Department of Electrical Engineering
香港城市大學
City University of Hong Kong

# Music Score Page Turner

## Scan and perform!

**Team Members (Project ID: 4)**

06 Chan Yat Long Ariel | 08 Edward Cheung

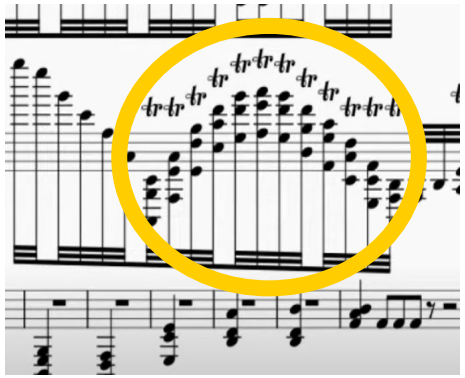
# Introduction

An automatic music score page turner for musicians. Uses Optical Music Recognition (OMR) and Dynamic Time Warping (DTW)

Demo Video:
https://www.youtube.com/watch?v=qrnlEPvXHVU

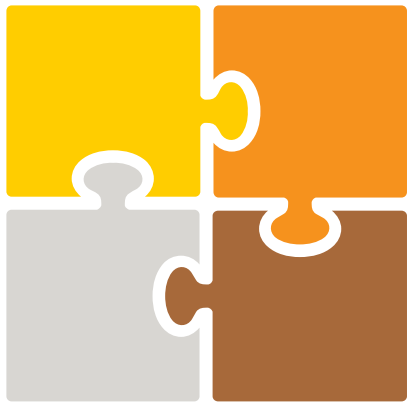
# Background & Motivation

- As music enthusiasts, we like to find sheet music from the internet to learn and play.
- However, it is annoying to manually turn a page of the score as it greatly interrupts the flow of our hands
- This problem is amplified by scores with poor typesetting. Imagine this is the end of page in a violin score



# What is the target market?

- Any casual musicians who plays an instrument
- Plans to expand the target market to professional ensembles/ orchestras as well as new learners



# Existing solution 1 — Enote3

- Enote3: A software that targets professional musicians
- Great features for professional musicians
- Automated page turning (Coming soon)
- Can’t import scores
- Expensive subscription fees

# Existing solution 2 — Page turner pedals

- Active user input
- Not suitable for instruments that already has need of using legs e.g. piano, organ
- Expensive (At least 44.99 Euros for a pedal with reasonable quality) Best Page Turners for Sheet Music in 2022: the complete review

# Existing solution 3 — OMR Apps

- Good examples: PlayScore 2, Sheet Music Scanner
- Both doesn't include realtime page turning functionality
- PlayScore 2:
  - Subscription needed (USD4.99 per month) for scanning whole pages of sheet music
- Sheet Music Scanner:
  - Less expensive (USD4.99, one time purchase), but the set of recognisable music characters is incomplete

# Existing solution 4a — Realtime Audio-to-Audio (A2A) Alignment Systems

- Github open source repositories e.g. https://github.com/Sma1033/Realtime-audio2audio-alignment
- Hard to setup for non-programmers
- Requires reference audio which might not exist for every single music scores
- Additional programming is needed for page turning functionality

# Existing solution 4b — Music Score to Audio + Realtime Audio-to-Audio (A2A) Alignment

- File formats for music scores include MusicXML, mscx, mscz … ⟶ Troublesome conversion and audio synthesis as specific software are needed
- Can't directly synthesize audio from images of music score/ inaccurate conversion (e.g. scan-score)

⇒ Unreliable/ extremely inconvenient for musicians, and they would still face countless headaches in the A2A alignment part

# Existing solution 5 — Page turning using eye-tracking technology

- Millie's Library and other e-book applications uses eye-tracking for page turning
- When the user glances at a certain part of the screen, the application turns a page

⇒ Troublesome for musicians who likes to look around during their performance, which is common for professional musicians

# Problems to address

- There is no easily available software that conveniently and automatically turns a page of any given music score
- Impromptu improvisations (e.g. transposition of melody) or unintentional mistakes by musicians during the performance may affect the accuracy of the audio alignment systems

# Our solution – Part I (OMR)

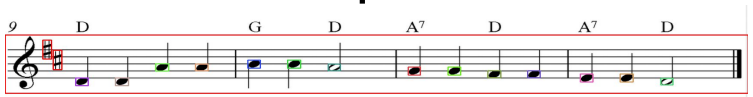
1. Using Optical Music Recognition (OMR) to extract music information from images of music scores
   - Uses GitHub - cal-pratt/SheetVision: Read sheet music and convert to midi, a GitHub Repository that runs a template matching algorithm using the OpenCV Library, generates a .mid file
   - The user can use other software to edit the generated .mid file to correct any mistakes from the OMR output
2. The .mid files are converted to a .wav files, which are used as a 'reference audio'

# Our solution – Part II (Real time page turning)

3. Real-time score following:
    - The chroma features of the ‘reference audio’ and real-time microphone input are extracted
    - Use the Dynamic Time Warping (DTW) algorithm, to compare sliding windows of the extracted chroma features, hence ‘tracking’ which part of the score is the musician at
    - When the DTW algorithm reaches the end of the reference audio of the page, the software turns a page

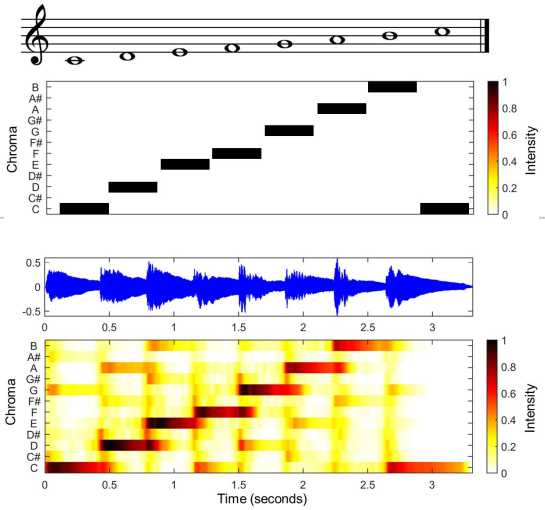
# Technical details to our solution — OMR

- Optical Music Recognition (OMR) is a superset of Optical Character Music Recognition (OCR). The goal of OMR is to teach the computer to read and interpret music scores — Wikipedia



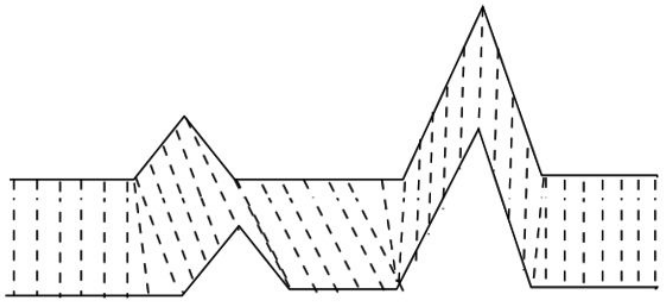

- https://github.com/cal-pratt/SheetVision uses a template matching algorithm to locate musical symbols on the music score
- Other feasible methods include using a neural network (*More in related publications – OMR)

# Technical details to our solution — Audio Feature Extraction



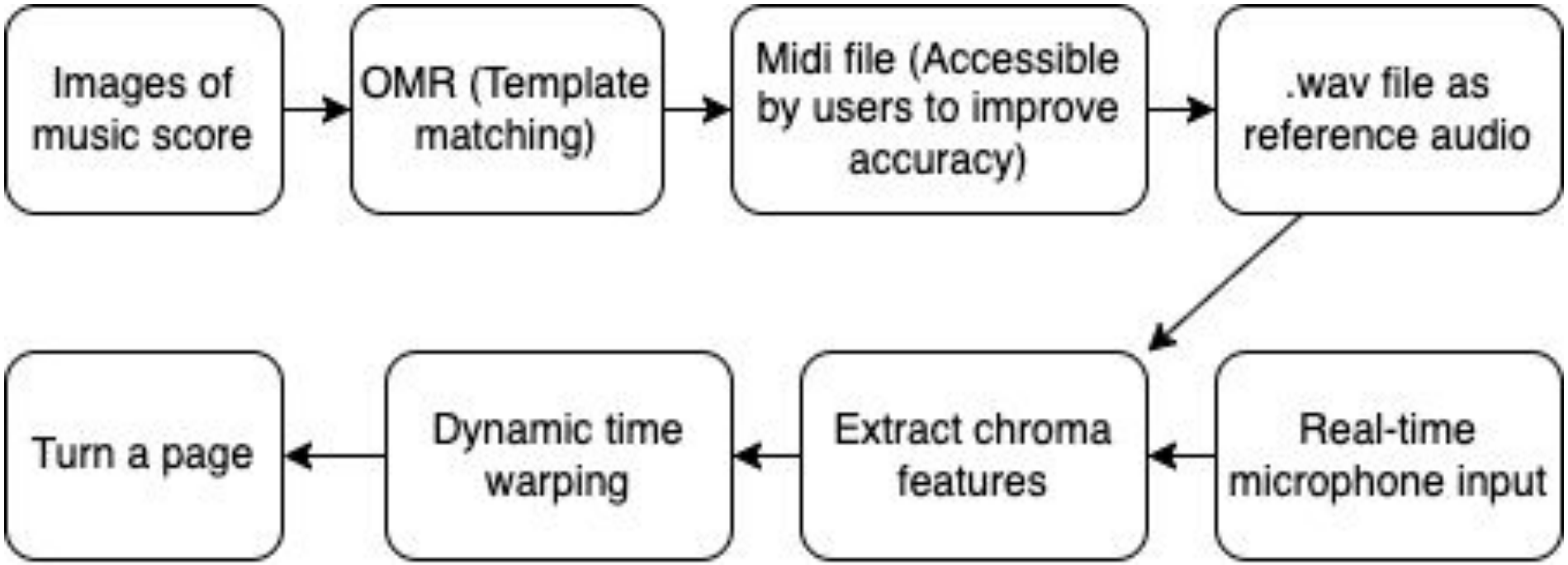

- Chroma-based features are pitch-based audio features
- In this software, 12 Chroma classes are extracted, representing 12 pitch classes in most modern western musical instruments (C, C#, D, ...)
- Chroma features captures the harmonic and melodic characteristics of music while being robust to changes on tone quality. Therefore theoretically this software works for multiple types of instruments

# Technical details to our solution — DTW



- Dynamic time warping (DTW) is an algorithm that measures the similarity between 2 temporal sequences, which may vary in speed — Wikipedia
- DTW is an efficient algorithm, hence suitable for real-time applications
- Parts of code in this software originates from https://www.audiolabs-erlangen.de/resources/MIR/FMP/C3/C3_MusicSynchronization.html

# Complete pipeline of our solution



# Timeline

## Christmas Holiday

Fininalising technical plans

## Early Jan

Completion of individual sections

Start assembling and testing

## Mid Jan

Deciding on whether need to change to other plans

Final calibration

## Late Jan

Filiming + editing for demo video

Completion of Pitching Deck Final Version

# Current limitations

- The SheetVision repository only recognizes a handful of musical symbols classes and is quite slow
- Noisy images of music score as well as loud background noises in real-time microphone input leads to low accuracy in page turning
- Right now the software can only turn 1 page, i.e. only 2-page music sheets can be fed into the software

# Future work/ directions

- Research on methods to increase the variety of recognisable musical symbol with improved accuracy and speed
- Research on improving the accuracy of DTW score following
- Preprocessing of real-time audio input e.g. noise reduction
- iOS/ Android app, with
  - Score annotation functionality,
  - In-app audio recording and playback functions, and
  - Marking and listing out mistakes during practice/ performance
- In-sync multi-device page turning for ensembles/ orchestras

# Thanks!

## *Any questions?*

**Contact details:**

- Email: cyla.hk@gmail.com
- GitHub: https://github.com/CYL-Ariel