Dancing while sightless

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Abstract:

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Introductions:

The human world is designed mostly with able-bodied people in mind. It often neglects the needs and desires of people who are afflicted by various disabilities, and thus, makes life even more difficult for them. For this reason, it is important for designers to be aware of this fact and think of new designs and inventions that are made with people who are not as fortunate as they are. A devastating disability many have is complete or partial blindness. It is not only dangerous for a vision-impaired individual to live in a society that does not have accessibility features that protect them, but it is also an injustice that they are unable to partake in many hobby activities, such as dancing. With this project, our intention is to create a device that vision-impaired people can wear which uses their developed sense of touch to communicate to them a general sense of where their arm should be going. Sighted individuals can follow a dance routine for the first time by simply looking at the teacher’s movements and mimic them to the best of their capabilities. Blind people on the other hand, does not have this privilege. The only way they can learn a choreography is with a teacher that help them position their body in the right location for each move through both touch and vocal instructions, which is a slow and lengthy process. Our device does not aim to be able to give complex instructions to the user so that they can, with the tactile instructions from our object, mimic a choreography just as well as a sighted person would be able to do by watching the teacher. Our objective is to create a simple tool that can help vision-impaired dancers, both new to dance and experienced dancer who recently lost their sight, to not feel as much difficulty due to not being able to see and to expedite the learning process with silent and simple instructions that take some efforts away from the dancer and the teacher.

Materials:

Our object consists of six vibration motors, six transistors, seven 1000Ω resistors, one wristband, one button, some sewing lines, some pieces of felt, electronic tape, many wires, five small braided elastic bands with Velcro straps, one large braided elastic band with Velcro straps, soldering iron, one ADXL337 accelerometer, one radio \_\_\_

Affordances:

Our project is designed to be comfortable to wear, easy to put on and take off, and, because accessibility is our priority, wearable for people with any size of the hand and can be worn on either the left or right hand to accommodate for left and right-handedness, user preferences, and potential missing limbs. The vibration motors serve as both the communicators for signs and for feedback to the user. They tell the wearer in which direction out of left, right, forward, backward, up, and down their arm is to move. Afterwards, it detects for one second if the motions detected by the accelerometer are of enough similarity to the recorded example of what that move’s accelerometer readings should be and gives feedback. Either the ‘win’ response of a vibration pulse to the middle finger or a ‘lose’ response to the middle of the palm. The reasons for using touch as the only from of interaction is because blind people cannot receive visual feedback and their auditory sensors (their ears) are focused on paying attention to the music. Smell and taste are not senses our project can interact with in any meaningful ways, thus the only reasonable sense to use is touch.

Research:

In our original team one three, we had a chat discussing what kind of project we would be interested in making. Out of all of us, the idea we found the most interesting was the idea of a device that can help blind people to dance. All members of our team are interested in dance, and we all have had various experiences with dancing, either in school or in hobby groups. To find out how we can accomplish our goal, we researched dancing for blind people. We found out that there indeed are blind dancers like Mana Hashimoto and organizations that host classes for blind people like The Blind Dance Company. Their perspectives are interesting to read and one commonality amongst them is that the sense of touch is very important and is the sense they rely upon the most to help them orient around the area. For this reason, we decided to create a wearable that stimulates their sense of touch to give instructions to them regarding how to move during each segment of music. Because we all have some experience playing Ubisoft’s ‘Just Dance’ series of video games that tracks and rate the player’s accuracy using a handheld device, we decided to make our wearable also for the hand.

Brainstorming:

After our team agreed to go with this idea of a hand wearable that uses vibrations to communicate with a vision-impaired individual in order to guide their movements to follow a dance, we started brainstorming for how this will be done. At first, we wanted to make the commands as specific as possible, so that when all of the vibration motors are combined in various ways the user who has learned all of the meanings of each signal can perform complex dance moves. This original idea required the use of at least three vibration motors per finger per hand and two wearables, one for each hand. However, we quickly realized that this was not beginner friendly and had too high a learning curve to be able to use. Not to mention that it would be very difficult for us to build, as we did not possess a level of expertise with building circuits and other physical electronic components that would be required for such a task. As students, we have all learned the lesson of not being overly ambitious and biting off more than we can chew, which is why we quickly simplified the device’s design to one hand only and to six vibration motors, one for each finger and one in the middle of the palm. We recognized that this means the amount of different unique signals and combinations is much fewer and thus, the user cannot simply follow the device’s signals to perform intricate and complicated motions. However, this is a limitation that is acceptable to us, and this simplification is beneficial to better allow blind people who are new to dancing to not feel intimidated by an overwhelming amount of information and learning. Also, we wanted to create a smartphone application that allows teachers to put in the movement instructions and then send it to the blind dancer’s device so that they receive the instructions, but this proved too arduous and require advanced knowledge we did not possess, so we decided to opt for a device that randomly generated instructions for the dancer instead.

Planning:

To create our object in a way that allows us to achieve our goal of helping blind people dance, we felt the need to ask for the opinions of blind individuals on whether or not this object would be useful to them. In addition, we wanted some vision-impaired people to test our prototype and give us feedback on how it can be improved in any aspects so that its utility and accessibility can be maximized for its intended users. Unfortunately, our attempts to communicate with a local organization for the blind was unsuccessful and thus, receiving direct feedback from the project’s target recipients was no longer possible given our limited time. After deciding on our object, we started listing the components we needed. Out of what we did not have, we needed vibration motors, an accelerometer, and a sports glove. We found matching objects online and promptly purchased them. To ensure a fair and balanced workload, we divided the work amongst the three members of our group. One would do the documentation, one would do the coding, and one would do the purchases, power points, and communications. All three of us will work together to build the physical artifact.

First Iteration:

After brainstorming, our first prototype idea was a right-hand glove with the vibration motors attached to the fingertips and the middle of the palm on the outside. The Arduino would be attached to the back of the hand along with the accelerometer, sown onto the glove, and the wires were to be either sown or taped onto the glove. We added a button to the device, so that after being powered-up, the device would not automatically give commands. The user can press on the button in synchronicity with a beat of the music they are to follow, and the program would begin after four beats so that the user can get ready. While the program is running, the button can be pressed once more to stop it and go back to before it was pressed the first time. The program is coded to follow 120 beats per minute or two beats per second because it was easier to do the math for the code. We wrote the code for the Arduino, and we used a breadboard to build the circuit and test the program. At first, we did not have access to vibration motors, so we built the circuits with white LED diodes instead. The code functioned as intended, with the button starting the program and the LEDs lighting up to give randomly generated commands of either one or two directions (up and left, right and forward, down, and right, etc.). After half a second, the LED that represents the vibration motor at the middle of the palm lights up, signifying that the move was done correctly. At this moment, the code for detecting if the motion was correct was not written, since we did not yet have an accelerometer to detect and compare the movements. Thus, the program always gave the ‘win’ feedback. Pairing the program with a musical track that is 120 BPM, the LEDs and the song synchronized perfectly, and we felt we were on the right track. A while later, we received the accelerometer and the vibration motors.

Difficulties:

We attempted to install them onto our breadboard and followed online instructions for writing the code to read the values of the accelerometer. However, we ran into some unforeseen difficulties. We did not do enough research on vibration motors. We believed that they would function just like LEDs and only needed to be installed onto the breadboard, but it did not work that way. Vibration motors required more power than the Arduino was able to produce, and we needed to use a transistor for each one, something that we only learned to do later. Plus, we thought the accelerometer would be easy to read and use. The way we hope it worked was that it would detect how much it moved in each of the three axes and that we would test each motion we wanted to check for and then write in the code the amount each axes should move in which direction for them. However, the

Prototype:

On November 11, 2021, we presented our prototype in class. Because we did not know how to install the vibration motors or to read the accelerometer, we were unable to present a proper working prototype. All we had to show was the Arduino with the breadboard and the only functioning components were the button and the LEDs. There were no further interactions beyond that, as the accelerometer was not set up properly and cannot detect if the movement was correct or not. After this, we took the time to regroup and find a way to catch up, learn the knowledge we needed to make the accelerometer and the vibration motors function, and finish what we set out to do. Unfortunately. Our third member had to drop out of the class for personal reasons quickly afterwards, leaving the remaining two of us with an even greater challenge. Luckily, we gathered ourselves and planned weekly meetings and work sessions to complete our project, undeterred by these obstacles.

Second Iteration:

For many weeks we worked on soldering the

Final Version:

Future Developments:

Our device can be further improved. An easy improvement would be to have an interface where the user can select the beats per minute that they want rather than go along with the hard-coded one beat per second rhythm. This can be done with a number pad attached to the wristband of the Arduino and a speaker that tells the blind users what beats per minute in which the program is currently set to run. New complementary parts can be created to further help vision-impaired people follow along with dance choreographies. A second copy of our object can be created for the second hand and radio communication capabilities programmed into both of them so that the user can receive instructions and feedback for both arms. It can be iterated further with another part for the torso area and two more for the legs. With both hands, legs and the torso being given instructions and feedback, the user can receive even more information and follow a dance choreography even more fully and accurately. Of course, this would require that there be a way for the teacher to send instructions for a whole choreography into each of the parts, which will require an easy-to-use application where moves can be selected and sequenced by the teacher, transformed into code for the vibration motors of each Arduino, then sent to them, where they will work in a synchronized fashion.

Conclusions: