Automated Seed Sowing Agribot using Arduino

Saurabh Umarkar and Anil Karwankar

***Abstract*—The Discovery of Agriculture is the first big step towards civilized life, advancement of agricultural tools is the basic trend of agricultural improvement. Now the qualitative approach of this project is to develop a system which minimizes the working cost and also reduces the time for digging operation and seed sowing operation by utilizing solar energy to run the agribot. In this machine, solar panel is used to capture solar energy and then it is converted into electrical energy which is used to charge battery, which then gives the necessary power to a shunt wound DC motor. Ultrasonic Sensor and Digital Compass Sensor are used with the help of Wi-Fi interface operated on Android Application to manoeuvre robot in the field. This brings down labour dependency. Seed sowing and digging robot will move on various ground contours and performs digging, sowing the seed and covers the ground by closing it. The paper spells out the complete installation of the agribot including hardware and software facet.**

***Index Terms*—Agribot, Arduino, Android application, Adafruit-IO, Seed sowing, Obstacle detection, Wi-Fi**

I. Introduction

Today the environmental influence of agricultural production is very much in focus and the demands to the industry is increasing. In the present scenario, most of the cities in India do not have sufficient skilled man power in agricultural sector and that affects the progress of developing country [1]. Therefore farmers have to use upgraded technology for cultivation activity (digging, seed sowing etc.).Seed sowing Machine which developed so far are operated manually or there is no Smartness of Work done by it expects seed sowing. Manual method includes broadcasting the seeds by hand [2]. Sometimes method of dibbling i.e. making holes and dropping seeds by hand is used. Also a pair of bullocks is used to carry the heavy equipment of leveling and seed dropping. So it's time to automate the sector to overcome this problem. There is a need to study on upgrading agricultural equipment [3].

Saurabh Umarkar is with Electronics and Telecommunication Department, Government College of Engineering, Aurangabad, Maharashtra,India(email: umarkar.saurabh@gmail.com)

Anil Karwankar is with Electronics and Tele-communication Department, Government College of Engineering, Aurangabad, Maharashtra,India(email: karwankar@yahoo.com)

Innovative idea of this paper is doing the processes of digging and seed sowing of crops and covering the land automatically so that human efforts will get reduce up to 90 percent. Agricultural Robots or Agribot is a robot deployed for doing agricultural purposes [4]. Pollution is also a big problem which is eliminated by using solar panel. The energy needed for robotic machine is less as compared with other machines like tractors or any agriculture tools; also this energy is getting from the solar energy which is found abundantly in nature. Nowadays robotics technology plays a paramount role in all Sections like medical field, industries and various organizations [5]. In other countries robots are used to perform different operations in the agricultural field. The main application area of robots in agriculture is at the harvesting stage and Seed Sowing Stage [6]. Driverless robots are designed to replace human labor. The data logger through Wi-Fi module on web server increases the effectiveness of the system so that surveillance of all actions will be maintained [7]. The Agribot developed in this paper performs digging, seed sowing and covering seeds simultaneously and powered by solar panel with a control of Android Application [8]. Also, every movement is monitored on web server as well as on Android Application from anywhere. The future scope for this paper is not only detecting obstacle but also avoiding it successfully without disturbing the main course of the system [9].

This paper is organized into four sections. Section I gives the introduction and literature survey of systems developed so far. Section II depicts theory related with seed sowing and the advantages of agribot and disadvantages of traditional sowing methods. Section III and IV delivers circuit designing, hardware and working principle. Section V and IV delivers the experimental results and conclusion.

II. Theory of Seed Sowing

There are various seed sowing methods used for agricultural purposes out of which some are cost effective but required more man power. In Agribot, we are trying to reduce the cost as well as human dependency by making it fully automated. In [10], the author states that traditional seed sowing includes broadcasting manually, opening furrows by a country plough and dropping seeds by hand, dropping seeds in the furrow through a bamboo/meta flannel attached to a country plough and for sowing in small areas dibbling [11] i.e., making holes or slits by a stick or tool and dropping seeds manually (by

978-1-5090-0396-9/16/$31.00 ©2016 IEEE

hand).Thus traditional seed sowing has limitations like uniformity in the seed distribution cannot

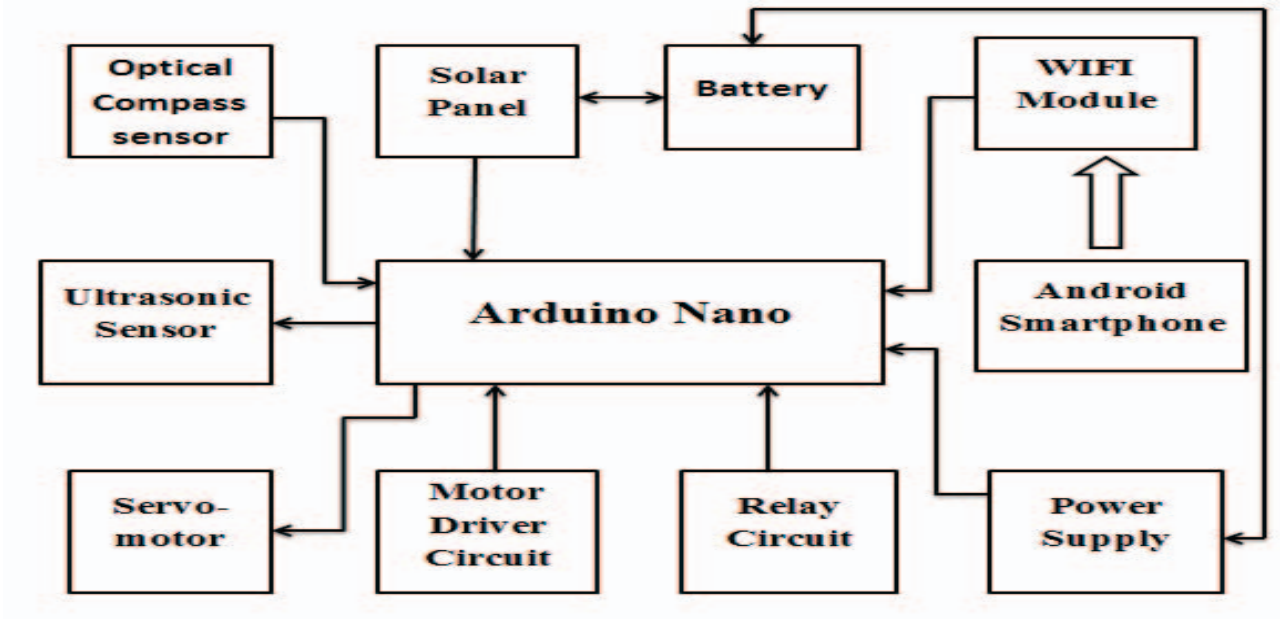

Fig. 1. Block Diagram

be achieved by manual planting, poor control over depth of seed placement so that labor requirement is high and during kharif sowing, placement of seeds at uneven depth may result in poor emergence. The innovative idea about this project is that agribot is not only performing various operations related with farming but also monitoring all the actions related with the movement of agribot like obstacle detection , battery voltage and panel voltage and compass sensor output. Here renewable source of energy i.e. solar energy is used as a power supply to feed the power requirement of the system in the form of solar Panel.

III. Circuit Design and Hardware

The block diagram of Agribot consists of Arduino Nano which is controller for the whole assembly as shown in Fig. 1 and solar Panel is attached with the lead-acid battery for storing energy and further it is given to power supply circuitry which is providing +5V for Arduino board and +12V supply for driving DC motors using l293d. Optical Compass Sensor HMC5883L is used for Compassing and ultrasonic sensor HC-SR04 is used for Obstacle detection .Servomotor is used for Seed Sowing and Wi-Fi module CC3000 is connected with Arduino and wirelessly with Android Smartphone to controlling the whole assembly. The hardware of agribot is mounted on Chassis which is 28cm long and 22.5 cm wide. All the hardware components and their features are explained below.

A. Arduino Nano Board

Arduino Nano is the heart of system which is connected with all the sensors and other hardware assembly required to achieve the desire work. In [2], the author explained features of Arduino Nano that it is a small, complete, and breadboard-friendly board based on the ATmega328. The ATmega368 has 32 KB of flash memory for storing code in which 2 KB is used for the bootloader. The ATmega368 has 2 KB of SRAM and 1 KB of EEPROM. It is low cost and easily available controller. All the software programming is written in Arduino Integrated Development Environment (IDE). Arduino IDE is open-source software which makes it easy to write code and upload it to the board. It runs on Windows, Mac OS X, and Linux. Interrupts are used in programming to make system more effective and respond to changes accordingly.

TABLE I

PIN CONFIGRATION OF ARDUINO NANO

Pin No	Name	Type	Description
1-2, 5-16	D0-D13	I/O	Digital Input Output port 0 to 13
3,28	Reset	INPUT	Rest(Active Low)
4,29	Ground	PWR	Supply Ground
17	3V3	OUTPUT	+3.3V output(from FTDI)
18	AREF	INPUT	ADC reference
19-26	A7-A0	INPUT	Analog input channel 0 to 7
27	+5V	OUTPUT or INPUT	+5V output (from on-board regulator) or +5V(from external power supply)
30	VIN	PWR	Supply Voltage

Serial and timing are used delays and serial communication. Arduino Nano has two different libraries to access Adafruit IO

server. One library is based on the REST API, and the other library is based on the MQTT API. The differences between these libraries are that MQTT keeps a connection to the service open so it can quickly respond to feed changes. The REST API only connects to the service when a request is made so it's a more appropriate choice for those projects that sleep for a period of time (to reduce power usage) and wake up only to send/receive data. Hence Agribot requires MQTT Library for Internet of Things. Nano Board has following pin out configuration as shown in Table I.

B. Wi-Fi Interface

In reference [3], [4] the author expressed the concept of Internet of Things is used with the help of Wi-Fi module CC3000 operated on adafruit-IO free server with the help of android application. It is Equipped with self-contained wireless processor that simplifies internet connectivity. It is an IEEE 802.11 b/g protocol with Wi-Fi Direct (P2P) and soft-AP. It uses SPI instead of UART so that communication will be faster. It is having Integrated TCP/IP protocol stack. Fig. 2 shows Wi-Fi interface of module with Adafruit Server and Smartphone Android Application.

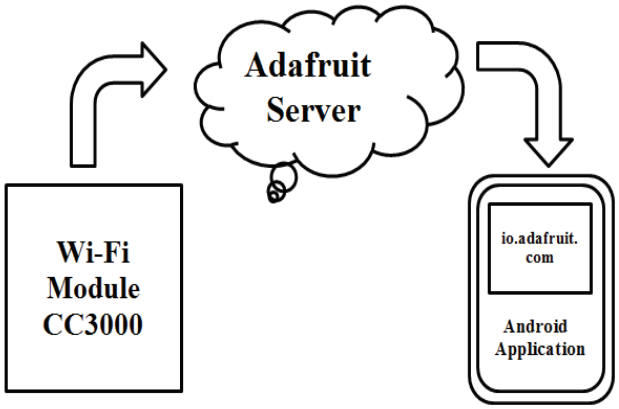

Fig. 2. Wi-Fi Interface

C. Digital Compassing

Digital compass sensor is used for determining exact 90^0 rotation of agribot if we need to rotate in right or left direction. In [5], the HMC5883L is a surface-mount, multi-chip module designed for low-field magnetic sensing with a digital interfaces for applications such as low-cost compassing and magnetometer logging. It includes high-resolution series magneto-resistive sensors plus an ASIC containing amplification, automatic degaussing strap drivers, offset cancellation, and a 12-bit ADC that enables 1° to 2° compass heading accuracy. It uses I2C serial bus which allows for easy interface.

D. Obstacle Detection

The important task of Agribot is Obstacle Detection. Fig. 3 depicts the ultrasonic sensor working with the help of waveforms. First waveform is Trigger, second is 8 consecutive clock pulses and third is time it takes to leave and return. In [6], Ultrasonic ranging module HC - SR04 provides 2cm - 400cm non-contact measurement function and the ranging accuracy can reach to 3mm which can be used for obstacle detection. The module includes ultrasonic transmitters, receiver and control circuit. The basic principle is by using trigger for at least 10us high level signal and then Module automatically sends eight 40 kHz cycle and detect whether there is a pulse signal back. If the signal gets returned through high level time duration, test distance can be calculated as shown in equation (1).

$$\text{Test Distance} = \frac{\text{Velocity of Sound} * \text{High Level Time}}{2} \quad (1)$$

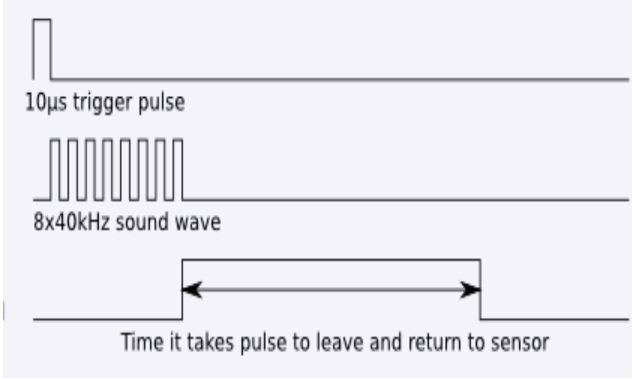

Fig. 3. Waveforms of Ultrasonic Sensor

E. Seed Sowing Mechanism

For the application of seed sowing, we are using servomotor. This is nothing but a simple electrical motor, controlled with the help of servomechanism. Fig. 4 shows seed sowing mechanism. As the shaft of servomotor can be turned by the required degree which is attached with the hopper containing seeds, the mechanism of seed sowing is achieved easily.

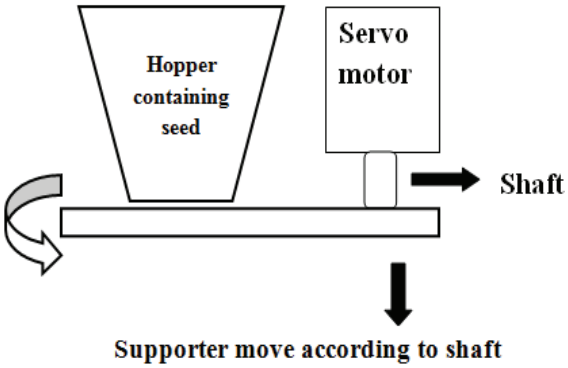

Fig. 4. Seed Sowing Mechanism

F. DC Motor Driver

A DC motor is an electromechanical device that converts electrical energy that can be used to perform movement of agribot chassis with the help of L293D IC. In [7], author demonstrated that as power required to run the motors through Arduino is not enough, L293D driver IC is able to achieve the current rating issues. It is a Dual DC motor Controller. Agribot requires 60 rpm motors so that torque given by it will

withstand the complete weight of whole assembly. The behavior of motor for various input conditions is given in Table II.

TABLE II

PATTERN FOR DC MOTOR

Pattern	Input A	Input B
Stop	LOW	LOW
Anticlockwise	LOW	HIGH
Clockwise	HIGH	LOW
Stop	HIGH	HIGH

G. Power Supply

The supply is taken from solar panel of 5 watt 12 V Output so as to fulfill the power requirement for the system. 12V lead-Acid battery is used to store the energy from solar Panel. In [7], when solar panel is kept in sunlight and voltage across it is greater than battery voltage, it will start storing the solar energy in the battery. Once the battery gets fully charged, the relay circuitry is on and it will break the connection between panel and battery.

IV. WORKING PRINCIPLE

In [8], the agribot is started through the initialization of Wi-Fi module CC3000 and configuration of Adafruit server using Android Application developed using MIT App Inventor. After that robot can start moving forward and performs various operations like seed sowing and simultaneously digging operation is performed as the sharp pointed iron plough is attached on the front of agribot and supporter is connected at the back so that removed soil is covered.

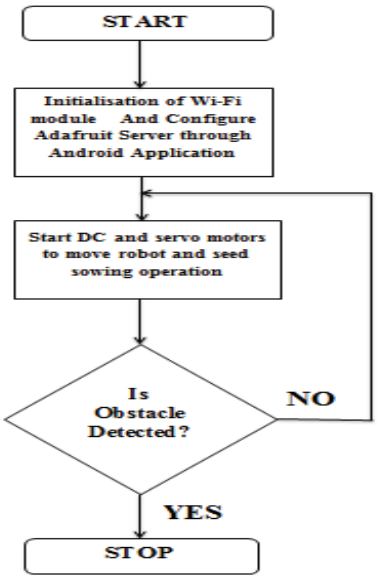

Fig. 5. Flowchart of Execution

If obstacle is detected by ultrasonic sensor HC-SR04, it will stop the dc motors and seed sowing operation till the obstacle is not cleared within specific time otherwise power supply is cut and whole system stops there so that there will be no damage to machine Fig. 5 delivers the flow of execution of whole system .

Android Application is used to control agribot in the field. Fig. 6 shows the images of Android Application. There are four buttons to manoeuvre agribot in the field. Start button is for configuring Wi-Fi module and adafruit server. Forward button is for starting DC motors in the forward direction and Seed sowing button starts the seed sowing operation by making servomotors on. For terminating complete activity, Stop button can be used.

Fig. 6. Android Application for Agribot

V. RESULTS

The proposed system gives a compact, low power and low cost system with an efficient output. The Table III shows the placement of seeds in three different contours effectively by controlling agribot in 15m track to get the expected results.

TABLE III

RESULTS OF SEED PLACEMENT

Placement of seed by Agribot (distance between two seeds)	Farm land	Grassy Land	Hard surface
Soybean seed (expected 5-6 cm)	5.3cm	5.2cm	5cm
Jowar seed (expected 10-12 cm)	10 cm	11 cm	10.5cm
Wheat seed (expected 8-10 cm)	9cm	8 cm	8.7 cm
Pulses (expected 6-8 cm)	7.2cm	8cm	7 cm

Hence the Agribot gives near about 93 % accuracy regarding placement of seeds. The graph of obstacle distances, battery and panel voltages graph with respect to time are attached in

results with the help of dashboards created in Adafruit Io web server using the concept of Internet of things as shown in Fig. 9, 10 and 11. As the Agribot is serving all the necessary requirement of farmers, it will be the great initiative and contribution to the society.

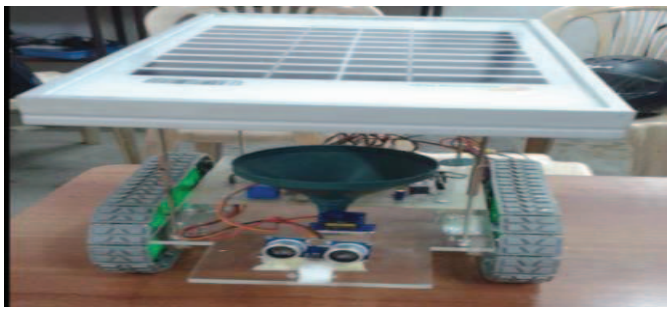

Fig. 7. Front View of Agribot Chassis

Fig. 8. Hardware of Agribot

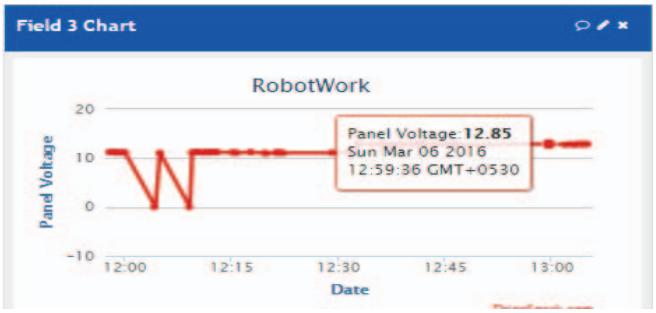

Fig. 9. Solar Panel Voltage output

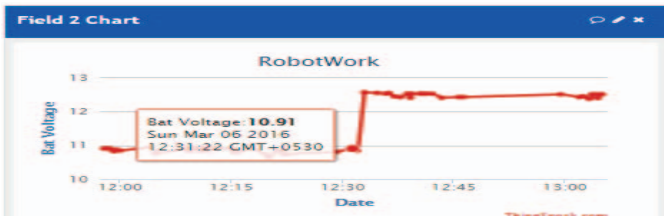

Fig. 10. Battery Voltage Output

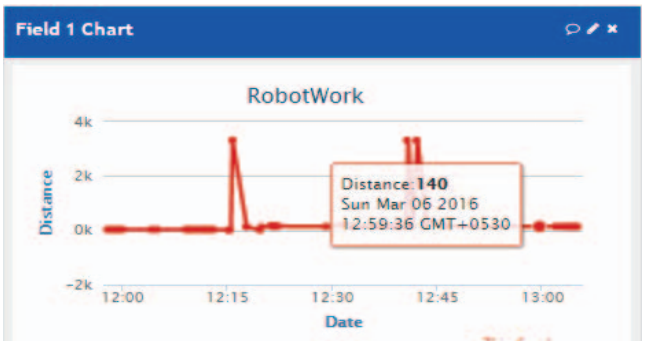

Fig. 11. Ultrasonic Sensor output

VI. Conclusion

This Automated seed sowing Agribot has considerable potential to increase productivity. The chassis handles the complete weight of solar panel, battery and the hardware mounted on Agribot which is able to perform each and every operation skillfully and successfully. Seed sowing operation results are observed with precision using different ground contours. All the data collected from agribot sends on Adafruit-IO Server and controls using Android Application successfully.

References

[1] Swati D. Sambare, S.S.Belsare, "Seed Sowing Using Robotics Technology," *International Journal of scientific research and management (IJSRM), 2015,* Volume3, Issue5, Pages 2889-2892, ISSN: 2321-3418.

[2] "Arduino Nano 3.0 version," Data sheet.

[3] https://io.adafruit.com/

[4] "Wi-Fi Module CC3000," Data Sheet.

[5] "Digital Compass Sensor Honeywell HMC5883L," Data Sheet.

[6] "Ultrasonic Sensor HC-SR04," Data Sheet.

[7] khanna,A;Ranjan,"Solar-powred Android based Speed Control of DC motors through Secure Bluetooth," *Communication systems and network technologies CSNT 2015 international conference* (IEEE Publication), pp 1244-1249.

[8] Amer,G;Mudassir, S.M.M; Malik,M.A., "Design and operation of Wi-Fi Agribot Integrated system,"*Industrial Instrumentation and Control,(2015) International Conference(IEEE Publication),*pp 207-212.

[9] Parth Gargava; Karan Sindhwani; Sumit Soman, "Controlling an Arduino robot using Brain Computer Interface," *International Conference on Reliability, Infocam Technologies and optimization, (2014)*, pp-1-5

[10] Golakotta,A;Shrinivas,M.B.,"Agribot-A multipurpose Agricultural robot," *India Conference(INDIACON), 2011 IEEE Annual conference,*1-4.

[11] Dhiraj Arun Patil; Manish upadhye; F. S. Kazi; N.M. Singh,"Multi Robot Communication and Target Tracking System with Controller Design and Implimentation of SWARM Robot using Arduino,"*2015 international conference on Industrial Instrumentation and Control*,pp 412-416.