4D Simulation for Laboratory Workflow of Life Science Automation

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Introduction

In Life Science Automation, it becomes more and more important to ensure the availability of desired assays and automated workflows in advance, especially for large high-end projects. This study presents a 4D simulation system, which synthesizes technologies including workflow, database, advanced CAD, programming and dynamic simulation technology, to realize a real-time simulation for the laboratory workflow of Life Science Automation. In addition, the system can also check the validity of the simulation results, and tell the PCS to drive the real devices to accomplish the scheduled assay automatically when the result is right.

System Architecture

The 4D simulation system mainly consist of five modules: Progress Control System (PCS), Database Management System (DMS), 3D Modeling, 4D Control System and Real-time Visualization. The five modules are interrelated, and the upper four modules decide the bottom one's realization. As shown in the Figure 1, we take the assay plan to generate a WBS, schedule and run the process in the PCS, and create 3D models which also contain the kinematic design information of mechanism for the animation of the whole workstation. Then we apply a strong database to store and manage the scheduling data and devices information from PCS, as well as 3D models ID information, and so on. After that, a 4D Control System is created as an interface between the database and animation tool.

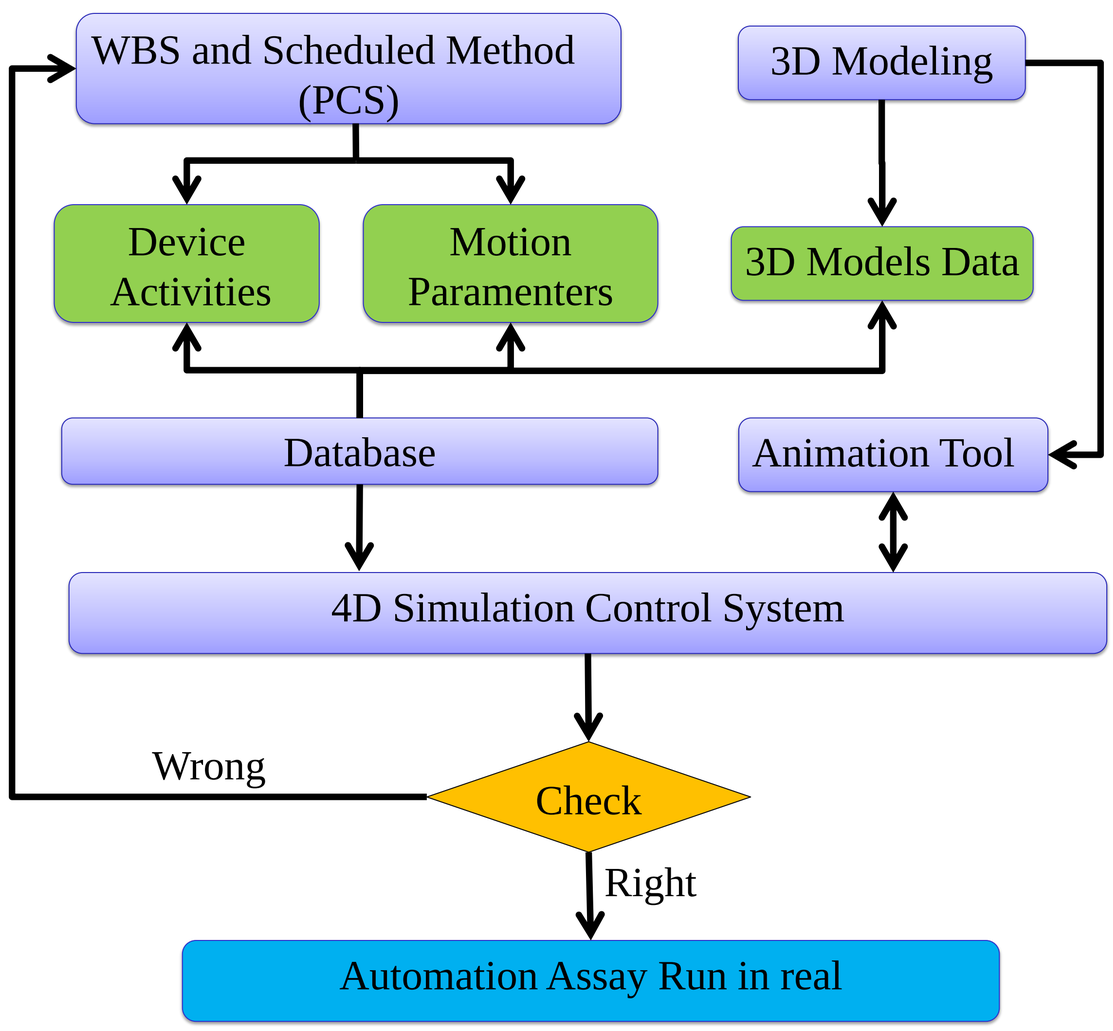

Figure 1: Operation procedures of the 4D Simulation System

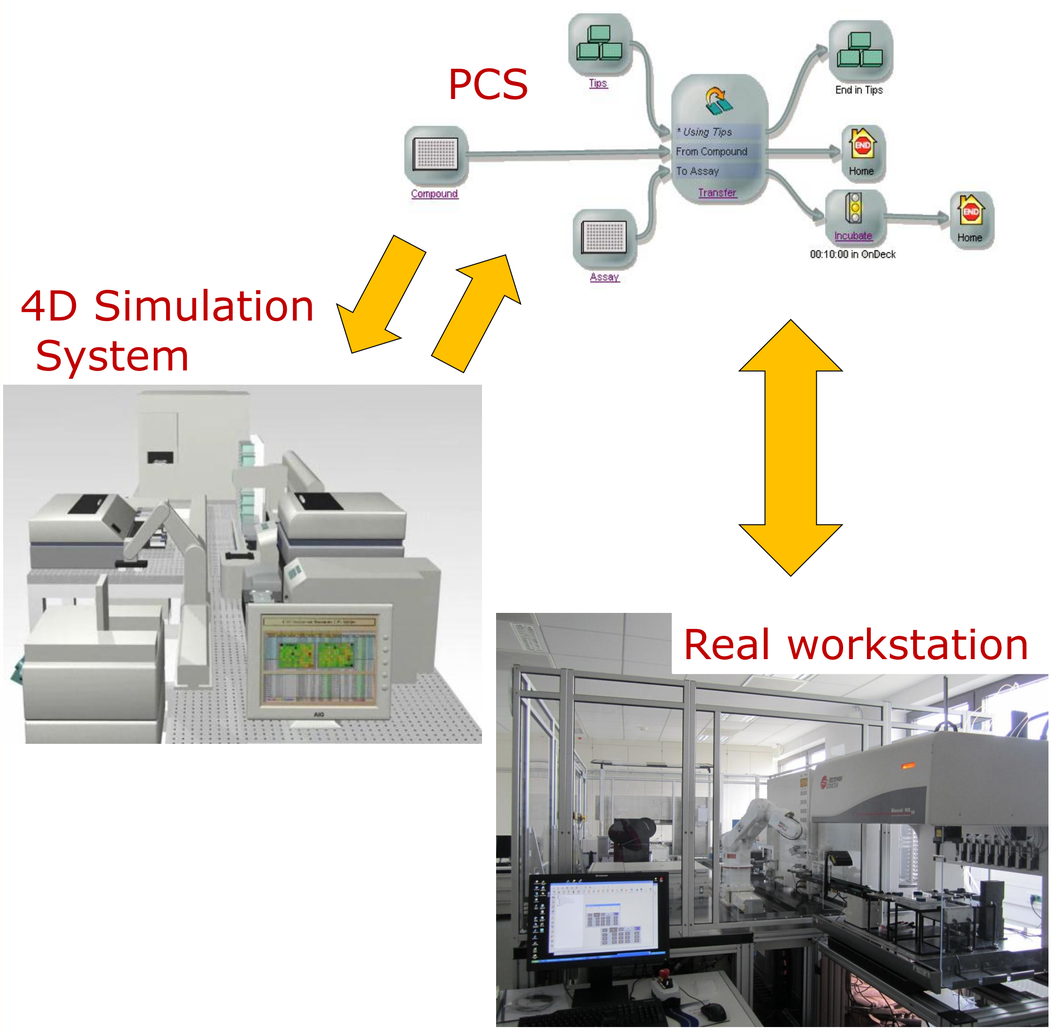

Figure 2: Working principle of the 4D Simulation System

The 4D Control System extracts useful data and information from the DMS, quotes Application Programming Interfaces (APIs) of the animation tool and expands it to control the animation tool to realize a real-time visualization for the whole assay workflow. At the end of the simulation, the Control System checks the validity of the simulation results. If the results are just as the one planed, the Control System will send instruction 'Run' to PCS, which drives and controls instruments to accomplish the scheduled assay automatically. Otherwise, the system would give a caution for users to revise the wrong, reschedule the assay methods and go along the whole system workflow again. See as Figure 2.

Outlook

As the future perspective, the 4D Simulation System could be extended to a simulation of an automated lab. It would be one of the crucial part in workflow management of Life Science Automation.

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