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IOT Based Agribot for Agricultural Farming

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***Abstract*—** Every living being requires energy for which it depends on food. Human population rely on agriculture, one of the main sources of food. In this project the main focus is to aid agricultural activities using IOT techniques in an effective and user-friendly manner. The system here consists of an agricultural robot which performs grass cutting, ploughing, seeding along with obstacle detection. All these functions of Agribot is chosen using user-friendly mobile application. Agribot uses Renesas microcontroller, DC motors for wheel rotation, to rotate cutting blades, to open or close seeding valve and to move the ploughing arm. Ultrasonic sensor is used for obstacle detection and android app is the mobile application. Bluetooth module is used to communicate between the app and Agribot. The function selected by the user is also displayed on the LCD of the Agribot. Agribot thereby helps to increase profit margins of farmers with minimal investments.

***Keywords*—**Internet of Things (IoT), Agribot, Ploughing, Seeding, Grass cutting, Bluetooth, Ultrasonic sensor and Mobile application.

I. INTRODUCTION

With increasing population, there is vast scale increase in requirement for food production. Agriculture is one of the major sources of food and the main occupation of India is agriculture. Recent shift from rural to urban occupation has affected agricultural production as there is less availability of farm labourers. This creates a necessity for alternatives which can help in improving the condition of agriculture. Earlier, farmers worked by their own hands and used smaller tools. In order to achieve greater production rates, farmers make use of farm machinery. These machines are not only large but also require large initial investments. It also requires more knowledge on how to operate such mechanical machinery. Robots are artificial virtual or mechanical agents which can perform activities on behalf of humans. These are guided by a computer program or electronic circuitry. Agribots are agricultural robots which can perform agricultural activities. These activities include seeding, ploughing, mud levelling, weed control, spraying pesticides, spreading chemicals, soil sample testing, irrigation etc.

Some of these agricultural robots are fully manual, these are more dependent on the choices of the user and can be time consuming. While fully autonomous robots can perform without human mediation, these robots cannot change the order of functioning when a user wishes to alter the functioning order. Due to these problems it is more convenient to have a solution which satisfies both the conditions, that is, to have a robot which permits changing the order of functioning as well as continues to perform repeated cycles of the function selected. This means that a semi-automatic robot can be more convenient to use in agricultural fields.

II. RELATED WORK

The paper [1] proposes an autonomous agricultural robot which performs ploughing, seeding and irrigation. This robot performs its functions using the click of a switch. It can change position from one farming strip to another using ultrasonic sensor. Drawback of this robot is that it has no notification system to alert the user, it can be implemented only on small land and also the user cannot change the order of the functions to be performed. And the overall system was not user-friendly.

The paper [2] proposes an Agribot which performs ploughing, seeding and irrigation. It uses Arduino Uno microcontroller. Ultrasonic sensor is for avoiding the obstacles in the field, IR sensor is for sensing the path and field of adjacent boundary. soil moisture sensor is used in this robot to detect the soil moisture content to decide whether or not to irrigate the land. Drawback is that this robot was not user-friendly, the selection of its functions was not easy.

The paper [3] proposes an agricultural robot which performs irrigation and farm monitoring. This robot is solar powered and hence is influenced by the climatic changes. It uses Arduino microcontroller. It uses several sensors to perform farm monitoring, it senses soil moisture content using soil moisture sensors and temperatures at regular intervals. The data transfer takes place through Wi-Fi to remote server. Since it is solar powered it is pollution free but at the same time it is more dependent on the climatic conditions as it cannot harvest enough solar energy on cloudy days.

The paper [4] is a study on Environmental condition detection in Greenhouse and traceability system. It describes about the working of a smart farm and how sensors can be used to determine various parameters based on which chemical spreading and irrigation system can then be operated. It also focuses on Auto dosing and foggy spray. Drawback is that the proposed system in this paper is particular to Greenhouse. QR codes are assigned to the results and products in this paper.

The paper [5] proposes a Multipurpose autonomous agricultural robot which performs seeding, ploughing and spraying pesticides. This system consists of DC motors used for wheel rotation and Bluetooth module for communication. This system is autonomous and hence does not allow reordering of the functionalities.

III. METHODOLOGY

Proposed system will use Mobile user-interface application to change functionalities of Agribot. It will also contain Bluetooth module to increase controllable range to 100m. Architecture of the Agribot consists of the following:

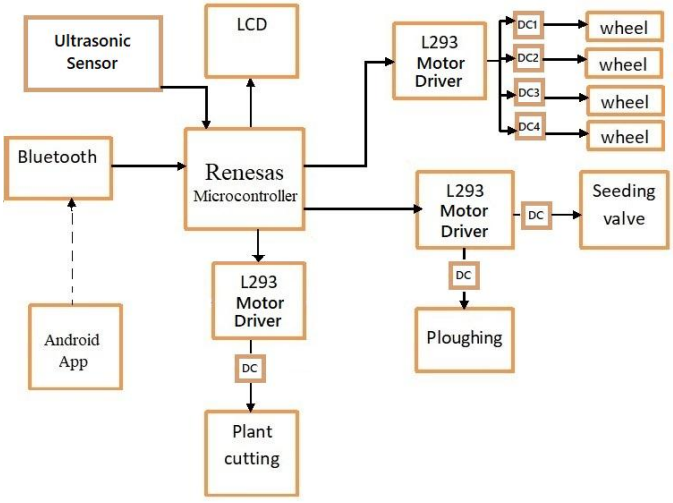

FIGURE 1: BLOCK DIAGRAM OF AGRIBOT

Base robot

This will have 4 wheels attached to DC motor, which in turn are connected to L293 Motor Drivers. Renesas Microcontroller which coordinates all the activities and Bluetooth HC- 05 module which is used to provide communication between the microcontroller and the mobile App.

Proposed Agribot will contain the following modules:

A. Ploughing Function

B. Ploughing arm designed using DC motor, screws and wiring to plough the soil and be lifted up when function is not selected.

Algorithm for Ploughing Function

Input: User selects function ploughing and sets FUNC="P"
Output: Agribot performs ploughing operation
Start
if FUNC=="P"
plough arm levels down to the ground level to plough the soil and displays "PLOUGHING" in LCD
    if FUNC=="PS"
        plough arm is raised a level above ground to stop ploughing
    else continue to plough
stop

C. Seed Sowing Function

Seeding is planting seeds in a soil. In this model, a small container will be used for Seed storage and opening is controlled by DC motor when Agribot wheels are rotated. Also, to drop the seeds at fixed interval a simple valve open-close mechanism after certain distance will be used.

Algorithm for Seeding Function

Input: User selects function seeding and sets FUNC="S"
Output: Agribot performs seeding operation
start
if FUNC=="S"
    Agribot uses valve open-close mechanism to drop seeds at regular intervals and displays "SEEDING" in LCD
    if FUNC=="SS"
        stops dropping of seeds
    else continue to drop seeds
stop

D. Cutting Function

Agribot will perform grass or crop cutting using movement of the blades. DC motor will be used to rotate the blades.

Algorithm for Cutting Function

Input: User selects function cutting and sets FUNC="C"
Output: Agribot performs cutting operation
start
if FUNC=="C"
    Agribot starts cutting mechanism and displays "CUTTING" in LCD
    if FUNC=="CS"
        stops cutting of grass or crop
    else continues to cut grass or crop
stop

E. Obstacle Detection

If the moving robot detects any obstacle within the detection range of the Ultrasonic sensor, then Agribot will stop functioning and wait for the user to reset it.

Working of Proposed System

Step 1: User selects option of functionalities in the mobile app.

Step 2: These commands are received by Bluetooth module which further sends it to microcontroller for further processing.

Step 3: Based on the command, microcontroller activates the components related to the selected functionalities (ploughing, seeding, cutting grass/crop).

Step 4: Obstacle detection occurs simultaneously, if any obstacle is detected the Agribot will stop.

Step 5: Finally, the Agribot performs the selected activities.

Coding for all the hardware components, that is, for microcontroller will be done using CubeSuite+ software in Embedded C language. And the mobile application will be created using Eclipse Kepler software using android SDK.

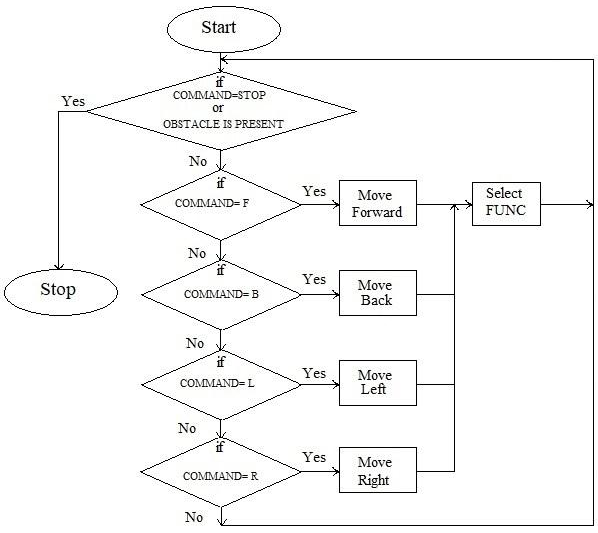

FIGURE 2: FLOWCHART OF AGRIBOT

In the FIGURE 2, the flowchart of Agribot describes that once the Agribot is switched ON, it initially checks if it has been stopped or if any obstacle is present. If no obstacle is present, then it continues to move in the direction selected by the user and also performs the function selected by the user. If variable COMMAND is set a value "F", the robot continues to move in forward direction.

In the FIGURE 3, the flowchart of select func describes how the Agribot will perform the actions once the user selects the function. When the user selects Ploughing function, the FUNC variable is set with a value "P" which indicates that the ploughing operation has to be performed. This value is reset to "PS" once the number of cycles of performing this function completes. Similarly, Seeding and Cutting are also performed by the Agribot as described in this flowchart.

When none of the functions are selected, the Agribot will simply continue to move in the selected direction.

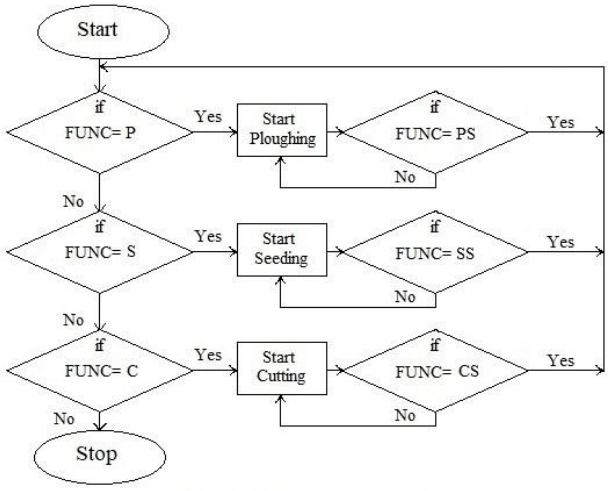

FIGURE 3: FLOWCHART OF SELECT FUNC

Mathematical Model for Obstacle detection

Consider the below pseudocode:

while obstacle is not found

It indicates that the loop is executed until an obstacle is found, that is, OBSTACLE = 1
Ultrasonic Sensor has object detection range of 2cm to 400cm

Speed = Distance / Time
Therefore, Distance= Speed*Time

$$\mathbf{s = v * t}$$

Here t = (Total time taken by signal to be received) / 2
Speed of sound= v = 340 m/s =0.034 cm/µs

Example:
If ultrasonic signal is received after 588 µs,
Total time taken by signal to be received = 588 µs

Therefore Distance = (588/2)*0.034
= 294*0.034 cm
= 10 cm
Since 10 cm is within the range, obstacle is found so OBSTACLE = 1.

IV. RESULTS AND DISCUSSION

Agribot accepts the input given from the App, these inputs are received using Bluetooth module (range 100 m) and it performs all the activities selected by the user.

Results of each Module of Agribot

1) Grass Cutting
The Blades attached to DC motor infront of the robot effectively cut the grass (as shown in FIGURE 4).

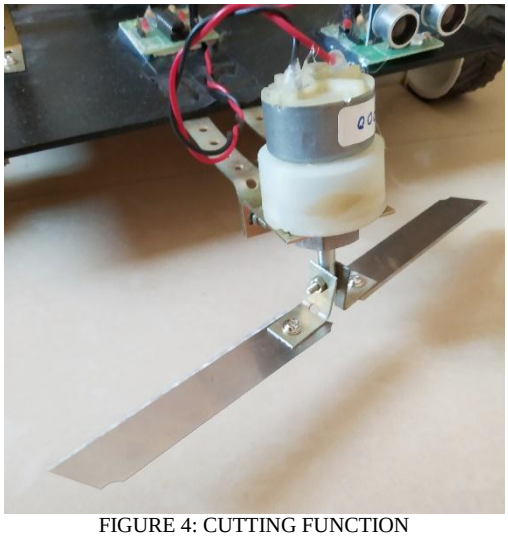

FIGURE 4: CUTTING FUNCTION

2) Ploughing
The Plough arm made of screws moves down and plows the soil and is lifted up after completion of ploughing (as shown in FIGURE 5).

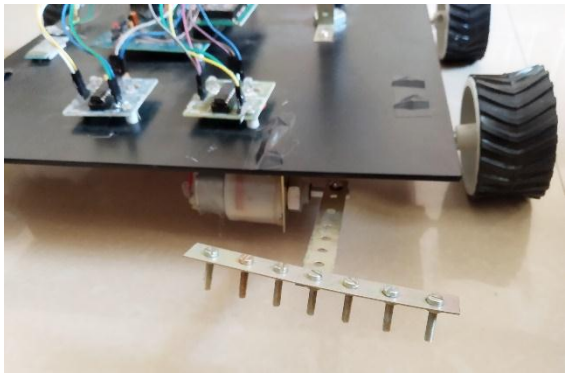

FIGURE 5: PLOUGHING FUNCTION

3) Seeding
Seeds are dropped from the funnel using the open-close movement of values at equal intervals.

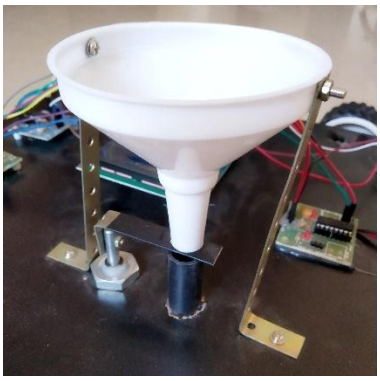

FIGURE 6: SEEDING FUNCTION

4) Obstacle Detection
On detection of any obstacle the robot stops its movement and waits for the user to remove the obstacle and to reset the robot.

FIGURE 7: OBSTACLE DETECTION

Mobile Application which is used to control Agribot contains two pages:

F. MainPage
This page contains button to connect to Agribot using Bluetooth. And also has options to choose number of cycles and steps. (as shown in FIGURE 8.b)
Cycles- Number of times the function has to be repeated.
Steps- Number of steps in the selected function.

G. Login Page
Username and password are the two inputs used here, so that only the authorized user can use this app to control the Agribot. (as shown in FIGURE 8.b)

FIGURE 8.a: Login Page

FIGURE 8.b: MainPage

Agribot with all its modules assembled together looks like the following images.

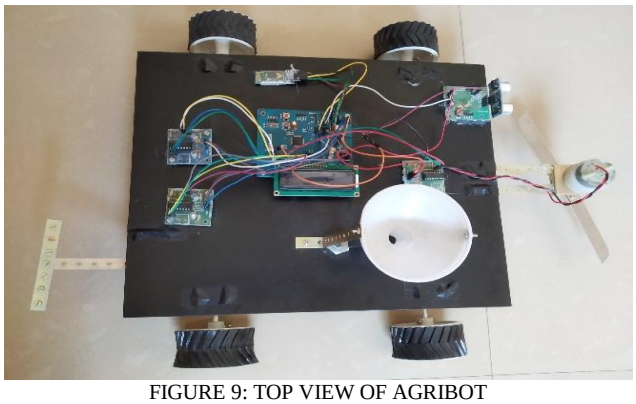

FIGURE 9: TOP VIEW OF AGRIBOT

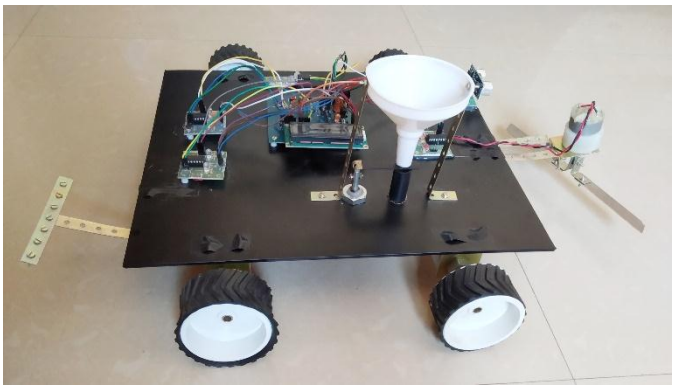

FIGURE 10: SIDE VIEW OF AGRIBOT

V. CONCLUSION AND FUTURE SCOPE

Agribot performs grass cutting, seeding and ploughing effectively and is designed as per the calculations made. It performs ploughing of soil followed by seeding the seeds at regular intervals and cutting of crop/grass. It is user-friendly and semi eco-friendly as it is electric battery powered. Hence it proves to be a helping hand in performing agricultural farming. Obstacle detection is also used here to detect the presence of obstacles like large rocks, fences and walls, upon detecting these obstacles the robot stops and waits for the user to reset it. Agribots can improve the quality of farmer's lives. Scarcity of human labour can be overcome using Agribots. It can perform several functions accurately and efficiently irrespective of the weather constraints. So, using IOT based IT technique we have improve performance of Agricultural activities.

The future of this Agribot will include more number of agricultural activities and stronger set of wheels to move even on harsh terrains. Using advanced Bluetooth module will help to increase the range of this robot further and similarly for Ultrasonic sensor. Cameras can be installed to record and monitor the activities being performed by the Agribot, output of this can also be used for Image processing. Several such robots can be linked to one single app. GPS and Magnetometer can also be used to correct the path of robot automatically todays its final destination. GSM module can be used to send notifications to the users after completion of work. Improved seeding mechanism to drop one seed at a time can also be done. Further if these robots are made available to the farmers on a rental basis by the government, the initial investment by the farmers can be minimized to larger extent.

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