CS 550 Final Project: 3D Traffic Management Simulation

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1. Project Proposal

Goal:

The goal of this project is to create a real-time 3D simulation of a traffic management system that incorporates basic traffic rules, vehicle movement, and intersection control. The simulation aims to showcase the implementation of 3D computer graphics in modeling a realistic traffic environment.

Features:

- **Traffic Light Control:**
    i. The simulation will include traffic lights at intersections, controllable via keyboard keys for user interaction.
    ii. Additionally, key time values will dynamically change the traffic lights for specific durations, adding a time-based element to the traffic signal management.
- **Vehicle Behavior and Traffic Rules:**
    i. Different vehicles in the simulation will adhere to traffic rules based on their respective lanes.
    ii. Each lane will have its designated traffic light, determining vehicle movement and behavior, adding realism to traffic flow simulation.
- **Visual Enhancements:**
    i. Lighting will be implemented to elevate the visual appeal, creating a more realistic and immersive experience within the simulation.

- **Viewpoint and Camera Control:**

    i. Users will have options to observe the simulation from various viewpoints and camera angles using keyboard keys (e.g., W, A, S, D), offering flexibility in exploring the simulated traffic environment.

- **Simulation Layout and Control:**

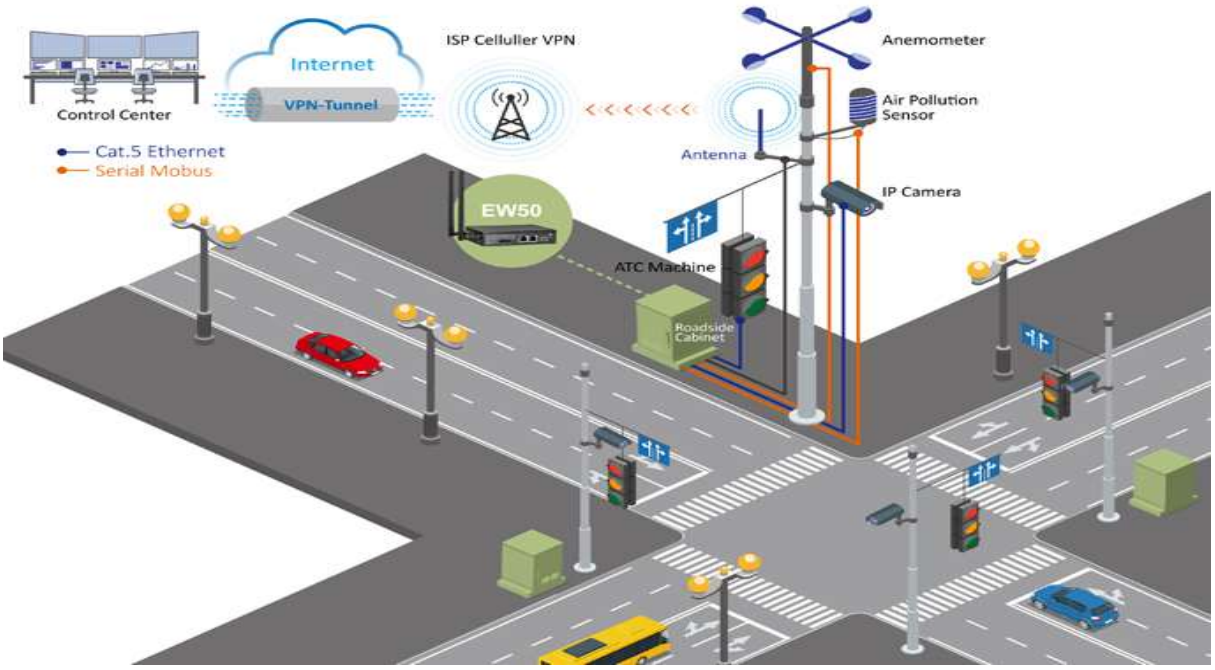
    i. The simulation aims to replicate a scenario similar to the provided picture with four roads, each equipped with distinct traffic lights controllable via keyboard input.
    ii. Key time values will be predefined to regulate the traffic lights' changes at specific intervals, ensuring a controlled traffic flow within the simulation.

- **Vehicle Movement Based on Traffic Lights:**

    i. When the green light illuminates, vehicles in the respective lanes will transition to other lanes, simulating movement towards a designated endpoint within the simulation.

Additional Features (if time permits):

If time allows, streetlights may be implemented and controlled in coordination with vehicle movement and traffic flow, adding further environmental realism to the simulation.



2. Project Implemented:

Environment Setup

- Created a grass layout using an OBJ file and mapped a grass texture to it for the simulation environment.
- Designed a four-road intersection by utilizing OBJ files for roads and applying road textures for a realistic appearance.

Traffic Signal Implementation

- Utilized an OBJ file for the traffic signal stand and employed OsuSpheres to represent red, green, and yellow lights.
- Translated these OsuSpheres concerning the stand to create a realistic traffic signal post with the correct sequence of light colors: red, yellow, and green.
- Replicated these traffic signals for each lane of the four roads in the simulation.

Traffic Control Logic

- Implemented key time values to manage traffic light changes every ten signals, facilitating the movement of vehicles when the light turns green for the respective lane.
- Altered the signal color to yellow for the next lane as the green signal changes lanes every ten seconds.
- Adjusted the animation time to 40 seconds to observe the simulation's functionality accurately with four lanes.

Vehicle Integration

- Included car, truck, and bus OBJ files along with their textures in InitLists to simulate different vehicles.
- Translated these vehicles to distinct lanes for traffic simulation purposes.

Lighting Implementation

- Integrated lighting into the simulation, initially set as white light.
- Implemented the functionality to change light colors based on key times and enabled the light source to move in a circular path above the simulation upon pressing the 'L' key.

Viewpoint and Camera Control:

- Provided options for users to observe the simulation from various viewpoints and camera angles using keyboard keys (e.g., W, A, S, D), offering flexibility in exploring the simulated traffic environment.

Manual Traffic Signal Control

- Incorporated manual traffic signal control using keyboard keys to allow users to manage the traffic lights and enable vehicle passage in desired lanes.
- Enabled toggling between manual and automatic simulation modes using the 'M' key.
- Assigned lane signals by pressing '1' for the first lane, '2' for the second lane, '3' for the third lane, and '4' for the final lane to turn the signal green, initiating vehicle movement in the respective lane.
- Facilitated vehicle movement in the manual phase using CPP time functionality.

3. How your project differs from what you proposed, and why?

I recreated the proposed simulation almost exactly as planned, but I had to skip coordinating streetlights with vehicle movement. I couldn't find suitable OBJ files for larger intersections, and since my intersection is small, adding streetlights wouldn't make a big visual difference.

Implementing manual traffic control was tough and took up a lot of time. Figuring out the logic for automatic simulation of traffic light changes was also quite tricky. Juggling these challenges with upcoming final exams meant I didn't have much time to delve deeper into streetlight implementation.

4. Any impressive cleverness you want us to know about?

The traffic signal control logic for automatic simulation and the vehicle movement using CPP time functionality in manual mode represent unique solutions that I'm particularly proud of. I dedicated considerable effort to devising and implementing these functionalities. Moreover, meticulously assigning key time values to the simulation was a clever approach that I'm pleased to have successfully executed.

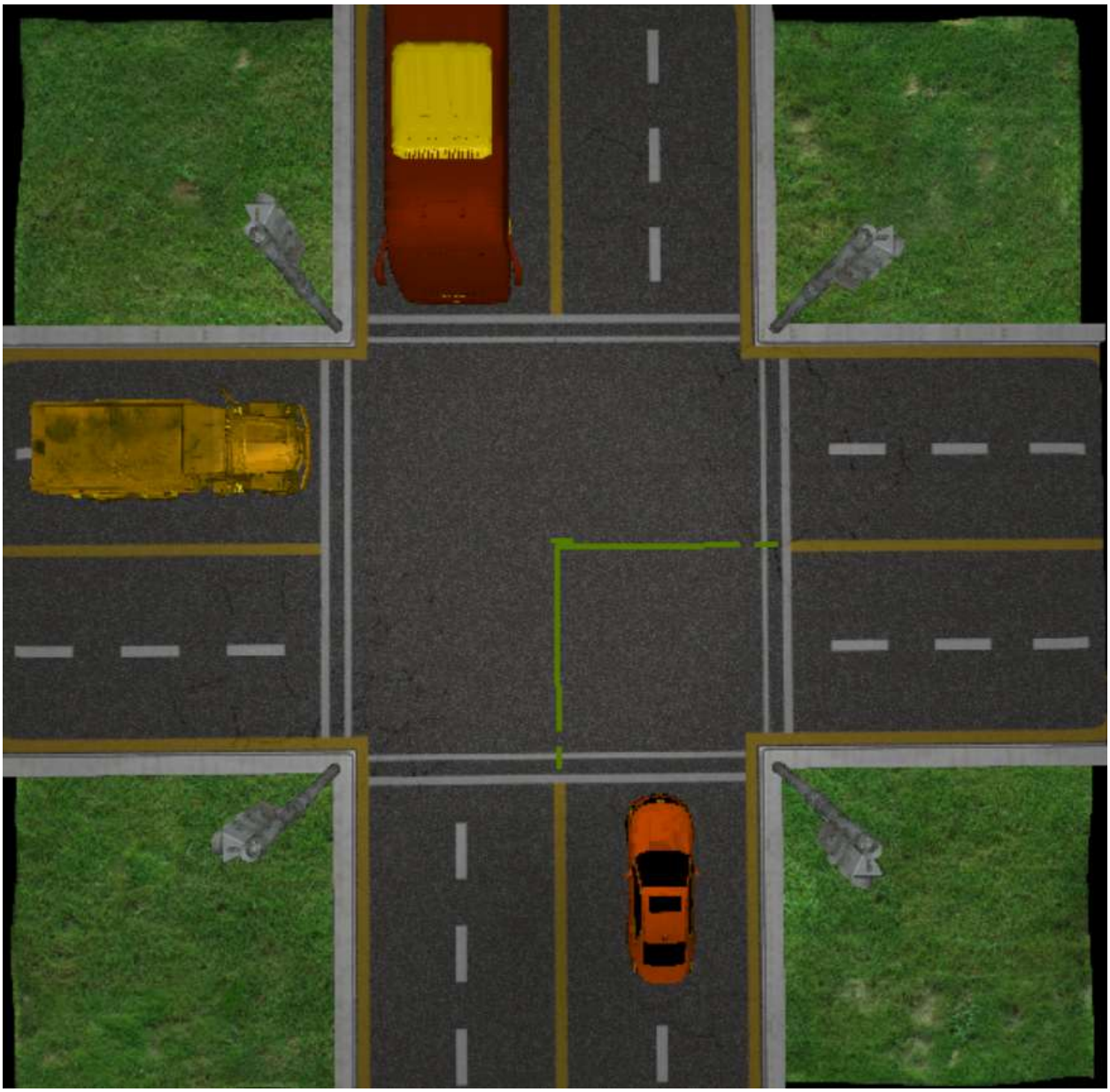
5. What you learned from doing this project?

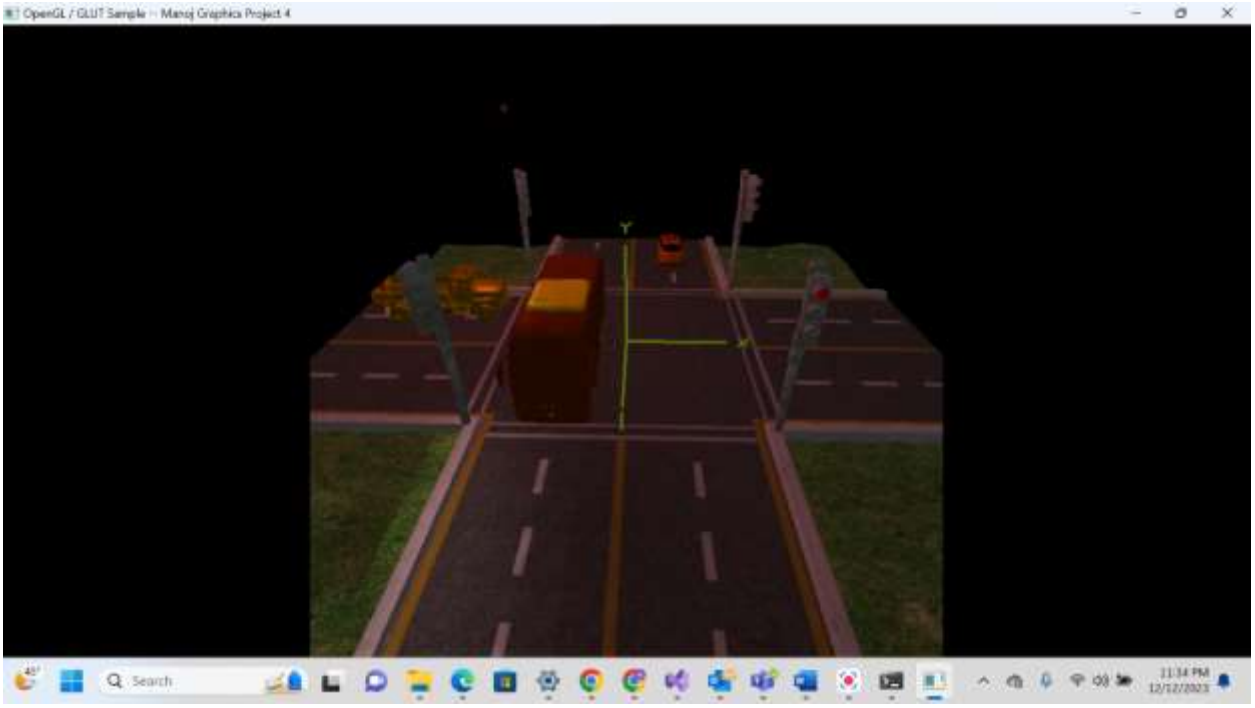
Through this project, I've gained extensive knowledge and hands-on experience in various aspects, particularly in texture mapping and the effective utilization of key time values. Texture mapping allowed me to enhance the visual realism of the environment by seamlessly applying textures to different surfaces, which significantly contributed to the overall immersive experience of the simulation.

Moreover, grappling with challenges such as implementing traffic control logic and managing vehicle movement based on key time values has been an invaluable learning experience. These challenges pushed me to think creatively and approach problem-solving from different perspectives. It taught me the significance of adaptability and innovation when faced with complexities in a project. Learning to tackle obstacles in unconventional ways has been an enriching part of this endeavor, fostering my problem-solving skills and enhancing my ability to

confront similar challenges in the future. Overall, this project has not only expanded my technical expertise but also honed my problem-solving mindset and adaptability in overcoming hurdles.

Screenshots:

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