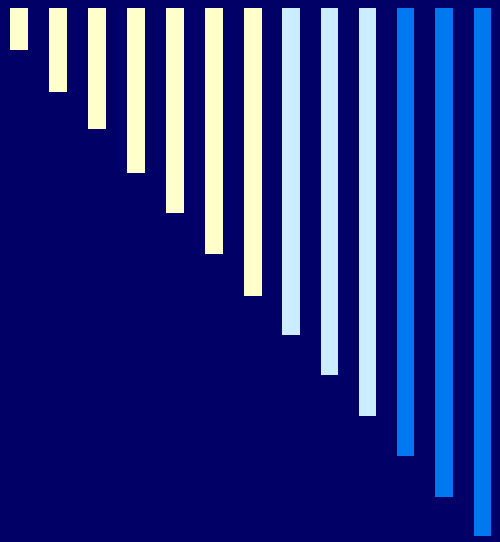


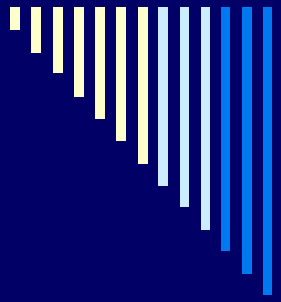
Music Coach

Real-time Evaluation of Music Performance using Nokia N900

CS290I Fall 2009 Group Project

David Johnson

Dianna Han



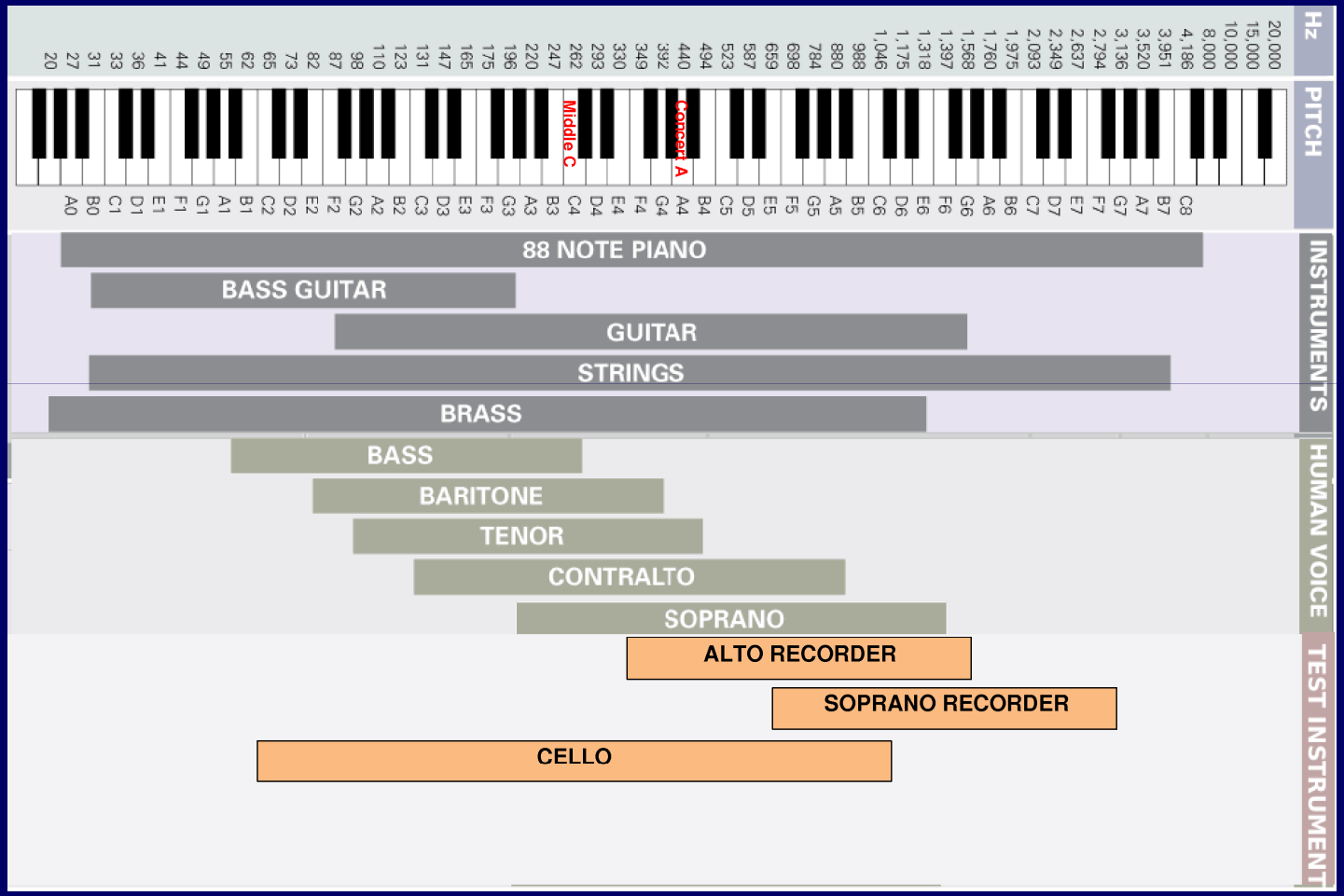
Overview

- Music Coach: An mobile phone application that
  - Checks if the user is playing a note at the correct pitch
  - Checks if the user is playing a note at the correct timing
  - Compares the user's musical performance to a pre-loaded score
  - Controls the tempo of the performance by shaking/rocking the phone in a rhythmic manner
- Other applications focus on Karaoke and tuning identification
- Ours aims more at serious learners who needs to evaluate their performance on real instruments

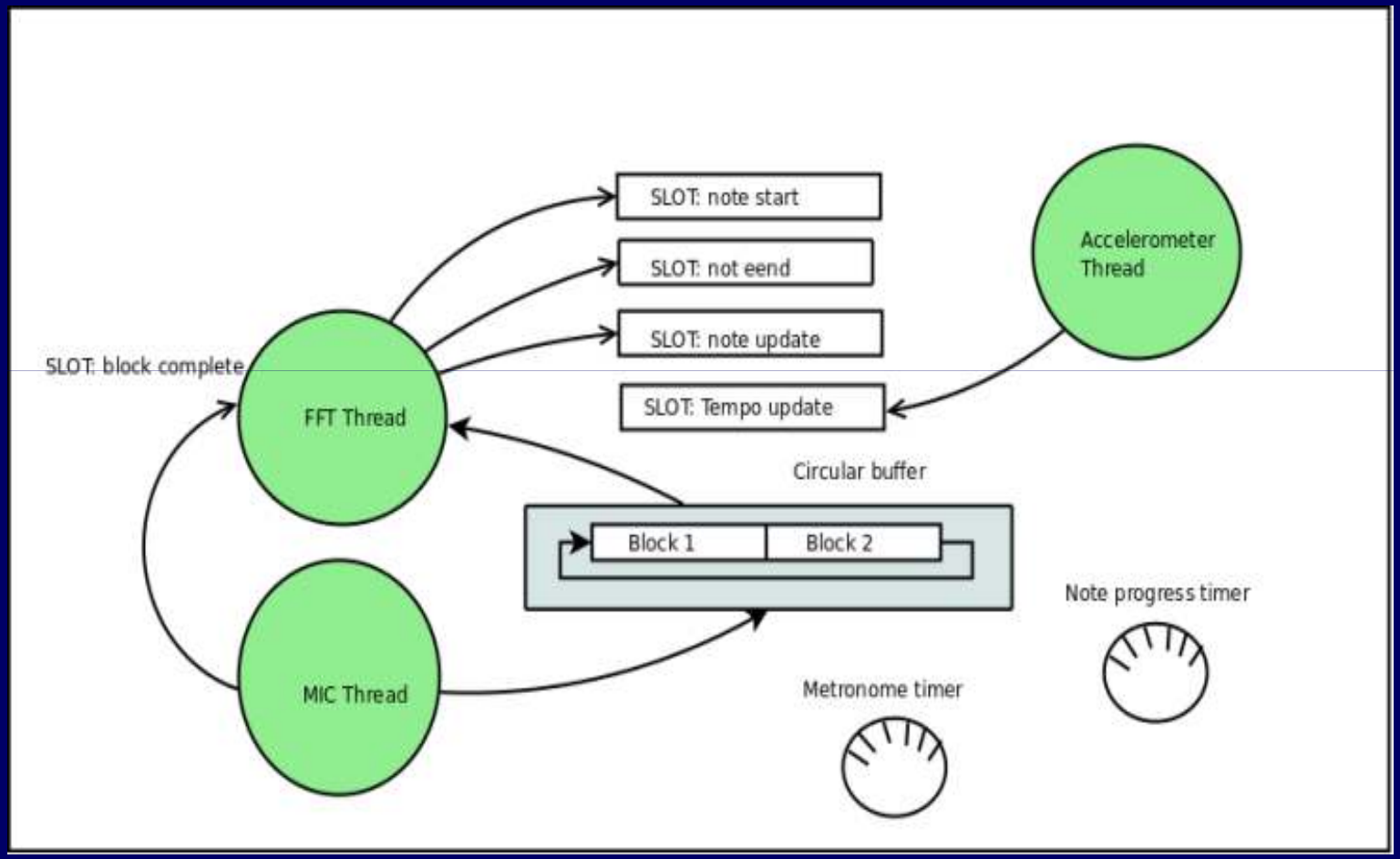
Main Technical Challenges

- Different pitch ranges for different instruments (logarithmic scale problem)
- Real-time frequency analysis of a pitch
- Extracting tempo from rhythmic phone movements (especially with slow movements)
- Fuzzy boundaries for evaluation (slight imperfections should be tolerated)

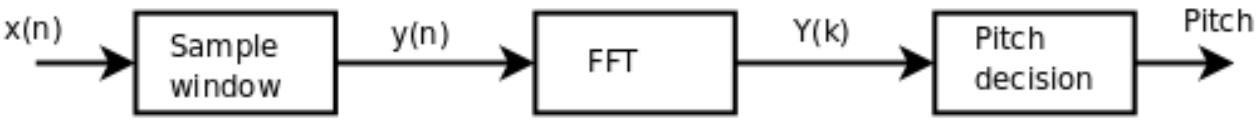
Pitch Range

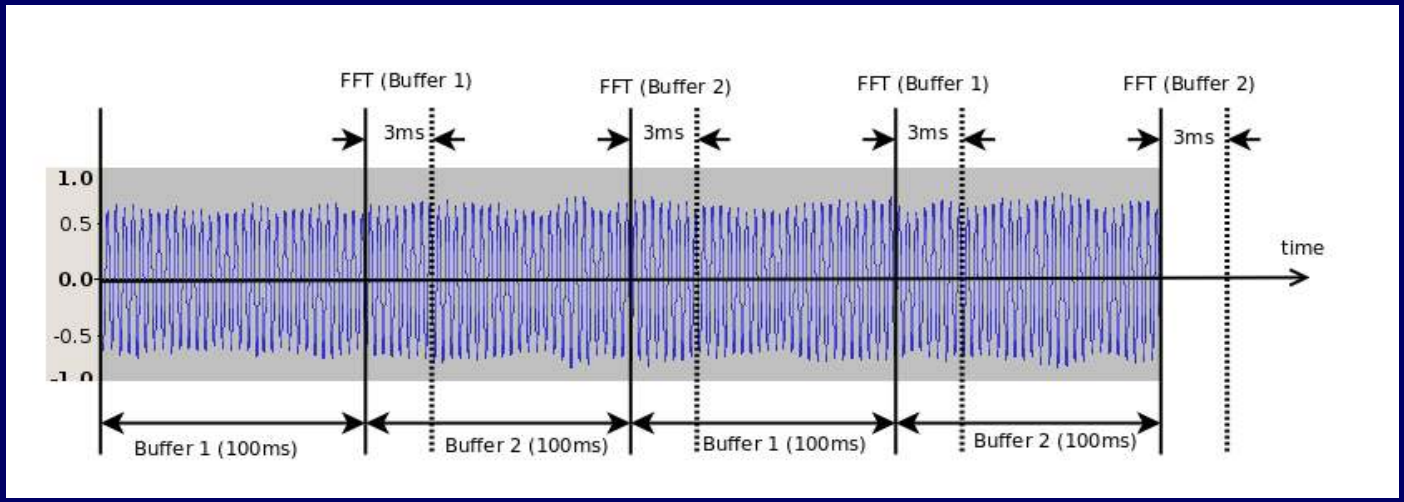

Hz
20 27 31 33 36 41 44 49 55 62 65 73 82 87 98 110 123 131 147 165 175 196 220 247 262 293 330 349 392 440 494 523 587 659 698 784 880 988 1,046 1,175 1,318 1,397 1,568 1,760 1,975 2,093 2,349 2,637 2,794 3,136 3,520 3,951 4,186 8,000 10,000 15,000 20,000
PITCH
A0 B0 C1 D1 E1 F1 G1 A1 B1 C2 D2 E2 F2 G2 A2 B2 C3 D3 E3 F3 G3 A3 B3 C4 D4 E4 F4 G4 A4 B4 C5 D5 E5 F5 G5 A5 B5 C6 D6 E6 F6 G6 A6 B6 C7 D7 E7 F7 G7 A7 B7 C8
Middle C
Concert A
INSTRUMENTS
88 NOTE PIANO
BASS GUITAR
GUITAR
STRINGS
BRASS
HUMAN VOICE
BASS
BARITONE
TENOR
CONTRALTO
SOPRANO
TEST INSTRUMENT
ALTO RECORDER
SOPRANO RECORDER
CELLO

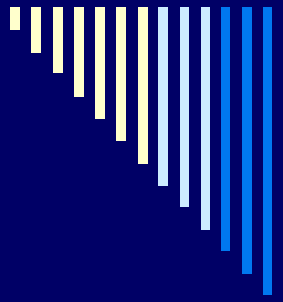
System Architecture



Pitch Detection

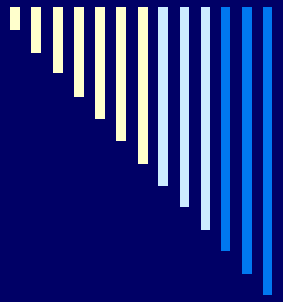






Pitch Detection: Accuracy/Resolution

- The pitch spacing between adjacent notes is logarithmic rather than linear
- Frequency resolution also depends on the number of samples in a sampling window



Pitch Detection: Sample Rate

- Determined by
  - The shortest note duration expected in the performance
  - The lowest expected frequency
- In Music Coach, 20Hz is used.
  - R = sample rate (Hz)
  - N = number of samples in the time window
  - T = N/R (period of time window)
  - F = R/N (frequency resolution of spectrum analysis)

System Processing Time

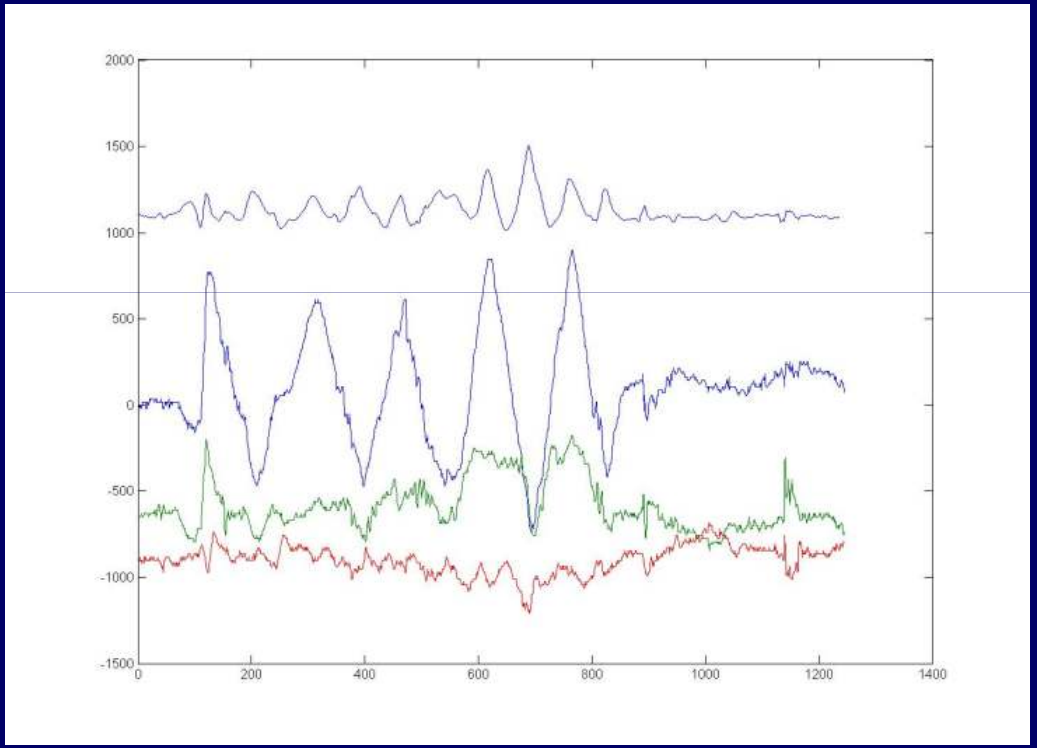
- Determined by:
  - Computational overhead of the application
  - Processing capability of the device
- Computational Load
  - Mainly introduced by pitch detection (FFT thread)
  - Minimized on tempo detection
- Overall, the processing time should not be more than 3ms for a 50ms-sample of audio data
  - In this case feedback will be delivered to the user 53ms after the note started playing

Metronome

- Tempo can be either pre-set or controlled by accelerometer
- Metronome provides both visual and audio indicators
- **It doesn’t interfere with the instrument recording because the metronome ticks are generated at high frequencies (6000Hz and 4500Hz)**

Tempo Detection using Accelerometer Readings

- Peak Detection in Digital Signals
  - Fast
  - Robust
- Algorithms
  - Significant Changes



Future Work

- GUI Design: Get user feedback from musicians.
- Improved Audio Isolation with Bluetooth headset.
- Do note timing in the time domain.
- Make use of professional musical type setting libraries, e.g. Guido.
- Display-Free Feedback using Buzzer
- Bird song recognition

GUI Design & Demo