LIGHT-RESPONSIVE FAÇADE PROTOYPE

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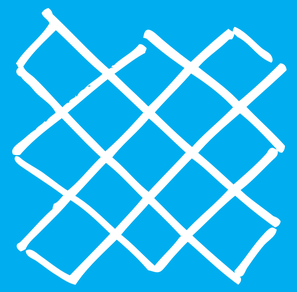
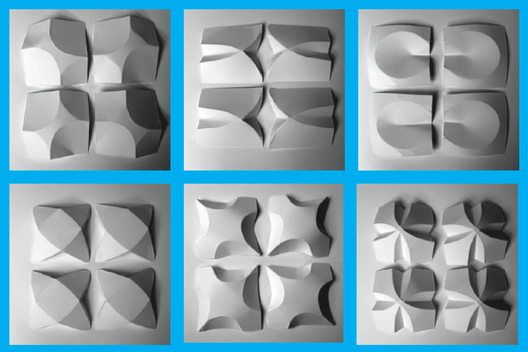
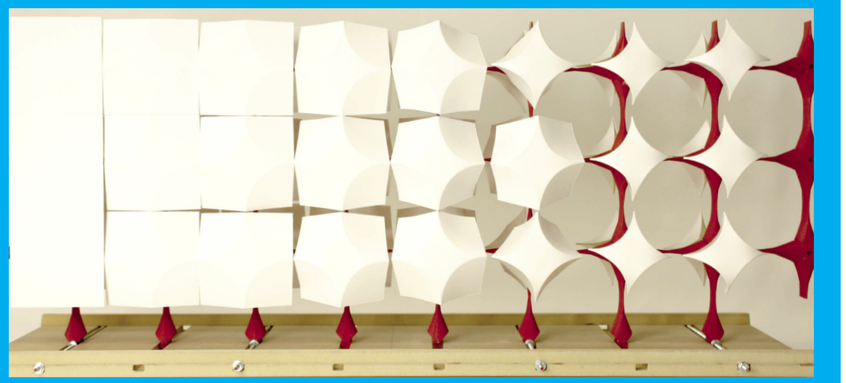


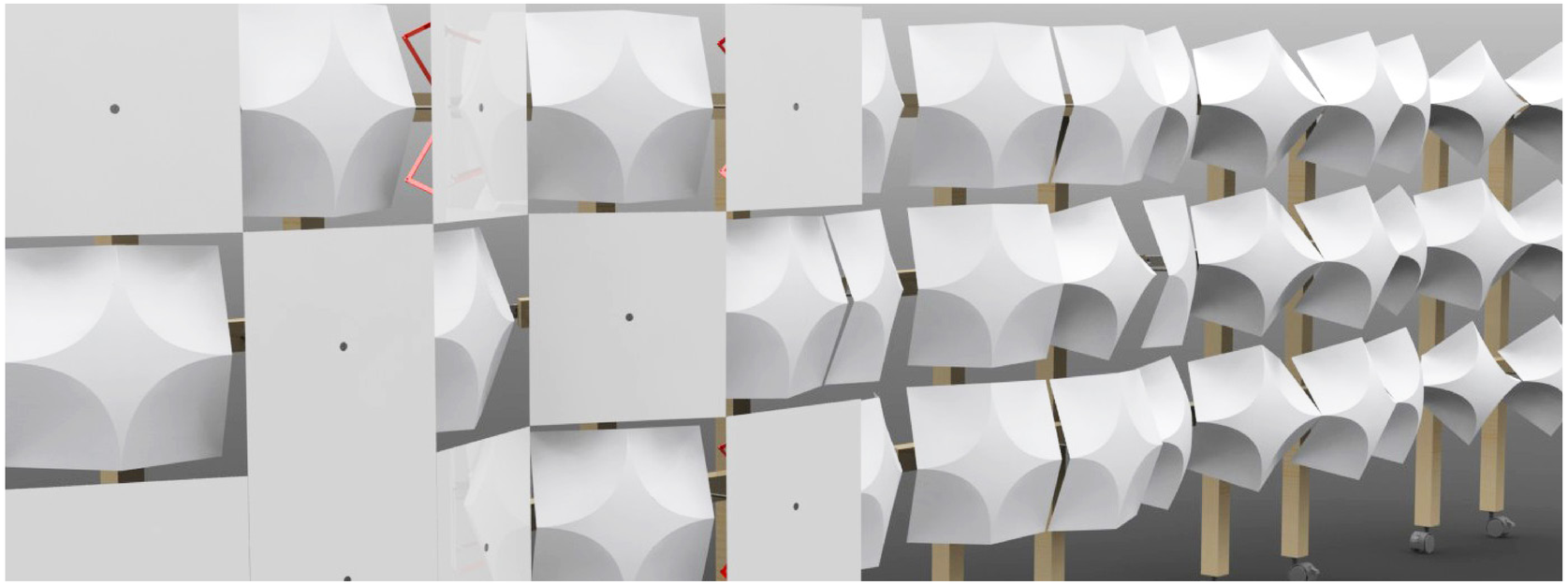
ABSTRACT

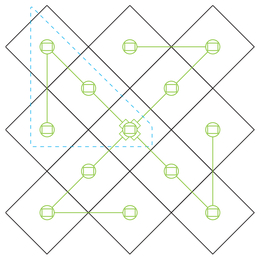
Research into improving building energy performance has the potential to create new and innovative architectural products. Through developing "green" architectural technologies aimed at increasing energy efficiency, architects and engineers must overcome the financial, architectural, and engineering challenges of their implementation. A prototype façade design was designed to respond to sunlight intensity as part of a study on similar façade schemes. Light sensors and Arduino microcontrollers are used to direct the actuation of 52 servos that independently control the actuation of folding panels. The purpose of this façade scheme is to increase building energy performance through the use of automated robotics programmed to permit sunlight into a building to achieve a desired interior temperature. This prototype built upon research into animated façades and created a working proof-of-concept prototype from these designs.



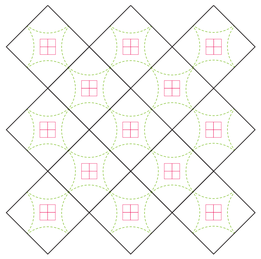
The 13 panels of this prototype generate their forms through curved folding. The particular curved folding motif used for this project requires the actuation of the four corners of each panel. This allows the two-dimensional paper rectangles to transform into three-dimensional forms, creating an interesting façade geometry. Through independent actuation of the panels, the façade is dynamic and capable of creating new forms. This research was motivated by the precedent of the Media-TIC building in Barcelona developed by the Consortium of the Zona Franca and the 22@Barcelona company. This building has a façade composed of translucent Ethylene tetrafluoroethylene (ETFE) sheets that are actuated by pneumatics that respond to sunlight intensity. Using this building as a reference point, this research aimed to use curved folding as a more cost-effective and architecturally viable method of creating a dynamic façade.



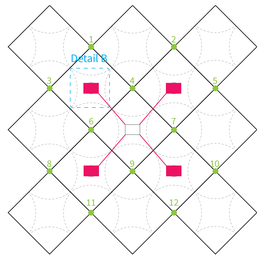




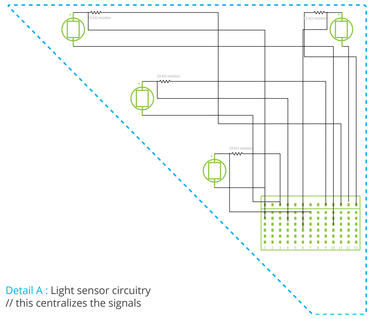
13 Panels with 13 Light Sensors
Centrally connected



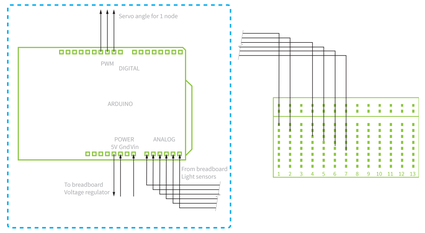
4 Leaves controlled by 4 Servos per Panel
Leaf // crease where panel folds



12 Nodes controlled by 4 Arduinos
Node // intersection of panels

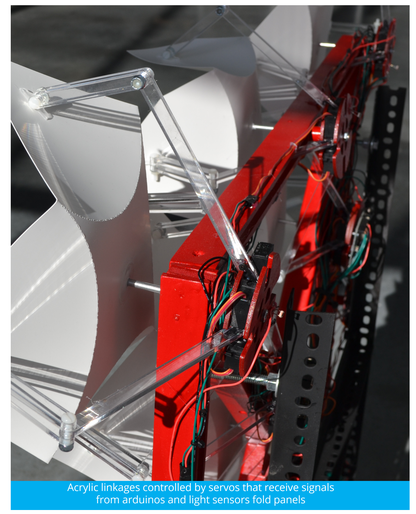


Detail A : Light sensor circuitry
// this centralizes the signals

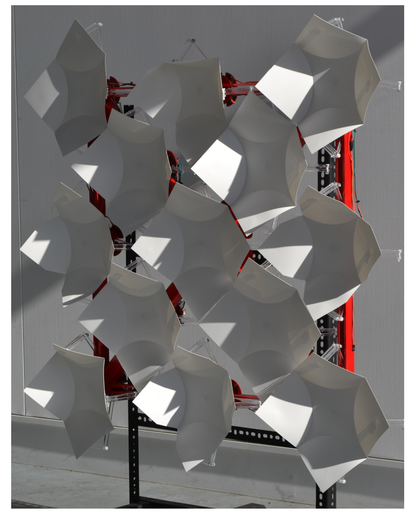


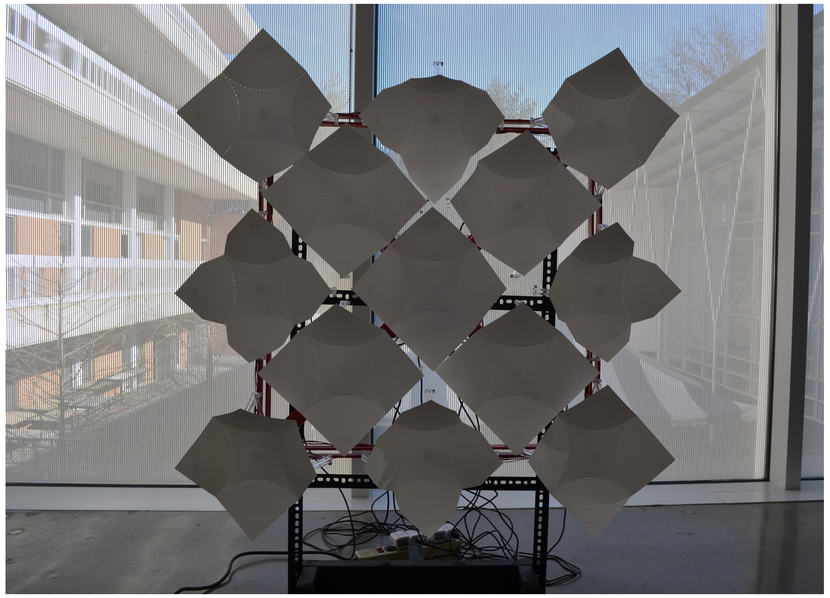
Detail B : Distribution of correct voltages to servos // this allows servos to be positioned correctly

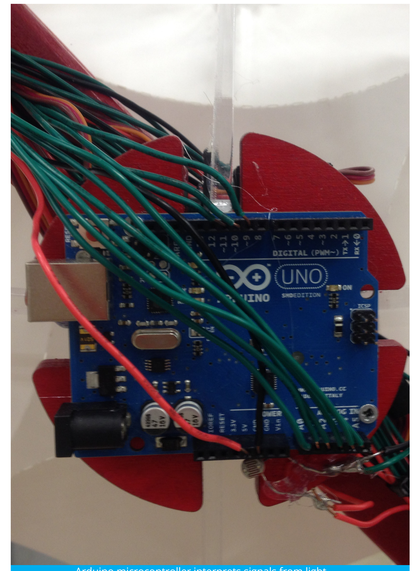
This prototype is designed to respond to sunlight intensity as part of a study on similar façade schemes. Light sensors and Arduino microcontrollers are used to direct the actuation of 52 servos. Two-member linkages connect the servos to 13 façade panels, allowing the panels to open and close as programmed. The purpose of this system is to increase building energy performance through the useof passive robotics. Interior temperatures can be increased by permitting sunlight. Biologically inspired by the properties of flowers, this design seeks to bring the soft, dynamic, and impermanent qualities of nature to imposing glass façades.



Acrylic linkages controlled by servos that receive signals
from arduinos and light sensors fold panels







Arduino microcontroller interprets signals from light
sensors and sends to servos