TRIBHUVAN UNIVERSITY
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Computer Graphics Project Report
TOH- Visualization
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The completion of this project brings with it a sense of satisfaction, but it is never complete without thanking the persons responsible for its successful completion. First of all, we would like to thank Mr. Lok Nath Regmi and Mr. Bikal Adhikari for providing us with valuable knowledge and insight on Computer Graphics.

Secondly, we would like to thank YouTuber The Cherno who has provided us with excellent OpenGl resources which helped us sharpen our concepts of OpenGL.

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ABSTRACT

Computer graphics is the process of making the design, 2D, 3D, and animation of an object. Computer graphics can do many things, including modeling, simulation, and visualization of an object or a problem.

Modeling is a representation of how people describe or explain an object, system, or concept, which is usually manifested by simplification or idealization. This can be represented by physical models (mockups, prototypes), the model image (design drawings, computer images), or mathematical formulas.

OpenGL supports this modeling capability as OpenGL has additional features to better produce something more realistic. OpenGL allows us to create a graph that can be run on any operating system with only minor adjustments.

The 3-D graphics package designed here provides an interface for the users for handling the display and manipulation of the Towers of Hanoi. The Keyboard is the main input device used.

CONTENTS

CHAPTER 1

INTRODUCTION

1.1 OVERVIEW

Graphics provides one of the most natural means of communicating with a computer since highly developed 2D and 3D pattern recognition abilities allow one to perceive and process pictorial data rapidly and efficiently.

Interactive computer graphics is the most important means of producing pictures since the invention of photography and television. It has the added advantage that, with the computer, can make pictures not only of concrete real-world objects but also of abstract, synthetic objects, such as mathematical surfaces, and of data that have no inherent geometry, such as survey results.

1.2 PROBLEM STATEMENT

The aim of this project is to show the simulation of Towers of Hanoi using OpenGL which includes changing visual properties, redisplay functionality, and keyboard button press actions. The package must also have a user-friendly interface.

The input cannot be given by the user and hence the project is not dynamic in nature. Few parameters can be changed in the #define constructs.

1.3 MOTIVATION

Computer Graphics involves the usage of the libraries provided by OpenGL in order to visually represent the logic that we program. This can give us a better idea of how Algorithms and Data Structures function. This was the motivation behind identifying the logic of the Towers of Hanoi. Recursion can be given a rigorous mathematical formalism with the theory of dynamic programming and Towers of Hanoi can be used as an example of recursion when teaching programming.

1.4 COMPUTER GRAPHICS

Computer graphics and multimedia technologies are becoming widely used in educational applications because they facilitate non-linear, self-learning environments that are particularly suited to abstract concepts and technical information.

Computer graphics are pictures and films created using computers. Usually, the term refers to computer-generated image data created with help from specialized graphical hardware and software. It is a vast and recent area in computer science. The phrase was coined in 1960, by computer graphics researchers Verne Hudson and William Fetter of Boeing. It is often abbreviated as CG, though sometimes erroneously referred to as CGI.

Important topics in computer graphics include user interface design, sprite graphics, vector graphics, 3D modeling, shaders, GPU design, implicit surface visualization with ray tracing, and computer vision, among others. The overall methodology depends heavily on the underlying sciences of geometry, optics, and physics.

Computer graphics is responsible for displaying art and image data effectively and meaningfully to the user. It is also used for processing image data received from the physical world. Computer graphic development has had a significant impact on many types of media and has revolutionized animation, movies, advertising, video games, and graphic design generally.

1.5 OPEN GL

OpenGL (Open Graphics Library) is a standard specification defining a cross-language cross-platform API for writing applications that produce 2D and 3D computer graphics. The interface consists of over 250 different function calls which can be used to draw complex 3D scenes from simple primitives. OpenGL was developed by Silicon Graphics Inc. (SGI) in 1992 and is widely used in CAD, virtual reality, scientific visualization, information visualization, and flight simulation. It is also used in video games, where it competes with direct 3D on Microsoft Window Platforms.

CHAPTER 2

SYSTEM DESIGN

2.1 PROPOSED SYSTEM

The Tower of Hanoi is a mathematical game or puzzle. It consists of three rods and a number of disks of different sizes which can slide onto any rod. The puzzle starts with the disks in a neat stack in ascending order of size on one rod, the smallest at the top, thus making a conical shape. The objective of the puzzle is to move the entire stack to another rod, obeying the following simple rules:

- Only one disk can be moved at a time.
- Each move consists of taking the upper disk from one of the stacks and placing it on top of another stack i.e. a disk can only be moved if it is the uppermost disk on a stack.
- No disk may be placed on top of a smaller disk.

With three disks, the puzzle can be solved in seven moves. The minimum number of moves required to solve a Tower of Hanoi puzzle is 2^n - 1, where n is the number of disks

2.1.1 ALGORITHM:

A key to solving this puzzle is to recognize that it can be solved by breaking the problem down into a collection of smaller problems and further breaking those problems down into even smaller problems until a solution is reached. For example:

- Label the pegs as A, B, and C
- Let N be the total number of discs
- Number the discs from 1 (smallest, topmost) to N (largest, bottommost)

To move N discs from peg A to peg C:

1. Move N−1 discs from A to B. This leaves disc N alone on peg A
2. Move disc N from A to C

3. Move N−1 discs from B to C so they sit on disc N

The above is a recursive algorithm, to carry out steps 1 and 3, apply the same algorithm again for N−1. The entire procedure is a finite number of steps, since at some point the algorithm will be required for N = 1. This step, moving a single disc from peg A to peg C, is trivial. This approach can be given a rigorous mathematical formalism with the theory of dynamic programming and is often used as an example of recursion when teaching programming.

2.2. DATA FLOW DIAGRAM

The interaction with the windows is initialized using glutInit() OpenGL API. The display mode-double buffer and depth buffer is, various callback functions for drawing and redrawing, for mouse and keyboard interfaces, and input and calculate functions for various mathematical calculations, the window position and size are also initialized and create the window to display the output.

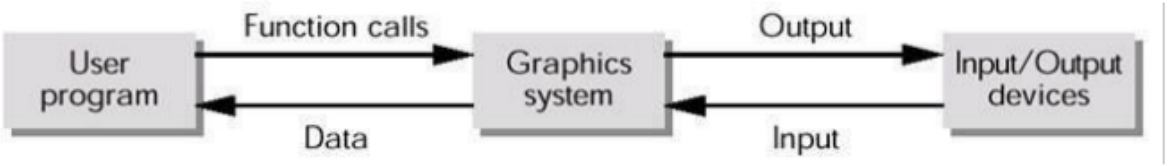

Fig 2.1 Graphics function flow

2.3 FLOWCHART

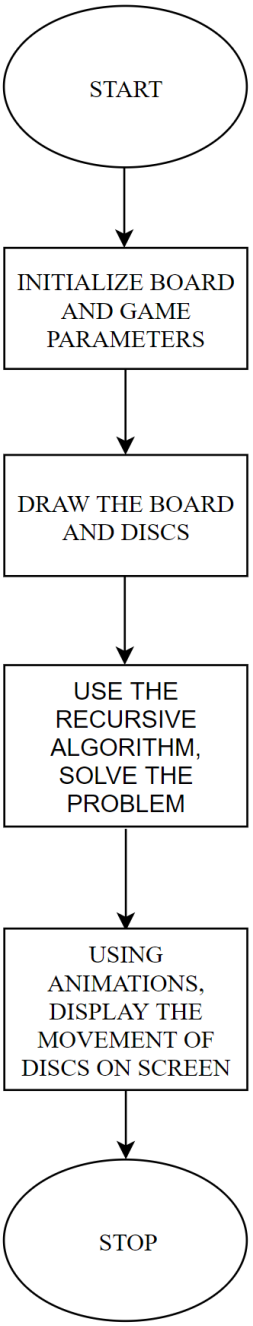

Figure 2.2 – Flow chart of the application

CHAPTER 3

IMPLEMENTATION

3.1 MODULE DESCRIPTION

- void initialize() – This function initializes the display parameters
- void initialize_game() – This function initializes the parameters required for Pegs and Game board.
- void display_handler() – This is the display handler for the second window.
- void anim_handler() – This function handles all the animation required for the game.
- void move_disc(int from_rod , int to_rod) – This function moves the disc from the first peg(from_rod) to second_peg(to_rod).
- void move_stack(int n, int f, int t) – This function is used to obtain the recursive solution to the problem.
- int main2() – The function provides the diver code for the second output window.
- void solve() – This function starts solving the problem from the initial state.
- int main() – This function provides the driver code for the first output window.

3.2 HIGH LEVEL CODE

3.2.1 BUILT-IN FUNCTIONS

- **void glClear(glEnum mode);**

  Clears the buffers namely color buffer and depth buffer. Mode refers to GL_COLOR_BUFFER_BIT or DEPTH_BUFFER_BIT.

- **void glutBitmapCharacter(void *font, int character);**

  Without using any display lists, glutBitmapCharacter renders the character in the named bitmap font. The fonts used are GLUT_BITMAP_HELVETICA_18.

- **void glutInit(int *argc, char **argv);**

Initializes GLUT; the arguments from main are passed in and can be used by the application.

- **void glutCreateWindow(char *title);**

  Creates a window on display; the string title can be used to label the window. The return value provides a reference to the window that can be used when there are multiple windows.

- **void glutMainLoop();**

  Causes the program to enter an event-processing loop.

- **void glutDisplayFunc(void (*func)(void))**

  Registers the display function func that is executed when the window needs to be redrawn.

- **void glColor3[b I f d ub us ui](TYPE r, TYPE g, TYPE b)**

  Sets the present RGB colors. Valid types are bytes(b), int(i), float(f), double(d), unsigned byte(ub), unsigned short(us), and unsigned int(ui). The maximum and minimum values for floating-point types is 1.0 and 0.0 respectively, whereas the maximum and minimum values of the discrete types are those of the type, for eg, 255 and 0 for unsigned bytes.

- **void glutInitWindowSize(int width, int height);**

  Specifies the initial height and width of the window in pixels.

CHAPTER 4

RESULTS

Figure 4.1 – Start Screen

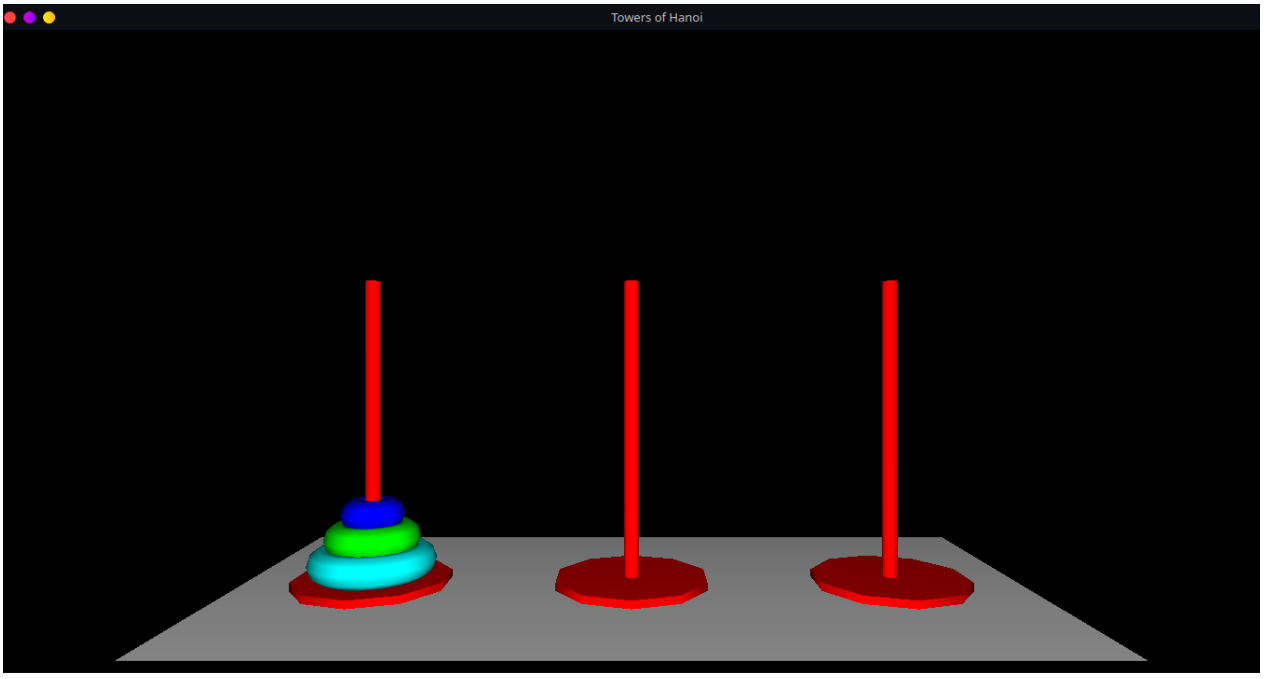

Figure 4.2 – Starting Position

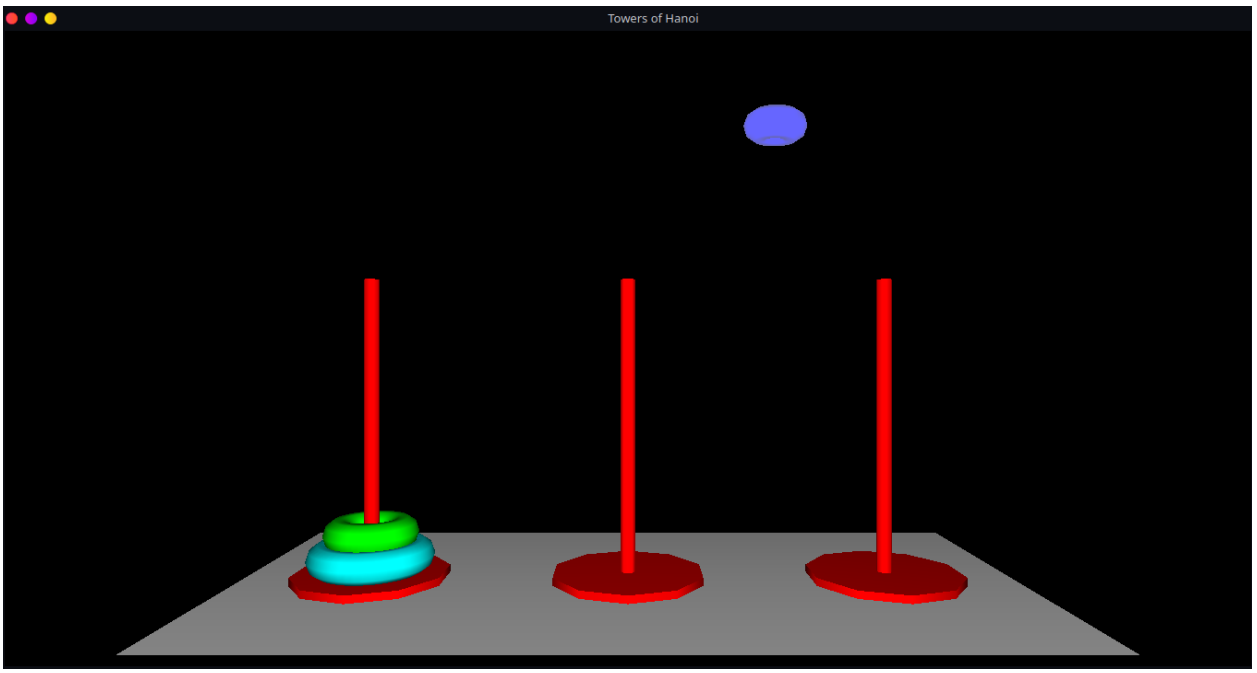

Figure 4.3 – Disc in Motion

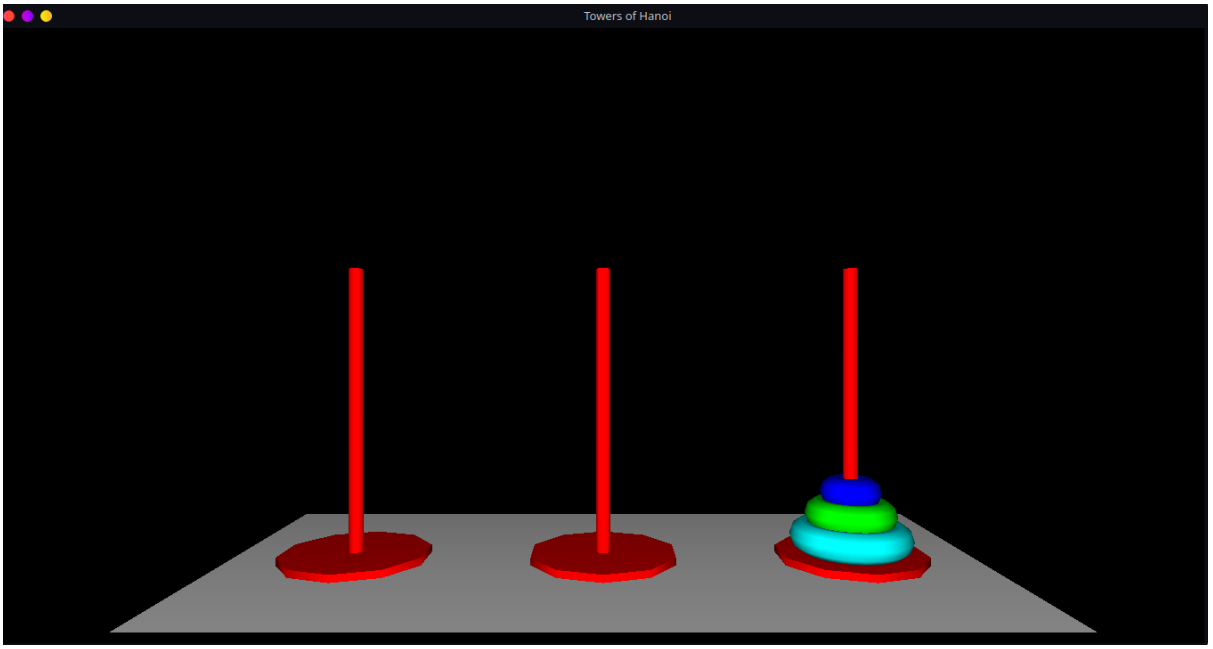

Figure 4.4 – Ending Position

CHAPTER 5
CONCLUSION AND FUTURE ENHANCEMENTS

Towers of Hanoi Simulation is designed and implemented using a graphics software system called OpenGL which became a widely accepted standard for developing graphics applications.

The usage of OpenGL functions and primitives are well understood and henceforth can be applied for real-time applications.

This project is both informative and entertaining. This project provided an opportunity to learn the various concepts of the subject in detail and provided a platform to express creativity and imagination come true. Further animation can be included to enhance the project's look and feel.

CHAPTER 6

References

1. https://en.wikipedia.org/wiki/Computer_graphics
2. OpenGL Documentation – https://www.opengl.org/documentation
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4. Glut Documentation – http://www.lighthouse3d.com/tutorials/glut-tutorial/