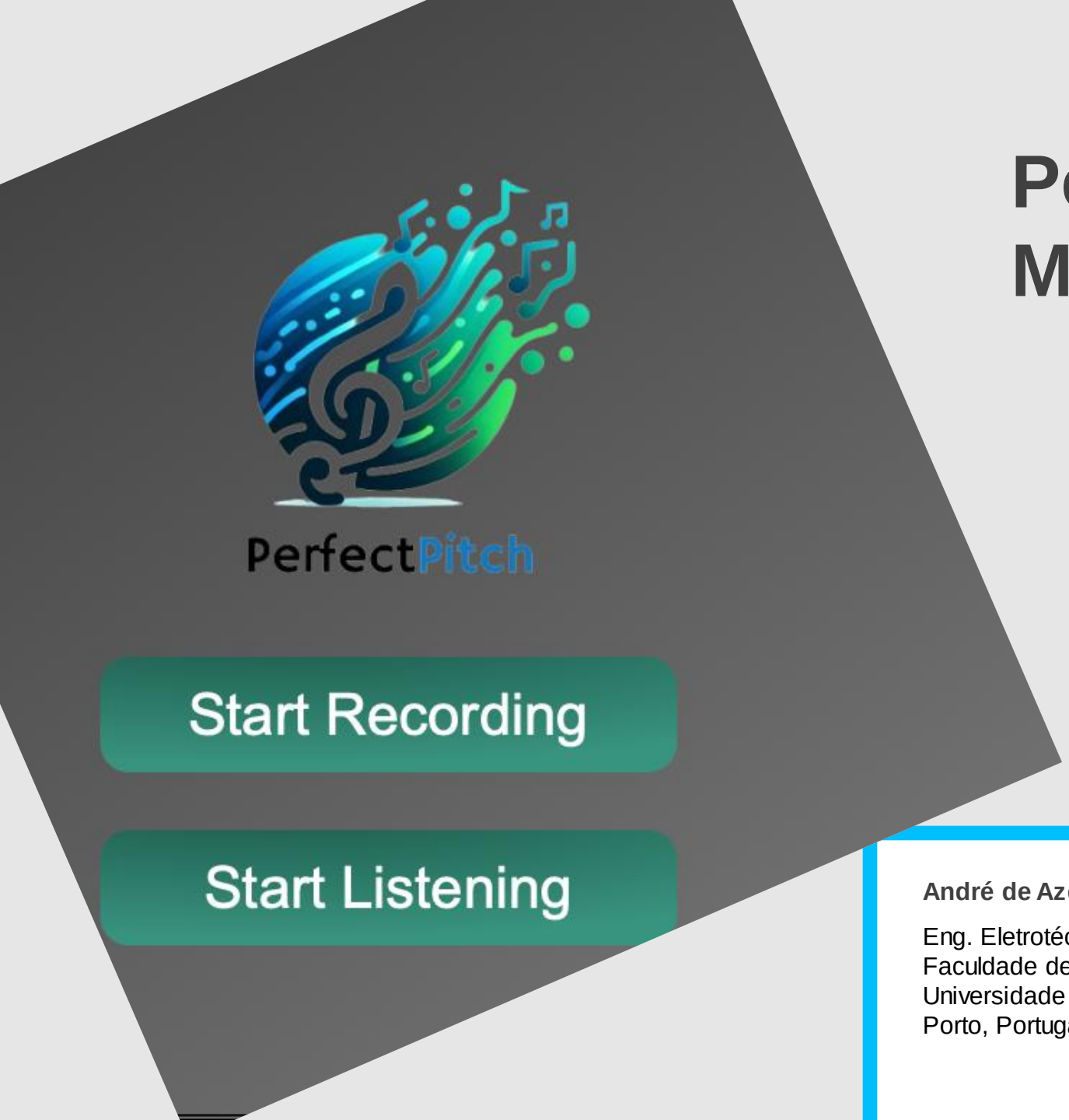

PerfectPitch – Online Melody Identifier

Computacional Áudio – 2nd. of Master in Electrical and Computer Engineering

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Index

Motivation and Objectives

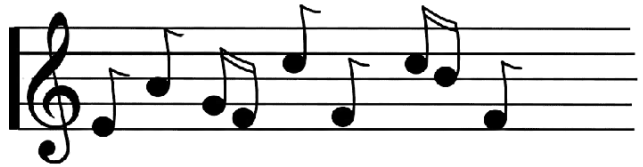
- Motivations
- Objectives

1

Motivation

Facilitating musical engagement for individuals of all backgrounds. Enhancing comprehension of processes such as the transcription of melodies and instrument tuning during musical performances without demanding specialized technical knowledge, promoting a more inclusive and accessible approach.

PerfectPitch



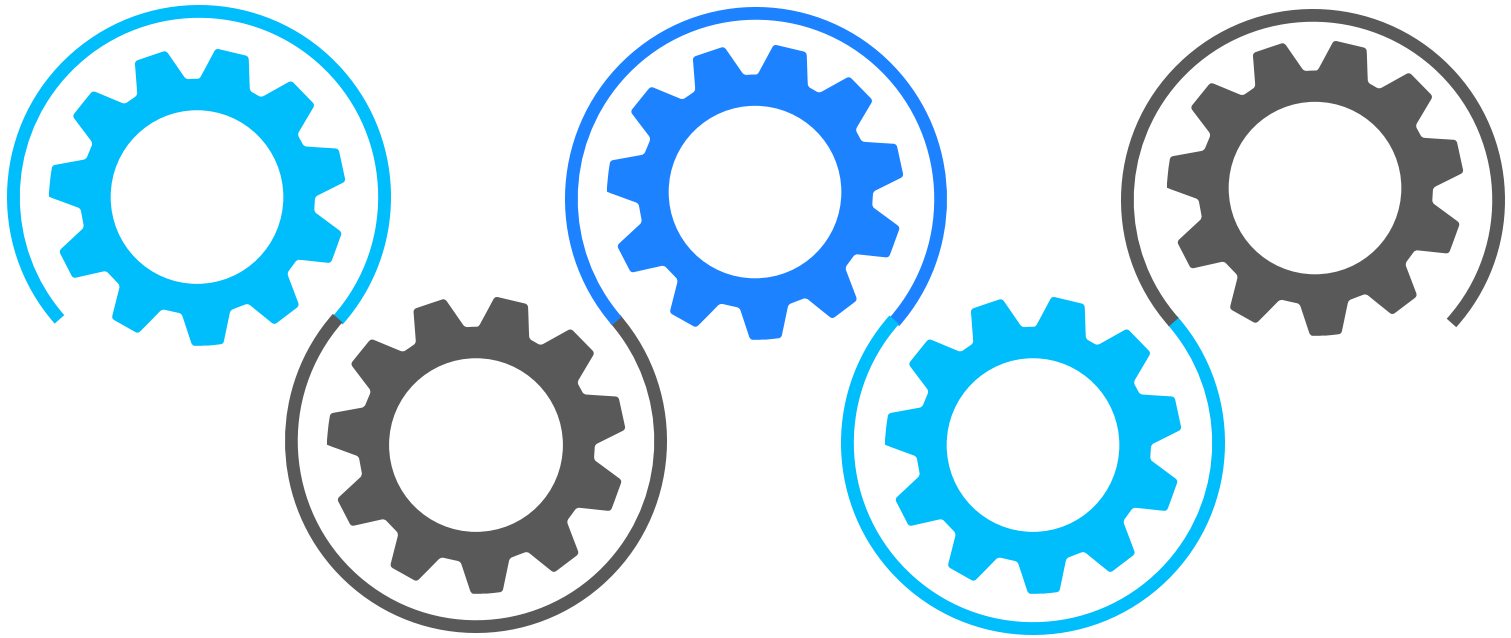
Objectives

PerfectPitch

Develop a real-time module for pitch recognition.

Create a real-time platform for plotting music sheets.

Integrate a sound reproducer that translates music sheets into audible melodies.



Implement a real-time rhythm recognition system.

Design a user-friendly graphical user interface (GUI).

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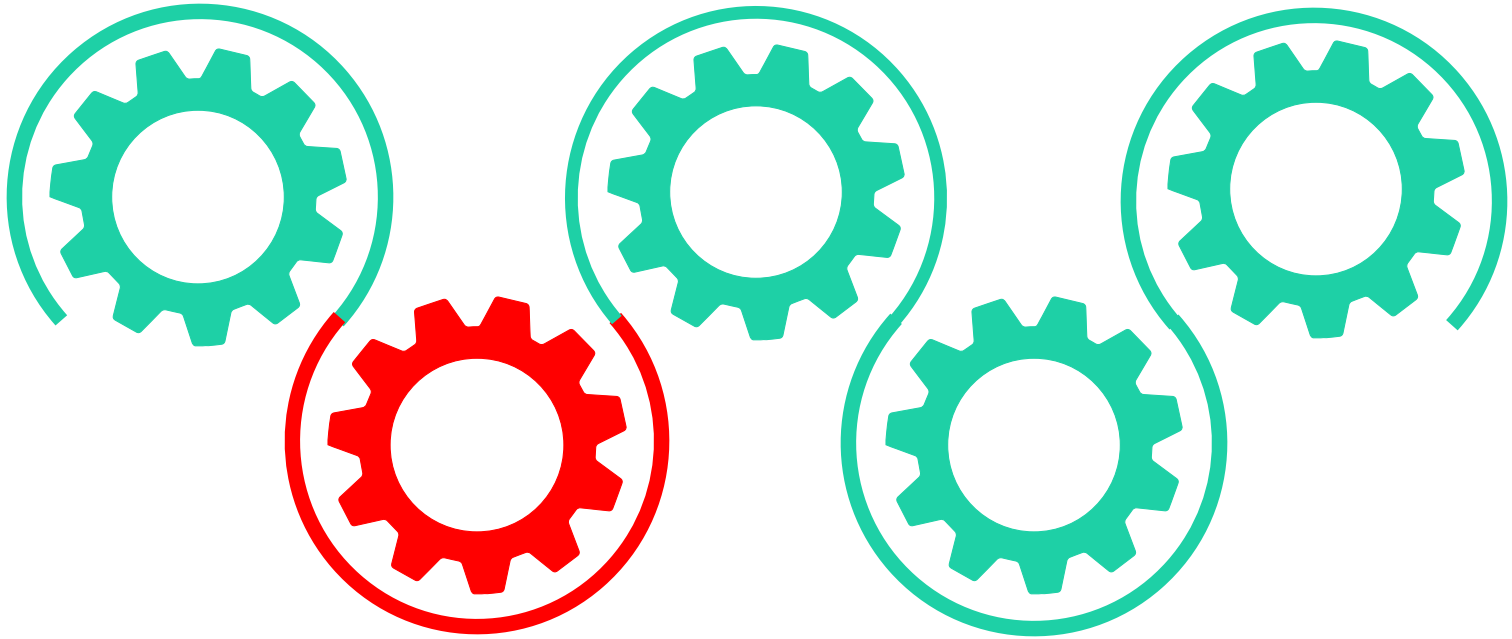


Implement a real-time rhythm recognition system.

Design a user-friendly graphical user interface (GUI).

State Of The Art

- Pitch recognition
- Rhythm recognition
- Market Analysis

2

Pitch recognition

PerfectPitch

Pitch recognition is the process of analyzing and identifying the specific musical within an audio signal using the frequencies present in the signal.

1

Auto-Correlation

Find the highest peek in the autocorrelation.
The index of the peek is the f0.

2

Deep-Learning

Neural networks to learn complex patterns in signals
High accuracy

3

Cepstral Analysis

Analysis of the audio signal into the cepstral domain.
Separation of vocal tract and excitation source characteristics.
Mitigate the influence of factors like noise

PerfectPitch

Rhythm recognition

Rhythm recognition is the analysis of temporal patterns in audio signals, identifying beats and accents to understand and reproduce musical rhythm.

1

Onset

Analyzing energy and spectral flux to identify discontinuities in the audio data.

2

Machine-Learning

Deep learning.
Recurrent Neural Networks.
Long Short-Term Memory Networks.

3

Pattern Matching

Compares input rhythmic patterns with predefined templates Identify similarities and patterns within the rhythm.

Market Analysis

PerfectPitch

Drivers

Tech Advancements
Digital Music Industry Growth

Competition

Key Players: VocalTuner, Nail the Pitch, Vocal Monitor, Pocket Pitch - The Singer App, Singscope.
Innovation: deep learning, Customization and User Profiles and Visual Feedback

Challenges

Audio Quality Variability
Real-time processing

Market Overview

Market Size: Growing demand from education and music production
Definition: Instruments converting musical pitch from audio signals.

Opportunities

Expansion in Emerging Markets
Real-time processing and adaption

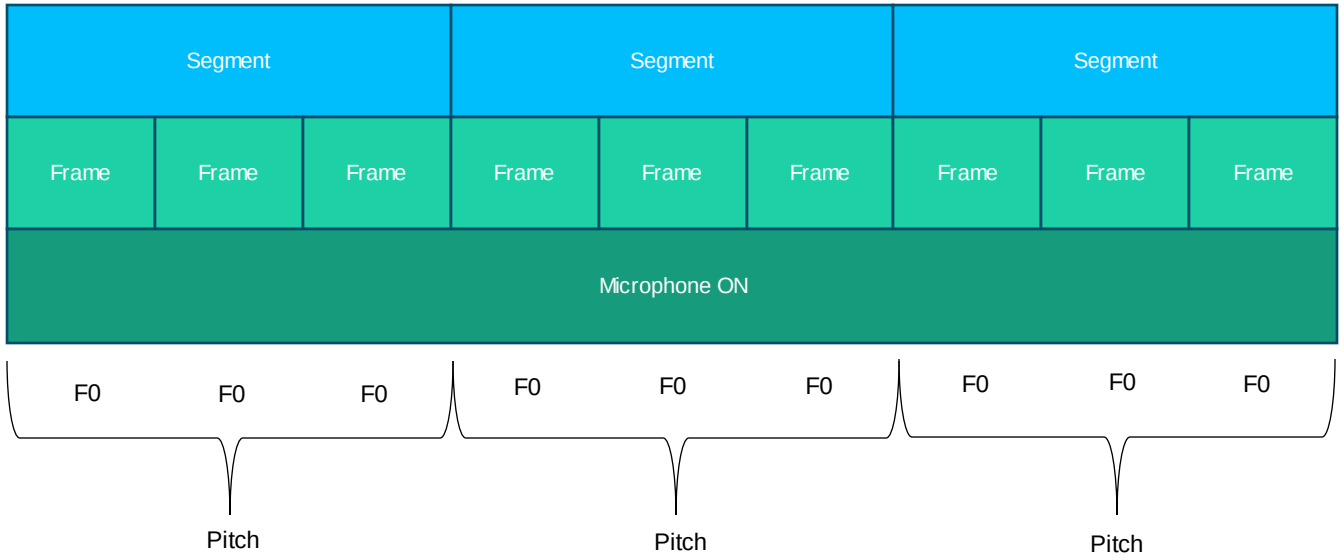
Adopted Solution

- Pitch Detection Algorithm
- Fundamental Frequency Calculation Algorithm
- Technologies

3

Pitch Detection Algorithm

Objective: While the microphone is on, output the pitch of audio segments with T seconds of duration and filter the ones that are composed of noise



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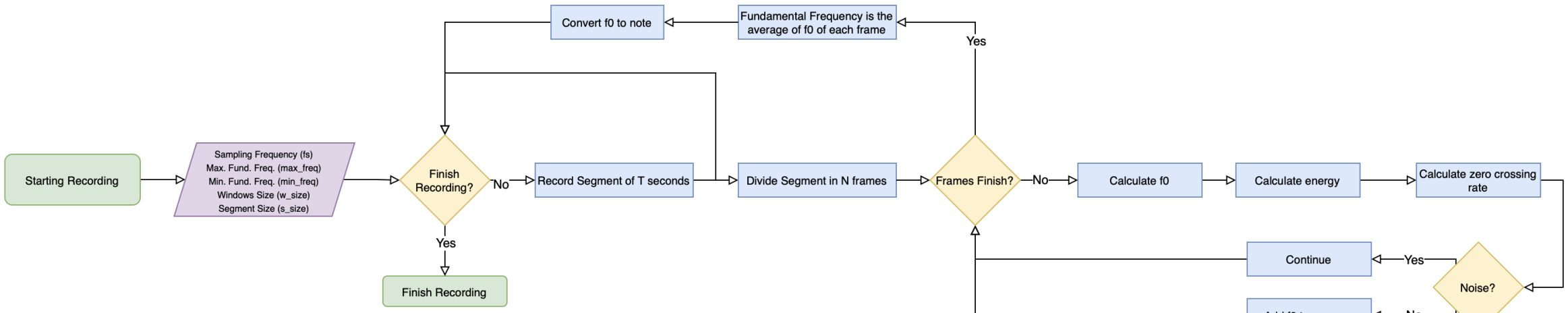
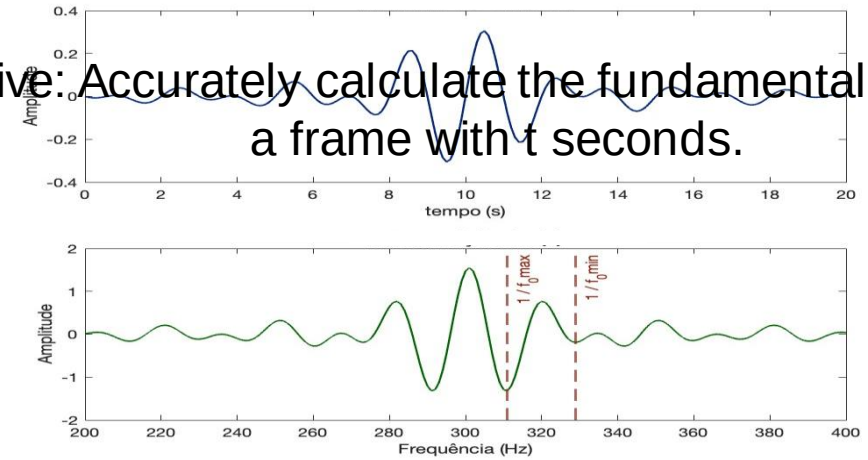
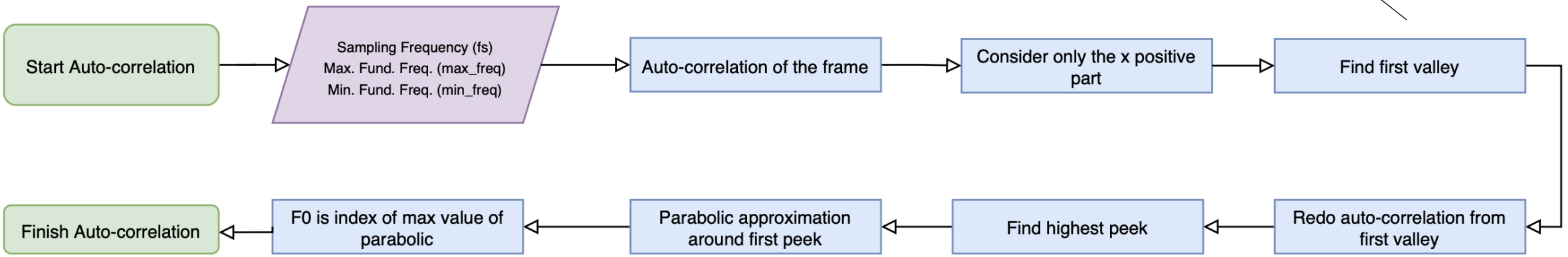


Fundamental Frequency Calculation Algorithm

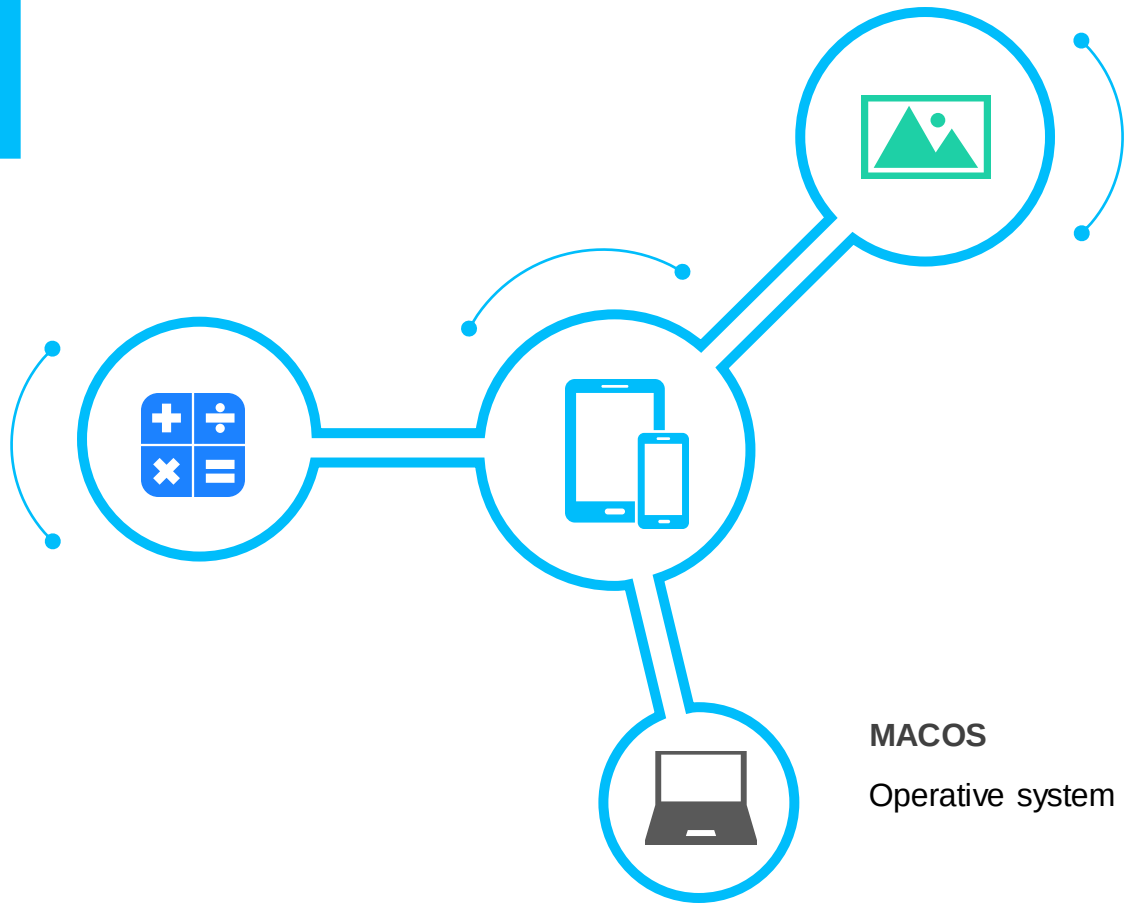
Objective: Accurately calculate the fundamental frequency of a frame with t seconds.





Technologies

Utilization of technologies to achieve the outcome



Python

Objected oriented

QT Designer

Simple GUI development

MACOS

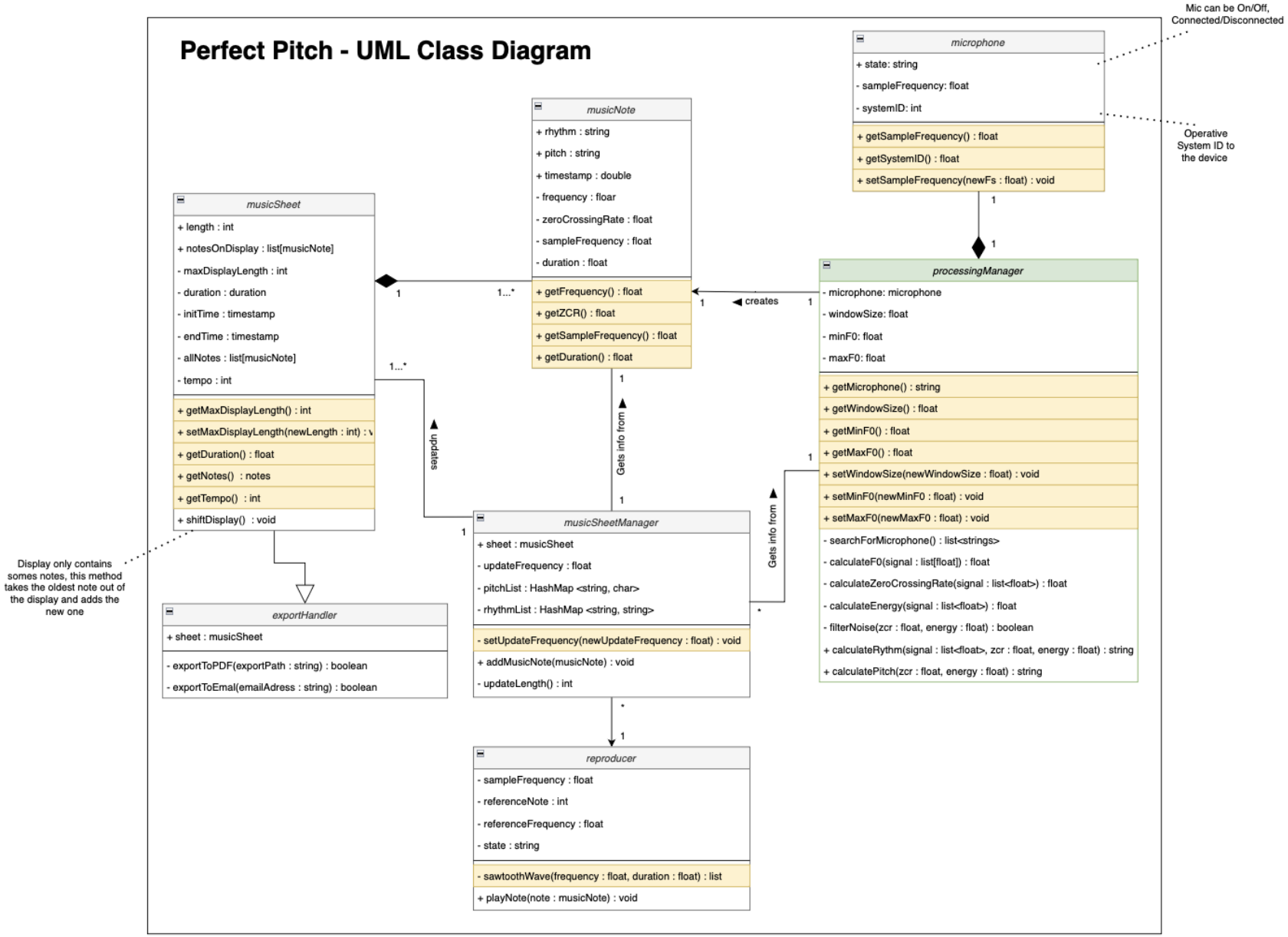
Operative system

Implementation

- Class Diagram
- Processes
- Melody generation

4

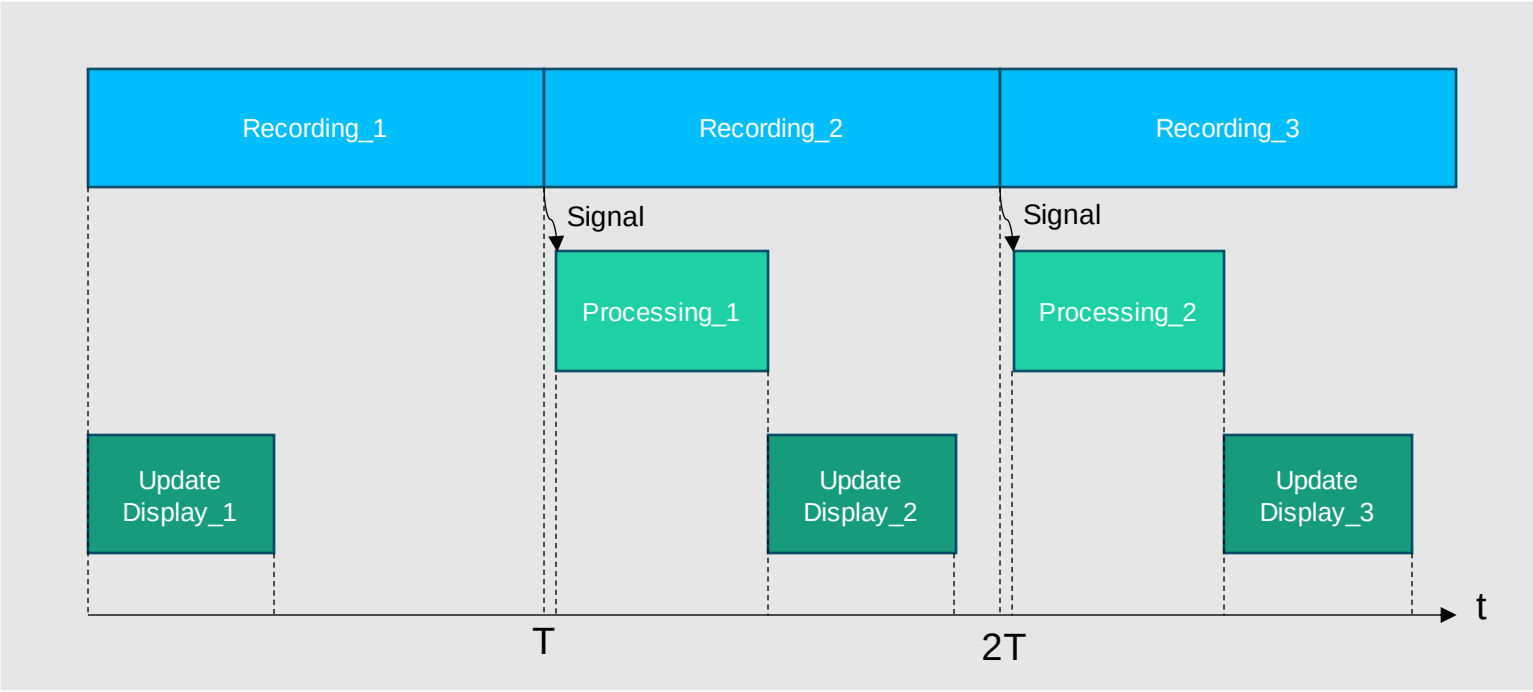
Class Diagram



Processes

The system is composed of 3 processes:

- Recording
- Processing
- Update Display

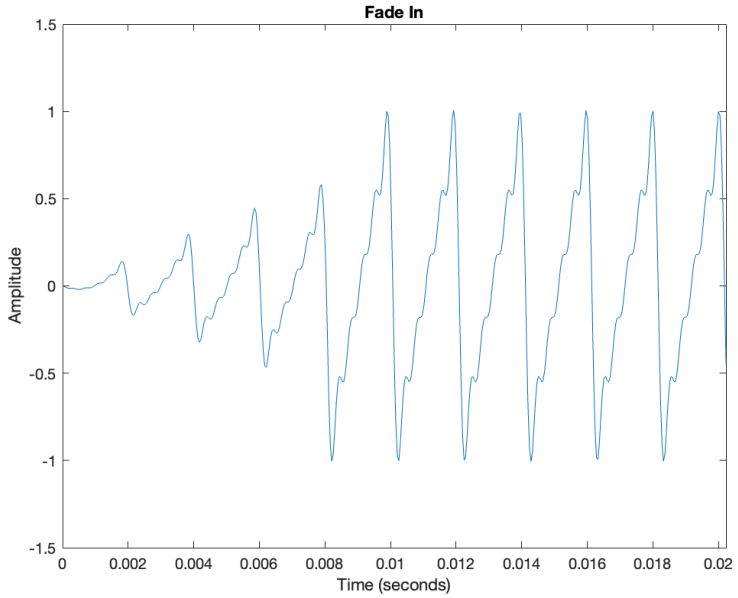


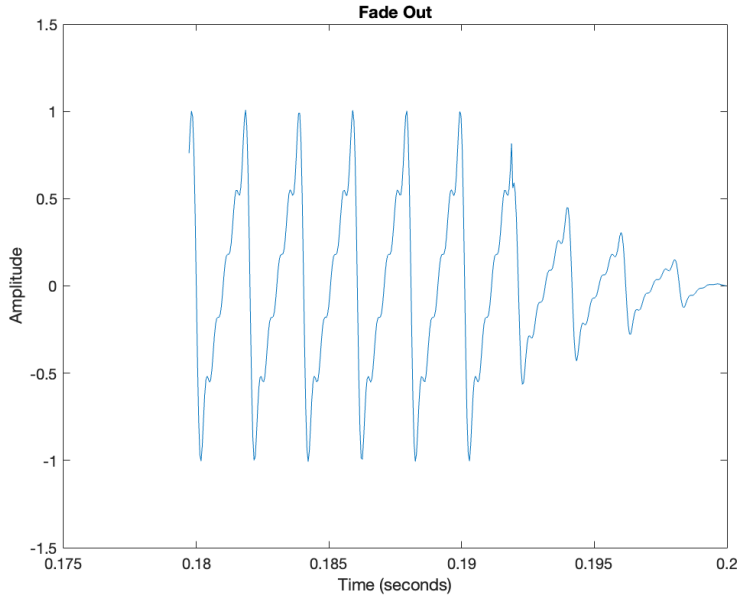
Melody Generation

Sawtooth waves with a given frequency, duration, and fixed sample frequencies. Fade in and fade out.

$$e(t) = \begin{cases} \sin(2.\pi.t.40T)\,, & 0 \le t < 10T \\ 1\ , & 10T \le t < dur.-10T \\ \sin(-2.\pi.t.40T)\,, & dur.-10T \le t < dur. \end{cases}$$

$$y(t) = 2 \times (\frac{t}{T} - floor(\frac{1}{2} + \frac{t}{T}))$$





Final

Results

- Test - Pitch recognition
- Test - Onset
- Demo
- Conclusions

5

Test – Pitch Recognition

Tests:

Test 1: 1s B2 1s pause T = 1s

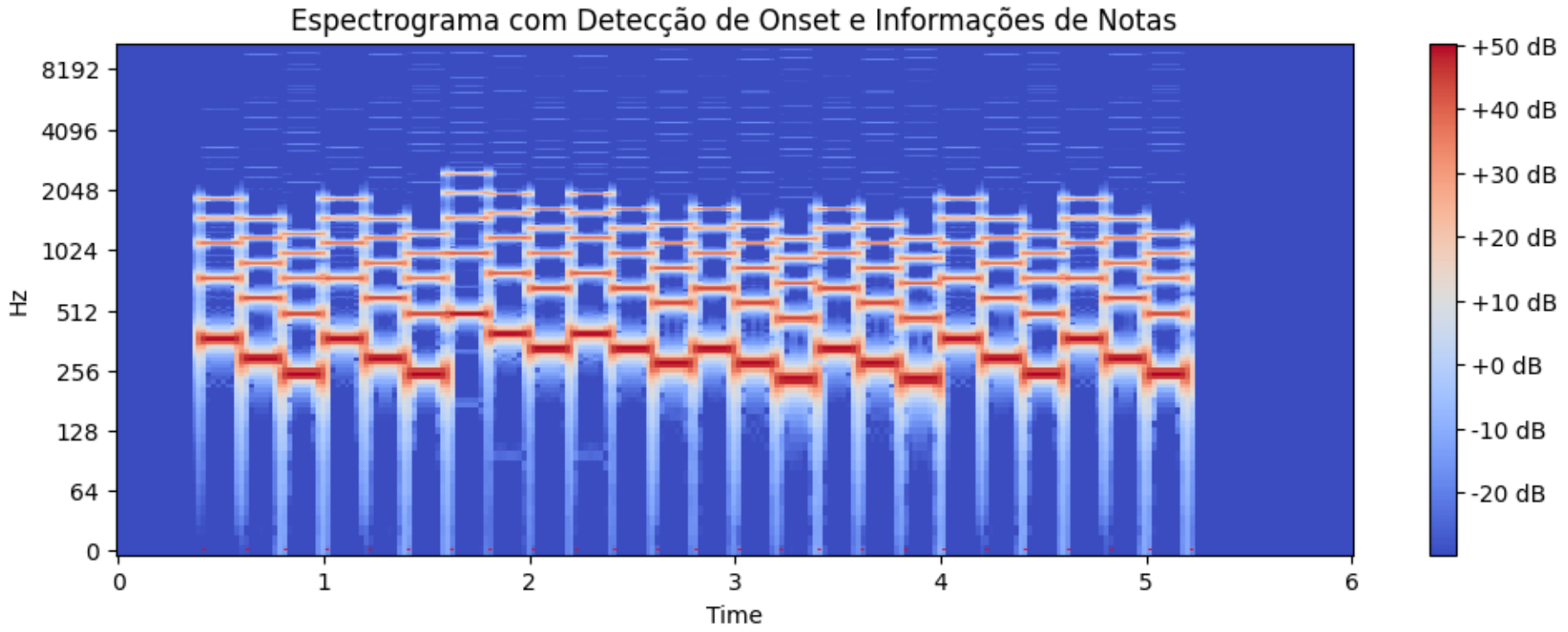
Test 2: 1s different notes T = 1s

Test 3: 1s note with rhythm

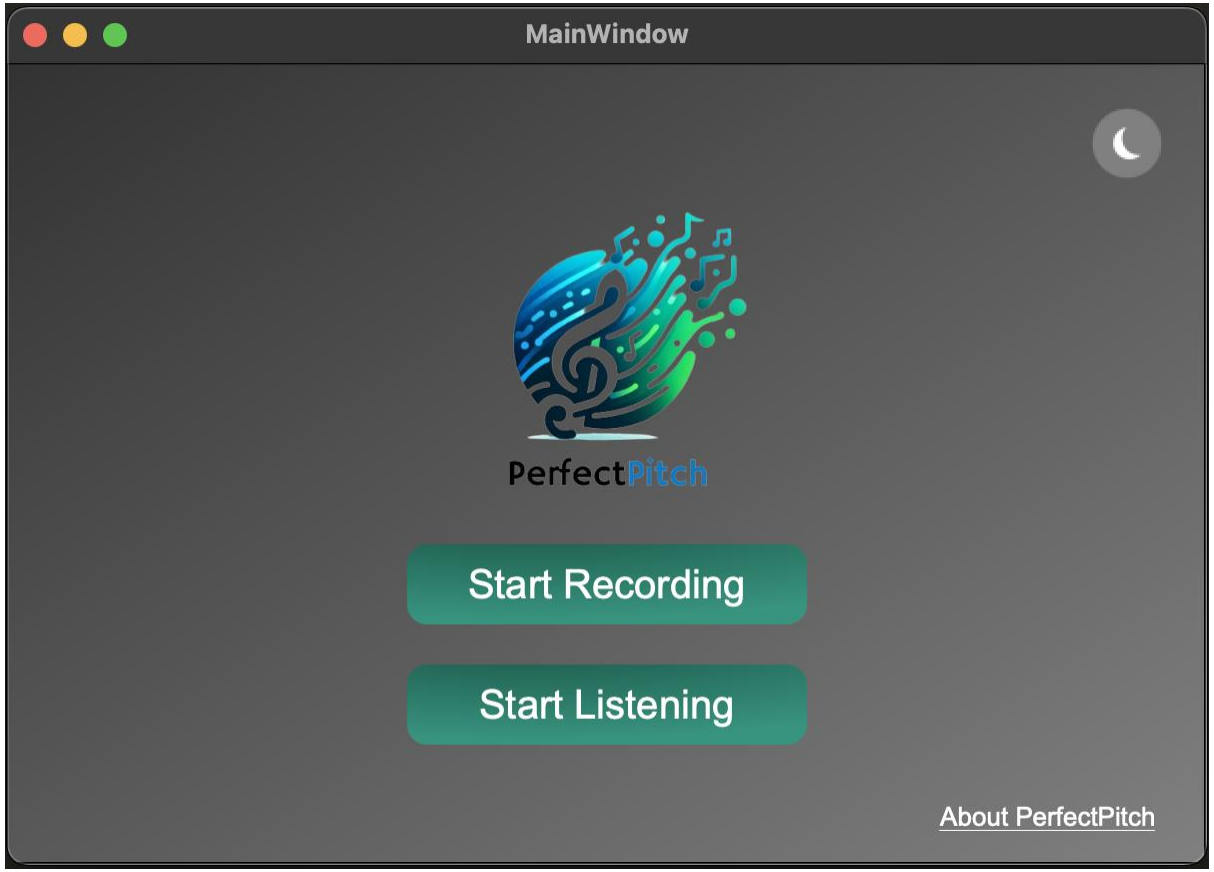
	Test 1	Test 2	Test 3
Pitch accuracy	100 %	100 %	45 %
MSE f0	0.156	0.260	-
Noise detection	100 %	100 %	-

Test – Onset

Onset functions effectively but exhibits high sensitivity, especially in the presence of noisy sounds. Despite the application of filters, it tends to overly segment the signal.



Demo


MainWindow
PerfectPitch
Start Recording
Start Listening
About PerfectPitch

Conclusions

Not Considering Rhythm

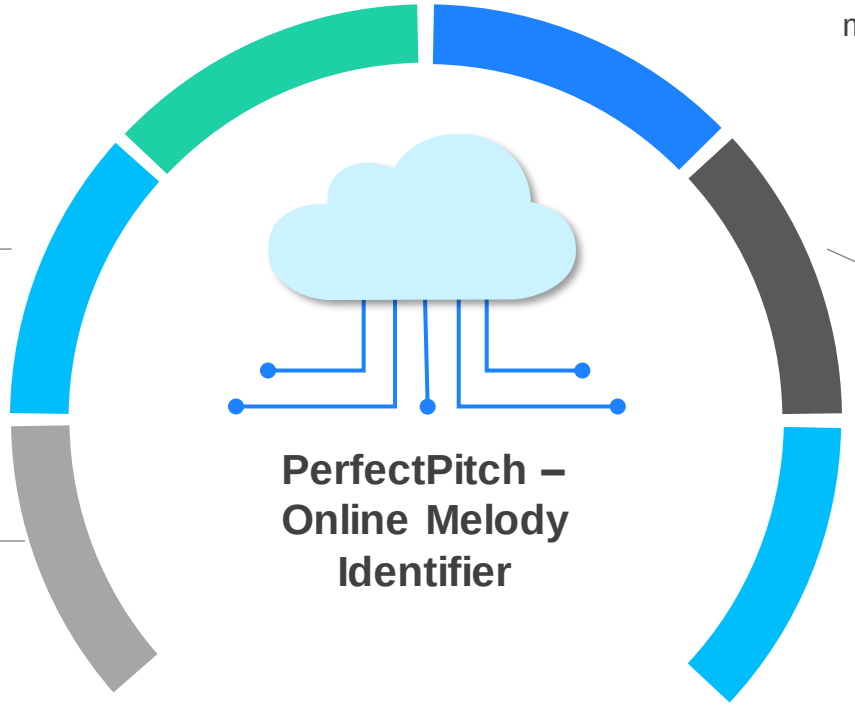
Significant Limitation.

Pitch Recognition

Exceptional performance even in moderately noisy conditions.

Reproducing Sheet Music

Exceptional performance, except for the occurrence of clips between notes.



User-Friendly Interface

Intuitive and responsive.

Project Objectives:

Four out of the five objectives have been successfully attained.

Enhancing Learning and Development

Developing Robust Methods for Perfect Pitch Calculation, Prototyping Online Pitch and Rhythm Detection, Implementing Object-Oriented Programming, and Learning New Technologies.

Thank You!

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