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DESIGN AND DEVELOPMENT OF CONTROLLABLE WATER SPRINKLER MANUAL MOBILE ROBOT PROTOTYPE BASED ON MOISTURE CONTENT OF SOIL

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ABSTRACT

The "Design and development of controller water sprinkler based on moisture content of soil" is a agricultural automation solution designed to do farming practices through the integration of cutting-edge technologies. This project leverages the ESP8266 microcontroller, Blynk IoT platform, L298 motor driver, DC motors, water pump, servo motor for soil moisture sensor, and an ESP32 Cam for live streaming. These components results in a versatile agricultural robot capable of performing tasks such as water sprinkling, soil moisture measuring and real-time field monitoring. Traditional agriculture is evolving towards greater efficiency and precision, necessitating the incorporation of modern technologies.. The ESP8266 microcontroller serves as the central processing unit, facilitating seamless communication and control of various functions. The Blynk IoT platform complements this by offering an intuitive interface for remote operations and live data monitoring.

Keywords: Agriculture, Smart Irrigation System, Farming Techniques.

I. INTRODUCTION

Modern agriculture faces the challenge of meeting growing food demands while optimizing resource usage. The Field Rover addresses this challenge by incorporating advanced robotics and IoT technologies into traditional farming practices. The ESP8266 microcontroller serves as the brain of the robot, allowing for seamless communication and control. The Blynk IoT platform provides a user-friendly interface for remote operation and monitoring, empowering farmers with real-time data.

The robot's mobility is facilitated by DC motors controlled by the L298 motor driver, ensuring precise navigation across the field. For irrigation purposes, a water pump is integrated, enabling targeted and automated watering. The soil moisture measuring function is achieved through a servo motor, providing controlled and accurate soil preparation.

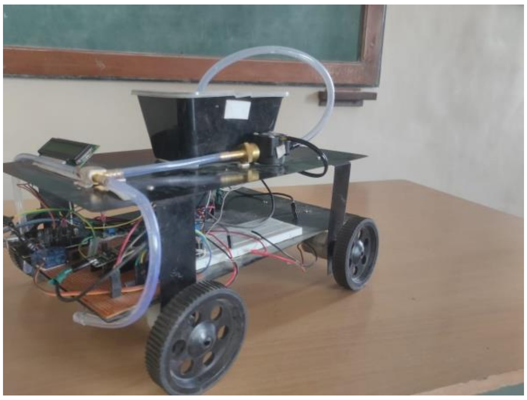

Figure 1: Controllable Water Sprinkler AGV Prototype based on Moisture Content of Soil

One of the key features of the Field Rover is the ESP32 Cam, enabling live streaming of the agricultural field. This feature allows farmers to remotely inspect and monitor the field in real-time, making informed decisions about crop health and overall farm management.

The Field Rover aims to revolutionize agriculture by offering a comprehensive solution that optimizes labor, conserves resources, and enhances productivity. The integration of smart technologies not only simplifies traditional farming practices but also opens avenues for precision agriculture and data-driven decision-making.

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This project represents a significant step towards sustainable and efficient farming practices in the era of smart agriculture.

II. DESIGNING OF THE ROBOT

The prototype design of the robot is developed on the software Fusion 360 by Autodesk. It is designed according to the parameters and accurate measurements taken to develop the robot and its application.

A. Designing the Prototype using FUSION 360

Fusion 360 is a powerful CAD (Computer-Aided Design) software developed by Autodesk that allows users to design 3D models, simulate functionality, and generate manufacturing documentation. Designing a prototype using Fusion 360 involves several steps:

- **Sketching**: Begin by creating a new design file in Fusion 360. Start by sketching the basic outlines or profiles for prototype's components. Using tools like lines, arcs, circles, rectangles, and splines to create 2D sketches on different planes to complete the prototype design of the AGV.
- **Extrusion and Revolve**: Once the 2D sketches ready, the shapes like wheels, agv base and upper body can be extrude or revolve them to create 3D shapes. Select the sketch for to extrude or revolve, then use the corresponding tool to specify the direction and distance for extrusion of angle for revolution.
- **Materials and Appearances**: Assign materials and appearances to your prototype to make it look more realistic. Fusion 360 comes with a library of predefined materials, assign the materials according to feasibility of the design and strength and initiate the final design and simulate it.

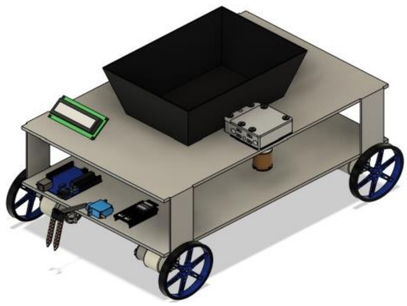

Figure 2: AutoCAD Design of prototype

III. CALCULATING STRAIN AND STRESS USING FUSION 360

The Fusion 360 allows us to perform stress and strain analysis using the built-in simulation workspace. This allows us to evaluate how your design will behave under various loads and conditions, helping you optimize its performance and durability. to calculate stress and strain using Fusion 360 involves steps:

- **Preparing Model:** Start by ensuring that the 3D model is fully defined and ready for analysis in Fusion 360.Make sure all components are properly assembled if the design involves multiple parts. Assign appropriate materials to your model. Fusion 360 offers a library of materials with predefined properties, or you can create custom materials if needed.
- **Access the Simulation Workspace:** Switch to the Simulation workspace in Fusion 360 by clicking on the "Simulation" icon in the toolbar. This will open up the simulation environment where you can set up and run analyses.
- **Set Up the Study:** Click on the "New Study" button to create a new simulation study. Choose the type of analysis you want to perform, such as static stress, modal frequency, thermal, or nonlinear analysis. For stress and strain analysis, select the "Static Stress" study type.
- **Apply Loads and Constraints:** Define the loads and boundary conditions that your design will experience in real-world conditions. Common loads include forces, pressures, torques, and gravitational loads. Apply constraints to restrict the movement of certain parts or fix them in place.
- **Run the Analysis:** Once you have set up the study and defined all the necessary parameters, run the analysis. Fusion 360 will solve the equations and calculate the stress and strain distribution throughout model.

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- **Review Results:** After the analysis is complete, you can review the results to understand how your design behaves under the applied loads. Fusion 360 provides visualizations of stress, strain, displacement, factor of safety, and other relevant parameters. Examine the results by viewing contour plots, graphs, and animations. The analysis also shows the shear stees and shear strain developed in the design of the robot's base.

IV. HARDWARE

The components selected for the project are taken from the study of research papers in literature review, internet, and other video sources. The components included in our projects are as follows:

A. Arduino Uno

The Arduino Uno is one of the most popular microcontroller boards in the Arduino family. It is widely used in electronics and robotics projects due to its versatility, ease of use, and a large community of developers and resources. The board is based on the Atmega328P microcontroller and is known for its simplicity, making it an excellent choice for beginners and experienced makers alike

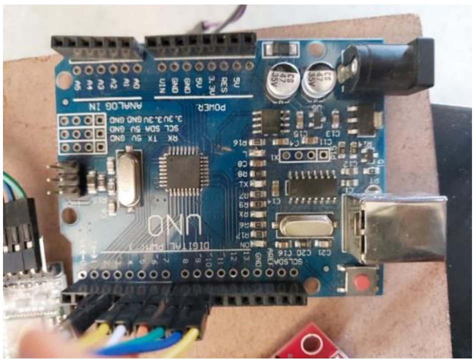

Figure 3: Arduino Uno board.

The Arduino Uno board is a versatile microcontroller platform designed for easy programming and interaction with a wide range of electronic components. Its simplicity and extensive community support make it an excellent choice for both beginners and experienced.

B. Motor Driver

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 module consists of an L298 Motor Driver IC, 78M05 Voltage Regulator, resistors, capacitor, Power LED, 5V jumper in an integrated circuit.78M05 Voltage regulator will be enabled only when the jumper is placed. When the power supply is less than or equal to 12V, then the internal circuitry will be powered by the voltage regulator and the 5V pin can be used as an output pin to power the microcontroller. The jumper should not be placed when the power supply is greater than 12V and separate 5V should be given through 5V terminal to power the internal circuitry. ENA & ENB pins are speed control pins for Motor A and Motor B while IN1& IN2 and IN3 & IN4 are direction control pins for Motor A and Motor B.

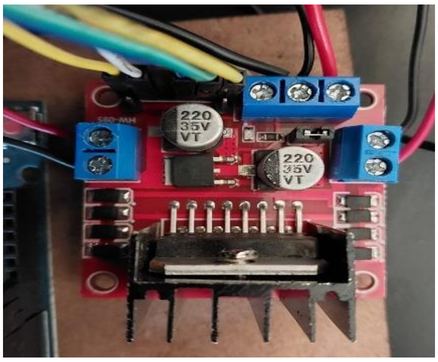

Figure 4: L298N Motor driver

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C. Soil Moisture Sensor

This **soil moisture sensor module** is used to detect the moisture of the soil. It measures the volumetric content of water inside the soil and gives us the moisture level as output. The module has both digital and analog outputs and a potentiometer to adjust the threshold level.

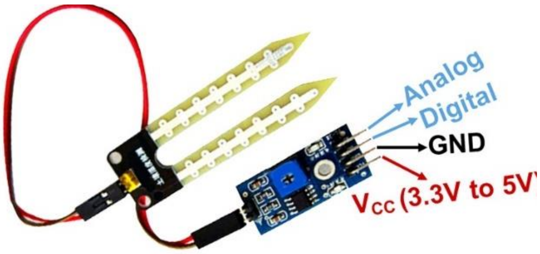

Figure 5: IR Sensor

D. ESP32- CAM

The ESP32-CAM is a small-size, low-power camera module based on **ESP32**. It comes with an **OV2640 camera** and provides an onboard TF card slot. This board has **4MB PSRAM** which is used for buffering images from the camera into video streaming or other tasks and allows you to use higher quality in your pictures without crashing the ESP32. It also comes with an onboard LED for flash and several GPIOs to connect peripherals.

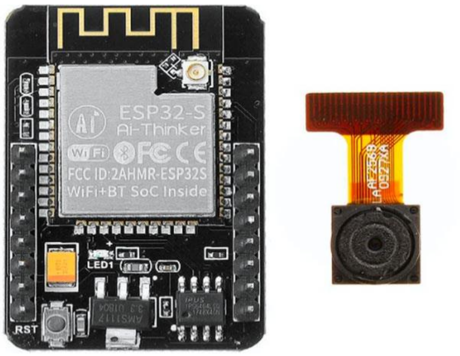

Figure 6: Bluetooth Module HC-05

D. YF-S201- Water Flow Measurement Sensor

YF-S201 is a water flow measurement sensor with high-grade quality sealing property. It works on the Hall effect principle and with a flow rate range of 1~30L/min. The module has three pins: Power, Ground, and the Analog output. YF-S201 consumes very little current and can work with an allowing pressure of ≤1.75MPa

Figure 7: YF-S201- Water Flow Measurement Sensor

V. ELECTRICAL CONNECTION CIRCUIT

The connection of the hardware used in the robot for ESP-8266 is shown below. The circuit consists of the following components like Arduino Uno, Soil Moisture Sensor, Motor Driver, ESP-32 CAM, and Water Flow Measurement Sensor.

The below circuit is created by the help of Tinker Cad software which is a basic ESP-8266 circuit which also has an App based control over the robot.

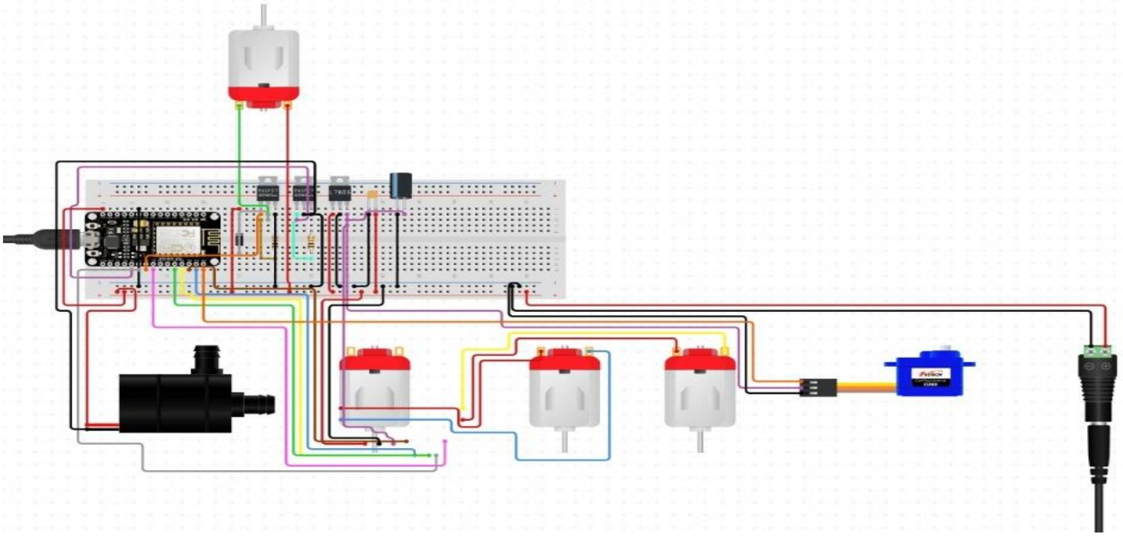

Figure 8: ESP-8266 Circuit

VI. SOFTWARE ARCHITECTURE

The software architecture includes App interface for the moment control and GUI interface for interactive user interface.

A. App Interface

The Interface developed for the robot is developed through use of Blynk App which is a free platform to develop the applications. The app is developed to control the rover. The App is developed on the platform i.e. Blynk APP which is a open and free source to develop and create the app.

The below image shows the app developed for the operating the movement of the robot.

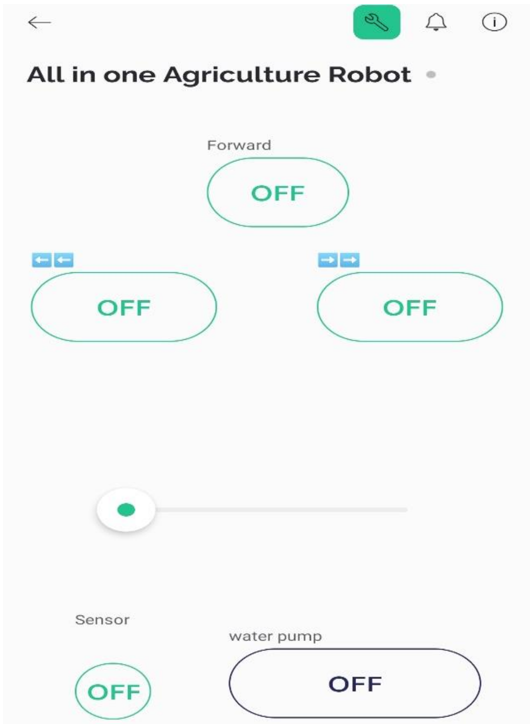

Figure 9: App Interface

The buttons which are seen in the above image of App Interface are basically forward, reverse, and left and right turn. The Manual mode is used for movement of the rover.

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VII. CONCLUSION

The development of the controllable water sprinkler AGV prototype demonstrates a promising solution for efficient irrigation management based on soil moisture content. Through the integration of sensors and actuators, the prototype effectively detects moisture levels in the soil and autonomously navigates to areas requiring watering. This not only optimizes water usage but also reduces labor costs and improves crop yield potential. Further refinement and testing are necessary to enhance the prototype's robustness and accuracy in real-world agricultural settings. Overall, this project lays a foundation for the implementation of smart irrigation systems, contributing to sustainable agriculture practices and resource conservation.

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