Signal Analyzer with Arduino Uno , BAOTER 3296 , and HC-05

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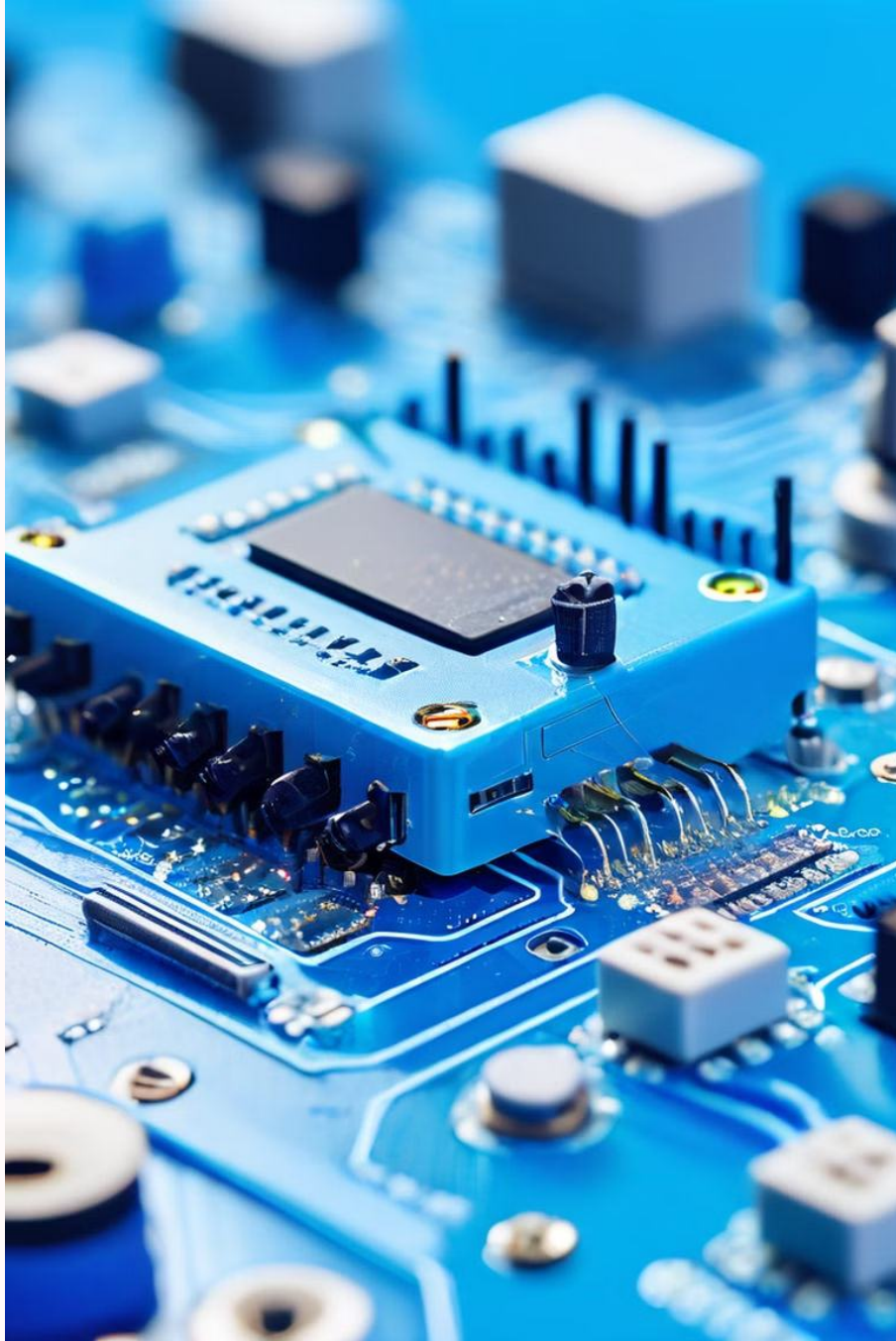
Introduction

Project involves creating a signal analyzer using an Arduino Uno, a Microphone (Baoter 3296) , and a Bluetooth module (HC-05). The project captures audio signals, processes them to calculate mean, minimum, maximum, RMS power, and fundamental frequency, and then transmits these values via Bluetooth.



Component Details

Arduino Uno

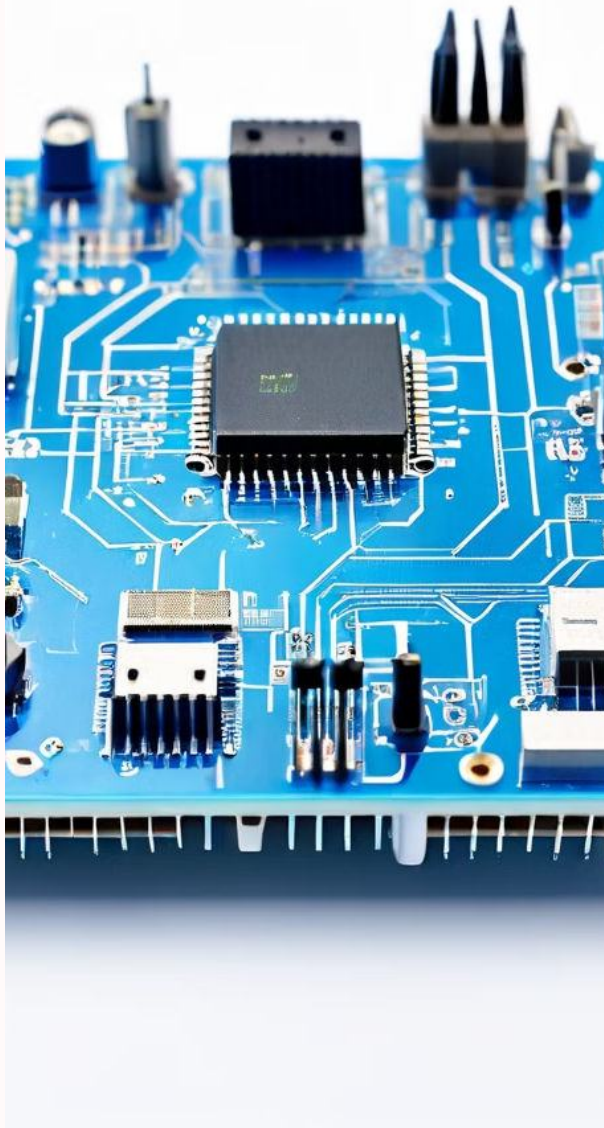
A popular microcontroller board based on the ATmega328P microcontroller, developed by Arduino.cc. It is widely used in electronic projects and prototyping due to its ease of use, flexibility, and open-source nature.

Microphone Sensor (Baoter 3296)

A sound detection module designed for use with microcontrollers such as Arduino. Typically includes an microphone, an operational amplifier, and a potentiometer for adjusting the sensitivity threshold.

Bluetooth Module HC-05

HC-05 is a Bluetooth module commonly used in embedded systems and microcontroller projects to enable wireless communication. Designed for serial communication and is popular due to its ease of use and reliability.



Applications and Use Cases

1. **Noise Pollution Tracking**

   Monitor and log noise levels in urban areas to assess compliance with noise regulations.

2. **Consumer Electronics**

   Evaluate performance characteristics of microphones, speakers, and other audio equipment.

3. **Music and Entertainment**

   Assist musicians in tuning their instruments by analyzing sound frequencies.

4. **Educational Purposes**

   Use in educational settings to teach students about sound waves, signal processing, and the Fourier Transform.

Signal Analysis Algorithm

Setup Phase

Use Serial.begin(9600) to set up communication with the PC for debugging.

Use BTSerial.begin(9600) to set up communication with the HC-05 Bluetooth module.

Main Loop

This loop continuously captures and processes the audio signals ,Sets the initial minimum value to the highest possible reading ,Initializes the sum of signal values to zero ,Sets the number of samples to collect

1 2 3

Functions Used

CalculatePower(sum, sampleCount):

calculate the power of the signal

Returns the average value of the sum divided by the sample count

calculateFundamentalPeriod(sampleCount):

Estimates the fundamental period

Reads the signal multiple times

Calculates the average period

Performance

Accuracy

Arduino Uno's ADC reads the microphone signal with a 10-bit resolution, providing values from 0 to 1023 which is adequate for basic audio analysis.
Mean, min/max, RMS power, and fundamental period are computed accurately using straightforward operations

Responsiveness

With a delay of 1 millisecond between samples, the project achieves an effective sampling rate of about 1000 Hz ,sufficient for capturing low-frequency audio signals but not high-frequency signals. The project updates data every second, balancing responsiveness and processing demands.

Reliability

Arduino Uno's limited processing power ,The microphone and analog circuitry may pick up noise and interference, affecting accuracy ,The HC-05 Bluetooth module provides reliable short-range wireless communication

Usability

project uses basic components ,simple wiring making it accessible.
Results are output to the Serial Monitor and transmitted via Bluetooth, allowing for real-time monitoring.Enhancements could include data visualization on a PC or smartphone app.

Future Steps

1

Data Logging and Visualization

Add an SD card module or cloud integration to log data for offline analysis. Develop a companion app or software for real-time data visualization and analysis on a PC or smartphone.

2

Machine Learning Integration

Advanced machine learning algorithms to classify and analyze different types of signals with highest accuracy.

3

Portable Design

Design a portable version of the project with battery power and a compact enclosure, making it useful for field applications.

Conclusion

Foundational Tool

Project effectively captures, processes, and analyzes audio signals, accurately computing mean, min/max values, RMS power, and fundamental period using straightforward methods.

Broad Applications

The signal analyzer can be applied to a wide range of industries, from industrial monitoring to biomedical research.

Ongoing Development

Future improvements, such as higher sampling rates, advanced signal processing, and noise reduction, can significantly enhance performance and expand functionality.

Credits

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