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Cloud Based Multipurpose Farming Machine

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Abstract : Agriculture is a globally essential industry, fundamental to a country's economic growth. The application of modern technologies to enhance crop production is known as agrotechnology. This not only boosts crop productivity but also facilitates the development of specialized tools for mechanical field tasks. Consequently, agrotechnology helps to minimize the overall cost of production while saving time and effort throughout the farming process. Before developing a new product or process, it is critical to consider the technology's performance and its societal role, ensuring it is economically viable. This study focuses on the design of multipurpose agricultural equipment aimed at helping farmers maximize their yield with minimal labor. A threshold value is defined for the machine's various operations, and this value is used to calculate the required operation time. This calculation is intended to improve the time needed to complete a single task. The machine is controlled using the Internet of Things (IoT), enabling it to perform multiple functions such as forward and backward movement, plowing, sowing, fertilizer spreading, and water spraying.

***IndexTerms* - Arduino, Android app, DC Motor, Motor driver.**

I.INTRODUCTION

The Multipurpose Farm Robot is a multifunctional agricultural machine designed for automated operation with minimal human intervention, powered by an internal motor system. This robot is tasked with performing five primary operations in the agricultural field. It incorporates a drip irrigation chamber where water is pumped from a storage tank into a perforated pipe containing an absorbent sponge. It also features a seed sower with controllable holes, managed via Arduino hardware and software. Fertilizer is distributed using a rotating blade powered by a motor, with flow regulated by a reciprocating mechanism attached to a wiper motor and controlled by a simple switch.

The entire machine is driven by motors connected to an Arduino circuit and is controlled remotely via a mobile application following specific code implementation. The system utilizes the Google Firebase Cloud for monitoring the entire process, including real-time observation and data collection. This cloud data is analyzed to provide farmers with the machine's current operational status, particularly the time taken to complete single tasks. Machine learning (ML) is then applied to the collected and processed data to generate precise predictions for the date and time required for remaining tasks. For instance, if the weeding of a 1,000 square-foot farm takes 60 minutes, the machine predicts the schedule for sowing, fertilizer application, pesticide spraying, and harvesting.

This autonomous functionality reduces the need for frequent farm visits, as farmers can monitor everything via the cloud interface, ultimately minimizing human effort and increasing operational speed. The system predicts task completion time and future task scheduling using a regression-based supervised learning model. The input features for this model include:

- Type of task (spraying, harvesting, weeding, ploughing, and sowing)
- Covered area, measured in square feet
- Duration of previous operation (in minutes)
- Humidity and soil moisture (from onboard sensors)
- Level of battery voltage
- Humidity and ambient temperature (from the cloud weather API)

The target variable is the Predicted Task Completion Time (in minutes), and the regression output is further processed to estimate the anticipated start date and time of the subsequent operation.

II. LITERATURE SURVEY

Multipurpose agricultural machines are designed to execute various tasks either simultaneously or sequentially. For example, they can drill, cut, grind, and shape materials in a single setup, thereby eliminating the need for multiple specialized machines [1].

Many of these machines feature a portable and compact design, allowing them to be deployed in remote areas or small workshops, which is particularly advantageous in sectors like construction and automotive repair where on-site work is common [2]. Operation can be automatic or semi-automatic; fully automatic machines require minimal human intervention and are ideal for high-volume manufacturing [3], while semi-automatic ones allow for precise control. Furthermore, these machines often incorporate energy-efficient mechanisms, such as motorized drives and gear systems, to minimize power consumption without sacrificing performance [4].

The steady shift in the construction industry from manual labor to automated technologies has been significantly influenced by the development of multipurpose frame machines [5]. Initially, their functions were limited to simple structural framing, but advances in automation and robotics have expanded their capabilities [5]. For instance, the creation of robotic construction systems and smart sensors has enabled accurate and effective framing operations [6]. The integration of 3D printing technology represents another historical breakthrough, revolutionizing the design and assembly of frames [7] [8].

The historical evolution of multifunctional frame machines is closely linked to the progress of Computer Numerical Control (CNC) machining and robots in production. The incorporation of robots into CNC machine tools has increased productivity, accuracy, and efficiency, making it possible to produce complex frames with little human involvement [9] [10]. The use of automated material handling systems and adaptive machining methods has further accelerated the production process, enhancing product quality and reducing costs [11].

III. RESEARCH METHODOLOGY

The proposed system utilizes the ESP32 camera module to stream real-time video data to the ESP8266 module. The ESP8266 then controls the remaining mechanical components, which are operated via a smartphone application. The user connects the agricultural equipment to the internet to view the real-time video feed and receive frames from the camera, confirming that the system operates on the Internet of Things (IoT) principle.

The remaining system is dedicated to controlling the machine's driving and operational motors. Motor Driver 1 powers the cutting/weeding motor. Motor Driver 2 operates the wheel motors for locomotion. Motor Driver 3 is connected to a water pump for herbicide/water spraying. This configuration allows a single machine to control multiple functions,

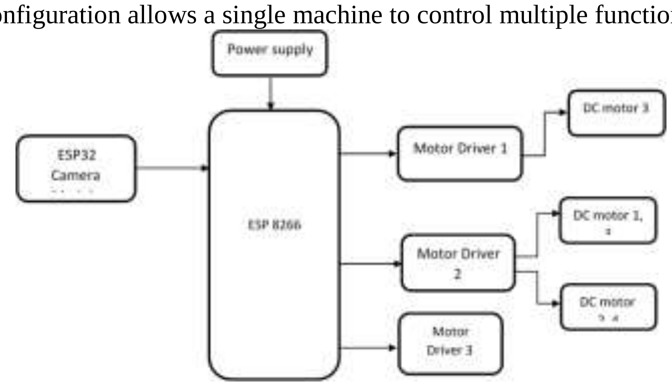


Fig.1.Block Diagram of Proposed System

3.1 Flow Chart:

The flow diagram illustrates the program logic for operating the robot. The robotic vehicle is controlled via the smartphone application and responds appropriately to the instructions received. Upon a user pressing a button, the data is translated into a hexadecimal format and processed. The robot then begins operating in the commanded direction (right, left, forward, or reverse).

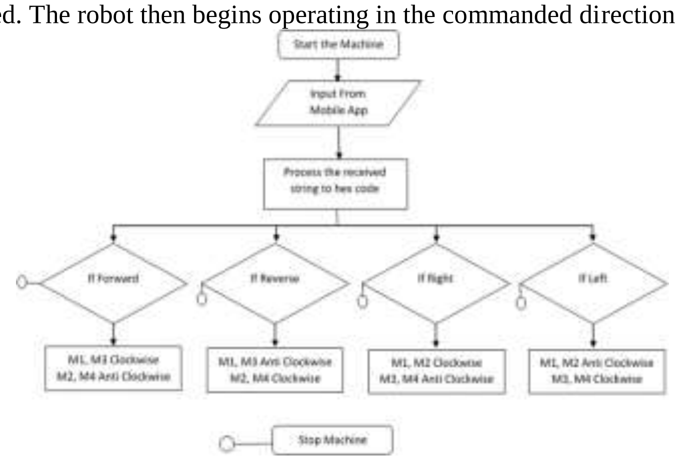


Fig. 2.Flow Chart of Proposed System

3.2 Simulation of Proposed Work

A software simulation was developed to test the system's accuracy and functionality.

The simulation diagram, developed in Proteus 8.0 software, features four distinct motors: two for driving the wheels, one for the water spraying pump, and one for the seed sowing mechanism. The entire system is managed by the ESP8266 Wi-Fi module, which connects to the mobile application and executes instructions received from the user interface. A 16x2 LCD display is included to show the machine's current status and the operation being performed.

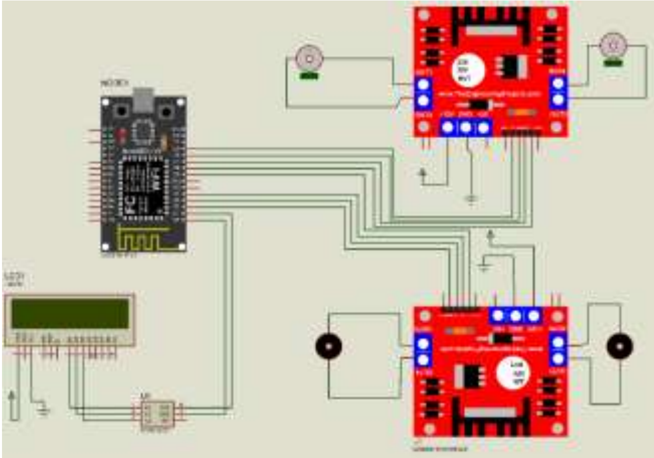
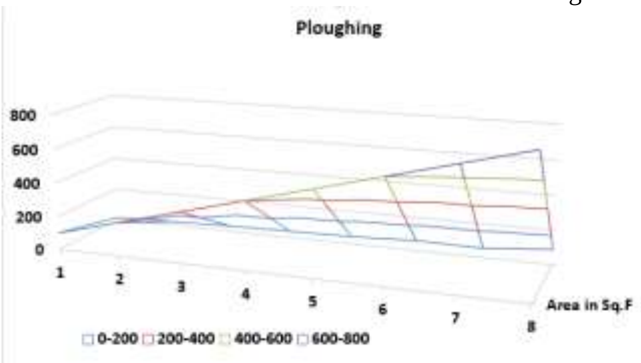


Fig. 3.Circuit Diagram of Proposed System

IV. RESULTS AND DISCUSSION

The multipurpose farming robot uses cloud services and the data is collected after testing it on the real farm is as follows,



. Fig. 4.Ploughing Process Analysis

The collected data reveals the time consumed for the Ploughing process. The machine completed the task efficiently with minimum time consumption. The test was conducted on a field of 800 to 1,000 square feet, and the machine performed well, finishing the task within the time frame.

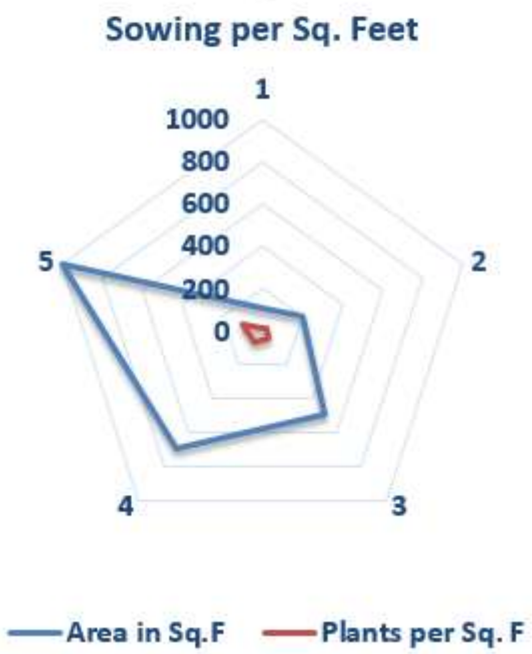


Fig. 5.Sowing Process Analysis

The sowing process was conducted immediately after Ploughing. The machine uses a specific algorithm to cover the designated area, aiming to sow 1 to 2 plants per square foot and a maximum of 5 plants for every 3 to 4 square feet. The chart below displays the real-time data collected during the sowing operation.

Machine layer: Real-time sensor and operational data (motor current, soil conditions, GPS, and area coverage) are gathered by the ESP32 and ESP8266 modules.

Transmission: At regular intervals, this data is sent over Wi-Fi to the Google Firebase Cloud.

Cloud layer: The dataset is prepared, saved, and fed into the ML regression model running on a Python environment hosted in the cloud.

Feedback and prediction: The ML model forecasts the anticipated day and time of the upcoming farming activity. The Firebase database receives these forecasts, which are then shown on the dashboard of the farmer's mobile app. The Cloud–ML–Prediction Data Loop is created by this closed-loop procedure, which guarantees ongoing learning and scheduling optimization.

Table 1. Analysis of Entire Process of Autonomous Farming Machine Process

Area Sq. Foot	Time (in minute) required to complete the process with date					
	5-May 24	20-May 24	21-May 24	28-Jun 24	12-Jul 24	10-Aug 24
	Ploughing	Sowing	Leveling	Fertilizers	Pesticides	Harvesting
100	12	5	2	14	7	14
200	23	10	4	25	14	27
300	33	15	6	35	21	39
400	39	20	8	41	28	47
500	45	25	10	47	35	55
600	60	30	12	62	42	72
700	55	35	14	57	49	69
800	90	40	16	92	56	106
900	55	45	18	57	63	73
1000	90	50	20	92	70	110

The above table 1 shows the time required to complete multiple tasks over a four-month period. All processes are conducted autonomously by the machine. The farmer can monitor operations using the camera module, and the time required for task completion is automatically measured via the cloud operation.

The robotic farm machine's front and side views are included in the design of the suggested gadget. As we can see, the feeder and roller are both available. The feeder will begin feeding the seed once the roller has begun to rotate. The farm ground is drilled according to necessity using the seed swing mechanism. The untidy dirt will be covered by a roller that is attached to the rear. Following the seed swing operation, this procedure will give the farm an even form. The battery power supply will power the entire system.

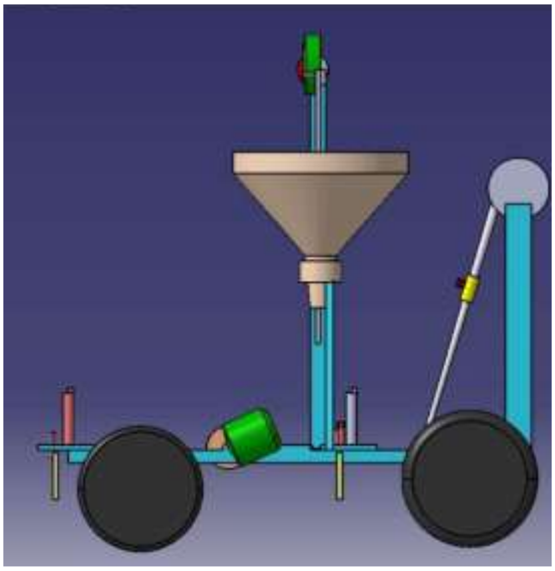


Fig. 6. Design of Proposed Device (Side View)

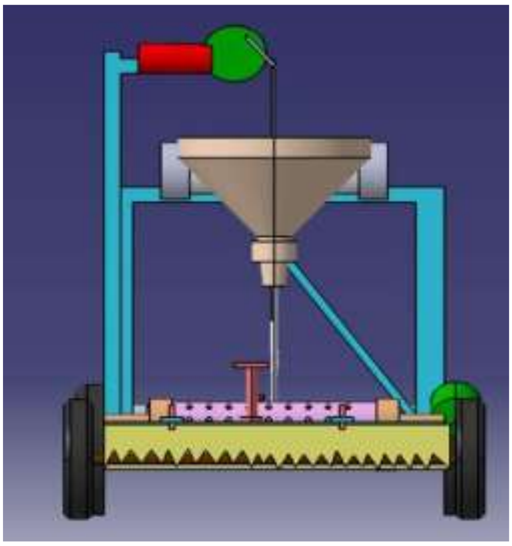


Fig. 7.Design of Proposed Device (Front View)

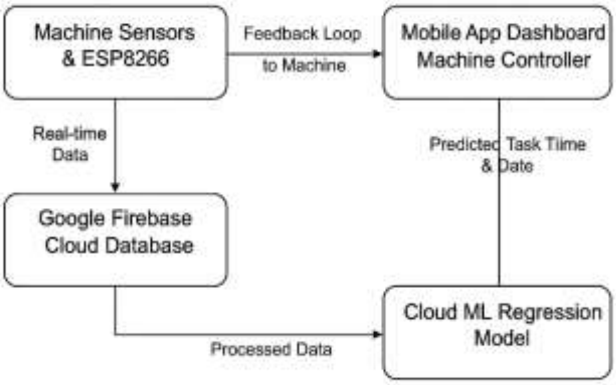


Fig. 8: Cloud–ML–Prediction Data Loop

4.1 Data Flow and ML Interaction: The Cloud–ML–Prediction Loop

The system operates using a continuous data cycle, known as the Cloud–ML–Prediction Data Loop, which ensures ongoing learning and optimized scheduling for the farming machine. This process can be briefly summarized in three layers:

4.2 Machine Layer (Data Generation):

The ESP32 and ESP8266 modules gather real-time sensor data from the field, including soil moisture and humidity, as well as operational data like motor current, GPS coordinates, area coverage, and battery voltage.

This data represents the input features for the machine learning model.

4.3 Transmission and Cloud Layer (Storage & Processing):

The collected data is sent wirelessly (via Wi-Fi) to the Google Firebase Cloud at regular intervals.

On the cloud, the data is prepared and stored in a structured dataset. The ML regression model, running in a Python environment, accesses this dataset.

4.4 ML Interaction and Prediction (Feedback):

The ML model, which is a regression-based supervised learning model, processes the input features (e.g., Task Type, Covered Area, Duration of Previous Operation, Sensor Data) to predict the Task Completion Time (in minutes) for the current or future operations.

The resulting predictions are sent back to the Firebase database.

This final predictive data is then displayed on the farmer's mobile application dashboard, estimating the anticipated start date and time of the subsequent operation (e.g., "Sowing predicted to start on [Date] at [Time]").

The fabrication cost of the prototype is ₹35,000.

4.5 Based on Table 2:

- The average time saving across operations ≈ 50%.
- Labor requirement reduced by ≈ 60%.

4.6 ROI estimation:

If a farmer previously spent ₹1,200/day (labor + machine rental) for 10 days = ₹12,000/season, the new system reduces this to roughly ₹4,800 (a saving of ₹7,200 per season).

Thus, the investment of ₹35,000 can be recovered in ≈ 5 seasons (2.5 years) while the machine remains serviceable for over 5 years—indicating a positive ROI and long-term cost benefit.

Table 2. Performance Comparison

Task	Traditional Method Time in Minutes	Machine Time in Minutes	Time Saved in Minutes	Efficiency Improvement
Ploughing	240	150	90	37.5%
Seeding	180	90	90	50%
Weeding	300	120	180	60%
Spraying	120	60	60	50%

- Ploughing: In 150 minutes, the machine was able to effectively plough a 43560 square feet of the field to a consistent depth of around 4-6 inches, appropriate for the majority of crop kinds.
- Seeding: The machine consistently spaced and deepened rows, achieving a 92% seeding accuracy.
- Weeding: Between 85 and 90 percent of the weeds in the test area were successfully eliminated by the mechanical weeding attachment.
- Spraying: With little pesticide waste, uniform spraying was accomplished over a 2-meter width.
- Time and Labor Saving: Because of the machine's multiple uses, fewer workers and pieces of equipment were needed for every agricultural task. The equipment cut the total amount of time spent on field preparation and cultivation by around 40% when compared to conventional techniques. Because a single operator could handle all the activities, the labor need was lowered by 60%.
- Cost-Effectiveness: The prototype's initial fabrication cost of ₹35,000 was far less than the price of purchasing separate equipment for every operation. With fuel and maintenance costs of ₹150 per hour, small and medium-sized farmers could afford it.
- Feedback from Users: Farmers who tried the machine praised its small size, ease of use, and capacity to complete several chores without the need for new tools. Increasing the fuel tank's capacity for extended operations and incorporating an automated depth control system were among the recommendations.

If the given data is compared with the Ashwin Chandran ,k. Varun Krishnan,T.V Arjun ,Vignesh, Nitin Joshwa " design and Fabrication of multipurpose farming equipment". It is found that the time required for the execution of single operation is enhances.

V. CONCLUSION

The development of multifunctional farming equipment is a promising advancement, particularly in addressing the need to boost agricultural productivity and mitigate the labor shortage. These machines have the potential to significantly reduce the time and expense associated with traditional farming methods by performing various functions, including digging, planting, growing, and spraying. For small-scale farmers facing issues like limited land holdings and financial restraints, multipurpose machines offer a practical and affordable solution. However, concerns regarding the initial cost outlay may discourage some farmers from adopting these technologies. Achieving widespread implementation will require balancing affordability with continued technical advancement.

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