Digital Twin Middleware

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September 17, 2024

1 Introduction

Digital Twin technology has become a powerful tool for creating real-time virtual replicas of physical objects, systems, or processes. Using data from sensors, cameras, and other sources, a digital twin mirrors its physical counterpart in a virtual environment, allowing continuous monitoring and simulation.

When applied to urban traffic systems, Digital Twin technology can improve how cities manage and control traffic flow. By replicating real-time traffic conditions in a virtual model, city planners and traffic engineers can gain deeper insights into congestion patterns, test potential infrastructure changes, and respond more effectively to emergencies. Additionally, it can be integrated with autonomous vehicle systems, enabling cars to communicate with each other and coordinate pathways in real time.

This synchronization can help reduce congestion, prevent accidents, and create smoother, more efficient traffic flow.

2 Objectives

The main goal of this project is to create a system that analyzes simulated sensor data to generate a digital replica of cars on the road. This digital twin can then be used to simulate traffic flow, which can help improve traffic management by, for example, optimizing stoplight control.

3 Weekly plan

The project was divided into the following steps:

- 18/9 - 25/9: Implementing simple programs to represent the data of physical objects (using C, C++, Python, ...). Simulating digital copies of physical object data by using Unity.
- 25/9 - 2/10: Implementing middleware (pub/sub, MQTT, ...) to communicate between physical objects and their digital twin copy. Develop algorithms to "control and handle" the physical world from the viewpoint of the digital world.
- 2/10 - 9/10: Implementing distributed servers to monitor the physical area and interconnection system among those servers (master/worker, consensus algorithms, ...). (Opt.: Creating databases to store clients information including their account and their vehicles as well as the middleware to connect the database to the server.)
- 9/10 - 16/10: Finalize the system and algorithms. Doing tests. Preparing presentations and reports.
- 16/10 - 23/10: Workshop
- 23/10 - 30/10: Backup week (Additional features, fixing bugs, presentation, reports, ...)