Quick Start Guide: 3MCU Automated Smart Greenhouse

Contents

About the Smart Greenhouse

- The goal with this design of the greenhouse is that a student does not have to solder, use a breadboard, or to strip wires. We use Grove sensors and Grove Shield that enables a user to simply plug and play sensors and use the codes in the following pages to control greenhouse variables to keep their plants healthy and happy.
- This 3-MCU powered greenhouse is ideal if you want to have students working in pairs with each pair contributing to the larger project. In this case, 6 students can work on the same greenhouse. Each micro:bit circuit is designed so that each pair of students are learning the

same science and computational science concepts so it does not matter which micro:bit students work on as they will be expected to learn and apply the same material.

- The version pictured above uses a hydroponic method to grow the plants called Kratky which is a very easy approach to growing plants. You can also use soil or other approaches to grow plants in the greenhouse.
- The greenhouse is purchased from IKEA. The holes seen in the picture were drilled by us but if you do not want to drill through the plastic then you can simply run the cables under the walls or under the roof of the greenhouse. The holes just make it a little easier to move the greenhouse.
- If you want to build the code yourself and do not want to find all the right extensions you can start with the Master Blank file that has all the extensions already installed
  - **http://bit.ly/sghMaster**

Air Flow and Temperature Control

What does this circuit do?

This circuit uses a relay to control a circulating fan by using data collected via a temperature and humidity sensor. The user sets a maximum temperature and humidity values and through the use of an if then statement that compares the actual temperature and humidity readings to the high values determines if the relay is turned on or if the relay is off. The data is shown on a small OLED screen.

> **Quick Science Connection**
>
> Air flow is important for a greenhouse because it allows carbon dioxide to move over the leaves promoting plant growth. Air flow helps to keep the temperature and humidity even throughout the greenhouse which can prevent diseases from developing.

The Code: Click on the link or type in a web-browser.
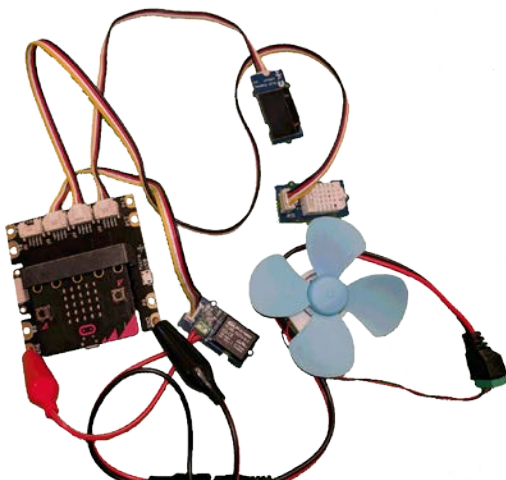
- http://bit.ly/sghairflow

Hardware and Sensors needed:
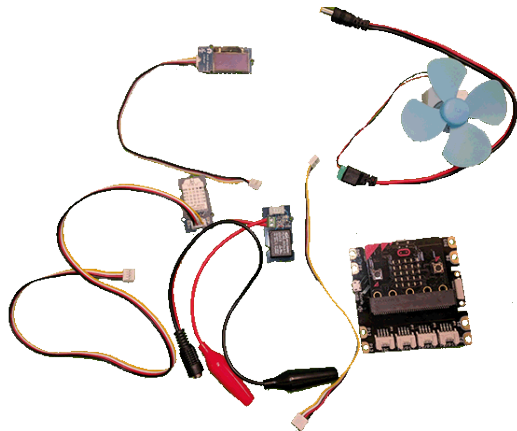
- Grove shield and Micro:bit
- Fan with male cable
- OLED Screen
- Temperature Humidity Sensor
- Relay with Female cable and alligator clips (red wires inserted into Relay)
- 2 short four pin wires (for Screen and relay)
- 1 long four pin wire (for Temp Sensor)

Wiring the Circuit

- Pin I2C: OLED Screen
- P0: Temperature and Humidity Sensor
- P1 - Relay
- P2 – Open (optional components)
- Connect female end of relay to the male end of the fan
- Connect Red alligator clip to 3.3V on Grove Shield
- Connect Black alligator clip to GND (ground) to Grove Shield

Light and Water Temperature

What does this circuit do?

This circuit uses a relay to control two LED lights by using a light reading from the micro:bit. A function converts the reading from the micro:bit LED display (which is in volts) to a lux (light intensity reading). The user sets a minimum light level (lux) and when the light shining on the greenhouse drops below that minimum reading a relay is switched on which turns on the lights. The code also measures the water temperature and displays a symbol on the micro:bit LED display.

Quick Science Connection

Light is critical for plants as without light plants will not be able to undergo photosynthesis. Light intensity is measured in a unit called lux. Lux is the amount of light energy per area. The higher the lux value the brighter the light.

Water temperature is important because if hot water does not contain as much dissolved oxygen as cold water. This means the roots cannot breathe which prevents the roots from absorbing nutrients.

The Code: Click on the link or type in a web-browser.
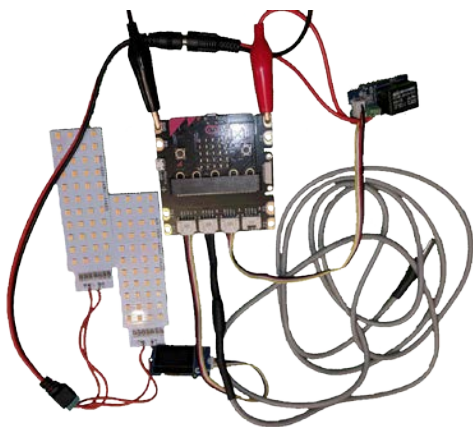
- http://bit.ly/sghlight

Hardware and Sensors needed:
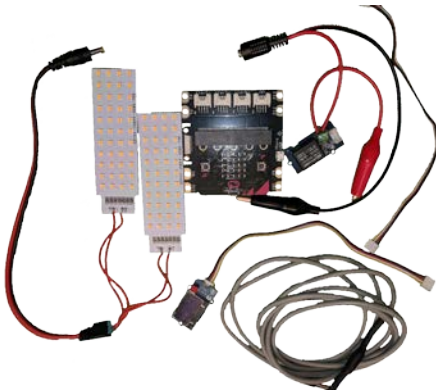
- Grove shield and Micro:bit
- One-Wire Water Temperature Probe
- OLED Screen
- LED Lights (2) with Male Connector
- Relay with Female cable and alligator clips (red wires inserted into Relay)
- 2 short four pin wires (for Screen and relay)

Wiring the Circuit

- Pin I2C: OLED Screen
- P0: Water Temperature Sensor
- P1 - Relay
- P2 – Open (optional components)
- Connect female end of relay to the male end of the fan
- Connect Red alligator clip to 3.3V on Grove Shield
- Connect Black alligator clip to GND (ground) to Grove Shield
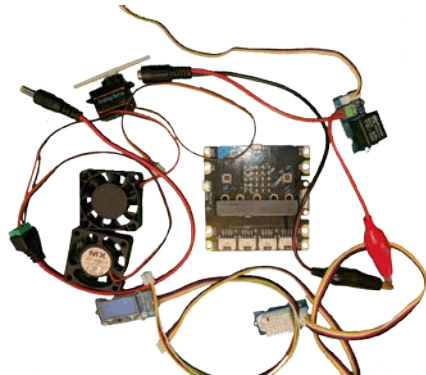
Exhaust Fans, Air Flow, and Servos

What does this circuit do?

This circuit uses a relay to control to exhaust fans. This circuit also controls a servo which is used to open the roof of the greenhouse. The user sets temperature and humidity values and if the temperature or humidity is higher than what is considered good by the user then the servo opens the roof and a relay turns on the exhaust fans.

The Code: Click on the link or type in a web-browser.

- http://bit.ly/sghexhaustfan

Quick Science Connection

The exhaust fans and servo help to control temperature and humidity. The exhaust fans can be placed to draw air out of the greenhouse to help with air flow and to cool down the greenhouse. The servo opens the roof to help release more hot and humid air. If the greenhouse gets too hot and humid it is likely that the plants will be stressed which will means they could transpire more and diseases or mold could hurt the plants.
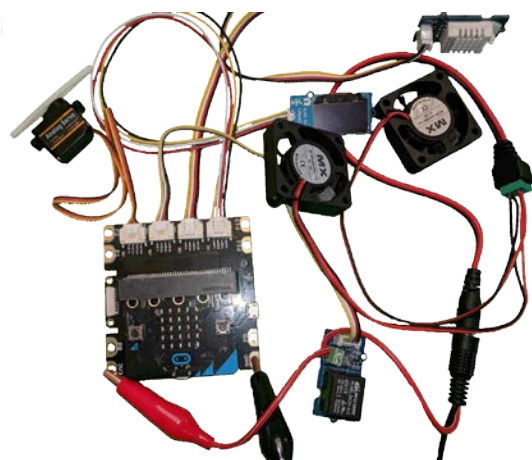

Hardware and Sensors needed:

- Grove shield and Micro:bit
- Temperature and Humidity Sensor
- OLED Screen
- Two Fans with Male Connector cable
- Relay with Female cable and alligator clips (red wires inserted into Relay)
- 1 servo
- 2 short four pin wires (for Screen and relay)
- 1 long four pin wire (for Temp Sensor)

Wiring the Circuit

- Pin I2C: OLED Screen
- P0: Temperature/Humidity Sensor
- P1 - Relay
- P2 – Servo
- Connect female end of relay to the male end of the fans
- Connect Red alligator clip to 3.3V on Grove Shield
- Connect Black alligator clip to GND (ground) to Grove Shield

Power Requirements and other materials

Optional Components

- There are some free Pins which means students can add other features to their greenhouse. Some ideas are:
  - Extra circulating fan
    - Can add another relay to the circuit and reuse same code
  - Extra set of lights
    - Can add another relay to the circuit and reuse same code
  - Adding a LED light to change color based on Temperature.
    - http://bit.ly/LEDStripTemp
  - A water sensor – determine if they need to add water to their jars
    - http://bit.ly/WaterDetect
    - (sensor link) https://www.seeedstudio.com/Grove-Water-Sensor.html
  - If using soil they could a soil moisture sensor could be used
    - http://bit.ly/sghSoilMoisture
    - (sensor link) https://www.seeedstudio.com/Grove-Moisture-Sensor.html

Power Requirements

- You will need 3 MicroUSB cables. If you are using a cellphone charging battery to run your greenhouse you should get a Y split USB cable because most cellphone charging batteries only have two USB ports.
- REMEMBER! Once the program is downloaded to the micro:bit switch the power to the Grove Shield!

Troubleshooting

- Most errors are because the sensor is not plugged into the right pin. If you are not getting any data or say the fan or lights do not turn on this most likely an error in the code
- If you have checked the code and all the sensors are plugged into the right pins then there may be a loose wire. Double check that all the wires are correct.
- If the code is correct and the wires look good then the component may be bad. Replace the component that is giving you trouble
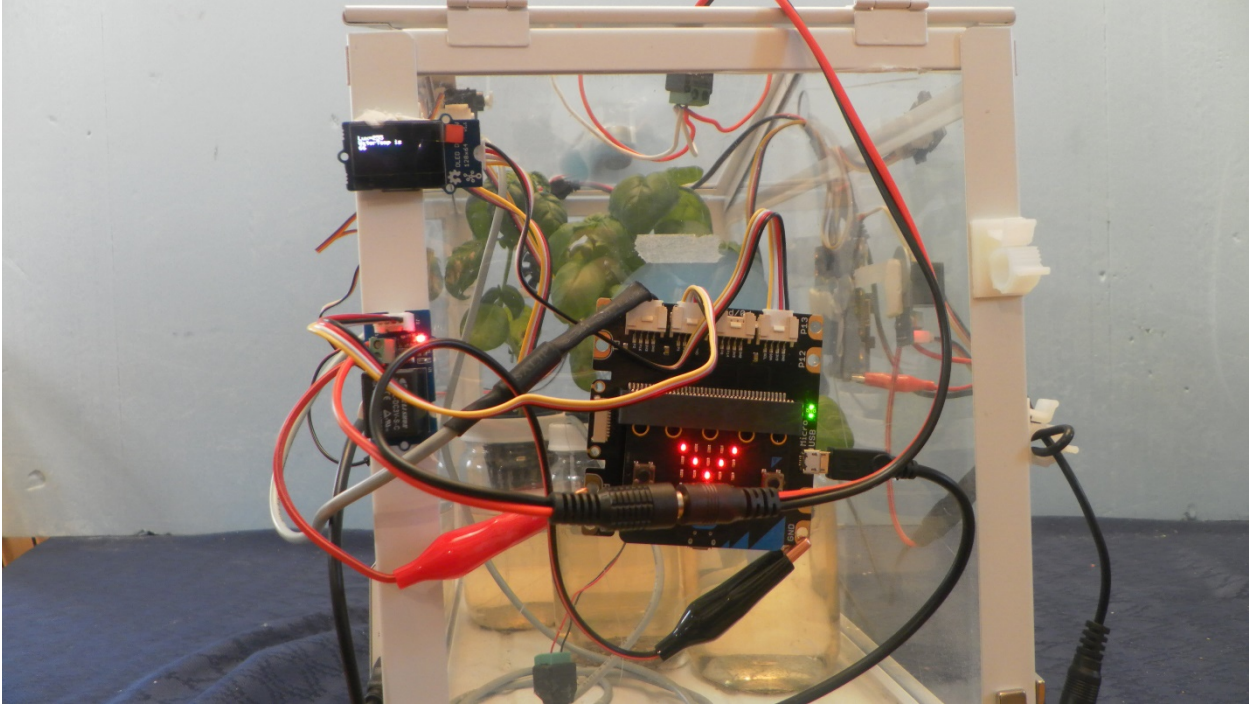
Pictures of Final Greenhouse

Exhaust Fans and Water Temperature
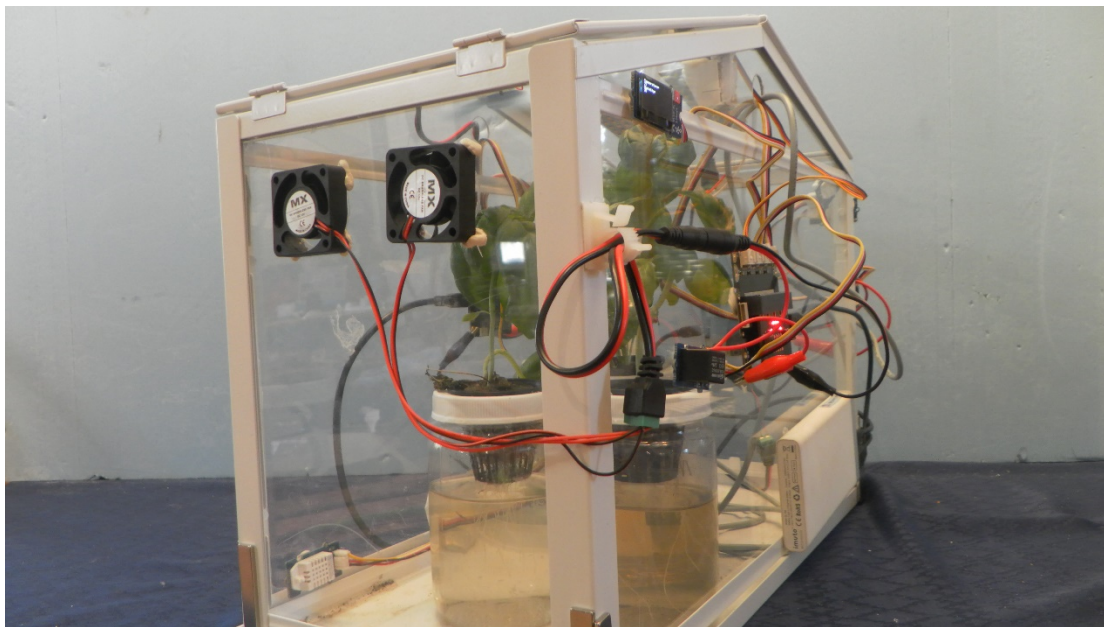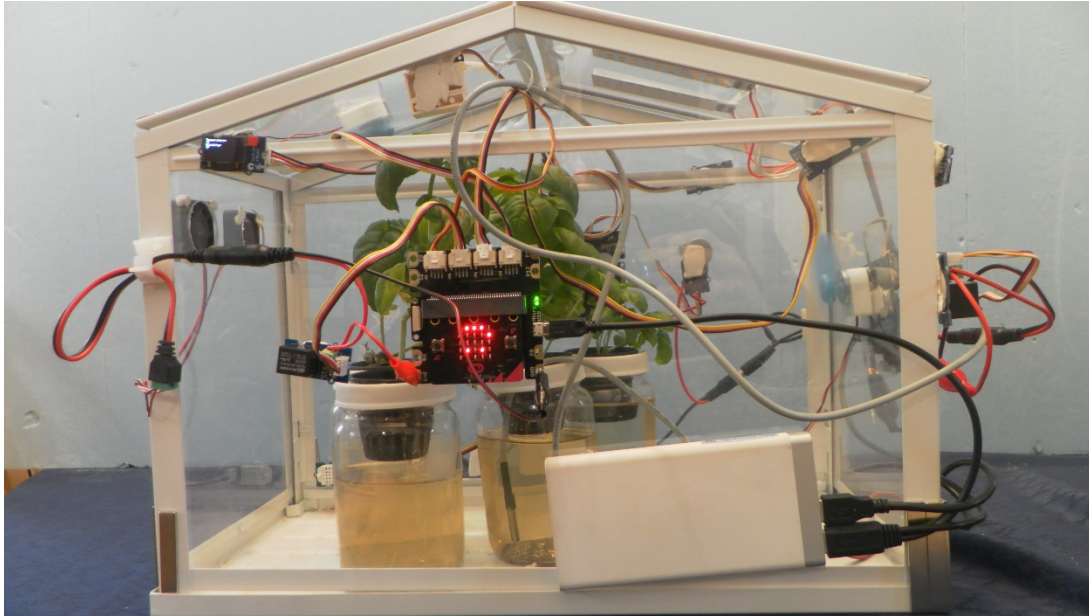
Circulating Fan (Image shown has two circulating fans with a splitter cable)
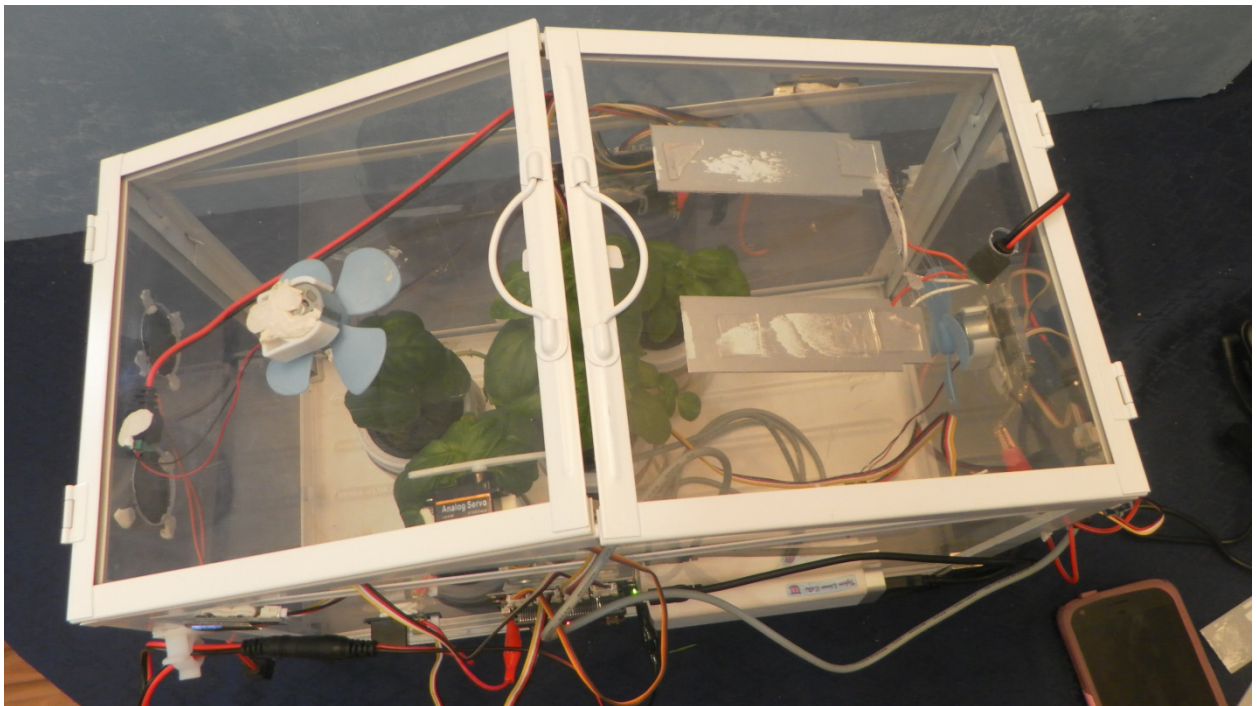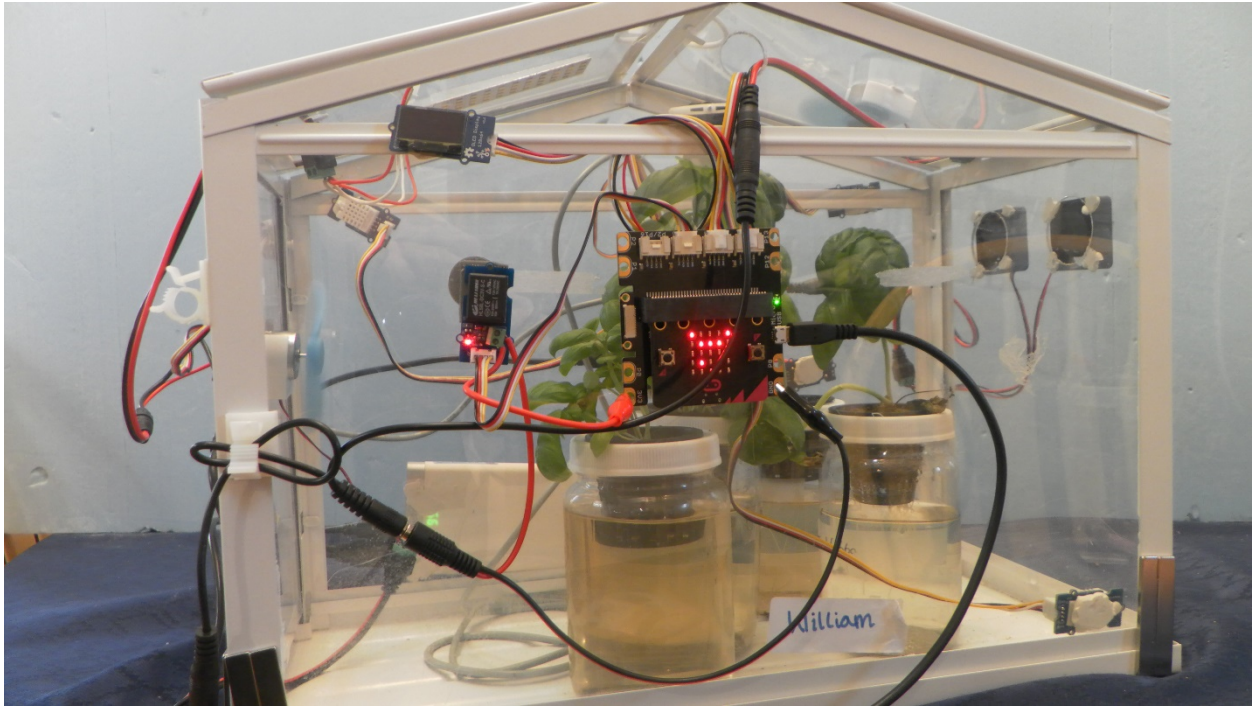
LED Lights circuit (on side panel opposite exhaust fans)

Parts, Tools, Software

Software Components

- Programming Website: https://makecode.microbit.org/#

Hardware Components

To make a 3 bit powered greenhouse

Parts	Where to buy
1 Ikea Socker Greenhouse	https://www.ikea.com/us/en/p/socker-greenhouse-white-indoor-outdoor-70186603/
3 Microbits	https://www.digikey.com/product-detail/en/pimoroni-ltd/MBIT0004/1778-1040-ND/6928253
3 Grove Shields	https://www.digikey.com/products/en?mpart=103100063&v=1597
1 split micro-USB cable	https://www.amazon.com/gp/product/B0179OXY9I/ref=ppx_yo_dt_b_search_asin_title?ie=UTF8&psc=1
2 6' micro-USB cable	https://www.amazon.com/AmazonBasics-Male-Micro-Cable-Black/dp/B072J1BSV6/ref=sr_1_4?keywords=3%27+micro+usb+cable&qid=1578354722&s=electronics&sr=1-4
2 Temperature Humidity Sensors	https://www.arrow.com/en/products/101020019/seeed-technology-limited
3 OLED screens	https://www.arrow.com/en/products/104030008/seeed-technology-limited
3 Relays	https://www.arrow.com/en/products/103020005/seeed-technology-limited
1 Servo	https://www.arrow.com/en/products/316010005/seeed-technology-limited
2 LED lights	https://www.amazon.com/KINGBO-Sunlike-Spectrum-Seedling-Growing/dp/B07N2V51WQ/
2 Exhaust Fans	https://www.amazon.com/gp/product/B06XHM7YZV/ref=ppx_yo_dt_b_search_asin_title
1 circulating Fan	https://www.amazon.com/gp/product/B078MSFFH5/ref=ppx_yo_dt_b_search_asin_title
1 Propeller	https://www.amazon.com/gp/product/B073XL73F6/ref=ppx_yo_dt_b_search_asin_title?ie=UTF8&psc=1
6 pair Alligator Clips	https://www.amazon.com/gp/product/B078BXPFMK/ref=ppx_yo_dt_b_asin_title_o00_s00?ie=UTF8&psc=1
3 female barrel plug	https://www.amazon.com/gp/product/B0768V9V5Q/ref=ppx_yo_dt_b_asin_title_o01_s00?ie=UTF8&psc=1
3 male barrel plugs	https://www.amazon.com/gp/product/B077HGTS4W/ref=ppx_yo_dt_b_asin_title_o00_s00?ie=UTF8&psc=1
6- Four pin cables (short)	https://www.arrow.com/en/products/110990031/seeed-technology-limited
2 - Four pin cables (long)	https://www.arrow.com/en/products/110990038/seeed-technology-limited
1 package sticky tack	https://www.amazon.com/gp/product/B01HQOIBJY/ref=ppx_yo_dt_b_asin_title_o05_s00?ie=UTF8&psc=1

Tools

- 1 pair wire strippers
- 1 phillips head small screwdriver
- 1 flat head small screwdriver