Chantel Chan Wilson Mui Annika Tan

KEYBOARD DANCING

Robert Loggia and Tom Hanks dancing on oversize keyboards in the film "Big" (1988)

concept

Our project is inspired by the popular piano scene from 1988 film "Big" starring Tom Hanks. Our concept is to create an interdisciplinary environment that combines technology and music. In addition to film, we have found more projects based on Arduino. It also grasps the similar concept of users creating music on an unorthodox keyboard.

This project will be able to demonstrate how robots can interact with their environment. It can show some of the possibilities of robotics with computer vision. The idea of playing music with images of a keyboard may not be anything new. However, having a robot play a resemblance of a keyboard from music loaded from its camera is very different. This project takes advantage of modern technology, like robots. It makes use of innovations in fields such as computer vision and image processing.

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implementation process

When we started the project, we had intended to use a camera to read in sheet music. A Raspberry Pi was assembled with a camera onto the Zumo robot. However, we had decided against using the camera for the project, so the Raspberry Pi and its camera was unused in the end.

To begin programming for the project, we downloaded Arduino to write the code required to operate the robot. While the robot was programmed on Arduino, another part of the code used in the project was written in Python. One part of the code was used to make the robot move around the keyboard to the correct keys and play the correct notes. The Python code was used to translate sheet music (an image file) into a list of notes the robot can use.

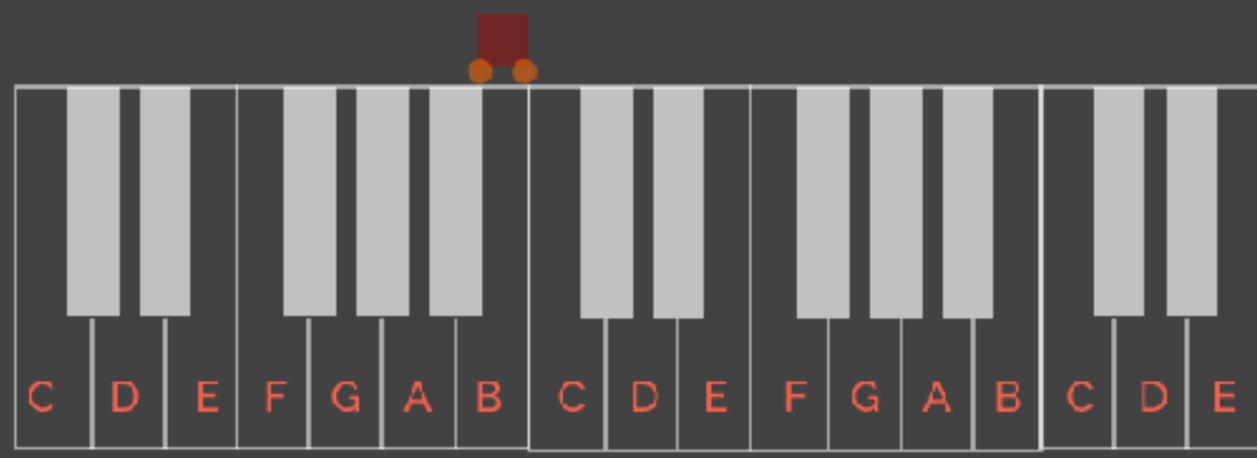
Calibrating the Zumo to move around the keyboard correctly was a challenge. Initially, we wanted the robot to follow the black line on the keyboard. The robot would turn into the key it was supposed to play. The code we intended to use did not work well with our project. It could not properly turn into a key on the keyboard, and there was no easy way to determine which key the robot was on.

Using the sensors on the Zumo to detect the lines worked a lot better. We decided to make the robot move straight forward and backward, stopping on the black keys to play a note. The position was easy to determine by counting the number of lines it passes. The Zumo can read each note and move to the correct position on the keyboard and play the note.

We also decided on how the keyboard would be represented. To test and calibrate the Zumo, the keyboard was originally made up of black tape on a whiteboard. Using black tape allowed for the robot to easily detect the lines. When we tried drawing lines with a marker, it was too thin to detect. After testing, we printed a keyboard made of vinyl that we applied on a whiteboard. The black lines on the vinyl was about 3” thick.

Playing sounds on the Zumo was straightforward. The robot is capable of playing all the notes we needed. It was simple to make it play each note in the array of notes we input. We set the volume and length of each note to be short and reasonable. We decided to make all notes the same length.

Reading the sheet music was done with the SheetVision python library. We altered the code slightly to output a text file of notes. This library allowed us to process an image file of sheet music. The code showed a graph as it processed the music sheet portraying the notes being read. When it was done, the output file contained the notes we need. We then copy the notes into the code for the Zumo.

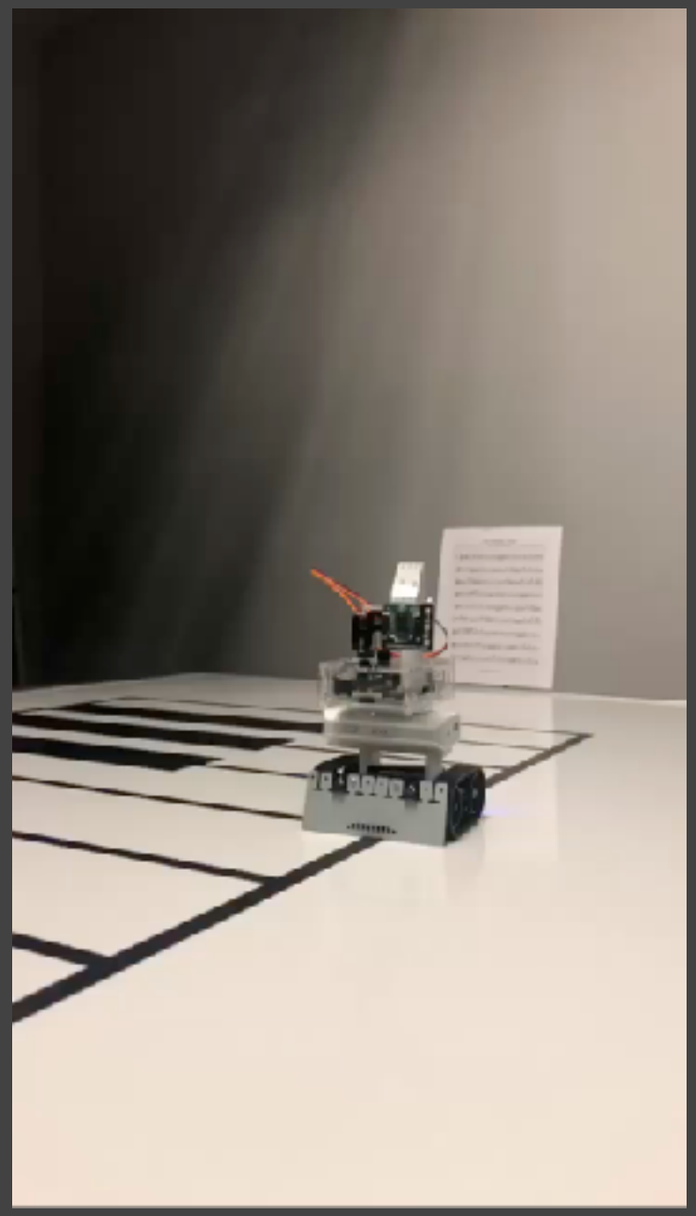


final result

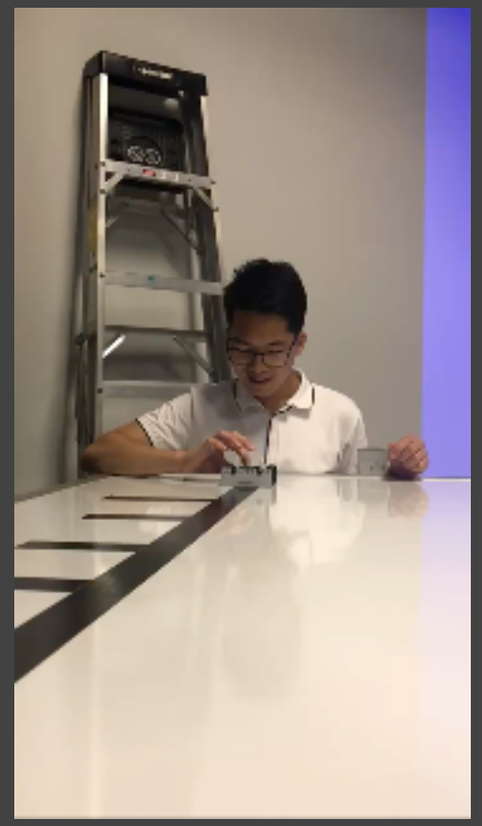
Overall, the final results of our project was successful. We were able to implement most of our factors from the original proposal. The image of the music score was analyzed through Python and output the music notes into a text file. Based on the output text file, we implemented the notes into the Arduino code. The Arduino code controlled the movements and the sensor of the robot. In our code, we assigned each music note a number for the targeted music note and the current keyboard position. In a for loop, the robot would move forward if the target note minus the current position is positive, else it would move backwards when it is negative. The sensor from the bottom of the robot is counting the intersection of the lines then plays the tone accordingly.

Although the Raspberry Pi camera was not implemented, we modified the Python code to read JPG and PNG files. These was more successful with reading music score than using the Raspberry Pi camera. The quality of the camera was not capable of capturing the music sheet with immense precision.

In the possible the future, we would include improvements with computer vision code to read music score in real-time. However, this would involve additional coding practices in Python and outside the scope of Arduino.



Video of robot performing in the final showcase

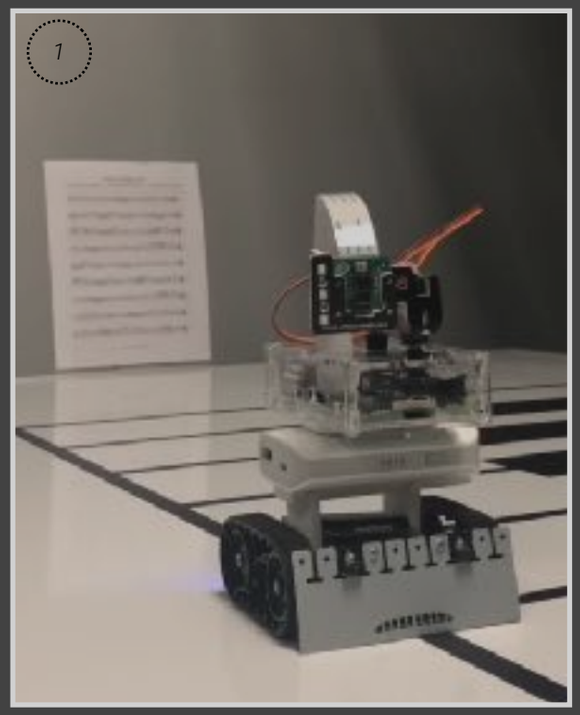


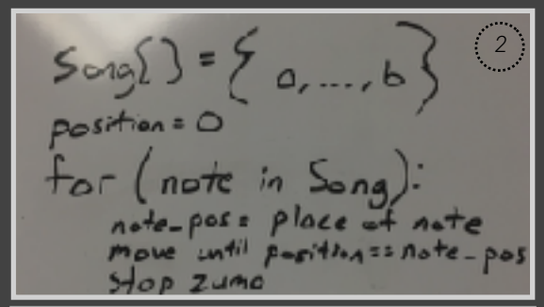
Video of Wilson testing the robot
Image of Annika presenting project

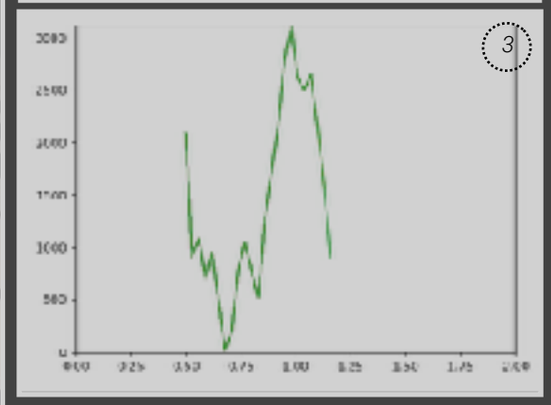
distribution of labor

Chantel took lead with implementing the Sheet Vision Python code to analyze the music sheet then output the music note in a text file. Wilson worked on the calibration of the robot using Arduino. He ensured the sensor of the robot was detecting the line and intersections. Annika worked on integrating both parts of the Python and Arduino code together. She created the environment for the robot to count music notes and piano keys.

Overall, the distribution of labor within the members was divided fairly. Each member was a part of the brainstorming and discussion process with how to create the keyboard, implement the computer vision, and utilize the robot's movement.







1) Robot playing the piano, 2) Brainstorming sample code, 3) Python analyzing music score

Wilson testing the robot's ability to detect lines