Reflection: Transforming Movement into Light Through Wireless Communication

https://mathi330.github.io/cart360/Project/index.html

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ABSTRACT

This paper goes over the progress thus far of the project Reflection. It covers the process of making this project with the different steps taken. We will start with the initial idea and see how it changed throughout the process. We will also cover the result thus far and how it could be modified and improved further.

DESIGN NARRATIVE

The original idea for this project was an interactive environment that would transform according to the user. An idea as to how to explain the project was with the concept of aura [1], as in something unique to everybody that represents someone through light via color, movement, intensity. From there, we wanted to make the experience based on the user by incorporating sensors on the person in order to try and convey, through light, personal data based on someone's body.

In order to do that, we thought of some sensors of interest like accelerometer for someone's movement [2], heartbeat sensor, sound sensor (to see how loud someone is in a space on their own), and temperature sensor (to try and capture very small changes of temperature from person to person).

With all these sensors, we then had to think of ways to get the sensors on the person in order to get personalized data. We thought of different ideas like a vest or a bracelet, but we went with the bracelet since it is smaller.

From this bracelet, we then had to think of how to retrieve the data in order to use it in the environment. We thought of using a Bluetooth module that would do wireless communication to prevent the user from being restrained with a cable and simply wear the bracelet.

For the environment, we wanted to use a dark room with either projectors or theater lights to have light all around the room.

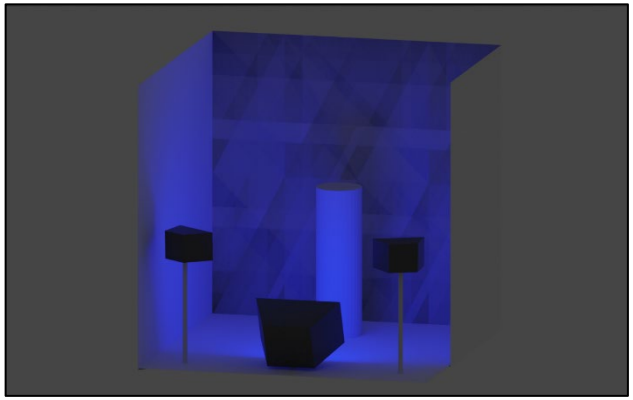

Figure 1: 3D sketch of what the room and lights could look like (using projectors).

We also thought about making the experience more immersive with sound and try to disturb the user's proprioception by using transducers on the floor.

We discussed Interaction Design Strategies to get the user engaged and willing to stay in the experience. Some ideas were:

- Time restraint, so the user would feel the need to use all the time they were

given similarly to the immersive experience infinite mirrors [3],

- Have one projector shine on a chair or bed to guide the user there, and only after the user followed the light would the lights start using the data from the user,
- Have a soundtrack that would go from everyday life sounds down to silence or low frequency sounds.

PROTOTYPE PROCESS

For the prototype, we started by experimenting with the different sensors we were interested in to find which ones were the most interesting. We quickly left the heartbeat sensor as the data we were getting was very unstable especially when the tester was moving and since we wanted our user to be able to move freely, the sensor was not interesting. The accelerometer (Figure 2) worked well and the temperature and humidity sensor was also functional despite not being as subtle as what we would have liked it to be. Another let down for the temperature sensor is that it is very slow; we can only get data every 2 seconds, which means that we have to store the data for when we don't get it. We also did not have the time to cover the sound sensor.

We then learned about the Xbee as an alternative to a Bluetooth module for wireless communication and looked at how to do the circuit and code (Figure 3).

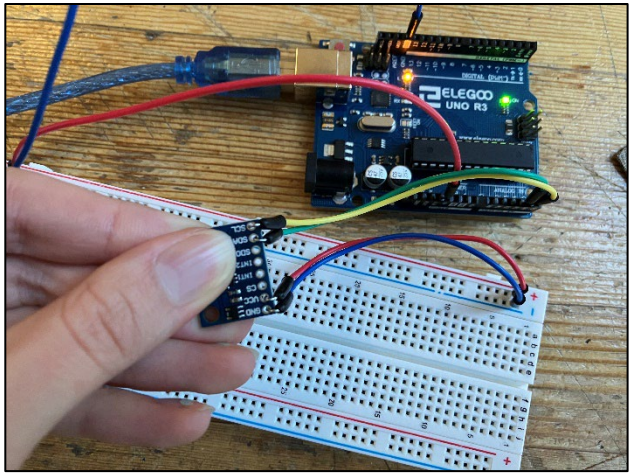

Figure 2: Accelerometer connected to the Arduino.

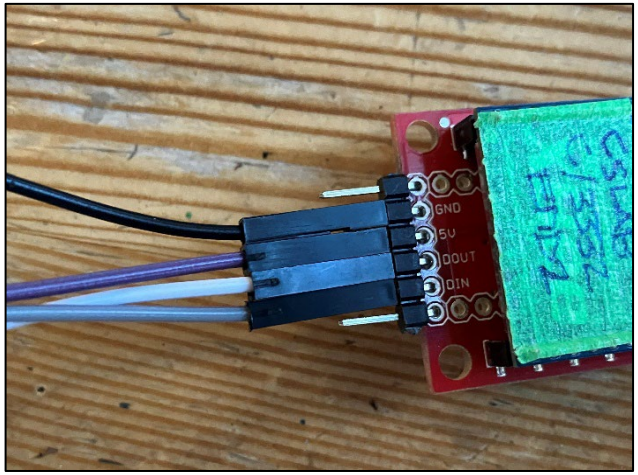

Figure 3: Wires connected to Xbee, black is ground, purple is 5V, white is digital out which can be connected to the RX port of the Arduino and grey is digital in connected to the TX port.

Once every sensor was tested on their own, we assembled them with the Xbee on the Arduino (Figure 4) and started the code for everything together by combining the individual codes. The hardest part here was with the Xbee. When sending data in the Serial monitor, we had unrelated symbols appearing in the monitors of both sender Xbee (coordinator) and receiver Xbee (End2). Through research, we realized that the problem came from the fact that the Serial monitor was trying to send the data to the monitors of the sender and receiver at the same time. We resolved the problem by using the SoftwareSerial library from the Xbee. Once the code was correctly sent over to the receiver Xbee, we put the circuit in the wristband (Figures 5-8).

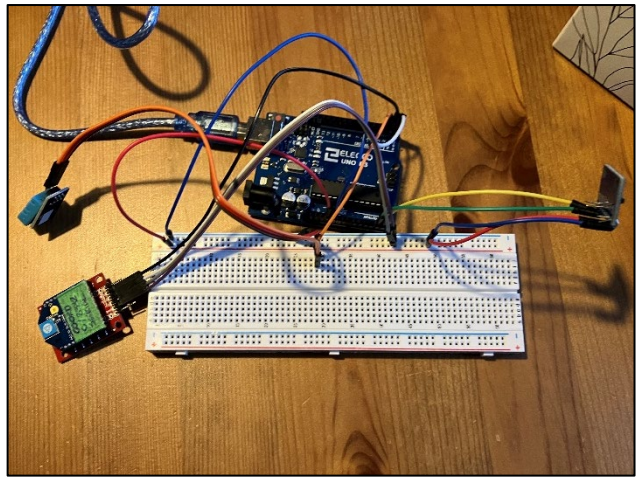

Figure 4: From left to right: temperature and humidity sensor, Xbee, Arduino, and accelerometer.

Figure 5: Cut an opening in the wristband.

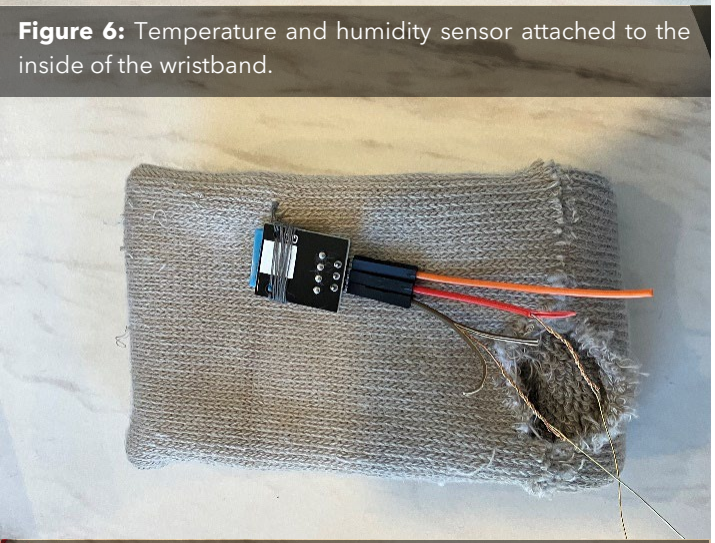

Figure 6: Temperature and humidity sensor attached to the inside of the wristband.

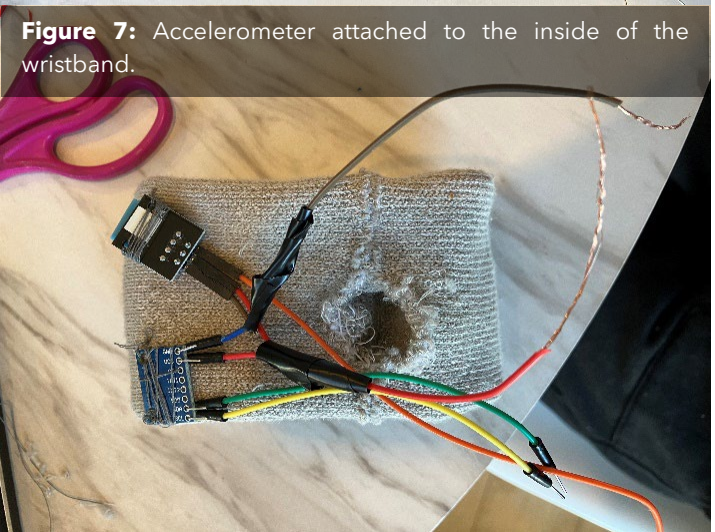

Figure 7: Accelerometer attached to the inside of the wristband.

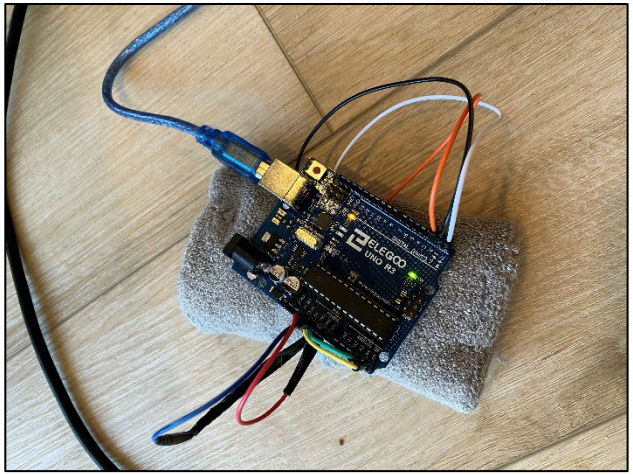

Figure 8: Arduino positioned on top of the wristband, connected to the sensors and Xbee.

Once the wristband was completed, we decided to create a simple reception circuit to give a better idea of what the final piece would do. For that, we simply connected the Xbee receiver to another Arduino and add an RGB LED to the circuit (Figure 9) and get the color of the LED to change with the wristband's data.

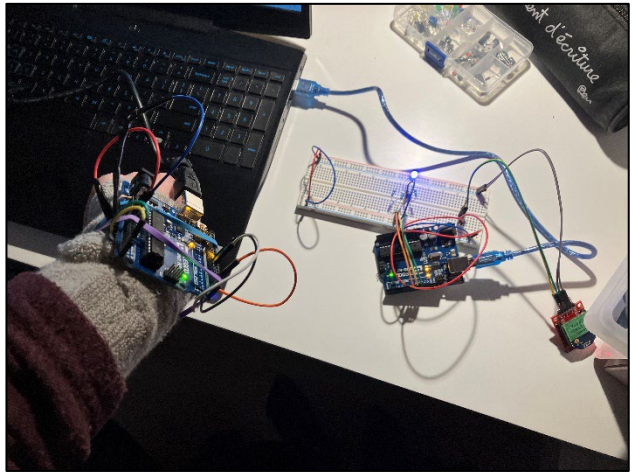

Figure 9: Setup with wristband and reception circuit.

FINAL ARTEFACT

For the final artefact, we had to retouch the bracelet, but mostly, we had to work on the reception of the data and the environment / artefact. During the prototyping process, we realized that creating a full experience was not feasible with the amount of time we had, so our idea shifted. We started thinking about how light could be sent into an environment and thought of lanterns and lamp shades as an elegant way of dispersing the light in the environment. Lanterns were also interesting because of the shape and space inside that could be used to put the Arduino and circuit without having them visible (Figure 10). We decided to go with that and bought an LED strip to put inside that would be connected to the Arduino and receptor Xbee (Figures 11-14).

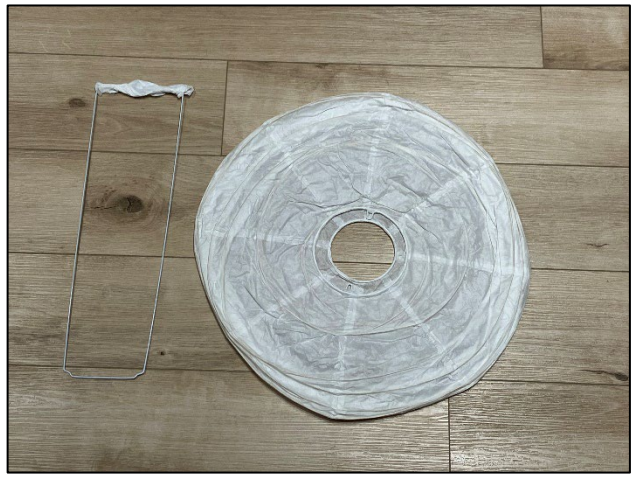

Figure 10: Lantern.

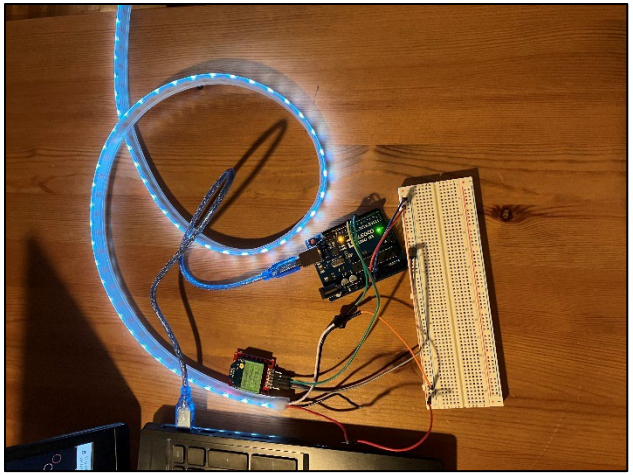

Figure 11: LED strip connected to Arduino and Xbee.

After reworking the reception circuit and code from the prototype to work with the LED strip, we used a rechargeable battery for phones as the power source for the circuit (Figure 15).

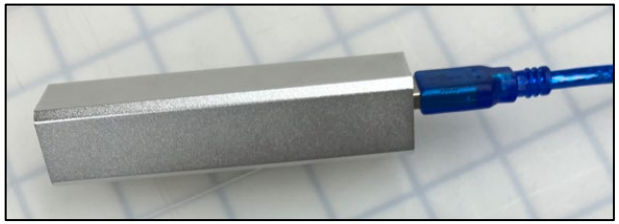

Figure 15: cellphone rechargeable and portable charger.

Once the circuit was working correctly without being plugged into a computer, we assembled the circuit to the metal frame used to hold the lanterns shape. While assembling everything, we made sure to put the Arduino, breadboard, Xbee and battery between the sides of the frame and tight together in the middle. We

Figure 12: Reception circuit attached to the lantern holder.

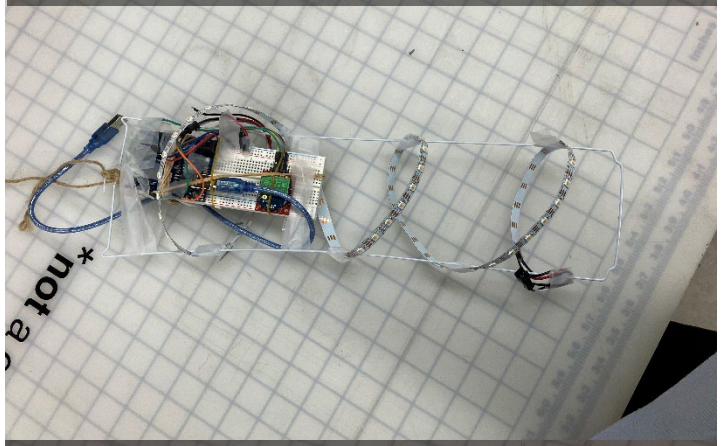

Figure 13: Reception circuit working on battery.

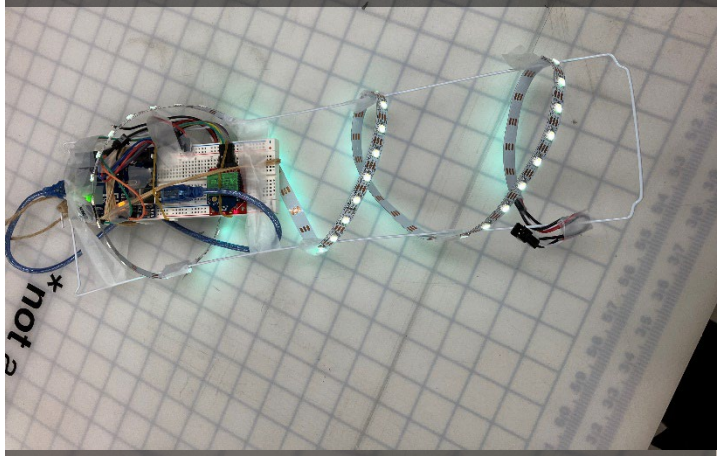

Figure 14: Attachment of the Arduino and breadboard to the lantern holder.

then attached the LED strip around it in a spiralling way and taped it to the frame. We did this to make sure the light from the LED strip would not create shadows by being directed toward the Arduino, breadboard, etc.

Figure 16: Final lantern with the reception circuit inside.

Once the lantern was completed, we went back to the bracelet. We started by getting an Arduino nano to replace the Arduino Uno that we were using previously. We needed something smaller with the same capacity in order for the sensors and Xbee to function correctly. After getting the nano, we decided to redo the circuit in a cleaner manner too. We did not have time to solder every wire correctly, so we used twistable wire connectors instead. We also decided to use a tiny

breadboard to plug the wires to the Arduino nano to put inside the wristband as it was both a simple way of connecting the wires to the Arduino and a way to prevent the pins of the Arduino to go through the fabric and hurt the user wearing the wristband.

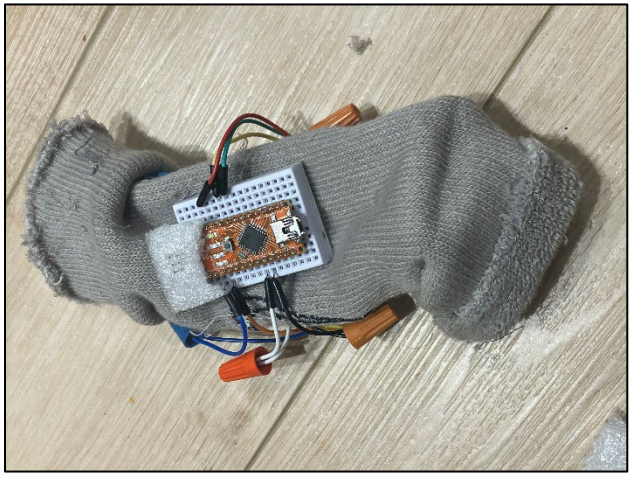

Figure 17: Wristband with the Arduino nano and the twistable wire connectors.

Figure 18: Wristband sewn with rechargeable battery.

OBSERVATIONS

We would have liked to have a more finished looking bracelet, and wanted to 3D print one, however, we only managed to get the 3D printed bracelet very late and did not have the time to transfer the circuitry onto it.

Figure 19: 3D printed bracelet.

For this iteration of the project, we managed to use wireless communication as a way to send data from one element to another. We also managed to get all the sensors working as well as the LED strip.

What did not work was more based on the design. In terms of the lantern, we are happy with the aesthetic we get when it is turned on, however, we believe we could have attached the circuitry inside it in a more elegant and durable way. For now, everything is taped to the frame in a way to prevent any shadow from showing. It would have been nice to design a pouch for the inside of the lantern to put all the electronics in except for the LED strip. This would have been more secure and made the electronics more accessible to us in case we needed to access them. For now, we have to remove the tape and tape it back together after.

We also have issues with the bracelet. First, since 9V batteries were not powerful enough to send constant data with the Xbee, we changed it for a rechargeable battery like for the lantern. However, this battery is bigger and does not fit inside the bracelet. This leads to the second issue; we cannot access the inside of the bracelet easily. To access it, we have to cut the thread used to close it. This means that if any sensor got disconnected, we would have to open it and sew it back together. Also, disconnecting the sensors can happen relatively easily: if someone has a wrist slightly bigger than the capacity of the bracelet, it will pull on the cables enough to disconnect the temperature sensor or the Xbee. Another way it could happen would be if someone stretches the wristband too much while trying to put it on. These issues would have been mostly prevented if we were using our 3D printed bracelet.

One thing that we observed after this iteration was completed was our choice of sensor. We were asked about the interest of the temperature sensor in our design. Going back to our design narrative, the goal was to use data from a user as personal information, but temperature is the same for everyone, more or less 37°C. After thinking about it, it would have been more interesting to look at other sensors or even use the humidity data of the sensor more. Humidity could have been interesting to indicate the perspiration of the user. Or use other sensors that could have measured

someone's breathing (although we don't know how we could have measured that from the wrist). We were also asked about the environment in which the user would be if we were to push this project further. If the environment was very hot or very cold, very dry or very humid, the human body would react, and we could get interesting data from the user.

FUTURE DIRECTIONS

Although the original idea of using theater lights or projectors as the source of light would still be interesting to explore, we really enjoyed the idea of lanterns. Therefore, for future directions, we would like to continue on that path by creating an environment filled with lanterns of various sizes. Going back to ideas for Interaction Design Strategies from the beginning, using sound would still be very interesting. Low frequency sounds and transducers might also still be interesting in order to completely immerse the participant in our experience. We also still think that a timer might be a good way to make the participants want to stay as long as they can.

We also thought about how to grab the participant's attention at the beginning to make them want to stay in the experience. We would like to guide the participant to one lantern by having that one lantern pulse in a white light at the beginning of the experience. Only after the user goes to that light does the data from the sensors start modifying the light.

After thinking, we also started wondering about the wearable aspect of the project.

First, should it still be a bracelet or something else? According to our observations during this project, the temperature sensor might not be the most appropriate sensor, and perhaps placing other interesting sensors on the wrist might not create the expected results.

Another question about the wearable is whether we even need it or not. Perhaps, it might be more interesting to have sensors either on the lanterns themselves, or in the environment. The interest of this idea is that the participant would not have to wear anything in particular for the experience.

These are all questions and avenues that could be taken in the future. This project changed a lot from our original idea, but the goal of an immersive environment where the user is separated from our fast-paced everyday life into a place for the self is still the same.

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