

COLLEGE OF ENGINEERING

Department of Computer Engineering and Computer Science

**Functional Bluetooth Control Car**

CECS 447: Microprocessors and Controller III

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# Introduction

This is the report for the final project of CECS 447. The project is a design of a Bluetooth control vehicle with some additional functions. The purpose of the project is to apply as many concepts learned in CECS 346, 347, and 447 as possible. The concepts which were used in this project are embedded programming in C, A/D and D/A converters, UART, PWM, Speaker, LCD controller, Bluetooth HC-05, and polling and handling interrupts. The only required concept that was not used is stepper motor because I used a DC motor instead. The reason I used DC motor is because I own an L298N motor driver, and it have never been used it in any project.

The vehicle is controlled by Bluetooth app on the cellphone. The vehicle is driven by two DC motors. The PWM signals are sent from the TM4C microcontroller to the motor driver L298N to drive the motor. The speaker will output some music when the ‘brake’ command is sent, which means the music goes on when the vehicle stop. The vehicle utilizes a thermistor to measure the temperature and display the temperature information on the LCD.

# Operation

There are some major steps to build this project. The first step is to implement the generic Bluetooth vehicle. In this step, I worked on controlling the DC motor by configuring controlled pins and sending out PWM signals in order to obtain proper vehicle’s movement. Then I configured the HC-05 Bluetooth module to control the vehicle. The second step is to implement the music module. The music module contains a DAC converter and a speaker. The DAC will convert digital signal sent by the TM4C to analog signal which can outputted by the speaker. The speaker will play the ‘Twinkle Twinkle Little Star’ song when the vehicle stops. To play the song, each note will have its frequency and duration. The frequency of the note is controlled by Timer0A, the duration of the note is controlled by Timer1B. The final step is using the ADC function to get the data from the thermistor then convert this data to a rational data to display on the ST7735 LCD. For adding new function to the vehicle, I usually worked on this function separately before embedding this function onto the vehicle.

Set of commands to control the vehicle:

‘w’ – move forward

‘s’ – move backward

‘a’ – turn left

‘d’ – turn right

‘b’ – brake

# Hardware

* A picture containing table, white, different, colorful

  Description automatically generated**Hardware Block Diagram**

Figure Hardware Block Diagram

* A close up of a map

  Description automatically generated**Schematic**

Figure Schematic

* **List of components**

|  |  |  |
| --- | --- | --- |
| Component | Description | Reason |
| Tm4c123gh microcontroller | 32-bit high performance ARM Cortex-m4 microcontroller | Required |
| HC-05 Bluetooth | Bluetooth communication module | Required |
| 10K thermistor | Type of resistor whose resistance is dependent on temperature | The only temperature sensor I found in my toolbox |
| 10K resistor | 10K ohm resistor | It is comparable with the thermistor |
| Adafruit ST7735 LCD display | 1.8 inches color TFT LCD | The only LCD that I have |
| MCP4801 DAC | Single channel 8-bit DAC | Was used from CECS 347 |
| Toshiba TA7222AP | 5.8W audio power amplifier | Was used from CECS 347 |
| Speaker | 8Ohm speaker | Was used from CECS 347 |
| L298N motor driver | Dual H-Bridge motor driver | I haven’t used it before. It has an internal 5V regulator which I used to power the tm4c123gh |
| 2 DC motors | DC 3V - 6V Geared Motor | Came with the car chassis when bought |
| Car chassis, wheels | Car chassis, wheels combo bought from amazon | Was bought for my CECS 346 project |

# Software

This project uses the interrupt-driven approach. The only polling interrupt signal is the signal received from the HC-05 Bluetooth module. The other interrupts signal are timer interrupts and ADC interrupt.

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  Description automatically generatedA close up of a map

  Description automatically generatedSoftware flowchart

Figure UART2\_Handler flowchart

Figure Timer1B\_Handler flowchart

Figure Timer0A\_Handler flowchart

A close up of a map

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Figure Software flowchart

# Video Demonstration

YouTube Link: <https://www.youtube.com/watch?v=NWSlVS8m4B4>

A picture containing toy, small, hand, black

Description automatically generatedA close up of a device

Description automatically generatedA picture containing meter, engine

Description automatically generatedA screenshot of a cell phone

Description automatically generated

Figure Car Image 2

Figure Car Image 3

Figure Bluetooth Control

Figure Car Image 1

# Conclusion

In conclusion, this project is very interesting. The successes of the project are that I get a chance to implement many embedded functions that I have learned and encounter many problems I haven’t seen before. It is easy to implement a single function; however, putting many functions into a system need to take into many considerations. Another success is timing. Timing is critical in designing embedded systems. In order to make all components work properly in the timing manner, it takes a great deal of work and effort. The failure of the project is the use of L298N motor driver and DC motor because DC motor took a lot of power. If the power source is low, the motor will be able to short entire system. Nevertheless, L298N has an internal 5V regulator which allows me to power the microcontroller. This is clearly a tradeoff.

# Source code





















