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Dynamic Audio Visualizer using FFT

An ME-GY 6933 Project

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The Idea

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- Began as an idea to develop the Pose Sensor designed in Project 1.
- Enhancing the interactive component, as well as improving the response and feedback to the audience was the chief goal.
- Dynamic system to provide a complete experience within the exhibit, based on the change in direction of the sensor as provided by the user.

Bill of Materials

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Pose Sensor	
Component	Quantity
Arduino Nano 33 BLE	1
Maxbotix MB1010 Maxsonar EZ1	1
Tower Pro SG-90	3
9V Battery	2

Visualizer	
Component	Quantity
Raspberry Pi 3B+	1
Adafruit RGB Matrix	1
Adafruit 16x32 LED Panel	1

Components

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- Pose sensor uses Arduino Nano 33 BLE, chiefly because of built-in Bluetooth and IMU Sensor.
- IR sensor connected - detects orientation, change in position in tandem with IMU sensor.
- A Raspberry Pi 3B+ was used because of its built in audio and computational capabilities, as well as for easy interfacing.

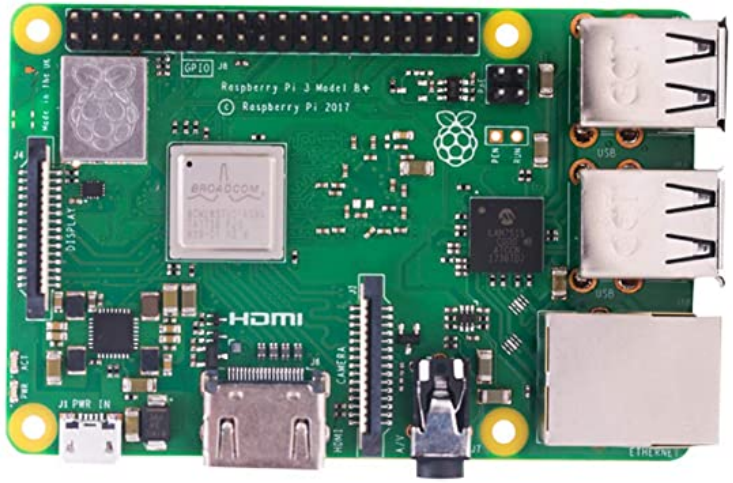

Figure: Raspberry Pi 3B+

The Process

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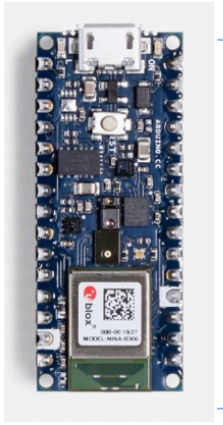


Arduino Nano BLE 33
(IMU Gyro, Euler Angle,
Acceleration, T/F, Ultrasonic Range)

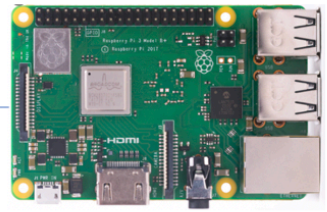
Capture
(Independent Optional Quantities)

Scale and send via BLE

PC Digital Workstation

Pro Audio out, MIDI
Control

PyAudio on RPI



Fast Fourier Transform
And dynamic color algorithm

Matrix mapping and LED Illumination

The Pose Sensor

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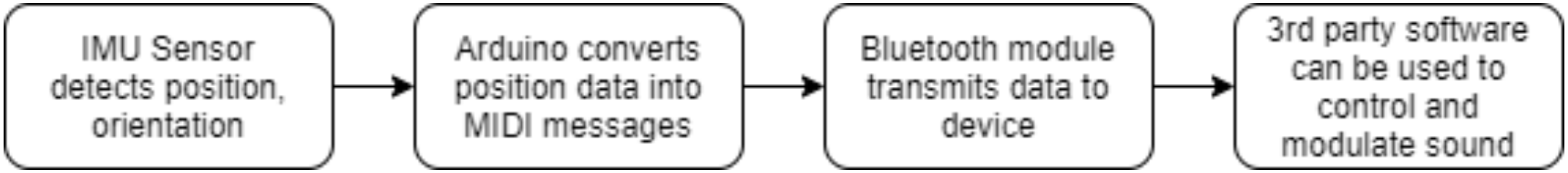

- The Pose Sensor
  - Detects orientation, angular acceleration using IR sensor
  - Converts the Pose data thus obtained to MIDI messages
  - Transmits data via Bluetooth
  - MIDI data is used to design sound based on the sensor’s movements.

The Matrix Visualizer

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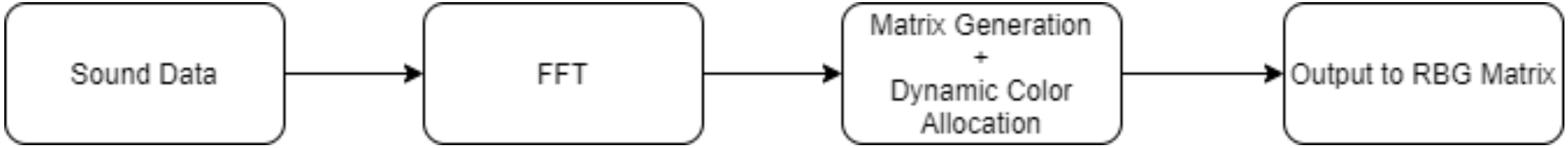

- Uses the PyAudio to “listen” to the sound produced dynamically by the Pose Sensor.
- This data is converted into the Frequency Domain using FFT.
- Color is provided onto the RGB Matrix using special frequency band and dynamic color algorithms.

Fast Fourier Transform

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- Fourier Transform converts a signal from time domain into frequency domain.
- DFT is obtained by decomposing a series of values into different frequencies, but is slow.
- FFT algorithm is used to rapidly calculate the DFT, changing the complexity from O[N^2] to O[NlogN], where N is the data size.

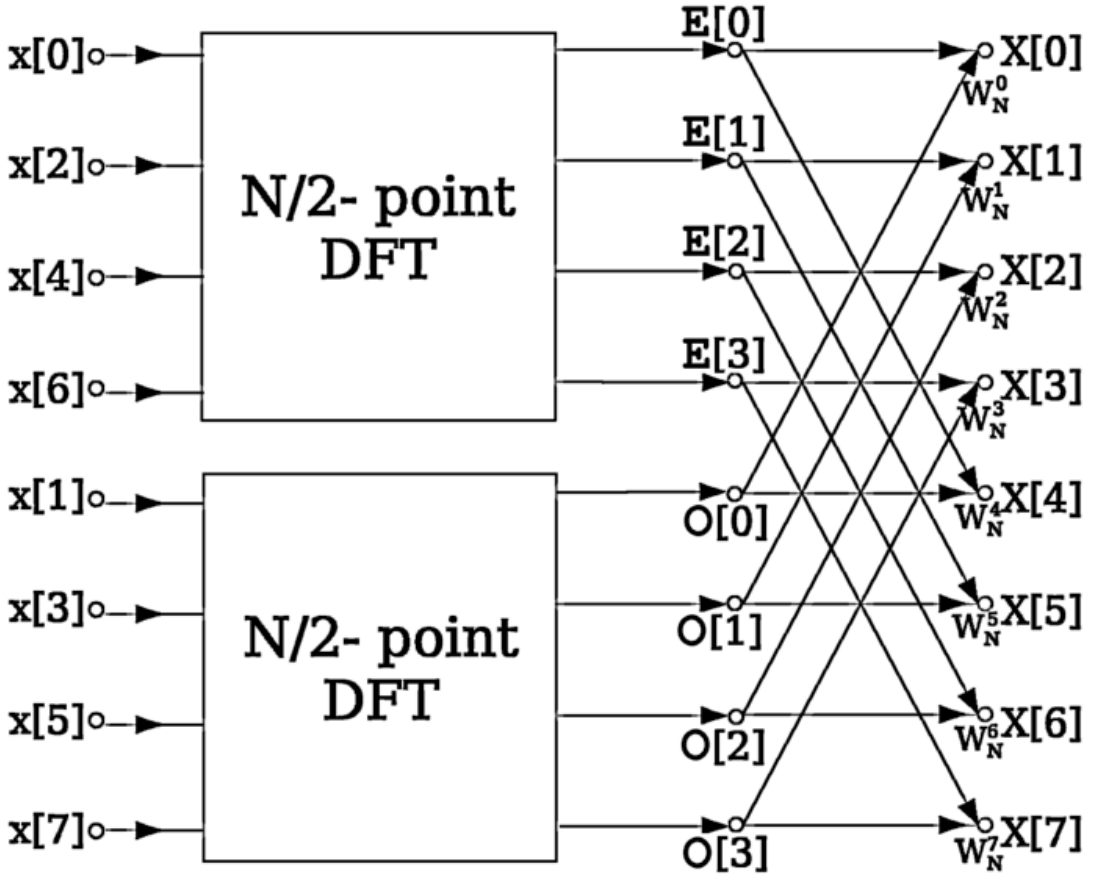

Figure: Example of an FFT algorithm, showcasing decomposition

Implementation

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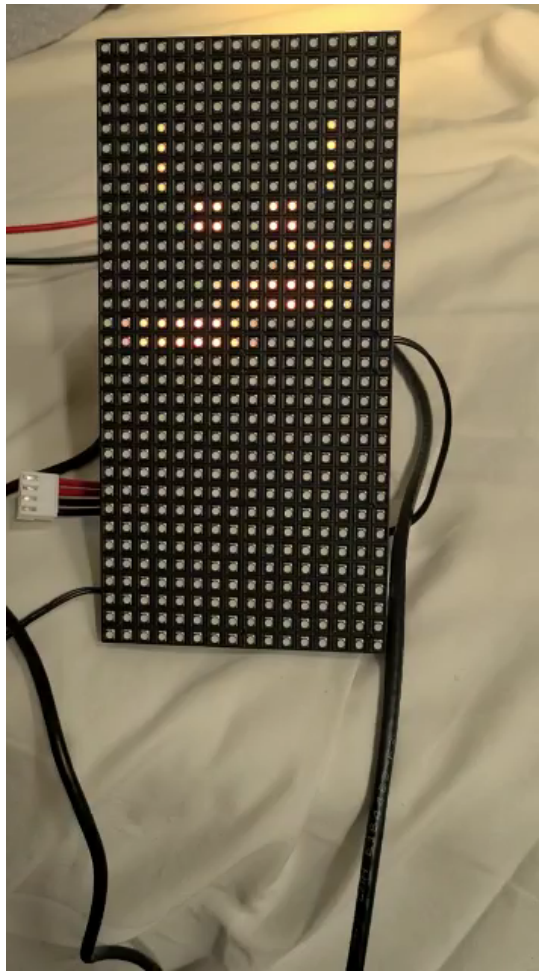

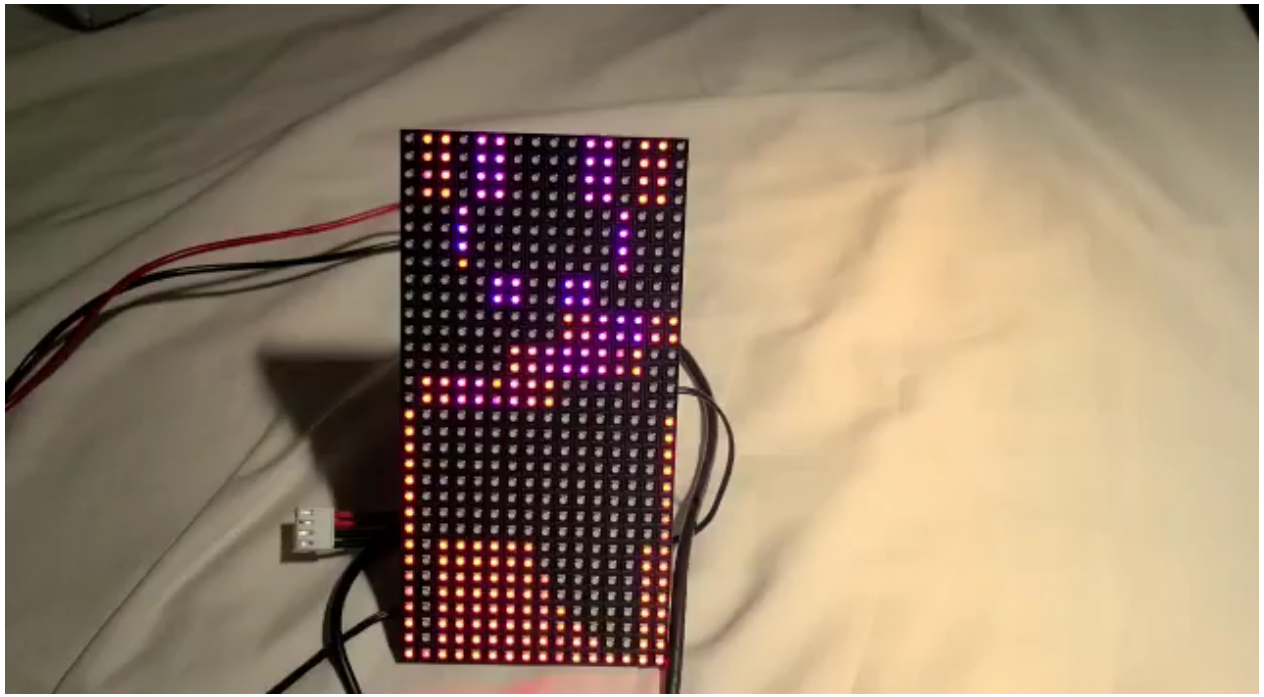

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Thank You!