National Autonomous University of Mexico.

Faculty of Engineering

Computer Graphics and Human-Computer Interaction

USER MANUAL

TOWERS OF HANOI

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INTRODUCTION

The Tower of Hanoi is a famous mathematical puzzle that involves moving disks of different sizes stacked on one of three posts or rods. This puzzle is comprised of the following rules:

You have three posts or rods and a stack of disks initially arranged in descending order of size on one of the posts. The objective is to move the entire stack of disks from an initial post to another, using the third post as an auxiliary, while following two fundamental rules: a. You can only move one disk at a time. b. A larger disk cannot be placed onto a smaller one.

The puzzle starts with all disks on the first post and must end with all disks on the second post, maintaining the original order of the disks.

The challenge lies in finding the minimum sequence of moves to successfully transfer all disks to the destination post while adhering to the aforementioned rules.

The minimum number of moves required to solve a Tower of Hanoi with n disks is $2^n - 1$. This makes the problem a commonly used example in teaching recursive algorithms due to its divide-and-conquer nature.

The Tower of Hanoi solution can be described using a recursive algorithm that follows a specific pattern of movements, resulting in an elegant and systematic solution. This puzzle serves as a classic example of how seemingly simple problems can have complex and fascinating solutions.

GENERAL INFORMATION

The purpose of this manual is to provide the user with the necessary instructions to run the project known as 'Tower of Hanoi', enabling them to fully enjoy and comprehend the integrated animations within it.

The objective is to ensure a pleasant and meaningful experience when interacting with the three-dimensional environment created for this purpose. This project was developed in Visual Studio 2022 using OpenGL libraries, alongside Blender version 4.0 software for constructing the three-dimensional models designed for it.

For the creation of the animations, the keyframes method was used to move each disk from one tower to another in a simple and dynamic manner.

SPECIFICATIONS

Objective: Representation of the Tower of Hanoi movement in a three-dimensional space.

Basic specifications for the computer system.

Operating System: Windows 10

Processor: Intel Core i3-2400 or AMD FX-6300

Memory: 4 GB RAM

Graphics Card: NVIDIA GeForce GTX 660 or AMD Radeon HD 7870 with 2 GB VRAM

Storage: 8 GB available hard disk space.

EXECUTION

Specifications for running the project:

- It is necessary to run the project from a desktop PC or laptop.

- You will be provided with a folder titled 'Projecto_316292896_CarolinaTellez Gallardo', which needs to be uncompressed in the Local Disk (C:) of the computer where it will be executed.

- Inside the provided folder, you will find an executable file with the extension .exe named 'Projecto_CarolinaTellezGallardo'.

- Once located in the folder, double-click on the file to execute it.

- The execution will commence when a new window opens displaying the 3D environment.

CONTROL KEYS

For camera control and animation playback, the following keys were implemented:

Camera Control: ADWS Keys

A - Camera movement to the left

D - Camera movement to the right

W - Camera movement upwards

S - Camera movement downwards

Key L: Execution of the disk animation

Mouse: Camera orientation

Keys for handling each of the discs (toroids).

For the small toroid (blue):
C - Move left
V - Move right
E - Move down
R - Move up

For the medium-sized toroid (green):
Z - Move left
Y - Move right
I - Move down
U - Move up

For the large toroid (red):
G - Move left
J - Move right
B - Move down
N - Move up

CONCLUSIONS

The Towers of Hanoi have been one of the prime examples of recursion in mathematics due to their complexity. This has aided in providing a more didactic understanding of the behavior exhibited by recursive algorithms. In this project, the aim was to replicate this behavior using three disks, which, when stacked on a base, had to be moved while adhering to specific positioning rules until reaching the other end base. For this implementation, Keyframes animation was utilized. Personally, this method helped me manage each disk autonomously to execute movements appropriately. However, it's not the sole approach; several other complex animations could have been implemented to recreate the movement. This choice ultimately relies on the programmer and their coding abilities.