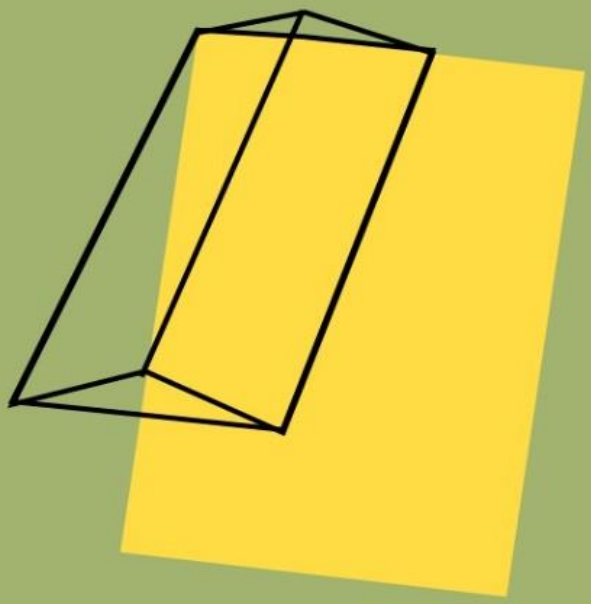
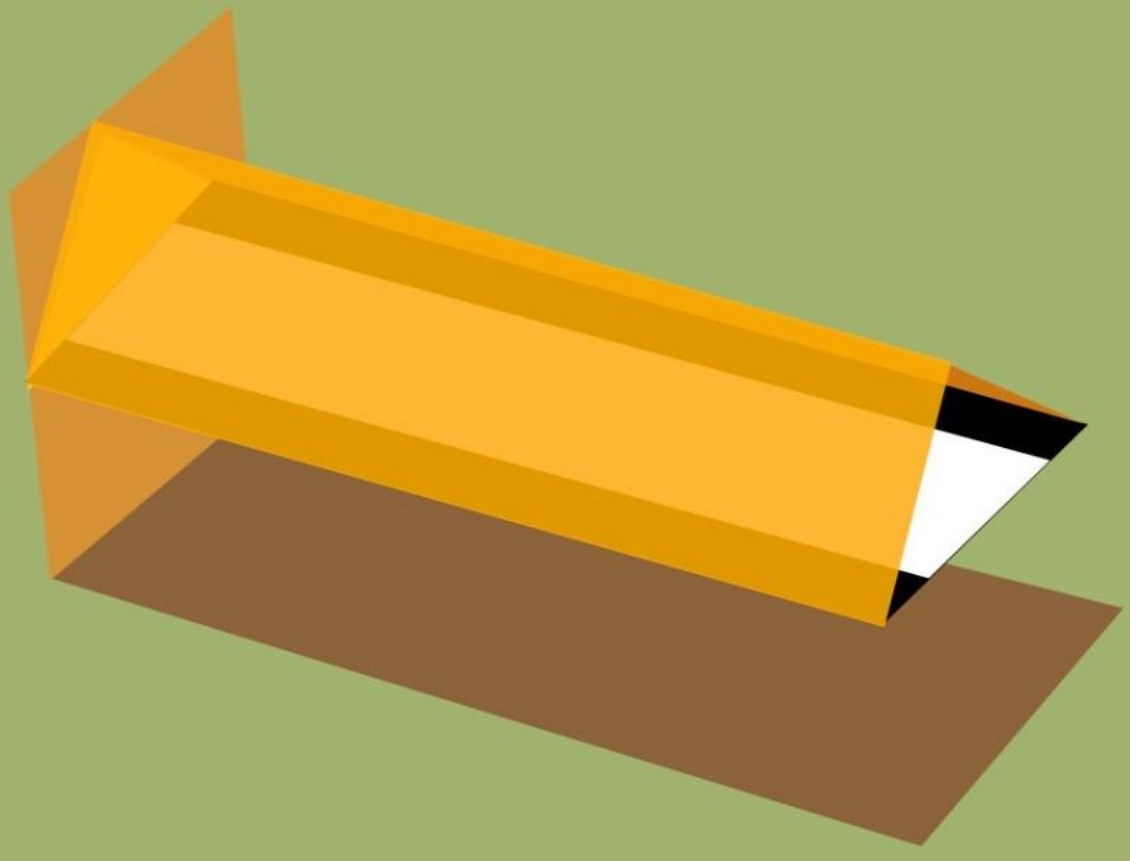
MORZ

Module 2
Smart Environments Project





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Jintana Lammerts van Bueren,
Felipe Ramires,
Baur Ongarbay,
Marina Stefanova,
Lisemijn Presser

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Abstract

During module 2 of the study Creative Technology, we are asked to work on the Smart Environments Project. This Project brings together all parts of Module 2. The goal is to develop and create a smart environment or a product for a smart environment. The theme of this year's project is Disasters.

Together with a team of 6 students, Mingqi Liu, Jintana Lammerts van Bueren, Felipe Ramires, Baur Ongarbay, Marina Stefanova, and Lisemijn Presser, in this report, we are taking the first steps towards the development of our Smart Environment.

People that suffer from physical or mental disabilities can encounter many difficulties when it comes to communicating with others. That is why in this project, our group aimed to develop a tool which makes use of a system similar to morse code, where victims of disasters, that have limited dominance over how they communicate with others, can possibly communicate with doctors, nurses or even family members. Communication happens through finger or hand movements, that are transmitted through long or short pulses, and later translated into a vocabulary that our group members have defined.

Introduction

Background Information about the project

The challenges that our team has focused on are the physical effects disasters can cause. In the

context of physical health, disasters not only do great infrastructural damage, but also individual physical impairments. Therefore, our team aims to aid victims of disasters, and more specifically victims that can no longer properly communicate with others, or victims who are physically impaired and cannot execute simple daily tasks.

The solution our team has focused on involves the development of a product that detects motion patterns. The apparatus would help victims that can execute little to no movements by transforming their small gestures into a helpful task.

Our idea is to develop a communication system using morse code where the user could ask for help by simply tapping one hand or finger over a sensor, additionally, we also thought about a product that could perform a simple task through the same motion, like turning on a light. On the other hand, we have brainstormed a more ambitious scenario where we would develop smart glasses that could recognize the blinking of the individual and help them communicate only by blinking.

This solution will encourage victims to act and perform their daily life efficiently. It allows them, to a certain extent, to express themselves and be able to connect to others. It will also make communication more effective; the individual may feel more comfortable.

Morse code

As mentioned earlier for this project, we decided to use a communication system based on morse code.

Morse code was invented around the 1830s by Samuel F. B. Mors, is often used in amateur radio or telegraphy. In the past, morse code was used to show numbers, however, it was developed by Alfred Lewis Vail which specified alphabets, punctuation, and prose. The code consists of two indentations: short indentations (dots) and long indentations (dashes). Each combination of indentations corresponds with a different letter or number, creating a language that would be used to transmit messages overseas.

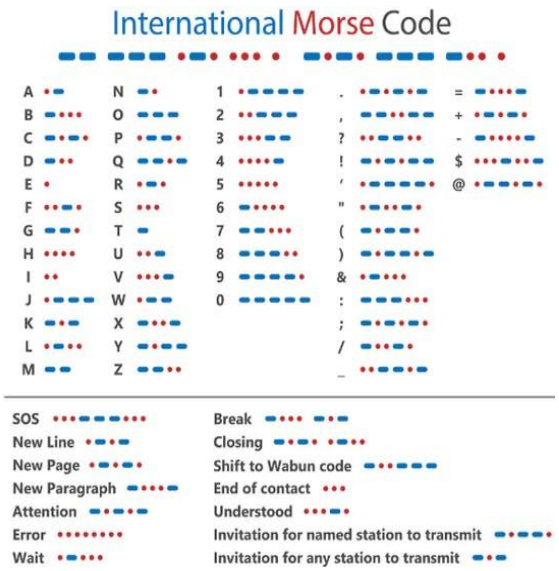

Image 1: *International Morse Code*

Image Source: ("How to Make a Morse Code Translator with Arduino - Arduino Project Hub," n.d.).

Original morse code uses spaces and long dashes while the International Morse code will eliminate spaces and edit long dashes into the standard length which is made to transfer the message faster than original code. For our project, applying the morse code method is an efficient way to establish communication between the sensors and users. (Tan, Durlach, Rabinowitz, Reed, & Santos, 1997).

HCI

Our project focuses on the contact and communication between the human and a computer, therefore researched into Human-Computer Interaction (HCI). Humans can control and link with the computer by using devices like mobile devices, consoles, and video terminals

HCI included aspects of the human perspective, perception, memory which are related to interface and interaction design. Involving an interaction with modern technology is an essential part of life, by having many various technologies, it allows people to learn new experiences on technology. The main principle of HCI is Human which is the user of the technology, the computer can access all technologies and interaction is the interaction between the user and technology. HCI is guiding the user to understand the surrounding environment which is developing the usability of the system that is communicated between user and computer. Referring to user development, the user must collect data, analysis, photo tying, design, and evaluate the usability of the interactive system. The most important senses in HCI are vision, hearing, and touching. Body movement tracking is a method that is related to HCI, it allows the victim to communicate with others by the gesture of the body movement which is responding to the doctor or nurse. In this project, we adapted the morse code into our own words by using the background of morse code. It will translate body movements into sentences often used to communicate with others. (Abdul Ashraf, Jo Vermeulen, Danding Wang, Brian Y. Lim, Mohan Kankanhalli, 2018).

Methodology

Blinking Detection – (not executed)

If we were to execute the ambitious plan for our project, to develop a program that detects eye blinking movements we would need to cover two parameters of blinking, the frequency, and the duration. The duration in blinking is the most important parameter for this project since we are using morse code to communicate. The difference in duration of the blinking will distinguish the different indentations, creating words. The same principle applies to our less ambitious project plan, using the motion of a hand or finger instead of the blinking of the eyes.

We decided to split our tasks and create 2 teams of 3 people that would split the workload depending on our strengths.

Research/ Theory / Management	Luke, Lisemijn and Jinna
Gathering materials/ Preparations/ understanding functionality	Baur, Lipe, and Marina
Data collection: Secondary	Luke, Lisemijn and Jinna
Programming + Primary data collection	Baur, Lipe, and Marina
Testing	Everyone
Analysis / Documentation	Marina, Lipe, and Baur
Preparing for the final demo	Everyone
Advertising/promoting.	Marina, Lisemijn and Jinna

Table 1: *Separation of roles*

Materials:

- Arduino/Processing
- Breadboard
- IR sensors
- LEDs
- Cables

Below is an electronics diagram of our application.

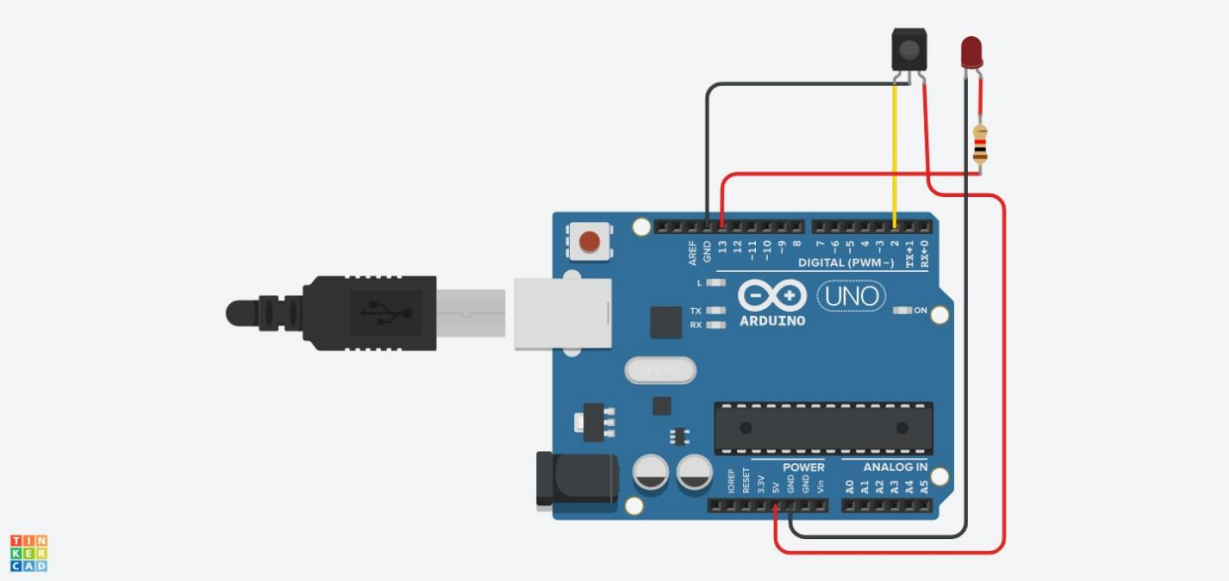

Image 2 – *circuit diagram*

Procedure

1. Research ways to build our product (sensors vs. camera).
2. Research on materials suitable for our product.
    a. research about morse code, how to communicate through morse code, the blinking detection is complex and requires more extensive research, however, we will still use IR sensors but not for the blinking detection.
3. Consult on how to program our product (Using Arduino)
4. Do research for documentation that backs up our product/ secondary data/ will help us with the construction of the program,
    a. Does the research we conducted on step 2 align with the program we would develop? → the research does not fully align with what we have developed, since the blinking the detection will not be executed, but the communication will.
5. Collect the primary data (documentation - record using a camera so it is easier for comparison) → as soon as the program with sensors is ready, we will document it
6. Program a program that will be able to analyze the movements → no longer movements, but the IR sensor will translate a dash or dot to the Arduino and translate it into helpful phrases.
7. Primary testing between the members of the programming group
8. Optimizing and improving the program based on the primary results
9. Test the program/or sensors with the whole group.
    a. We would test the functionality of our product ourselves.
10. Documentation (compared with possible secondary data).
11. Final test moments.

Execution

The functionality of our project is as follows. The main components are an *Arduino Uno, Object Detection Sensor (IR), LEDs*, and a computer where you can connect your Arduino and execute your code. We used a *Morse Code Decoder* Arduino code written by Saeed Hosseini from *Electro Peak.* With some adjustments, and sourcing the original creator, the programming team made modifications to the code which suits the purpose of our project. The main function of the original code is to read short (dot) or long (dash) pulses which reflect the dots and dashes from morse code and translate those into the letters of the alphabet. The pulses could be sent from the press of a button, or any digital input device that writes binary data to the program (on or off state). The program differentiates the dots and dashes by the time a button is kept pressed, in the case of the code we are using, if someone triggers the motion sensor for less than 0.6 seconds, it is sent as a dot, if the person triggers it for more than 0.6 seconds, it is sent as a dash. Since our project aims at aiding victims of disasters, namely individuals with physical disabilities, we developed a system where the person using the system must make little to no physical effort in trying to communicate, and that is why we opted to use *IR Motion Sensors.*

Results

As previously mentioned, for this project we decided to execute the basic scenario. That was done due to the lack of materials, time, and the Covid-19 challenges. We decided to build the Morz device for communication using the IR sensors whilst sensing the time a hand or finger is in front of the sensor, rather than building the smart glasses for blinking sensing.

For both scenarios, we constructed the Morz vocabulary which is based on morse code and can be seen in Image 3 below. The phrases can be adapted and changed according to the user's needs, so the predefined phrases are not fixed.

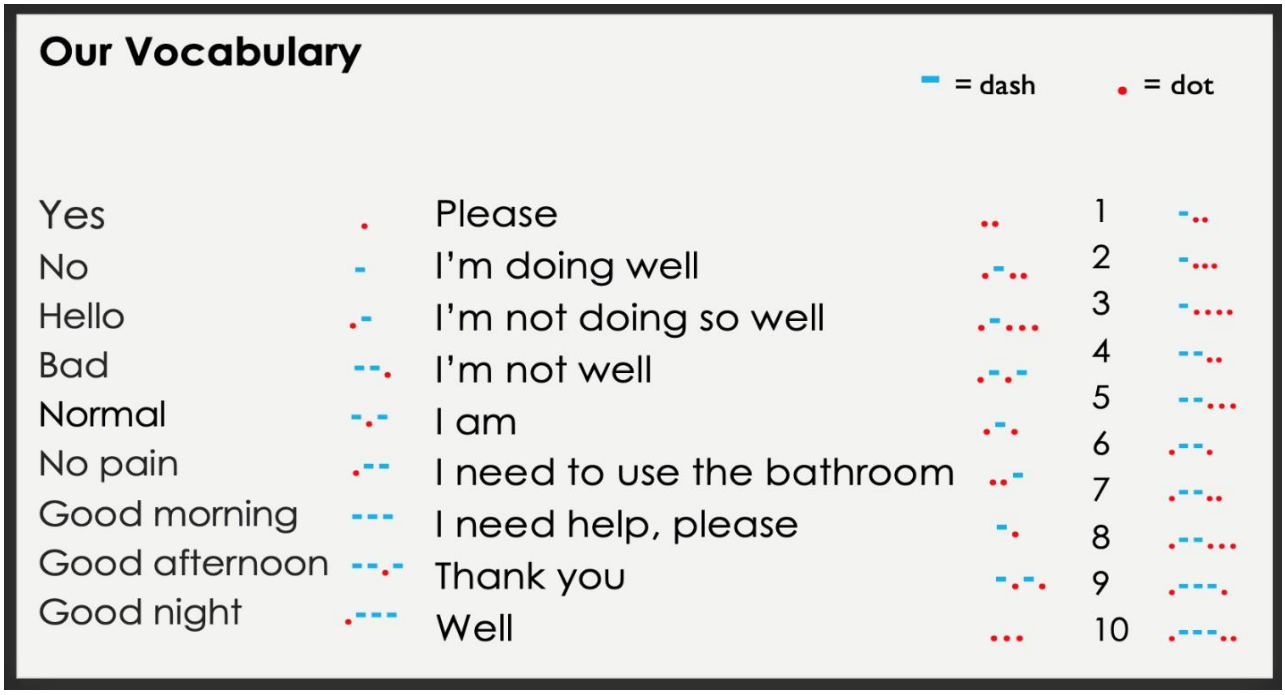

Image 3 - *Morz Vocabulary*

Our results when using the IR sensors, were as expected. Attached to the sensor, is a potentiometer which is used to adjust the sensitivity of the sensor, in other words, the sensing distance of the module. For our project, we adjusted the potentiometer to the lowest sensitivity possible, because we wanted little interference due to outside factors, therefore limiting the sensor's range would help in that sense.

It is important to note that morse code was used to deliver messages from one end to another, where the receiving end had to decode the transmission, meaning that morse code was developed in such a way that the letters needed to be recognized as soon as their corresponding morse code was received.

However, the mathematics behind encoding does not need to be considered for this project, since the Arduino code decodes the morse equivalent regardless of the characters that come before or after since we have a predefined array of words and phrases, as well as a predefined array of dots and dashes as represented in the image above. Additionally, the arrays of predefined phrases can be altered by the user, so communication is not fixed on the phrases that we presented.

We created a vocabulary where the code equivalent aims to be as short as possible for a faster response from the user. According to **image 1,** "YES", would be sent as "-. -- . …" and when compared to our Morz vocabulary **on image 3,** we use only "." as a quick response within less than 0.6 seconds, which is more convenient for the user.

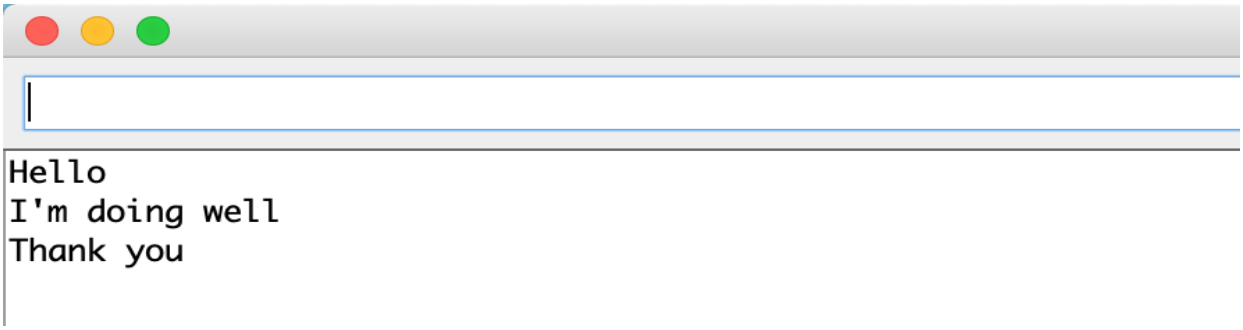

Image 4 – *screenshot of Arduino Serial Monitor (printed phrases)*

Image 4 is a representation of how the phrases and words are printed on the Arduino's Serial Monitor. Each phrase or word will be printed on a different line, however, that can be adjusted on the code, if preferred, the phrases can be printed out next to each other.

A practical issue of the product involves the timing of pulses which correspond to dots or dashes. At the moment, the program is set to interpret a dot if the sensor is activated for less than 0.6 seconds, and a dash if the sensor is activated for more than that. It is possible that, due to several reasons, that the user might not get the timing right, leading to incorrect readings of the sensor and therefore incorrect messages being displayed. The program will print out "this code does not exist" if the user inputs a series of dots and dashes that do not correspond to the code table, however it may occur that a phrase will be printed out, but it is not the one that the user wants.

Discussion

Even though our product works correctly and as it is supposed to, we need to discuss a few factors for the application of this product in the lives of people with disabilities, and in general how our solution could further aid them properly.

When it comes to practicality, we believe that the product can be very handy to these individuals. It requires little pressure or ability to move their hand, therefore it is preferable over techniques that us buttons for communication, for example. It is small and portable, therefore making it affordable since it does not require too many components. The overall performance of the product is good. There are some factors that could be improved, but there are not too many limiting factors. The functionality is straightforward, with some practice, one is able to print the messages easily, taken that the user is aware of how to manage the sensing inputs.

Additionally, to achieve the right results, it is necessary for the user to understand how the product works. The table holding the Morz codes is sufficient for the user to understand how the phrases are formed and their corresponding code, however, to get the right phrases printed on the console, the user inputs need to be in accordance to the timing of the program. So, it would be helpful for the user, if someone could possibly provide aid during the first trials of using the sensors.

When it comes to whether this product can become a market product there is room for discussion. If we simply consider the basic scenario of our project, then that could have less of a potential to become a popular market product. At its current form, it would not be suitable, but if some aspects of the product were adapted, for example making it wireless and smaller, it could certainly become a market product. However, the ambitious scenario of our project (smart glasses that recognize blinking motion), would be more interesting to the market.

The project could be executed with a button, however, with the use of the IR Motion Sensors, no physical effort, aside from moving a finger, is needed. Because of that, our project does have a limitation that was not initially regarded. Since our initial plan was to use blinking as a way in which people could communicate, it would be suitable for any person if they were able to control their facial expressions. However, our final project requires some physical dominance of either your hands or a part of your body that can hover over the sensor. So, one disadvantage of our final product is that it would not be suitable for individuals that do not have control over their arm and hand movements.

With the basic product, we slightly narrow down our potential users due to the fact that they must have certain dominance over their hand and finger movements. With the ambitious product, this small challenge would be eliminated allowing more people to have it as a choice to help them with their communication.

Conclusions and Evaluation

After evaluating our final product, our group was able to identify strengths and weaknesses. It is important to note that our initial proposal was to develop an eye blinking detection system, but

since that proved to be beyond our scope, our final product is simpler when compared to the initial prototype.

From the beginning of the project, we were interested in developing a device to aid individuals with communication. As mentioned earlier, there was an ambitious and ordinary plan for the project. We brainstormed on the more ambitious product, where we would develop smart glasses where eye tracing would be sensed through muscle movement rather than using IR sensors. At the first stages of the project, where our proposed idea was already eye blinking detection through IR sensors, the project with muscle sensors was an ambitious idea. However, eye blinking detection proved to be ambitious, and that is why our final product does not include eye blinking detection, but we base it on motion sensing.

Overall, there were several issues that we ran into with this project. As mentioned previously the eye blinking detection was an issue that we could not solve and therefore had to redirect our project. Some other concerns were the delay of products, and the unavailability of some components that we were interested in, as well as the limited opportunities for us to work as a team. Of course, most of these problems were due to the current COVID-19 pandemic. However, despite that, we believe that we were able to deliver an interesting and new idea for a product, as well as present a realistic prototype of a potential new communication device for the use of disabled people.

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