Project Final Report

Configurable Temperature Logger

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Project Abstract

The project I did is called Configurable Temperature Logger. Instead of creating and purchasing new hardware, I chose to take advantage of everything I've learned from class and components loaned from the university to build this project, thus to let me see the potential of these hardware and also to maximize my chance of accomplishing this task.

The project contains three main functional parts which are indicated by the project name. First of all, it measures temperature with accuracy. Second, the temperature information is stored in certain way. Third, there are methods to configure the way of the temperature logging and fetching.

I used a PWM temperature sensor to measure the environment temperature, a real time clock to add time stamp (date and time) for information needed, and SD card inserted in a mini board to store and display temperature result. The configuration part is done by writing a CLI to access Zneo through serial cable.

Status

There are more things planed than the work I got at the final demonstration. Originally I planned to use not just the console window but also the LED array on Zneo to display some of the information. It didn't work because I failed to deal with the conflicts of ISR needed for scanning the LED array and the ISR needed for other functional parts. Another change is that I opted out of a more delicate temperature record and analysis system. It could be done mostly in software, and unfortunately I didn't get to it since there's no enough time.

Specification

As I mentioned earlier, the hardware components I used are all from the university loaned development kit.

- Microcontroller – Z16F
- Temperature sensor – TMP04
- Real time clock – DS1307
- SD card mini board – ET-MINI SD/MMC

Jumper wires (both F to M and M to M) are needed to connect these components, A RS232 serial cable is used to let Zneo and my laptop to talk to each other (via putty) and my own Transcend SDHC 16GB SD card (formatted as FAT32) inserted in the SD card mini board. TMP04 sits at a bread board.

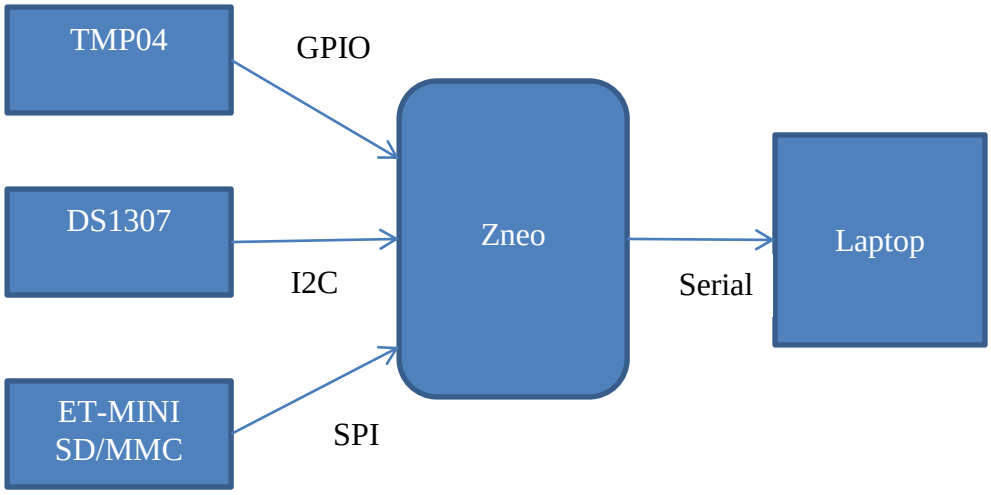
The capabilities of Z16F I used include:

- UART (to implement CLI)
- I^2C (to interface real time clock)
- SPI (to interface SD card)
- Interrupt (to control timing aspects of the system)

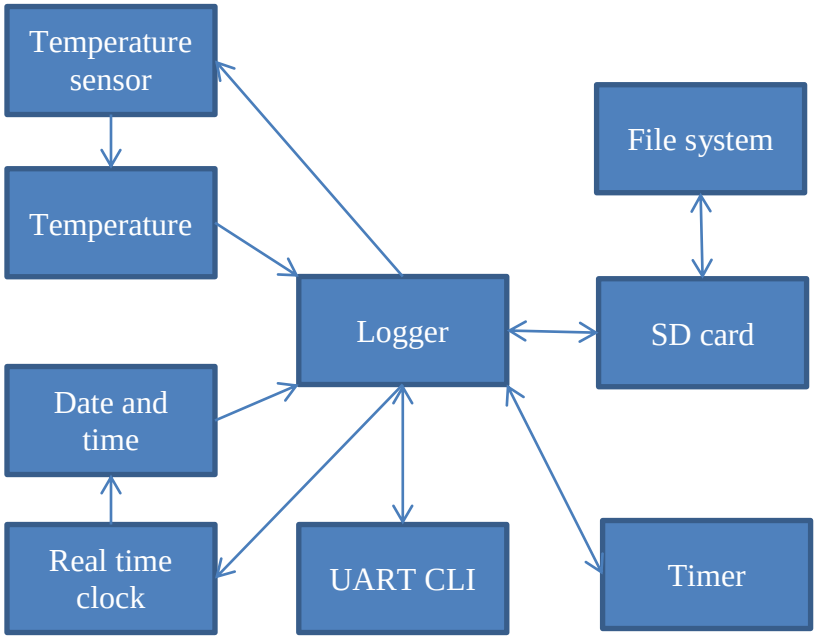
Software modules include I2C – i2c.c, SPI – spi.c, SD card – sdcard.c, file system – fs.c, fsformat.c, fssupport.c, real time clock – ds1307.c, CLI – cli.c, logger – logger.c, timer – timer.c and Utils – utils.c. Main function initializes all components and provides an entry to the CLI command menu, then implement all commands inside a while loop. The supported commands are:

- SD card command:
    - >> 1: Get File/Dir List
    - >> 2: Read File
    - >> 3: Write File
    - >> 4: Delete File
    - >> 5: Get Dir File List
    - >> 6: Create Dir
    - >> 7: Delete Dir
    - >> 8: Card Statistics
    - >> 9: Format SD Card
- Application command:
    - >> A: Get Current Date & time
    - >> B: Set Date & Time
    - >> C: Get Current Temperature
    - >> D: Set Temperature Format (F/C)
    - >> E: Log Once
    - >> F: Set Logging interval
    - >> G: Start Logging
    - >> H: Abort Logging
    - >> I: View Temperature Data
    - >> ?: Display Menu Item

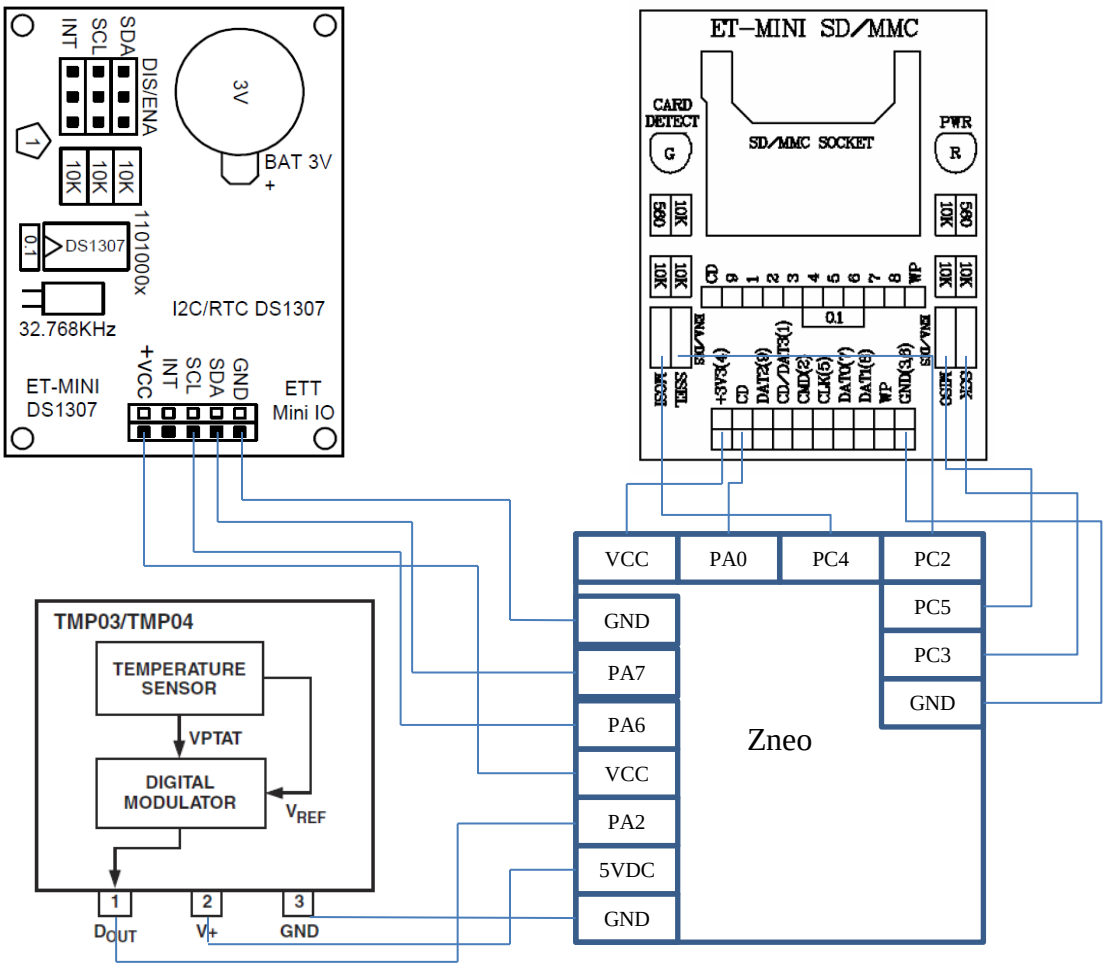
Implementation & Construction



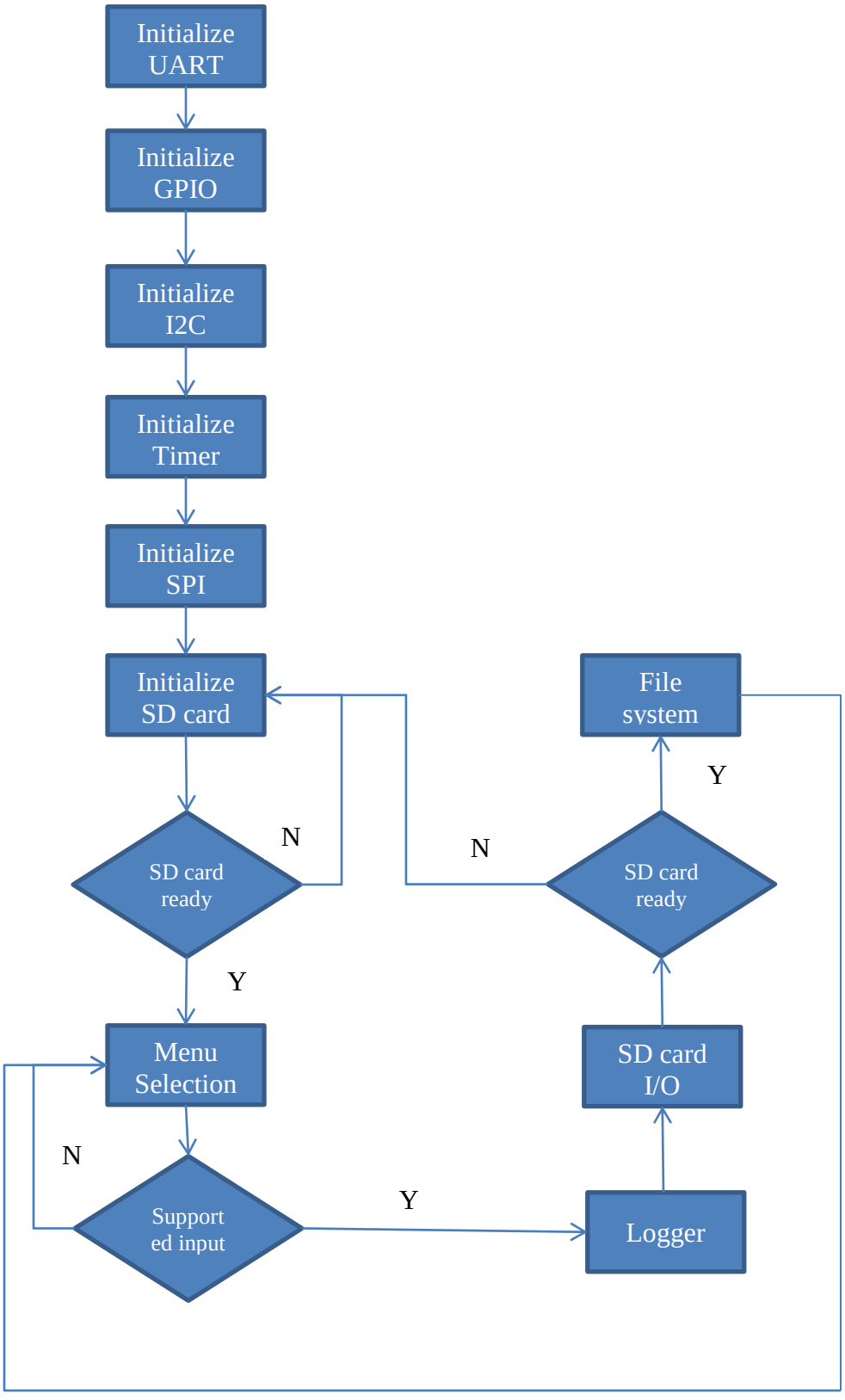
Hardware block diagram



Software block diagram

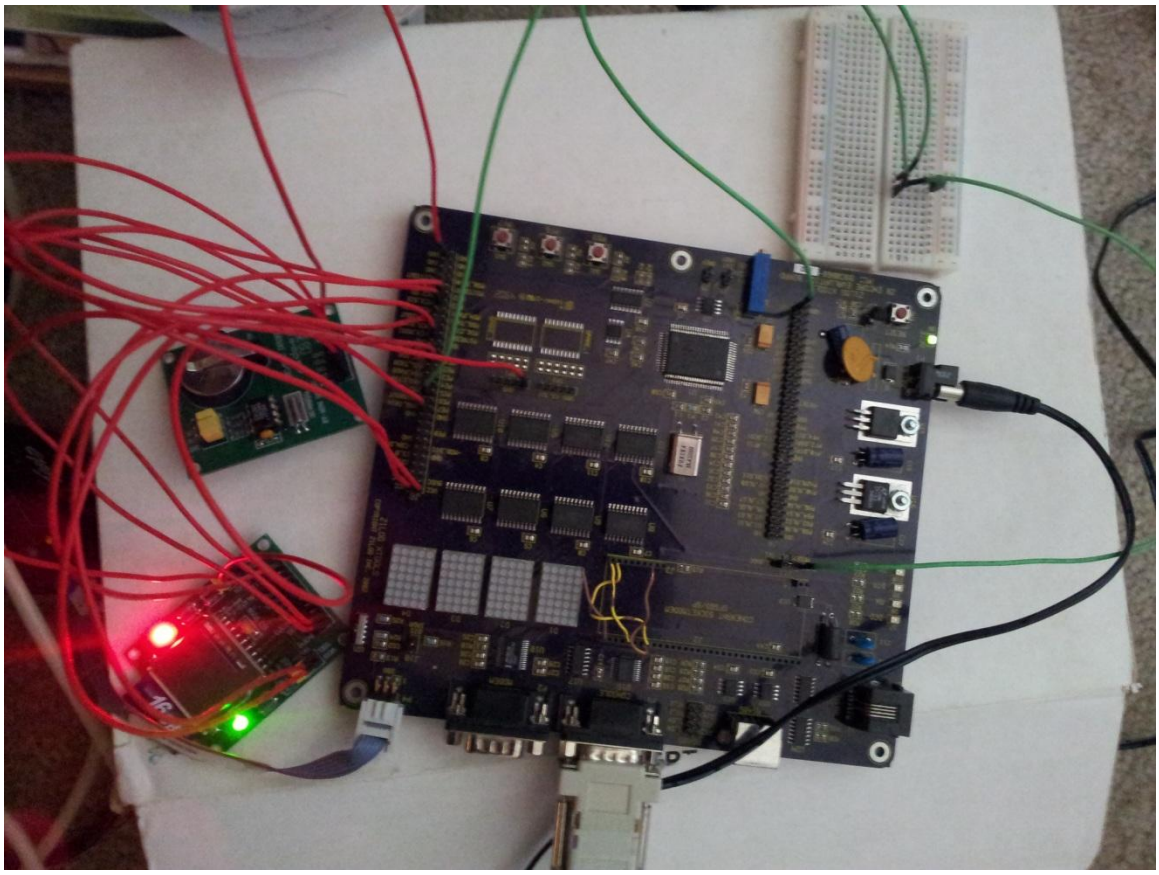

INT
SCL
SDA
DIS/ENA
3V
BAT 3V
+
10K
10K
10K
DS1307
1101000x
32.768KHz
I2C/RTC DS1307
ET-MINI
DS1307
+VCC
INT
SCL
SDA
GND
ETT
Mini IO
ET-MINI SD/MMC
CARD
DETECT
G
SD/MMC SOCKET
PWR
R
CD
WP
0.1
TMP03/TMP04
TEMPERATURE
SENSOR
VPTAT
DIGITAL
MODULATOR
VREF
DOUT
V+
GND
VCC
PA0
PC4
PC2
GND
PA7
PA6
VCC
PA2
5VDC
GND
PC5
PC3
GND
Zneo

Schematics



Flow chart (none SD card operations are not shown)

Milestone	
2/21/2012	Project proposal: MP3 player
3/15/2012	Study required hardware and software
3/20/2012	SD card file system study
3/25/2012	mp3 decode study
4/1/2012	change of plan, new proposal: configurable temperature logger
4/9/2012	Finish basic SD card I/O function
4/13/2012	Finish temperature recording into SD card
4/20/2012	Finish interfacing real time clock and CLI
4/22/2012	Project enhancement and test



Picture of finished project

Retrospective

These are the important design decisions I've made:

- Use PWM TMP04 temperature sensor. This decision makes things actually easier. This sensor outputs digital signal directly so that I can simple use one GPIO pin to capture its pulses, unlike regular analog sensors which requires ADC. However, in order to provide accurate results, one should be careful with using while loop to count pulse width, and the key is to eliminate any unnecessary statements before and after one high or low looping count.

- Use SD card to store temperature data is another important decision. To interface with SD card using SPI isn't hard, yet to deal with the FAT file system is huge challenge. Fortunately, Zneo released an application note talking about how it is done with source code. It pushes things much faster. After study it for a while, I gained some basic understanding of file system, and then I am able to modify the source code the way I want to meet the requirement of my project. Also, the mini board's CD pin can be used to detect the SD card's insertion status, and this another benefit.

- The file I used to store temperature data. Temperature information is stored and is also read. There should be an easy way to do that. I think the most reasonable way is to store all temperature data in one file whose name is the date when the logging happens. In this way, I can fetch those logging data easily by using data information, and logging can automatically create txt file if it finds no file is created for the date.

I am really amazed what these small and simple hardware are capable of doing. At first, I really had no idea of how it can work, and many things remained unknown to me. Luckily, when I kept reading class slides, text books and talk to professor Eisenreich, it is

becoming clear eventually. I made it work, although it is not a too complicate project. If I am going to redo the project, I think I'll add a few enhancements. A LCD display would be great to serve as an additional view, an internal algorithm to produce scientific level temperature information and more sensors to collaborate to give more complete environment parameters. I learned a lot from this class and I am going to miss the days when I was banging my head in front of Zneo.

Attachments

- TMP04 data sheet
- DS1307 data sheet
- ET-MINI SD/MMC data sheet
- AN0320 Implementing a Secure Digital Card with a ZNEO Microcontroller application note
- Project source code