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Automated Agrobot

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Abstract

Objective: This paper is a proposal for a prototype of an agricultural based robot capable of performing various farming activities like ploughing the field, sowing seeds, spraying fertilizers and shoving soil over the seeds. **Method/Statistical Analysis:** This autonomous robot has the capability of processing and monitoring field operations. Its operation is controlled using a PIC16F877A microcontroller. The robot is fed with inputs like field dimensions, spacing between the seeds and the tasks are performed accordingly. The alerts for shortage of seeds can be triggered by using tuning fork level switch. **Findings:** This model of the agricultural robot is cost effective and user friendly. The entire mechanical model has been created in AUTO CAD and verified. Further the electronics involved in the working of the robot has been simulated using PROTEUS. **Applications/Improvements:** The agrobot promises a future with maximum food productivity to meet the demand of growing population.

Keywords: Automation, Fertilize, Plough, PIC16F877A, Sow

1. Introduction

Agriculture is one of our most important industries, providing food, feed and fuel necessary for our survival. Over the past 40 years, there has been gradual fall in the contribution of agriculture to the GDP. This could be attributed to the present generation's lack of interest towards farming as there are other easier ways of survival over farming. Technology has found solutions for every problem, so the problem encountered in farming also can be addressed by the application of technology.

Hailing from a country like India, we have always been quoted for the famous saying- "Agriculture is the backbone of India". And yet we see that agriculturists, rather the farmers, happen to be the people who work the hardest, resulting in a rapid decline in the number of people opting for this job. The growing population demands an increased need for food. This paper presents an automated robot, named 'AGROBOT', that can ease the work of our 'bread-yielders'. The Agrobot being a multipurpose robot, not only reduces the efforts required by the farmer, but also is a solution to the declining number of people opting for this occupation. A single bot can perform several tasks thereby greatly reducing the number of labors involved. The agrobot has also served as a solution to the toils that a farmer faces and thus farming activities could be done with a click of a button. Another factor that has to be considered during the inception of the robot was the cost effectiveness to enable its availability to all Indian farmers. The agrobot would enable a drastic increment in yield and set agriculture back as a major contributor to the wealth of the nation.

Various researches and developments have been done in the area of agricultural robotics to assist the farmers at the field. Robots to harvest coconuts[1], duck robot for weeding works in paddy fields[2], gesture controlled robot for weeds eradication[3] and automatic irrigation system[4] are some of the works which incorporates robotics into agriculture by the use of various technologies like wireless interface unit[4], Microelectromechanical Systems (MEMS)[3], haptic technology robotic arm[5] and end effector designing methodology. These works have focused on harvesting, irrigation and weed removal aspects and involves the use of complex systems. Agrobot

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focuses on implementing the basic initial stage in farming that is, ploughing, sowing seeds and fertilizing. As mentioned[6], one of the most important aspects to be focused in case of agricultural robots is that, it must be able to sow seeds even when the soil conditions vary with seasons. Moreover robots should have safety measures to alert the farmer. Further elaborates on the necessity for robots to understand the type of environment in which it is working and take necessary actions[6]. Agrobot uses four wheels powered by DC motor for its proper movement. Incase of any obstacles in its path, the wheels may not be able to move, this can be detected using the speed sensor attached to each wheel.

2. Methodology

2.1 Mechanical Model

The agrobot can perform operations of ploughing, sowing and fertilizing the plants. The agrobot can assure unimaginable efficiency and quality of yield. The robot is provided with four wheels run by DC motors. The front part of the robot comprises of circular disc type ploughs to loosen the soil. A sharp rod positioned at the center of breadth immediately behind the ploughs to create fissure on the field for the seeds to be planted. The seeds are stored in a funnel which is provided with a valve to regulate the release of seeds. The valve is operated by a dc motor, actuated by microcontroller. The microcontroller will ensure that the valve opens and closes within seconds. An average of four seeds will be released when the valve opens (this can be user defined). The time between two consecutive releases of seeds can be adjusted by defining spacing between plants. The rear of the bot has a plate that will enable shoving the soil over the seeds filled fissures. The robot is also fitted with a buzzer to produce an alarm upon lack of seeds and completion of the work. The robot consists of a fertilizer container which is fitted with tubes controlled by a switch. The robot is equipped with a small cylindrical tank to store the fertilizer. The fertilizer from the tank is pumped to the sprinkler using a hydraulic pump. When the farmer needs to fertilize the plants he can opt for fertilizer operation in the bot, so that the robot can move across the field and spray the fertilizer.

2.2 Working

The robot runs on a PIC16F877A microcontroller. To fill the seeds into the fissures made by the plough in an efficient way, a DC motor controlled valve mechanism is employed which functions as follows: the seeds are collected from the storage in a funnel shaped seed collector which is controlled by motor mechanism. The funnel opening is kept closed by movable metallic slab provided with a hole whose radius depends on the dimensions of the seed used. When the robot moves the defined distance (entered by the farmer), the microcontroller will energize the DC motor attached to a rack and pinion arrangement. The motor will move the metallic piece such that it allows the seeds to fall to the ground. Different metal pieces can be used for varying seed sizes. The diameter of the tube will let on an average of four seeds at a time. Once the seeds are released for set time, the microcontroller will send a signal to the motor driver circuit to reverse the direction of rotation of motor thereby bringing back the metallic rod to its original position, thus blocking the seed. Prior to the operation of the robot, the farmer has to enter the length and breadth of the field and distance between the plants in the field. So for every distance between the seeds entered, the same process is repeated and the microcontroller compares the distance covered by the robot with the dimensions of the field. Once the robot had sowed along the length of the field, it will turn, travel a few centimeters, turns at right angle and starts the process again. The orientation and turns of the bot is accurately monitored by gyro sensor. The robot is also capable of fertilizing the plants at the request of the farmer. In design and implementation of seeding agricultural robots[7], the fertilizing mechanism is also controlled by using the microcontroller. The fertilizing process is carried out only after the seed pits are closed. A similar mechanism is suggested through this paper, automated agrobot provided the farmer is also given the option to fertilize the plant at the time of need. This is achieved by providing a separate switch for controlling the fertilization process. Using a hydraulic pump, the fertilizer stored in the fertilizer tank is sprayed all over the plant.

2.2.1 Algorithm

The microcontroller (PIC16F877A) forms the central unit of the AGROBOT. Figure 1 gives the entire block diagram representation of the agrobot.

The following are the steps involved in the operation of AGROBOT:

- When the robot is turned on, the user is requested to enter the dimensions of the field and spacing between each plant.

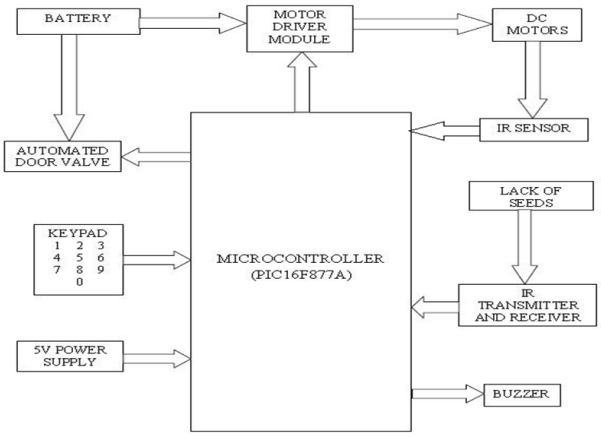

Figure 1. Block diagram of automated agrobot.

- When the parameters are entered, the microcontroller is set to function and powers up the motor driver circuit (L293D) to move the robot forward.
- The speed of the motor is sensed by the speed sensor placed near the wheels, which sends signal to the microcontroller; the microcontroller keeps track of the distance covered by the bot.
- When the specified distance i.e. spacing between the seeds is reached, the microcontroller sends signal to the L293D motor driver circuit to stop the motor.
- It then sends signal to the DC motor operated valve to move the metallic piece such that the valve is opened for the release of seeds
- After the release of the seeds, the microcontroller yet again energizes the wheels of the robot and the above process repeats.

2.2.2 Additional Features

When the process has been completed, a signal is given from the microcontroller to buzzer which raises an alarm to inform the farmer.

Interruptions during operation:

- Sometimes, the power to the motor may exhaust. During such situations, the buzzer is turned on to notify the farmer.
- Shortage of seeds: The seed container is provided with tuning fork level switch to monitor the seeds level. Upon the deprivation of seeds, the photodiode is exposed to illumination which powers the buzzer, thus alerting the farmer.
- The robot is fitted with a tank to store fertilizer and a hydraulic pump with sprinkler to sprinkle the fertilizer on the plants. The shortage of fertilizer can also be notified by alarm.

3. Results

A model of the agrobot has been developed in AUTO CAD and further the simulation of the agrobot has been carried out in PROTEUS.

3.1 Auto CAD Model

The mechanical model of agrobot is developed using AUTO CAD. The chassis of the robot has a tiny hole at its bottom which allows the seeds to be sown. The opening on the chassis will be blocked by a nova or foam sheet which moves forward and backward using a motor fitted to a rack and pinion arrangement. Figure 2 shows the mechanical view of the robot with a dimension of 30X40 cm and a height of 20 cm.

The seeds are placed inside a funnel shaped container which forms a part of the robot structure. A narrow tube connects the seed container with the tiny opening on the chassis. The robot also provides space for the fertilizer sprinkler mechanism powered by a hydraulic pump which is depicted in Figure 3.

3.2 Agrobot Model in Proteus

The entire robot model has been simulated using Proteus ISIS Professional simulation platform. The wheels of the robot gets energized and de-energized in the form of pulses, thus enabling the movement of robot and sowing of seeds process. The four wheels and also the DC motor operated seed control valve have been shown in the Figure 4. It has been successfully simulated with the four wheels operating for a fixed time period, after which the

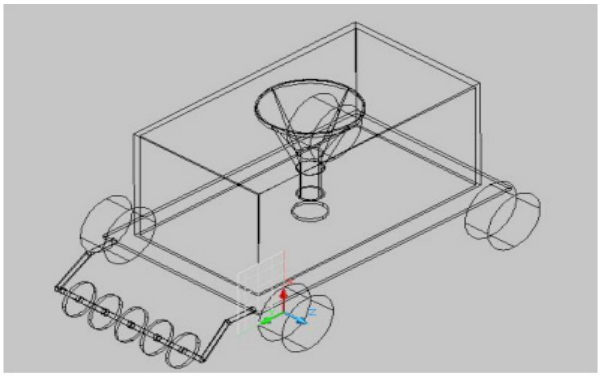

Figure 2. AutoCAD model for seed storage and funnel.

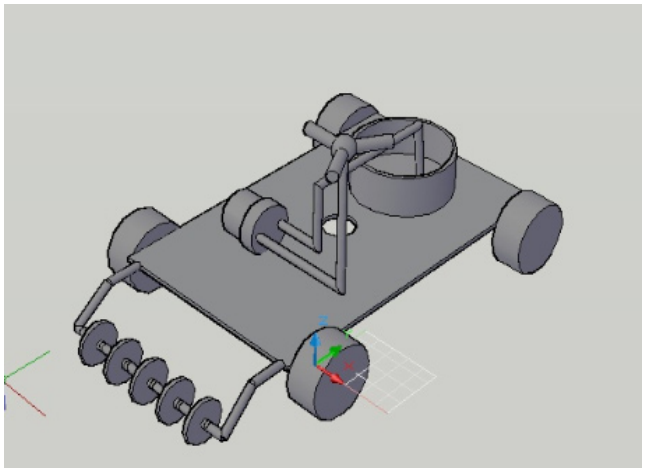

Figure 3. AutoCAD model of fertilizer compartment and sprinkler.

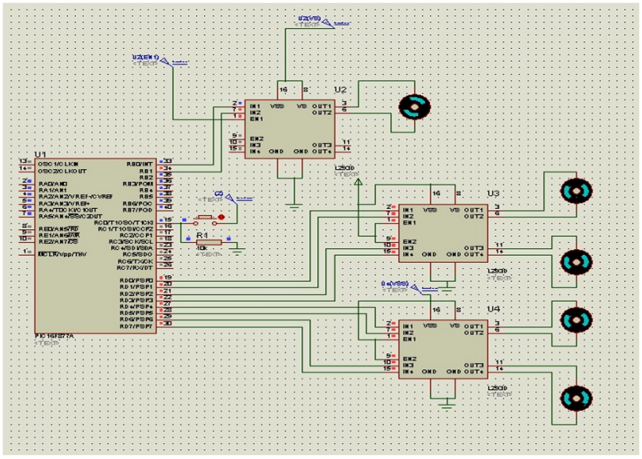

Figure 4. Proteus model of Agrobot circuitry.

four wheels stop rotating and the DC motor for the seed control valve will get activated. Once the seed control valve has been activated for milli seconds (monitored by timer module in microcontroller), the seed control motor stops and powers up the four robot wheels.

4. Conclusion and Future Scope

Agrobot is designed and built according to design criteria and open field tests are conducted. The robot was built less than 4000. The cheap cost of Agrobot is another great advantage and it would reduce the investment costs of farmers. The Agrobot can be further developed with Zigbee technology to alert farmers in case of emergencies through messages to their mobile phones. This proposed prototype of agrobot can be made effective and efficient by using renewable energy to power up the robot. Solar panels can also be incorporated in this system. Agrobot promises a future with newer hopes and great potential.

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