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LEVERAGING IOT FOR VERSATILE AGRICULTURAL SOLUTIONS

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Abstract--In India, where agriculture sustains over half of the population, many farming tasks such as seeding, cutting, spraying, and plowing are carried out manually due to the economic inability of farmers to invest in modern machinery. This reliance on traditional methods, often involving bullocks, falls short of meeting the energy demands of farming. To address this, there is a growing demand for automation in agriculture to improve productivity. This project proposes an innovative solution: an IoT-based agricultural machine powered by rechargeable battery. This multifunctional device handles various tasks like seeding, spraying, and cutting, aiming to streamline operations and reduce dependence on manual labor. User-friendliness, efficiency, and time-saving benefits are prioritized in its design. The objective is to alleviate the challenges faced by farmers and offer them greater convenience in their daily routines. Powered the system employs wireless modules and IoT technology for remote control, enhancing efficiency and reducing the need for manual labor, particularly in planting. Each farming task, from plowing to watering, is being integrated into separate vehicles, consolidating functions into one automated machine for increased yield and profitability.

PROBLEM STATEMENT:

In India, where agriculture is the mainstay for more than half of the population, numerous tasks are traditionally carried out manually due to economic constraints. This cutting-edge solution seeks to revolutionize farming methods by integrating functions like seeding, spraying, cutting, and plowing into a cohesive, automated system. Powered by rechargeable energy, the machine employs wireless connectivity and IoT technology for remote management and monitoring, offering farmers increased efficiency and reduced dependency on manual labor. Through its seamless integration of advanced functionalities and unwavering dedication to user-centric design, it not only addresses immediate farmer needs but also lays the groundwork for sustainable agricultural practices capable of withstanding the test of time . Here's a revised version.We present a practical hardware assessment of a robust, cost-effective, location-independent, straightforward, and infrastructure-free cluster-based agricultural Internet of Things (CA-IoT) network. This network utilizes a commercially available Bluetooth Low-Energy (BLE) communication method and the Raspberry Pi 3 B+ module. The aim is to combat global food insecurity resulting from climate change and the growing global population by implementing precision farming and greenhouse technology..

INTRODUCTION :

In India, agriculture is a cornerstone of livelihood, with over 54% of the population dependent on it .This sector has historically been a crucial aspect of the nation's economy, significantly contributing to its growth and development. Central to food production in India are its farmers, who predominantly employ traditional or modern cultivation methods.Traditional farming involves manual

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labor with the assistance of bullock carts and tractors, while modern methods incorporate advanced machinery.

However, the agricultural sector faces several challenges in adopting modern technology, including labor shortages, limited knowledge of new techniques, rising labor costs, seed wastage, and inefficient water usage. In response to these challenges, an agricultural machine has been developed to introduce automation into the farming process. This machine aims to streamline various tasks such as harvesting, seed sowing, weed removal, and irrigation, addressing the shortcomings of traditional methods and enhancing overall efficiency in agriculture. The current imperative is to advance technologies and infrastructure that can adequately address both present and future demands.[1]. In a world where agricultural demands are on a relentless rise due to factors like population growth, shifting climate patterns, and evolving consumer preferences, the urgency for such innovations has never been more pronounced. By reducing reliance on manual labor, the machine not only eases the burden on farmers but also addresses concerns about labor shortages and escalating wage costs. Moreover, its emphasis on sustainability, demonstrated through its utilization of solar energy and minimal resource wastage, positions it as a catalyst for promoting environmentally conscious farming practices.

According to the forecasted figures, in 2050, the world population is expected to touch 9.7 billion, an increase of approximately 26% from the current figure[2].

The Multi-purpose Agricultural Machine serves as a demonstration of human creativity and technological progress.It represents a pivotal moment in agricultural history, where the convergence of tradition and innovation, efficiency, and sustainability promises to revolutionize farming practices. As we begin this journey of discovery, we are reminded of the significant influence that technology can wield in shaping our surrounding world. And in the case of the Multi-functional Agricultural Machine, that impact is poised to be nothing short of transformative. As we set out on this voyage of exploration and discovery, we're reminded of the profound influence that technology can exert on the world surrounding us. In the case of the Multi-functional Machine, that impact promises to be nothing short of revolutionary.

I. Methodology:

lOT (The Internet of things) interconnects information sensing devices such as RFID,and sensors, The main components used are a Battery, Buck converter, 5V Relay, ESP32 Microcontroller, and Motors that drive Two-dimensional codes operate in accordance with predetermined protocols, facilitating the exchange of information and communication across wired or wireless networks. IoT systems can perform tasks such as plowing, cutting, spraying, and harvesting vegetables.

The machine contains different switching modes and for each ,operation one switch mode is given. So according to the instruction given the machine operates and completes the function required by a farmer.

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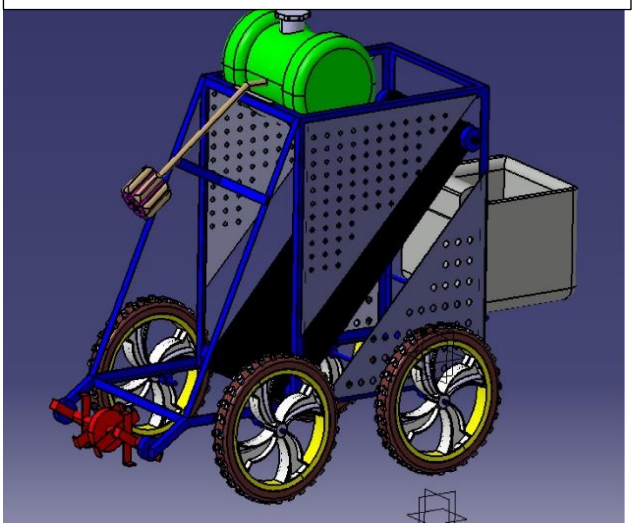
Fig 1:Platform Framework



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At the core of this machine lies the microcontroller, serving as the central control unit. Via a Wi-Fi module, it receives user commands, facilitating communication and coordination. The motor drive, essential for any automation project, supplies power to control motors and gear motors, which drive the machine's movements and operate its agricultural implements. High-torque motors are carefully selected to ensure efficient handling of diverse agricultural tasks. This machine boasts a range of attachments tailored for specific tasks, including pesticide spraying, vegetable harvesting, weed plucking, and seed sowing. Seamless switching between these implements enhances the machine's functionality and versatility across various farming scenarios. The microcontroller orchestrates the entire process, optimizing energy usage and task execution. A motor powers the setup, equipped with blades for efficient vegetable harvesting, powered by a battery. Pulley and belt drives connect to the wheels and seed-sowing mechanism via a shaft. A seed feeder within a hopper setup feeds seeds to the planting hose, while a flat plate ensures proper planting and flattens the ground. A water pipe near the machine's handle connects to the sprayer pump, facilitating efficient watering. Upon motor activation, the water pump's impeller rotates, propelled by the motor's electromagnetic force, causing water to be thrown out from the tire center. This setup enables effective water spraying. Gear motors, connected to the motor drive, regulate speed and direction. When controlling the weed plucking machine, the microcontroller interfaces with sensors to make decisions based on weed-detection. Upon activation, the sensor scans the field for weeds, and if detected, the microcontroller directs the motor to navigate toward them. The weed plucker attachment, connected to the motor, consists of rows of discs with curve blades rotate in opposite direction, facilitating weed cutting.

These advantages span increased crop yields, conservation of carefully monitored resources like water for irrigation, and reduction in the reliance on harmful chemicals such as those found in fertilizers, pesticides, and herbicides [3].

II. PROPOSED MODEL:

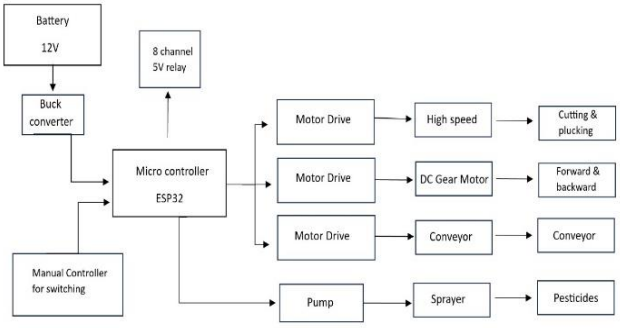

Fig 2:Block Diagram of our work

Components required:

i) Battery
ii) 8chanel 5v relay
iii) Esp 32 wifi
iv) Motor drives
v) Sprayer pump
vi) High speed motors
vii) Dc Gear motors
viii) Conveyor belt & Blades and plucker

1. Battery:

Batteries play a vital role in storing and releasing electrical energy through chemical reactions.Generally, they comprise one or more electrochemical cells,where positive and negative electrodes are isolated by an electrolyte.Various battery varieties exist,such as alkaline, lithium-ion, lead-acid, nickel-cadmium, and nickel-metal hydride, each offering distinct features and functionalities. In our context, we have chosen a lead-acid battery to energize a multifunctional agricultural apparatus.

Table no. 2.1 Specifications of Battery

S. No	Description	Ratings
1.	Specific energy	34-39 w/kg
2.	Energy density	78-90 w/L
3.	Specific power	179 w/kg
4.	Charge/discharge efficiency	49%-94 %

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1.Power Source:

The battery supplies the electric current to the motor, replacing the need for an internal combustion engine

2.Reduced Emissions**:**

By using electricity, the machine contributes to lower emissions and quieter operation compared to fuel-powered options.

3.Versatility**:**

Batteries can be designed to provide power for different tasks depending on the machine's capabilities. For instance, a small battery might power functions like seed dispensing, while alarger one could handle tasks demanding more power, like tilling.

4.Applications**:**

Battery-powered multi-purpose agricultural machines are becoming increasingly common for tasks like seeding, spraying, and light tilling, particularly for smaller fields or organic farming.

2. 8Channel 5V relay:

A Triode-driven 8-channel 5V relay is an electronic component designed to manage up to 8 independent circuits or devices. Each channel functions as a switch, enabling the control of individual electrical loads by utilizing a low-voltage signal, typically 5V. This relay is well-suited for integration with microcontrollers, Arduino boards, or similar digital control systems. Widely employed in automation endeavors, including home automation and industrial settings, it facilitates the simultaneous management of multiple devices. However, it's essential to emphasize the importance of possessing a comprehensive understanding of electrical circuits and adhering to safety protocols when utilizing relays.

3. ESP32 microcontroller:

The ESP32 stands out as a collection of budget-friendly, energy-efficient microcontrollers equipped with built-in Wi-Fi and Bluetooth connectivity.

4.Motor driver:

A motor driver IC, an integrated circuit chip, is a vital component in managing motors within autonomous robots and embedded systems. particularly in straightforward robotics and RC car projects. Essentially, the motor driver acts as a bridge between a controller or processor and the physical motor, enabling smooth movement as per predefined commands. It interprets low-voltage

signals from the controller and converts them into the higher input voltage required for motor

5. Sprayer pump:

A 12V water pump is operated by a DC power supply. Before you 1z starting the pump motor, individuals fill its chamber with water to expel any air from the inlet pipe. Once the motor initiates, the impeller within the water pump begins to rotate alongside the rotor propelled by the electromagnetic force generated by the motor. As the impeller spins, water situated between its blades is propelled along, experiencing centrifugal force. This transformation converts its kinetic energy into pressure energy, consequently increasing its pressure level. Finally, the pressurized water flows into the drainage pipe. Throughout this process, the impeller continues to operate under the motor's driving force**.**

6. High-speed DC motor

A high-speed motor is an electric motor designed to operate at speeds higher than those commonly found in standard models. The exact speed requirement for a motor to qualify as "high-speed" can vary depending on the particular application. Nevertheless, as a general rule, these motors are engineered to run at rotational speeds surpassing 3,600 revolutions per minute (RPM). They are often utilized in situations where characteristics such as compact size, lightweight construction

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7. DC gear motor:

A gear motor, which integrates a motor with a gearbox, serves dual purposes as a torque amplifier and a speed reducer, thereby requiring less power to manage a given load. Several factors influence the performance of these motors, including gearbox design, gear type, lubrication, and coupling technique. The choice of gears, in terms of quantity and type, enables various combinations of output RPM and torque. Typically, fewer gears yield higher RPM and lower torque, whereas more gears lead to higher torque and lower RPM. Through adjustments to the internal gear structure and the number of reduction stages, the gear motor can finely regulate the speed at the output shaft.

8. Conveyor belt:

A conveyor belt, commonly referred to as a belt conveyor, functions as the conveying mechanism within a belt conveyor system, which is one of several types of conveyor systems. This system consists of two or more pulleys, also known as drums, around which a closed loop of carrying medium—the conveyor belt—rotates. One or both of the pulleys are usually powered, propelling the belt and the material it carries forward. The pulley responsible for driving the belt is called the drive pulley. These systems find applications both internally within facilities and externally for transporting large volumes of resources and agricultural materials over long distances.

9. Weeds plucker:

The weed-plucking mechanism consists of two sections, each containing two spur gears. Positioned on the front side of the moving mechanism, these mechanisms are designed to be driven by two DC motors situated on the left and right sides. Each section comprises two identical spur gears with the same number of teeth. One spur gear is directly connected to the motor shaft, which is powered by a 12V DC source and rated at 30 RPM, ensuring a consistent rotation speed. The other spur gear is linked to a motorized spur gear, enabling both gears to rotate clockwise. The purpose of this mechanism is to remove any grass or weeds encountered during operation. As the vehicle traverses the field, the mechanism effectively eliminates any small weeds that may have grown along the path.

III. IOT TECHNOLOGY USED IN AGRICULTURE

The Internet of Things (IoT) involves a network of tangible entities, including devices, vehicles, and appliances, embedded with sensors, software, and connectivity, facilitating data collection and sharing. These entities, commonly known as smart devices, range from commonplace items like smart thermostats and wearable devices such as smartwatches to advanced industrial equipment and transportation systems.

Additionally, IoT-enabled machinery, such as precision farming equipment and drones, assist in optimizing crop yield and minimizing resource usage By facilitating communication among smart devices and other internet-connected entities like smartphones and gateways, IoT establishes an extensive network where data exchange and various tasks can be autonomously executed.

This ranges from monitoring environmental conditions on farms to optimizing traffic flow through the integration of smart cars and other automotive IoT devices in essence, IoT empowers interconnected devices to communicate, collaborate, and undertake diverse functions, thereby contributing to enhanced efficiency and convenience across numerous domains, including agriculture and farming technology.

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1. Sensors/Devices:

These components interface with the external physical environment, capturing data from changes in surroundings. Sensors detect these variations and record them, making them indispensable in IoT applications. For instance, smartphones contain sensors like GPS, which track location data. Cloud servers then process this collected information. However, to accomplish this, platforms are necessary for connectivity. Connectivity serves as the link between all IoT devices within an ecosystem, including sensors, routers, gateways, user applications, and platforms.

2. Connectivity:

Cloud servers process data collected by sensors, but this requires platforms. Connectivity facilitates communication among all IoT devices within an ecosystem, comprising sensors, routers, gateways, user applications, and platforms. Effective connectivity management is vital for overseeing the entire IoT system. Choosing the appropriate connectivity path—whether Wi-Fi, Bluetooth, Zigbee, or cellular networks like VOLTE or 5G—is crucial for transmitting substantial amounts of data efficiently.

3. Data Processing:

Once data is transmitted to the platform, it undergoes processing to derive necessary outputs. This involves performing functions on the data for analysis purposes. Data analysis is a critical step in IoT technology, requiring rapid processing to yield accurate results.

4. User Interface:

The user interface represents the concluding phase of the process. It directly interacts with the user, presenting the output visible on the screen. Each IoT device features a distinct interface tailored to its specific task or purpose.

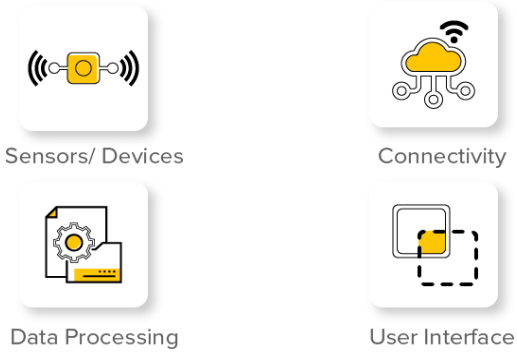

Fig 3: Technology Used To Develop

IV. Schematic Diagram:

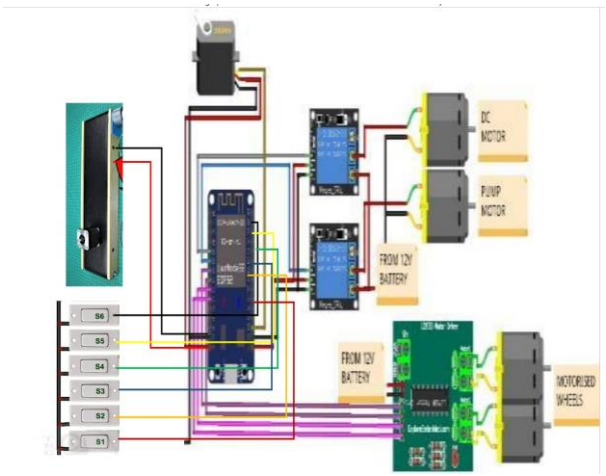

Fig 4:overall schematic diagram of machine

V. Future scope :

Drones with advanced imaging technology can be used to provide real time information about crop health which enables the farmers to take corrective measures quickly.

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Tracking and monitoring can be done by using cameras.
Solar energy can be utilized in the process.

VI. Result and Discussion:

Fig 4:Front view of machinery

Fig 5: side view of machinery

Fig 6: Top view of machinery

VII. Conclusion:

The project entails creating a versatile agricultural machine capable of seed sowing, grass cutting, pesticide spraying, and vegetable harvesting. This all-in-one solution caters to the needs of small-scale farmers who often face financial constraints when investing in costly agricultural equipment. By labor and time requirements compared to traditional metstreamlininghods, the machine addresses some of the challenges encountered by farmers. Its IoT-based design ensures affordability and efficiency, empowering farmers to boost productivity through smart agricultural practices.

Demonstrating the feasibility and potential of an IoT-based multipurpose agricultural machine, the project integrates remote monitoring and control functionalities via the Internet of Things. This enables the machine to perform various tasks, from seeding to harvesting, with ease. This innovative approach to agriculture offers several advantages:

1. Enhanced efficiency and productivity: Automation accelerates tasks, reducing the reliance on manual labor and optimizing resource utilization.

2. Improved resource management: The machine operates efficiently based on predefined parameters, ensuring timely task completion.

3. Decreased operational costs: Through its efficiency and data-driven operations, the machine has the potential to minimize expenses associated with labor, water usage, and other inputs.

4. Promotion of sustainability: By advocating for precision agriculture and efficient resource allocation, the machine contributes to a more sustainable agricultural ecosystem.

This project lays the groundwork for the advancement of sophisticated agricultural machinery, heralding a smarter and more efficient future for farming. Continued innovation aimed at addressing affordability and accessibility barriers will propel further progress in agricultural development. Ultimately, the developed model proves invaluable to small-scale farmers striving to enhance their farming practice.

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