International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 04 Issue: 05 | May -2017 www.irjet.net p-ISSN: 2395-0072

Design and Development of Agribot for Seeding

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Abstract – *Agriculture is one of the oldest forms of occupation. The use of tools and livestock in the agricultural process has reduced the human effort. Major factors that affect agriculture include less holding area, shortage of seeds, fertilizers and labor and uncertainty of monsoon. The mechanization of agriculture refers to the use of tools or machines in the agricultural process that potentially reduces the human effort. Although it reduces the human effort in the agricultural process, it requires complete human interaction. The automation and robotics application in the branch of agriculture is at the booming stage when compared to its wide range of application in other sectors. Many researches have been done in this field to automate the process. In the present paper an effort is made for the design and development of the robot that can perform seeding process without any human intervention. The robot developed is capable of making a hole in the soil up to certain depth, placing the seed accurately in the same hole and closing the mud. The process is controlled by a microcontroller. The robot developed overcomes the drawbacks in the traditional method of seeding which includes wastage of seeds, high labor wage, lower utilization of land etc. By the application of automation and robotics in the field of agriculture it is possible to increase the overall efficiency of the agricultural process and can mitigate effects of labor shortage.*

Key Words: **Agriculture, Robotics, Seeding, Automation**

1. INTRODUCTION

Agriculture plays a very important role in India's economy. The need for the automation in the field of agricultural sector is mainly due to the increased need of agricultural products due to increased population and shortage of labor in the agricultural sector. This paper is mainly concerned with the automation of a partial process involved in the agriculture. The traditional methods of seed sowing includes broad casting, putting seeds behind the plow, line sowing, transplanting, dribbling etc.

The use of tractor is most common in the current agricultural trend. Before the seeding process is done it is necessary to properly mix the top layer of the soil with the fertile bottom layer of the soil which is usually done by the tractors or animal driven plough. This requires a lot of energy and human interaction. Due to the heavy weight of the tractors the soil will be compacted, the compacted soil will lose porosity and it becomes difficult for the seeds to germinate.

The agricultural census gives vital information on the distribution of land holdings in our country. According to the census majority of the farmers are having the land less than 1 hectare [1]. This is one of the major drawbacks for the mechanization in agricultural sector in India.

The machineries that are currently being used in the agricultural sector are very weather dependant [2]. These machineries use a lot of energy and require human labor to co-ordinate the process. In addition to that the costs of these kinds of machineries are high.

Mechanization is nothing but use of tools and machineries that are helpful in agricultural processes. The mechanization of agriculture can be divided into two categories, one is the mobile type and another one is the stationary type [3]. The former aims at replacing the animal power and the latter aims at reducing certain operations that are performed either by human labor or by a combined effort of labor and animals. The mechanization of agriculture leads to the increased productivity to some extent however the human effort and the participation of human in the agricultural activity are not reduced.

1.2 Problem Statement

The existing method of seed sowing process is associated with extensive human effort. In the traditional method of seed sowing process it is difficult to achieve uniform soil depth for seed placement and to obtain uniform distance between the seed placement. In addition to this the overall utilization of the field is less due to the low germination rate of the seeds as its difficult to achieve uniform cover of soil over the seed. The seeds will not germinate if the depth of the seeds placed is more.

In order to overcome these limitation in the existing process, a robot is developed that can perform the seeding operation autonomously.

2. PROPOSED SYSTEM

The robot that is developed for the purpose of automating the seeding process consists of a frame which is made up of aluminium sheet metal of two millimeter thickness Frame is rectangular in shape. The robot developed is wheeled type of robot. It consists of following elements in it

- **Wheels:**
  Wheels used in this robot are made up of solid rubber with nylon center which is anti corrosive and it is having high impact strength.
- **Clamps:**
  The clamps are used for motor mounting. The motor mounting clamps are five millimeter sheet metal which is bent at 90 degrees. The motor is mounted on to the vertical surface and the clamp is fastened to the frame.
- **Motors:**
  There are six motors used in this project. All the motors are 12V DC geared motors. Four high torque motors are used for driving the wheels. One high torque for the purpose of making hole and another motor for the purpose of seeding
- **Seed container:**
  The seed container is made up of plastic material. The main feature of the container is the flexibility in terms of the type of seed size that can be used. The seed container consists of a screw rod that pushes the seeds out of the container.
- **Arduino Uno**:
  Arduino Uno board is used for the purpose of controlling. It consists of Atmega328 microcontroller.
- **Motor driver:**
  Driver is used to control the motor. L298 type of motor driver is used. It consists of dual H-bridge circuit which enables the voltage to be applied across either of the directions.
- **Voltage regulator:**
  Voltage regulator785 is used in the project. The working voltage of microcontroller is 5V but the battery used is 12V. The voltage regulator receives 12V from the battery and cuts it down to 5V which is required for the operation of the microprocessor.
- **Power supply:**
  The battery used is a rechargeable type of lead acid battery. Supply voltage is 12V. This battery supplies power to all motors, drivers and microcontroller.
- **Ultrasonic sensor:**
  Ultrasonic sensor is used to measure the distance from the source and the target object. It makes use of time taken by the sound waves to reach back the sensor. The operating voltage is 5V DC and working frequency is 40Hz. The maximum range of this sensor is 40Cm and minimum range is 2Cm with the working current of 15mA.

Fig -1: Final assembly of robot

3. METHODOLOGY

The final assembly of the seeding robot is as shown in the **Fig -1.** The fabricated robot is capable of performing the seeding operation. The process involved in the operation/working of the robot can be divided into two categories, first one is the drilling process second one is the seed feeding process along with the mud closing.

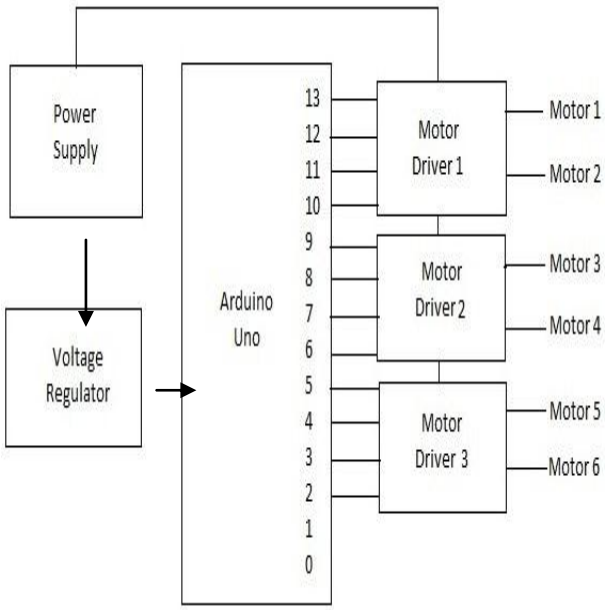

Fig -2: Block diagram of electrical assembly

The above **Fig -2** shows the block diagram of the electrical assembly. The robot consists of an on board battery which supplies the required power. The battery is rechargeable type.

The drilling arrangement consists of a nut, bolt, motor mounting plate and a motor. The nut is fastened to the robot frame. The bolt is placed inverted in the nut. The motor shaft and the bolt is connected each other by a coupler made up of mild steel material. When the motor is actuated the bolt will move along the nut and the hole is created. The depth of hole to be done depends on the type of seed that is being used and the moisture content present in the soil.
When the motor shaft is rotated in the clockwise direction, the bolt will move downwards and when the motor shaft is rotated in the anticlockwise direction the bolt will move upwards. A high torque 12V DC geared type of motor is used for this purpose.

Once the hole is done in the soil the next process is the seed placement. The seed placement arrangement consists of a seed container and a motor. The opening of the seed container consists of a hole through which the seed will be dropped. The motor used for the purpose of seeding is low rpm high torque 12V geared DC motor. The seed container is made up of plastic. It can be used to store and feed wide variety of seeds. The main advantage is the seed feeding flexibility in terms of the size of seeds used.

The seed container consists of a screw rod which is used for seed feeding. The end of the screw rod consists of threaded portion. This threaded portion is connected to the motor shaft by a coupler. The motor is directly mounted on to the frame. When the motor shaft is rotated the seeds that are accumulated in the container will move towards the opening of the container and will fall from it. The number of seeds that are dropped can be controlled by the number of rotation of the motor shaft. It also depends on the size of the seed that is being used.

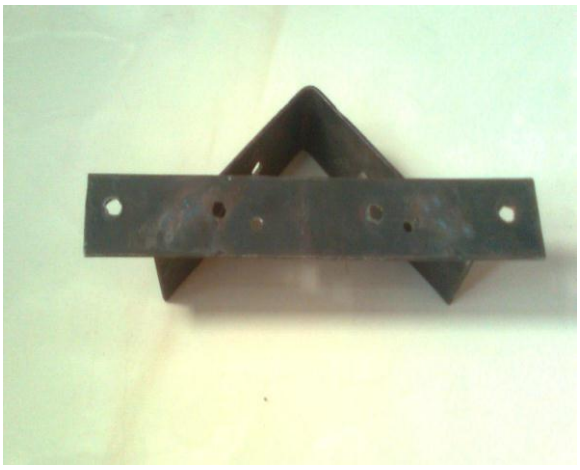

Fig -3: Mud closing arrangement

Final step is the mud closing. The mud closing arrangement as shown in the **Fig -3** consists of a flat plate that is mounted onto the bottom of the frame. It is fitted with a v plate. As the robot moves the mud accumulated will be filled to the hole.

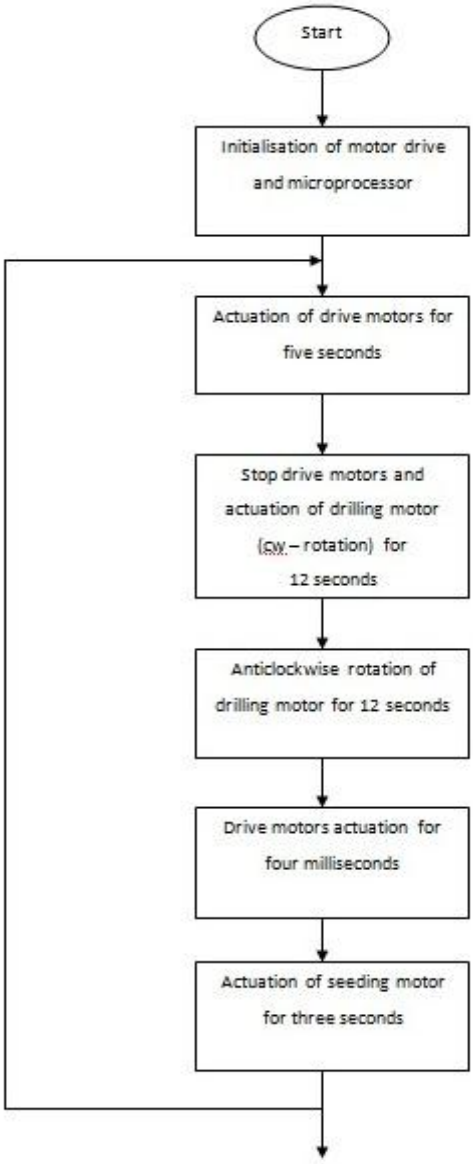

Fig -4: Working flowchart

Fig -4 shows the flowchart of the operation involved in the process. This robot can perform its operation once the sand bed is prepared. Due to the power constraints it is not possible for this robot to perform the ploughing. The working of the robot begins with the initialization of the motor drives and microprocessor. Next step is the actuation of the wheel motors. Both front and rear drive wheel motors are actuated for five seconds. The entire robot will move certain distance. After that the motors will stop and the drilling motor is actuated. The drilling motor is actuated for approximately twelve seconds. The motor shaft is made to rotate in the clockwise direction. Due to this the bolt will move in the downward direction and make a hole in the soil. After twelve seconds the directions are reversed. Due to this the motor shaft starts rotating in the counter clockwise direction. The bolt will move in the upward direction.

Once the drilling motor is turned off, again the wheel drive motors are actuated. The motor will move forward for four milliseconds. The drilled hole will be in concentric with the hole that is present at the opening of the seed container. Next step is the actuation of the seed feeding motor. The seed feeding motor will be actuated depending on the type of seed used. In the current work the trails are done on green gram seeds. Based on the trial and error method it is necessary to actuate the feed motor for three seconds. The motor drives the screw rod and the seeds present along with it falls at the opening of the seed container. This will drop down exactly to the hole drilled. The process is continuous and it will continue to proceed till it is switched off. The program is done in such a way that there is no need for the control of the robot by an operator. The system is capable of operating itself based on the program fed. It consists of an on board ultrasonic sensor which will detect the presence of any obstacles. During the operation if there are any obstacles, the ultrasonic sensor senses the obstruction and signals the wheel drive motors to stop. In addition to this a moisture sensor and a temperature sensor is also used. The temperature sensor will give a warning when it crosses the set temperature

3.1 Advantages:

- Reduced human participation
- System can work autonomously
- Uniform drill depth
- Uniformity in the seed placement
- Increased land utilization
- Increase in yield/productivity

3.2 Disadvantages:

- The depth of hole made is limited
- Hole can be made only if the sand is loose

4. SCOPE OF FUTURE WORK

- The controlling of the robot can be made via mobile by using Bluetooth or wifi module
- This robot fitted with a camera can be used for surveillance purpose
- Instead of making use of electrical energy to recharge the battery, solar power can be used
- By modifying the drilling arrangements more depths can be achieved
- By making use of GPS technology seed mapping can be done

5. CONCLUSIONS

This paper is an effort towards the automation of seeding process. The developed system is capable of performing the seeding operation in the agricultural field. The major limitation that was found in the previous systems is the seeding arrangement. The seeding arrangement is not flexible and only one type of seeds can be used. This limitation is overcome in the existing system. Based on the trials done the system is capable of performing the seeding operation. Uniform depths for the seed placement and uniform distance between the two successive seeds were obtained. The developed robot is capable of performing its operation without any human effort and the human intervention in the process is significantly reduced. Developing a robot that can perform wide variety of agricultural task is a challenging process. The use of robots can be economically justified when they are capable of performing wide variety of agricultural process without human intervention. Apart from the agricultural process these types of seeding robots can be used for mass plantation, reforestation and afforestation.

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