ILLINOIS INSTITUTE OF TECHNOLOGY
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ARCHITECTURAL ROBOTICS

SUMMER RESEARCH ORIENTED BY PROFESSOR BRETT BALOGH

Chicago – Illinois
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1. PROJECT DESCRIPTION

“Architectural Robotics” is a course oriented by Professor Brett Balogh at Illinois Institute of Technology during the summer 2016. The objective is that each student researches and develops a robotic system over the period of two months, as a prosthesis that augments the built environment and adds some characteristics and behaviors to static structures.

Knowing the main focus, the following research started with some quick and basic ideas for the robot system until getting to the main topic chosen to be studied: Light Control and Color. With this topic, the intention is to work with relations between interior and exterior light, economy of energy and light color therapy, with a device that is supposed to make a modification into a building, changing its behavior and giving it personality as a result of people’s action.

As a reference to the project, there is a responsive building called “Prairie House”, it is located in Illinois and designed by ORAMBRA, The Office for Robotic Architectural Media & The Bureau for Responsive Architecture in Chicago.

Prairie House uses new tensegrity systems (property of three dimensional structures consisting of members under tension and compression) and cladding technologies, emitting less than half of the carbon of a typical house in Illinois. Characterized as a parametric architecture that flow into the world via physical responses, it uses programming as a form of architectural media that is able to transpose new modes of specialized operation onto standardized building assemblies.

Through the use of the following four characteristics, the building contributes to increase the annual savings of energy up to 23.72%.

- *Color*: there are skins that change color via thermo-chromatic inks to provide savings. The interior membrane becomes lighter on warmer days, while on colder days it becomes darker. The thermal performance during cold days for example, makes the darker color absorb more heat to the building, decreasing the air conditioning system demand. Annual Savings = 0.45%

- *Openings*: further savings are provided when combining color with permeability. A building with screens that can open or close according to the exterior can save even more energy. The exterior screen opens to let warming sunlight hit the dark interior on cold days, while closing to shade the interior during hot days. Annual Savings = 2.48%

- *Insulation*: levels of insulation can also be controlled. The thickness of insulation is reduced to shed heat in the summer while insulation is increased in thickness during colder periods. Annual Savings = 8.01%

- *Shape and Volume*: structural systems that change shape and volume also contribute. During hot days the building should expand to reduce the impact of internal heat loads and shrink to reduce heating requirements on cold days. Annual Savings = 23.72%

Using “Prairie House” as an inspiration and reference to the main idea, the project will focus in two aspects. The idea is that the building would change its exterior colors according to the temperature that is on the outside but also change the artificial light inside.

- *Exterior Color Changing*: if the color from the exterior changes, it can absorb or reflect the sun light in a more intense way. During cold days for example, the building would be darker, in order to absorb more heat.

- *Interior Color Changing*: if the color from the interior changes, it is possible to bring a better sensation for who is inside. During warm days, the color would be lighter, in order to give the sensation of a colder room. A device would measure the temperature outside and the light inside would be regulated according to it. If the day is cold, the interior would have warm colors (as red and orange). If the day is warmer, the color outside would be cold (as blue).

The idea about the interior light is also to work with different colors that bring benefits to our health, according to studies of Light Therapy. Studies already confirmed that stimulations from colors can help to promote sleep, correct hormonal imbalances, combat depression and SAD (Seasonal Affected Disorder).

To achieve these two aspects, some devices and new technologies will be necessarily. The *changing of color* would be given by thermochromism, which is the property of substances to change color due to a change in temperature. There are already temperature sensitive inks with this property, they are called Thermochromics Inks and it was developed in the 1970’s to change color with exposure to heat.

The same property is found in Inorganic Materials, there are some of them that are thermochromics to some extent. Most examples involve subtle changes in color, as titanium dioxide and zinc oxide, which are white ate room temperature but yellow when heated.

The *changing of interior* light would be given by a different way. As the light inside is artificial, some programming will work into it. As the level of exterior heat increases, the light will automatically change to a colder color, as blue and white. To catch this, a temperature sensor will be installed outside of the building.

2. RESOURCES

- Responsive Architecture: Six Amazing Projects, Design Curial
http://www.designcurial.com/news/amazing-examples-of-responsive-architecture

- Praire House, ORAMBRA
http://www.orambra.com/~prairieHouse.html

- Thermochromism, Wikipedia
https://en.wikipedia.org/wiki/Thermochromism

- Thermochromic color changing materials, Chris Woodford
http://www.explainthatstuff.com/thermochromic-materials.html

- Temperature changing paint, Paint With Pearl
https://www.paintwithpearl.com/shop-custom-paint/temperature-changing-paint/

- Enhance Building Optimization with Energy Modeling, You Tube
https://www.youtube.com/watch?v=6P2XmZoI16A#t=788.432944

- Energy Modeling and optimization for Rhino, You Tube
https://www.youtube.com/watch?v=OjVsjdVm0Ew