

# Final Project Proposal: A pitch-matching game

## ECSE 444 - Microprocessors

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**Abstract** — Being able to recognize and match musical pitch is a fundamental skill for musicians, but it is also a fun challenge for all. This project aims to build a pitch-matching game on an STM32 B-L475E-IOT01A microcontroller over the span of 4 weeks, utilizing the DAC, DFSDM, CMSIS-DSP, and UART features of the board. This proposal also outlines the development timeline of the project and how each member contributes.

**Keywords** — ARM Cortex-M4, STM32, embedded systems, microcontroller, digital signal processing, music technology.

### I. PROJECT DESCRIPTION

This project develops a real-time pitch-matching system on an STM32 microcontroller. The game starts when the user presses the blue button. The board then plays a tone to a speaker via its DAC, listens to the player's voice through a DFSDM microphone as they attempt to replicate the tone, and uses CMSIS-DSP FFT for real-time digital signal processing and for pitch detection. The result is sent to a computer console via UART so players can see how close they are.

### II. PROJECT REQUIREMENTS

#### II.A - FEATURES REQUIREMENTS

This project integrates four major board features: (1) DFSDM microphone for audio capturing, (2) DAC speaker, (3) UART interface, and (4) CMSIS-DSP for FFT analysis. This fulfills the feature requirement criteria stated in the project handout.

For the performance enhancement requirement, we opt for one of several potential options: Low-power operation using wait-for-interrupt (WFI), OS for threading, or using sub-word parallel arithmetic (SIMD) instructions. Further discussion and testing will determine which

enhancement is fit for the final implementation of the project.

#### II.B - PROPOSED DESIGN

Below is the graph displaying the interactions between components of the project.

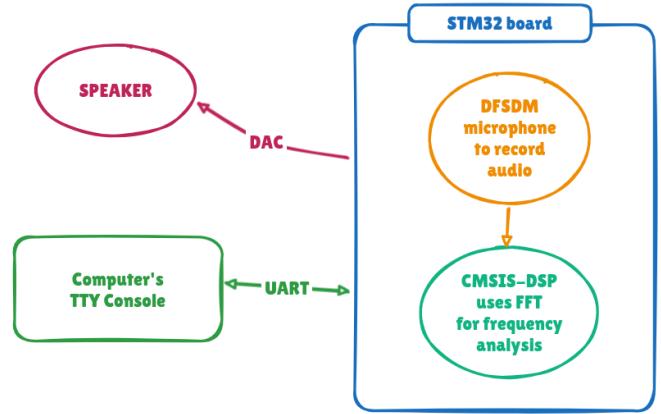


Figure 1: Interaction between components of the project

#### II.C - TIMELINE

This project will span 4 weeks and follow an Agile sprint/milestone cycle. Our group will have a meeting each week to discuss our collective progress:

- Week 1 - Setup and preliminary implementation
- Week 2 - Implementation & testing of the game
- Week 3 - Implement the performance enhance
- Week 4 - Integration & Demo

#### II.D - EVALUATION

Our project will be evaluated on the following four (4) criteria:

- Correct functionality and deterministic behaviour of the system
- Proper implementation of features and performance enhancement
- Code quality and documentation
- Low latency between interactions