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"Smart Multipurpose Agricultural Robot"

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Abstract: Agriculture plays a vital role in sustaining the global economy, yet farmers face challenges such as labour shortages, high costs, and inefficient resource utilization. To address these issues, this project presents the design and development of a Smart Multipurpose Agriculture Robot capable of performing multiple farming operations autonomously or semi-autonomously. The proposed system integrates IoT (Internet of Things), embedded systems, and sensor technologies to carry out tasks such as seed sowing, pesticide spraying, soil moisture monitoring, and weed detection efficiently.

Keywords: Arduino Uno, IoT (Internet of Things).

I. INTRODUCTION

Agriculture is a primary pillar of many economies and constitutes a source of income for numerous people around the world, particularly in developing nations. Farmers regularly encounter issues such as labor shortages, the physical strain that comes from labor-intensive jobs, and maintaining a proven, reliable way to manage the crop. Even if the traditional method of agriculture is warranted, it still represents a land, and labor burden for critical farming activities such as planting seeds, cutting grass or weeds, or lab to analyze and assess soil and environmental condition. With very fast-paced advances in technology developments, mechanization of agriculture addresses such situations. Agricultural mechanization has emphasized growing use of robots, embedded systems, and other technology, necessarily entirely and partly eliminate and reduce the need of human labor and create efficiencies performing agriculture operations exactly and accurately. Machines that act as robots in agriculture have cumulatively increased productivity, reduced budgets with operating expenses, and reduced human labor. This project focuses on designing a multi-functional agriculture robot capable of completing important agricultural labor functions in an easy to automate fashion. The robot uses gear motors driven by an L293D motor driver for movement, a mechanism using a servo motor for planting seeds, and a cutting blade driven by a DC motor for cutting grass. Temperature and humidity sensor is pitched on the robot and also includes a second moisture sensor for environmental readings. All of which can be displayed in real-time on a provided 16x2 LCD display for users, which can be used by farmers for decision-making.

In this project we incorporate several functions into one robot. This project showcases the potential of automation in precision agriculture and steps towards smart farming processes in terms of efficiency and simplicity. Likely all at less cost if purchased or contracted out.

II. METHODOLOGY

The design process for the robot to be used in farming was a careful combination of both hardware and software into an integrated system that can also be used to autonomously complete multiple simple agricultural tasks. The powered mobility through locomotion of the robot is provided by 12V geared motors that have enough torque to move across the soil-surface terrain. The 12V geared motors are connected to L293D motor drivers that allow the microcontroller unit to (MCU) control the directionality of the motors through an exported signal to the motor driver. The microcontroller (an Arduino Uno or similar development board) is used to manage the functions of the motors, seed sowing and or grass cutting and to interprehow to process the obtained sensor data. The seeding mechanism has been designed to utilize a servo, which turns in predetermined angle increments to drop the seed down into the soil to minimize seed waste, and also make sure that seeds are dropped after a certain distance. The DC motor has also been mounted to the robot chassis and is used with a cutting blade as a simple and efficient means of trimming grass and weeds that grow in and around the farming designated area. To introduce precision agriculture to the platform, environmental sensors are built into the robot.

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A DHT11 sensor was incorporated specifically for measuring temperature and relative humidity, and, because they are capable of communicating together, a soil moisture sensor was also added to measure the moisture content in the soil. The environmental sensors provide output signals that are consistently sent to a microcontroller that accepts values from the environment and records the output in a 16x2 LCD screen for the farmer to observe. For all software programming, the Arduino IDE was utilized to program the Arduino board, writing algorithms to control the motors, time the seed sowing process, and receive output from the sensors. The process was broken down into steps, first testing each component (motors, environmental sensors, and LCD) separately, an and brought together as a system.

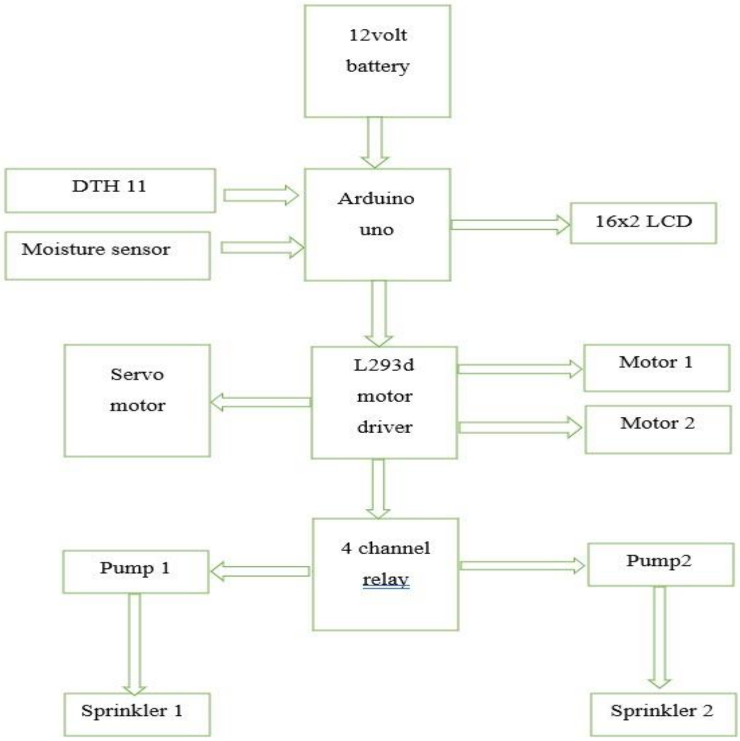

Fig 1: Smart Multipurpose Agricultural Robot

III. IMPLEMENTATION

This multi-functional agricultural robot works under the control of an algorithm that initiates with the initialization of the entire embedded system. Upon initialization, the Arduino microcontroller turns all the peripheral components on: L293D motor driver shield, DC motors for locomotion, a servo motor for dispensing seeds, a grass-cutting blade motor, temperature and humidity sensor-DHT series, a soil moisture sensor, and a 16×2 I2C LCD module. After successful initialization of the hardware modules, the system enters its main operational loop; first, sampling of the ambient temperature, humidity, and soil moisture levels is performed. These values are immediately processed and showed on the LCD so as to keep the user constantly informed about the field conditions in real time. Having done that, the robot checks what mode of operation is selected through the user interface or previously set in the program-movement, dispersion of seeds, or grass cutting-and then executes the associated sequence of actions. In the movement mode, all four gear motors are turned on by the robot in order to move in the desired direction while scanning for any obstructions or irregularities. The algorithm provides stable navigation, allowing the robot to stay balanced and navigate over uneven agricultural terrain by controlling the motor speeds and directions. The Arduino calculates the distance traveled or the timing interval before turning the servo to a predefined angle, which opens the seed chamber slot and releases a predefined number of seeds into the ground. The system then turns on the servo motor in seed-sowing mode. After the seeds are dispensed, the servo precisely repeats the cycle, closing the slot and going back to its starting position to ensure uniform seed distribution across the field.

Step1: Start
Step2: Arduino Initialization, Sensors, LCD, and Motor Driver
Step3: Reading the Temperature, Humidity, and Soil Moisture Sensors
Step4: Display Sensor Values on LCD

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Step 5: Check Robot Mode: Movement / Seed Sowing / Grass Cutting
Step 6: If Movement Mode is Active Move Forward Check Obstacles or Manual Stop Command
Step 7: If Seed Sowing Mode is turned on Servo motor rotation Open Seed Slot Drop Seeds Close Slot Repeat at Fixed Intervals
Step 8: If Grass Cutting Mode is active, turn ON Cutting Blade Motor Move Robot Across Grass Weed Trimming Turn OFF Blade After Completion
Step 9: Read Constantly
Temperature
Humidity
Soil Moisture
Step 10: If Soil Moisture Below Threshold Display "LOW MOISTURE" on LCD
Step 11: Update LCD with:
Current Operation
Sensor Values
Robot Status
Step12: Stop Motors
Step 13: Terminate and Clean Up

In addition, the algorithm ensures that environmental data is refreshed from time to time and displayed consistently so that informed decisions could be made by farmers while the robot operates autonomously. After the completion of all selected tasks or in the instance of an issued command for a stop, the robot safely brings to a halt all DC motors, stops the cutting blade, resets the servo position, updates the final status on the LCD, and gracefully terminates the operation by entering into an idle or shut-down state. This broad algorithmic structure works to ensure the robot functions reliably, efficiently, and autonomously, bringing together several farming operations into one intelligent and user-friendly robotic platform.

IV. RESULT

A prototype of Smart Multipurpose Agricultural Robot was designed and tested. It performs multiple agricultural operations: efficient grass cutting, seeding, sowing, and water spraying.
Rotating blades powered by DC motors allowed the grass-cutting mechanism to cut small and medium-height grasses effectively and efficiently.
The seed-sowing system was designed to dispense the seeds into the soil at accurate and consistent spacing, with a view to giving the plants the right spacing for maximum growth.


Fig 2: Grass Cutting Mechanism

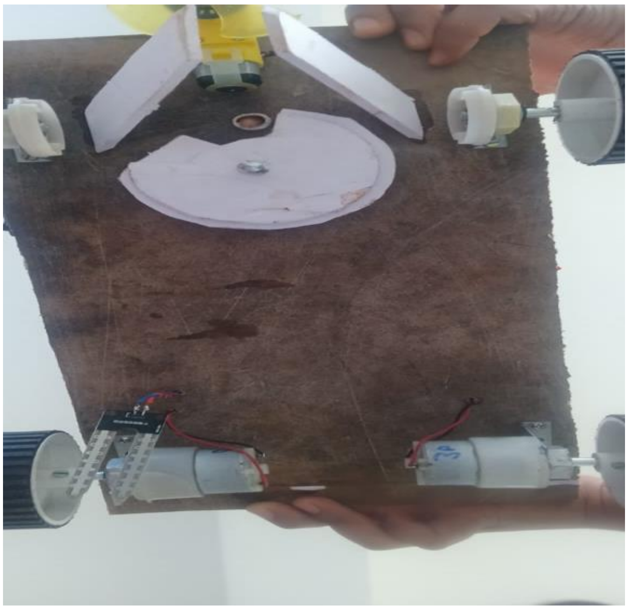
Fig 3: Seed Sowing Mechanism

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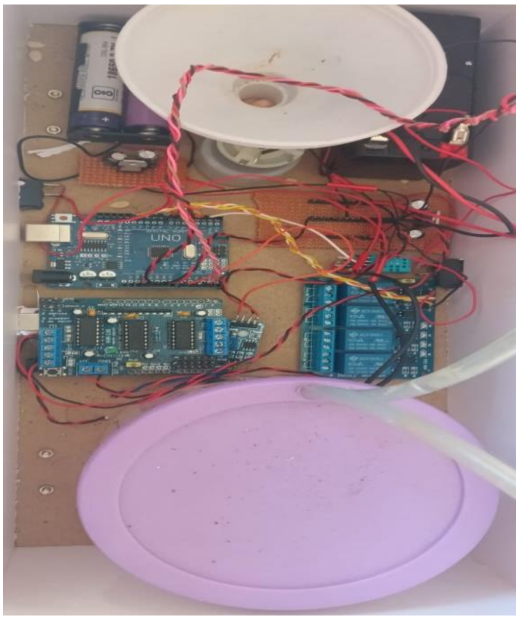

Fig 4: Hardware connection

V. CONCLUSION

The Smart Multipurpose Agricultural Robot exemplifies a practical, autonomous, and modular approach to small scale precision agriculture utilizing an Arduino Uno, various sensors (moisture, temp, and humidity), actuators (DC Motors, servo motor, and water pumps), a 16x2 LCD screen and 4-channel relay. The robot is capable performing a comprehensive list of to-dos: seed sowing, grass cutting, precise irrigation, and environmental monitoring- which are laborious, while they are efficient with respect to resource management. The system has been programmed in Embedded C to allow for reliable control of sensors and actuators with the LCD providing relevant feedback, thus providing proof of concept and feasibility in modern agricultural practice.

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