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IOT based Smart Robot using Arduino

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ABSTRACT

Agriculture is the main profession for a majority of people living in India. So, advancement in the field of agriculture is directly proportional to the advancement of the nation. Also, making the process of agriculture automated makes it efficient, less prone to errors and more flexible. This research paper explains the development of the prototype of such a robot named Agrobot (agricultural robot). Agrobot is an IOT based designed for automatic ploughing of fields, seed sowing and irrigation of field's with solar panel as power source. As a result human efforts and time will be reduced as well as it runs on solar panel and technology which is a sustainable energy source. The increased usage of IoT has only led to more and more advances.

Keywords: Agriculture, Arduino, Electromechanical, Robotics, Solar Energy, Sensors.

The Agriculture in India is a source of employment for 50% of population in India. It contributes approximately 17% to 18% of India's GDP as of 2018 report (Kumar *et al.* 2018). Hence advancements in the field of agriculture will not only help improve the GDP but also pave the way for people to do more of smart work than manual work (Pandey *et al.* 2017). The tasks performed in agriculture, e.g. Seeding, harvesting, irrigation or ploughing are mainly manual jobs (Praseena *et al.* 2019). Making these tasks automatic or robotic based, saves a lot of time and manpower (Mutharasu *et al.* 2019).

All these saved human efforts could be then put up to other more important tasks. All these saved human efforts could be then put up to other more important tasks.

Some developing countries are still struggle with feeding their country on their own. And with this huge increase in population, the need to manage demand and supply increases many folds. The main concern related with this issue is of making enough resources available to feed them. This situation thus presents opportunities to make new inventions in this field.

Many inventions have been made in agricultural field and still more are welcome. From using trucks to drones – agriculture has evolved a long way and the invention of IoT has only paved the way for more complex yet very successful and useful devices.

The Internet of Things (IoT) was developed recently and very soon it has spread in almost every field. From manufacturing, health, IT sector, educational field, communications department, resource and energy to agriculture – IoT has its applications everywhere.

IoT has made the data handling and data surveillance very easy. Implementing IoT with appropriate sensors gives us an amazing device to implement all the resources efficiently that are available at our hand (Sominindia *et al.* 2019).

This paper presents prototype for such an agricultural robot. The AGROBOT is first of its kind. It performs the functions of harvesting, seeding and irrigation. The various features are integrated using Arduino UNO and interfacing it to Wi-Fi module. The Agrobot derives its power from solar panel and which is sustainable energy and makes use of various sensors such as ultrasonic, infrared, soil and moisture. Sending data from sensors to cloud helps to manage the field efficiently and easily. The sensors increase the accuracy of the device. Also, the sensors used are inexpensive, hence making the Agrobot is pretty cheap. The use of solar panel makes it an energy efficient device which is the need of hour in our global warming effected era. Using IoT, makes this an easy device for tracking and monitoring the developments in agricultural land. So, in this manner this paper contributes towards learning and contributing to the field of agriculture by

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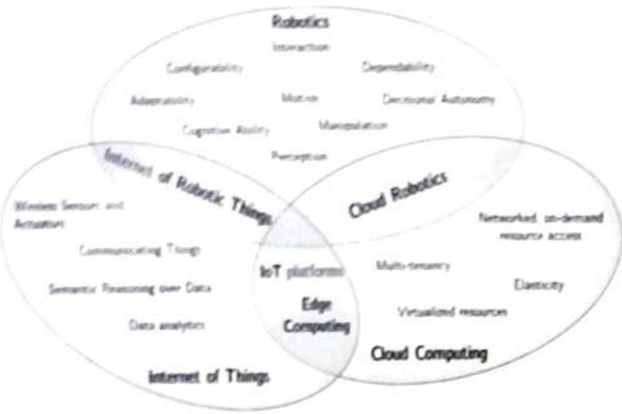

Figure 1 IoT+ Edge Computing + Cloud Computing+ Cloud Robotics+ Robotic (Nayyar *et al.* 2018).

the use of Internet of things.

The above figure properly depicts the architecture of Internet of Robotics Things (IoRT), in recent years. IOT operates in heterogeneous environment, where different IOT devices of different standards and specifications are mixed up, that's why IOT needs to provide high security for those devices because in wireless communication when data is transferring without any circuit medium it will be unsecured.

When Internet of Robotics Things, Robotics, Internet of things and cloud computing are mixed up in a Venn diagram, IOT provides end-to-end encryption and things become easy to operate (Sreelakshmi *et al.* 2016).

Considering the viewpoint of technology, the following technologies will assist Agrobot in performing complex tasks and operate in multi-dimensional environment:

Internet of things (IOT): IoT is the intersection of the digital and the physical world. IoT enhances the physical devices (Agrobot) with sensing, computing and communication capabilities (Ashwariya *et al.* 2019). These enhanced devices (Arduino or raspberry pi) are communicating with the digital world, producing data, send it to cloud.

Sensor networks: sensor networks are a group of sensors which are used for collecting useful data from the surrounding and sending them to servers or either remains up to user end.

Table 1 Literature Survey

S.No	TITLE OF PAPER	YEAR	FEATURES
1	Innovative Analysis of Precision Farming Techniques with Artificial Intelligence (Joseph et al. 2020)	2020	Harvesting, spraying, Mapping, Sensing
2	Machine Vision and Machine Learning for Intelligent Agrobots: A review (Bini *et al.* 2020)	2020	Harvesting, pest spraying
3	Design and implementation of AGROBOT using IOT (Mutharasu et al. 2019)	2019	Seed preparation
4	Using Sustainable Robotics in an Intelligent Robotic Gardening System for Education Araizal et al. 2019	2019	Gaming interface
5	Smart Agriculture Robot (Arun et al. 2018)	2018	ploughing,sowing of seeds, obstacle detection, obstacle clearance and irrigation.
6	Farmbot-a Smart Agriculture Assistor Using Internet of Things 1P (Hemalatha et al. 2018)	2018	Seeding, Harvesting, Ploughing
7	AgRobots (A combination of image processing and data analytics for precision pesticide use) (Kala et al. 2018)	2018	Seeding, Harvesting, Ploughing
8	Multipurpose Agricultural Robot (Kokate & Yadav 2017)	2017	Seeding, Irrigation, Fertilization
9	Versatile Agribot Using Solar Panel (Malini et al. 2016)	2016	Seeding, Digging, mud level, function, pesticide
10	Development of Agricultural and Seeding Equipment (Ramesh & Girishkumar 2014)	2014	seeding
12	Automated Irrigation System Using a Wireless Sensor Network and GPRS Module (Gutierrez et al. 2013)	2013	Irrigation

Previously, there have been made attempts to develop a robot that performs either of these functions. The previous attempts are available in many forms. Some of them are Electromechanical while some are IoT (Internet of Things) or embedded based and their references are given below. Table 1 shows a few examples of Arduino based agriculture robots that have been made in recent years.

MATERIALS AND METHODS

The main components of the prototype are represented with the help of the block diagram as shown in figure 2. Arduino is the heart of the Agrobot prototype design proposed in the paper. We used Arduino UNO for our design. All the connections between Arduino and the bot are made through the breadboard. The three major functions ploughing, seed sowing and irrigation of the Agrobot are performed by certain blocks represented as plougher, seed dispenser and irrigation respectively. The plougher is attached at the back end of the robot. It is connected with a servomotor. Plougher moves in up and down motion. When plougher is not used, we move it upwards and when it is required to plough, we keep it downwards.

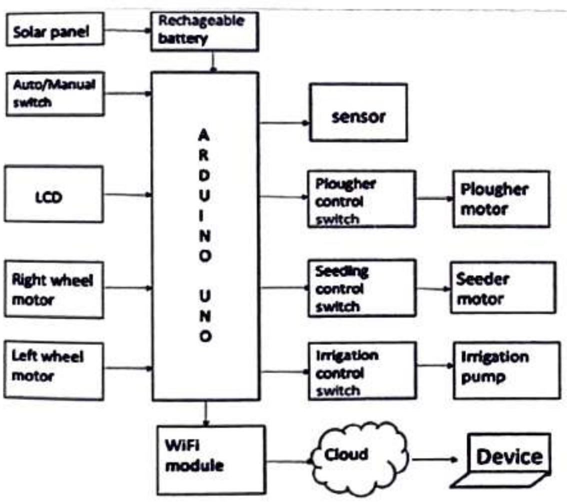

Figure 2 Block diagram of Agrobot

- Arduino uno: Arduino uno is a small board used for prototyping, with 14 digital input/output pins and 6 analog pins.
- Esp.8266: It is Wi-fi module interfaced with Arduino. It has 16 GPIO pins.
- Motor: It is used in seed dispenser so that the seeds will dispense one by one through it.
- Sensors: The Agrobot uses several sensors. Ultrasonic and infrared sensor is used to detect obstacles and for the movement if the bot. Soil moisture sensor is being used to measure the moisture content in the soil.
- Solar panel: It is an assembly of photo-voltaic cells to generate current. The Agrobot derives its power from here.
- LCD display: A 16x2 LCD screen is used for displaying information of the task being processed. It has 16 pins.
- Switch: It is used in either ON/OFF (HIGH/LOW) purpose. This is used to control the functions.
- Battery: Battery will supply the current to the whole circuit when the solar panel is not working.

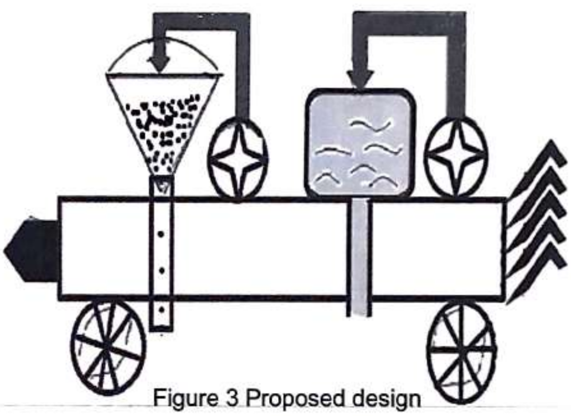

Figure 3 Proposed design

The Agrobot structure is made on a high – quality rectangular DMF board. Four wheels are connected to the board for Agrobot movement. Now on the back side of the Agrobot, a claw like structure is connected so that it works as a plougher. 2 holes are drilled on the left and right side of the bot. On the left-hand side on the top of the board, we mount a seed dispenser. This dispenser is attached to a dc motor to disperse off one seed at a time. On the right side we mount an irrigation pump. The irrigation pump is also connected to a dc motor to perform pumping.

On the front side of the Agrobot, there are various sensors placed. We use ultrasonic sensor, soil moisture and humidity sensor and one infrared sensor. In the upper middle part, we have base for Arduino interfaced with Wi-Fi module which will send the data to cloud so that farmers can monitor their field. Then we attach another DMF board on top of this existing board. On this second layer, we install our solar panel. Detailed description of each function is as follows:

a) Source of Power: The bot derives its power from the rechargeable battery and battery is connected to solar panel which is mounted on the top. So the Agrobot performs even in the absence of sunlight.

b) Ploughing: A plougher is attached at the end of the Agrobot. Whenever the command for plougher is given, the plougher pulls down and starts performing. When not in use it is pulled up.

c) Seeding: We have a seed dispenser for this purpose. The dispenser is connected to a dc motor. The dispenser is a box which has a rotating shaft inside it. The DC motor helps rotating the shaft. The seed box has a funnel in the lower portion which through a hole goes inside the bot. So, when seeding is performed, the shaft rotates and one seed comes at a time through the funnel.

d) Irrigation: A small water tank is connected to a dc motor which has a pipe below it that runs to the end of the Agrobot through a hole. When the irrigation process is selected, the Agrobot first checks the data of all sensors. We have used soil moisture and humidity sensor for this purpose. They read the values of moisture and humidity present in the soil and compare it with a pre set threshold value. The threshold value can be set by the user according to the crop, type of soil, weather and such affecting points. When the value is lower than threshold value, the process of irrigation begins. The motor pumps water from tank to the pipe and then to the soil. But if the values from sensors are greater than threshold values, then no irrigation is performed.

e) Movement: There are four wheels and one ultrasonic sensor to control the movement of the bot. The ultrasonic sensor detects hindrances in the path of the Agrobot whenever any obstacle is detected; the Agrobot is configured to change its path.

f) Surveillance: We have mounted one infrared sensor at the front end of the bot. In this way, we can monitor the field for intruders at any time in the field.

g) Configuration: All the above functions are integrated through Arduino UNO and Wi-Fi module. Each function is switch enabled. Connecting the Arduino board with a wi-fi module, takes this device to next level. It will gather their data and send it to user end. We can now control and manage our operations over phone. If in a field there are multiple such robots, the data can be transferred to Cloud and then handled easily.

RESULTS AND DISCUSSION

The Agrobot has the advantage of being the first device that integrates all three functions – ploughing, seeding and irrigation. The use of solar panel makes it energy efficient. In the times when energy and fuel are of much conservative importance, this device seems to be very helpful. The devices used are relatively cheaper. This makes the overall bot inexpensive. The sensors perform the task with accuracy and precision. The use of sensors to check whether irrigation is needed or not, somewhere saves water. Making the whole process automated means the task can be done 24*7. Human error and boredom will not be a threat to a machine. Using IoT, huge areas can be monitored. Even in smaller fields, the user can manage all the operation using his phone. This agricultural robot is a new kind of robot integrating all the features in one device. This makes agricultural processes very efficient and accurate. Including the aspects of IoT makes it truly a coming of age device. This not only widens the areas of use, but this also makes the tasks of monitoring and security very easy. Using IoT and sensors, the tasks which previously required physical monitoring can now be done online through any handset with good internet connection. The prototype image is shown in figure 4 and figure 5.

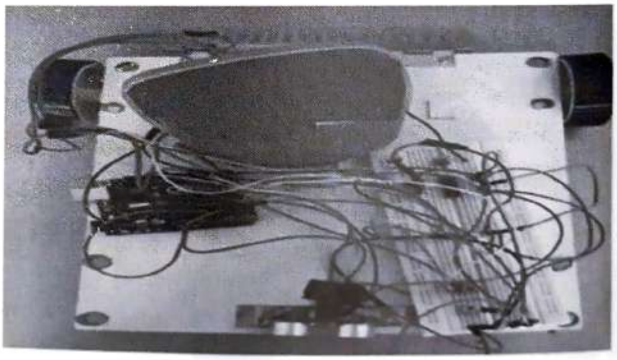

Figure 4 Agrobot Prototype (top view)

Figure 5 Agrobot Prototype (Side View)

Efficiency of the proposed design is better as compared to design developed in previous years in terms of range, due to increase of equipped IoT devices and sensors as shown in figure 6.

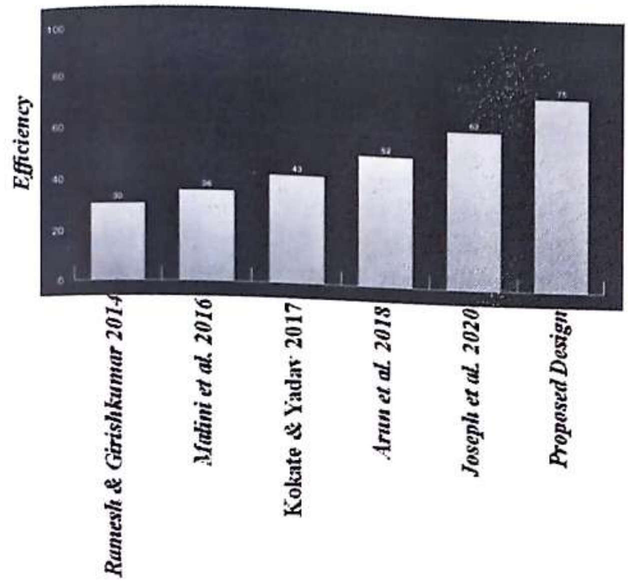

Figure 6 Efficiency of developed Agrobot

The range is increased three times and its efficiency is increased upto 75%. The Agrobot is already ahead of its time. But we can still make moderate changes in it. Pest control mechanisms can be implemented in it. Pesticide can be sprayed through sprinklers. Bug and worms can be detected using various kinds of sensors. An alarm system can also be installed in the bot. To monitor huge acres of farming land, the physical structure can be modified of this bot. Instead of wheels, the Agrobot can be made as a drone. But changing the structure to drone would mean, removing the ploughing feature.

Technology wise, the IoT structure of the robot can be scaled. Developing an IoT structure through GCP or related programs, the monitoring and tracking feature can be increased to a great level. We can also include ML (Machine Language) at the edge.

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