Middle East Technical University

Electrical Electronics Engineering Department

EE447 Project Final Report

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Contents

1. Introduction

In this project, a step motor is driven by sampling the audio signal's frequency. The ADC module is used for the microphone to sample the audio signal. Systick does the audio measurements with a 2k Hz sampling frequency. The ARM CMSIS DSP library processes the measured data to obtain frequency. The step motor is driven by GPTM. Two frequency thresholds and one amplitude threshold are determined to configure step motor speed. There are three different step motor speeds.

Additionally, according to step motor speed, the LED color is changed on the TM4C123GXL Board. Switches on the board also can determine the direction of the step motor. In the end, threshold values and current frequency and amplitude are displayed on Nokia 5110 LCD screen over the SPI communication protocol.

In my project, frequency calculation does not work properly. Audio sampling and the ARM CMSIS DSP library are applied properly however, the meaningful values cannot be obtained. The rest requirements are satisfied.

2. Solution Approach

a. Microphone

The measurements are done in Systick ISR. The Systick counts down from 0x7D0 (#2000). When the counter value reaches zero, it enters the ISR handler. The handler takes 256 measurements and stores them starting from the location 0x2000.0400. Before storing them, the DC offset value is subtracted from the measured value. After finishing measurements, the Reload Value is set again to 0x7D0, and it starts to count down again.

After that, the ARM CMSIS DSP library is used, and frequency of the measurements are obtained. However meaningful frequency and magnitude values cannot be obtained.

b. Decision Unit

For watching the status of the step motor, a status address is used. The status address is 0x2000.0300. In the status address, the direction and speed of the motor speed are stored in 8 bits.

The lowest significant 4 bits are used for determining the direction. The direction is determined from the switches on the board. SW2 is assigned for CCW, SW1 is assigned for CW direction. In the decision unit, GPIO_PortF_ISR is checked whether any switch is pressed or not. If switches are pressed, the status data are updated and stored in the status address.

After that, the frequency and amplitude values are taken, and the speed configuration is set. If the amplitude value is lower than the amplitude threshold, the speed configuration doesn't change, and the LED is configured as OFF. If the amplitude value is higher than the amplitude threshold, it continues to the frequency decision section. The speed and LED configuration are set as shown in Figure 1. Then status data is updated for determining speed.

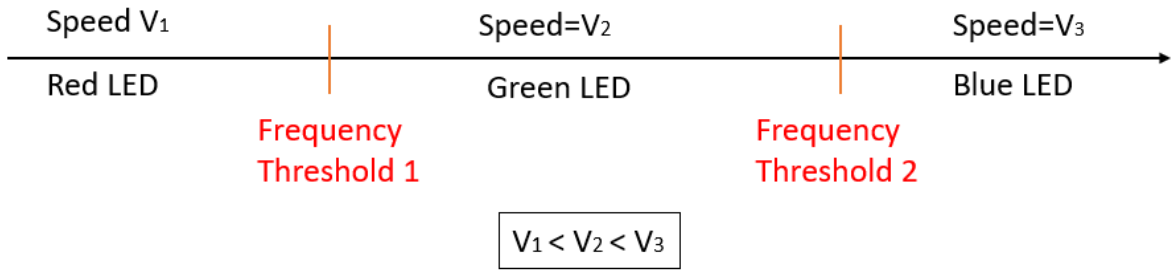


Figure 1. The speed and LED configuration for the step motor

Initially, the status data is configured as 0x41. The step motor starts to turn in CW direction and at normal speed. After that decision unit may change the status.

Status Data	**Explanation**
0xY1	CW direction
0xY0	CCW direction
0x2Y	Slow speed
0x4Y	Normal Speed
0x8Y	Fast Speed

**Y is used as don't care.*

c. Step Motor

GPTM Timer0 configures step motor direction and its speed. The timer is configured as periodic and count down. The prescaling is set as 63. In the handler, the status data in the status address is taken. According to status data, the direction is set for the step motor by changing the logical shift direction. For the speed configuration stated in status data, the counter value amongst three different values is chosen and stored to TIMER0_TAILR. Then, the TIMER0_ICR address cleared, and it started to count down again.

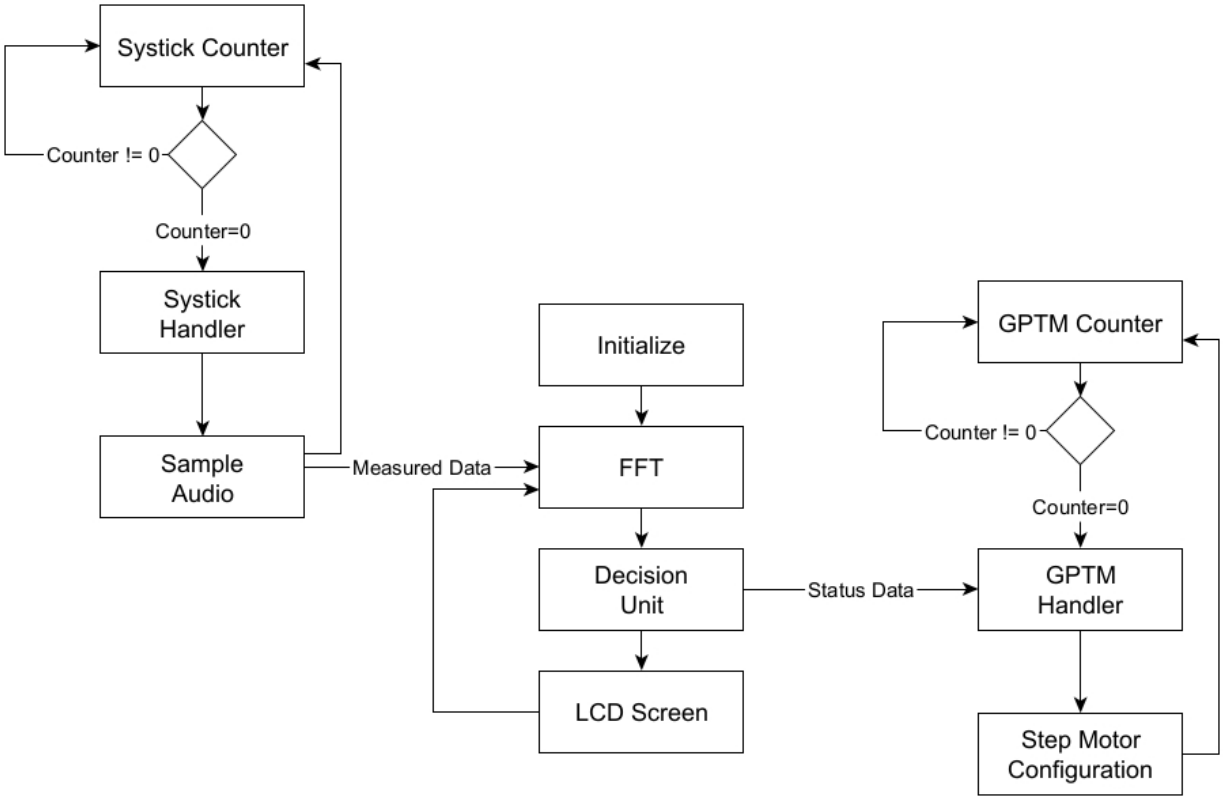
d. LCD Screen

Nokia 5110 LCD screen is controlled by using SPI communication protocol. For displaying characters and strings, different functions are configured. Firstly, the initial coordinates should be stated from the SetXY function to display anything. After that, the message should be stored in R5 as a string to display a message. OutStrLCD takes the string and displays it on the LCD screen by one-by-one ASCII characters. For changing values, in other words, current frequency and amplitude values, the modified Convrt function is used. Convrt function determines the amplitude or frequency values and converts each digit to an ASCII character. Each digit is displayed by calling the OutCharLCD function. Then, other digits are calculated, LCD screen coordinates are updated and displayed by calling the OutCharLCD function again.

3. Connections

TM4C123GXL	**Components**
+3.3 V	Microphone- Vdd
GND	Microphone- GND
PE3	Microphone- OUT
+3.3 V	Nokia 5110- Vcc
GND	Nokia 5110- GND
PA3	Nokia 5110- CE
PA7	Nokia 5110- RST
PA6	Nokia 5110- DO
PA5	Nokia 5110- DIN
PA2	Nokia 5110- CLK
VBus	Step Motor- +Vcc
GND	Step Motor- GND
PB0	Step Motor- IN1
PB1	Step Motor- IN2
PB2	Step Motor- IN3
PB3	Step Motor- IN4

4. Flow Chart

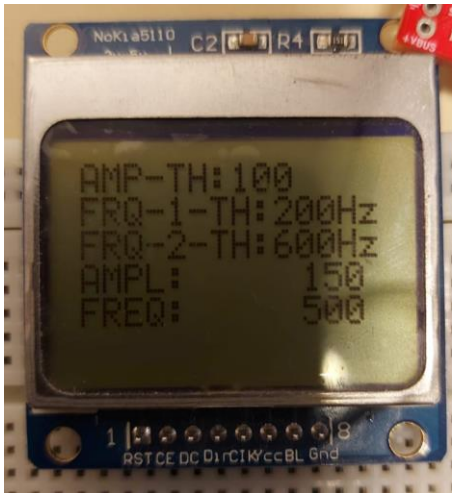


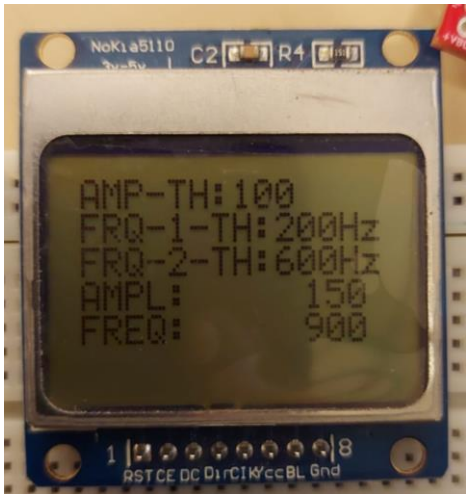
5. APPENDIX-1

Project video can be found from the following link.

https://youtu.be/cGYuEyrNX4I

6. APPENDIX-2


Nokia5110
C2
R4
AMP-TH:100
FRQ-1-TH:200Hz
FRQ-2-TH:600Hz
AMPL: 150
FREQ: 500
1
8
RST CE DC DinCLK Vcc BL Gnd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