A Low-Cost Method for Precision Agriculture Using Arduino

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Abstract: *Precision agriculture" brings data and automation to traditional tasks, making farming more productive and profitable. Seed plantation is one of the most important and periodic jobs of the farmers. A low-cost agriculture robot or seed Robot has been designed for ploughing and precise sowing of seeds in a cost-effective method. While traditional sowing methods such as dropping seeds manually into the soil or dibbling allow for seeds to be sowed in organized rows and columns, broadcasting involves sowing of seeds across an area by scattering resulting in poor germination rates. Yet, higher seeding rates are achieved by trading off with more expenditure on seed inputs to maintain the gain in yield. Poor germination in the broadcasting method because of insufficient contact between the seed and the soil is also rectified by this robot. As an approach to achieve optimum crop growth seed spacing is done. Seed spacing is designed with ARDUINO and automation is achieved as the robot takes a turn on detecting a fence at the end of the farm. Thus, drastically reducing the number of days and labor required for the above-mentioned processes.*

Keywords: ARDUINO, economic standards, motor, nozzle size, obstacle, seed spacing, ornithopter mechanism

1. Introduction

In the current scenario of agriculture methodology, many changes like seed sowing, pesticides, and irrigation are occurring. For improving our economic growth, it is essential to boost our agricultural efficiency and quality. Out of them, seed plantation or sowing remains one of the most tedious and routine jobs of the farmers. The conservative method for sowing is manual and it requires more time, effort and labor. Man-labor has decreased greatly in the field of agriculture. To compensate this, automation is used.

Current advancements in instrumentation and control system play a significant role. We have developed a system for "seed plantation robot" using ARDUINO which is very economical and beneficial. Due to automation, planting seeds in rows or straight lines is made possible. It enhances the potential yield and improves ease of activities like weeding, nutrient application, maximizing light absorption, and harvesting.

Our system is a four-tire vehicle which is driven by geared DC motor. A mechanical structure with a pointed end is attached to the front portion to plough the soil as the robot moves forward. According to the ARDUINO program, after a specific desirable distance, the seed would be dropped through the nozzle, which is operated by a relay. Nozzle size is determined based on the diameter of the seed. The soil is then pushed back from the sides using the ornithopter flapping mechanism. This system is present beneath the robot at the center. The use of flapping mechanism is to convert the rotary motion of the motor into the reciprocating motion of flapping wings. As the crank goes around, the connecting rods push the wings or flaps up and down. A wooden plank is attached at the end of the robot to level the land after sowing. This operation is repeated after some time delay. Further advancements can be done to give information about weather conditions for seed plantation. Hence most of the problems of traditional methods are overcome by using this system.

2. Construction and Working

Construction:
The robot has 4 wheels. A mechanical structure with a pointed edge is attached to the front of the robot to enable ploughing. The rotation of these wheels determines the distance covered by the robot. The presence of seeds in the storage unit will be sensed by a proximity sensor and pulse will be generated accordingly. The proximity sensors are nothing but a pulse generator which is digitized by specific circuitry and then sent to central processing unit i.e. ARDUINO in this case. DC motor driver, L293D, drives the wheels of the robot. A rack and pinion gear is used to push the seeds into the hole in the chassis of the robot. Two different motors are used, one to drive the gear (for which a 10RPM motor is used) and another to drive the robot (30RPM motors are used). An IR sensor is attached to the front of the chassis of the robot. After sowing the seeds, soil from the ridges present on the sides of the ploughed land is pushed back to the center by using the ornithopter flapping mechanism. The basis for this mechanism is called a "four-bar linkage". This is present exactly beneath the robot in the central portion. A motor is used to rotate the crank shaft. As the crank goes around, the connecting rods push the wings or flaps up and down. By using a staggered crank, the connecting rods go off at different angles, but their timing is corrected by having them placed on separate crank throws. The staggered crank is most easily constructed from bent wire. The final step of the robot is to level the land as it moves forward. With the use of a flat plank in the rear portion of the robot, levelling is achieved. On reaching the end of a row, the robot will face the fence. It will be detected by the IR sensor present in the front portion and instructions to the ARDUINO for controlling the motion of the wheels will be given. Thus, the robot will take a turn and proceed to continue the above steps for the consecutive row.

Working:

The availability of seeds is judged by a proximity sensor that is placed right outside the container. In the case of absence of seeds, the robot doesn't move. Else, in the presence of seeds, the ARDUINO UNO is coded to give pulses to the motor driver L293D. The motor depending on the pulses drives the robot front or rotates the robot (as in the case of reaching the end of a row). The robot is made to move forward every 5 seconds with the help of a 30RPM motor. The mechanical structure with a pointed edge attached to the front of the robot does the ploughing or tilling. The tilled soil forms ridges on either side of the robot. The 10RPM motor then drives the rack and pinion gear which pushes the seeds from the seed storing unit forward. The end of this unit is shaped like a filter whose nozzle size is dependent on the diameter of the seeds that are being sown. This causes a few seeds to fall to the ground through the hole in the chassis. For closing the furrows created because of ploughing, ornithopter flapping mechanism is used. A motor is used to rotate a crank shaft. As the crank goes around, the connecting rods push the wings or flaps away and back. This is present exactly beneath the robot in the central portion and the wings push the soil from the ridges on the sides towards the center. Then the robot moves forward for the placement of the next few seeds (after every 5 seconds as per the movement of the robot) depending on the availability of the seeds. As the robot moves, the flat plank present at the rear portion of the chassis moves along. This helps in levelling the soil after sowing.

In general, the robot moves in a straight line of the first row and on reaching the end of the ploughed land (indicated by the presence of a fence), the robot rotates 90 degrees twice before it starts moving in the second column and proceeds further. An IR sensor is used to detect the presence of the fence. The command is then passed on to the ARDUINO to take a turn accordingly. The robot will take a turn, 90 degrees left twice or right twice depending on whether the row is odd or even numbered. It then occupies the next column and moves forward. The robot will stop moving if there are no more seeds to be sown or after it has completed sowing the desired number of rows.
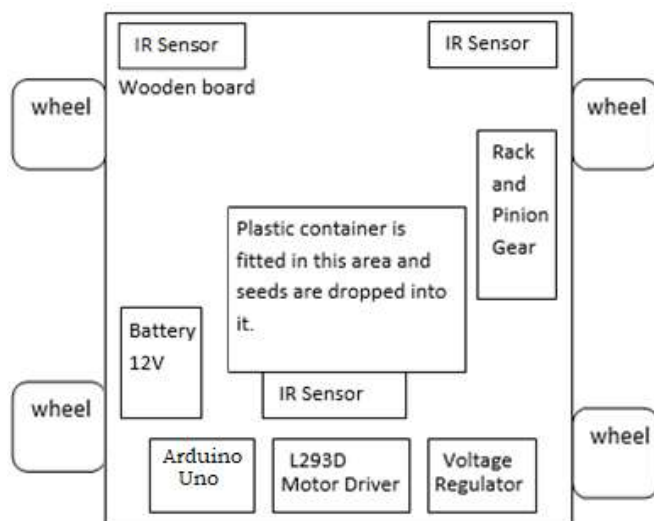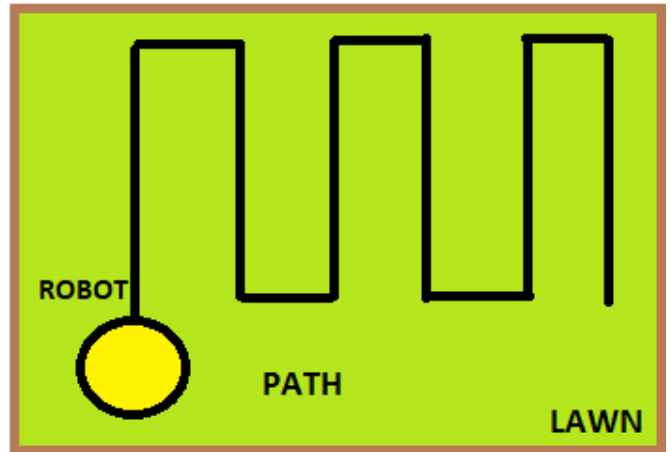
3. Figures

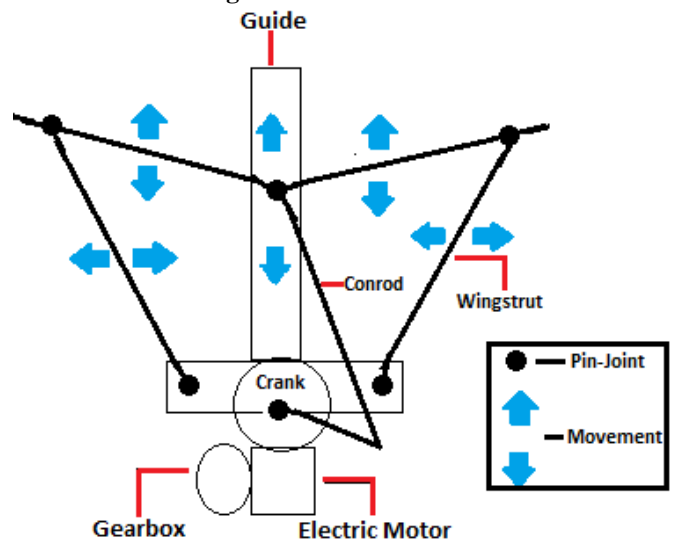

Figure 3.2: Path of Robot

Figure 3.3: Ornithopter flapping wings

4. Conclusion

In this project, the process of seeding is done by using DC motors, IR sensors, rack and pinion gear and ornithopter flapping mechanism. The aim was to reduce the man power and labor while increasing the productivity rates. Further improvements can be done by:
- Monitoring through the GSM system.
- The robot can also include weeding and harvesting systems in it.
- A module for water irrigation can also be included.
- Solar energy can be used to power the robot.

Use of autonomous system or robot in agriculture will make farming more flexible than conventional systems in terms of manual labor requirement and time constraints involved. Usage of inexpensive navigation sensors and ARDUINO makes the system economically viable. Seed spacing can reduce poor quality crops that were having insufficient moisture and sunlight during growth.

With the advancements in robot farming systems, optimum crop growth can be achieved and yield can be improved considerably and economically.

Figure 3.1: Outline of Robot

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