Eric Liu & Henry Dacres

Lab 7 Documentation

[CSE 379]

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Lab Objective

Pre - COVID-19

Lab Seven, Incorporates all of the concepts learned throughout the Labs #1 through #6 to design a game. Over the period of lab #7 students will use the ARM assembly language to implement the game of Pac-Man. Prior to the Covid-19 Pandemic, Lab #7 was to be implemented using the Serial Port (UART)—to accept the user's input and display the game. The RGB L.E.D which would have been illuminated during game play to indicate the number of lives remaining.Three lives remaining is indicated by green, two lives by yellow, and one life by red. When Pac-Man is powered up, the RGB LED would have been blue. The Momentary Push Button to be used as a pause button and the hardware Timer. Students will have the option to combine C code with their ARM Assembly code. Up to 200 lines of C code may be used to decrease development time.

Post COVID-19

Post COVID-19, Lab Seven lost the majority of the hardware components such as the RGB LED, Momentary Push Buttons. The lab shifted to a software based approach with the emphasis being on the ARM assembly language, Efficient programming and Hitting target based goals as outlined in the CSE-379 Lab Seven Checklist.

Purpose of Program

Program Objective

The Motivation

This game is motivated by the classic video game Pac-Man. The Program link can be found on the course website. This game will closely represent the gameplay and layout of this project.

The Story

You are Pac-Man. Your objective is to navigate a maze and eat all pellets along the paths of the maze, while avoiding four ghosts (Blinky, Pinky, Inky, and Clyde) as they navigate the maze.

The Gameplay The user uses the keyboard to move Pac-Man left, right, up, or down. Pac-Man eats the pellets in the maze as they are encountered. Ten points are awarded for each pellet eaten. The four corners of the maze contain power pellets. When one of the pellets is eaten, 50 points are awarded, and Pac-Man is empowered with the ability to eat a ghost. If Pac-Man comes in contact with a ghost while under the influence of a power pellet, the ghost will disappear, and return to the center of the maze, waiting for the effects of the power pellet to wear off before re-entering the maze. Pac-Man will receive 100 points for the first ghost eaten, 200 of the second, 400 for the third, and 800 for the fourth. This point distribution is repeated for every power pellet eaten. Pac-Man cannot move faster than the board refresh rate. Every time Pac-Man comes in contact with a ghost (while not empowered by a power pellet), a life is lost. If there are remaining lives, Pac-Man must restart in the center of the board in Pac-Man's initial position. You start the game with three lives, and the game ends when you have used up all your lives. When Pac-Man is empowered by a power pellet, coming into contact with a ghost will cause the ghost to return the box in the center of the room where the ghosts started. Pac-Man will continue moving the direction it was moving in when contact occurred. The ghost may not leave the room until Pac-Man is no longer powered up. When the game ends, the user must be informed that the game has ended. For example, "GAME OVER" might be displayed on the game board when the game ends.

The Board

The board in PuTTy will look something like the board shown below. Pac-Man is shown in the position in which it should start. Ghosts start in the center box, as shown, and once they leave, they don't re-enter the box unless they are apprehended by Pac-Man. Pac-Man may exit the board midway down the left or right side of the board, and wrap around to appear on the other side.

Game Speed & Movement

Initially Pac-Man moves two positions every second and the ghosts move three positions every second. When Pac-Man eats a power pellet, the speed of the ghosts and Pac-Man are swapped, so that Pac-Manmoves faster than the ghosts. After the effects of the power pellet wear off, the speeds revert back. After a level is completed (all pellets are eaten), a new game board is presented, and the game speed increases by 25%. When a power pellet is eaten, Pac-Man is empowered for 8 seconds. Ghost movement is random. When a junction is encountered by a ghost, it chooses a random direction and continues in that direction until it hits a wall or enters another junction (where a new direction is chosen). Each possible direction has an equal probability. During movement, if the ghost is ever within four spaces (horizontal or vertical) from Pac-Man, the ghosts should move away from Pac-Man if he is empowered or toward Pac-Man if he is not empowered.

Debugging Steps

The hardest parts of debugging this lab were the parts that required interaction with the hardware. The Tiva C Series board we used for testing presented some challenges mainly getting the Light-emitting diode to change to a blue hue. This bug was caused by a small syntax error where we used LDRB instead of STRB. This small mistype led to register values being mis-read and producing undefined behavior. After narrowing down the possible causes of the issue by process of elimination and stepping through the Assembly code in Code Composer Studio. The register values did not match the expected values so that led to us discovering the mistake and switching it to STRB.

A key feature of the Pac-Man game is the ability to teleport from one side of the board to the opposite side. When Pac-Man enters the center tunnel on the game board he appears on the opposite side of the board. This step took a lot of planning and conceptual thinking. The main issue was getting the address of the right side of the center tunnel to be next to the left side in memory so it was a seamless transition for Pac-Man and he could go back and forth without appearing on a random address on the board. After much discussion with the TA's we came up with a plan of attack and finished.

Outside Resources

1. ARM Assembly Reference Card
2. ARM Cortex-M4 Generic User Guide
3. Tiva™ TM4C123GH6PM Microcontroller
4. ARM Assembly Language Tools (Assembler Directives)

Instructions and Guidelines

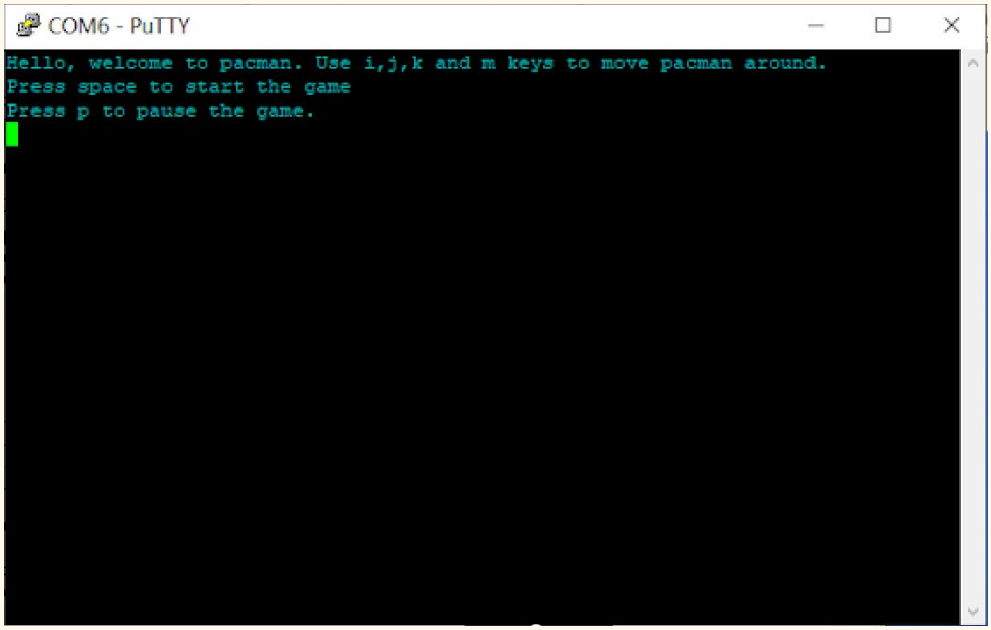
Guidelines & Relevant Information

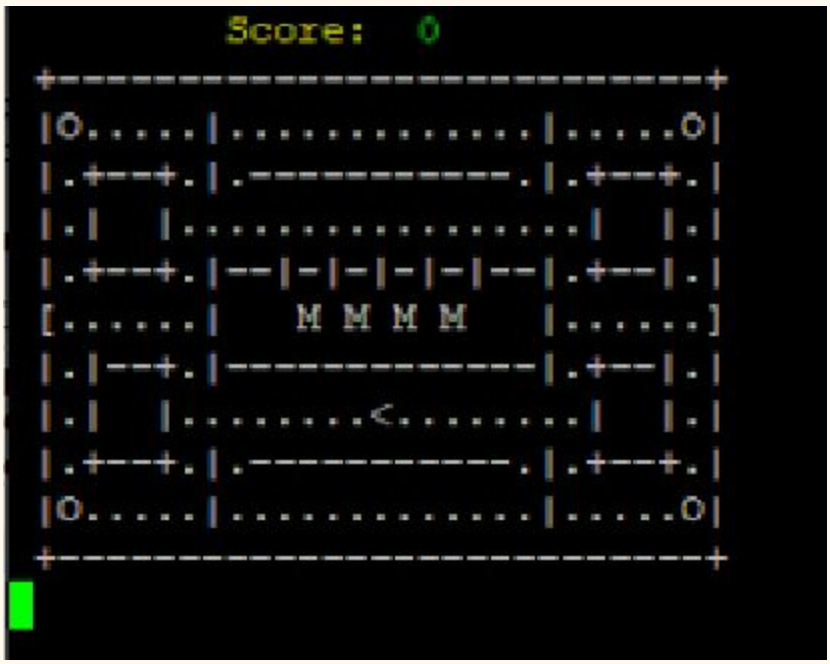
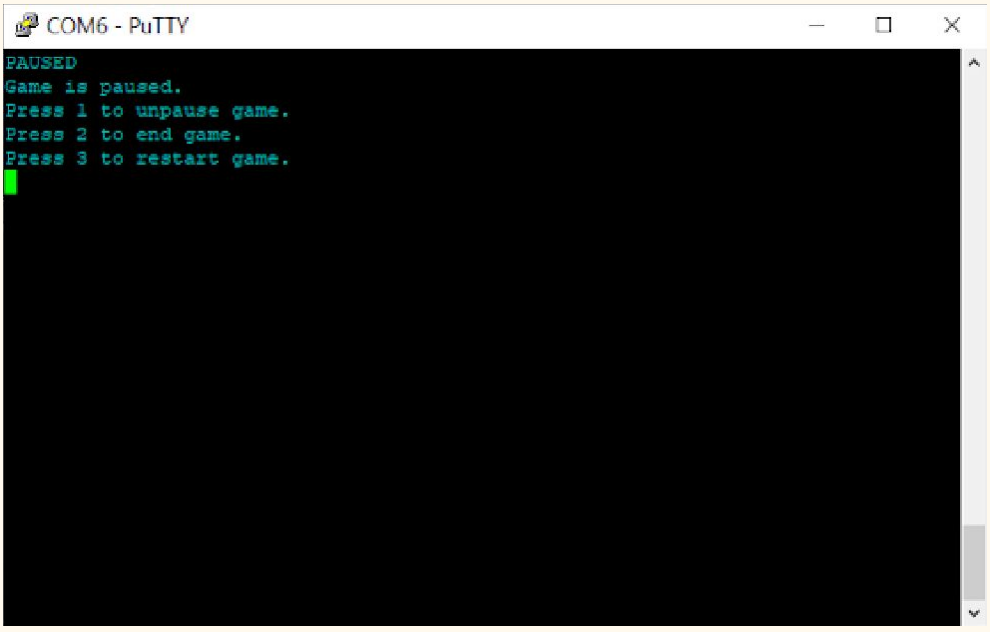
URGENT: DO NOT PRESS ANY KEYS NOT IN PROMPT

Movement
Up: i Down: j Left: k Right: m
Scoring System
Ten points are awarded for each pellet eaten
• The four corners of the maze contain power pellets • Upon consumption 50 points are awarded • Upon consumption, ghosts can be eaten
• 100 points for the first ghost eaten • 200 of the second • 400 for the third • 800 for the fourth
This point distribution is repeated for every power pellet eaten
Game Mechanics
Every time Pac-Man comes in contact with a ghost (while not empowered by a power pellet), a life is lost.
If there are remaining lives, Pac-Man restarts in the center of the

board in Pac-Man's initial position.
When Pac-Man is empowered by a power pellet, coming into contact with a ghost will cause the ghost to return the box in the center of the room where the ghosts started.
Pac-Man will continue moving the direction it was moving in when contact occurred.
The ghost may not leave the room until Pac-Man is no longer powered up.
When a power pellet is eaten, Pac-Man is empowered for 8 seconds.
When the game ends, the user will be informed that the game has ended.

Instructions

No.	Pic
Upon Start Read initial prompt	

Move Pac-Man around the board to avoid ghost and eat pellets	
Press p to pause the game	

Flowchart

LAB 7 FULL FLOWCHART

LOGIC

The flowchart follows the path of the code readers should begin at the “Startloop” and follow the arrows. The Startloop will link user output functions and input functions. The user can then follow the lab7loops which will wait, take user input and run throughout the game. The function will wait for conditions to to output the “GAME END” Message. If followed the reader will see the linking of the interrupts which will reflect the action on the game board. Once the game has started and the user has entered prompts the user will have control of pacman and Following the flow chart various interrupts will constantly be running and functions which control the random nature of ghost will also run in the background. The flowchart will have descriptions on the various functions and their defined behaviors

Subroutines Summary

Subroutine	Summary
Startloop:	Links necessary library functions for use in program
lab7loop	Displays the User interface to the player will display score,lives, and an end game message
Pellet Count Routine	This keeps a running total of all pellets eaten and add them to score
Reg Ghost	Keeps the track of ghost in there regular state and keeps track if pacman is within 4 spaces
isghost	Checks to see if the address pacman is currently at intersects with that of a ghost
newlevel	Increases game speed and resets offset of the ghost
Newlevloop	Loads the character from original board Stores them in the playing board
checkpause	Checks if Pause flag is set to 1

ispaused	Activates if pause flag is set to 1 checks to see if user has pressed a button to change state
out_of_respawn	Responsible to ghost behavior one they have spawned, (time before exiting box)
checkpacman	Check if pacman is within 4 spaces of a ghost if so set ghost to chase him
goawayleft	For running away from activated pacman to the left
goawaydown:	For running away from activated pacman downward
goawayright:	For running away from activated pacman to the right
goawayup	For running away from activated pacman to upward
checkup	Another function is checking where Pac-Man is
loop_random	Responsible for the random direction a ghost will go in after reaching a crossroads or wall
not_walled	Checks if the ghost has encountered and wall object and activated random redirection
kpressed	Responsible for behavior of k keypress
jpressed	Responsible for behavior of j keypress
ipressed	Responsible for behavior of i keypress
mpressed	Responsible for behavior of m keypress

Division of Work

Eric Liu	Henry Dacres
• Printing the Board,Pacman,Ghost • Using ASCII escape characters to change board colors • If Pac-Man comes into contact with	• After level completion, a new game board is presented, and the game speed increases by 25%.

a ghost while in a non - ” powered up” mode, a life is lost. ● Implementation of Score Counter ● Ghosts start in the center box, as shown, and once they leave, they don’t re-enter the box unless they are apprehended by Pac-Man.	● If Pac-Man comes in contact with a ghost while under the influence of a power pellet, the ghost will disappear, and return to the center of the maze ● Powered-Up/Normal Pacman, Power pellet logic,