**ENEL 387 Project Final Report**

**Apr. 3, 2017**

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**SID: 200351253**

**Hardware Description**

**Block Diagram:**

C:\Users\Daniel Shevtsov\Downloads\Untitled Diagram.png

**System Inputs:**

The following is a list of inputs available to users of the system, and their purpose:

* Analog Joystick
  + The analog joystick provides movement and selection capabilities. With it, the user may navigate through the interface and select games. Different games can use the joystick differently (e.g. character movement, option selection)
* Button A and Button B
  + Buttons A and B are general purpose user buttons. In general, A is used to ‘accept’ an action, and B is used to ‘cancel’ an action. Within a game, these buttons may be bound to different operations depending on game controls.
* Menu Button
  + The menu button serves to allow the user to return to the main menu and select games. Returning to the menu can be done from any game, at any point in the game.

**System Outputs:**

The following is a list of outputs available to the system, and their purpose:

* LCD Display
  + The 4x16 text display is the main output of the system. It is the primary device that users use to interact with the menu and various video games. Different video games can use the device differently, and each may have its own user interface.
* 4 LEDs
  + The 4 LEDs complement the LCD display by providing additional information to the user during gameplay. Different games may implement usage of these LEDs differently, with features such as displaying remaining player health, or flashing when a round ends.
* Buzzer
  + The buzzer is a form of basic audio output from the system. It provides the user with different cues depending on the game played. For example, it may alert the user when they take damage, or when a round completes, accompanied by visual cues from the LEDs and LCD display.

**Electrical Schematic:**  
Please see file doc/schematic.pdf for the full electrical schematic of the device.

**Datasheets:**

Please see files under doc/datasheets for vendor datasheets of components used in this device. See doc/functional\_specification.docx for more information on this device.

Vendor datasheet description:

* doc/datasheets/4x16\_lcd.pdf
  + Datasheet for NHD-0416BZ-FL-GBW 4x16 LCD Module
* doc/datasheets/piezoelectronic\_buzzer.pdf
  + Datasheet for TDK PS1240P02BT Piezoelectronic Buzzer
* doc/datasheets/pushbutton.pdf
  + Datasheet for E-SWITCH KS-01Q-01 Pushbutton
* doc/datasheets/thumbstick.pdf
  + Datasheet for Adafruit MINI 2-AXIS ANALOG THUMBSTICK

**Software Description**

**Summary:**

This project implements a device capable of running multiple basic video games. At the core of the device is the STM32F100RB micro-controller, and the device comes with a basic controller with an analog stick, two buttons, a menu button, and a buzzer for audio cues. Games run on a 4x16 text display, with games also making use of four LEDs to display the game status to the player. When the system starts, the user is greeted with a menu to pick between available games, and at any point during a game, the user may choose to return to the menu and select a different game to play.

**System State Diagram:**

C:\Users\Daniel Shevtsov\Downloads\StateDiagram.png

**System States Table:**

The table below maps states to the indices that they are represented by in the program:

|  |  |  |
| --- | --- | --- |
| **INDEX** | **STATE** | **IMPLEMENTED IN** |
| 0 | Splash | prog\_splash.c |
| 1 | Main Menu | prog\_main.c |
| 2 | Game 1 – Snake | prog\_snake.c |
| 3 | Game 2 – Tic-Tac-Toe | prog\_tictactoe.c |
| 4 | Game 3 – Connect Four | prog\_connect4.c |

**Testing Documentation:**

[**No date (Feb – Mar)]**

Confirmed working operation of microcontroller, LEDs, and LCD display during ENEL 387 labs.

[**Mar. 11, 2017]**

Started tracking testing procedure. Laid out components on breadboard and wired the thumbstick and the buzzer to interface with the microcontroller.

[**Mar. 22, 2017]**

Struggles with configuring buzzer. Datasheet lists 70dB/10cm @ 3V rectangular wave, 4KHz frequency, but the device was very quiet in this configuration. Created a small program to iterate through a range of frequencies for a square wave using PWM @ 50% duty cycle to observe the maximum volume that could be produced by the buzzer. Created a simple program to test the operation of the buzzer, thumbstick, and SysTick timer interrupt. Thumbstick tested to be working successfully, outputting a value between 0x000 and 0xFFF in the X and in the Y directions. Used SysTick to successfully create alarm-like beeping with the buzzer, although the buzzer was still too quiet.

[**Mar. 23, 2017]**

Wired the three buttons to the microcontroller following the electrical schematic and wrote a small test program to ascertain their correct operation. Button B worked as intended, but buttons A and MENU were stuck at ON state.

[**Mar. 24, 2017]**

Tested same program again, this time all buttons worked correctly. This might be an issue with some contacts, but I could not replicate it in my testing.

[**Mar. 26, 2017]**

Created a driver for the thumbstick to allow detection of 4 directions (positive and negative x and y axes) and tested with a simple program that turns on an LED corresponding to a direction of the thumbstick. See diagram below for a graphical representation of the driver’s operation.

C:\Users\Daniel Shevtsov\Downloads\thumbstick.png

Created the basic skeleton for the state machine based on the state diagram and table. Each state prints out its own name to the LCD display to indicate which state is currently active. Created the interrupt handler for PD2 (Menu Button) as EXTI0\_IRQHandler to always change state to main menu whenever menu button is pressed (except when the state is splash screen or main menu).