光合成の家

チーム
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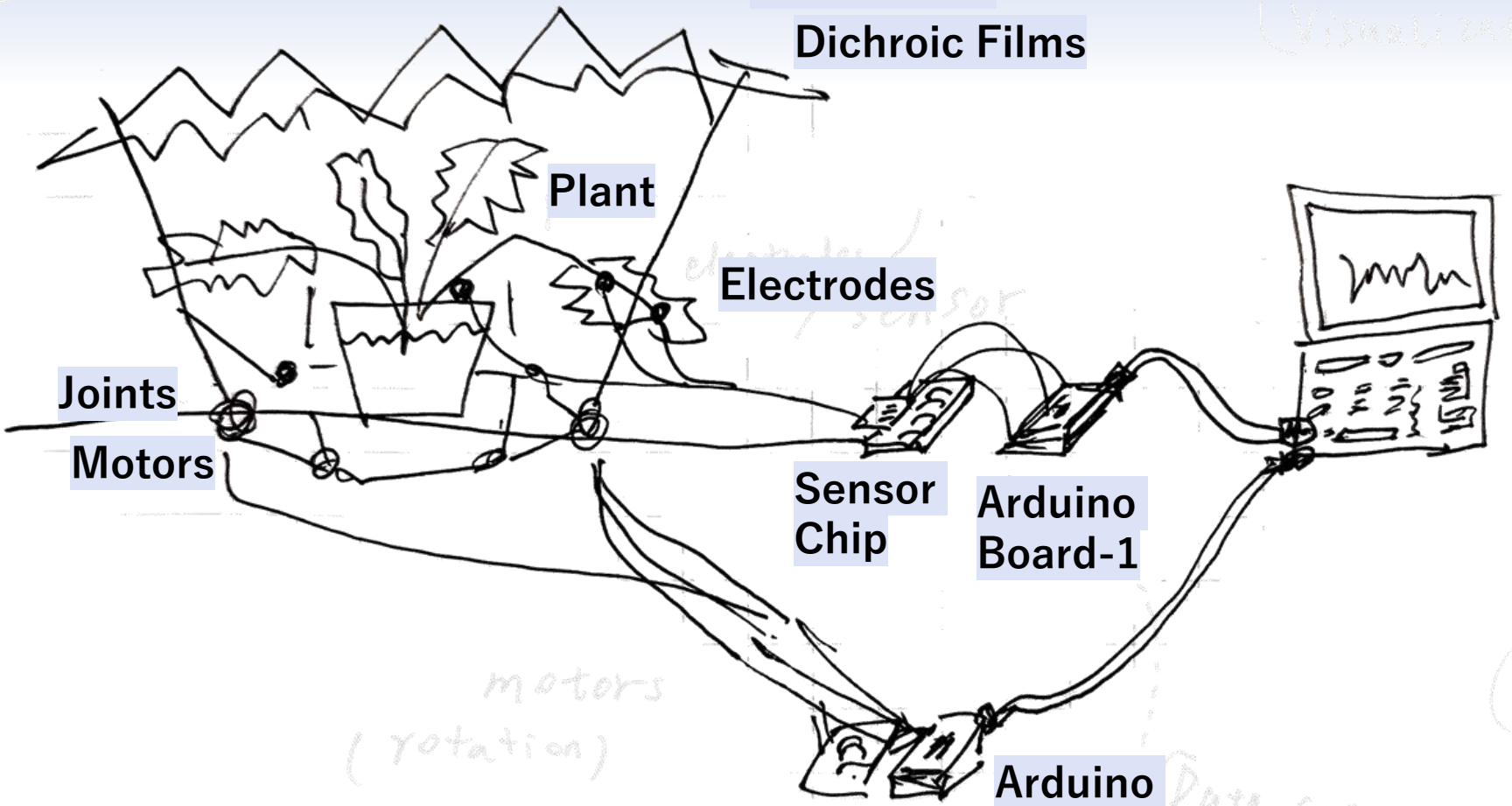
Concept

植物の生体電位をモニタリング
光を自動的に調整します

Overview

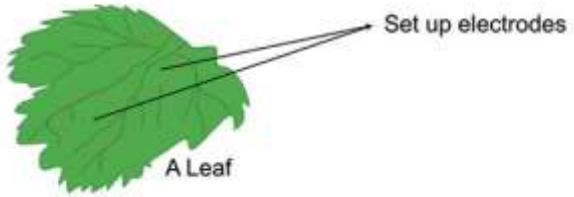

Folded Roof
Dichroic Films
Plant
Electrodes
Joints
Motors
Sensor Chip
Arduino Board-1
PC
Arduino Board-2

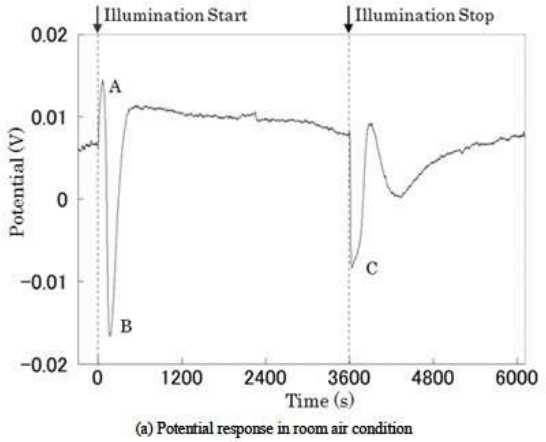
Background Research

More people choose to grow their own food while living in the city.

Hiroaki Taniguchi, etc., 2020, Biopotential Measurement of Plant Leaves with Ultra-Light and Flexible Conductive Polymer Nanosheets

With electrodes we can measure biopotentials in plants, which react sensitively to all the outside environmental changes and most drastically affected by photosynthesis.



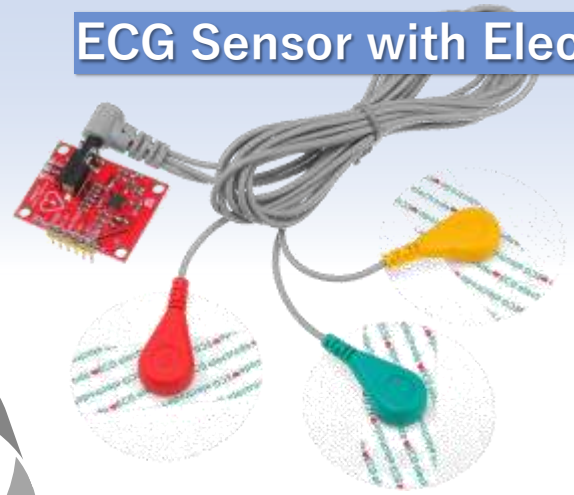


Not like ECG (Electrocardiogram) signals, biopotential changes in plants can be very subtle and the reaction to light change is enormous.

安藤 毅 - 光合成過程中の光化学反応と炭素固定反応に起因する植物生体電位応答の研究

Auto Adjustment Cycle

ECG Sensor with Electrodes



Environmental Light Change

Biopotential Change in Plants

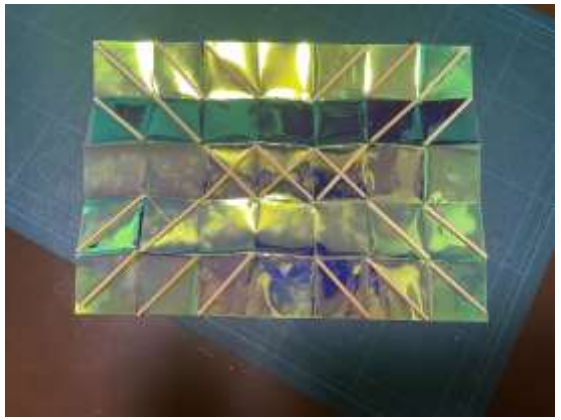
Response

Biopotential Change in Plants

React

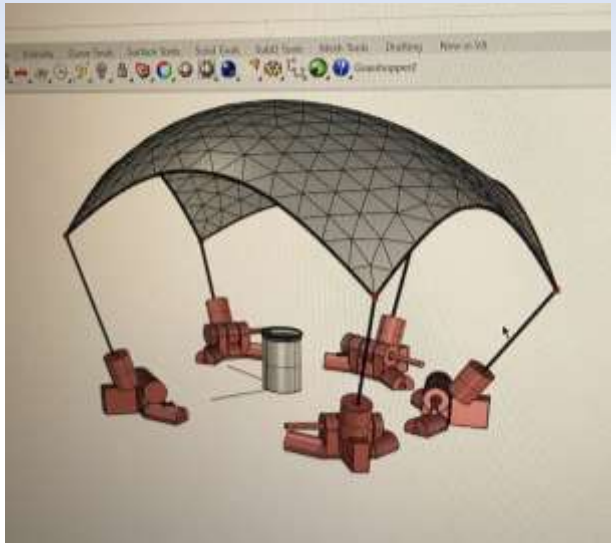
Equilibrium

Best Light Condition



Folded Roof with Dichroic Films

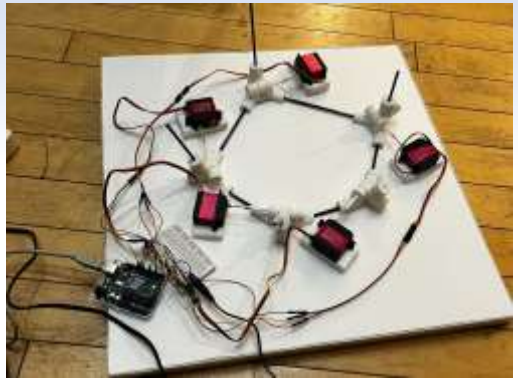
Process of Development



Form Design

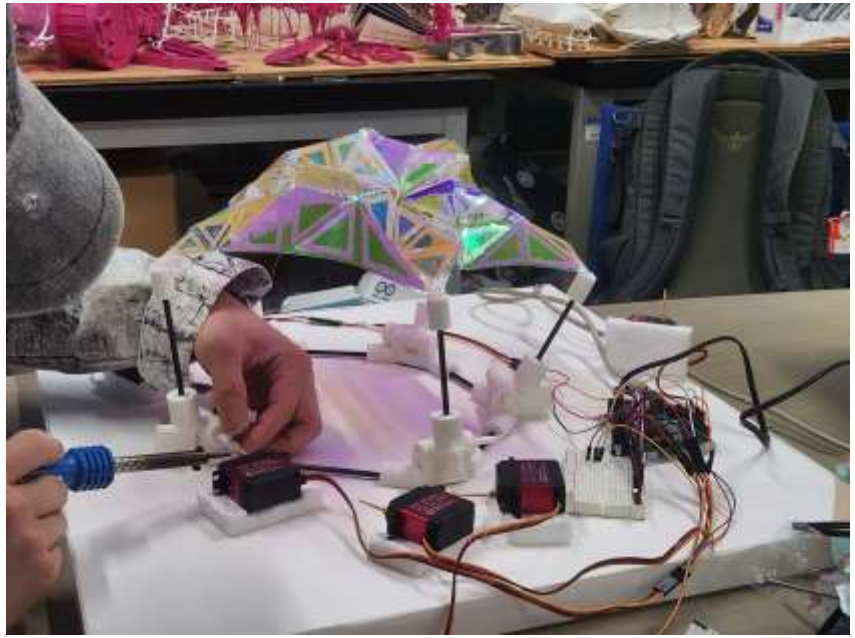
Prototype

Sensor Test

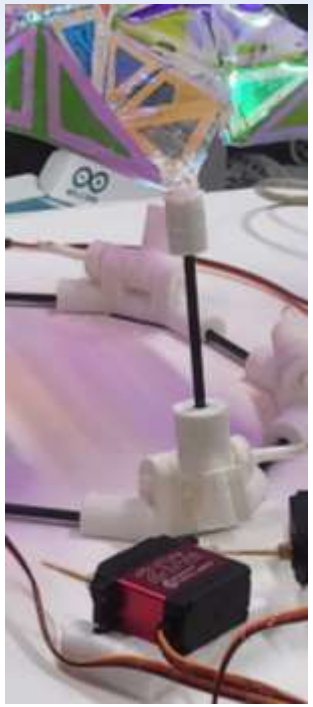


Motor Test

Implementation

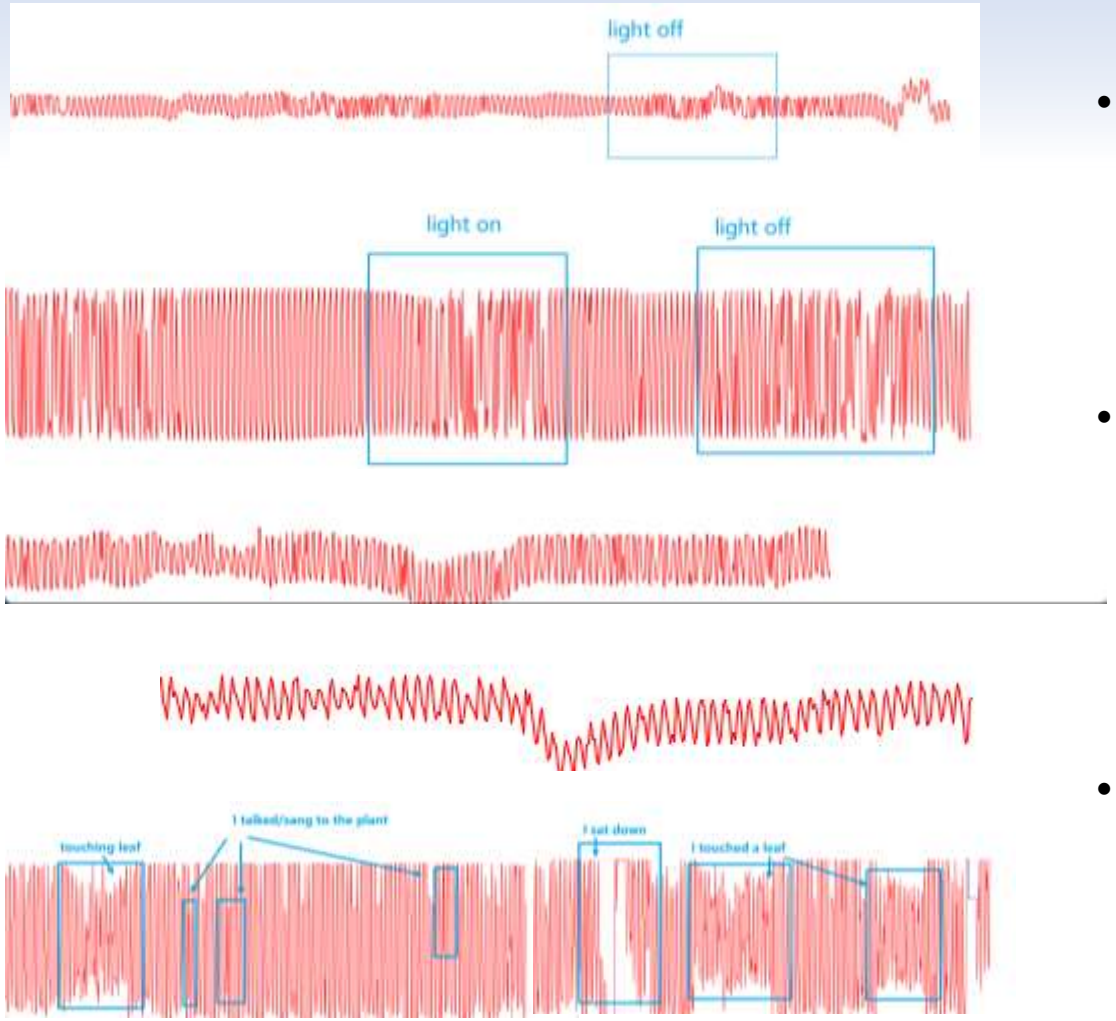


Mechanism



- Evaluating the plant's response to changes in lighting conditions is achieved by analyzing the difference in area between low and high frequencies through real-time FFT processing. The maximum area difference is considered the optimal response state of the system.
- The motor adjusts the position of the supporting rod by rotating, thereby altering the angle of the roof panel and the overall light intensity. After testing various angles, the motor identifies the optimal position.
- Noise is filtered by specifying the frequency range for FFT analysis.

Sensing



- AD8232 ECG sensor was used to capture the extremely weak bioelectric potential of plants. Three electrodes were employed, functioning as the active electrode, reference electrode, and ground electrode, respectively.
- The stability of the DC power supply, the connectivity of the electrodes, and their placement significantly influenced the measurements. An amplifier component was considered to enhance the display of potential changes.
- Multiple tests were conducted to observe the plant's responses to environmental changes and the corresponding frequency variation patterns.

Structure

- Dichroic films were selected as the roofing material to create a dynamic and complex light environment through origami-inspired structures.
- A combination of inverted suspension structure and folded structure was used to achieve a stable yet elegant structural form. Various folded methods were explored to enhance the stiffness of the roof surface.
- Custom 3D-printed joints were developed to connect vertical and horizontal rods, accommodating complex rotational requirements and enabling diverse roof transformations.
- To address challenges, the connection between the motors and joints was refined, ensuring effective control of vertical rod rotation by the motors.

Future

Biopotential Meaning

The relationship between the frequencies derived from plant bioelectric potentials and external lighting conditions, including the plant's response time and intensity, needs to be clarified further.

Roof Possiblities

The potential for this roof to generate diverse forms can be explored and developed further.

If plants can tell their feelings...

Thanks for watching.