Automated greenhouse

Made by Vitaly Okolelov

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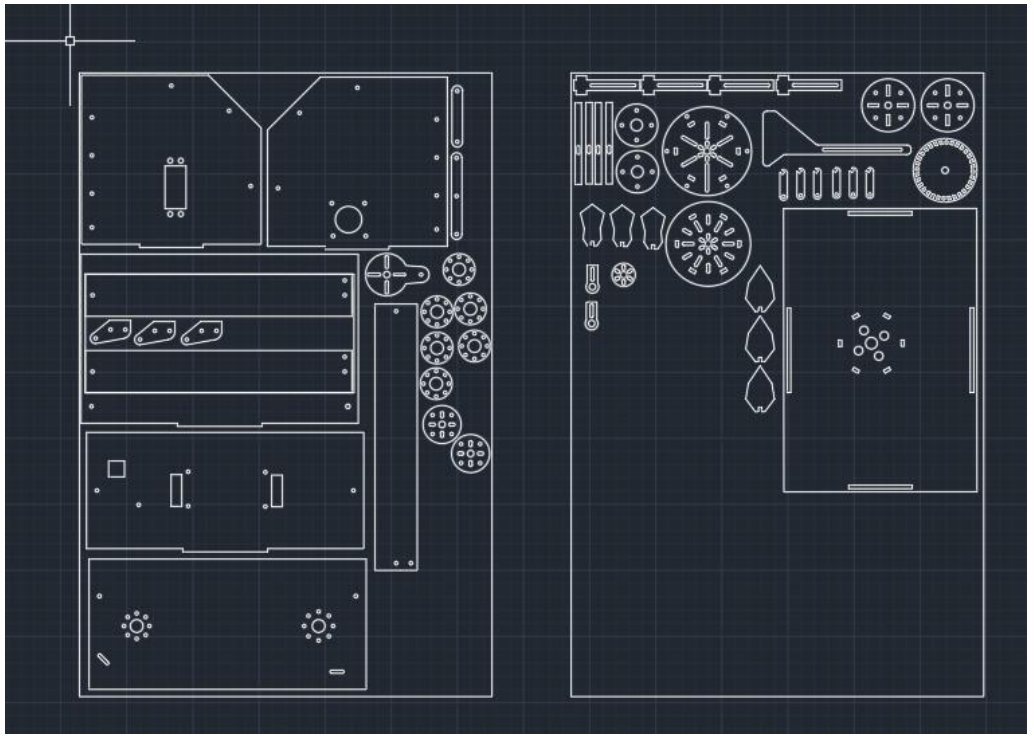
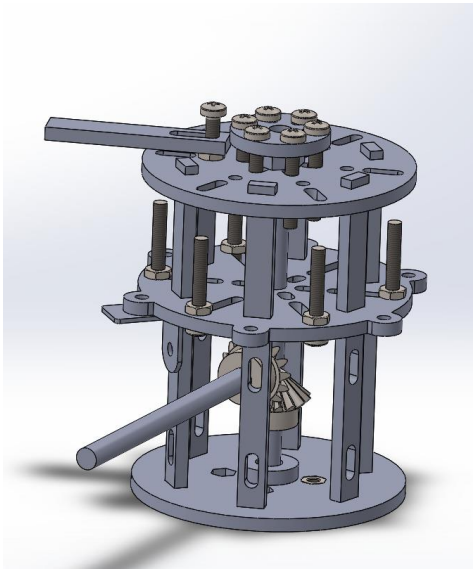
About the project

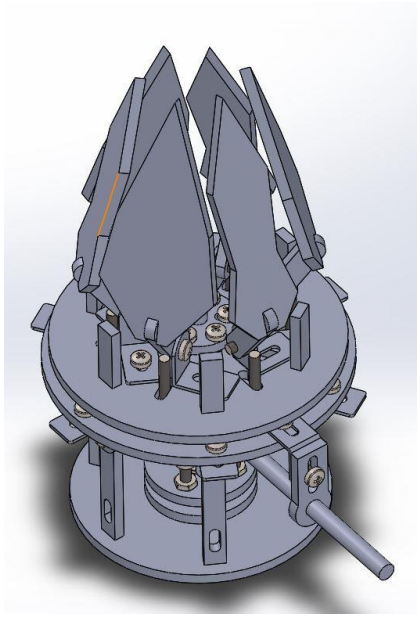
- University group project for a team of 3 students
- Most of components are designed in 2D software, then laser cut from acrylic
- Sensors: temperature, light, wind speed and direction
- Has louvred ventilation panel and animatronic flower simulating life and death of a greenhouse plant
- 3 types of LEDs simulating heating, cooling, and lighting + fan
- Control logic is written in C and designed to dynamically react to environment and maintain desirable conditions

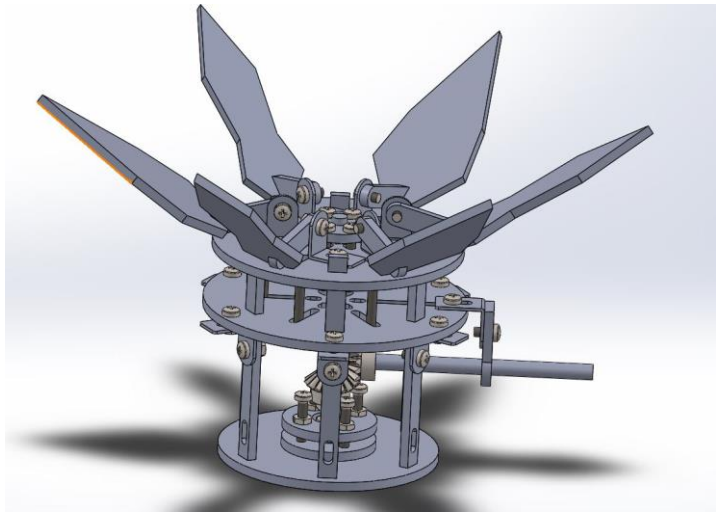
Mechanical design

- 3D model was created in Solidworks to simulate all dynamic components which was then transferred into 2D design and edited in AutoCAD
- Examples (Solidworks below and AutoCAD on the right)



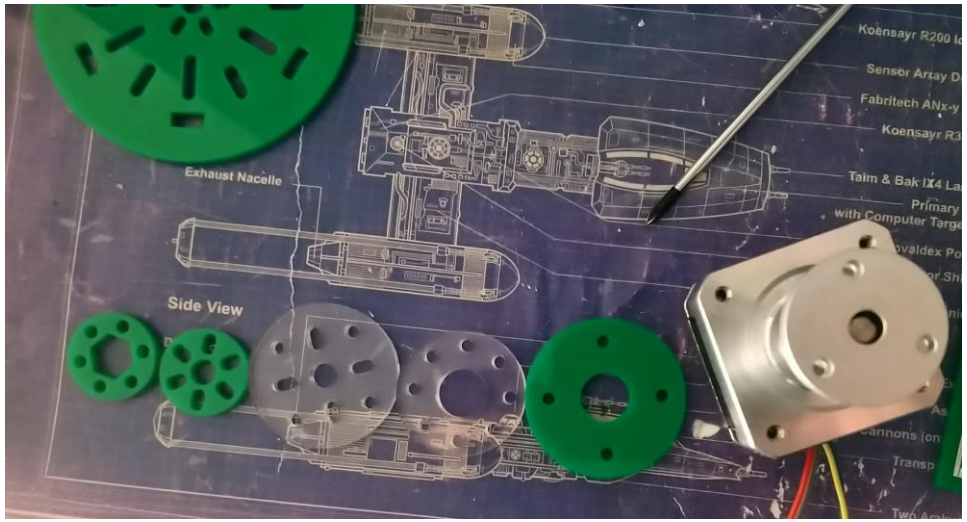






Mechanical design

- Examples of components

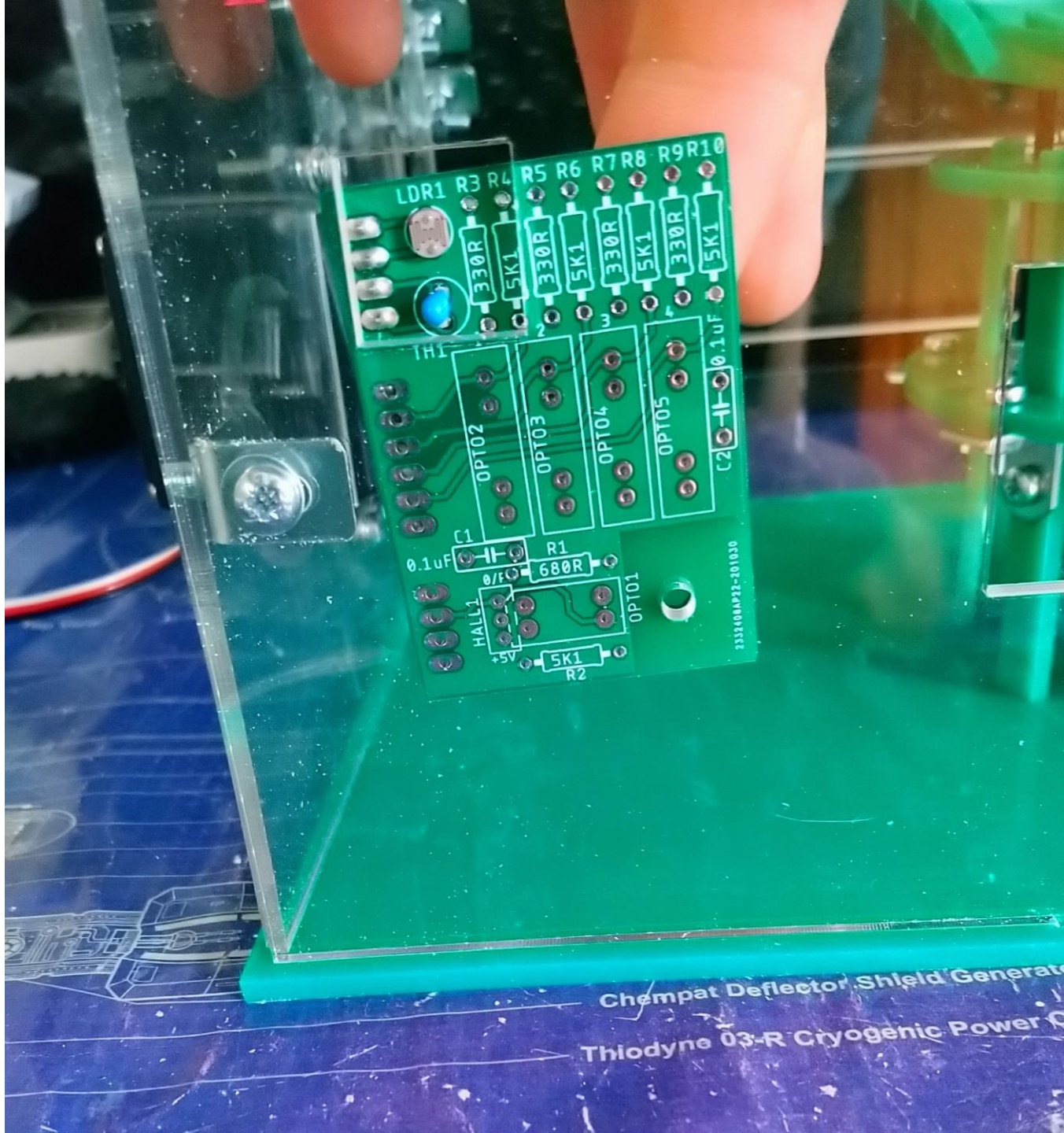


Sensors

- Wind direction sensor (left) using absolute encoder
- Wind speed sensor (right) using incremental encoder

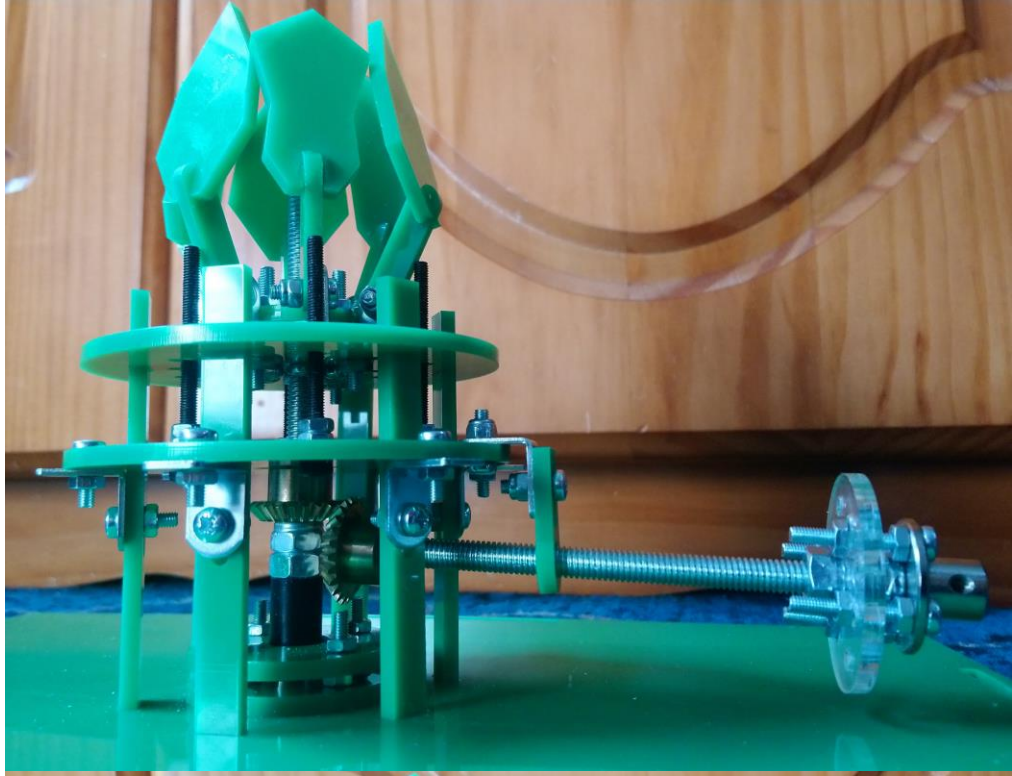
Sensors

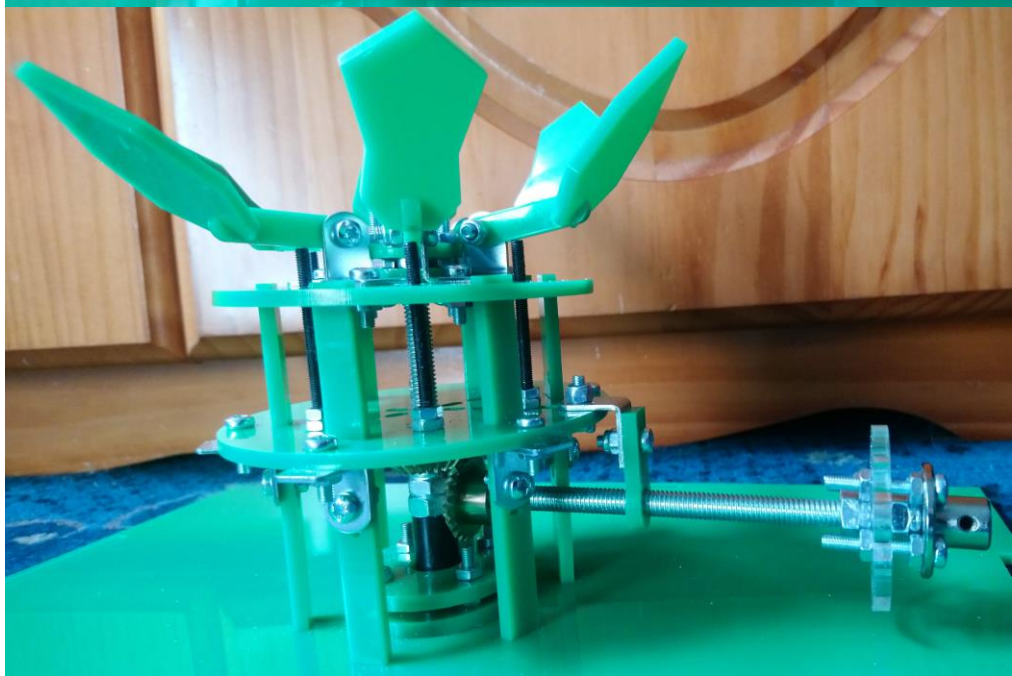
- Light sensor (top)
- Temperature sensor (bottom)



Animatronic flower

- Death state (top)
- Life state (bottom left and right)
- Powered by stepper motor





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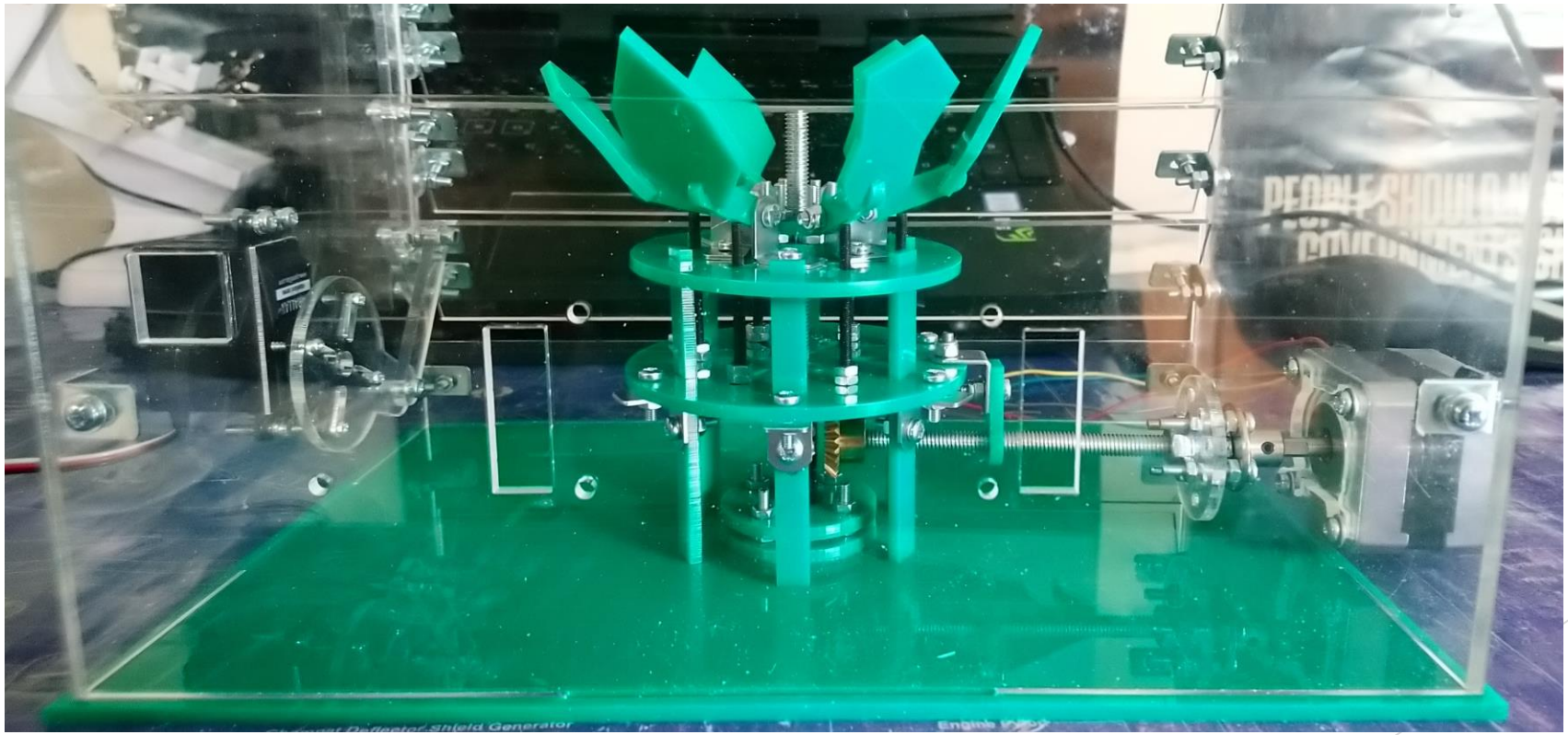
Louvred ventilation panel

- Powered by servo motor
- Photo: panel is behind the flower, servo motor is on the left



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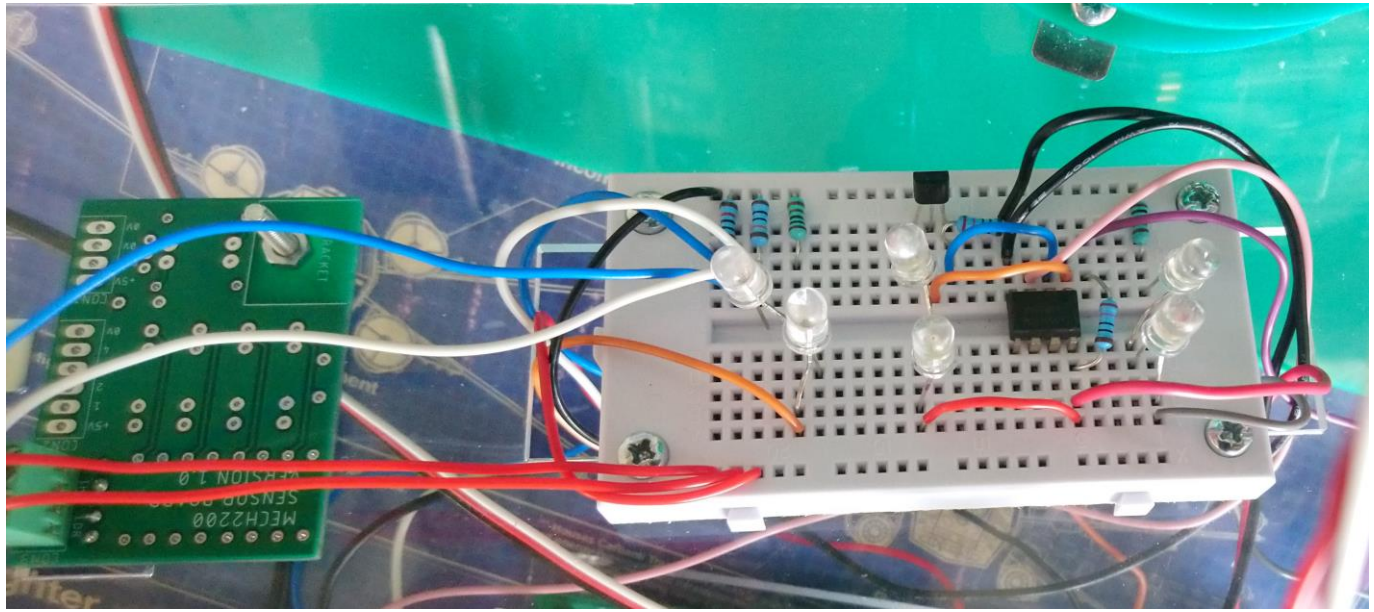
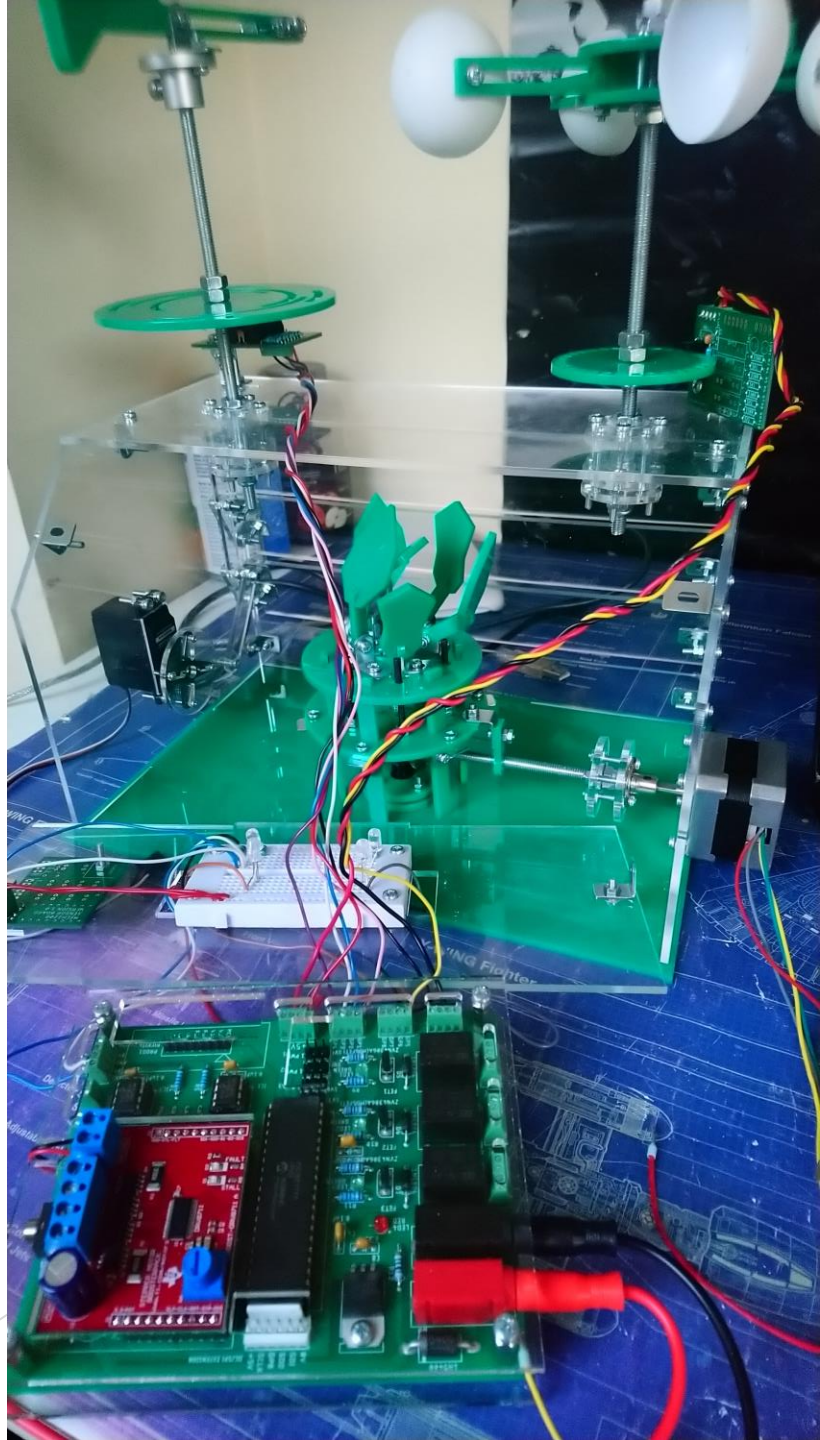
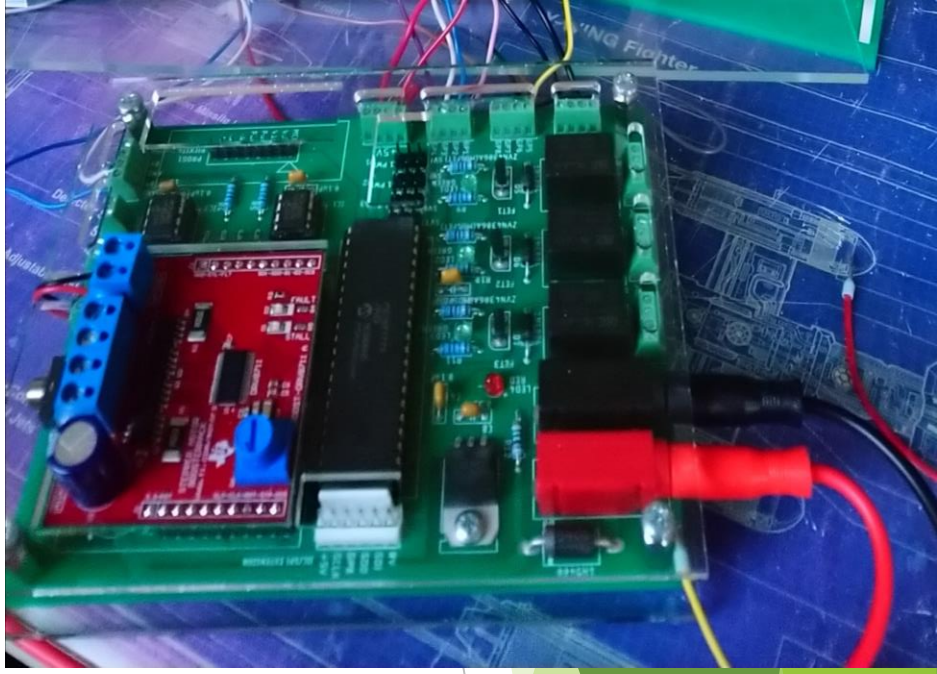
Wiring and extra electrical components

- Op-amp
- MOSFET
- Resistors





Use of development board



- Relay for fan
- ADC for temperature and light sensors
- DAC for white LEDs (lighting)
- PWM for servo motor (louver ventilation panel)
- General purpose input for wind speed and direction
- General purpose outputs for red, blue, and orange LEDs (heaters, coolers, and additional animatronic flower light)
- Stepper control circuit for stepper motor (animatronic flower)

Control logic

1. If the temperature < 10°C, then the louvre ventilation panel is closed and the ‘Heaters’ (RED LEDs) and Fan are on
2. If the temperature > 25°C, then the ‘Coolers’ (BLUE LEDs) and the ‘Fan’ are on
3. If the temperature > 15°C and < 25°C, then the ‘Heaters’, ‘Coolers’ and ‘Fan’ are off. However, see item ‘6’
4. If the wind speed is ‘High’ then the louvre ventilation panel should be closed
5. The louvre ventilation panel is positioned proportionally to the wind direction
6. If there is no wind or the louvre panel is completed closed then the fan is on
7. The ambient light levels should change the internal lighting (WHITE LEDs) of the greenhouse so as to maintain a stable light level within the house
8. The plants die if the temperature goes < 4° or > 30°C, but flourish at any temperature between these values

Programming

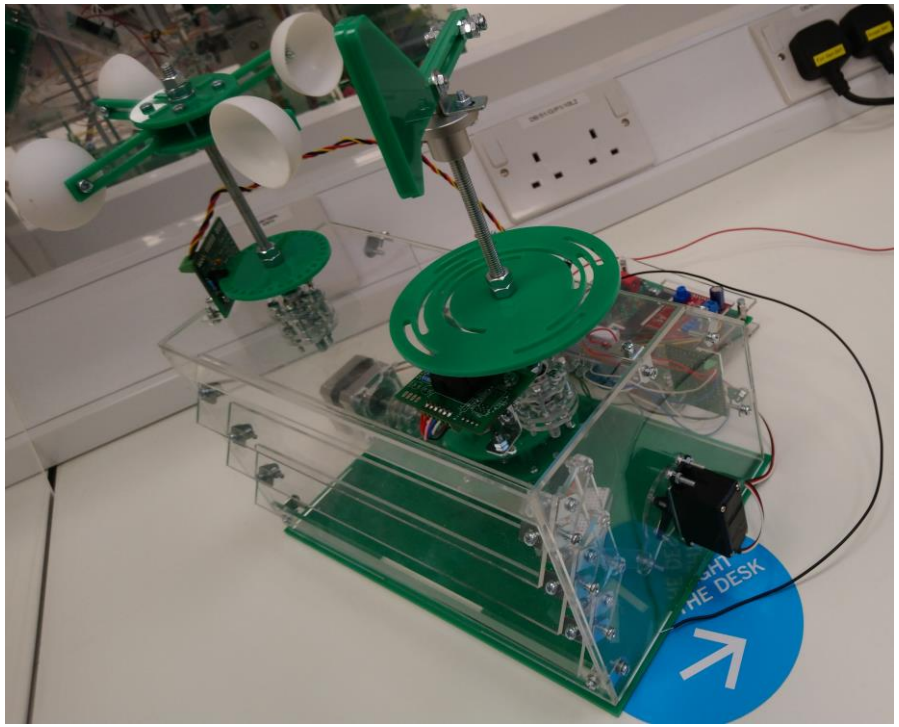
- Microcontroller: Microchip PIC16F1779
- Modular code with a great use of functions and source files
- Using interrupts to increase precision
- Using internal oscillator for timers
- Smart HMI providing configurable parameters for sensors and actuators calibration
- Louvre ventilation panel: smooth operation due to small incremental values
- Temperature sensor: precise functioning due to saving threshold values for temperatures needed for logic

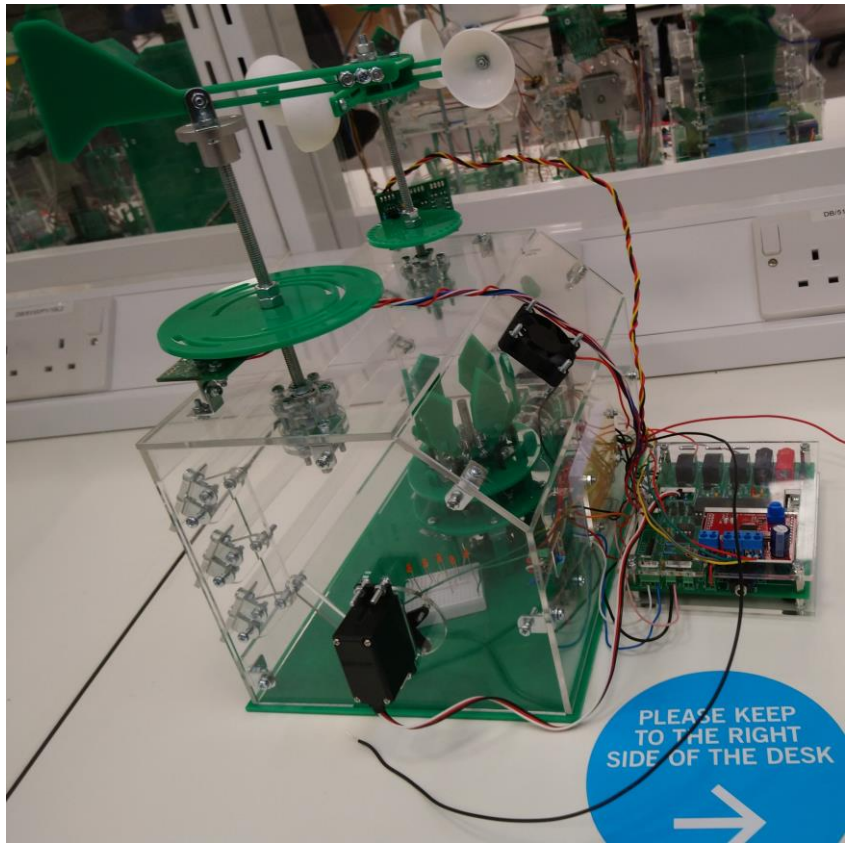
My role as a Team Leader

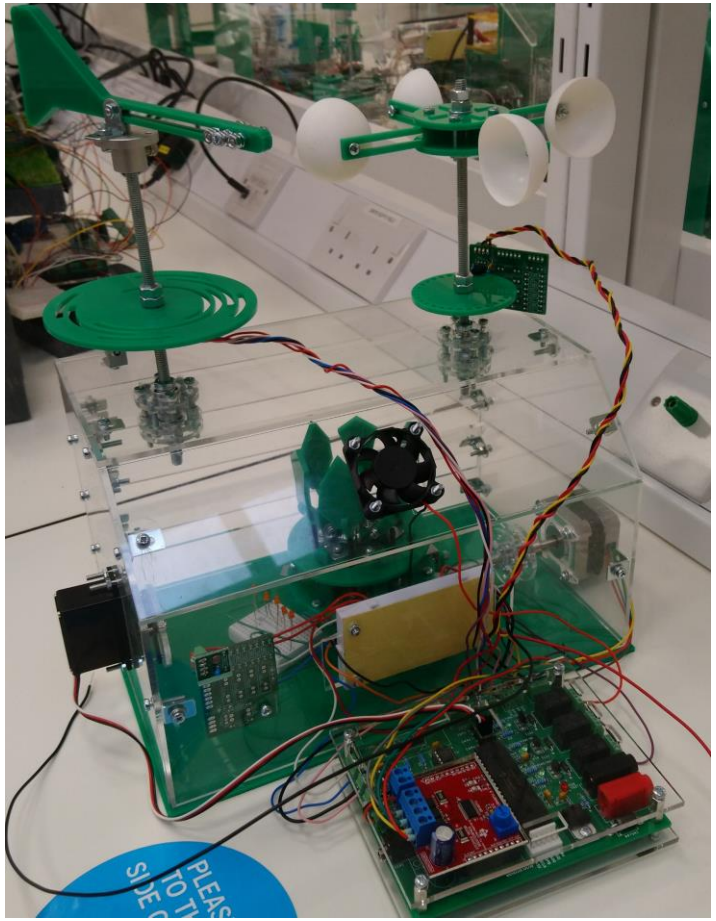
- Assisted teammates with concept development and verification of greenhouse components in Solidworks and AutoCAD
- Supported teammates with information about components
- Regularly synchronised progress via meetings
- Assisted with programming control logic, created main framework and HMI
- Assembled the whole structure, connected electrical components, calibrated sensors and actuators
- Presented the main features of the greenhouse to examiners
- After assessment, disassembled the greenhouse to recycle and reuse its components

Final result: Scored 95% out of 100%

See video of the demonstration here: https://youtu.be/Cwb1tl9I_Ac







Thank you!