EIE3810 Microprocessor System Design Laboratory

Lab 6. Mini Project

School of Science and Engineering

The Chinese University of Hong Kong, Shenzhen

2023-2024 Term 1

1. Objectives

In Lab 6, we will spend the 3-week session on the following:

- To design and build up a 2-player bouncing ball game based on the knowledge learned through Lab 1-5.
- To propose and improve the game based on your design.

2. Basics

In this lab, you are required to include all you have learned through Lab 1-5, including

- GPIO
- USART
- LCD
- External interrupt
- Timer

We have provided _SampleLab6.hex, Font.H (including 12×6, 16×8 and 24×12 sized fonts), and part of EIE3810_TFTLCD.c (including functions to draw a circle, and to display 24×12 sized fonts). You can download _SampleLab6.hex into the project board. This is a bouncing ball game for two players.

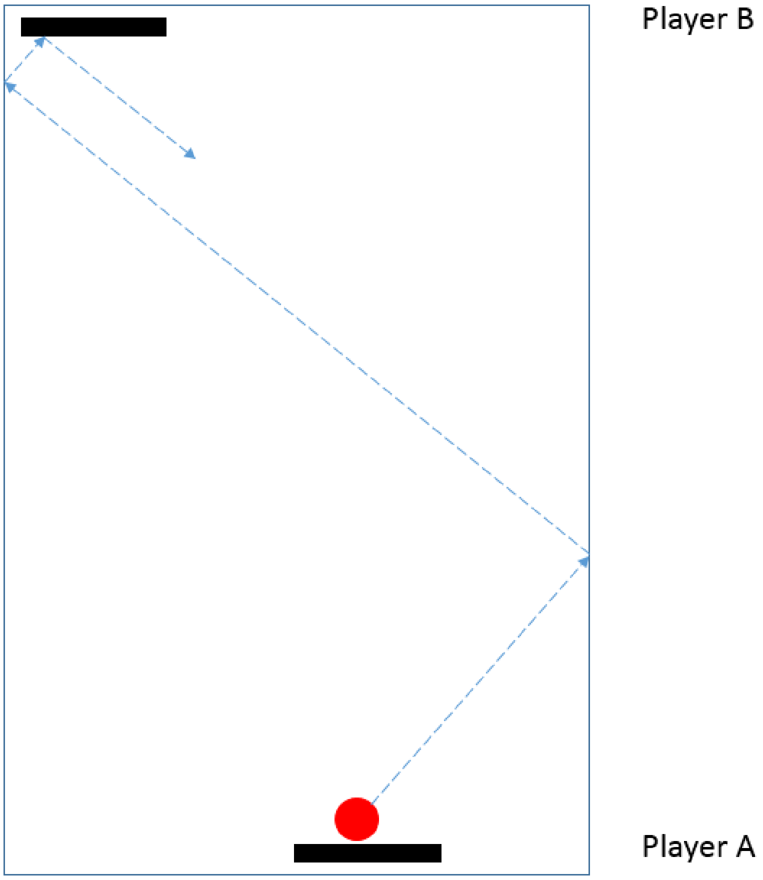


Fig. 1 General layout of the bouncing ball game

Here below is the simple manual to play it.

2.1 Connect the project board (USART1) to the computer through a USB cable. We also recommend powering the board with an external power supply. Connect JOYPAD to the board through COM3 of the project board. After that, power on the project board. Download the "_SampleLab6.hex" provided in Blackboard into the board. Then power off the board, and power it on again by pressing the blue button at the right upper corner of the board. This will allow for a more stable system startup, compared with pressing the red RESET button.

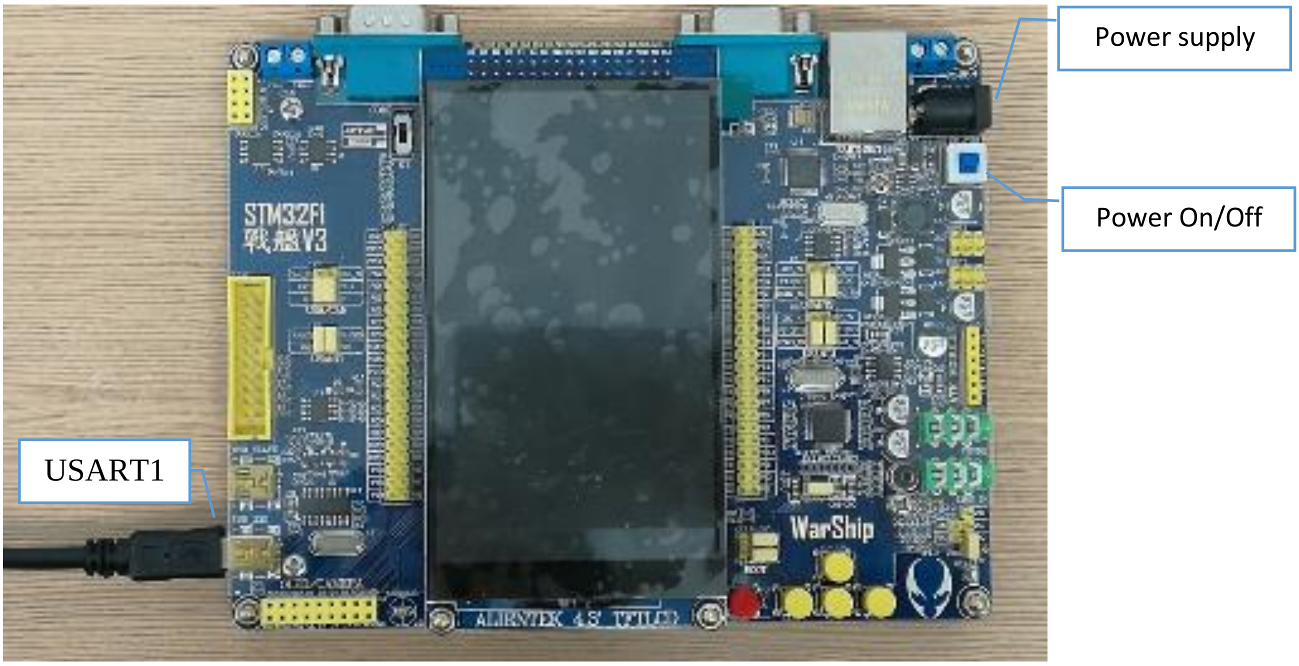
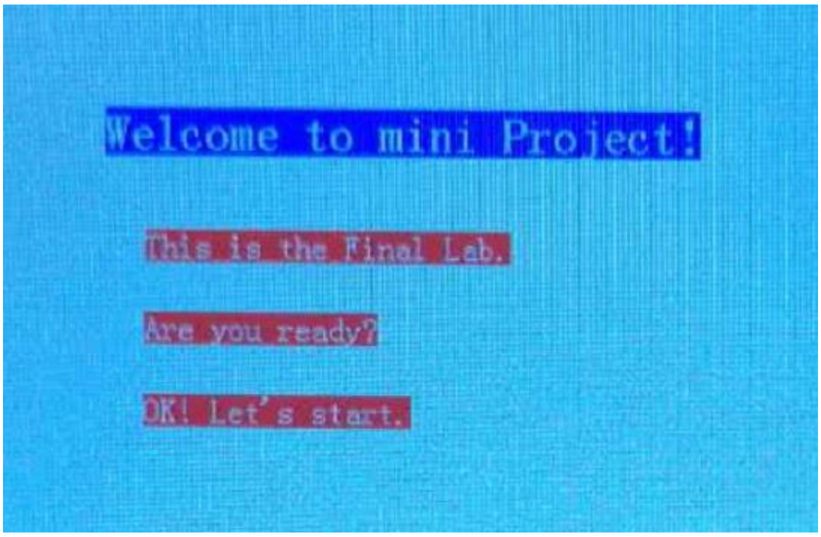


Fig. 2 Hardware settings

2.2 There will be a brief introduction text shown on the LCD (Fig. 3 and then changed to Fig. 4). Press Key_Up and Key1 to select the difficulty levels (i.e., easy or hard), then press Key0 to confirm. In the LCD, there will be one line of text, indicating to receive a random direction from USART (Fig. 4).

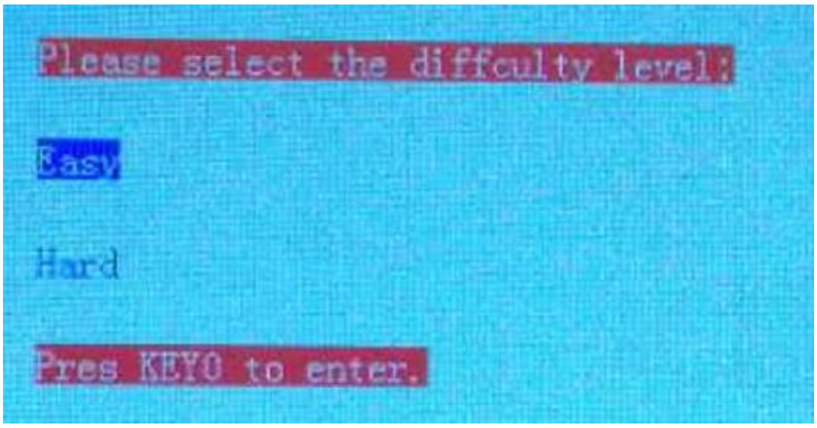

Welcome to mini Project!

This is the Final Lab.

Are you ready?

OK! Let's start.

Fig. 3 First page



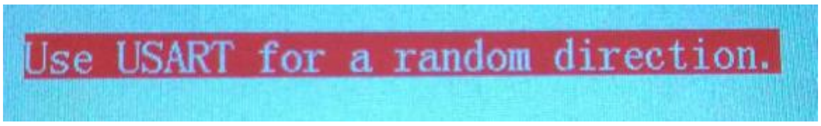
Please select the diffculty level:

Easy

Hard

Pres KEY0 to enter.

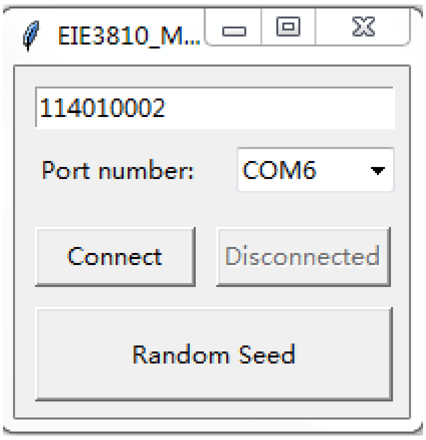
Fig. 4 Second page



Use USART for a random direction.

Fig. 5 Third page

2.3 Run Python code EIE3810_Lab6_PC.exe (provided in Blackboard). In the GUI (Fig. 6), input a **<u>sample student ID</u>** “114010002”, choose the correct COM port based on your computer setting, and click “Connect”.



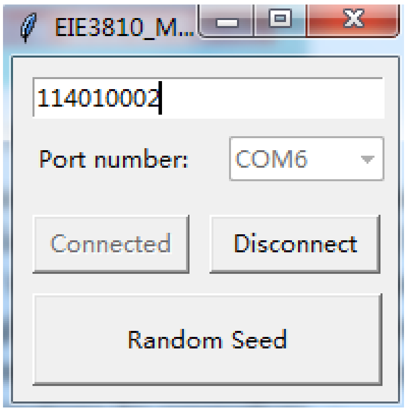
EIE3810_M...

114010002

Port number: COM6

Fig. 6 Input student ID and press “Connect”

Then, the COM port will be connected to the board (Fig. 7). Press “Random Seed” to generate a random number from the set {0, 1, 2, 3, 4, 5, 6, 7} by Python, and then transmit it through USART to the microprocessor. You can use this random number to specify 8 random directions when starting the ball. The sample code “_SampleLab6.hex” provides some references. You can always specify the random directions by yourself.



114010002

Port number: COM6

Fig. 7 The GUI connected to the board

Each frame of USART communication has 8 data bits (for the digits from 0 to 7) and 1 stop bit, with no parity bit. However, the baud rate is chosen according to the student ID input to the GUI based on some computation. You are required to use **your own student ID** for your own code. We do not give you the mapping of the baud rate to your student ID directly and would like you to get the baud rate by yourself. (Hint: use the oscilloscope to observe, and then set that to the baud rate in your coding.) When the random number is received, it will be shown on LCD.

2.4 A 3-second countdown will then appear on the LCD, and Player A will automatically kick off the ball in the specified random direction.

2.5 Player A will use Key2 and Key0 to change the position of the pad to bounce back the ball, while Player B will use Left and Right in the JOYPAD. When there is a bounce, i.e., the ball collides onto the two vertical boundaries or one of the two player's pads, it will change directions based on some rules, and the buzzer will make a sound. A simple rule is a reflection like a light.

2.6 The elapsed time and the number of bounces will be shown on the LCD.

2.7 If either Player A or B fails to bounce back the ball, he/she loses. Some text will be shown on LCD.

2.8 If Player A would like to pause the game, he/she can press Key1. A second press will continue the game. For Player B to pause/continue the game, press Start.

3. Experiment

3.1 Experiment 1: Realize the bouncing ball game

Write **your own code** to realize the game in 2.2-2.8.

[Demonstration] When you have completed each step (2.2, 2.4, 2.5, 2.6, 2.7, and 2.8), demonstrate to the instructor, TA, or technician, that your program works.

[In Report] Use an evidential way to show in your report that you have completed this experiment.

[Source code] Provide the source code with adequate comments.

3.2 Experiment 2: Improve the bouncing ball game

Use your creativity to make the game **more challenging**. Try your best to complete Experiment 2 with a 1-minute video explaining (verbally) and demonstrating your improvement. The video should be uploaded to Blackboard before the end of the last lab session.

[Presentation] We will not have questions in this lab report. The 20 points in question (of the report) will be substituted by Experiment 2 based on the criteria below.

- 5 points will be obtained for those who have improved the game and uploaded the video before the end of the lab session.
- An extra 5-15 points are given to the selected students whose improvement and video presentation are outstanding.

[In Report] Elaborate your proposed improvement, how you realize it, and then present the result that you have achieved.

[Source code] Provide the source code with adequate comments.

4. Lab Report and Source Code

Submit the report softcopy and your code (complete project folder of each experiment) in zip format to Blackboard by the deadline below:

- L01 (Friday Session): 9:00, Friday, December 22, 2023.
- L02 (Tuesday Session): 15:00, Tuesday, December 19, 2023.

Each day of late submission will result in 10% deduction in the report and source code raw marks.