Midi Marko

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Description:
Midi Marko is a gadget to map dance movements to musical notes
to enable “reverse” choreography.

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Promo Video: http://www.youtube.com/watch?v=Kg8RJx0Xrn0

Class: ES50
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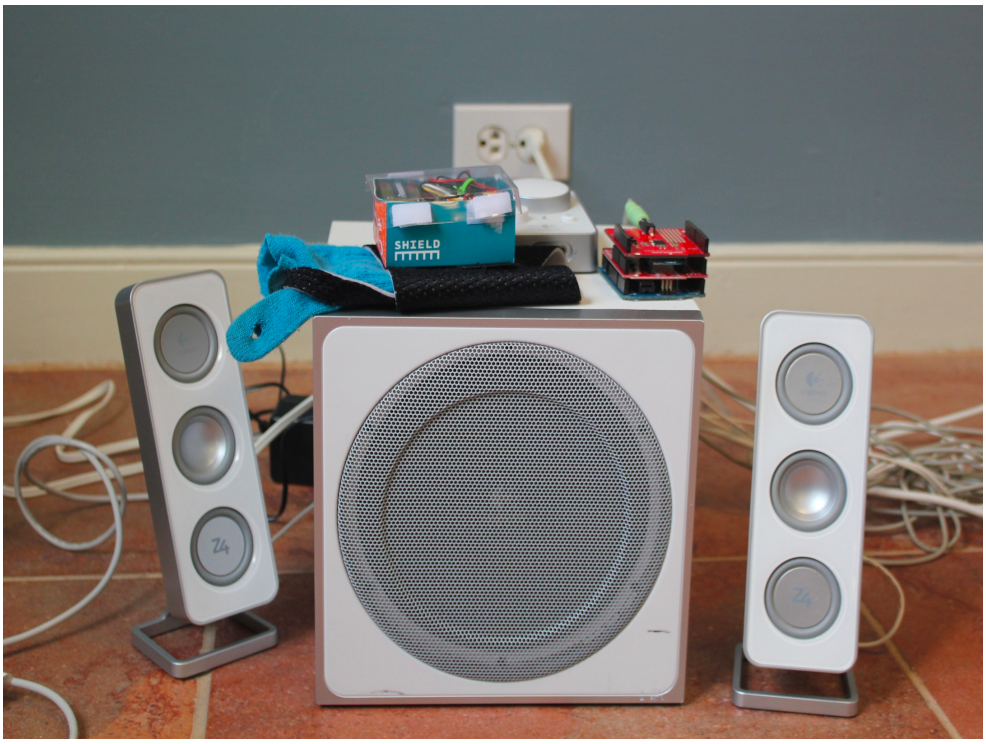
ABSTRACT

Our final ES 50 project is a modified theremin device that uses a gyroscope affixed to the hand to make music by communicating through an xBee directly to a music shield. Our version of the theremin, the Midi Marko, is a musical device that makes music based on the movements of your hand, and can be used to reverse-choreograph songs through dance.



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INTRODUCTION

The goal of this device is to create music from movement such that a melodic piece of music can be composed through choreography. By linking each note to an angle of the wrist, and each sharp and flat to a twist to the left and right, the wireless instrument attached to your hand communicates to a music shield through the xBee system, and the music shield plays midi notes into a speaker (hence the name, Midi Marko!)

DESIGN

Our final design for the wireless device used an Arduino attached to an xBee, push button, and gyroscope. The device attached to speakers uses an xBee and a music shield.

In our original plan we considered building two Midi Marko's -- one for each hand -- attached wirelessly to a speaker system. As such, the speaker could receive two inputs and we'd be able to play harmonies and more complicated forms of music. Other ideas we considered were a mind-reader that would increase the volume with more mind activity, or a wireless arduino attached to the feet to play beats (think house music) by tapping the foot up and down.

In the end, we constructed a prototype that uses one wireless connection attached to one hand, since this is the core functionality of the Midi Marko.

We also considered using lilypad Arduinos to make the device less bulky, but in the end decided that the wiring would have been much more realistic using a regular Arduino. The size does not take away from the usability of the device.

PARTS LIST

Key parts for the Midi Marko:

- 1x gyroscope-accelerometer with breakout board https://www.sparkfun.com/products/11028 - $40
- 1x xBee wireless kit with two xBees, one Explorer, and one shield https://www.sparkfun.com/products/11445 - $94
- 1x music shield https://www.sparkfun.com/products/10587 - $30

Additional standard parts used:
Push button, Arduino Uno, wires, resistors, cardboard and plastic enclosure, 9v battery, cotton gloves, athletic wrist sleeve

PROJECT IMPLEMENTATION

Our project required hardware and software implementation. For the hardware, we first set up the xBees to communicate with each other and with the Arduino. We also set up the music shield to communicate with the xBee and to play midi notes when directed to from a computer terminal. One of the key parts in setting up the xBee was to ensure that they were on the same Baud channel so that they could listen to each other properly. To do this, we used the X-CTU software bundle.

Next, we soldered the hardware together. For the mobile unit attached to the hand, we soldered the xBee Explorer and gyroscope-accelerometer to the Arduino. One of the critical points of the wiring was ensuring the voltages were consistent with the maximum allowed on the instruments. For the xBee, this was 3.3V, but attached to the shield, 5V. For the gyroscope, this was strictly 3.3V. Soldering was straightforward, but we encountered some problems with soldering the wires to our gyroscope, which had a very small surface area.

For the software, our goal was to link notes to certain ranges of yaws, pitches, and curls. We decided to align curls with sharps and flats, and yaws/pitches with notes on a harmonic scale. Initially, we encountered issues reading the output of the gyroscope. In particular, the yaws would not stabilize. However, with some tinkering, we were able to make it work. Also, initially we had programmed a delay in the notes to make them distinct, but the delays were longer than the time it took to change notes so the music would continue for around 20 seconds after we put the Midi Marko down! Furthermore, we could not delay getting readings from the accelerometer since it is necessary to constantly read from the FIFO buffer which the hardware writes to. However, this

issue was fixable by only transmitting note *changes*, so that continuous notes can be played until a new pitch has been activated.

To optimize the performance of the software, we added a debounce threshold to note changes. We saw that there was often a sequence of notes as the gyroscope stabilized even for slight movements. Therefore, we only changed the note when a sequence of 20 of the same note in a sequence were heard. The cycle of the accelerometer is so short that the delay was imperceptible.

Finally, we added a button to the mobile unit which enables rests in the music. We used a push button and a resistor in a simple circuit, and used a digital read on one of the Arduino pins to sense the button press or release. To transmit this to the music shield, we sent the note zero, which would be intercepted and used to mute/unmute the output. Any notes sent in the interim would be tracked so that the correct note was playing when the button is released.

One of the issues we faced towards the end was loose connections. This device is made to move, so the wires are far more susceptible to moving out of place than a standard electrical device, and this wasn't something we fully considered ahead of time. Though the soldered wired stayed in place, the ones attached to the Arduino without solder would dislodge more easily. It's also possible that there was interference with the xBee at the ES50 fair that would affect the connectivity of the wireless device. Future engineers be warned -- if you want your device to be flung around your body, makes sure your wires are well connected to the Arduino!

OUTLOOK AND POSSIBLE IMPROVEMENTS

Midi Marko's concept would have potential for even larger mass-market appeal with a few modifications. Below are some of our ideas for future possibilities and improvements before this hits the shelves:

Size. Midi Marko could be shrunk, sewn and soldered directly to a glove by using a smaller lilypad Arduino.

Range of inputs. Midi Marko could take inputs from two hands instead of one, and volume could be controlled through acceleration or even through mind waves or foot movements.

Diverse range of sound. Buttons on the Midi Marko could change the instrument of the notes, and even the scale type (from major to jazz to pentatonic) for different styles of music.

Move off xBee. Future Midi Marko's should use a more reliable connection, such as direct bluetooth to speakers.

ACKNOWLEDGEMENTS:

We would like to warmly thank the help of Professor Marko Loncar and Professor Evelyn Hu for their continued support of our project from the design stages through the end.

We would like to thank Changlin, Ben, and Felipe for their help in lab for critical stages of the project, including help with choosing our parts and setting up the hardware.

Finally, we would like to thank Xuan, our all-knowing lab coordinator who was instrumental in helping us find all of our parts for this project.

DISCLAIMER

It is okay to share our project with future ES 50 generations! Here is the code: https://github.com/thepapaya/midimarko Feel free to use or add to it!

REFERENCES:

Libraries for gyroscope/accelerometer:
https://github.com/jrowberg/i2cdevlib/tree/master/Arduino/MPU6050

Tutorial and sample code for Music Instrument Shield:
https://www.sparkfun.com/tutorials/302

APPENDIX:

Photos A. The mobile device, with battery, xBee, gyroscope, and Arduino.

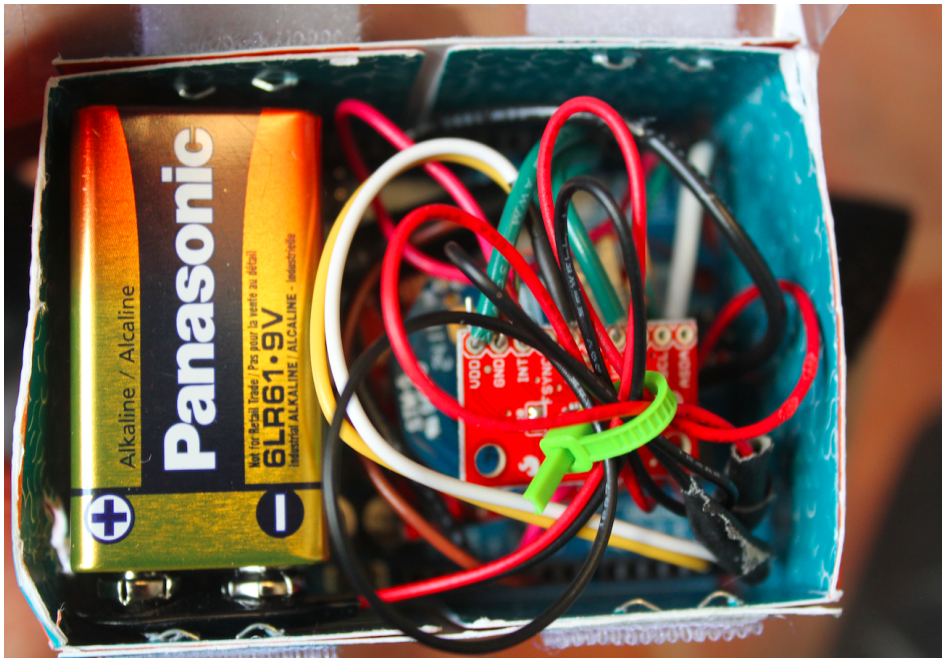

Photo B. The receiving device, with xBee and music shield.