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Multipurpose Solar Powered Agribot

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ABSTRACT: *The biggest problems faced by farmers, especially in rural areas, are low productivity rates and less exposure to appropriate technologies in the agriculture sector. Hence, additional support is required to carry out certain tasks on agricultural land. There are many modern methods and machines available in the market, but all farmers cannot afford to buy them. In this paper, a multi-purpose solar-powered Agribot for supporting agriculture purposes has been designed. This robot has four modes of operation: 1. Ploughing 2. Seed sowing 3. Soil moisture monitoring 4. Weed removal. The robot is instructed to carry out these processes with details about the total land surface dimensions as well as the distance between plants. The variables are sent as SMS by the user to the GSM Module. A PIC Microcontroller receives the information. For the ploughing operation, the rotating blade and Plough will be activated. During the seed sowing mode, the robot starts to drop the seed by first loosening the soil and then covering the seed and then followed by dropping the seeds and covering the seed with loosened soil. Solar Panel has been provided to recharge these batteries. During the Weed-removing mode, a spinning blade removes the unwanted plants in between the sown seeds. During the soil moisture monitoring mode, sensors determine the exact moisture content of the land. Accordingly, it will switch the ON the water pump kept in the agriculture field. This highly cost-effective robot can be shared by a large group of farmers.*

Keywords: weed remover, soil moisture monitoring robot, weeding mechanism, seed sowing mechanism, ploughing mechanism

1. INTRODUCTION

The base of the Indian economy is mainly dependent on the Agriculture sector. Food production has always been on the rise. But sometimes due to a lack of appropriate supervision and as well as natural calamities, huge portions of cultivated crops are affected which leads to lesser production thereby raising the selling price due to higher demand. There should be sufficient labourers in the field. But, nowadays, Landowners are starting to sell their property because they are not getting labourers for doing some work. In case they get labourers, they charge very high wages. Many landowners could not afford such paying high wages. The conventional method of agriculture is usually very time-consuming and highly labour dependent. There are many modern methods to do some agricultural activities. But they have a very high initial investment, most farmers cannot afford to pay the high price. So, to simplify the farmer's work some agriculture robots can be used instead of the human labourer. The idea is to make agriculture robots that can perform the task of the labourer namely ploughing, seeding, weed removing, and water pouring. So, the labour problem in the agricultural sector can be reduced. Mobile phones are used by a huge number of people globally. Here, used a mobile phone is the interface between the robot and the user. The GSM (Global System for Mobile communication) supports wireless communication. The farmer can send the appropriate instructions to the GSM module which is fixed in the robot.

In this paper, Agribot has four modes of operation: 1. Ploughing 2. Seed sowing 3. Soil moisture monitoring 4. Weed removal. For ploughing mode, a curved tool is used. it can do burrowing as well as closing the seeds with soil. During the seed-sowing mode, three control variables are given as input. Distance between the seeds is very important. Proper germination and further growth require the correct spacing. During soil moisture monitoring mode, a soil moisture sensor is used to determine the amount of moisture content in the soil. According to the moisture level, the robot will turn ON/OFF the water pump kept nearby in the agriculture field. The yield of the crop mainly depends on the moisture in the soil rather than the available nutrients in the soil. It helps biologically well to grow crops effectively. Another big problem faced by the farmers is the growth of weeds. Weeds are the unwanted crops grown in between the seeded crops. This occurs mainly due to more fertilizer content in the agricultural land. So, such types of unwanted crops should be removed to grow seeded crops. Weeds should be removed in the earlier stage itself to get more yield from the agriculture field.

The Microcontroller is the heart of this robot. Here a PIC microcontroller (PIC16F877A) is used which is an 8-bit microcontroller. This robot will operate in open atmospheric conditions. So, Solar Panel is placed on top of the agribot. Which is used to recharge the 12V batteries used. This highly cost-effective robot can be used by a large group of farmers and for huge agricultural lands. It can be easily operated and

user-friendly. By implementing such technologies in agriculture, the yield of the crops can be increased.

2. PROPOSED SYSTEMS

In this paper, we deal with the use of automation and robotics. This Agribot has four modes of operation. For seed sowing operation, the length and no. of columns to be sown seeds in the land are the agricultural two variables and the distance between seeds is another variable. The proposed robot automatically drops the seeds and covers of soil after planting a seed in a sequence, till it reaches the end of the proposed area. This robot is controlled by a smartphone using GSM and PIC controller to automate the entire function. The microcontroller is programmed to control agricultural purposes like opening the soil, dropping the seed in the soil, and putting the soil back We are also programming the PIC to send the report to the remote place through the GSM module. The report can also be monitored on a mobile phone anywhere in the world. Thus, the main problem faced by the farmers that lack manpower can be manpower led by the robot. A soil moisture sensor is placed to determine the moisture level of the land. According to it turn ON/OFF the water pump placed in the agriculture land. For removing the weed in the agricultural land, weed cutting mechanism is provided here. It has a spinning blade that is used to cut down unwanted crops. This proposed work is done to provide better results in the field of agriculture.

3. METHODOLOGY

This paper focuses on designing a robot that is used for various agricultural activities like ploughing, seed sowing, soil moisture monitoring, and weed removal. Using GSM technology, the variables are sent in the form of an SMS to the robot. The PIC microcontroller receives the variables from the GSM modules and does the programmed sequences. SMS (Short Message/Messaging Service) is only sent after the GSM connects to the cellular network. It can be known by the text displayed on the LCD "ENTER THE DISTANCE". For each mode of operation, the activating mechanisms were different. This hardware of the robot consists of a ploughing tool where a shovel is used to dig and loosen the soil. For the seed-sowing mechanism where the funnel-shaped container is used to store the seeds and a wooden plate is used to open the bottom of the funnel to drop the seed into the land. Here a limit switch is used to limit the position of the wooden plate. For soil moisture monitoring, a soil moisture sensor is used to monitor the moisture level of the soil and sent the data to the microcontroller accordingly it will turn ON/OFF the water pump. If the moisture level is very high means it turns OFF the water pump and vice versa. For weed removal, a fan-shaped blade is placed under the robot to remove the weeds. Users get the completion status after each operation. Here, the GSM module transmits and receives data using AT (ATtention) commands. This robot could be used by the farmers to make their work even more productive.

4. BLOCK DIAGRAM

The block diagram of the Agribot is shown in Figure 1. It consists of a PIC 16F877A microcontroller, two sensors namely an Inductive proximity sensor and soil moisture sensor, a Solar panel with 12V rechargeable batteries, an LCD for showing the data sent by the users, a GSM module with an antenna for transmitting and receiving the data to the users and totally five relay drive circuit used for watering mechanism, seed sowing mechanism. The ploughing mechanism, weed-cutting mechanism, and robot moving mechanism.

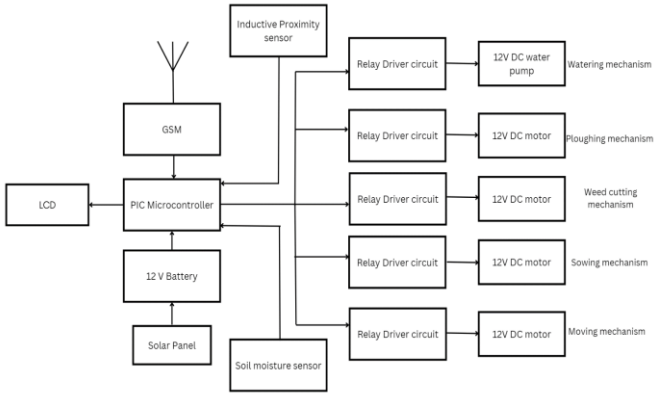

Fig-1: Block Diagram

5. HARDWARE IMPLEMENTATION

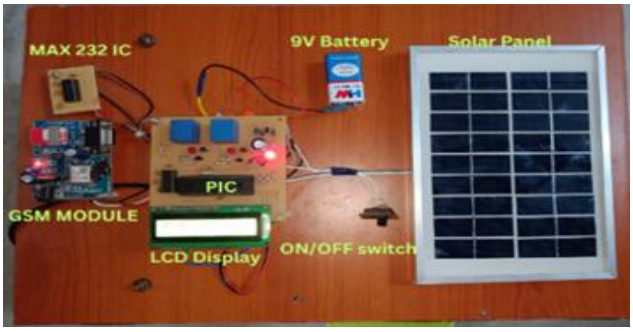

Fig-2: Top view of the Agribot

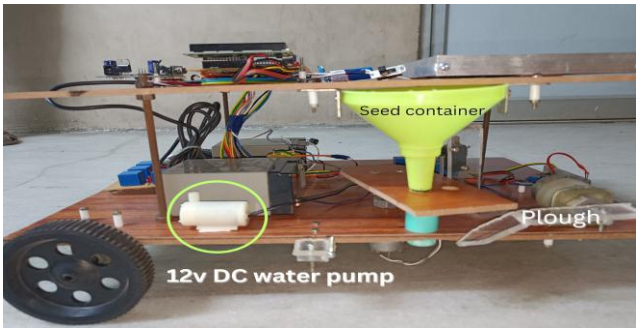

Fig-3 Side view of the Agribot

Fig-4 Bottom view of the Agribot

The top view, side view and bottom view of the hardware set-up are shown in Fig 2, Fig 3, and Fig 4. Here 12V DC power supply is used. When the power supply is switched ON, it will start to process the robot with the PIC microcontroller, according to the program written. The program used here is written using Embedded C and it is implemented in MP LAB IDE software. The first process is to detect the signal in the GSM module of the robot. To start the entire performance of the robot is given through SMS. When the GSM module receives the input signal, the Red-LED blinks slowly. Now it is ready to receive the SMS from the user. When the LCD displays "ENTER THE DISTANCE", the SMS is sent by the user from the mobile phone to activate the robot's functioning. This SMS is in the form of a sequence of 7-digit numbers. Solar Panel is used here to power up the 12V Battery. An inductive proximity sensor is used for this robot to calculate the distance by it. A soil moisture sensor is also used here to monitor the moisture content in the soil.

Modes of operation: This robot can perform 4 operations namely ploughing, seed sowing, soil moisture checking, and weed removal.

Mode 1: Ploughing: Farmers prepare the land before cultivating the crops. The Ground is well-loosened and prepared for proper germination. When this mode is selected, it brought the plough structure down and loosens the soil for effective germination. The total dimensions of the land were given through the SMS.

Fig-5: Ploughing mechanism

Fig. 5. shows the arrangement of the mechanism used for this robot. Here, a 12V 10 RPM motor is used to control that mechanism. 2 channel relays are used to control the forward and reverse positions. Whenever it gets a signal from the microcontroller, the plastic-like structure will go down to dig the soil. It works according to the instructions given in the program. After finishing the work, it will go back to its original position.

Mode 2: Seed Sowing

Fig-6 Seed sowing mechanism

A Wooden disc (diameter: 50 mm) is provided to support the dropping of seeds. The seeds are stored in a funnel-shaped container above the wooden disc. The funnel has a hole in the bottom through which the seeds drop one after the other. In the rigid disc, there is a hole (diameter:10 mm). The disc rotates till the robot reaches the location where the seed has to be dropped. The limit switch is used to control the movement of the wooden disc. For better germination, placing the seed correctly on the land is very important. This mode is very useful for farmers to save their time and be productive.

Mode 3: Soil moisture checking

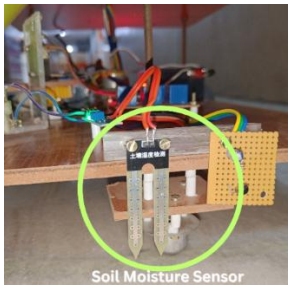

Fig-7 Soil moisture monitoring

As a farmer, the moisture of the land should be constantly monitored, providing water at right time and not wasting the water is important. If the soil moisture option is selected, it will start to move around the seed-planted areas and check the moisture level and send that value to the user. If the water moisture level is high it will ON the water pump and vice versa.

Mode 4: Weed removing

Weed control is very important in agricultural land. Because it reduces the efficient growth of the crop and interferes with harvesting. Weed should be removed in the initial stage itself to get a higher crop yield. The process of removing weeds

from agricultural land is called weeding. The weed removal mechanism consists of a rotary blade that will cut down the unwanted crops grown on the land. Here, the 12V DC motor is used to drive the blade. This whole mechanism is placed on the bottom side of the robot for efficient cutting of weeds.

Fig-8: Weed removal mechanism

Measuring the distance

Robot has to be instructed about the distance where it needs to drop the seeds. An inductive proximity sensor is used to measure the distance. This sensor is placed on the rear left wheel. As the wheel rolls, the position of four nuts is sensed by the sensor to calculate the distance.

Fig-9 Inductive proximity sensor

Four nuts are placed on the rim of the left rear wheel. As the sensor senses every nut, the controller automatically calculates the distance moved by the robot. The Robot can be programmed to be stopped as per the requirement as required. One full rotation of the wheel can move the robot approx. 15 cm.

6. RESULTS AND DISCUSSION

Table-1: Format of SMS

0	x	y	z	w	X	X
Distance between the seed		No. of Columns	Length	Mode of operation	0	0

- 'x' variable denotes the distance between the seeds that are to be sown.
- 'y' variable denotes the number of columns in the land in which the seeds will be sown.
- 'z' variable denotes the total length of the land in units.
- 'w' variable denotes the mode of operation.
- 1 unit is approx. equal to one rotation of the robot wheel and it is equal to 10 cm

Table-2: Modes of Operation

SMS variables	Modes of Operation
1	Ploughing
2	Seed Sowing
3	Soil moisture monitoring
4	Weed removal

Experimental methods:

(i) Ploughing

The Total dimension of the land is represented as the 2-unit length and 3-unit breadth. So, the SMS is sent in the format of <0232100>. Hence, the first two digits represent the distance between the seeds. For selecting the Ploughing option, the Variable 'w' is represented by 1 in the message.

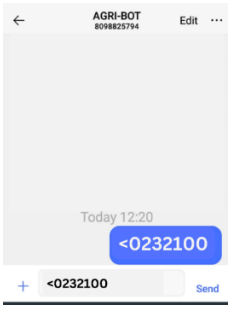

Fig-10: Screenshot of SMS (Ploughing mode)

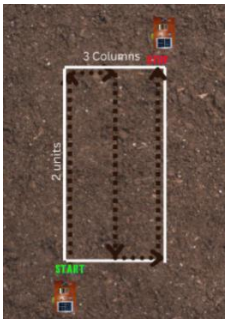

Fig-11: The output of Ploughed land

Figure 10 shows the screenshot of the SMS sent by the user for the Ploughing operation in the format mentioned in Table 1. Figure 11 shows the diagrammatic representation of the land. In this figure, the White colour line represents the area that is ploughed. The route of the robot is represented in a

dark brown colour. The entire process is explained in the following steps

STEP 1: The first step of the programmed sequence is to receive the values from the user through GSM in the form of SMS. This is then transmitted to the microcontroller.

STEP 2: Based on the variables given by the user, the Distance to be travelled by the robot in the first column is supported by a proximity sensor which allows the wheel rotation in the forward rotation. When it completes the length given by the user it stops and turns right and continues the ploughing process in the next column.

STEP 3: During this process, the ploughing shovel remains down and in addition to cleaning unwanted plants, the rotating blade also rotates to cut down them. The rotary blade is kept in the basement of the robot. A 12V DC motor is used for the purpose.

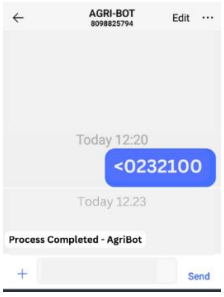

Fig-12: Ploughing completed SMS

STEP 4: At last, the Agribot will send the message "Process completed – AgriBot" to the user once the process is finished as shown in Figure 12.

(ii) Seed Sowing

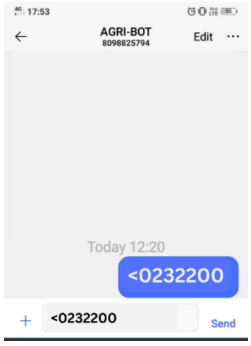

Fig-13: Screenshot of SMS (Seed sowing)

Fig. 13 shows the screenshot of the SMS sent from the user's mobile phone. After sending the SMS to the GSM module, the GSM module will receive the SMS content and transmit that input variable to the microcontroller and it starts the process. The process sequence is explained in the below steps.

STEP 1: The Shovel lowers down and loosens the soil and the wheels rotate and the robot moves forward.

STEP 2: It stops after moving through the distance mentioned (the distance between the dropping of two seeds).

STEP 3: A Wooden disc (diameter: 50 mm) is provided to support the dropping of seeds. The seeds are stored in a funnel-shaped container above the wooden disc. The funnel has a hole in the bottom through which the seeds drop one after the other. In the rigid disc, there is a hole (diameter:10 mm). The disc rotates till the robot reaches the location where the last seed has to be dropped. The limit switch is used to control the limit of the wooden disc.

STEP 4: While the robot moves forward dropping seed after seed the dug pit is closed using the soil-closing shovel.

STEP 5: After the robot reaches the endpoint covering the entire length given through the SMS, it automatically turns right and stops. The seeds are sown at equal distances in the field.

STEP 6: After completing the entire operation, the robot will automatically stop and display the value 00 00 in the LCD display and send an SMS as well as shown in Fig. 14.

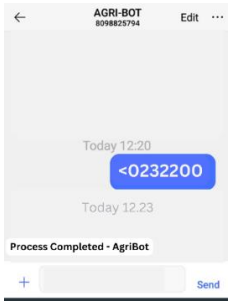

Fig-14 SMS screenshot of Seed sowing (completed)

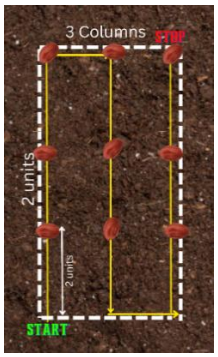

Fig-15: Seed sown land

STEP 7: Finally, the shovel goes back to its original position. Fig 15 shows the output of the land with sown seeds.

(iii) Soil moisture monitoring

In the agriculture field, a Water pump is used to supply the whole land. Sometimes due to heat, the moisture level of soil will go down. By using this soil moisture checking mode, this problem can eliminate. For selecting this operation, the variable 'w' should be given '3'

CASE 1: SOIL MOISTURE LEVEL IS LOW

When the moisture level of the soil is detected to be low by the moisture sensor, Microcontroller will turn ON the water pump in the agricultural land by using a relay connected to it. The water pump provided here is a 12V DC water pump powered by a 9V battery.

STEP 1: A SMS is sent by the user along with the details of the land area that has to be monitored.

STEP 2: The GSM sends the variable received by it to the microcontroller.

STEP 3: Soil moisture sensor continuously monitors the moisture content of the soil by moving forward in the seed sown area.

STEP 4: After it detects the low moisture level, The robot automatically switches on the water pump.

STEP 5: "Process completed-Agribot" is shown finally in the SMS after it completes the entire programmed sequences.

CASE II: SOIL MOISTURE LEVEL IS HIGH

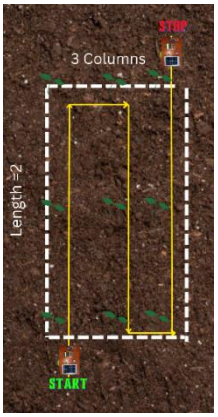

Fig-15: Soil moisture monitored land

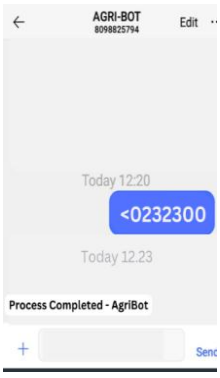

Fig-16: SMS screenshot of Soil moisture monitoring

The SMS is sent in the format of <0232300 as shown in fig 16. Here, '02' represents the distance between the seeds sown, '3' represents no. of columns, '2' represents the length of the land, and '3' represents the soil moisture monitoring mode. SMS received by the GSM is sent to the microcontroller and starts the sequence of operations as mentioned below. During the day time due to high temperatures, the land can easily be dried. So, it is necessary to check the land during the evening time.

STEP 1: SMS sent by the user along with the details of that area need to be monitored

STEP 2: GSM sent the variable received by it to the microcontroller.

STEP 3: soil moisture sensor continuously monitors the moisture level content by moving in the seed sown area.

STEP 4: After it detects the high moisture level, it automatically switches off the water pump.

(iv) Weed removal

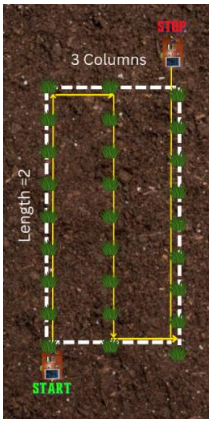

Fig-17: weed cutting

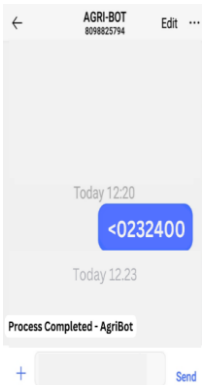

Fig-18: SMS screenshot of Weed cutting

STEP 1: SMS with control variables is sent by the user shown in fig. 18

STEP 2: After receiving the SMS from the GSM it will forward it to the PIC microcontroller.

STEP 3: In the bottom of the robot it has a rotary blade fixed, which rotates and will cut down all weeds. These blades also work during ploughing.

STEP 4: After finishing all the work the robot will stop at the end location shown in fig .17

STEP 5: After completing all operations, an SMS will be sent by Agribot to the user.

6. CONCLUSION

In this paper, A robot has been proposed to perform specific agricultural activities namely ploughing, seed sowing, weeding, and soil moisture monitoring. The robot is designed to perform these activities using program sequences. It drops the seed without wasting any of them at equal distances as mentioned by the user. The GSM module is used as an interface between the user and the robot. Land dimensions are given to the robot using the mobile phone. All the activities are carried out according to the instructions given by the user. The robot has been tested successfully and performed all mentioned activities. This robot will be very helpful to the farmers who cannot afford to pay high wages to the labourers. Hence, large groups of farmers can use this cost-effective robot for huge agricultural lands. This project may be improved with more agricultural activities. Spike wheels can be placed for more mechanical strength. Also, the Usage of IoT and machine learning algorithms in this project can be done as a fully autonomous robot. Other features such as detecting types of weeds and diseases and the percentage of the growth of the vegetables can be included.

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