SDU ENERGY INFORMATICS

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Digital Twin Framework for Cyber-Physical Systems

Background

With the advanced manufacturing strategies of many countries, such as Industry 4.0, Made in China 2025, etc., the Digital Twin technology has become highly pervasive. As a result of its ability to realize the interaction and communication between cyber and physical world [1].

For now, Digital Twin technology has been applied in versatile domains since the application of NASA in 2011. For example, in the manufacturing area, Digital Twin can facilitate better decisions about the mechanical properties of the part, which requires extended quality control, such as the process of parts with carbon fiber composite materials [2]. Besides, [3] introduces an application of Digital Twin on Smart City. Digital Twin enables increased visibility into cities' human-infrastructure-technology interactions and the real-time intersection of reality-virtuality.

Objective

Based on the existing research results and the object-oriented genetic algorithm framework Controleum, a digital twin framework is established for universal assets. Through experiments, the modelling of the digital twin is accurate and trustable, the optimization results satisfy the complicated multi-objective system, and the control signals from the Decision-making layer can be transmitted precisely and fast to drive the actuators.

Methodology

The collected data are transmitted to the information layer through the network layer. These data can be collected by sensors [5].

The network layer is the bridge for the data between the physical world and the cyber system. On this layer, data packages are transmitted between the physical layer and the cyber platform. Security process of data transmission is also necessary, in order to prevent external signal interrupt.

The original data are transmitted into the data process module. The data from different sensors are merged and compared, including the comparisons between current data and history data and data from different devices. Thus, the data, which are going to be transmitted to Data Model module, can be more trustable and accurate.

Data model includes mathematic model and geometric model. Mathematic modelling can be made by some modelling functions or described by digital situations directly. Geometric modelling provides monitor information in a virilization way based on the physical structure of the system and can be developed by the real-time data from sensors.

The Decision-making layer supports operators to analyze visually the expected results and the real-time information, and optimize the control decision based on different concerns. Besides, with the help of the controllers, such as the optimization framework Controleum, the control commands can be calculated automatically.

The control commands are transformed into signals and transmitted back to the physical world to drive the actuators through the Network Layer. For example, the expected situations of the lights in the greenhouses are transformed into digital signals to drive the switches of the specific lights.

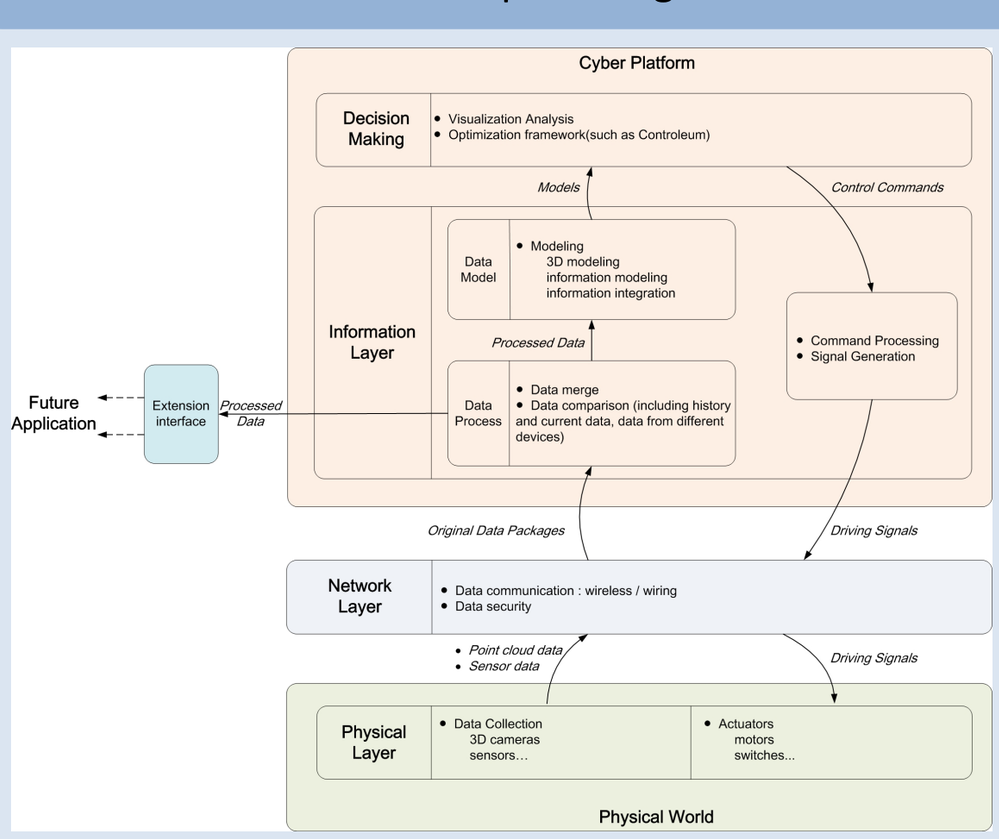

Figure 1 Architecture of the Digital Twin System for the PhD project.

References

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