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Design Of An On-Field Smart Agri- Assistor And Its Implementation ForMultipurpose Farm Utility

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Abstract — The world population, which is rapidly increasing, is difficult to be fed using traditional agricultural practices. Though farmers are spending a substantial amount on machinery, profit and efficiency are not as expected. The latest technologies enable the agricultural sector to obtain high yield and efficient produce, thus promoting smart farming activities. Agricultural automation is the only method to overcome this problem. In this paper, a smart agri-assistor is designed, which is affordable, compact, multi-purpose robot so that its utility in farming not only reduces the energy, labour costs and water consumption, but also significantly reduces the restrictions on working hours. The proposed system, which combines the robotics with agriculture, can perform soil digging, seeding, soil levelling, grass cutting, watering and fertilizing is a boon to farmers, and all the operations are controlled via Bluetooth module.

Keywords: STM32 microcontroller, Bluetooth module, agricultural automation, smart farming

1. Introduction

Agriculture is regarded as the life-sustaining human activity because it is that the main supply of food grains and other alternative raw materials. It plays an indispensable role in boosting the country's economy. People are provided with enormous employment opportunities in the agricultural sector. Advancements in agricultural sector has a significant impact on the economic development of the country. Currently, the agricultural sector is principally relying on man power. So, agricultural automation through the adoption of technologies like IoT eases farming activities, thereby reducing the price and decreasing the mediation of farmers within the field. IoT in agriculture mainly concentrates on automation of agricultural methods to improve its effectiveness and efficiency. Robotics play a remarkable role in industrial, medicinal and military applications, etc. Agricultural robotics deals with applying automation in bio- systems like agriculture, fisheries and others. Robots can be programmed to perform required activities and can be designed to operate in the desired environment. Conventional techniques rely upon human power for digging, lifting, seeding, fruit choosing and any other farming activity. Automation significantly improves the yields in the sectors where it is employed, through the use of automatic machines. So, the implementation of modern science and technology in the agricultural sector is the need for increased productivity. The proposed system makes the bot flexible to monitor and control the field information. The paper emphasizes on smart agriculture through IoT and automation technologies. The proposed system concentrates on performing functions like digging, seeding, soil levelling, grass cutting, watering and fertilizing. The agribot is developed to perform these operations in an economical, effective and efficient manner with least human intervention.

2. RELATED WORKS

The paper [1] proposes a controlling unit consisting of Raspberry Pi which controls the entire process of the smart assisting robot. The Bot designed has an automated framework which can play out numerous operations like soil digging, seed spraying, intruder alarming, pesticide sprinkling, and harvesting. The solar panel used helps the Bot to operate without external powered battery so that the battery usage becomes less. Hence farmers are not stressed out in the field, by manually operating Bot. The farmers cultivate crops much faster than their usual presence. This system helps in the reduction of work expenses and constraints on working hours can be improved.

The proposed system [2] suggests the method of soil digging, seed sowing and fertilizer spraying. Depending on variety of seeds, it is sowed into the ground through drilling operation. The digging operation is performed by including a dc motor with shaft. Servomotor performs or enables the mechanism of seeding operation in vertical position and place it along horizontal direction such that vertical dropping and horizontal placing actions happen perpendicularly. The up and down drilling operations takes place through drills with respect to end effectors been used, and it varies from crop to crop. LiPo batteries are used to provide supply voltage to the controller. The basic design of autonomous robot can be customized depending on the area of field.

The paper [3] deals with real time concepts along with its efficient use in the field of farming. A fully computerized observation of the agricultural field was considered, which gradually minimized the man power and eventually progresses the crop quality. This approach is based on IoT technology using raspberry pi and sensors, thus timely monitoring of sensor data is done. The proposed system measures soil moisture, detects flooded water, measures the pH value of soil and records humidity and temperature.

This paper [4] presents the agricultural activities using a smart Bot. Arduino microcontroller is used, and farmers can easily handle it using a Bluetooth module and also different sensors are used to perform variety ofapplications. The most required functionalities to design a bot system are reliability, low-cost system, farming safety, quick response and accuracy. Moisture sensor is included for irrigation and fertilizer spraying. A water pump and small water storage is added to the bot for irrigation. An end effector tool is added for loosening or turning the soil before sowing seed. Thus, a low-cost bot is designed, but power consumption is comparatively higher.

The bot was implemented [5] to reach out farmers doing the agricultural actions in their field working all day long. The paper presents the use of IoT and other emerging technologies including big data and cloud. Focus is on the need for better integration using IoT services. The robot control remotely through GPS based mobile function. Motion detector will detect the motion, and sends the notification to user via Raspberry pi. The designed bot can perform multiple operations like seed dispensing, ploughing, and fruit picking. GSM module provides for manual control. On the field, the bot is operated by sensor signals in coordination with raspberry pi controller, being a fast controller, it provides faster operations with great memory backup.

3. System Architecture

The control system architecture of the agri-assistor is as shown below.STM32 Microcontroller is used for controlling the operation of the bot. It is a powerful microcontroller for robotic designs. The STM 32 is programmed using Embedded C programming language and Arduino IDE. The source code written is verified and uploaded to STM32 microcontroller. The system architecture includes moisture sensor, temperature sensor ,16 × 2 LCD, STM32 microcontroller, water pump, power regulator, relay circuit. Temperature sensor records surrounding temperature while the moisture sensor records the soil moisture reading, which will be displayed on the LCD display. The real-time temperature and moisture values are monitored via www.thingspeak.com interface. A graph of the recorded values is plotted. Camera will be implemented through ESP 32 camera module for livestreaming purpose. The agri-assistor is designed to perform the operations viz soil digging, seeding, soil levelling, grass cutting, watering and fertilizing. Bluetooth module is used for controlling the working of the bot. The bot is mobile, which can move is all 4 directions (i.e., Forward, Reverse, Right and Left). The operation of the bot can be controlled through a mobile phone paired with the Bluetooth module.

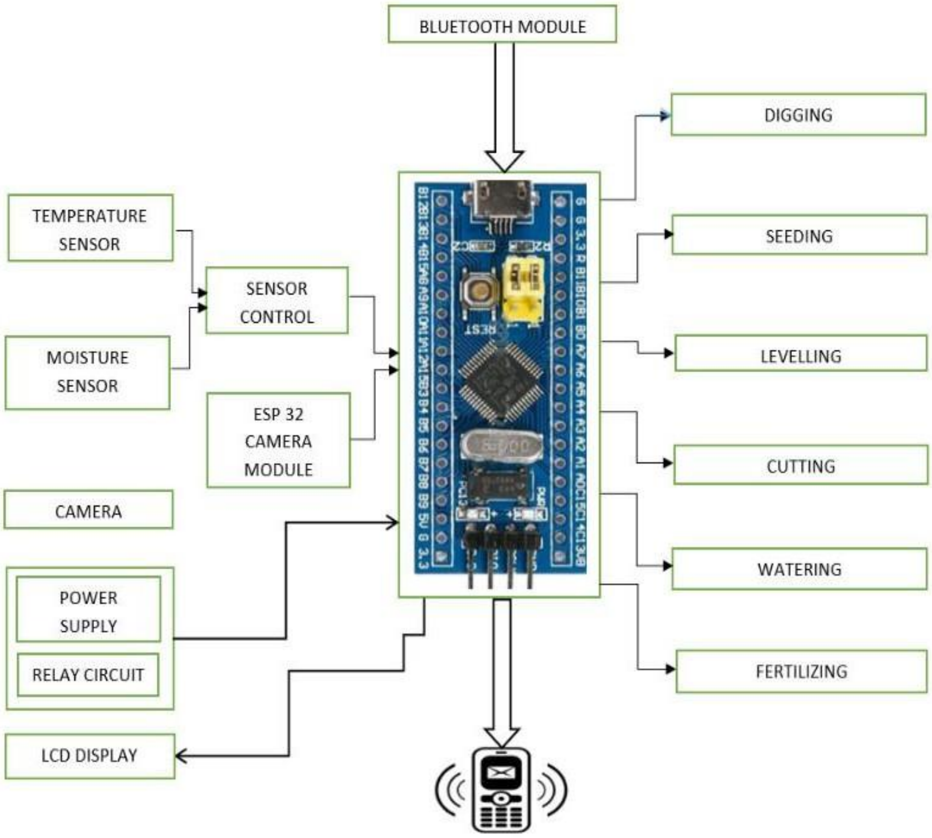

Figure 1: The Agri-Assistor Control System architecture

4. System Modelling

The agri-assistor is designed to work in all directions i.e., it can move forward, reverse, left and right. Bluetooth module is used for controlling the working of the bot. Once the bluetooth module and the mobile phone are paired, the operations of the bot can be initiated. The operations are commanded by the user through bluetooth module by selecting the required commands on the mobile application. On receiving the command, the bluetooth module sends it to the STM32 microcontroller. The microcontroller then drives the circuitry for performing the desired operations. The soil digging operation is performed using the tool attached. Seed sowing is done through the rotation of the circular funnel base, where the seeds fall into the area where soil is dug. Soil levelling is initiated once seed sowing operation is completed. All these three operations (digging, seeding and levelling) are performed in a sequential manner with a single command. Grass cutting, watering and fertilizing operations are done based on thechoice of the user. ESP 32 Camera module is used for livestreaming purpose.

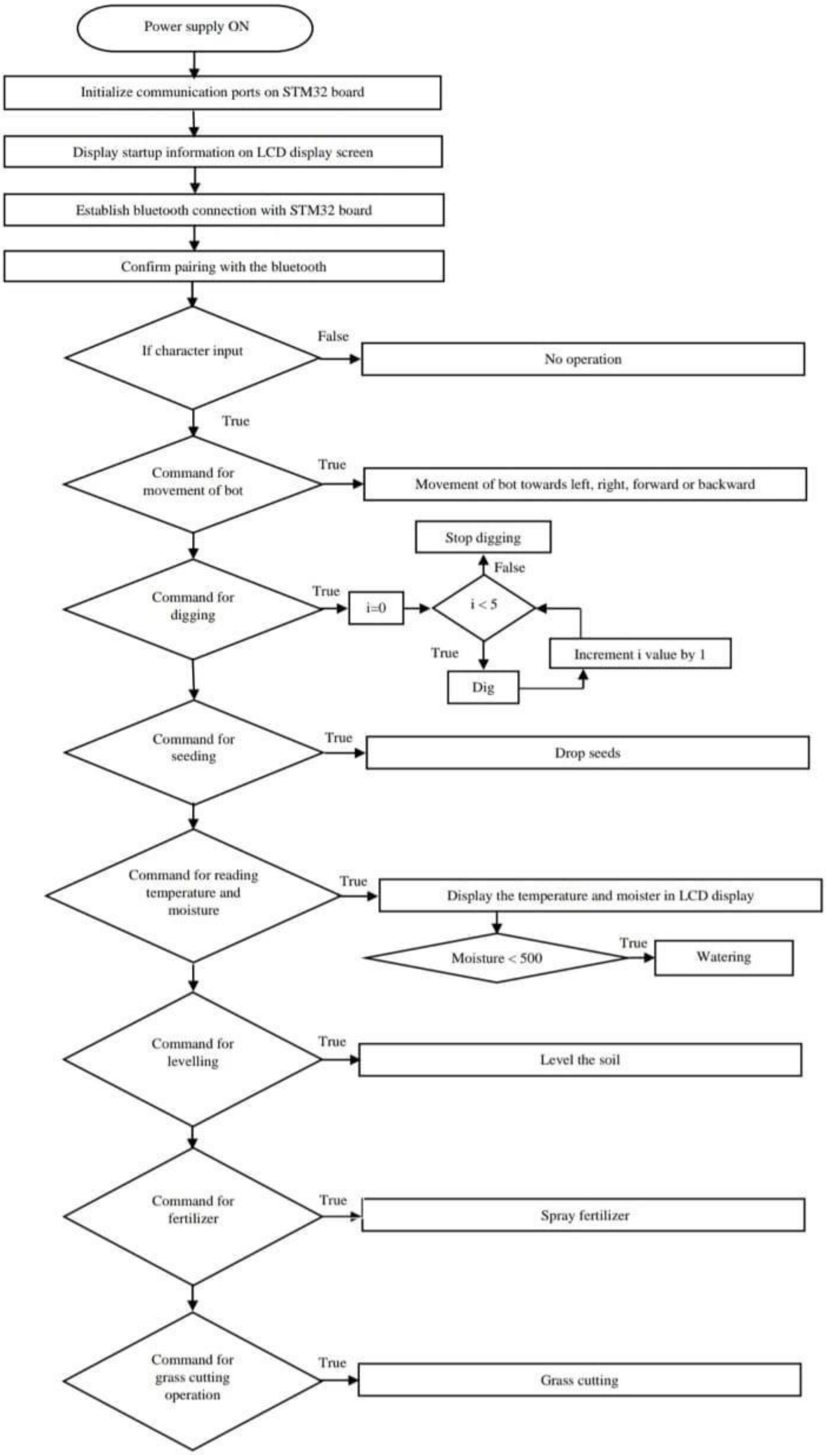

Figure 2: Proposed Method Control Flow Diagram

5. Algorithm

```
// Algorithm to Calibrate the moisture sensorint MoistMin ← 250;
int MoistMax ← 1023;
while (t () < 10 sec)
{
MoistValue ← analogRead (MoistPin)if (MoistValue > MoistMax)
{
MoistMax ← MoistValue
}
if (MoistValue < MoistMin)
{
MoistMin ← MoistValue
}
}
MoistValue ← map (MoistValue, MoistMin, MoistMax, 250, 1023);
```

```
// Algorithm to Calibrate the temperature.int TempMin ← 25 deg;
int TempMax ← 35 deg;while (t () < 10000)
{
TempValue ← analogRead (TempPin)if (TempValue > TempMax)
{
TempMax ← TempValue
}
if (TempValue < TempeMin)
{
TempeMin ← TempValue
}
}
TempValue ← map (TempValue, TempMin, TempMax, 25,35);
```

6. Results

The moisture content is recorded timely on a day to day basis and the graph of moisture content v/s duration in days is plotted as shown in Figure 3.Similarly, the temperature values were recorded on a particular day from time to time and the graph of temperature v/s time on that particular day is plotted as shown in Figure 4.

Percentage moisture content per mass of dry soil is given by,
% M.C = (Wet_mass - Dry_mass) x 100 / Dry_mass. Temperature conversion from analog to digital value is given by,fa=a*3.3/4096.0
fa1=fa*100.0+20. (fa1 is the digital value of temperature)

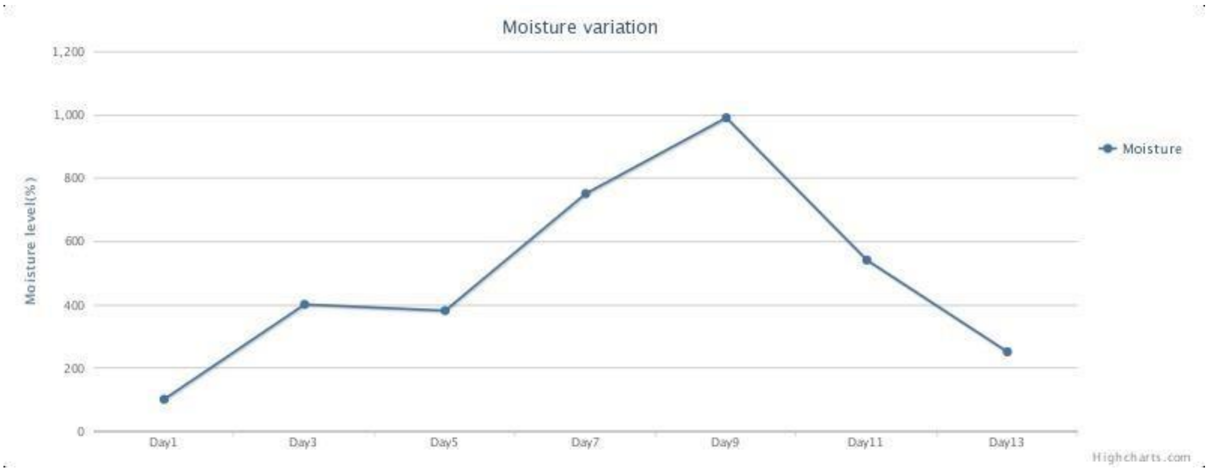

Figure 3: Plot of Temperature v/s duration in days

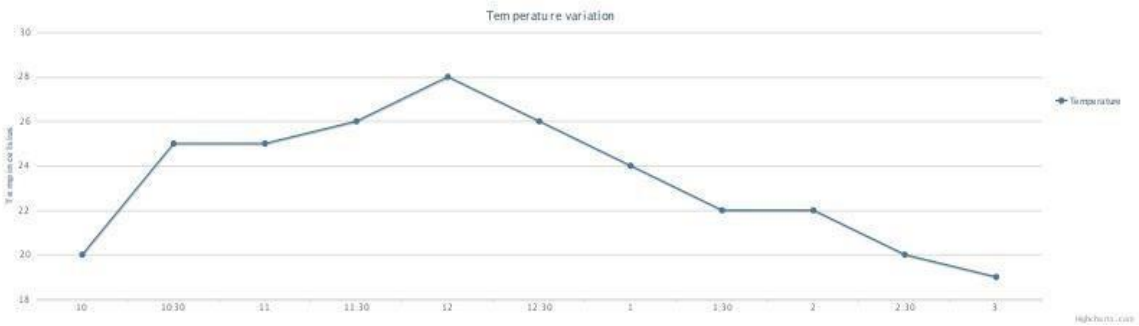

Figure 3: Plot of Temperature v/s duration in days

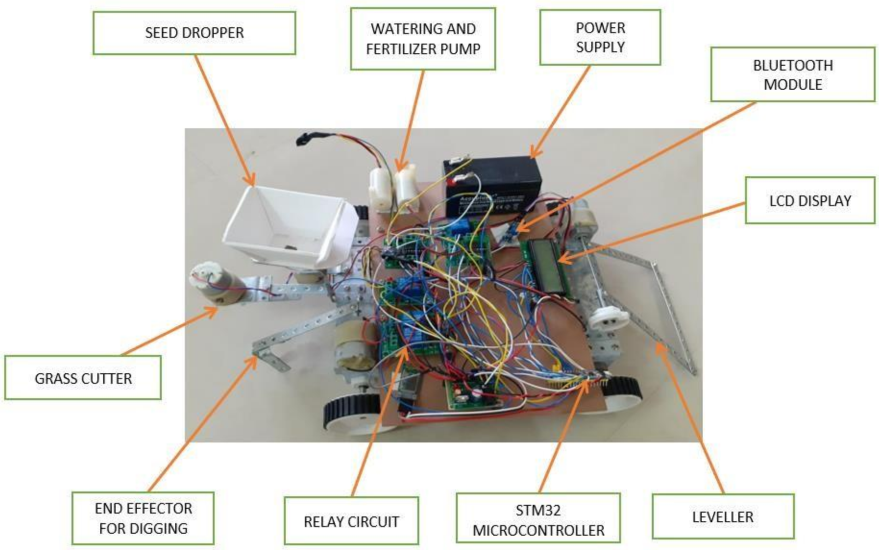

Figure 4: Model for the proposed architecture

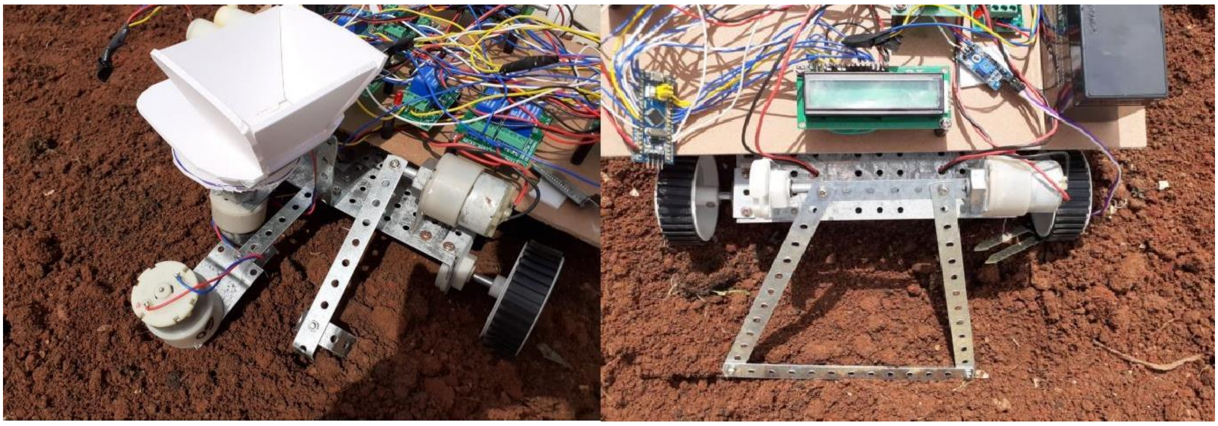

Figure 5(a): Front View **Figure 5(b):** Rear View

Figure 5: Working Model Deployed for its operation

7. Conclusion

The project aims for the improved design, development and manufacture of a multifunctional robot which has an ability to perform programmed soil digging, seed sowing, land levelling, grass trimming, watering the land, fertilizing and live monitoring of all operations on-field, thus revolutionizing the agricultural sector. The model is proposed to significantly reduce the requirement of substantial labour and cost of equipment manufacturers and is moderate to agriculturists. This system helps in the reduction of work expenses and constraints on working hours can be improved. The agribot is intended to assist and help the agriculturists. A fully computerized observation of the agricultural field is considered, which gradually minimized the man power and eventually progressed the crop quality. Once the idea of computerization and automation in agriculture are acknowledged, the selection rates will increment and innovation's expenses will significantly reduce, thus this agribot becomes affordable to every agriculturist.

8. Future Scope

The project, on successful implementation, will profit each farmer to the maximum extent. In addition to the process of soil digging, sowing the seeds, land levelling, grass cutting mechanism, watering the land and fertilizing operations; ploughing, harvesting the land and other cultivating processes like pesticide spraying and so forth can be executed in one robot, thus making this a skilled multitasking machine. For more progressed and appropriate control of elements of robots over an extensive scale, the complete mechanization of robot can be done. In the near future, inclusion of drones is also possible in order to dispense the seeds and also for pesticides and fertilizers spraying action.

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