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Design and Development of Urea Fertilizer IoT based Robot for Agriculture Fields

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Abstract

The Urea Fertilizer Robot Using Arduino and IOT is an innovative and efficient solution designed to automate the process of distributing urea fertilizer in agricultural fields. The aim of this project is to reduce human effort, minimize fertilizer wastage, and optimize the distribution of urea fertilizer for enhanced crop growth and yield.

The robot is equipped with an Arduino microcontroller, which acts as the brain of the system, enabling precise control and coordination of various components. The hardware components include motors, wheels, sensors, and a hopper for storing urea fertilizer. The robot navigates the field using predefined paths, avoiding obstacles with the help of ultrasonic sensors.

To ensure accurate and efficient fertilizer distribution, the robot employs a system of augers and conveyors controlled by the Arduino. The urea fertilizer is dispensed in predetermined quantities at specific intervals, based on soil and crop requirements. This eliminates the need for manual labor and ensures uniform fertilizer distribution across the field.

The Arduino microcontroller also facilitates real-time data acquisition and analysis. The robot collects data from various sensors, such as soil moisture sensors and temperature sensors, enabling farmers to monitor field conditions remotely. This data can be used to make informed decisions regarding fertilizer application and irrigation, resulting in improved crop health and reduced environmental impact.

The automatic urea sowing, fertilizer/water sprayer is operated through a remote android device and can be designed for various applications as well. With the remote control Bluetooth technology we can send the robot to various farms where spraying or urea sowing by humans is not possible or difficult and also is very fast and accurate than mankind. It can spray fertilizer to the root of field and save the greenery from the attack of pests, insects and rats etc. as well as sow urea at desired points. The machine designed here is quite useful for the large cultivating areas where, when compared with man power many acres can be sowed with urea in less time and also can spray water or fertilizer as per the requirement.

Index Terms – Atmega 328, Bluetooth Module, Servo Motor, L293D Motor Driver, DC Brushless Motor, Urea Fertilizer, Arduino IDE,

I. INTRODUCTION

In the rapidly advancing field of agriculture, technology plays a pivotal role in enhancing efficiency and precision. The integration of robotics and the Internet of Things (IoT) has opened up innovative avenues to address challenges in farming practices. One such groundbreaking application is the development of a Urea Fertilizer Robot, utilizing the power of Arduino and IoT.

Traditional methods of fertilizing crops often lack precision, leading to inefficiencies in resource utilization and environmental concerns. The Urea Fertilizer Robot aims to revolutionize this process by leveraging the capabilities of Arduino, an open-source electronics platform, and IoT, which enables seamless communication between devices over the internet.

The primary objective of this project is to design and implement an autonomous robot capable of dispensing urea fertilizer precisely based on the specific needs of crops. By integrating Arduino for control and sensing, and IoT for real-time data exchange and monitoring, the robot aims to optimize fertilization processes, minimizing waste and maximizing crop yield.

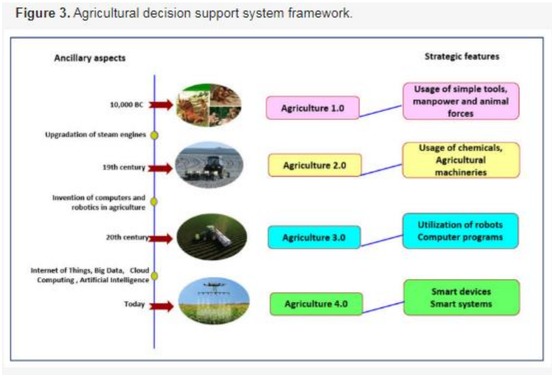

Fig:1 Agricultural decision support system framework.

II. EASE OF USE

User-Friendly Interface:

The robot should have an intuitive user interface, either through a dedicated app or a web-based platform, allowing farmers to easily interact with and control the robot.

Plug-and-Play Setup:

Simplified setup procedures ensure that farmers can deploy the robot without extensive technical expertise. Clear instructions and minimal configuration steps contribute to ease of use.

Automated Operation:

The robot should be capable of autonomous operation, requiring minimal intervention from the farmer. Automated tasks, such as path planning and fertilization based on sensor data, enhance usability.

Remote Monitoring and Control:

Farmers should have the flexibility to monitor and control the robot remotely. This feature enables them to make on-the-fly adjustments, check the status of fertilization, and receive real-time data insights from anywhere.

Alerts and Notifications:

Implementing a system that sends alerts and notifications in case of any issues or when specific actions are required ensures proactive management. This feature keeps farmers informed and helps in timely decision-making.

Compatibility and Integration:

Ensuring compatibility with existing farming equipment and practices enhances ease of integration. The robot should seamlessly fit into the farmer's workflow without necessitating significant changes.

Maintenance and Upkeep:

Designing the robot with easy maintenance in mind contributes to long-term usability. Components that are easily replaceable or upgradable make the robot more user-friendly.

Training and Support:

Providing adequate training resources and support materials can empower farmers to effectively use and troubleshoot the robot. Accessible customer support channels, such as online forums or helplines, further enhance ease of use.

Energy-Efficiency:

Implementing energy-efficient components and systems ensures prolonged operation without frequent recharging or refueling, reducing the burden on farmers.

Scalability:

A user-friendly system should be scalable to accommodate varying farm sizes and types. Whether a small-scale local farm or a larger agricultural operation, the robot should be adaptable to different contexts.

III. SURVRY OF THECHNOLOGY

In today's era of IoT, lots of new devices in terms of Smart IoT based product's development is being carried out to facilitate Smart Farming in terms of Crop Management, Pest Management, Agriculture Precision, Agriculture Fields Monitoring via Sensors and even Drones. In this section Smart IoT based Agricultural Robot being developed for seed sowing and watering process using Arduino, Motor Driver, Soil Sensors and etc. which are discussed below. The internet of things (IoT) is a catch-all term for the growing number of electronics that aren't traditional computing devices, but are connected to the internet to send data, receive instructions or both. It encompasses all the enabling hardware IP, tools, systems, sensors, and software that support IoT device and application development. With IoT technology, everyday objects can be made smart.

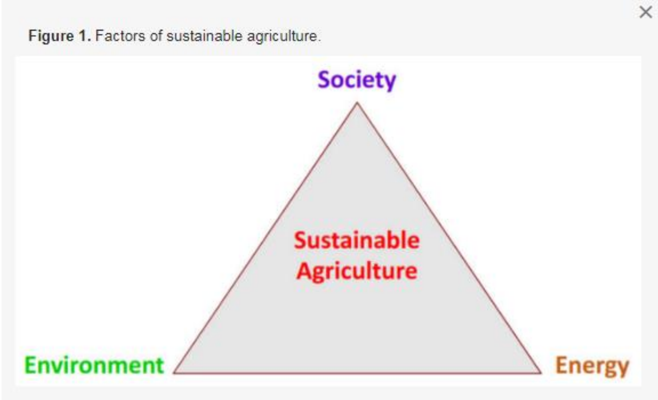

Fig:2 Factors of sustainable agriculture.

IV. REQUIREMENTS AND SPECIFICATIONS

In The Proposed Solution, We Used Hardware Components

(Atmega 328 Microprocessor "Arduino", Bluetooth Module Hc-05, Servo Motor, H-Bridge L293d, Relays, Water Pump)

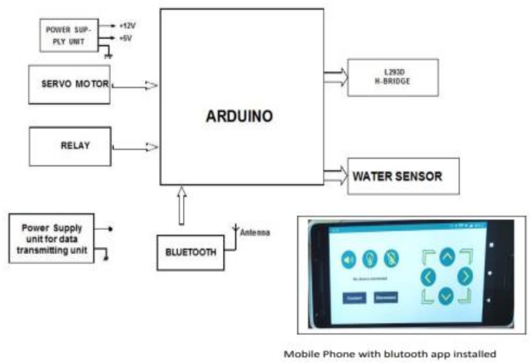

Fig.3 Block Diagram of proposed model

A.HARDWARE

ARDUINO

Arduino is a tool for making computers that can sense and control more of the physical world than your desktop computer. It's an open-source physical computing platform based on a simple microcontroller board, and a development environment for writing software for the board. Arduino can be used to develop interactive objects, taking inputs from a variety of switches or sensors, and controlling a variety of lights, motors, and other physical outputs. Arduino projects can be stand-alone, or they can communicate with software running on your computer (e.g. Flash, Processing, Max MSP.) The boards can be assembled by hand or purchased preassembled; the open-source IDE can be downloaded for free. The Arduino Uno is a microcontroller board based on the ATmega328.

It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

BLUETOOTH MODULE

This project work consists of two main modules: the android mobile phone and the Arduino BT board (Bluetooth module). The android mobile phone consists of several Bluetooth apps which enables the user to access the voice guider for the requirement. In this project we are targeting Android platform since it has huge market and open source. Android is a software stack for mobile devices that includes an operating system, middleware and key applications. The Android OS . Android Applications are made in a Java-like language running on a virtual machine called 'Dalvik' created by Google. The Android SDK provides the tools and APIs necessary to begin developing applications on the Android platform using the Java programming language. Accessory mode is a feature of Android OS since version 2.3.4 Gingerbread and 3.1 Honeycomb and above.

SOIL MOISTURE SENSING PROBE

The Soil moisture sensors measure the volumetric water content in soil. Since the direct gravimetric measurement of free soil moisture requires removing, drying, and weighing of a sample, soil moisture sensors measure the volumetric water content indirectly by using some other property of the soil, such as electrical resistance, dielectric constant, or interaction with neutrons, as a proxy for the moisture content.

The relation between the measured property and soil moisture must be calibrated and may vary depending on environmental factors such as soil type, temperature, or electric conductivity. Reflected microwave radiation is affected by the soil moisture and is used for remote sensing in hydrology and agriculture. Portable probe instruments can be used by farmers or gardeners.

L293D 'H'-BRIDGE

The motor driver package L293D is interfaced with 89C51 microcontroller through IN1 to IN4 of H Bridge (L293D). Both the enable pins (EN1 and EN2) of motor driver L293D is combined together and fed to controller to access the command signals. Depending up on the command signals issued by the controller, the enable pins are activated to control all the four internal drivers of L293D respectively to drive two geared DC motors. Hear H Bridge is required, because the microcontroller output is not sufficient to drive the DC motors, so current drivers are required for motor rotation.

DC Motor Driver

Basic circuit of using L293 forms an H-Bridge Driver is shown in Basic Circuit. As shown for such inductive load as DC motor, external diodes for suppressing back EMF must be connected. The Mini Board uses L293D instead, the L293D has internal diodes, however providing a bit less driving capacity, i.e., 600mA ,4.5V-36V. From the truth table, we see that direction of the motor can control by pin C and D. VINH enable/disable power to the motor, thus for speed regulation, we then use this pin for PWM signaling.

B.SOFTWARE

Arduino IDE

The Arduino Integrated Development Environment (Arduino IDE) contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino hardware to upload programs and communicate with them.

C/C++

The Arduino Programming Language is basically a framework built on top of C++. You can argue that it's not a real programming language in the traditional term, but I think this helps avoiding confusion for beginners. A program written in the Arduino Programming Language is called sketch. A sketch is normally saved with the .ino extension (from Arduino). The main difference from "normal" C or C++ is that you wrap all your code into 2 main functions. You can have more than 2, of course, but any Arduino program must provide at least those 2. One is called setup (), the other is called loop (). The first is called once, when the program starts, the second is repeatedly called while your program is running.

V.PROPOSED SECTION

The proposed model consists of the following functions working operation as per the block diagram is explained below. The block diagram and the circuit diagram and flowchart are provided.

The **Urea Dispensing Mechanism**: The robot should be equipped with a urea dispensing mechanism that can accurately measure and distribute the desired amount of urea fertilizer. This can be achieved using a hopper, auger, or similar mechanism.

Sensor Integration: Various sensors can be integrated into the robot to gather data about soil moisture, pH levels, temperature, and other environmental factors. This data can be used to optimize the fertilizer application and ensure it is targeted to the specific needs of the crops.

Data Logging and Analysis: The robot can log data from sensors, GPS, and other sources during each fertilization session. This data can be analyzed to generate insights about crop health, fertilizer usage, and field conditions over time, aiding in decision-making for future fertilization cycles.

Safety Features: Safety features like emergency stop buttons, collision detection, and fail-safe mechanisms should be incorporated to ensure the robot operates safely and minimize the risk of damage to crops or equipment.

These features can be implemented using Arduino boards for control and connectivity, along with various sensors, actuators, and communication modules compatible with the Arduino platform.

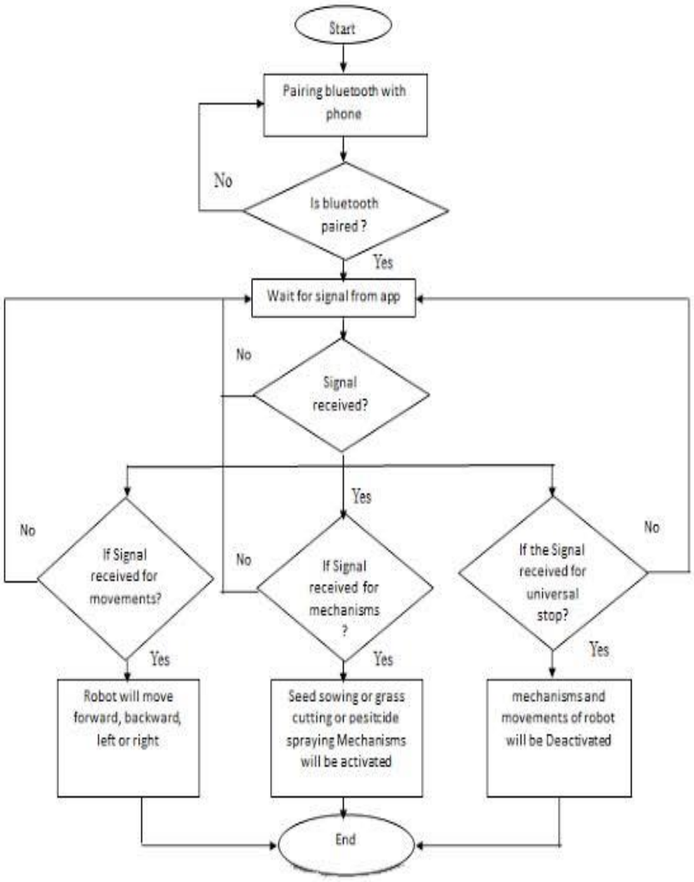

Fig 4: Flowchart of the proposed model

As mentioned in the introduction the unmanned warfare vehicles are either operated autonomously or through tele-communications i.e., remote. The module constructed here is the remote operated one. Through this remote (MOBILE) the vehicle is controlled in all the directions.

The receiver unit is nothing but the metal detecting vehicle. This unit consists of Bluetooth module, Arduino controller, H-bridge IC (L293D), 3 DC motors, Soil Sensing probe, Urea Funnel Mechanism and a battery for providing power supply to all these devices.

VI. RESULT

The project is designed and developed successfully. For the demonstration purpose, a prototype module is constructed; and the results are found to be satisfactory. Since it is a prototype module, a simple vehicle is constructed, which can be used for many applications

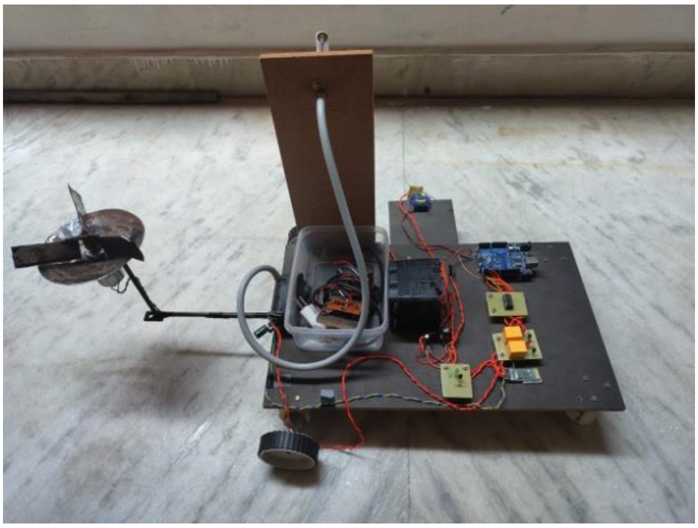

Fig 5 : Urea Fertilizer Robot With Arduino And Iot

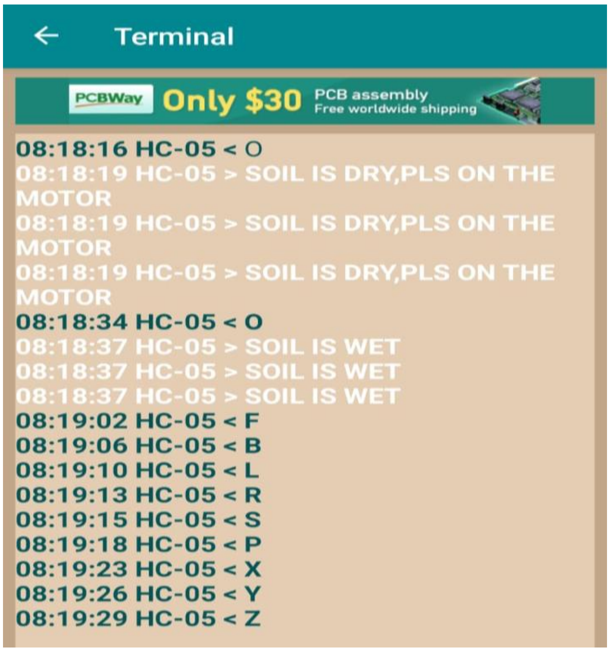

Fig 6: Output of the project

VII.CONCLUSION

The project work is designed and developed successfully. For the demonstration purpose prototype module is constructed & results are found to be satisfactory. While designing and developing this proto type module, we have consulted few experts those who are having knowledge in Mechatronics, these professionals working at different organizations belongs to Hyderabad helped us while fabricating the agrobot. Since it is a prototype module, much amount is not invested, the whole machine is constructed with locally available components, especially the mechanical components used in this project work are procured from mechanical fabricators, and they are not up to the requirement, lot of modifications must be carried out in design and is essential to make it as real working system. Hence, the module is to be enhanced further for obtaining better results.

This project revealed that building a relatively low cost, high precision spraying/sowing robot which is aimed to control through android device through its Bluetooth interface. The idea of controlling through remote is to enhance the operator safety.

VIII. FUTURE SCOPE

Scalability is a key feature, allowing the technology to adapt to different crop types and varying agricultural terrains. Additionally, the integration of predictive analytics and machine learning algorithms presents a future scope for enhanced decision-making, predicting soil needs, and refining fertilizer application strategies. The system's ability to contribute to sustainable agriculture by minimizing fertilizer wastage, improving crop yield, and reducing environmental impact underscores its significance in modern farming practices. Its potential for expansion into complementary agricultural technologies, such as automated irrigation systems or crop health monitoring, further highlights its broad scope in transforming and optimizing agricultural processes.

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