Robotics in Architecture

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Final Paper

CrownBot

Summary

The idea is to create a robot that display information about the space it is in like temperature and noise with graphic bars and even the weather in the outside with pixelated images describing the weather condition. The robot itself should be a display of RGB 32 x 16 LEDs showing an eye and feedback for the information it is gathering from its surroundings with the help of temperature and humidity sensor, a photo cell, a microphone and the internet. The eyes gives the robot a curious personality, since it looks around randomly, this is a way to make the robot more friendly and approachable by users, also, the eye has a simple, clean and rectangular form that try to follows the Crown Hall aesthetics. With all of this the whole building will look like a robot and will have an enhancement on its communication to the users.

Concept

A robot is a machine that is programmed to execute a task. Usually we use robots to make repetitive tasks, jobs that would demand too much effort or strength for a human being or to accomplish missions on dangerous environments. They can be controlled by a human directly or remotely or they can be controlled by a computer that follows a program. Robots can be as simples as toys or automatic vacuums or as complex as mechanical arms that realize precise surgeries. Not all of them look like a bunch of metal pieces, there are also androids robots that resemble to humans.

Architecture can commonly be divided in two aspects: hardspace and softspace. Hardspace is the physical part of a build, like the walls. It is usually static and hard to change. The softspace is more about the feelings and experience we have in a space. It is ephemeral and usually ever changing. [2]

Analyzing the relationship between robots and architecture it is easy to make two groups: robots that build a space, work with the hardspace, like some robotics arms that pile bricks up or another one that can 3D print concrete buildings; and robots that enhance the space, work with the softspace, like robots that controls the amount of sunlight that comes inside the build or a robot that makes humans interact more with a building.

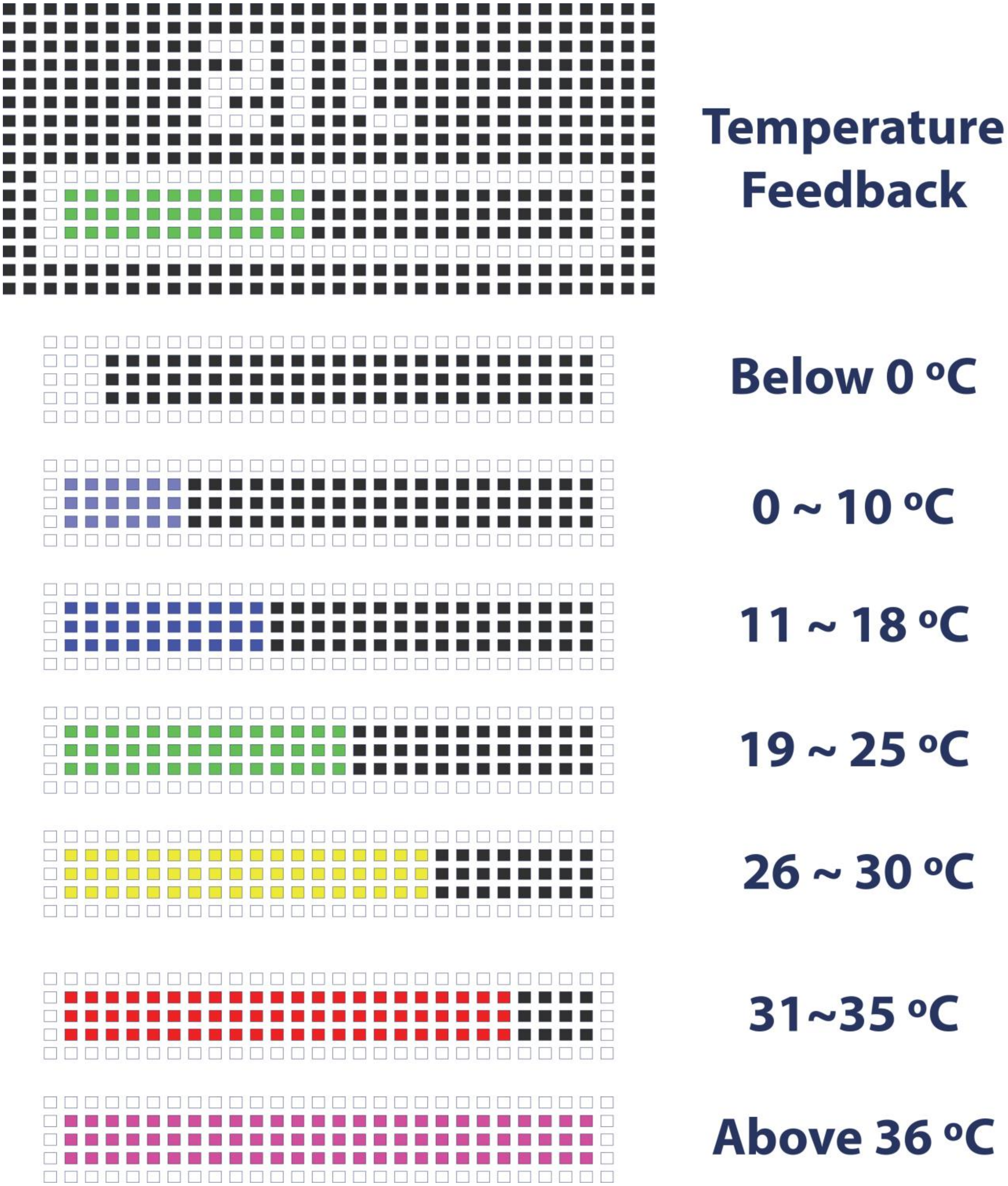
As an architecture student I've noticed through my years in college that architects pay a lot of attention to buildings and treat them almost as a living being, but common people do not. Architects are trained for many years to observe and feel the space, so maybe there could be a way for the building to show everyone what is going on inside it.

After reading about user-friendly interfaces [1] it became clear that us humans reacts to appearance. There are studies about shapes, colors, positions and how all of this triggers different reactions on us. When a product easy to use and pleasant to the eyes it is called user friendly product.

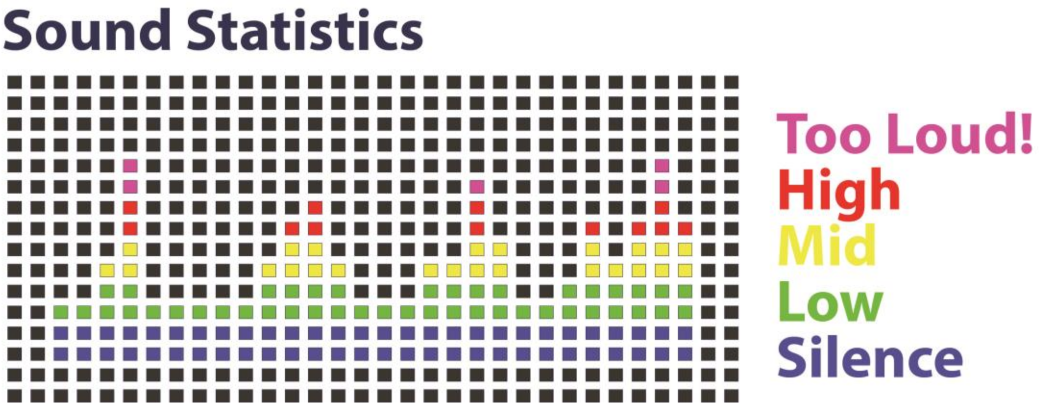
That way the concept of the project is to bring people closer to the building using appearance and information. The eye takes advantage on people curiosity and try to attract them by visual appeal. The idea is that the person looking at the robot eye might follow it and look around the build along with the robot. With a set timer, the eye then changes to a bar that shows the room temperature, then a graphic that shows how noisy the room is and finally the weather cast and then comes back to the eye and repeats.

The information the robot shows should help people to pay attention on the surroundings and it should help people to evaluate the architecture efficiency. For instance, if the robot always shows that the room it is inserted in is hot, then there is probably something wrong with said room. Most of thermal comfort problems are possible to solve with architecture.

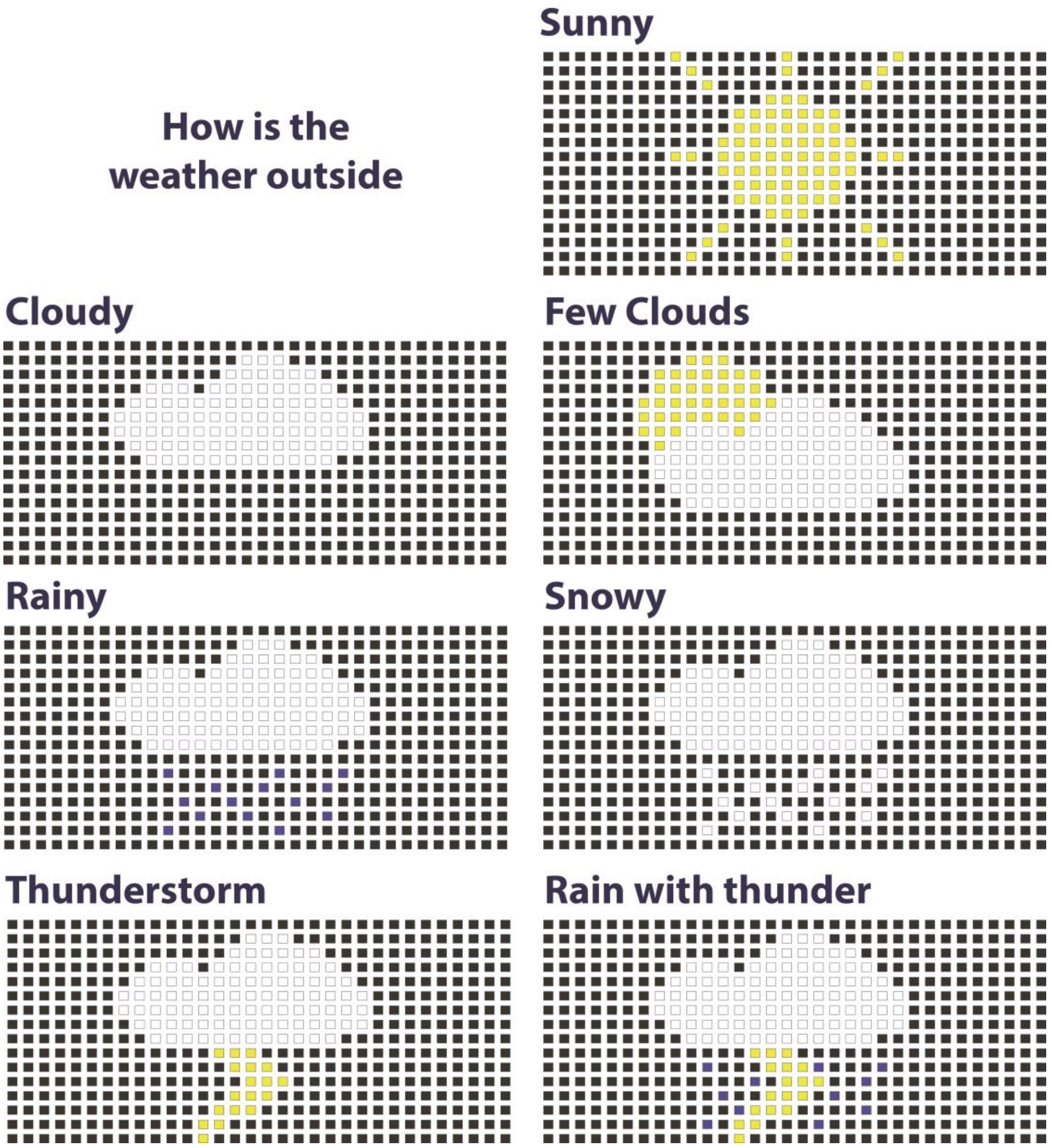
The same applies with noise: if a classroom is always noisy, even when the students are quiet inside it, then it’s possible that some undesired noise if coming from outside. The weather cast can be useful to people, so they can prepare themselves to the difference between the outside and inside environments.



(Fig.1 – Schematics of temperature bars)



(Fig.2 – Schematic of noise bars)



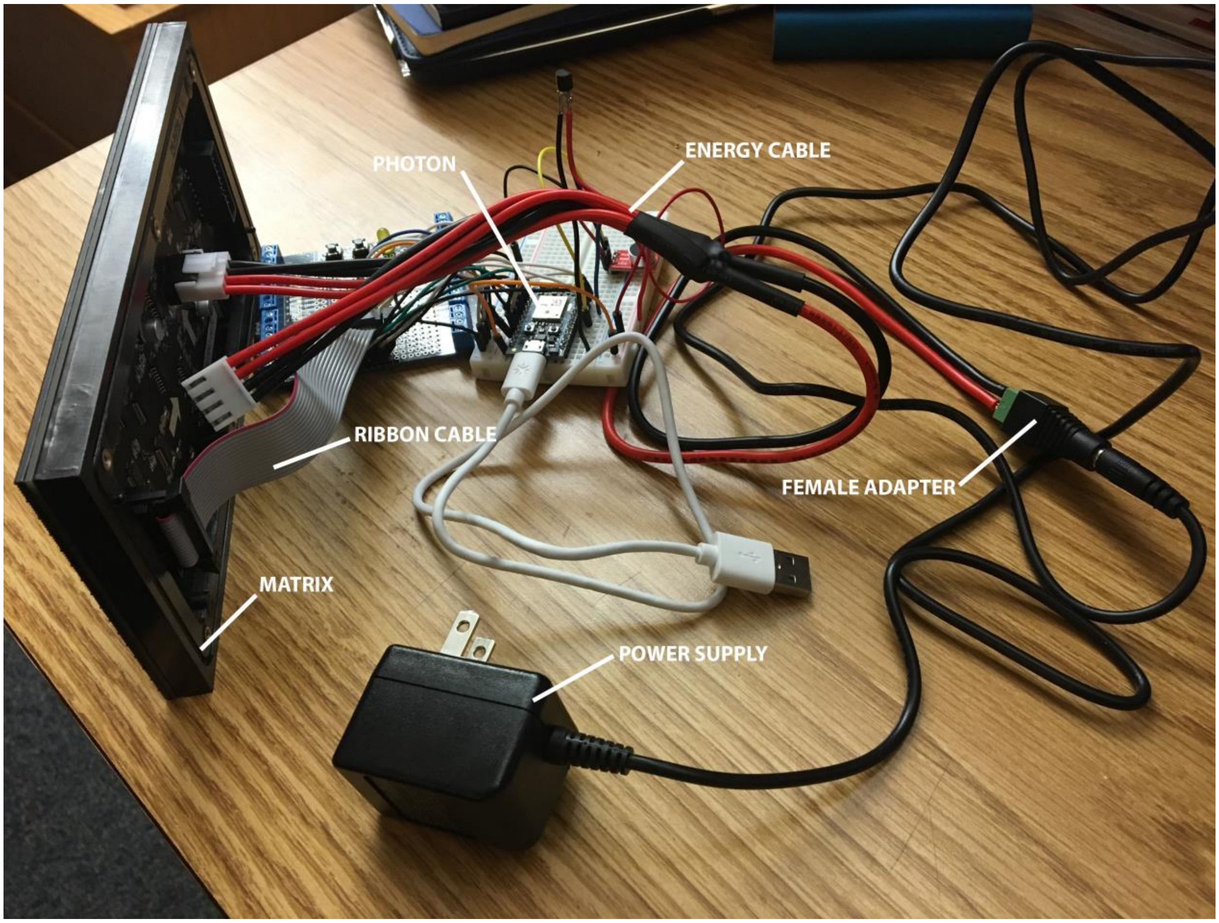
(Fig.3 – Schematic of weather conditions feedback)

Materials and Methods

To the project it was used the following materials:

- Photon - $ 19.00
- Breadboard - $ 1.85
- 16x32 RGB LED matrix panel - $ 24.95
- TMP36 - Analog Temperature sensor - $ 1.50
- Adafruit Perma-Proto Quarter-sized Breadboard PCB - Single - $ 2.95
- Electret Microphone Amplifier - $ 6.95
- 5V 2A (2000mA) switching power supply - UL Listed - $ 7.95
- Female DC Power adapter - 2.1mm jack to screw terminal block - $ 2.00
- Some wire jumpers

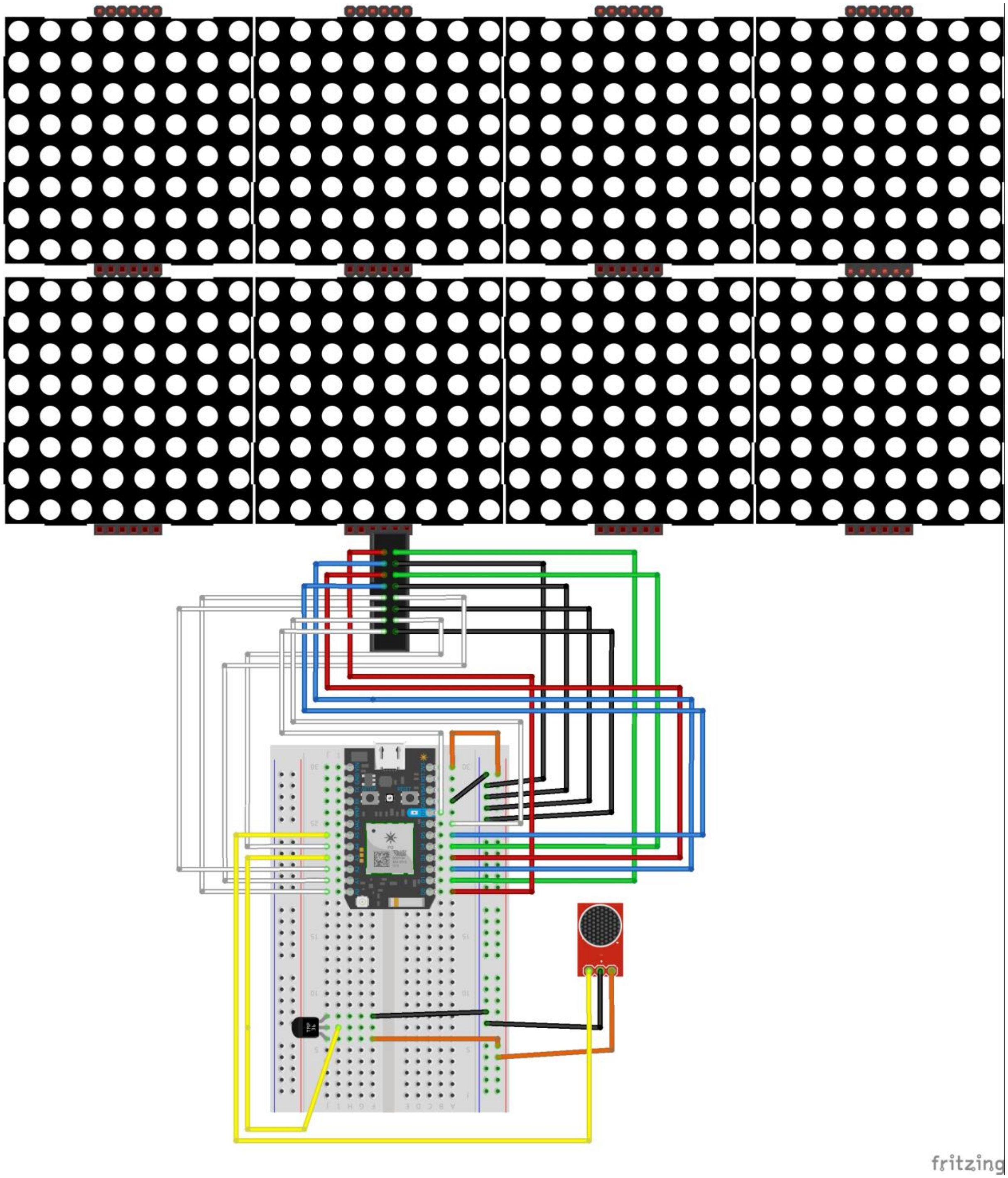
The RGB matrix works with a 5v energy input, for that it is need the 2A Power, the matrix comes with the energy cable and the ribbon cable for the input pins, but the energy cable needs the female DC adapter and the 2A power supply so it can be plugged to a common outlet.



(Fig.4 – Wiring and power supply)

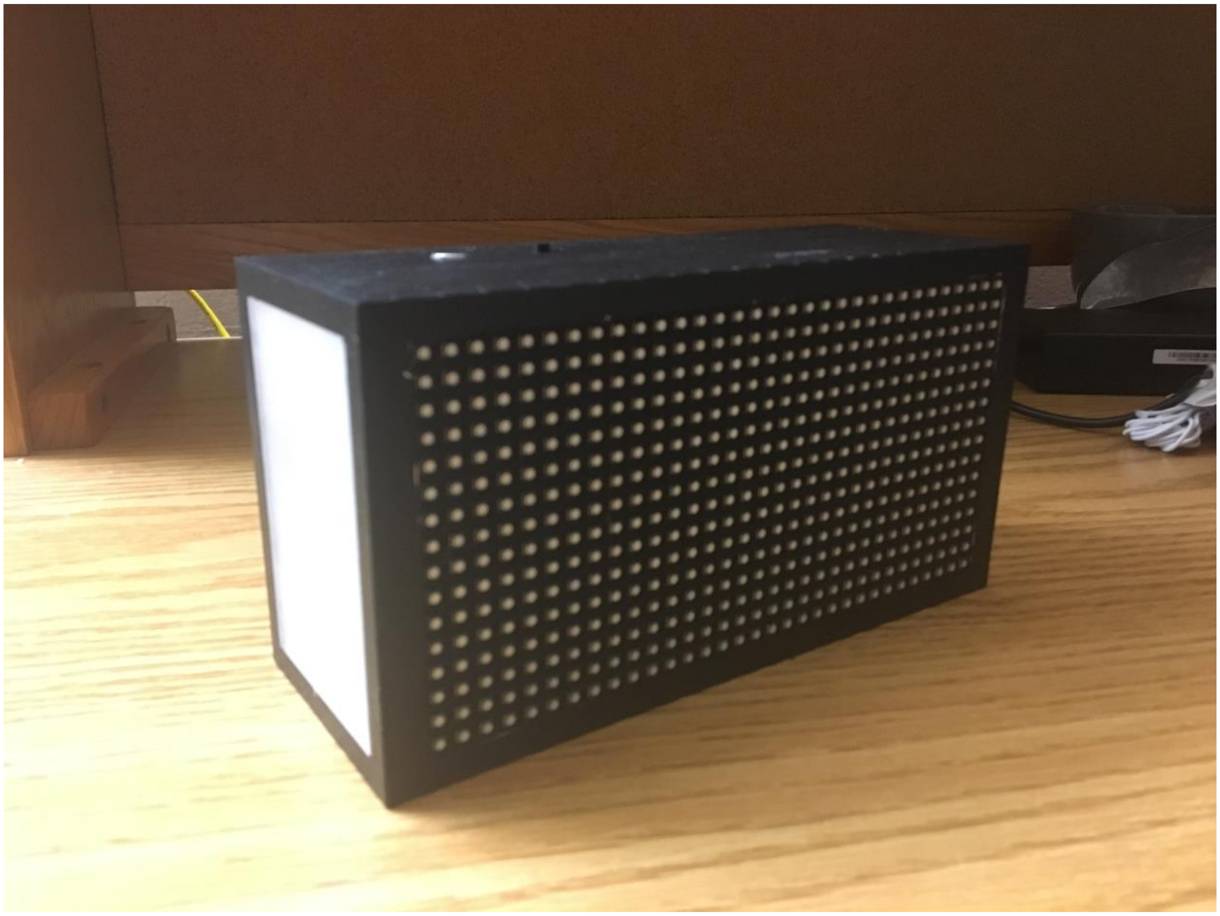
With the power supply connected, the next step is to connect the matrix to the Photon pins. For that it should be used an Adafruit Perma-Proto Breadboard, but in this case it was used an already used Screwshield. To this connection a solder is recommended since it minimizes bad contacts that can cause some failures to the matrix.

The wire jumpers connections should follow the image:



(Fig.5 – Wiring Schematics)

To go further with the main idea of user friendly interface, the robot needs a case to hide its wires and some pieces in order to make more visually appealing. The case is a black painted rectangular box made out of a 3mm plywood with the matrix in the frontal face, two frosted acrylics in the sides that makes the box resemble to crown hall. There is also a hole in the back for maintenance access.



(Fig.6 – Finalized CrownBot with plywood case)

The code consists basically in 4 functions joined in one software: one for the eye, one for the noise measurement, one for the weather cast and one for the temperature measurement. The software has a timer that chances which function is being shown after every 20 seconds.

Each function was developed as a separate software alone then tested. After debugging and solving all problems in a function it was then added to the final software code and tested again.

The eye function draws a white square with the LEDs in the matrix with a smaller black (LEDs off) square in the middle. It changes the position of the central black square to up, down, left and right randomly, making it looks like an eye looking around.

The sound measurement function uses a microphone attached to the top of the robot. It translates the reading got from the microphone and put it in a scale, the maximum value the microphone can read is 3.30 so that represents the loudest reading in the graphic (magenta).

The temperature measurement uses a temperature sensor also located at the top of the robot, next to the microphone. The sensor translates heat to voltage and the code converts that voltage to a temperature reading in Celsius degrees. The matrix shows the number translated by the code on the top of a colored gauge bar that increases as with hotter temperatures and decreases with colder ones and changes color according to the temperature. For this scale is used some temperature values of thermal comfort zones found in some studies about buildings and human thermal comfort [3].

The weather cast function is probably the most complex one. It uses a preexisting library [4] to access a weather forecast web site that gives the code a number from a table of the web site. That number represents a weather condition, the code then reads that number and has a pixel art associated to each condition (see Fig.3).

Outcomes

The robot and the code work as expected. There are, however, some issues with the transition between functions. The matrix needs to be cleared out before it shows a new drawn which can be done with the line of command “matrix.fillScreen(matrix.Color333(0, 0, 0));”. This line of coding works fine after the eye function and the sound measurement function, clearing the previous function draws before the next one comes up. However the temperature measurement won’t show the colored bar with the clear out command is used, it will only show the borderline of the gauge and the numerical value of the temperature. The weather cast functions stops working if the clear out command is used alongside it, it won’t show any drawing nether will it make any readings to the photon. That way when the CrownBot changes from the weather cast to the temperature gauge it shows both for a brief time before showing only the temperature gauge as expected. There is also a problem with the animation for rain, rain with thunder and snow. All the three of those conditions should show an animated rainfall or snowfall and although it works when the function is called to use individually, it won’t animate when used together if the other functions in the timer. The timer part of the code is probably generates a conflict with the weather function since it is made out of two functions.

Conclusion

The original concept of the project was more complex than the final outcome. Originally the CrownBot should be able to measure humidity, light and movement in addition to all the existing functions. The sensor movement would change the expression in the eye, making it look sad when no one was around. This concept was based on the idea that buildings seems to die when no one is using it and look much more lively with people inside it. However the LED matrix alone uses all of the 7 digital pins of Photon and 4 of the 6 analog pins. The humidity sensor needs a digital pin, so it was cut out from the project since there was not a pin left. The photo cell, to read the amount of light and the movement sensor need an analog pin each as well as the temperature sensor and the microphone, this way, the photocell and movement sensor were also cut out from the project, since the temperature and noise readings seem more interesting to show.

After the proper cuts in some of the robot functions what is left works as expected, except for the weather function that shows some conflicts with the timer that controls how often the functions switch, making it to show the weather only once and not allowing the animations for rain and snow.

Bibliography

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