Unity 기반 Digital-Twin Simulator 를 이용한 Multi-Vehicle Monitoring System Testbed 구현

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Implementation of Multi-Vehicle Monitoring System Testbed using Digital-Twin Simulator based on Unity

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Abstract

This paper represents the importance of a digital twin technology for the monitoring system and describes the testbed using unity platform. Key characteristics of the system is utilizing digital twin as the way for simulation of real physical world in the virtual environment. The purpose of the monitoring system is to enable the controlling of automated vehicles and the collision prevention in real world which is synchronized with the virtual environment. Our goal is to implement a testbed for an intelligent remote monitoring system that has ability for changing the status of the physical environment according to the change in virtual environment.

Ⅰ. Introduction

According to [1], the superiority of Digital Twin was shown in the following areas: product design, production, and prognostics and health management (PHM). In the product design, the digital twin can be used to design new products in a more responsive, efficient, and informed manner. For production, the digital twin can make a production process more reliable, flexible and predictable. Moreover, most of the digital twin applications are related to the PHM which it is used to applied in the PHM of the aircraft to predict in the structural life of the aircraft through multi-physics modeling, multiscale damage modeling, integration of the structural finite-element model (FEM) and high-resolution structural analysis. The digital twin is useful for depicting the features, behaviors and virtually represent of the physical environment. The physical environment communicates with the virtual environment to exchange data and information, and the optimization of physical space is in sync with virtual space [2]. Developing and testing algorithms using digital-twin based technology has the ability which is a particularly useful and sustainable means. It reduces cost for building the real physical experiments that could be time-consuming, expensive, and take a long time to know the result of the system due to the changing parameters [3].

The proposed system focuses on utilizing Unity as a tool for monitoring each vehicle in a physical environment [5]. The data is possibly exchanged in real-time by using Google Remote Procedure Calls (gRPC) [6]. A critical goal of this research is to guarantee that the behaviors such as the moving of autonomous vehicles can be simulated and monitored, and the collision in traffic should be prevented. It also analyzes to avoid the wrong path driving for mobile robots and corrects if the vehicles run out of the path (black line shown physical environment of in Fig. 1) by feedback sent from the physical environment.

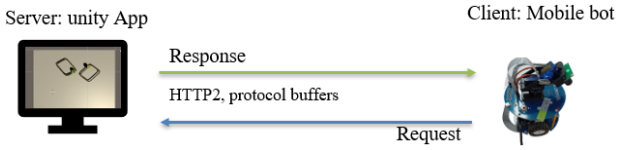

Figure 1. The illustrates the use of gRPC with vehicles monitoring system

Ⅱ. Methodology

a) Simulation of Physical Environment

To build a virtual environment, it requires information about the geometry of each vehicle which is taken by using camera installed with Raspberry Pi. The testbed was installed, and picture was taken for extracting position coordinate of vehicles and sent that information to the virtual environment which is the Unity software used for model-based engineering and operating scenario simulations.

b) Communication and Monitoring Functionality

In order to transfer and receive data between these two environments, the proposed system uses the gRPC framework which requires connection to various

wireless technology Wi-Fi or cellular networks, which has good service that provide high-speed, low-latency, and large-capacity features to enable real time and efficient communication. The main concept of gRPC is client and server communication which are physical and virtual environments respectively, see Fig. 2. gRPC has provided rich features such as integrated authentication client and server, bidirectional streaming and flow control. Moreover, it has used a powerful binary serialization/deserialization toolset and language for format of information exchange [4], which the serialization is always necessary for transferring objects across the network. gRPC also supported a feature of termination the message of client and the server. A cancellation terminates an RPC immediately collision event likely to happen, the vehicle changes speed and understands its environment and situation. Then the collision can be prevented.

c) Description of Proposed Architecture

The system provides users to control and monitor behaviors of the physical system such as moving forward, turning left or right, speeding by the interaction with the virtual system. As the messages were sent through the network from the virtual system, the physical system received those messages and immediately changed the performance from the current state according to change in the virtual system. The general aspect of the proposed architecture is depicted in Fig. 2.

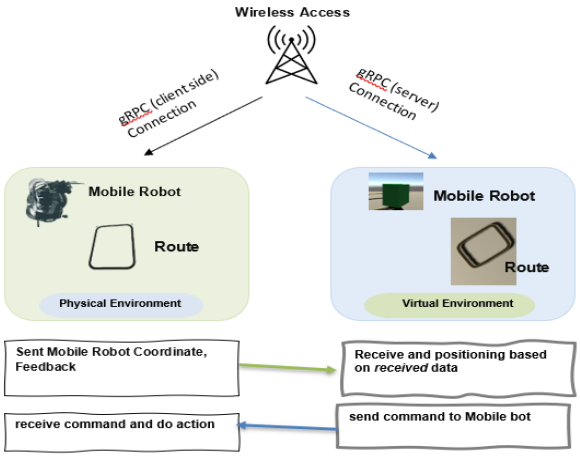

Figure 2. The Proposed System Architecture

Ⅲ. Conclusion

The usage of digital twin-based simulation technology is the key technology that is an important part for design, analysis, and testing of the remote monitoring system. The implementation of a digital twin-based testbed will make it more useful for smart systems according to the ability to send messages from a virtual environment. With the integrated virtual and physical environment, we can reach another level of remote monitoring system that is more efficient than the previous systems which is to build some applications like mobile applications for users to interact with designed and implemented user interfaces as tools for monitoring, that is not virtually seeing the real environment.

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