mAh
- Output Voltage: 6V
- Output Type: dc
- Material: Polycrystalline

Fig. MINI SOLAR PANEL

4.13 RFID

The RC522 RFID module based on MFRC522 IC from NXP is one of the most inexpensive RFID options that you can get online for less than four dollars. It usually comes with a RFID card tag and key fob tag having 1KB memory. And best of all, it can write a tag, so you can store your some sort of secret message in it. The RC522 RFID Reader module is designed to create a 13.56MHz electromagnetic field that it uses to communicate with the RFID tags (ISO 14443A standard tags). The reader can communicate with a microcontroller over a 4-pin Serial Peripheral Interface (SPI) with a maximum data rate of 10Mbps. It also supports communication over I2C and UART protocols.

4.13.1 SPECIFICATION

- Voltage: DC 3.3V
- Operating Current :13-26mA.
- Operating Frequency: 13.56MHz.
- Working frequency：13.56MHz
- Card reading distance ：0 ~ 60mm

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Fig. RFID

4.14 LITHIUM - ION BATTERY

This battery pack is made up of the best quality tested ICR 18650 2500mAh 20C Lithium-Ion Batteries and BMS circuit. It is small in size and weight compared to Ni-Cd, Ni-MH, and Lead Acid Batteries. With the inbuilt Charge protection circuit, the battery pack can be directly charged with the DC power Adapter, so need not use the specialized battery chargers and worry about overcharging. We build these battery packs in a diverse ranges to fulfill 7.4V to 14.8 V and differential capacities.

4.14.1 SPECIFICATION

- Battery specification: 18650 / 11.1V / 2600mAh
- Termination voltage: 8.25V
- Charging temperature: 10~45℃

Fig. LITHIUM - ION BATTERY

4.15 BLYNK APPLICATION

Blynk was designed for the Internet of Things. It can control hardware remotely, it can display sensor data, it can store data, visualize it and do many other cool things.There are three major components in the platform:
Blynk App - allows you to create amazing interfaces for your projects using various widgets we provide.
Blynk Server - responsible for all the communications between the smartphone and hardware. You can use our Blynk Cloud or run your private Blynk server locally.
Blynk Libraries - for all the popular hardware platforms - enable communication with the server and process all the incoming and outcoming commands

Fig. BLYNK APPLICATION

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V. WORING

5.1 CIRCUIT DIAGRAM

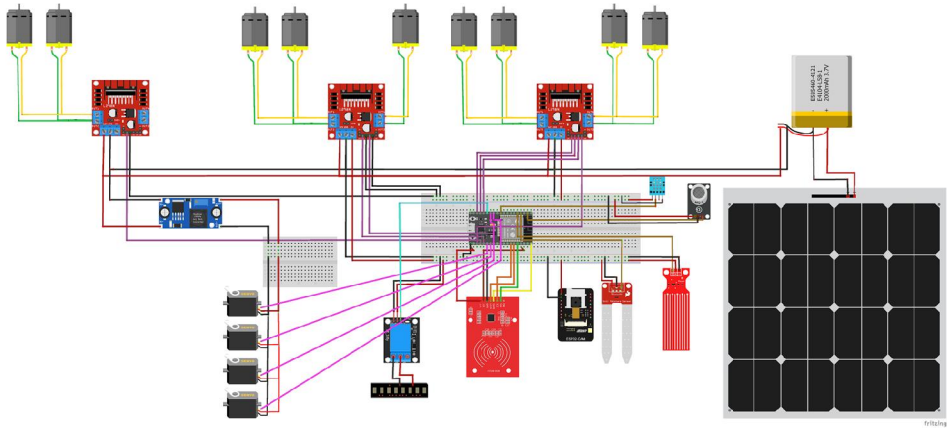

Figure: CIRCUIT DIAGRAM

5.2 WEED CUTTING

The weed cutting feature is equipped with a dual cutting mechanism. There are two different cutting blades attached to its motor, which is powered by a 5V DC supply. The entire system is designed in such a way that the cutting blade and motor combo is attached to an arm that can be retracted and kept out of sight when not required. This retractable mechanism can be achieved by using a 6V servo motor. Once the farmer switches the robot to the weed cutting mode, the arms will extend outwards enabling the blades to cut through the weeds.

5.2.1 KEY POINTS

- Dual Blade cutting mechanism.
- Larger blades for effective cutting.
- Blade is attached to a 5V DC motor which can rotate at 1000 rpm.
- A 6V servo motor is attached to the end of the arm, which is used for:
    - Retractable mechanism.
    - Enabling swinging mode.

5.3 PLOUGHING

For the ploughing mechanism we have a custom designed plough placed at the backside of the robot for a smooth and undisturbed workflow. The engaging and disengaging of the plough can be achieved by the help of a servo motor that's attached to the arm of the plough. The servo motor will also help in maintaining the angle at which the plough is set.

5.3.1 KEY POINTS

- Custom designed plough placed at the backside of the robot for a smooth and undisturbed workflow.
- A 6V servo motor is used for engaging and disengaging.
- Since the servo motor works on the basis of a closed loop feedback system it tries to maintain the desired position even if an error is generated at the output.

5.4 IRRIGATION & FERTILIZATION

The robot consists of an onboard tank that could hold water, pesticides or fertilizers according to the need of the farmer, thus enabling all three purposes and eliminating the need of 3 separate systems. The fluid in the tank is pumped out by the help of dual submersible pumps that is kept on either side of the tank, enabling the robot to cover both sides at once.The tank has two different partitions enabling an option to mix the fertilizers and pesticides in a given percentage. This will remove the need for the farmer to be exposed to harmful toxic components. The mixing is done by the help of a third

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submersible pump placed in the small compartment pumping the concentrated mixture to the waters in the larger compartment. The ratio of the mixture can be controlled by the amount of the liquid pumped.

5.4.1 KEY POINTS

- Onboard tank with dual chambered designs.
- Dual chambered designs allow the ability to mix the fluids.
- Dual submersible pump is used for even distribution on either side.
- The entire system can be repurposed for fertilization and spraying pesticide.

5.5 SOIL MOISTURE TESTING

The robot consists of a soil moisture sensor that helps it to determine the moisture content of the soil. The overall system consists of a circuit control board and a probe. The probe is the part that goes into the soil, so it's equipped with a metallic sensor strip which helps in detecting the values.The output values of the soil moisture sensor are received as analog signals from the onboard circuit board.The operating voltage is between 3.3V to 5V and the power is applied between VCC and GND.

5.5.1 KEY POINTS

- It is used for detecting soil moisture level.
- There is a probe placed at the bottom of the arm which detects the soil moisture level.
- The movement of the arm is controlled by a servo motor..

5.6 WATER LEVEL INDICATOR

The water level indicator placed in the tank helps us to properly track the amount of water present. The sensor has multiple elongated metallic electrodes which can measure the change in water level due to the change in conductance between the electrodes. This change in current is measured by the onboard circuit and is converted to analog signals of 3.3V or 5V depending on the input voltage.

5.6.1 KEY POINTS

- Helps to monitor the water level in the tank.
- The value received also depends on the salt contents of water.

5.7 SOLAR RECHARGING

The top panel consists of a group of 6 solar panels. Each can output upto 6V and 100mAh. So the total combined can produce up to 600mAh in connected in parallel or upto 36V 100 connected in series. But as per the rated input of the battery the pair of 3 connected in series are connected in parallel to obtain the required output as 12V 300mAh. This power could be used to charge the battery.

5.7.1 KEY POINTS

- Consist of a group of 6 panels in total.
- 3 sets of series connections kept in parallel can give 12V and 300mAh.

5.8 SMOKE DETECTION

MQ2 is one of the commonly used gas sensors in MQ sensor series. It is a Metal Oxide Semiconductor (MOS) type Gas Sensor also known as Chemiresistors as the detection is based upon change of resistance of the sensing material when the Gas comes in contact with the material. Using a simple voltage divider network, concentrations of gas can be detected.The sensor is actually enclosed in two layers of fine stainless steel mesh called Anti-explosion network. It ensures that the heater element inside the sensor will not cause an explosion, as we are sensing flammable gasses.

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5.8.1 KEY POINTS

- MQ2 sensor is a general purpose smoke detection sensor.
- It can be used for detecting fire in the field.
- Can also be repurposed to detect internal short-circuit.

5.9 AI IMPLEMENTATION

Making the ability to think is the success rate of the model due to different sensors are assembled together in a model which could override the thinking ability of the system if it does not have enough memory, so we have to consider the necessity of applying the processor which has enough memory to handle the data and memory dump due to the flow of collected information. We have also arranged the facility for the system to let itself get accessed with the help of a smartphone which makes it more reliable as the control is placed to the user who uses the system thus making it more user friendly and the ability to access the data with the real time world.The camera module is connected to the main board, which is assigned the 115200 baud rate. After the connection of the AI thinker cam, the live streaming platform is started which is then utilized to determine the image recognition.The benefit of using this type of feature is that the AI makes the model autonomous and thus controlling the flow of data across the system and hence making itself work without any human attention.

5.9.1 KEY POINTS

- Alfes is used for the AI / ML implementation
- Feedforward Neural Network (FNN) interference and training
- The ESP32 CAM is installed onto the robot, and is started for the environment analysis. The camera detects individual objects and entities which helps in the defining of a crop and a weed.
- The training model given is of a crop that is utilized for the crop image processing. The trained model then distinguishes between the object that has been feeded in the training phase.
- Individual analysis then reports whether the distinguished object is a crop or a weed thus starting the weed cutters if the detected image is a weed.
- Also once the operation gets satisfied it terminates its loop and performs the rest of the iteration.

5.10 RFID BASED NAVIGATION SYSTEM

RFID is used for navigation purposes. As the RFID module detects the RFID tag, it first identifies if the tag is one among the tags that's added to the system or not. If it's found not to be one of its systems then it will leave it as and continue on its path. But if it identifies it to be a part of its system then it reads the command that's specified on to that tag and performs the new task, in this its the motion, ie LEFT, RIGHT, FLIP and STOP.

The interface is controlled by the blynk app. Using the blynk app the user can add a new card or remove an existing card that's previously added. This provides an extra layer of convenience to the user, as they don't have to purchase the specific cards for a specific purpose, but a universal card to assign it to a new task.

5.10.1 KEY POINTS

- Consist of a RFID reader module on top of the robot for capturing the signal.
- Ability to add and remove cards as per the requirement.
- A Reader consists of a Radio Frequency module and an antenna which generates a high frequency electromagnetic field. On the other hand, the tag is usually a passive device, meaning it doesn't contain a battery. Instead it contains a microchip that stores and processes information, and an antenna to receive and transmit a signal.
- To read the information encoded on a tag, it is placed in close proximity to the Reader (does not need to be within direct line-of-sight of the reader). A Reader generates an electromagnetic field which causes electrons to move through the tag's antenna and subsequently power the chip.
- The powered chip inside the tag then responds by sending its stored information back to the reader in the form of another radio signal. This is called backscatter. The backscatter, or change in the electromagnetic/RF wave, is detected and interpreted by the reader which then sends the data out to a computer or microcontroller

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VI. CONCLUSION

The aim of the project is to reduce the workload on farmers, on time consuming and tedious processes. As there are few farming processes like weed cutting, soil moisture testing, fertilization that has to be done frequently in every week or two, such tasks require more human resources and manpower, leading to an increase in the total investment to farming, thus resulting in lower profits for farmers. By implementing a robot to perform these tedious tasks, farmers can actually reduce the manpower investments as well as get better yields. As a result the total cost that's needed to perform will reduce significantly, in addition to that the time involved in the process will also be reduced. Thus leading to overall improvement in farmers income which in turn improves overall farming quality.

VII. APPENDIX

7.1 BLYNK INTERFACE

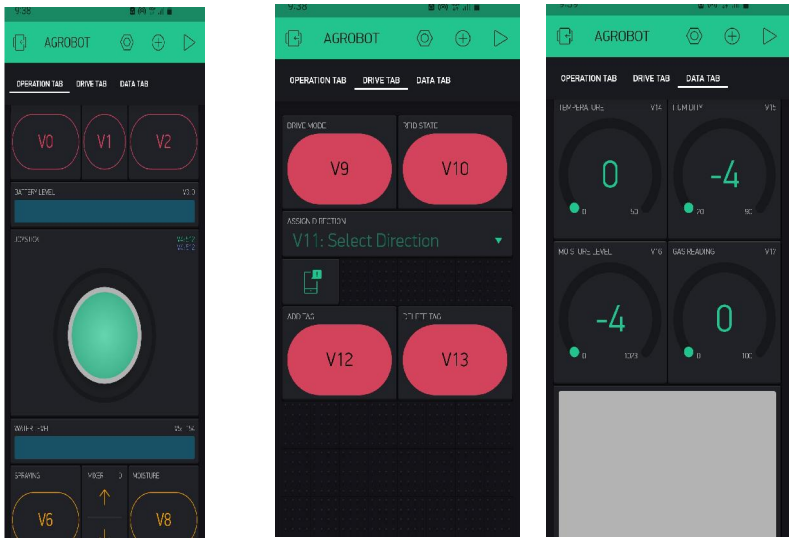

Fig. BLYNK INTERFACE

7.2 RFID BASED NAVIGATION SYSTEM

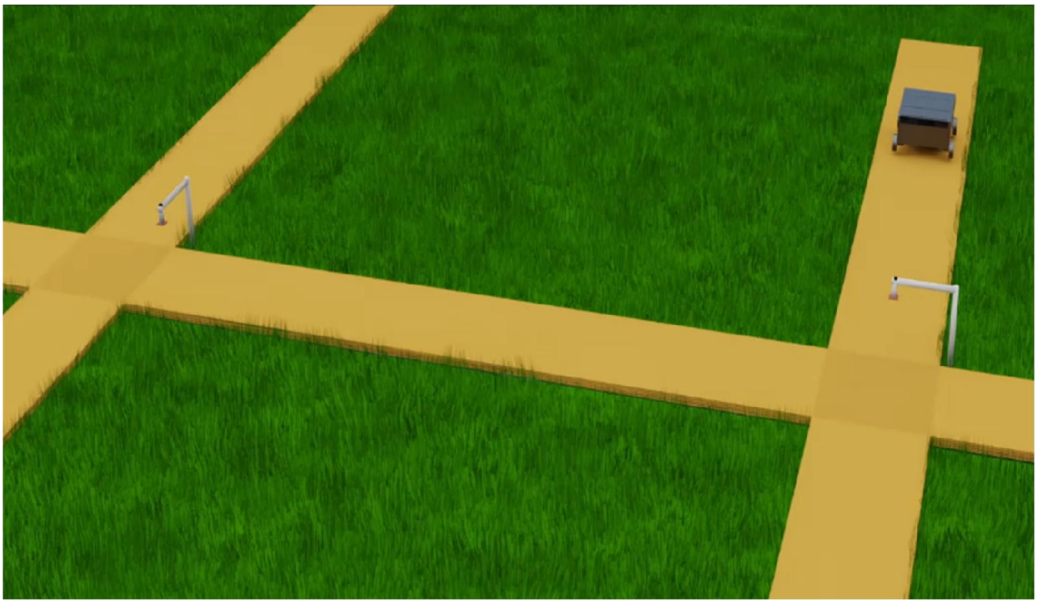

Fig: RFID BASED NAVIGATION SYSTEM (A)

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Fig: RFID BASED NAVIGATION SYSTEM (B)

7.3 PROJECT IMAGES

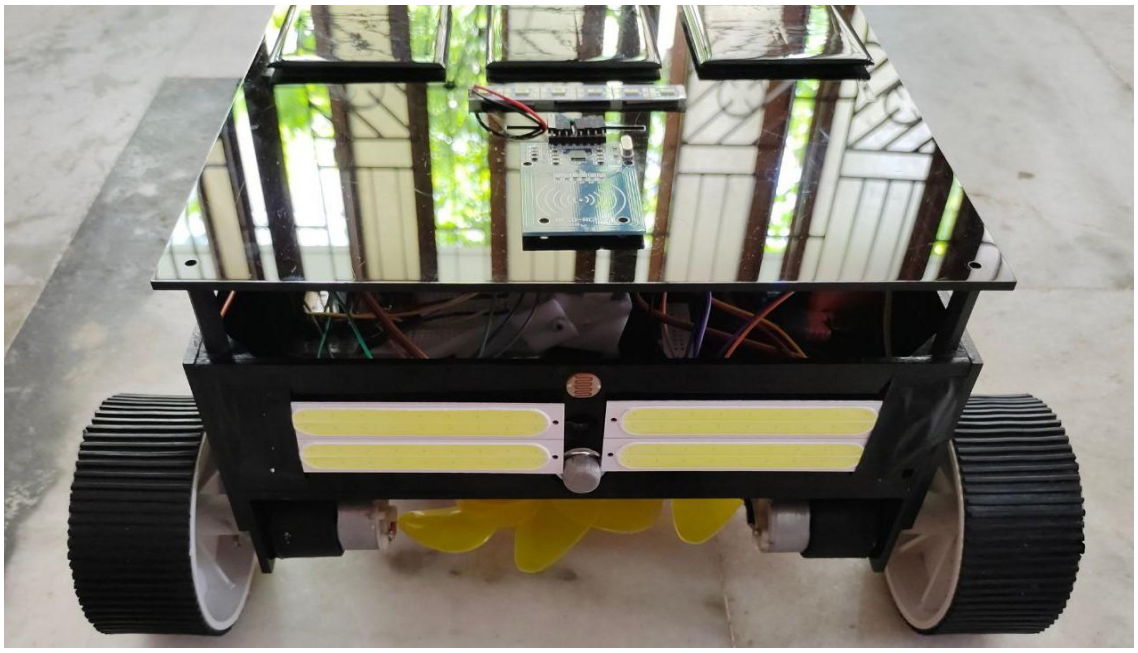

Fig. PROJECT IMAGE (A)

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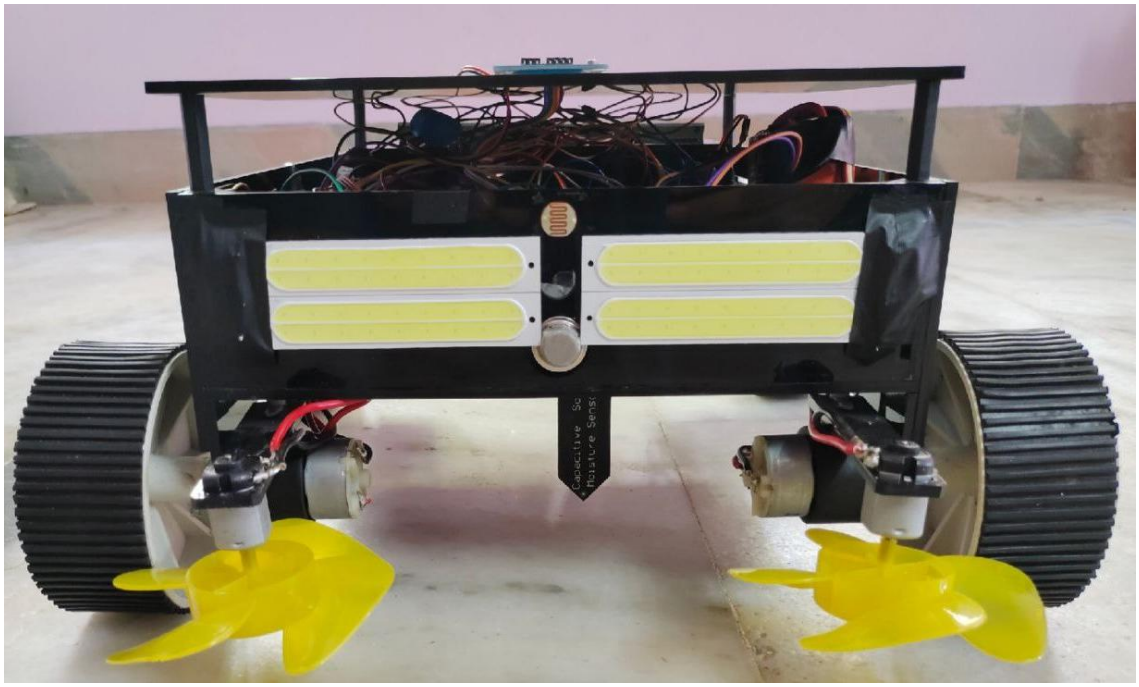

Fig. PROJECT IMAGE (B)

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