Abstract

Digital twin refers to a technology that senses information from the real world and reproduces and simulates it in a virtual space. It creates virtual models of urban buildings, spaces, infrastructure, people, climate, and all other information, senses the constantly changing information, and reproduces it on a computer. Furthermore, a key feature of this technology is that simulations are performed in the reproduced space to predict the future, which is then reflected again in the real world. Current digital twins are created for individual purposes and are used vertically. Each digital twin has an individual purpose, but the target city is the same, sharing space and time. If there is information shared in physical space, it can be integrated in virtual space as well, and by exchanging information with each other, digital twins can generate interaction. However, there is still no talk of integrating digital twins. There is talk of using sensing data in simulations in various fields, but there is no integration of digital twins that would create interaction between simulators, such as passing the output results of a simulation to another simulator. Therefore, we will consider methods of integrating digital twins and discuss rules that digital twin producers should follow in order to participate in the integration.

This study proposes an urban digital twin infrastructure that integrates simulators of different nature. One of the challenges of integrating a digital twin is that the time within the simulations running on the digital twin is different. Because of the different way time moves forward, there is a possibility of using data from a time that is not intended. In addition, the digital twin may recalculate according to the sensed data. Two types of data can be created: data generated in the past and data newly generated by recalculation. The ability for other digital twins that are working together to understand this is necessary.

Therefore, this study proposes the management of digital twins by "coordinators and messages" and data management by "shared database. Time stamps are attached to stored data to ensure that there are no inconsistencies in the causal relationships between the data used. In addition, messages will be used to notify when the digital twin starts and stops, and when values are updated by recalculation. When deleting data in the database, the digital twin asks the coordinator if there are any other digital twins using the data. If there is a digital twin using the data, it stops. The digital twin also makes a decision whether or not to use the values updated by the recalculation. The data not to be used are labeled, and if no digital twin using them exists, they are deleted.

In the experiment, we considered only input/output and dependent data for three digital twins and verified that they work with the proposed digital twin infrastructure. We were able to achieve periodic startup and shutdown. In addition,

by optimizing the data generated by the recalculation, we succeeded in reducing the data by 40 65% compared to when all the data was saved.