An Arduino-Based Interactive Music Practice Assistant for Beginners

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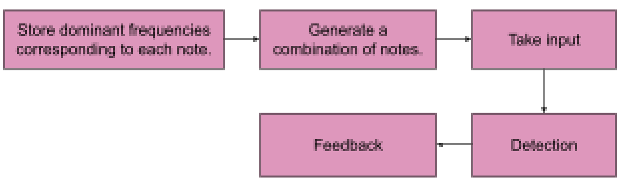
***Abstract*—This project aims to assist beginners in music learning, as note recognition is a common challenge without real-time feedback. It presents an interactive Arduino-based assistant that generates patterns of musical notes and evaluates whether the user correctly reproduces them. A microphone captures the input sound, and the dominant frequency is extracted using the EasyFFT library in the Arduino IDE. This frequency is compared to the expected note, and feedback is given via the serial monitor. A green LED indicates a correct match within a 10% tolerance, while a red LED signals a mismatch. The prototype accurately detected notes in quiet environments, making it a useful tool for self-guided practice and pitch training.**

Keywords— Arduino, EasyFFT, note detection, microphone module, music practice, real-time assessment and feedback.

I. Introduction

Many beginners face challenges while learning music, especially in identifying and accurately reproducing basic notes from a musical scale. While practicing by themselves they do not know surely whether they are playing the correct note or not. To address this challenge, a system has been developed that generates random combinations of musical notes from a predefined scale for users to play and practice. This system detects the notes played by the user through a microphone module and verifies their accuracy through frequency analysis performed using the Fast Fourier Transform (FFT) algorithm. This analysis is carried out on an Arduino-based platform, which identifies the dominant frequencies of the played notes and compares them with the expected notes from the generated sequence. This system helps beginners learn faster by allowing them to identify their mistakes in real time. The interactive, game-like environment also makes practice more engaging and enjoyable.

II. Systematic breakdown of project tasks



A reference set of data of dominant frequency corresponding to each musical note is stored as an array in the Arduino program.This enables directly to compare notes played by the user and the expected notes.

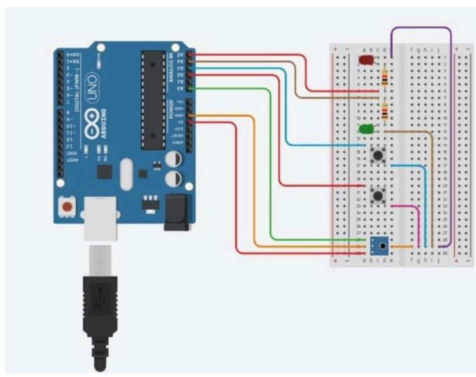
In the next step,a program was implemented that generates a combination of three notes in a defined scale(for the prototype A4 has been chosen). This random note is used as the target note for the user.

Now the user plays the pattern of notes generated in the previous step. To compare it with the pattern generated and detect whether it is correct or not, the sound of the notes played has to be taken as input. This will be done using a microphone.

The program will find the dominant frequency of each note played by performing an Fast Fourier Transform(FFT) on the input sound. It matches this dominant frequency against the notes in the generated pattern within the tolerance range. The system provides feedback through the Serial monitor of the Arduino IDE and through LED indicators, differentiating whether the input signal matches or not.

III. Circuit Design and components

The prototype shown was built by using components such as Arduino UNO board for processing, a General Purpose Input or Output(GPIO) for inbuilt switch and Light Emitting Diodes(LEDs), Jumper wires for connections, Breadboard for circuit assembly, a MAX4466 Microphone for detection of sound, An adaptor for 5v power supply to the system. A USB Type-A to Type-B cable was used to connect the Arduino with the computer for programming and serial communication.

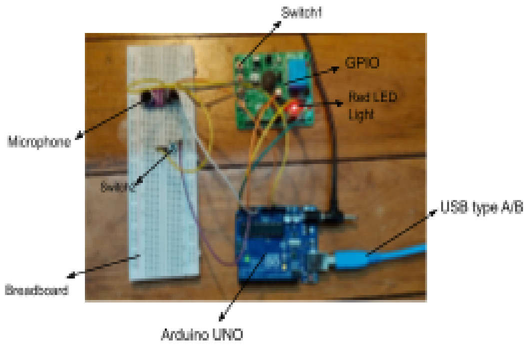


Connecting the microphone: the Microphone module consists of three pins labeled OUT, GND, VCC . The OUT is connected to A0 analog input pins of the Arduino UNO.

GND is connected to the arduino's ground. VCC to the 5V supply. The breadboard is used as a platform to connect the arduino board with the microphone using jumper wires.

Connecting the switches: Two user input switches were connected for one to initiate random note generation and the other to trigger detection. This can be done using two methods-If four legged push button is used then one leg connected to ground and diagonal to any of the analog input pin of the arduino board.Alternatively,switch can be used from the GPIO board, the board was powered by connecting 5V pin of GPIO board parallel to the VCC pin of the microphone.

Connecting the LEDs: Green and red LEDs were connected to analog input pins via GPIO board. These are used to give real time feedback to the user.

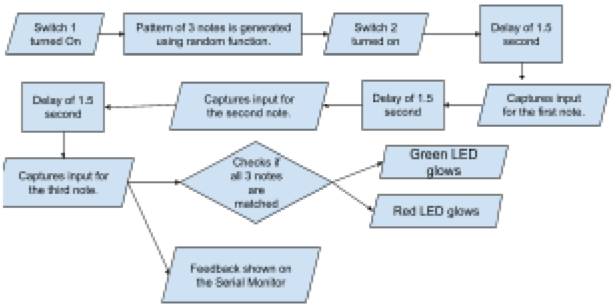


IV. Working of the Prototype

When the first switch is pressed, the system generates a random sequence of notes on the serial monitor. The second switch is pressed to begin note detection. The system then prompts the user to play each note in sequence, with a 1.5-second delay between prompts.

The system records and processes the sound input from the microphone using Fast Fourier Transform (FFT) to identify the dominant frequency of each note.It then compares the detected frequencies with the originally generated note sequence.If all notes match within a set tolerance, the green LED lights up; otherwise, the red LED indicates a mismatch. And also detected notes are displayed on the serial monitor and prompts whether it is matched or not.

V. Stepwise Breakdown of the Code

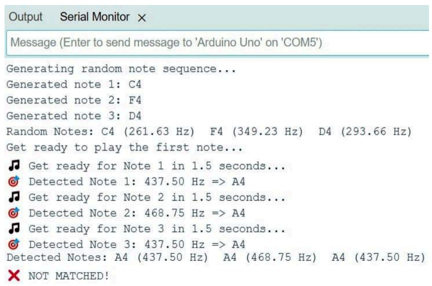


After the switch 1 is turned on, the program generates a random pattern of three notes from the C scale and displays it on the serial monitor. Then when switch 2 is turned on, it waits for 1.5 seconds and starts capturing the input sound for each note. There is a gap of 1.5 seconds between the instants at which the input for two consecutive notes is captured so that the user has enough time to switch between notes. The program then displays each note detected and whether all three matched or not on the serial monitor. If all three notes match, the green LED lights up, else the Red one glows.

VI. Result

The prototype was tested by generating a sequence of three notes from the preferred scale. Upon receiving the input from the microphone, the system extracts dominant frequencies using the Fast Fourier Transform(FFT) algorithm.

On testing, the system was able to identify the frequency and notes of the input signal and match them with the generated sample. The note played gets successfully matched with the generated note if its frequency has a percentage deviation from that of the generated note within ±8%. This value is the tolerance. If all three matches are successful then green light glows , while red glows even one note is mismatched.


```
Output   Serial Monitor ×
Message (Enter to send message to 'Arduino Uno' on 'COM5')
Generating random note sequence...
Generated note 1: C4
Generated note 2: F4
Generated note 3: D4
Random Notes: C4 (261.63 Hz)  F4 (349.23 Hz)  D4 (293.66 Hz)
Get ready to play the first note...
🎵 Get ready for Note 1 in 1.5 seconds...
🎯 Detected Note 1: 437.50 Hz => A4
🎵 Get ready for Note 2 in 1.5 seconds...
🎯 Detected Note 2: 468.75 Hz => A4
🎵 Get ready for Note 3 in 1.5 seconds...
🎯 Detected Note 3: 437.50 Hz => A4
Detected Notes: A4 (437.50 Hz)  A4 (468.75 Hz)  A4 (437.50 Hz)
❌ NOT MATCHED!
```

VII. Conclusion

The model can correctly detect individual notes when played consecutively with a small error margin of 8%.This margin accounts for the defined frequency tolerance. This makes it competent to be used as a model to help beginners for their music practice which provides an easier and efficient way for them to become more thorough with musical notes, as well as serve as a finger exercise.

VIII. Acknowledgement

We thank the Electrical Lab at IIT Gandhinagar for providing us with the components and required guidance to work on this project.

IX. References

[1]. Abhilash Patel, "Arduino Music Notes and Chord Detector," *Arduino Project Hub*, 2019. [Online]. Available: https://projecthub.arduino.cc/abhilashpatel121/arduino-music-notes-and-chord-detector-497dc5. [Accessed: Apr. 22, 2025].