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Automatic Farming Robot for Smart and Effective Cultivation

Ajo Eldho Baby[1], Aphsana Salim[2], Rose Mary Benny[3] Riya Kuruvilla[4], Dr. Jinsa Kuruvilla[5]

[1,2,3,4]Student, Dept. of Electronics and Communication Engineering, Mar Athanasius College of Engineering Kothamangalam, Kerala, India
[5]Assistant Professor, Dept. of Electronics and Communication Engineering, Mar Athanasius College of Engineering Kothamangalam, Kerala, India

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Abstract – *This project aims to create an accessible technology aiding everyone to grow vegetables. It is basically a precision agriculture CNC farming project consisting of a Cartesian coordinate robot farming machine. Automatic farming robot can perform almost all processes prior to harvesting including sowing and watering. It performs different task automatically by rotating different tools mounted on the universal tool mount, including a seeder, seed injector, watering nozzle and soil moisture sensor. Automatic farming robot helps in the growth of dying agriculture in urban areas and grow healthy non-poisonous vegetables at home and on any terrain. Automatic farming robot helps to reduce labour, time, water use and energy. It also improve efficiency, control inputs and test new growing methods. Automatic farming robot can be setup on any terrain and can be used for personal and commercial purposes*.

Key Words: **Gantry, Bluetooth, Arduino, Extrusion, Servo**

1. INTRODUCTION

Agricultural automation using Automatic farming robot is an attempt to reduce the burden of maintaining a farm for small scale and large scale alike by automating the most commonly performed tasks such as sowing of seeds, watering of plants and finally even removing weeds .It is a precision agriculture CNC farming project consisting of a Cartesian coordinate robot farming machine. It requires electricity, internet connection and water supply which will be provided using off grid solutions including a water barrel to collect rain and battery to provide electricity. Automatic farming Robot move around in the XYZ space day and night, 7 days a week growing food. Automatic farming Robot precisely sows seed in any pattern and density and then water them efficiently the exact amount that each plant needs based on its type ,its age ,soil, conditions, the local weather and growing preference. Automatic farming Robot can grow a wide variety of crops all in the same area at the same time while each plant is cared for individually in an optimized automated way.

2. LITERATURE SURVEY

When presented with the current food production system one cannot look past how broken it is we have surrenders. Our knowledge and control over how our food is being produced is negligible and a result we are destroying our health and environment. We are here to change that, the idea lies at the intersection of automation. Automatic farming robot is CNC farming machine. Automatic farming robot precisely sows seed in any pattern and density you want and then water them efficiently the exact amount that each plant needs based on its type ,its age ,soil, conditions, the local weather and your growing preference . Automatic farming robot can grow a wide variety of crops all in the same are at the same time while each plant is cared for individually in an optimized automated way. Commercially, farms -big and small can use Automatic farming robot to reduce labour, improve efficiency, control inputs and test new growing method. By planting many plants at once your garden will benefit from natural of polycropping and crop rotation, while get you and your family gain from a healthy and varied diet. Commercially big and small can use Automatic farming robot to reduce labor. Automatic farming robot improves efficiency, control inputs and test new growing methods.it helps in the growth of dying agriculture in urban areas. Development in agriculture is important for improvement of financial state of the nation. Automatic Farming Robot grown veggies are significantly less expensive than veggies purchased at the grocery stores.

3. METHODOLOGY

The Figure 1 shows the general idea that will be used to solve the problem of automated farming. The tracks allow the motion of the gantry along the x-axis, the gantry allows the motion of the cross-slide along the y-axis and finally the universal tool mount allows for using different tools/farming modules and also facilitates the motion of the tools along the z-axis to suit to the required height of the plants .The universal tool mount interfaces the cross-slide with various tools such as water distribution module, seed-injection module and plant-removal module. This universal mount also allows for newer modules to be interfaced to it, thus making such an implementation future-proof and gives more power to the user as he can use only the modules that

is actually required by him. The working is simple and the plants are planted in straight lines along the tracks at regular pre-defined spaces by using the seed-injection module and the water distribution module waters the plants regularly and finally the plant-removal module is used to remove the plant after the stipulated period of time to obtain the required vegetable.

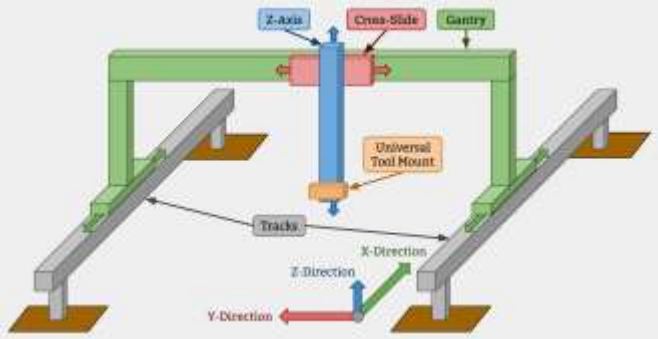


Fig-1: Structure of automatic farming system

4. COMPONENTS USED

1. Aluminum square tube: square tube

   (3x12feet,1inch inner diameter,1.5mm thickness)

2. Chromium plated steel rod:
   steel rod (2x12 feet)
3. Nut and bolts
   Nut and bolt M3(1inch,1.5inch,2inch),M5,M8
4. NEMA 17 stepper motor
   2 NEMA 17 Stepper motor and 1 NEMA 17 Stepper motor with lead screw is used. It is a 12 v standard stepper motor. It has 1.8 degree 120 steps per revolution.
5. Motor driver-3
   A4988 is the Motor driver used. It has 16 pins. It is used to drive stepper motor of 12v.DIRECTION,STEP pin determines the direction and step of stepper motor.
6. Linear bearing
   Linear bearing provides low friction motion along a single axis. They are little costlier than classical round ball bearings, but simpler to integrate in carriage design
7. Rotary bearing
   We are using 8mm(608RS) and 5mm(625zz) rotary bearing.
8. Servo motor-1
   Servo motor is provided to rotate each tool. It has angle of rotation from 0-180 degree.
9. Bluetooth module

We are using HC-05 Bluetooth module. its frequency is 2.4GHz ISM band.

10. Soil moisture sensor
    Moisture sensor used is FC-28.I t has 4 pin-VCC ,GND, digital and analog. Soil Sensor consists of two probes which are used to measure the volumetric content of water.
11. Vacuum pump
    Its a 12V vacuum pump used for seed picking and drop it in the correct position. Vacuum Pump-370 diaphragm 3-5V Self-Priming small micro vacuum pump.
12. Water pump
    It is a 12v R365 DC water pump used for watering the plants
13. Silicon tube: 2 m silicon tube is used to connect water pump to water tank and watering nozzle.
14. Other components are GT2 pulley, Open timing belt, leadscrew, Zip tightner, End stops, Jumper links, Acrylic, sandpaper

5. MECHANICAL STRUCTURE

Fig-2: Prototype of automatic farming system

The Automatic farming Robot is driven by four NEMA 17 stepper motors, the arduino microcontroller, a HC-05 Bluetooth module and an android app. Current models can cover growing areas of 80cm length and 60cm width, and plants as tall as 30 cm. With additional hardware and

modifications, it may be possible to scale the system concept to cover larger area and taller plants.

5.1 Tracks

Tracks are one of the components that really differentiate the product from traditional free-driving wheeled tractors. The tracks are what allow the system to have great precision in an efficient and simple manner. There are many reasons of why tracks are superior, a few of which are listed below.

(a) Tracks provide great precision and allow the system to return to the same position repeatedly

(b) Any type of packing structure of plants can be created and managed

(c) Tracks take up less area than paths for tractor wheels and do not compact the soil

5.2 Gantry

The Gantry is the structural component that bridges the two Tracks and moves in the X-direction via an X-Direction Drive System. Typically, it serves as a linear guide for the Cross-Slide and a base for the Y-Direction Drive System that moves the Cross-Slide across the Gantry in the Y-direction. It can also serve as a base for mounting other tools, electronics, supplies, and/or sensors.

5.3 Cross-Slide

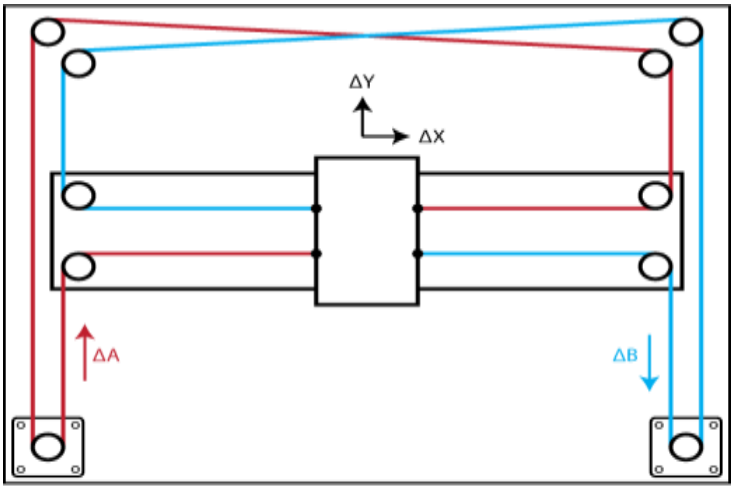
The Cross-Slide moves in the Y-Direction across the Gantry. This motion provides the second major degree of freedom for the system and allows operations such as planting to be done anywhere in the XY plane. The Cross-Slide is moved using a Y-Direction Drive System and functions as the base for the Tool Mount and Z-Direction Drive System.

5.4 Z-axis

The Z-axis attaches to the Cross-Slide and provides the system with Z-Direction movement. It serves as the base for attaching the Universal Tool Mount and other Tools and perform all the function.

6. MOVEMENT MECHANISM

CORE XY mechanism is used for the Cartesian movement of the system. It is a simple, fast and flexible mechanism. The horizontal bar is a straight-edge which can be moved up and down by the user. The horizontal bar can be moved up and down by the help of motors and pulleys. Rotating both motors in the same direction results in horizontal motion. Rotating both motors in opposite directions results in vertical motion.



Equations of Motion:

$\Delta X = {}^1/_2 (\Delta A + \Delta B)$, $\Delta Y = {}^1/_2 (\Delta A - \Delta B)$

$\Delta A = \Delta X + \Delta Y$, $\Delta B = \Delta X - \Delta Y$

Fig-3: Core XY mechanism

7. BLOCK DIAGRAM

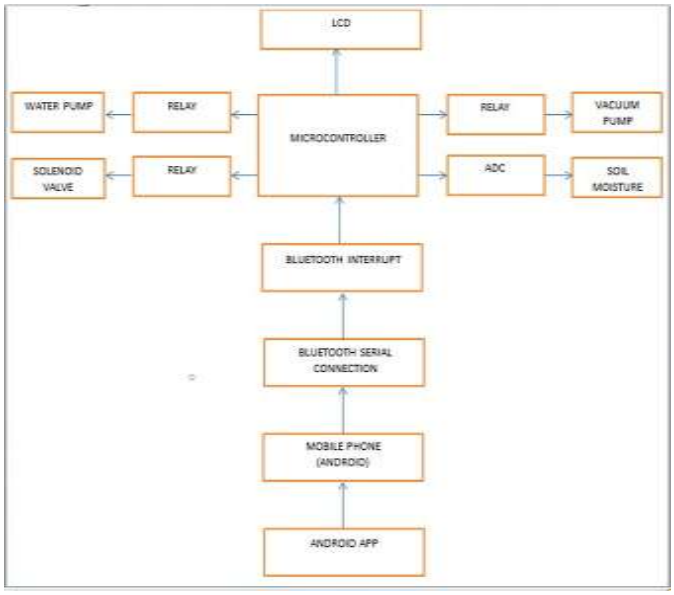


Fig-4: Block diagram of automatic farming robot and its android phone remote

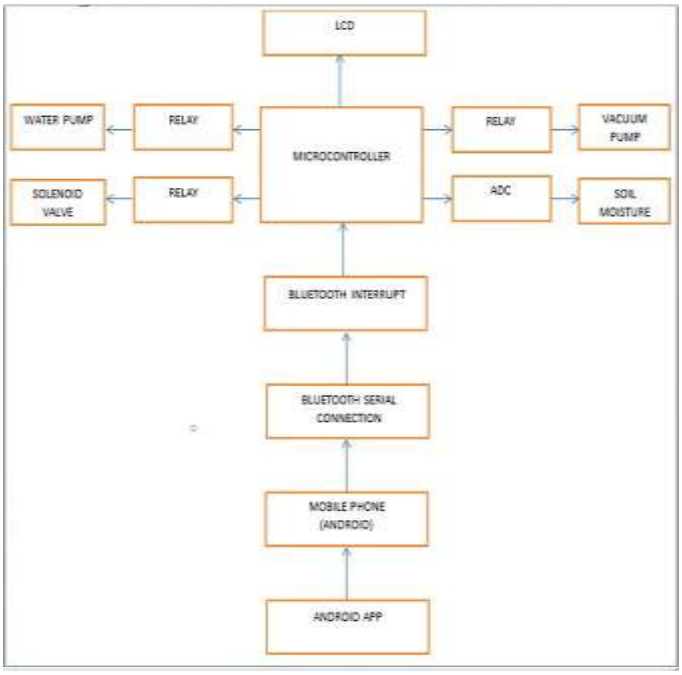


Fig-5: Flow chart for the software part of the embedded system as well as the android application

8. TOOLS AND TOOL MOUNT

8.1 Universal Tool Mount

The Universal Tool Mount (UTM) allows to automatically switch tools in order to perform different operations. It is a plastic component that mounts to the z-axis aluminum extrusion using two M5 screws and tee nuts. Switching of the tools is done with the help of a servo motor in the prototype. When going on an advanced scale with large number of tools an electromagnet can be used to automatically select the tools.

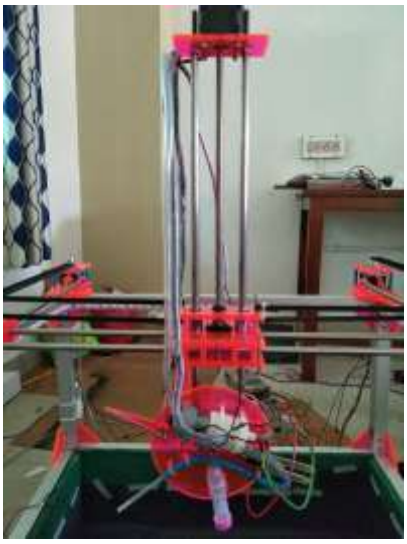


Fig-6: Universal tool mount

8.2 Seeder and vacuum pump

The seed digger digs the hole to drop the seed and the seed picker works by using a vacuum pump to suction-hold a single seed at the end of a needle.

Fig-7: Seed digger

Fig-8: seed picker

8.3 Soil moisture sensor

Moisture sensor used is FC-28.I t has 4 pin-VCC ,GND, digital and analog. Soil Sensor consists of two probes which are used to measure the volumetric content of water. The two probes allow the current to pass through the soil and gets the resistance value to measure the moisture valve.

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Fig-9: Soil moisture sensor

8.4 Watering nozzle and pump

The watering nozzle accepts a concentrated stream of water coming from the UTM and turns it into a gentle shower for your plants .The reading of the soil sensor is compared in the microcontroller. If the value is greater that the threshold limit motor is opened Otherwise motor is closed. The motor is controlled by relay. Showering mechanism is used.

Fig-10: Watering nozzle

9. SOCIAL RELEVANCE

Commercially, farms -big and small can use Automatic farming robot to reduce labor, improve efficiency, control inputs and test new growing method.

1. Automatic farming robot produces 25 percentage fewer carbon dioxide than standard national food production.
2. Automatic farming robot helps in effective weed control.
3. Automatic farming robot can be setup on any terrain like on a raised bed, rooftop or in a greenhouse to grow food for yourself, your family and your community.
4. It helps in the growth of dying agriculture in urban areas. Development in agriculture is important for the improvement of the financial state of the nation.
5. Automatic farming robot grown veggies are significantly less expensive than veggies purchased at the grocery stores.
6. Automatic farming robot reduce the risk of working in unsafe conditions like splashing chemicals and pesticides.

10. RESULT AND CONCLUSION

Implementation of the wireless control is done with the help of the Bluetooth HC-05 module. Controlling of the various modules (motors) are done by receiving the commands over the Bluetooth from Android mobile application. Once the commands are received, the microcontroller sends a digital signal to the respective port pins in the microcontroller, these are in turn connected to the enable pins of the Motor driver boards, which drive the respective motors. The robot designed in this project is connected to the user mobile phone over Bluetooth link therefore it is limited to the Bluetooth range, this can be extended with the help of a GSM module in the place of a Bluetooth receiver. When the application is first launched, the user is greeted with a login screen that can be unlocked by entering the username and password. The application also displays required notifications to display the current command being transmitted to the Microcontroller via Bluetooth. The agriculture automation system has been designed and realized using a simple model controlled over the Bluetooth signal from Android Mobile Phone. The designed system is a low cost demonstration model, which is able to convey the application and future scope for modular automated agriculture systems. This demonstration system was made at a low cost and was tested successfully

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BIOGRAPHIES

Dr Jinsa Kuruvilla

Project Guide, Dept. of ECE, Mar Athanasius College Of Engineering, Kothamangalam, India

Ajo Eldho Baby
Student, ECE, Mar Athanasius College Of Engineering, Kothamangalam, India

Aphsana Salim
Student, ECE, Mar Athanasius College Of Engineering, Kothamangalam, India

Rose Mary Benny
Student, ECE, Mar Athanasius College Of Engineering, Kothamangalam, India

Riya Kuruvilla
Student, ECE, Mar Athanasius College Of Engineering, Kothamangalam, India