Final Project

ECE 241
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Lab Section 01B & 07B

Objective: To create an 2 LCD games with an Arduino and external LCD screen that implemented the requirements. Both were scrolling games, where asteroids would approach the player. At the end of the games, they were supposed to print the correct results.

Part 1: The project we did was the LCD game. The first draft of the code was from project 8, and instead of using the `ButtonDebounce.h` file we put its contents in the main file, because we couldn't figure out how to get the header file to work with our program. After a couple hours of trying things, we finally figured out how to get the header file to work, and it drastically cut down the size of the main file. on this draft, we also implemented the first game, where the player tries to avoid the asteroids, and lose a life every time they touch an asteroid. When trying to write the `shiftArrayRight` method we ran into the problem where when an asteroid went off the first row, it would then appear on the second row, and likewise from the second row to the third, and the third to the fourth. This was because on the first draft, the starting position of `j` was 20 - 1 (19), which is the last index in the row of the array. When the program went to set the character in `j+ 1` to be the character at `j`, it would instead just access the next row of the array instead of throwing some kind of exception or reading garbage from memory. After fixing this bug, the game worked as intended. To implement the second game, we used mostly the same code as the first, but changed what the game did if we had a collision, and added a termination condition if the game had been going for over 30 seconds. We also changed what the end of game method printed. You can see the code in AppendixA. The project implemented the 5 features:

1. Button Press used to a) reset game (short press), or b) switch to another game (long press)
2. Encoder tracking consistent.
3. At least two games implemented.
4. Number of lives, or time shown and end detected.
5. Game speeds up over time.

The paradigm that we used was a state machine, using two kinds of enums, one to represent the game we were playing, and another to represent the game state (playing, end of game, new game, etc). Another important thing about the software of this project was writing lots of descriptive helper methods, so we just called those in the main program, which allowed us to think about the flow of the program at a more abstract level.

The testing we did was just to make sure the functionality worked, that the short and long presses did what they were supposed to, and that we accurately kept track of lives and encoder position.

```
If the current state was `Playing`
```

```
    If we are over 30 seconds and are game2, we set the state to be  EndOfGam
e and calculate the delta.
    If there was a long press, we switch the game we are playing
    If there was a short press, we make a new game
    We then clear the LCD and perform operations on the array to update it.
    If there was a collision, we handle that depending on which game we are p
laying.

If the current state was `EndOfGame`
    We print the end Data , reset `INTERVAL`
    If there was a button press, we change the state to playing and make a ne
w game.
If we are in some other state, we make a new game, and set the current state
to Playing.
```

You will find pictures in AppendixB

Appendix A

```
#include <LiquidCrystal.h>
#include "ButtonDebounce.h"

volatile int encoderPosition = 0;
int numRows= 4;
int numCols= 20;

float curRow;
float curCol;
char contents[4][20];
int lives = 5;

unsigned long timer;
unsigned long startTime;
unsigned    long delta;
LiquidCrystal LcdDriver(11,9,5,6,7,8);

// Set up pin and button state.
int bState;

enum GameStates { Pause,NewGame, Playing, BetweenGames, EndOfGame };
enum GameNumber {Game1, Game2};
GameNumber gameState = Game1;
GameStates curState = Playing;
unsigned long bTime;
char emptyChar =' ';
char spriteChar='*';

int INTERVAL = 200;
#define INIT_INTERVAL  200 //the interval to start out at and reset to at beg
inning of each game e

void setup()
{
```

```
    //pinMode(12,OUTPUT);
    pinMode(4,INPUT);
    prepopulateArray();
    attachInterrupt(digitalPinToInterrupt(2), MonitorA, CHANGE);
    attachInterrupt(digitalPinToInterrupt(3), MonitorB, CHANGE);
    Serial.begin(9600);
    ButtonInitialize(4);
    LcdDriver.begin(numCols,numRows);
    LcdDriver.setCursor(0,0);
    timer = 0;
}

void loop()
{

    if(millis() - timer >= INTERVAL)
    {
        if((INTERVAL - 10 > 50) && curState     == Playing    )//decrement ti
me interval if playing to speed up game
        {
            INTERVAL -= 10;
        }
        bState = ButtonTest();
        if(curState == Playing)
        {
            if((millis() - startTime)/1000 >= 30 && gameState == Game2)//if w
e are 30 seconds into game2
            {//we should end the game
                curState = EndOfGame;
                delta = millis() - startTime;//calculate how long the game wa
s played for
            }

            if(bState == 3)//use did a long press
            {
                switchGame();//we go to the other game
            }
            else if ( bState == 2)//short press
            {
                curState = NewGame;//just make a new instance of the current
game
            }
            LcdDriver.clear();//clear screen
            shiftArrayRight(contents);//move array right
            insertRandomChars(contents);//put the new asteroids in the leftmo
st side
            if(hasCollision(contents, curRow))//if the cursor is at the same
place an asteroid
            {
                if(gameState == Game1)//if game 1
                {
                    if(--
lives <= 0)//if the decremented lives is less than zero
                    {

                        curState = EndOfGame;
```

```
                        delta = (millis() - startTime);//calculate how long t
he game lasted
                    }

                }
                else//is Game2
                {
                    lives++;//we want to collect asteroides

                }
            }

            printArray(contents);//print out our array

        }//end playing
        else if (curState == EndOfGame)//we are at end
        {
            printEndData();//print out end of game stats
            INTERVAL    = INIT_INTERVAL    ; //reset interval
            if(bState==2 || bState == 3)//if they press button
            {
                curState = Playing;
                newGame();
            }
        }

        else
        {//if we end up here, something has gone horribly wrong
            newGame();
            curState = Playing;
        }
        timer += INTERVAL;//increment timer
    }
}
void printEndData()
{
            LcdDriver.clear();
            LcdDriver.setCursor(0,0);
            LcdDriver.print("End of game");
            LcdDriver.setCursor(0,1);
            LcdDriver.print(delta/1000);
            LcdDriver.print(" seconds");
            LcdDriver.setCursor(0,2);

            if(gameState == Game2)//if we got done with game 2
            {
                LcdDriver.print(lives);//actually represents how many collece
td
                LcdDriver.print(" collected");
            }
            LcdDriver.setCursor(0,3);
            LcdDriver.print("press button ");
            INTERVAL     = INIT_INTERVAL    ;
}
void prepopulateArray()
{
    for(int i =0; i<numRows-4; i++)//clears array
```

```
    {
        for(int j =0; j<numCols; j++)
        {
            contents[i][j] = emptyChar;//sets to space
        }
    }

    for(int i =0; i<numRows;i++)
    {
        for(int j =0; j<numCols;j++)
        {
            contents[i][j] = (random(0,100) < 20)? spriteChar:emptyChar; //ha
s a 20% chance of inserting a * at [i][j]
        }
        shiftArrayRight(contents);
    }
}
int switchGame()
{
    if( gameState == Game1)
    {//if currently at Game1, go to Game2
        gameState = Game2;
    }
    else if (gameState == Game2)
    {//else go to Game1
        gameState = Game1;
    }
    newGame();
}
bool hasCollision(char inArray[4][20], int r)
{
    if(inArray[r][19] == spriteChar) return true;
    return false;
}
void newGame()
{
    LcdDriver.clear();
    prepopulateArray();

    startTime = millis();//sets to now
    if(gameState == Game1)
    {
        lives = 5;//presets lives
    }
    else if ( gameState == Game2)
    {
        lives =0;//presets num collected
    }
    curRow=0;
    INTERVAL = INIT_INTERVAL;
}
void shiftArrayRight(char inArray[4][20])
{
    for(int i =0; i<4;i++)
    {
        for(int j =20-2; j>=0;j--)
        {
```

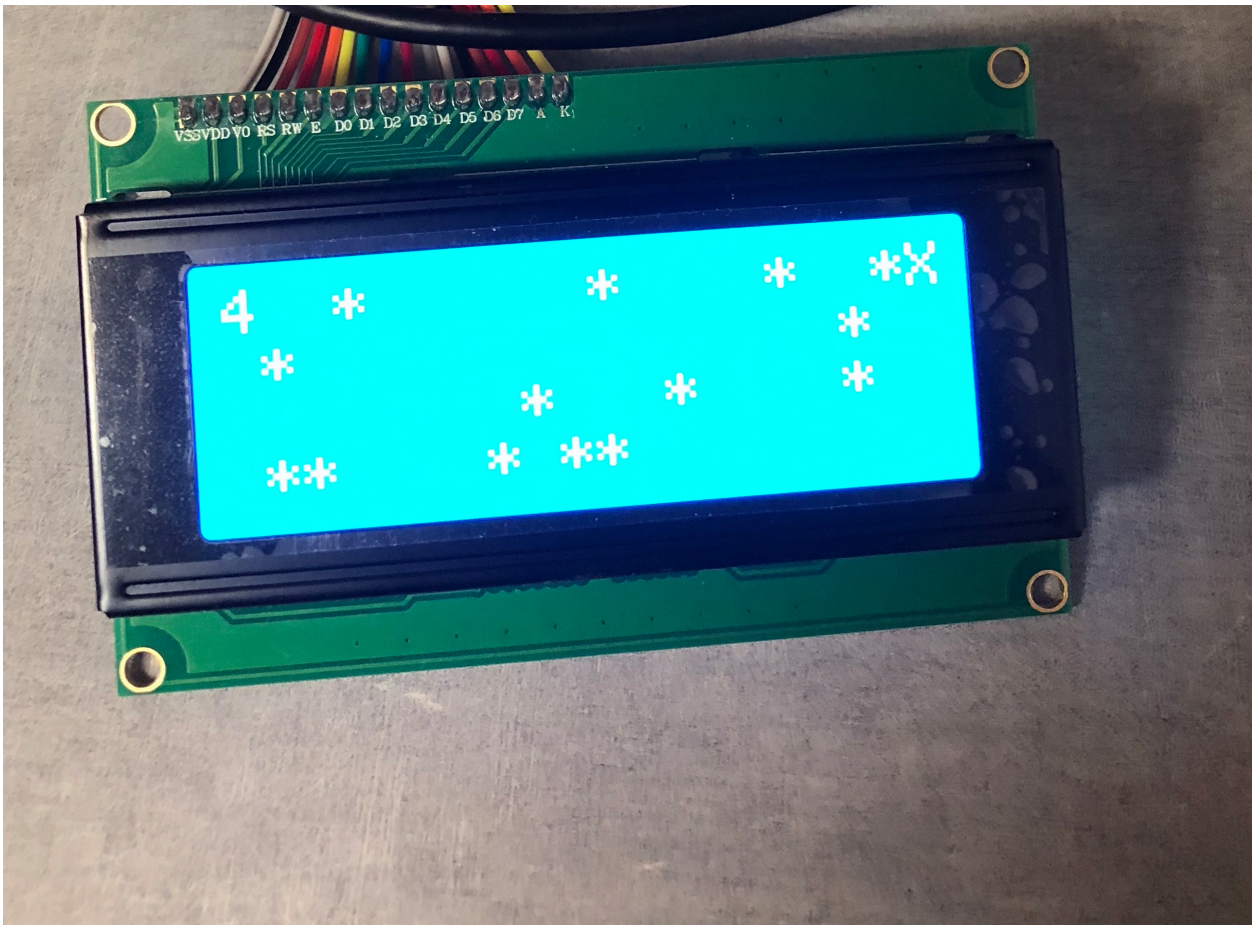
```
            inArray[i][j+1] = inArray[i][j];
        }
    }
}
void insertRandomChars(char inArray[4][20])
{
    for(int i =0; i<numRows; i++)//loop through rows
    {
        bool shouldPlaceNew = (random(0,100) < 15);
        if(shouldPlaceNew)
        {
            inArray[i][0] = spriteChar;
        }
        else
        {
            inArray[i][0] =emptyChar;
        }
    }
}
void MonitorA()
{
    if (digitalRead(2) == digitalRead(3)) //if inputA and input B are pins 2
and 3 respectively
    {
        incrementVHState(.25);
    }
    else
    {
        incrementVHState(-.25);
    }
}
void MonitorB()
{
    if (digitalRead(2) == digitalRead(3)) //if inputA and input B are equal
    {
        incrementVHState(-.25);
    }
    else
    {
        incrementVHState(.25);
    }
}
void incrementVHState(float n)
{

        curRow += n;
        if(curRow > numRows)
        {
            curRow = numRows;
        }
        if(curRow < 0)
        {
            curRow =0 ;
        }
        return;
}
```

```
void printArray(char inArray[4][20])
{
    for(int i =0; i<4;i++)
    {
        for (int j = 0; j < 20; j++)
        {
            LcdDriver.setCursor(j,i);
            LcdDriver.print(inArray[i][j]);
        }
    }
    LcdDriver.setCursor(19, curRow);
    LcdDriver.print('X');
    LcdDriver.setCursor(0,0);
    LcdDriver.print(lives);
}
```

Appendix B

This is the screen that is displayed at the end of the first game, it shows the number of seconds that the player played the game.

This is the screen that is displayed at the end of the second game, it shows the number that the player was able to collect in the 30 second time span.



This is the game in action, the cursor is on the right side, and the asteroids are moving across the screen, with the score/lives at the top left.