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COMPUTER HARDWARE LAB

Report

Project 3: Snake game

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1 Introduction

1.1 Concept

Snake is the common name for a video game concept where the player maneuvers a line which grows in length, with the line itself being a primary obstacle. The concept originated in the 1976 arcade game *Blockade*, and the ease of implementing *Snake* has led to hundreds of versions (some of which have the word *snake* or *worm* in the title) for many platforms.[1]

1.2 Requirements

Snake game project: Implement the concept and functionality of a snake game using the hardware components listed below:

- MAX7219 Dot Matrix 4-in-1.
- Choose an option: STM32F103C8T6, ESP32 NodeMCU or Arduino.
- Keypad.
- Joystick.
- LCD display: Displaying the state/info according to the design.

1.3 Why we choose this project

This project allows us to apply the skills and knowledge we have learned so far in this course to follow the requirements and implement the concepts needed for the creation of an Arduino-based snake game. This is also a chance for us to improve our embedded programming skills and work as a team to finish the project.

2 Modules used and connections

2.1 Arduino Uno

Arduino Uno is a microcontroller board based on the ATmega328P. It contains everything needed to support the microcontroller. The Arduino Uno is one of the most popular and easy-to-use development board for learning embedded programming and developing simple projects. More information about the board can be found at Arduino Uno main page on Arduino Store.[2]

2.2 Joystick

This joystick is very similar to the 'analog' joysticks on PlayStation controllers.

Directional movements are simply two potentiometers - one for each axis. It also has a select button that is actuated when it is pressed down.

2.3 Keypad 4×4

The 4×4 matrix keypad is used as input in this project. It has 16 keys in total. The keys on the keypad are arranged in rows and columns. Each row and column is brought out to a single pin, for a total of 8 pins on a 4×4 keypad.

2.4 I2C LCD

This type of LCD is ideal for displaying text and numbers. The I2C LCDs module features a small PCF8574 chip (for I2C Communication) and a potentiometer for adjusting the LED backlight. The advantage of this module is simple wiring since it only uses 2 pins to control the LCD.

2.5 MAX7219 Dot Matrix 4-in-1

This module consists of four 8×8 LED matrix. Each one of them is driven by a MAX7219, which is an IC that is capable of driving 64 individual LEDs while using only 3 pins for communication with the Arduino.

2.6 Header board

All the modules are connected together using jumper wires and a self-made PCB as a header board. The PCB was made using the etching method:

1. Design the schematic and PCB Layout for the circuit using Altium Designer.

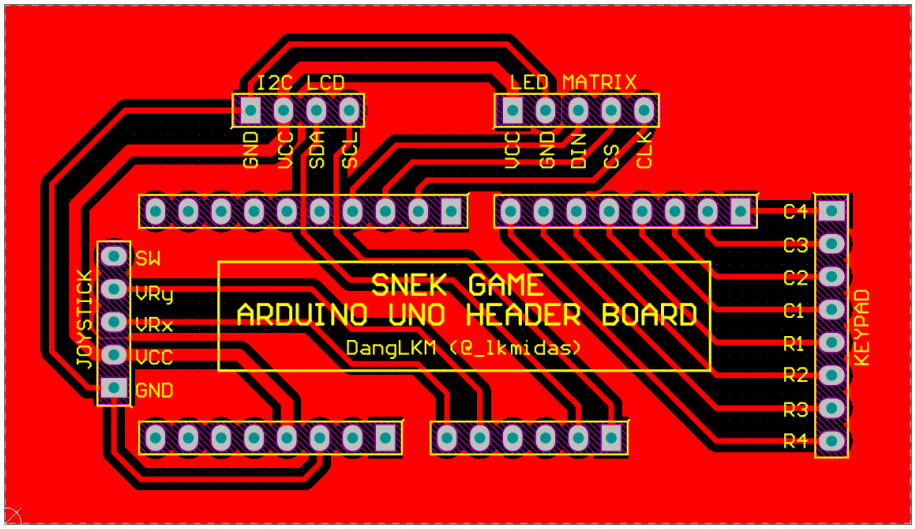

Figure 1: PCB Layout created using Altium Designer

2. Get the printout of the PCB layout in monochrome.
3. Cut the copper plate according to the size of the layout.
4. Iron on Glossy paper method: Transfer the printed image from the printed paper to the board using an electric iron. The ink on the paper will be transferred onto the copper plate.
5. Peel out the glossy paper then etch the ironed board in ferric chloride.
6. Drill holes on the plate using a hand drill.
7. Hand-solder the headers on the board.

2.7 Wiring instructions:

Keypad 4×4	Arduino Uno
C4	0
C3	1
C2	2
C1	3
R1	4
R2	5
R3	6
R4	7

Table 1: Wiring instruction for keypad 4×4 to Arduino UNO

Analog Joystick	Arduino Uno
SW	Not connected
VRy	A1
VRx	A0
VCC	5V
GND	GND

Table 2: Wiring instruction for Joystick to Arduino UNO

I2C LCD	Arduino Uno
GND	GND
VCC	5V
SDA	A4
SCL	A5

Table 3: Wiring instruction for I2C LCD to Arduino UNO

MAX7219 Dot Matrix 4-in-1	Arduino Uno
VCC	5V
GND	GND
DIN	11
CS	10
CLK	13

Table 4: Wiring instruction for Dot Matrix 4-in-1 to Arduino UNO

3 Functionalities and features

- The game menu and current score while ingame are displayed on the LCD.
- In the menu, the game title is scrolled on the dot matrix.
- The game menu can be navigated using the 4×4 keypad.
- The game boots into the first menu, press `1` to start the game, `2` to choose the difficulty, and `B` to switch to the second menu.
- Difficulty can be chosen using key `1` to `4`, ranging from easy as the easiest difficulty to hell as the hardest.
- In the second menu, press `3` to choose the border type of the game and `4` to view your last score and high score.
- Border type can be chosen between bordered and borderless using key `1` or `2`.
- In all of the sub-menus, press `A` to return to the first menu.
- As we start the game, the dot matrix will proceed to display the snake game. The snake's movement can be controlled using the joystick, the speed of the snake depends on the difficulty, and there are always 5 food blocks on the screen at a time. The game ends when the snake bites its own tail (and the border in bordered mode).
- Press `A` while in-game to pause the game and press `1` while pausing to quit the game and return to the main menu.
- Physically, all the modules and jumper wires are encased in a console-liked case, which is self-crafted using LEGO.

4 Features implementation

List of library used:

1. `MD_UISwitch` from https://github.com/MajicDesigns/MD_UISwitch:
   Manipulate the functionality of the joystick.
2. `MD_MAX72XX` from https://github.com/MajicDesigns/MD_MAX72XX:
   Use the LED matrix as a pixel device, displaying graphics elements to according to the design.
3. `LiquidCrystal_I2C` from https://github.com/johnrickman/LiquidCrystal_I2C:
   Interact with the I2C LCD display.
4. `Wire` from Arduino Standard Libraries:
   Used to communicate with I2C/TWI devices.
5. `Keypad` from https://github.com/Chris--A/Keypad:
   Used for using keypad 4×4 with Arduino.

The code used in the project was modified and improved from the source code from the tutorial *Snake game with Arduino* on the *Instructables* website.[3]

Noticeable modifications:

- Re-implemented the design logic into state machine based design to improve system's stability.
- Used I2C LCD as user interface instead of 7-segment LEDs and LEDs.
- Removed the power-up mechanism, replaced them with the borderless and bordered mode.
- Solved the problem of having the snake dies when issuing a movement in the opposite direction.
- Removed the potentiometer as the difficulty selector, replaced it with the keypad.
- Made the snake's movement more interactive.
- Improved the readability of the source code by adding comments and renaming variables and functions.
- Optimized memory used by removing some unnecessary global variables.

5 Product demonstration

The video where we demonstrate the product in details can be accessed at https://youtu.be/WMlZ-hNHN7w.

Below are some pictures of the finished product:

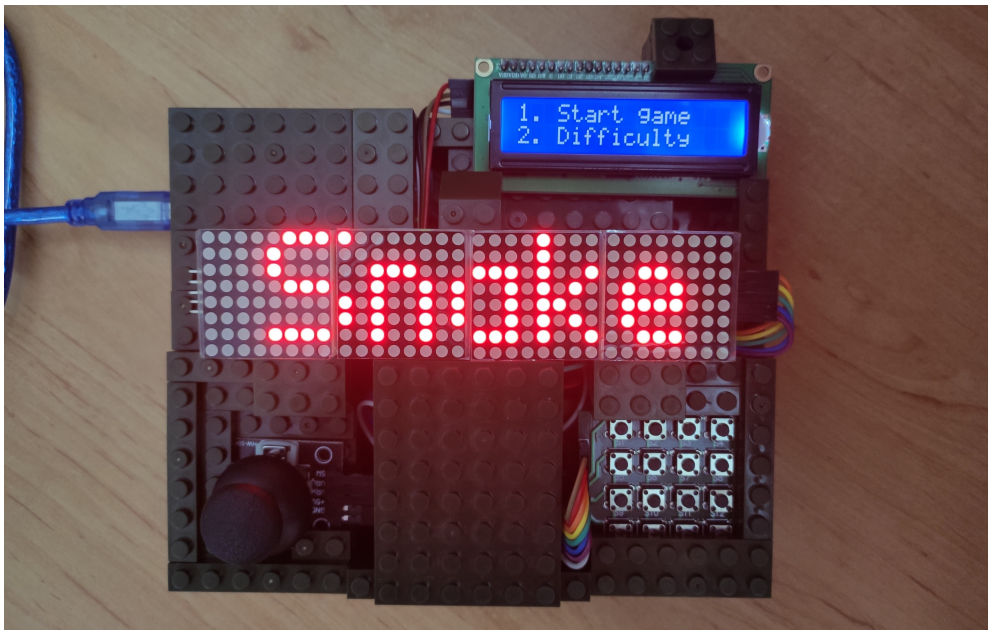

Figure 2: The first initial menu

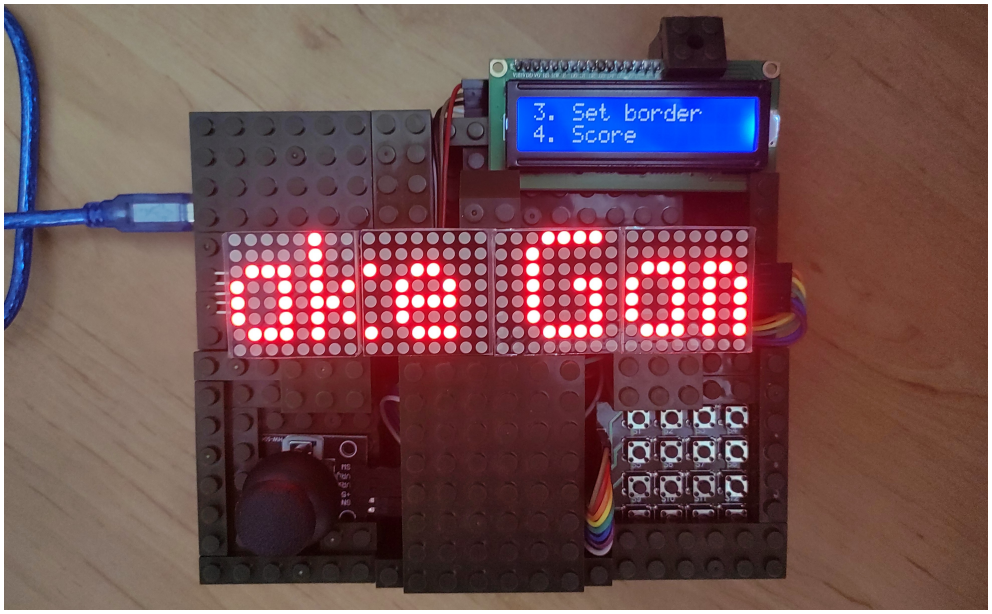

Figure 3: The second menu

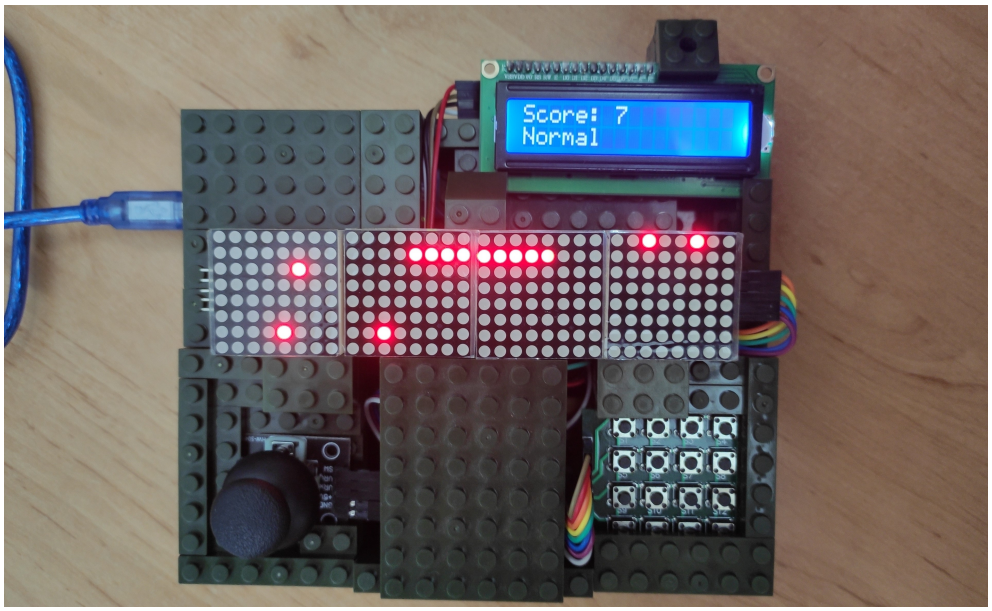

Figure 4: In-game, normal difficulty

6 Conclusion

6.1 What we have done so far

So far we have designed, connected the hardware modules and implemented the software concepts following the requirements of the project successfully. The result has been shown in the *Product demonstration* section.

6.2 Further improvement

As of now, the game itself is still somewhat bare-bones. Hopefully, we can implement the following improvements in the future:

- Use different module for the processor.
- Make the product more compact.
- Consider adding levels, obstacles, power-ups, etc.
- Design and extend the hardware for multiplayer.
- Consider making exciting multiplayer game modes.

References

[1] Snake (video game genre). (n.d.). In Wikipedia. Retrieved on July 13, from https://en.wikipedia.org/wiki/Snake_(video_game_genre)

[2] Arduino Uno Rev3 on Arduino Store. Retrieved on July 13, from https://store.arduino.cc/usa/arduino-uno-rev3

[3] Snake game with Arduino. Retrieved on July 13, from https://www.instructables.com/id/Snake-Game-With-Arduino/