Development of a Virtual 3D Simulator Working With an Actual Hardware Testbed to Verify Element Technologies for Pyroprocessing Automation

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1. Introduction

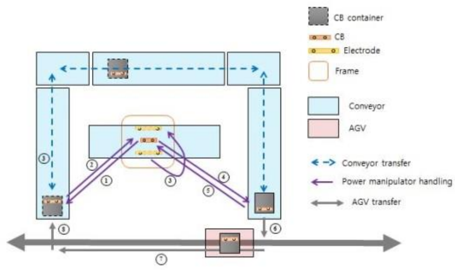
Pyroprocessing, a method to recycle spent fuels, has been studied at KAERI (Korea Atomic Energy Research Institute). The process should be performed in a hot cell due to high radiation. The human workers cannot access in the hot cell, and all operation should be done out of the hot cell by using remote devices. Thus, all procedures should be thoroughly verified in advance. Since the existing remote devices and procedures were complicate and difficult, simplification and automation of handling procedures were issued. The preliminary automation concept for integrated Pyroprocessing was proposed [1], and virtual 3D simulator was developed to verify the concept. However, the simulation assumed only ideal situation. The simulator was hard to show real physical behavior, especially for the case of hand over the basket. To overcome this problem, hardware in the loop simulation (HILS) were proposed [2].

In this study, a simulation framework for interlinking a virtual simulator and a real physical testbed is discussed to verify element technologies for Pyroprocessing automation.

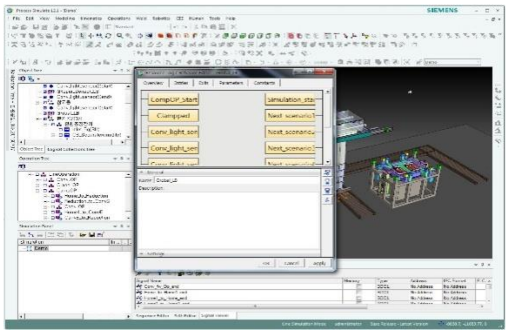
2. Virtual 3D simulator to verify element technologies for Pyroprocessing automation

The preliminary automation concept for integrated Pyroprocessing requires several element technologies, such as, transferring electrode, moving basket, replacing sensor module, and etc. An actual physical hardware testbed to verify the element technologies was integrated at KAERI. The testbed was composed of various handling devices, i.e., power manipulator, gripper, AGV (automated ground vehicle), and conveyor, so that it can performed experiment to move dummy baskets and electrode automatically. An example scenario using the handling devices was planned as shown in Fig. 1. (a).

A virtual 3D simulator for working with the real physical testbed is implemented by using Tecnomatix. The first step to construct a virtual environment is importing a 3D CAD data. The 3D data for the handling devices in testbed were prepared by using Solidworks 3D modeling software. Because the Tecnomatics only accepts JT format, the 3D models of the handling devices were converted to JT files. The kinematics of the handling devices was implemented, and logic block were defined to describe moving algorithm, as shown in Fig. 1 (b) [3].



(a) Example operation scenario to verify element technologies for Pyroprocessing automation



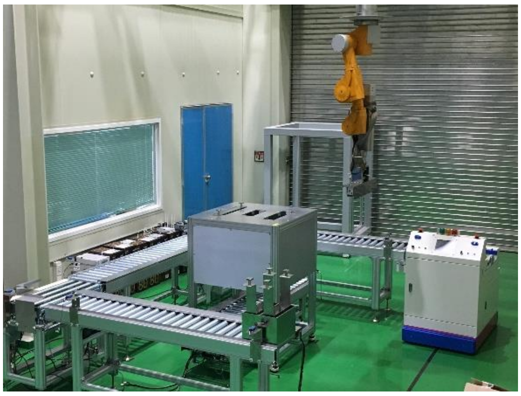
(b) Development of virtual 3D simulator using Tecnomatix

Fig. 1. Virtual 3D simulator to verify element technologies for Pyroprocessing automation.

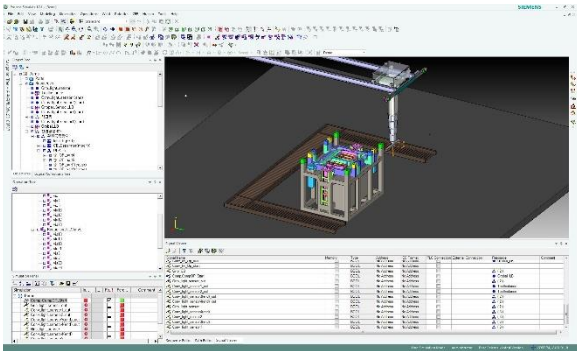
In the 3D simulator, a virtual sensor was attached to mimic a real sensor on the handling device. The automation logics for the simulator can be driven by either the actual sensor data or the virtual sensor data, whereas the actual handling devices only works with actual sensor. Similarly, the operation logic of each handling device can be simulated by logic block in Tecnomatix or actually controlled by the PLC controller on the hardware [2]. The operator monitors all the parameters on the simulation and the hardware status. For the running method of the simulation, the operator chooses the controller and the sensing data either virtual or actual, when the simulation starts.

3. Interlinking with an actual hardware testbed to verify element technologies for Pyroprocessing automation

Fig. 2 (a) shows the actual physical hardware testbed to verify the element technologies for Pyroprocessing automation, based on the experimental scenario as sown in Fig. 1 (a). The 3D simulator was implemented as same configurations of the testbed, as shown in Fig. 2 (b).



(a) Actual handling devices in the real physical testbed



(b) Virtual 3D simulator interlinking with the testbed

Fig. 2.Cyber physical experimental setup, using a virtual simulator and an actual testbed.

To interlink the simulator and the actual hardware, OPC (OLE for Process Control) communication was utilized. OPC is widely used in industrial fields for factory or plant automation. In this research, the sensing and control data was shared in one data base on the OPC server between the virtual simulator and the actual testbed in real time. Fig. 3 shows the control architecture to share the data for interlinking the virtual simulator and actual testbed. The selected memory addresses in the PLC controller were synchronized on the data base in OPC server. Tecnomatix also update data in 10 millisecond. In the virtual 3D simulator, the updated OPC variable was used signals to drive the simulation scenario.

Fig. 3. Control architecture for interlinking the simulator with actual hardwares.

4. Conclusion

In this paper, the virtual 3D simulator working with an actual hardware testbed was developed. Siemens Tecnomatix was used to integrate the 3D simulator for enhancing reliability of the simulation. CAD 3D models of the handling devices in the testbed were imported, and the kinematics and control logics were implemented. The simulation data were shared with the actual testbed via an OPC server. Finally, the developed virtual 3D simulator was interlinked to the actual hardware testbed. The integrated system will be utilized to perform experiments to verify element technologies for Pyroprocessing automation.

REFERENCES

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