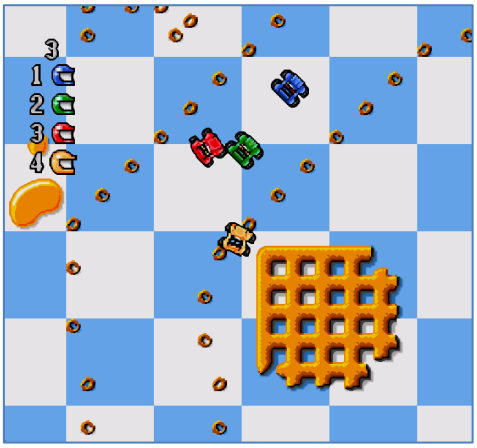
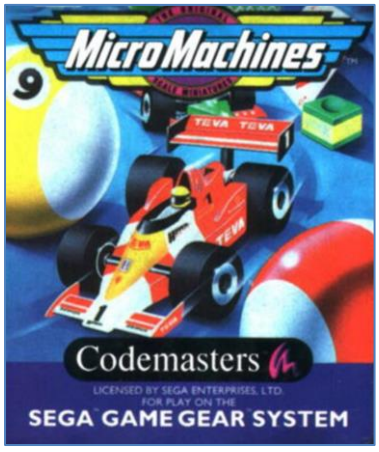
TÉCNICO LISBOA

AVT 2021/2022

Introduction

The Micro Machines game was the first of a series based on the known toy cars sets with the same name. This game was originally released in 1991 and several versions were launched for a wide range of platforms till 2006. The player controls a car to play in unconventional environments such as a kitchen or garden. The car has to go through a track avoiding different types of obstacles. To hit or climb over obstacles the car slows down or becomes more difficult to control. You can watch about seven minutes of gameplay[1] in the channel NESguide of Youtube.





Recently several versions of the game have appeared, including some re-implementations with the original graphics, illustrated in the previous figure, with the cover of the game. Some of these versions can be played online[2].

Work to do

The main goal of AVT laboratory work this year is to recreate this classic in a 3D version, by using **C++** and **OpenGL version 3.3**. The

[1] https://www.youtube.com/watch?v=BMpZznee74I
[2] http://www.classicgamesarcade.com/game/21618/micro-machines-driving-racing-game.html

idea is to maintain the original gameplay but changing the graphic perspective for a 3D appearance. You can see an example for inspiration in the figure below.

The laboratory work corresponding to the Micro Machines 3D is divided into 12 lab classes where each Group will perform the resolution of several exercises and 2 assignments. Each assignment will be evaluated according to a calendar provided in the Presentation class and corresponds to a certain percentage of the final grade. In each of these assessments there are specific objectives and tasks so they can explore the various components of the AVT program.

The rest of this document refers to the tasks for Exercise 2 to be developed in the 2 lab classes of week 2 (October 4th).

Exercise 2 (week 2, October 4th)

Objectives

The objectives for the 2 lab classes of this week, are to understand and implement the architecture of an interactive graphical application and explore the basics of modeling, geometric transformations and lighting.

Tasks

The tasks for this Exercise are:

1. Model the table as well as the road and their margins by using a cube for each element. Model the car, orange and small packets of butter, by using simple three-dimensional geometric objects (cubes, cylinders, cones, spheres and torus). The car should be composed of more than a geometrical object, a minimum of five objects. It is suggested to represent the car's wheels and cheerios with torus. For now, you can use the **basic_geometry.cpp** library available in the AVT template as discussed in Exercise 1. Later, Groups can improve the graphic quality of the models by using modeling tools and the Assimp tool.

2. Set three virtual cameras: a fixed camera to provide a top view of the scene by using an orthogonal projection (like a 2D view of the original game), another fixed but perspective camera to provide also a top view, and a third moving perspective camera, which must be placed behind the car and follow your movement (the car should be visible). It must be possible to switch between the three cameras by using the keyboard keys “1”, “2” e “3”.

3. To orient the moving camera with the mouse movement and simultaneously pressing its left key.

4. To control the movement of the car with the keyboard using the 'O' key to move the vehicle to the left, 'P' to move to the right, 'Q' to move forward and 'A' to move backward. The car should not reach full speed immediately after pressing the key or stop immediately when the key is released. The car should have a uniformly accelerated movement, considering as scalar the velocity and acceleration: the direction of movement is defined by a 3D vector.

5. To start implementing the movement of the oranges. This should be a uniform rectilinear movement, but these elements should rotate as they are moving. Different oranges should move with different speeds and their speed increase with the playing time, i.e., as the user is playing longer, faster oranges move. After leaving the field of play (table) oranges should disappear and reappear **randomly** after a while elsewhere in the table.

6. Program the shaders to perform the lighting and shading of the scene using the concepts of materials, directional light sources, point lights, spotlight, Phong-Blinn reflection model and Phong shading. Thus:

    - Set the suitable materials for the car, butters, oranges, the table, and the road.
    - Create the global illumination of the scene by using a directional light source. This light source must be turned on or off via a button ('N' key) that alternates between day and night mode.
    - Create a total of six candles (Point Lights) distributed on top of the table which partially illuminate the game. This illumination must be sufficient to be able to play, but do not need cover the entire gaming area. These light sources should be activated or deactivated via a button ('C' key) that turns on and off all six lamps. It´s strongly advised to consult page 376 of the book OpenGL RedBook 8th Edition, available in Support Material/books of the page Course.
    - Create two spotlights for the car headlights. These spotlights indicates where the car is facing and should be turned on or off through the 'H' key. Consult the Spot Light shader example in
      http://www.lighthouse3d.com/tutorials/glsl-tutorial/