



# Sonic Score Saxophonics

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# Use Case

- Problem: Learning saxophone, especially at the beginning, is impractical at home
  - Lessons needed: self-practice can result in undetected errors
    - Note pitch can be different from expected
- Solution: An add-on system of a saxophone to detect fingering and combines fingering and audio data to detect player errors and provide feedback
- Area: Hardware Design & Software Design

# Use-case Requirements

- Accuracy
  - Fingering collection ( $\geq 90\%$ )
    - Standard saxophone has 23 keys
  - Audio note detection ( $\geq 90\%$ )
    - Based on A=440Hz
  - Accurate feedback ( $\geq 95\%$ )
    - At most 5% miss when the user's fingering/audio input is incorrect (false positive)
  - All above based on playing in a quiet room (SNR  $\geq 40$  dB)

# Use-case Requirements

- Latency
  - Feedback given within 1s (audio and fingering feedback)
  - Overall feedback for a 1-minute playing session given within 3s of finishing session
    - Including error rate, out-of-tune feedback, and suggestions on how to improve
- User Experience
  - Fingering collection system shall not cause damage to saxophone itself
  - Detachable wired connection to a computer
  - Intuitive interface for beginner players and instructors
  - First-time setup time less than 30 minutes

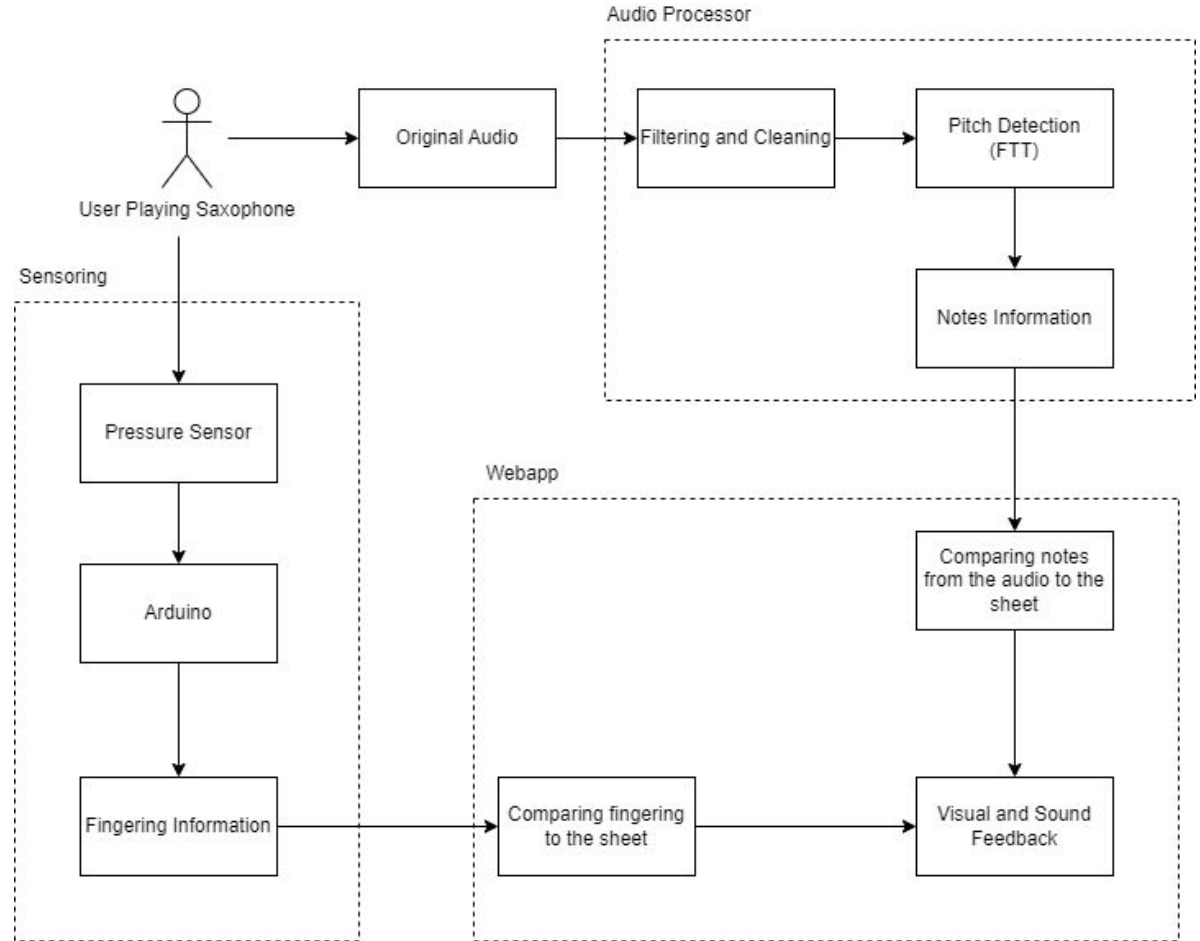
# Technical Challenges

- User experience
  - Small and light sensors that won't affect the user's playing
  - Intuitive Web App
  - Feedback generation
- Latency
  - Sensor Processing
  - Data transmission
  - Real-time audio analysis
- Accuracy
  - Sensors (fingering information accuracy  $\geq 90\%$ )
  - Audio Processing (pitch accuracy  $\geq 90\%$ )

Risk mitigation: Pressure sensor doesn't produce high accuracy-Hall effect sensors

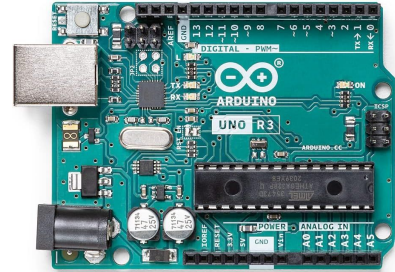
# Solution Approach

- Sensor
- Audio Processor
- WebApp



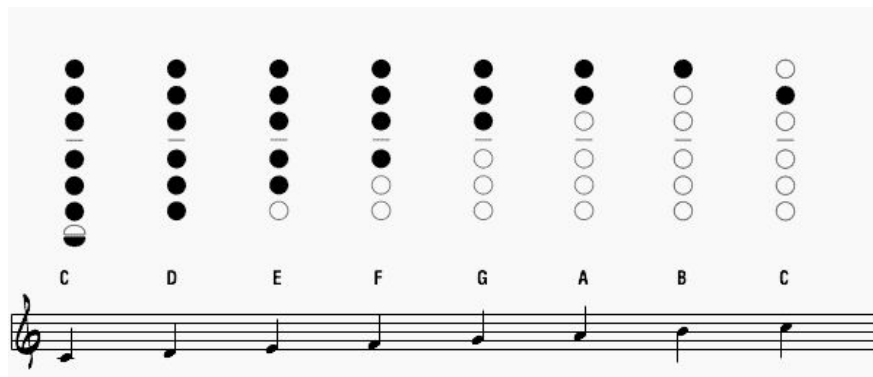
# Solution Approach - Hardware

- Pressure sensor on saxophone keys
  - Hall effect sensors
  - Thin pressure sensors
- Connection to Arduino board
- Wires attached to saxophone using Putty
  - Adhesive dots
  - Avoids damage to saxophone and hanging wires



# Solution Approach - Software

- Audio processing
  - Filtering and cleaning (Band-pass Filtering)
  - Pitch detection - Fast Fourier Transform (FFT)
- Web Application
  - Front-end construction: React



Example sheet music that will appear on the Webapp



# Solution Approach - Software

- Web App Functions:
  - A range of built-in exercise sheets
    - Each sheet contains 7-60 notes
  - Wrong fingering detection
    - Correct note sound with fingering displayed
  - Wrong audio detection (fingering doesn't match correct note)
    - Provide potential solutions
  - A built-in tuner and metronome
  - Ability to play pre-recorded recordings slower/faster without change in pitch

# Testing, Verification and Metrics

Area	Testing Strategy	Metrics
Fingering collection	Test different combinations of fingerings	$\geq 90\%$ of cases match input
Audio note detection	Use tone generator to test our system against TE Tuner	$\geq 90\%$ of cases are within 5 percent of existing tuner app
Feedback error detection	Run previous two tests at same time w/correct and incorrect combos	$\geq 95\%$ of mismatch cases detected
Latency of feedback	Play one/a series of notes and count the time for feedback generations	$\leq 3s$ for all session, $\leq 1s$ on average for one note
User testing	User survey testing finished product	$\geq 80\%$ user satisfaction

# Tasks and Division of Labor

Jordan:

- Hardware for fingering information collection

Lin:

- Audio processor

Junrui:

- Webapp design and construction

# Schedule

	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12	Week 13
<b>Slack</b>										
<b>Web App</b>										
Design and setup										
Display fingering chart										
Import API for audio										
Load exercise sheets and recordings										
Implement feedback for fingering										
user testing										
<b>Hardware</b>										
Design/Order Parts										
Build Fingering Collection System										
Accuracy Testing										
<b>Audio Processing</b>										
Data structure for audio										
Data structure for Fourier Transform										
Frequency processor reserach										
Frequency processor in Matlab										
Testing										
<b>Integration</b>										
Integrate app with sensors&audio										
Testing										
Final Product										

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