WRO Junior Future Innovators

HOME FARMER

Project Report

Written By
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India

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Picture 1 - Yogeshwar & Vihaan

ABOUT US

The rooftop farmers, a duo of school students, are on a mission to revolutionize sustainable development through robotics. With a keen interest in environmental conservation, they're making innovative solutions that promise a greener future. These two young minds are tirelessly developing a sustainable robotics project, aiming to safeguard the environment and promote eco-friendly practices. Their dedication, creativity, and passion for sustainability make them a force to be reckoned with, embodying the spirit of youth-driven change in the quest for a more sustainable world.

VIHAAN

Loves Robotics, loves to create new things, and is also passionate about playing video games. Passion in coding makes him a code freak. He has made a with his coding skills and is planning to develop even more. Other than coding, he likes to do light research and read books, along with singing.

YOGESHWAR

Interested in railroading, making show theories, aviation and flight simulations and also making flight simulation hardware. Is also interested in Lego models in Real life and also in BrickLink studios. Sometimes plays the piano, tennis and pickleball.

THE PROBLEMS

A Brief Description About the Current Scenario

The current scene regarding land pollution and soil infertility paints a concerning picture of environmental degradation. Rampant use of chemical fertilizers has led to soil degradation, reduced fertility, and contamination of groundwater. These practices not only harm the soil but also affect the quality and safety of our food supply. Excessive use of fertilizers contributes to nutrient imbalances in crops, leading to health issues like diabetes, cardiovascular diseases, and certain cancers in consumers. These adverse effects not only endanger public health but also hinder sustainable development by compromising the long-term viability of agricultural systems and ecosystems, emphasizing the urgent need for eco-friendly farming practices.

The Global Warming Effect

Global warming makes land pollution and soil problems worse. It changes rain and causes droughts or floods, harming soil. The heat also makes soil worse faster. This makes growing food harder and harms health and development. We need to act fast to fix this.

The Urban Challenge

The challenge of urban food production, where space constraints and busy lifestyles make traditional gardening difficult. This problem is significant due to the growing need for sustainability and self-sufficiency in food sources within urban environments.

THE SOLUTION

Problem Statement:

Our project, Home Farmer, aims to address the pressing issues of soil degradation, land pollution, and the growing need for sustainable urban farming. These challenges are critical due to their impact on food security, environmental health, and sustainable development. Though home farming is recognized, only a few individuals engage in it, particularly upon realizing the negative impacts of regularly consuming chemically fertilized food. Our robotic solution aims to tackle this issue effectively and ensure sustainable life on land.

Why This Problem

We chose this problem because conventional farming practices often contribute to soil degradation and pollution through the heavy use of chemical fertilizers, pesticides, and intensive land cultivation. Urbanization further exacerbates these issues by reducing available arable land and increasing pollution levels.

Robotic Solution

Home Farmer is a cutting-edge robotic solution designed to revolutionize farming practices. It is capable of autonomously planting seeds, nurturing crops, providing daily water requirements, and monitoring plant health. By incorporating sensors and sustainable farming techniques, Home Farmer minimizes soil disturbance, optimizes resource usage, and reduces reliance on harmful chemicals. The solution also reduces the human efforts for farming and makes it easily available at home.

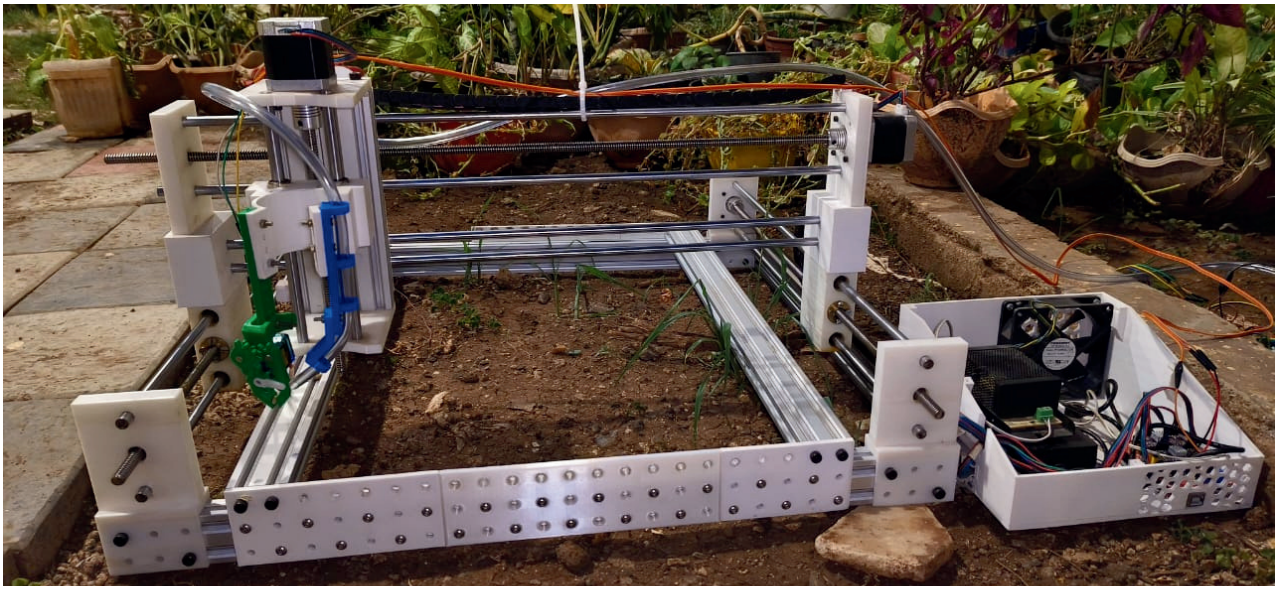
THE SOLUTION

Value of the Robotic Solution

The implementation of Home Farmer in real-life scenarios offers immense value. It significantly reduces soil erosion, conserves water through precise irrigation, eliminates the need for chemical inputs, and promotes healthy plant growth. This not only improves crop yields but also enhances soil fertility and biodiversity. Furthermore, Home Farmer enables efficient urban farming, making it possible to produce fresh, healthy food. By dedicating minimal time to farming, individuals can enjoy freshly grown plants without the use of fertilizers, all conveniently at their doorstep. This is achievable without disrupting their daily schedules, work commitments, or leisure time, thanks to our Farm bot.

Importance of the Project

Home Farmer is crucial in addressing global challenges related to food production, environmental sustainability, and urban development. By promoting sustainable farming practices, reducing pollution, and conserving natural resources, our project contributes to building resilient agricultural systems and ensures a healthier future for both people and the planet.



Picture 1.2 - Home Farmer V1

HOME FARMER

Origins of the Idea: The concept of Home Farmer emerged from our deep concern about the environmental impact of traditional farming methods and the challenges posed by urbanization on agricultural practices. We recognized the need for a sustainable solution that could address soil degradation, land pollution, and the growing demand for urban farming.

Although established farming techniques exist, it's surprising that home farming isn't more popular. This is especially concerning given the harmful effects of pesticides on daily consumed crops. To tackle this issue, we came up with a simple and cost-effective solution – introducing Home Farmer.

OUR MISSION

To empower individuals with the tools and knowledge to cultivate their own food at home, we harness accessible and innovative technology. Our aim is to foster sustainability and self-sufficiency, guiding individuals towards healthier lifestyles and environmental stewardship.

OVERVIEW

Our project revolves around the development of a Home Farming Robot, a sophisticated yet user-friendly system designed to enable individuals to grow their own food at home autonomously. Leveraging cutting-edge technology such as robotics, automation, and sensor integration, the Home Farming Robot streamlines the process of home gardening, making it accessible to people of all skill levels.

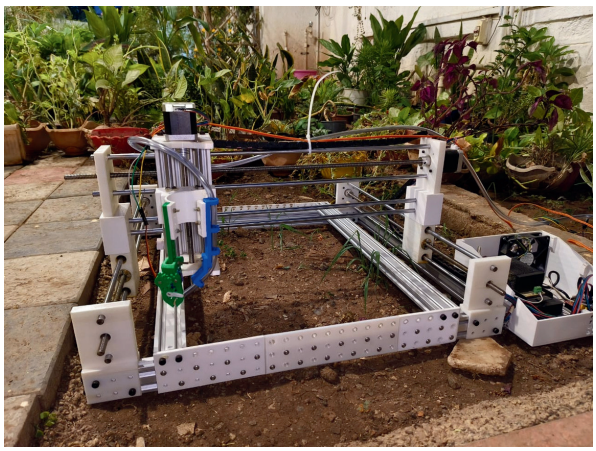
OUR JOURNEY

How we got the idea for our solution

When we found a pricey commercial farmbot meant for home, we liked its features but couldn't afford it. So, we decided to make our own version which can be used in homes. We wanted something cheaper and easier for home use. By taking ideas from the expensive one and simplifying them, we aimed to create a friendly and affordable system for home farming.

Mechanical Construction - V2

- 3D printed parts provide structural support and secure aluminum profiles.
- Aluminum profiles provide horizontal support.
- Belt and trolley provide movement for X and Y axes.
- Allen bolts connect aluminum profiles to 3D printed parts.
- Linear bearings and lead screw facilitate Z axis movement.
- Ball bearings reduce rotational friction for Z axis.
- Couplers connect stepper motors to pulley.
- The belt goes around 1 axis, with the ends connecting to the trolley, which is then moved by the stepper motors.



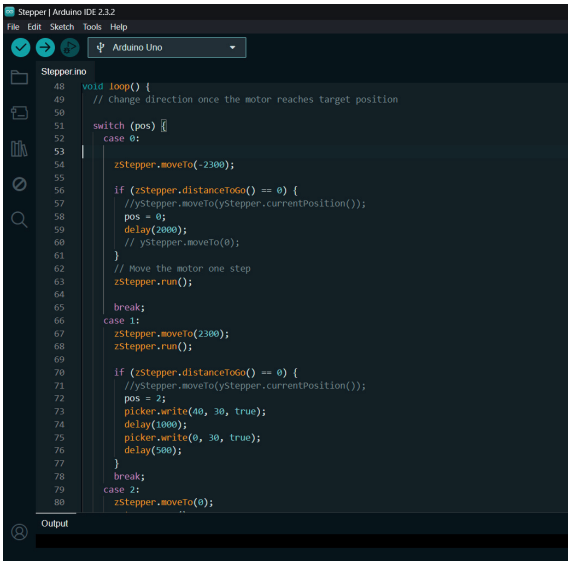
Picture 1.3 - Home Farmer V1

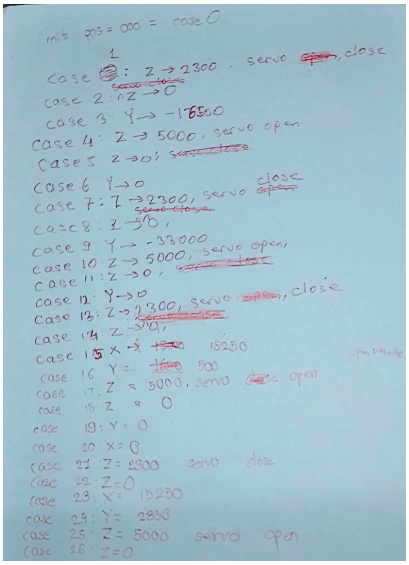
Picture 1.4 - Home Farmer V2

OUR JOURNEY - CONTINUED

Coding of the Solution

The code automates movement with stepper motors and a servo, looping through predefined actions based on the XY-coordinate system. It's part of a robotics or automation project, requiring precise motor control. Additionally, it features a 20x4 LCD for real-time updates on the bot's function and seeding recommendations, with a switch for plant watering. This indicates its integration into a formalized project, possibly in robotics or automation, demanding meticulous motor control for synchronized operations.





Scribble of initial code

Social Impact of the Product

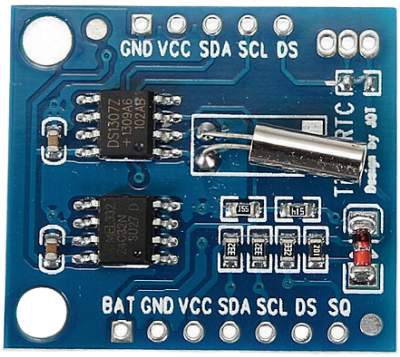
The Home Farmer robot helps everyone grow fresh, healthy vegetables right at home, even in small spaces like apartments. This means people get safe, chemical-free food, reducing the need for harmful pesticides and fertilizers that damage our soil and water. By using Home Farmer, we promote healthier eating habits and protect our environment from pollution. It also encourages families and kids to learn about farming and caring for our planet. With Home Farmer, we can make our world greener and healthier, one home at a time, while making farming easy and fun for everyone!

Component List

Component	Quantity	Usage of Component
DS1307 RTC	1	For Time display on LCD
20x4 I2C LCD	1	For Display of Menu, features, and for selection of action
Arduino UNO	1	Arduino UNO specifically to host the CNC Shield V3
CNC Shield V3	1	To host the Stepper Motor drivers needed
DRV 8825 Stepper Motor Driver	4	For Proper functioning of Stepper Motors
NEMA 17 Stepper Motor	4	2 for movement of x axis, 1 for y axis, and 1 for z axis.
DHT11	1	To measure the humidity and temperature of surrounding
Soil Moisture Sensor	1	To measure soil moisture for plant health
Encoder	1	For user input to select an action on LCD
Switch	1	Reset Button for emergency stop or homing
Fan (12v)	1	To cool the DRV8825 Stepper motor driver
Servo Motor (180 Degrees)	1	To pick up the seeds and plant them
Water Pump	1	To water the plants when called for

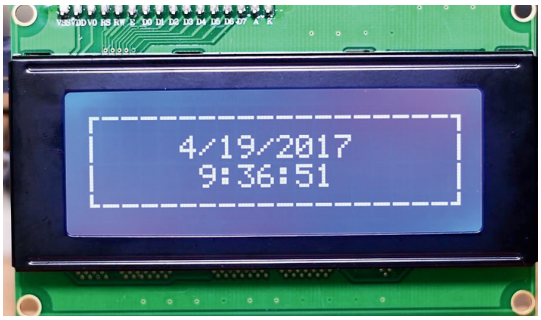
Components - Additional Information

DS1307 RTC



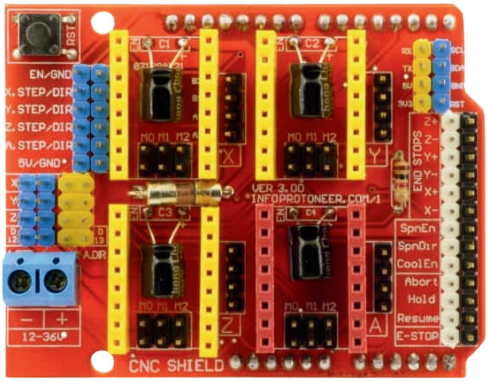
- I2C Address -> 0x68
- Data Pins -> SDA (A4), SCL (A5) for I2C Protocol
- Requires Li-ion coin battery for offline time backup
- Requires external library - <uRTCLib.h>

20x4 I2C LCD



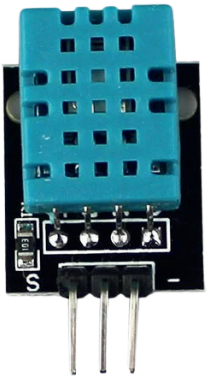
- I2C Address -> 0x27
- Data Pins -> SDA (A4), SCL (A5)
- Requires external library - <LiquidCrystal_I2C.h>

CNC Shield V3



- Supports 4 A4988 or DRV8825 Stepper motor Drivers
- Is a PCB that is placed exactly on top of the Arduino UNO board
- Supports Axis cloning

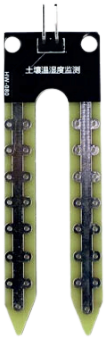
DHT11



- Requires external library - <dht.h>
- Has sampling rate of 1Hz, meaning it can provide new information every 1 second.
- Temperature is given in Celsius by the DHT, but we can use the formulae to convert it into Fahrenheit or Kelvin.
- Data Pins -> Middle Pin goes to a Digital Input Pin

Components - Additional Information

Soil Moisture Sensor

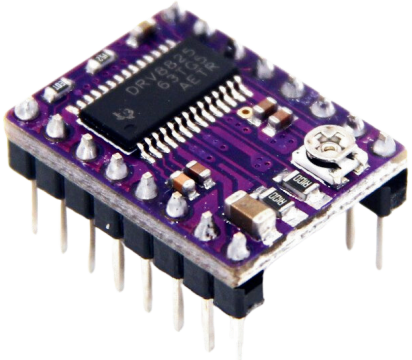


- Provides Analog and Digital
- Data Pin -> A0 goes to any analog pin for analog input or D0 to any Digital pin for Digital Input

NEMA 17 Stepper Motor

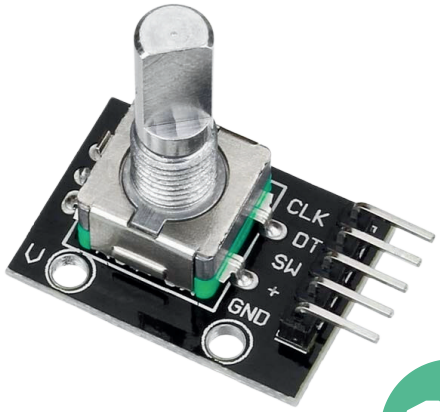
- Provides precise movement without the sacrifice of speed or movement range
- Requires a stepper motor driver to properly function
- Has external libraries, but can function without them

DRV 8825 Stepper Motor Driver



- Has an output drive capacity of up to 45V, allowing for control of bi-polar stepper motor, such as NEMA 17.
- Placed directly onto the CNC Shield V3

Incremental Encoder



- Rotary encoders can rotate 360° without stopping, whereas potentiometers can only rotate 3/4 of the circle.
- Data pin -> CLK and DT for the rotary movement and SW for Switch inbuilt

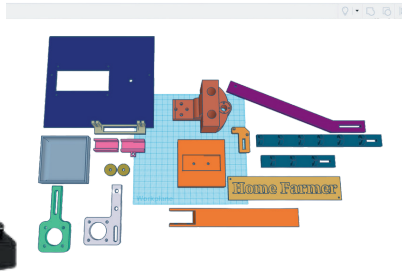
Mechanical Components - Additional Information

2040 Aluminum Profile

- Used for Basic Structure of the robot
- Is connected using T-Nut and Bolt

3D Printed Materials

- All Materials made on Tinkercad and Freecad and uploaded here:-
  - bit.ly/homefarmer3dprint



T-Nut and Bolts

- Keeps stability in between the profiles, and prevents it from falling apart

Lead Screw, Belt, Pulley, and Trolley

- Helps in movement of all axes
- Lead Screw allows for precision in the z axis.
- Pulley connects to stepper motor and the opposite end to host the belt, which is connected to the trolley for movement

LIST OF SOURCES

- https://lastminuteengineers.com/ds1307-rtc-arduino-tutorial/
- https://lastminuteengineers.com/arduino-1602-character-lcd-tutorial/
- https://www.youtube.com/watch?v=Hb6WJTX5X_E&pp=ygUSY25jIG1ha2luZyBtYWNoaW5l
- https://www.youtube.com/watch?v=uNkADHZStDE&pp=ygUIZmFybSBib3Q%3D
- https://www.youtube.com/watch?v=tkOhH9OUMto&pp=ygUVbGVhZCBzY3JldyBhcnJhbmdlbXRu
- https://www.youtube.com/watch?v=zUb8tiFCwmk&pp=ygUSY25jIGFyZHVpbm8gc2hpZWxk
- https://www.youtube.com/watch?v=JlhjcTh4yts&pp=ygUSY25jIGFyZHVpbm8gc2hpZWxk
- https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&cad=rja&uact=8&ved=2ahUKEwjfp7noz7eFAxUas1YBHR40BXkQFnoECBEQAQ&url=https%3A%2F%2Fwww.handsontec.com%2Fdataspecs%2Fcnc-3axis-shield.pdf&usg=AOvVaw2eTWlYBw_TEDD2ZzLp-D4L&opi=89978449
- https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&cad=rja&uact=8&ved=2ahUKEwjfp7noz7eFAxUas1YBHR40BXkQFnoECA4QAQ&url=https%3A%2F%2Fwww.makerstore.com.au%2Fwp-content%2Fuploads%2Ffilebase%2Fpublications%2FCNC-Shield-Guide-v1.0.pdf&usg=AOvVaw2UMJIT_IKxabxmtCtCJyOl&opi=89978449
- https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&cad=rja&uact=8&ved=2ahUKEwjPzIuG0LeFAxWehlYBHRRDAQ4QFnoECBQQAQ&url=https%3A%2F%2Fen.wikipedia.org%2Fwiki%2FStepper_motor&usg=AOvVaw2w8OG9jY8h_kLBLAqEAniF&opi=89978449
- https://www.youtube.com/watch?v=eyqwLiowZiU&pp=ygUVc3RlcHBlciBtb3RvciB3b3JraW5n
- https://www.youtube.com/watch?v=5CmjB4WF5XA&pp=ygUac3RlcHBlciBtb3RvciBkcml2ZXIgYTQ5ODg%3D
- https://www.youtube.com/watch?v=BV-ouxhZamI&pp=ygUYc3RlcHBlciBtb3RvciBkcml2ZXIgZHJ2
- https://www.youtube.com/watch?v=rAIXfkRIQ5s&pp=ygUYc3RlcHBlciBtb3RvciBkcml2ZXIgZHJ2
- https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&cad=rja&uact=8&ved=2ahUKEwilqtLG0LeFAxXRTGcHHfSjAisQFnoECDoQAQ&url=https%3A%2F%2Flastminuteengineers.com%2Fdrv8825-stepper-motor-driver-arduino-tutorial%2F&usg=AOvVaw15iBpFG5ksEUIYtJ-z77SN&opi=89978449
- https://forum.arduino.cc/t/using-cnc-shield-v3-directly-with-arduino-ide/1022999/2
  https://www.handsontec.com/dataspecs/cnc-3axis-shield.pdf
  https://www.arduino.cc/reference/en/libraries/accelstepper/
- https://www.tinkercad.com/ - For designing parts