Data Sensing in Living Wall Architecture

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This project documents research from a collaboration between Danelle Briscoe (Associate Professor, University of Texas at Austin School of Architecture), Michelle Bright (Environmental Designer, Lady Bird Johnson Wildflower Center), Marcus Hogue (Program Coordinator, Irrigation and Water Conservation UT), Ben Rice (UTSOA Robotics Lab) and Kim Ballare (Jha Lab at UT Integrative Biology). The primary focus of the project post installation was defining and collecting useful data associate with water usage, plant growth, and ecological interaction. Translating this data into useful information will then assess the environmental effects of the wall's location in relation to the selection and maintenance of the plants within. Still on-going, the project has achieved several objectives, including facilitating a successful collaboration across the architecture, computer science, and ecology disciplines and beginning to integrate robotic methods for fabrication. The analysis over the last six months period has also identified ways in which the project could be developed and expanded to further the goal of water usage, heightening the biological species living in the wall and transforming it into an interactive experience.

The majority of the data collection process involved developing the method through which sensors could be placed within the living wall and used to track data that would be recorded in real time. The soil moisture is being monitored by the Irrigation and Water Conservation team through 4 Toro monitoring devices imbedded in the cells. For the other values captured, the design team evaluated types of data to monitor (ultimately temperature, light, sound, and proximity), the types of sensors to use and the locations within the wall to best monitor this data. The mapping of the sensors was broken into two phases: (i) positioning one of each sensor type on the wall in locations closest to the hardware interface, and (ii) distributing sensors throughout the wall. Sensors were attached and installed onto the wall using custom-designed 3D-printed attachments in the chosen locations. These sensors were soldered to cable and wired into breadboards, where connections were made to multiple Arduino Uno boards.

On an ongoing basis, the Arduino Uno boards receive all of the data collected from the sensors and send it to a computer constantly running to track the values. The temperature, light, sound and proximity data is read out and translated into real units (degrees fahrenheit, lux, decibels, and inches, respectively) using Grasshopper for Rhino and the Firefly plugin. These quantifiable values are written into Excel sheets at specified intervals and are saved at specified intervals, allowing the data to be tracked over time.

The diurnal swings of light and temperature and the seasonal changing of these swings is particularly interesting in order to monitor the endurance of the biological species within the wall through varying weather conditions. It is necessary to collect the data from these sensors at different intervals than the data from the sound and proximity sensors in order to track useful information. When collected at frequent intervals, the sound and proximity sensors can give a sense of wildlife and user interactions with the living wall, while data from the light and temperature sensors collected at longer intervals is more useful for determining average values of weather conditions. Research Assistance by Phil Richardson, David Sharratt, Yiqing Wang and Melissa Sparks.

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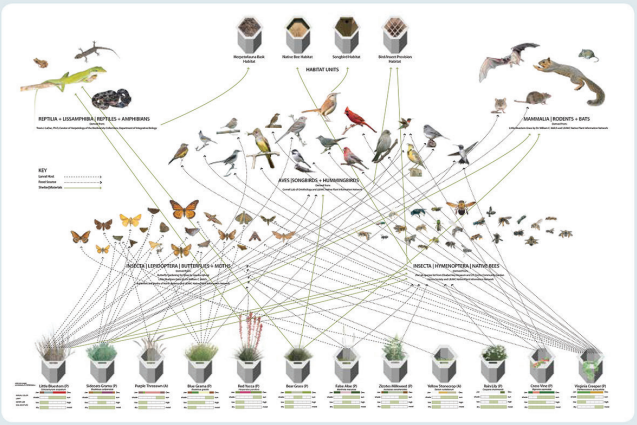
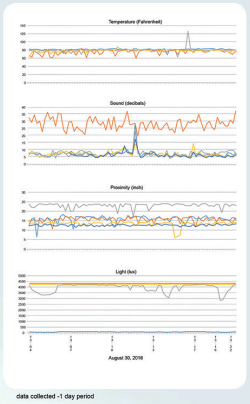


Soil Moisture data collected -1 week period



data collected -1 day period

SOUND SENSOR
Microphone detection of sound. Capable of detecting sound produced by wildlife or user interactions near habitat cells.

PROXIMITY SENSOR
Infrared detection of distance. Capable of detecting movement of wildlife or users interacting with the habitat cells.

LIGHT SENSOR
Light detection. Captures the amount of light hitting different parts of the wall throughout the day.

TEMPERATURE SENSOR
Temperature detection. Captures the diurnal temperature swings that affect the living wall.

SOIL MOISTURE SENSOR
Water distribution. Captures water salinity, temperature and moisture in soil of cell.

SM measure soil moisture, temperature andn salinity

P1 and S1_measure proximity and sound within the bird cell
P2 and S2_measure proximity and sound on the bee cell
P3 and S3_measure proximity and sound on the lizard house
P4 and S4_measure proximity and sound at the bento box
PC and SC_measure proximity and sound above the threshold

T1_measures temperature at top left wall
L1_measures light levels in the center of the grassy plants
T2_measures temperature at top right wall
LC_measures light levels just above the threshold
T3_measures temperature at bottom left wall
T4_measures temperature at bottom right wall
L4_measures light levels within the vine circle
LT_measures direct light levels on the top of the wall

ARDUINO PROCESS

Sensors on Living Wall
↓
Breadboard
↓
Arduino Uno
↓
Desktop Computer
↓
Firefly for Grasshopper
↓
Microsoft Excel
↓
Touch-Screen Diagram