Advanced Driver Monitoring System(ADMS)

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1. Introduction

This project aims at monitoring the environment conditions in a car and provide feedback. The physical quantities to be observed include temperature, carbon dioxide(CO2) level, volatile organic compound(VOC) level and power of sound signals. The feedback are given in the form of texts in OLED, color changing in Tricolor LED and bluetooth signals. The microcontroller board to be used is Carte TI TIVA123g.

1. Adaptation conditions of sensors

2.1 Temperature sensor

Type: LM35

Power supply: 5V

Signal pins: PD\_2

Signal transmission method: Analog

2.2 CO2 & VOC sensor

Type : MiCS-VZ-98-TE

Power supply: 3.3V

Signal pins: PA\_6 for SCL, PA\_7 for SDA

Signal transmission method: I2C

2.3 Microphone sensor

Type : ADA-1063

Power supply: 5V

Signal pins: PD\_1

Signal transmission method: Analog

2.4 OLED

Type: TF051

Power supply: 5V

Signal pins: PE\_4 for SCL, PE\_5 for SDA

Signal transmission method:

2.5 Tricolor LED

Type: Normal

Forward voltage: 1.85V​ for red, 2.68V for green and 2.85V for blue

Signal pins: PF1 for red, PF2 for blue and PF3 for green.

Signal transmission method: Digital

2.6 Bluetooth

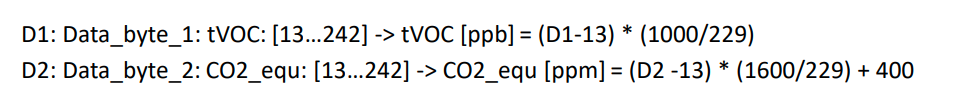
Type: HC-06

Signal transmission method: Serial Communication

1. Signal processing of temperature and co2 sensors

Temperature is calculate based on the following formula:

Following picture is parts of datasheet for CO2 sensor. It shows the calculation formulas to derive the value of CO2 and VOC level base on the analog data read. Codes are written based on it.



1. Signal processing of microphone sensor

4.1 Trigger

4.1.1 Block Diagram

4.1.2 Objective

To define a threshold value, to erase the meaningless signals at the beginning.

• Defining a threshold helps us to have a reference value to isolate useful information from noise.

• In a real-life scenario, audio collected via Tiva are stored in a buffer of finite size and we can’twait to detect the signal until the buffer is full.

• So, we measure the data at an interval before the buffer gets full and compare it with silence power in order to detect noise.

4.1.3 Simulation in MATLAB

**1. Read the audio data**

Our audio data is a 4 seconds audio file with frequency equals to

1000hz. And we create a plot to show how the amplitude of the audio signal varies overtime.

**2. Calculate the power based on the intervals**

We set the interval as 0.1s. Power is calculated based on the energy and time: P = . Energy is calculated based on the amplitude values of the audio file.

**3. Set power threshold to erase meaningless noise**

Assume the power of silent room = 10. If the calculated power < 10, we delete the audio at that interval. At the end of the process, we get a filtered audio, which contains only the useful signals.

4.1.4 Result Analysis

In this experiment, we successfully achieved noise reduction in an audio signal. Initially, we obtained a raw audio signal and segmented it into small parts at 0.1-second intervals for energy analysis. This process involved calculating the energy of each segment, generating a series of energy values. Based on this, we set a threshold of 10, considering signals with energy below this threshold as meaningless noise and subsequently eliminated them. Through this method, we effectively removed noise from the original signal, obtaining a clear and useful audio signal. This experimental procedure not only demonstrates basic audio processing techniques but also has practical engineering value. In fields like voice recognition, communication systems, and audio editing, such noise reduction techniques can significantly enhance signal quality, thereby improving system performance and user experience.

4.1.5 Implementation in Tiva board

4.2 Password

4.2.1 Block diagram

4.2.2 Objectives

To design abandpass filter to extract specific frequency components from the audio signal, to activate the system once the energy of the target signal exceeds the threshold.

• Defining a bandpass filter to helps us to collect the useful component from the audio signal

• In a real-life scenario, if the useful audio collected meets some conditions, the system will be activated and start next steps.

• So, we measure the energy of the collected signal and set a threshold as trigger conditions

4.2.3 Simulation in MATLAB

**1. Read the audio data**

Our audio data is a 1 second audio file with frequency equals to

300hz. And we create a plot to show how the amplitude of the audio signal varies overtime.

**2. Frequency Analysis**

We perform frequency analysis of the audio file through the fourier transform. And create a plot to display the variation of the amplitude (in decibels) of the signal with frequency.

**3. Filter Design and Apply**

To capture signals between 250 and 350 Hz, we designed a bandpass filter that permits only these frequencies, filtering out others. This

filter is then applied to the original audio signal.

Parameters of a bandpass filter:

Center frequence: 300 Hz

Lower frequence: 250 Hz

Upper frequency：350 Hz

stopband attenuation: 50dB

passband ripple: 1dB

log( 10(10)0(0).(.)1(1)δ(R) 1(1))

Calculate the Filter order: N = 2⋅log(()l(u))

Filter order ：19

**4. Anylize the Filtered Audio.**

We perform Fourier analysis on the filtered audio and plot its time series graph and frequency spectrum.

**5. Calculate the energy of the filtered audio signal**

We calculate the energy of the filtered audio signal based on the amplitude values of the audio file.

**6. Set threshold to activate system**

If the audio energy exceeds this value, the system will start and proceed to the next step. Energy of the filtered audio signal is 311.1995, so the system is activated.2.4 Results Analysis After being processed by a bandpass filter, the original audio signal had its components within the 250 to 350 Hz frequency range extracted. The spectrum of the original audio displayed a prominent peak at 300 Hz, indicating this frequency's dominance in the signal. The spectrum of the filtered audio (fourth image) showed that the signal within the 250 to 350 Hz range maintained its amplitude, while the amplitude of signals at other frequencies was significantly attenuated, demonstrating the effective operation of the bandpass filter. The energy of the filtered audio signal, calculated by the function, was 311, exceeding the set threshold of 200. This indicates that the target frequency signal (approximately 300 Hz), processed by the filter, had sufficient energy, and as a result, the system was activated. In practical applications, this corresponds to triggering   alarms, initiating communication links, activating voice command recognition, and other functions.

1. Presentation of results

5.1 LED

5.2 OLED

5.3 Bluetooth

1. Conclusion

This project succeeded in building a whole system to monitoring the environment conditions

Reference