Snake game Development in C: A classic game Implementation

CSE115.2; Project Group-4

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Abstract— **The Snake game is a classic arcade game that has been widely implemented across various platforms. This project focuses on developing a simple yet efficient version of the Snake game using the C programming language. The game mechanics include player-controlled movement, food consumption, collision detection, and score tracking. The primary objective of this implementation is to explore fundamental programming concepts such as structured programming, input handling, real-time processing, and efficient memory management. This report provides a comprehensive overview of the project, including methodology, game design, implementation, results, and potential future improvements. The findings highlight the challenges encountered during development and propose optimizations for enhanced performance and user engagement.**

Keywords— Snake game, game development, C programming, real-time processing, collision detection, input handling, structured programming.

I. Introduction

The Snake game is one of the most well-known arcade games, gaining popularity through its adaptation on mobile devices and personal computers.The objective of the game is for the player to navigate a snake across the screen, consume food, and avoid collisions with walls or the snake's own body.With each food item consumed, the snake grows longer, increasing the difficulty of maneuvering.Developing the Snake game in C provides an excellent opportunity to explore core programming principles, such as game loops,event-driven programming, and efficient memory allocation.This project aims to create a fully functional console-based version of the game, incorporating smooth input handling, randomized food placement, and accurate collision detection.

II. Literature review

According to Smith [1], game development is an effective way to engage students with programming, and the Snake game is ideal for introducing core programming constructs. Previous studies have noted the use of simple 2D games as tools to teach programming logic and problem-solving techniques. For instance, Doe [2] discusses the role of collision detection algorithms in arcade games, emphasizing their relevance in real-time systems. Similarly, Brown [3] explores user input strategies and non-blocking input mechanisms, which are crucial for developing responsive gaming experiences.

Existing work in this area has demonstrated the educational potential of small-scale arcade games, but often lacks detailed guidance on efficient resource usage in lower-level languages such as C. This project contributes to this body of knowledge by offering a comprehensive design-to-evaluation pipeline, using a console-based environment without reliance on graphics libraries.

III. Methodology

The development of the Snake game follows a structured methodology designed to ensure a maintainable, saleable, and functional application. The methodology is divided into several key stages:

A. Requirement Specification:

The essential requirements for developing the Snake game were identified through analysis of existing implementations and gameplay expectations. The game should feature real-time user interaction through keyboard controls. Movement must be responsive and intuitive to ensure smooth gameplay. The snake should grow incrementally as it consumes food, and the food should appear randomly in available empty spaces on the board. A scoring system is essential to track user performance, and a game-over state must be triggered by either self-collision or contact with the boundaries of the play area. The game must run within a terminal or command-line interface, making use of simple character-based rendering for cross-platform compatibility and low resource usage.

B.Functional Requirements:

The functional requirements describe the key behaviors and features that the system must perform in order to fulfill the objectives of the Snake Game. These requirements are essential to ensure that the game provides a complete, playable, and responsive experience.The system must initialize the game environment, including the screen, snake starting position, initial food placement, and score counter reset.The system must display the game boundaries clearly and update the screen in real-time. The system must allow the snake to move in four directions (up, down, left, right) in response to real-time keyboard input (W, A, S, D or arrow keys).Movement must occur continuously at a set speed, with the direction change only allowed between ticks.The system must randomly generate food at positions not currently occupied by the snake.When the snake's head collides with the food location, the snake should grow by one node.Upon food consumption, a new food item must be spawned immediately in a new random location.The system must maintain a running score that increases by a fixed amount each time food is consumed.The score must be displayed in real-time on the game screen.The game must end when the snake collides with:The boundaries (walls of the game area),Its own body (self-collision).A "Game Over" message must be displayed upon collision, and the final score shown.The system must allow players to restart the game from the beginning without restarting the program.The system must provide an option to exit the game cleanly upon player request.The system must detect key presses in real time using non-blocking input methods.The game should ignore any invalid key presses that do not correspond to movement controls.The game must implement a continuous loop that checks for key inputs, updates the game state,redraws the screen, and manages game timing.The loop must pause appropriately to control game speed and avoid excessive CPU usage.A delay must be included in the game loop to manage speed and responsiveness.The delay must be adjustable for difficulty tuning or to match player input response.The system must display the game area, score, and relevant messages using console-based graphics.The interface must be simple, clean, and readable from any terminal running the game.

C. Development Tools *:*

The programming language selected for this project is C due to its ability to closely interface with system-level operations while maintaining high performance. The GCC compiler was chosen for compilation due to its reliability and widespread use in academic and professional environments. Code::Blocks served as the integrated development environment (IDE), offering a user-friendly interface, project management features, and integrated debugger support. Additional libraries included `<conio.h>` for handling keyboard input without requiring the enter key, `<stdlib.h>` and <stdio.h> for memory management and input/output operations, and <windows.h> (or <unistd.h> for Unix-based systems) for implementing timed delays.

These tools were selected to create a consistent, responsive, and modular codebase suitable for extension or porting in the future [1], [2], [3].

D. Text Design phase:

Design of game flow using flowcharts and pseudo code.Structuring modular components for logic, display, input, and scoring.Defining data structures to represent the snake, food, and game area.

E. Implementation:

Writing functions for drawing the board, moving the snake, and generating food.Handling keyboard inputs in real-time using kbhit().Implementing condition checks for collisions and game over scenarios.

F. Testing and Debugging:

Unit testing individual components for correctness.Debugging control logic and input responsiveness.Performing integration tests for the full game loop.

G. Optimization:

Improving code efficiency, reducing computational complexity, and ensuring seamless gameplay.This structured approach ensures that the game is developed systematically while adhering to best programming practices. Reducing redundant calculations in the game loop.Here given the Algorithm of Snake Game :

Step 1: Start the game and initialize all game components:Draw the game board or rectangular playing area.Set the initial score to 0. Set the initial direction of the snake.Generate the snake in its starting position.Generate the first food item at a random location.

Step 2: Begin the movement of the snake based on the default or user-provided direction.

Step 3: In a continuous loop, check whether the snake meets the food.

Step 4: If the snake meets food:Increase the score.Increase the snake length (add one segment or node).Generate a new food at a random location not overlapping the snake.

Step 5: Check if the game is over:If the snake hits the boundary or collides with its own body, end the game.

Step 6: If the game is not over:Accept user input (arrow keys) for direction.Implement key protection (prevent reverse movement direction).Introduce a small delay to regulate the snake speed.

Step 7: Repeat Steps 3–6 in a loop until the game over condition is triggered.

Step 8: End the game and display the final score and a message indicating that the game is over.

This algorithm directly follows the logic presented in the accompanying flowchart. It is also designed to suit a C language implementation of a console-based Snake game, adhering to fundamental concepts such as condition checks, loops, collision detection, and real-time input handling.

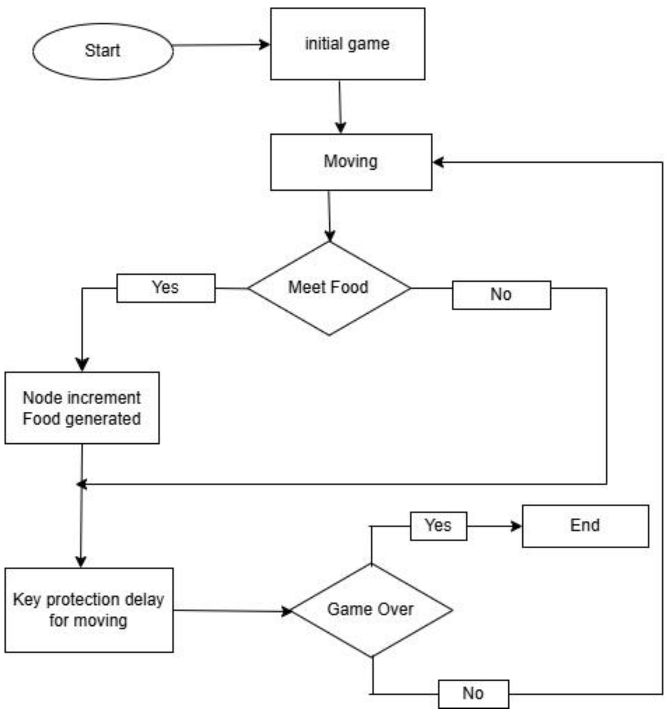


Fig 1: Flowchart of snake game

IV. System Overview

The Snake game system is designed to simulate a grid-based environment within a terminal where a snake can move in four directions, consume food, grow in length, and avoid obstacles. It consists of several modular components:

Captures and interprets user keystrokes to control the snake's movement. Manages the core gameplay mechanics, including movement, food consumption, collision detection, and score tracking. Displays the current state of the game on the console using character-based graphics.Sets up the game environment, initializes variables, and resets the game state when restarted. Regulates the game speed using delays to ensure consistent snake movement.These modules work together in a continuous loop to process player input, update the game state, and render the output in real time. The system is designed to be lightweight and efficient, capable of running on basic hardware using minimal resources.

V. Game Overview

The Snake game is a classic single-player arcade-style game in which the player controls a continuously moving snake inside a bounded area. The core mechanics of the game involve the snake growing longer as it eats randomly generated food items. The game becomes increasingly difficult as the snake lengthens, reducing maneuvering space and increasing the chance of collision.The player uses keyboard controls to change the direction of the snake (up, down, left, or right). The snake moves automatically in the current direction, and user input is captured in real time. If the snake collides with the wall or with its own body, the game ends.Key components of the game include:A bounded rectangular play area.A snake represented by coordinate segments.Food randomly positioned within the play area.A score counter that tracks successful food consumption.Collision detection logic for game termination.This version of the game is implemented in the C programming language using simple text-based rendering on the terminal, offering a lightweight, fast, and accessible gaming experience.

Game Components:

The following are the core components required to build the Snake game. Each component plays a specific role in defining the gameplay mechanics, player feedback, and interactive environment:

Snake Sprite:The main object controlled by the player.Represented on the screen as a line or chain of characters.Moves in four directions using keyboard input (W, A, S, D or arrow keys).Increases in length each time it consumes food.

Wall Sprites**:** Defines the boundaries of the playable area.Represented by fixed characters (e.g., '#') that surround the game grid.If the snake collides with a wall, the game ends.

Apple Sprites**:** Represented using a special character.Placed randomly on the grid at locations not occupied by the snake.When the snake's head reaches the food, it "eats" it, increasing its length and score.

Score Display:Displays the player's score in real-time during gameplay.Starts from 0 and increases each time the snake consumes a food item.Typically shown on the top or bottom edge of the game screen.These components are crucial for maintaining the game's logic, structure, and visual representation in a console-based environment.

VI. Game Design and Implementation

Development Environment:

Programming Language C use here.Compiler: GCC. IDE: Code::Blocks.Libraries Used**:** `conio.h` for input handling, `stdlib.h` for memory management.

Core Game Machanics:

Game Loop: The core of the game resides in a continuously running loop responsible for updating the snake's state, checking for events (e.g., collisions), rendering the game field, and receiving user input. The flow follows:

```
while (!gameOver) {
   drawBoard();
   input();
   logic();
   Sleep(delay);

}
```

***Snake Movement**:* The player controls the snake using keyboard inputs (W, A, S, D or arrow keys) to move in four directions.

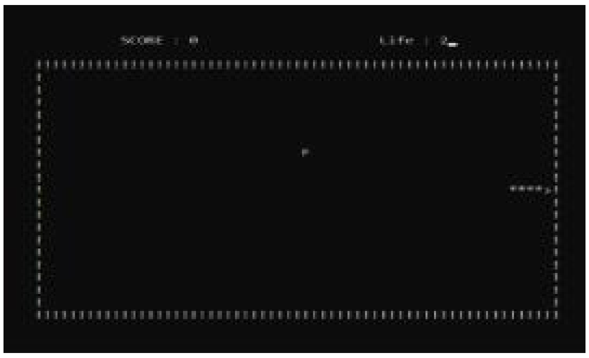


Fig 2: snake movement

Food Generation: Food appears randomly on the screen. Each time the snake eats food, its length increases, and the score updates.
Collision Detection: The game detects when the snake collides with the screen boundaries or itself, triggering a game-over state.
Scoring System: The player's score is based on the number of food items consumed, displayed in real time on the screen.

Input handling:

Smooth input handling is crucial for real-time gameplay. The kbhit() function from conio.h is used to detect keyboard presses without requiring the user to press enter. This ensures that movement is responsive and intuitive.

```
void input() {
   if (_kbhit()) {
      switch (_getch()) {
         case 'w': direction = UP; break;
         case 's': direction = DOWN; break;
         case 'a': direction = LEFT; break;
         case 'd': direction = RIGHT; break;
      }
   }
}
```

Challenges and solutions:

Real-Time Movement: Implemented using a time delay function to regulate snake speed and ensure consistent gameplay.
Collision Handling: Used a coordinate-tracking approach to detect self-collisions and boundary violations.
Randomized Food Placement: Ensured that food does not spawn inside the snake's body by checking occupied positions before placement.

VII. RESULTS AND DISCUSSION

The implemented Snake game successfully provides a responsive and engaging gameplay experience. The game maintains smooth movement, real-time input response, and accurate collision detection. Performance testing indicates that the application runs efficiently with minimal CPU and memory usage, making it suitable for execution on low-resource systems.Key Observations:
Functional Testing: The game performs well across Windows and Linux terminals, demonstrating stable frame rates and responsive controls. Key gameplay components passed unit and integration tests.
User Experience: The game mechanics function seamlessly, providing a challenging and enjoyable experience.
Performance: The use of efficient algorithms ensures low computational overhead.
Scalability: The game can be expanded with additional features such as difficulty levels, graphical improvements, and multiplayer support.
Limitations: No graphical interface.Limited resolution due to console constraints.Single-player mode only.

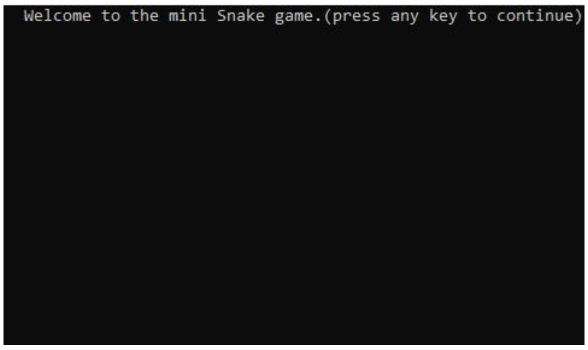
Snake Representation: The snake is represented using a set of coordinate arrays to store the X and Y positions of each segment. Dynamic movement is achieved by shifting segment positions based on the direction of the head.

Food Mechanics: Food is placed using the `rand()` function, ensuring it does not appear on the snake's body. A check is performed to reassign coordinates if overlap occurs.

Collision Detection: Collision with the wall is detected by comparing the head's coordinates with boundary limits. Self-collision is detected by comparing the head's coordinates to the body segments.

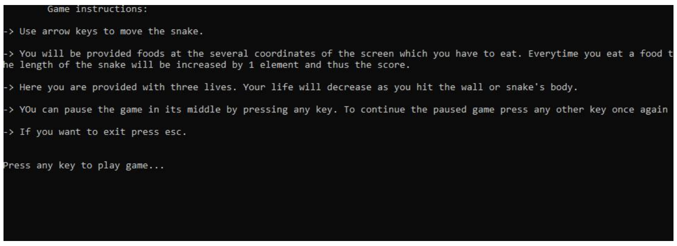
Scoring System: A simple integer counter increases upon each successful food consumption, displayed using `printf()`.

The Snake game begins with a home page displaying a welcome message prompting the player to press any key to continue. Once entered, the main menu appears, showing the game instructions—players use arrow keys to move the snake, eat food that appears randomly to increase their score and snake length, and try to avoid collisions with walls or themselves.The game allows pausing by pressing any key and resuming with another, and it can be exited using the Esc key. DuringDruring the game ,the snake moves continuously across the screen, and the score and remaining lives are displayed at the top. Every time the snake eats a piece of food, it grows by one unit and the score increases, adding a progressive challenge.



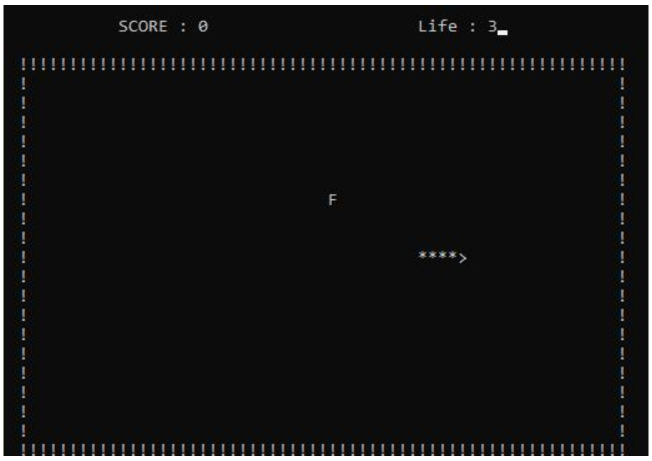
```
  Welcome to the mini Snake game.(press any key to continue)
```

Fig 3: Home Page



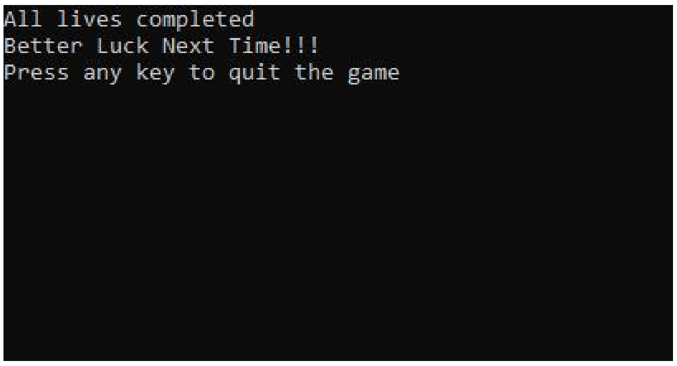
```
       Game instructions:

-> Use arrow keys to move the snake.

-> You will be provided foods at the several coordinates of the screen which you have to eat. Everytime you eat a food t
he length of the snake will be increased by 1 element and thus the score.

-> Here you are provided with three lives. Your life will decrease as you hit the wall or snake's body.

-> YOu can pause the game in its middle by pressing any key. To continue the paused game press any other key once again

-> If you want to exit press esc.


Press any key to play game...
```

Fig 4: Main manu



```
          SCORE : 0                      Life : 3
```

Fig 5: Size and score increasing after eating



```
All lives completed
Better Luck Next Time!!!
Press any key to quit the game
```

Fig 5:Exit

VIII. GAME OUTPUT AND FEATURES

The final implementation of the Snake Game provides a complete user-interactive console-based experience. Key gameplay results and observable features include:

A simple home screen or welcome page acts as the main menu to start or exit the game.The snake moves continuously and responds to real-time keyboard inputs (W, A, S, D or arrow keys).Upon consuming a food item, the snake increases in length, and the score increments by a predefined value.Collision with walls or the snake's own body immediately ends the game and displays a “Game Over” message along with the final score.Players can exit the game instantly by pressing the 'X' key.The game offers a smooth and responsive interaction flow. Tests showed consistent behavior in both gameplay logic and interface rendering, reinforcing the success of the designed structure.

IX. USER INTERFACE AND EXPERIENCE

The game’s user interface (UI) is developed entirely within a command-line interface (CLI), utilizing simple ASCII characters to represent the snake, food, and game borders. Despite its simplicity, this minimalist design supports an intuitive user.experience and emphasizes functionality over graphical appeal.At startup, the user is greeted with a welcome message and game instructions. Real-time updates are displayed continuously, including the current score and the game state. The control scheme is responsive, with immediate reaction to user input via the keyboard.The interface also features a clear game-over message and options for restarting or exiting. The design ensures that users with minimal technical experience can navigate and play the game easily, reinforcing its suitability for educational use.Design decisions were focused on keeping the interface accessible and educational [1][4].

X. SECURITY AND STABILITY

Considerations Although the Snake game is a relatively simple console-based application, ensuring the reliability and safety of the program is crucial for user trust and educational deployment. Proper bounds checking is used throughout the code to prevent buffer overflows and segmentation faults,particularly in input processing and array management. Additionally, graceful handling of invalid input (e.g., pressing keys outside WASD or arrow keys) is implemented to avoid unintended behavior or crashes. Memory is managed efficiently, and all data is stored in fixed-size arrays, avoiding dynamic memory allocation that could introduce memory leaks.In the event of a crash or logical error, the game prints diagnostic messages to help users or developers identify the problem. These safeguards enhance the game's suitability as a learning tool in introductory programming courses.No dynamic memory allocation was used, reducing potential for leaks [3].

XI. EDUCATIONAL VALUE

The Snake game is not only entertaining but also serves as a powerful educational tool. It provides practical exposure to fundamental programming concepts such as loops, conditionals, arrays, modularization, and function calls. Students gain hands-on experience with real-time systems, debugging, and user interaction.Due to its simplicity and modularity, instructors can use the Snake game to teach a wide range of computer science topics. Examples include:
Demonstrating procedural programming techniques.Practicing algorithmic thinking with collision and movement logic.Teaching input/output operations in console applications.Exploring file handling by saving scores to external files.As noted by Brown [3], projects like Snake engage students in a practical and interactive way, fostering creativity and programming confidence.The game also prepares students for larger-scale projects by reinforcing disciplined code structure, testing, and documentation.

XII. FUTURE WORK

Future enhancements of the Snake game could focus on both functionality and user experience. First, the implementation of a graphical user interface (GUI) using SDL or OpenGL would enhance the game's visual appeal and provide a more immersive experience. The introduction of multiple difficulty levels, with varying snake speeds and obstacle placements, could make gameplay more dynamic and challenging. Additionally, adding a pause/resume feature and high score storage using file handling would improve playability and engagement.Multiplayer capabilities, either through turn-based local modes or real-time networked gameplay using sockets, would expand the interactive potential. AI-controlled opponent snakes could also introduce an element of competitive play or simulation. Finally, integrating sound effects and background music would further enhance user interaction. Porting the game to mobile or embedded platforms could broaden its accessibility and reach, while retaining its educational value.

XIII. Conclusions

This report details the successful design and implementation of a text-based Snake game using the C programming language. The project reinforces foundational programming knowledge while emphasizing user-centric game mechanics, modular architecture, and efficient system resource usage. The experience and insights gained can serve as a stepping-stone to more complex game development or systems programming. As technology advances, such classic implementations remain crucial for educational and experimental purposes.

References:

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