VioScribe: A Mobile Application for Music Notation from Audio

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Project Abstract

VioScribe is a music audio transcription/notation app, intended for an Android or iOS mobile device. Specifically, this app will be for transcribing audio from a violin. For increased rhythmic accuracy, a small accelerometer/gyro unit will be clipped onto the tip of the bow to detect bow direction changes. This app will be useful to violinists who want to compose music, removing the need to stop playing to write or type notation.

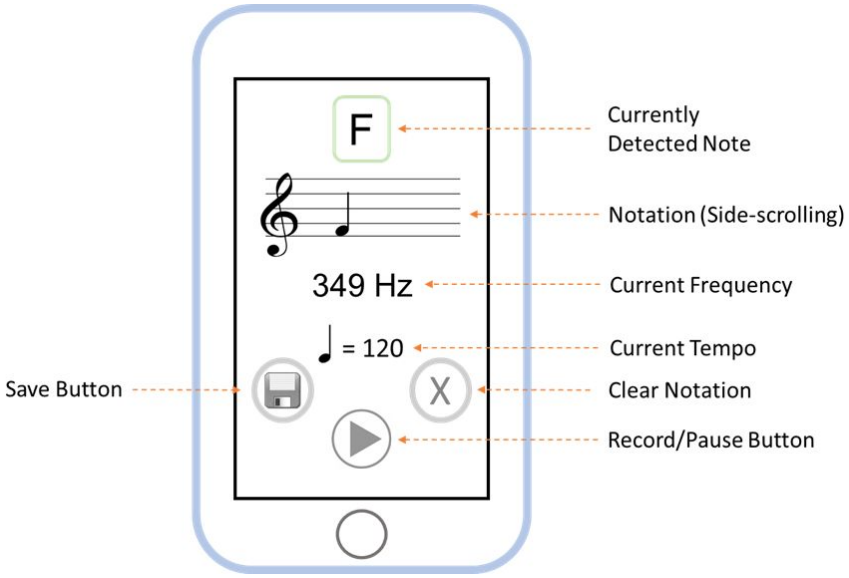
Project Scenario and Goals

Usage Scenario

While practicing, a violinist has an idea for a melody that could become the basis for a new composition. They would like to write down this melody in standard notation, however this would require that they stop playing, sit down with a laptop or a piece of staff paper, and try to translate the melody from their imagination onto the page. This can be time consuming and difficult, and the violinist would risk forgetting the melody as they write it down.

With the proposed app, the violinist could simply grab their mobile phone and play the melody, which would then be recorded and notated automatically. For increased accuracy, they could also quickly clip the motion sensing unit to the tip of their bow, which could be kept in their instrument case, for instance. This would be significantly faster and more convenient than stopping and sitting down to compose manually.

Hypothetical User Interface Sketch



Hardware and Software Constraints

The accelerometer/gyro unit must be small and light enough to clip onto the end of a violin bow without disrupting the weight and balance of the bow. It should be wirelessly connected to the mobile phone, as wires connected to the bow may be cumbersome or become tangled as the user plays. It also must be able to transfer data to the mobile phone at a sufficient rate such that it may be processed and synced with the audio data from the microphone. The microphone needs to have a sampling rate sufficient to capture audio from the violin such that frequency analysis will yield and accurate pitch.

One complaint that many users had for past attempts at transcription apps was the inability of the app to detect every note played above a certain tempo. Ideally, the proposed app would be able to detect all notes played at any tempo, but this may require an unrealistic amount of computing power. Using an accelerometer/gyro to detect bow changes should help with this, but ultimately a goal tempo should be set, where the aim of the project will be to accurately capture all notes performed up to that tempo.

Design Strategy

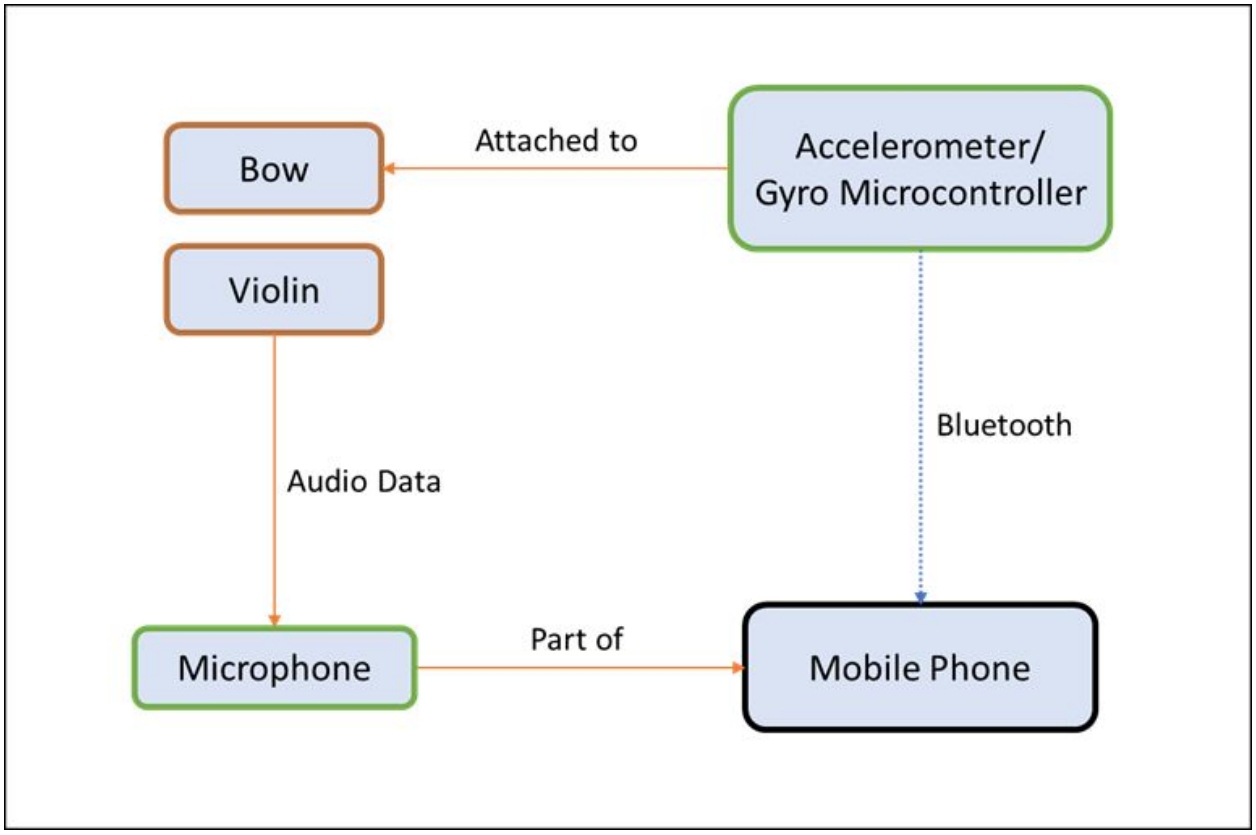
Overall Design

The design consists of a mobile device running the transcription app, connected to a motion sensor positioned at the tip of a violin's bow. When a simple piece is played on the violin, the microphone in the mobile phone records the audio, which is then processed to determine which pitches were played at which time points. Additionally, the sensor on the bow provides the app with data on bow changes, which can add precision to the transcribed note durations. The app will use this pitch information to generate sheet music - either after the player is finished or, if time allows, in real time.

Major Components

- Android or iOS mobile phone with microphone
- Bluetooth-enabled accelerometer/gyro

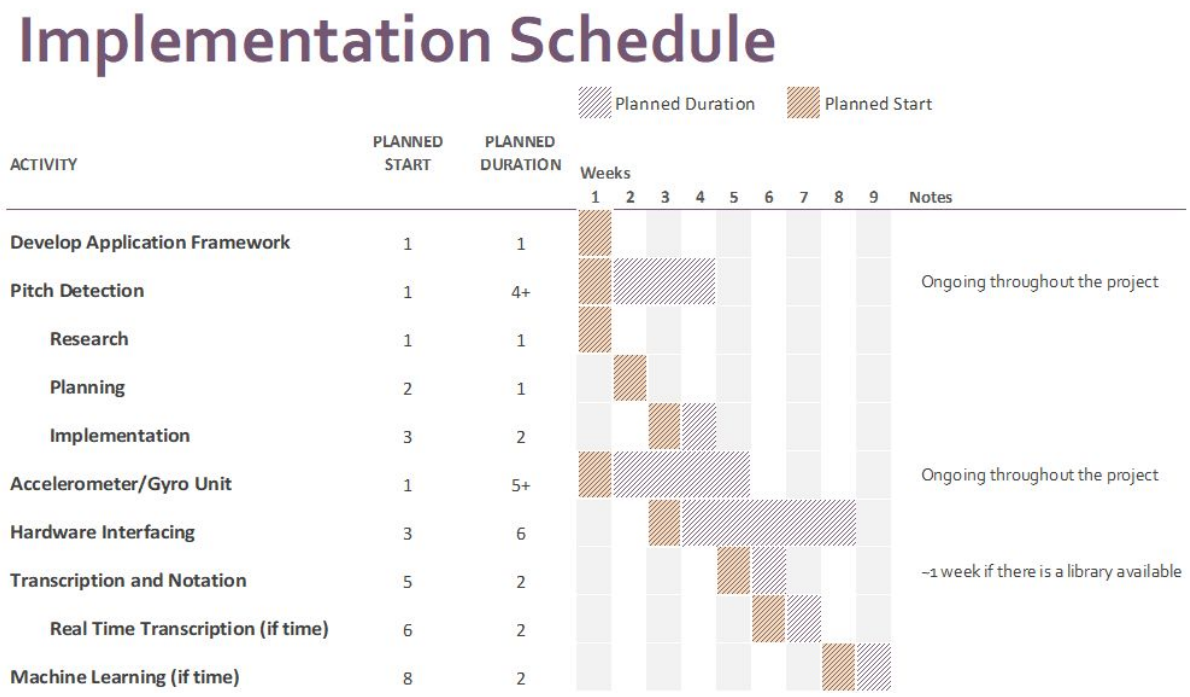
Architectural Diagram



Design Unknowns/Risks

- One group member has little to no app development experience.
- Pitch detection is known to be a challenging task, but hopefully there will be open source libraries to assist in this part of the project.
- Actually taking our pitch data and transcribing it into sheet music may prove to be a significant amount of work. Again, we hope that we may be able to find an open source library that deals with this.
- Neither group member has done any work interacting the hardware on a phone before. For our project, we may need to be able to read the data from the phone's microphone and transfer data from an accelerometer/gyro module to the phone.

Implementation Plan and Schedule



Division of Labor

At this point in time, the application framework is being developed by Jack, since he has more app development experience. Lauren will focus on research and planning for pitch detection, although both team members will be working on pitch detection implementation throughout the quarter. Lauren has experience working with microcontrollers and interfacing with hardware, so she will also work on connecting the accelerometer/gyro to the mobile phone. However, for essentially all aspects of the project both team members will contribute.

Evaluation

The simplest method of evaluation will be to play pieces of varying styles and tempos on the violin or through recordings, and then observe what percentage of the pitches and note durations the application notates correctly. We will also focus on well we can identify pitch in suboptimal environments - for example, how accurately can we transcribe a piece played on a low quality microphone, or in a noisy environment. This could be visualized in the final report as a table displaying the accuracy of transcription in various environments and at various tempos.

One particular tradeoff we will have to evaluate is the use of the accelerometer. The accelerometer greatly simplifies the work of pitch detection, since if we get it working we will know exactly when each note begins and ends. However, it brings a different set of obstacles that we will have to work through, such as actually rigging the accelerometer to the bow in a

way that isn't unwieldy, and accurately interpreting the acceleration data. This will be something we evaluate as we begin writing code. If the accelerometer proves too difficult to use, we may end up trying to make our app work without it.

Another tradeoff we are considering is the additional of machine learning for our pitch detection. While this would allow us to reach a greater deal of accuracy than we could without it, it's also a significant amount of work, and neither group member has much experience with machine learning. Currently, we're planning to tackle this with any additional time we have left at the end, but if we end up not being able to achieve a good enough degree of accuracy in pitch detection early on we may try to implement it earlier.

Related Work

- http://news.mit.edu/2006/grad-students-hyperbow-makes-music-measure - Tod Machover's research group at MIT, including grad student Diana Young, developed the Hypercello, Hyperviolin and Hyperbow to allow for enhanced musical performances. Sensors on the performer's hands, the violin/cello body and the bow allowed for precise analysis of the performer's technique and the acoustic qualities of the instrument.

- https://play.google.com/store/apps/details?id=com.musicroquis.hum_on - HumOn is an Android app with 4.3/5 stars on Google Play. The user hums into the phone's microphone and notation is generated on a staff. According to the app reviews, notes are captured with a moderate degree of accuracy, but the app is mostly useful for very simple melodies.

- https://play.google.com/store/apps/details?id=com.stringapps.capture - Capture Music Notes is an Android app that claims to accurately transcribe music. It is rated 3.7/5 on Google Play, and the reviews are generally positive, but there are some complaints about limited accuracy and an inability to capture every note at higher tempos.

- https://play.google.com/store/apps/details?id=com.bzgames.musicalair - Music to Notes is an Android app with a 3.1/5 rating on Google Play. Reviewers state that the app has issues differentiating foreground and background noise, and that the UI was difficult to use.

- https://itunes.apple.com/us/app/music-wrench/id965939820?mt=8 - Music Wrench is an iOS app for violinists that records audio and notates based on that audio as you play. The proposed app will be similar, but will also use an accelerometer attached to the bow to increase rhythmic accuracy.

Image References (For UI Sketch)

Play Symbol: http://www.symbols.com/gi.php?type=1&id=273

Time Signature: http://2.bp.blogspot.com/-vVtF-R9c2BY/UmGIm64erwI/AAAAAAAAABs/Rk-fOEz6sQc/s1600/4:4.png

Save Button: http://www.tomliberman.com/wp-content/uploads/2013/12/save-button.jpg

Staff with Treble Clef: http://3.bp.blogspot.com/-FtPP160_tcY/TWMvQrVZWFI/AAAAAAAABZs/tCTAVaqom0g/s1600/treble+clef+staff+game.png