PIANOMAN

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Overview

PianoMan is a Piano education device aimed at helping beginner piano players learn the instrument with more enjoyment. Using a laptop, a Raspberry Pi microcontroller and a chain of LED matrices, it will take PDFs of sheet music of a song and transform them into a DDR-style game where notes will move down to a keyboard representing which notes to play and for how long.

Python software on the laptop will allow the user to select a sheet music pdf file. Using Optical Music Recognition (OMR), notes, rests, accidentals, will be recognized and ordered into a MusicXML file and sent to the Raspberry Pi over Wifi. The RPi will parse it and play the notes on the LED matrix while a MIDI output finds the performance score for the piece and lets the user know at the end.

Motivation

Learning Piano can be challenging for many beginner players. Being able to keep track of reading sheet music properly, knowing where the keys are, and pressing them at the correct times and for the right amount of time is intimidating at best and makes learning a daunting and perplexing task. However, music should be a positive factor on someone's life and learning an instrument should not be discouraging. Therefore, we aim to simplify this process of learning to play the piano and make it a fun experience. Piano players will be able to use a game-like system where they can take any sheet music that they want to learn and transform it so that it is easier, more enjoyable and inexpensive.

System Architecture
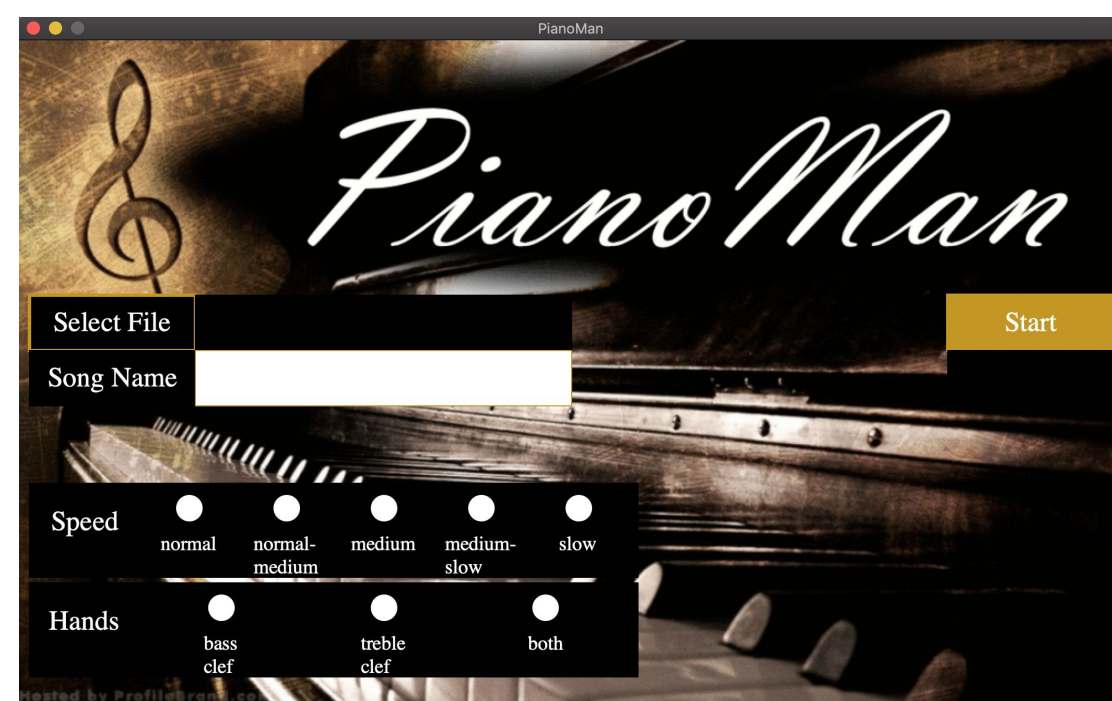
Graphical User Interface of Optical Music Recognition Processing
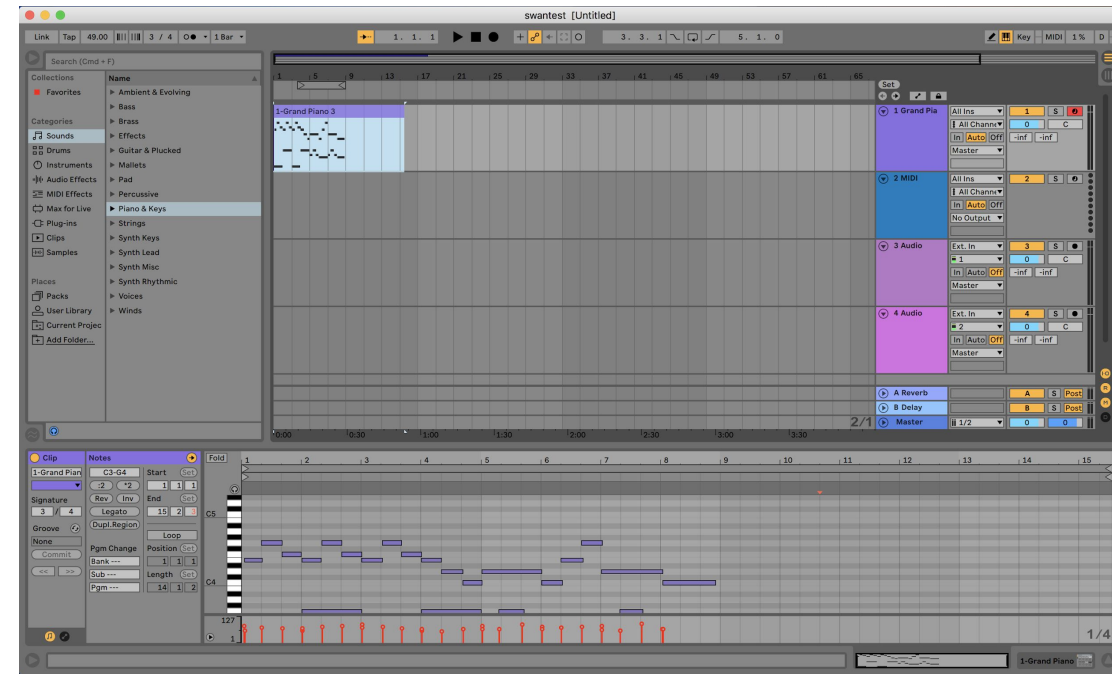
Recording Software for Performance Evaluator

**Optical Music Recognition (OMR)**
The OMR is performed by a python program using openCV to find notes, their correct duration, pitch, and placement in the piece, rests, any accidentals that occur, as well as the time signature and key signature. It then creates a MusicXML file and Start text file that are sent to the RPi over Wifi.

Hardware: Raspberry Pi and LED Matrix Chain
The MusicXML file received from the GUI is parsed and the LEDs wait for START button to be pressed to begin playing the song. After the song is played, the LEDs wait for the performance score details to be received and displayed for the user.

Performance Score Evaluator
The performance score evaluator converts the OMR's output MusicXML file to a MIDI file and compares it with the recorded user performance. It sends the calculated score along with specific number of notes in different categories: hits, miss, wrong, duration, early, and late for a detailed evaluation.
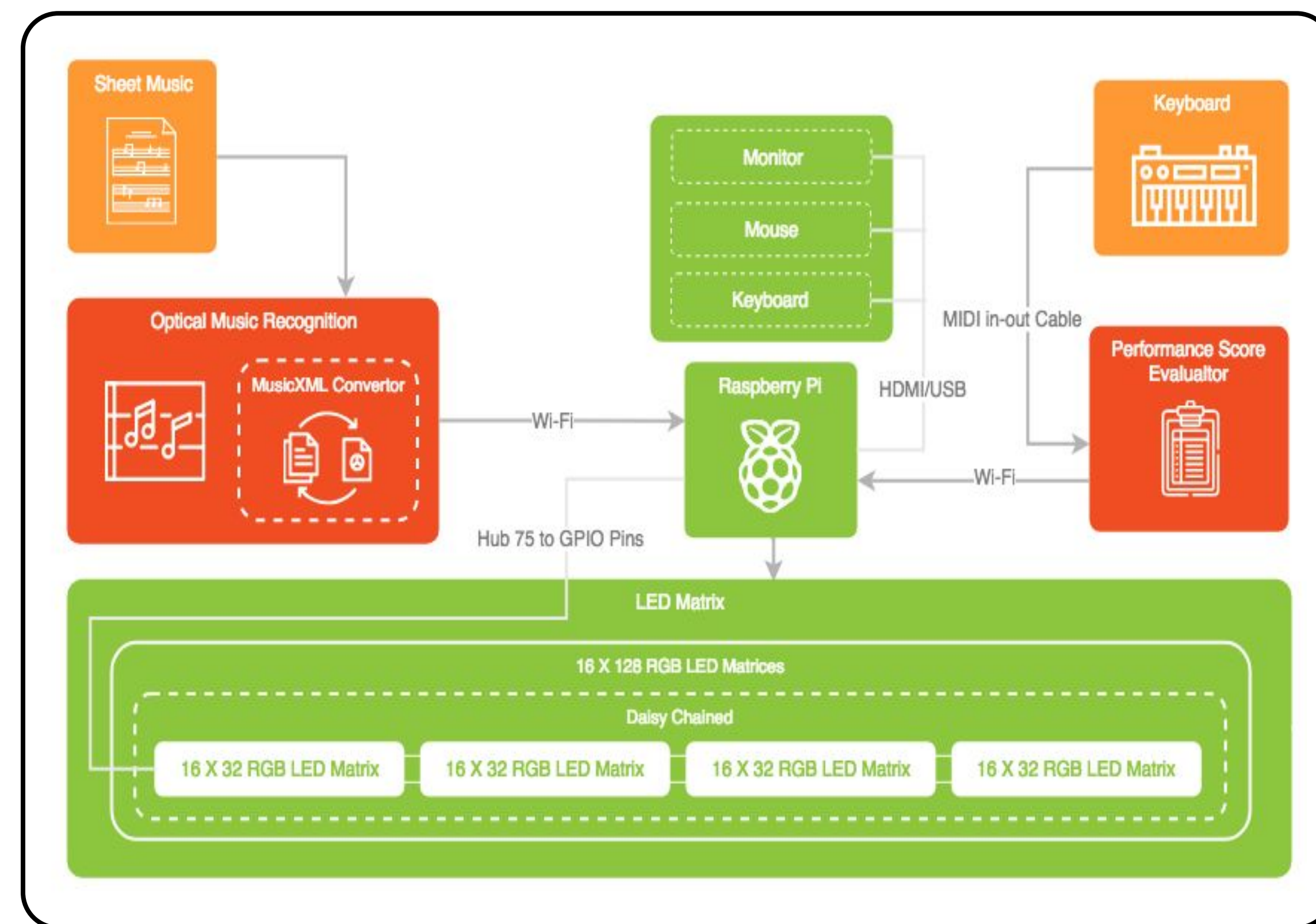
Approach

Music XML is used as a default file structure of a sheet music because we can easily get sample MusicXML files for testing different components. Moreover, its detailed documentation allows us to increase the types of musical objects to detect in OMR which makes the project much more extensible.

On the other hand, MIDI files are used to represent User Performance because there exists a Python library called Music21 that converts MIDI files to comparable objects such as notes and rests in a very efficient manner. MIDI files are used in the performance score evaluator instead of MusicXML files because recorded performance contains undesired noises which makes the converted XML file much more complicated to use.

Future Work

From the feedback of our faculty and peers, we believe that our project has so many avenues to improve the music teaching industry by adding Real-Time feedback technology to our system as well as detailing the performance score by giving more visual information about th exact mistakes in the played piece. Real-time feedback was beyond the scope of our project but we hope that given more time and budget, a system could be designed around our current architecture to incorporate that.

Evaluation

OMR: The program correctly identifies 90% of all noteheads, rests, accents (dots, sharps, flats, naturals), time signature, clef symbols, and key signature to produce a musicXML file. Complete OMR in 1 min/120 recognizable items

Hardware: Parse MusicXML files for playing within 3 seconds of receiving them. Play the notes of the song on the LED Matrices Chain with 99% accuracy.

Performance Score Evaluator: Evaluates the user performance score and sends it to Raspberry Pi within 3 seconds after receiving the MIDI file.

Additional Information