Development of Testbed for Advanced Remote Dismantling System

Dongjun Hyun*, Ikjune Kim, Sungmoon Joo, Jonghwan Lee, and Shin Young Kang
Korea Atomic Energy Research Institute, 989-111 Daedeok-daero, Yuseong-gu, Daejeon, Republic of Korea
*dongjunn@kaeri.re.kr

1. Introduction

The advanced remote dismantling system is a remote dismantling system incorporating advanced technologies such as spatial perception based teleoperation technology and high payload robot arms and underwater laser cutting technology. In the field of nuclear dismantling, conventional equipment had to be replaced at every time a target structure was changed during the process stage. The replacement work has been a major cause of increased time, cost and risk of dismantling processes. However, thanks to advanced technologies mentioned above, the advanced remote dismantling systems could handle all the processes without equipment replacement. A seamless remote system was proposed by the author et al. with a similar concept [1].

This paper proposes a testbed to develop spatial perception based teleoperation technology and control framework. The testbed consists of a 3d scanner, robot arms and various computer systems to acquire and process 3d data as well as to build a control framework. Spatial perception based teleoperation technology and control framework developed by this testbed will be integrated with the currently being developed high payload robot arms and underwater laser cutting technology to complete the advanced remote dismantling system.

2. Objectives of testbed

Objectives of the testbed are to study algorithms related to spatial perception and teleoperation of robot arms, and to develop an integrated control framework governing various computer systems, PLCs, local controllers and sensor networks.

2.1 3D perception based teleoperation technology

3D perception based teleoperation technology is a key technology that enables robot arms to devote to nuclear dismantling because excessively difficult remote manipulation has become an obstacle to the dismantling of nuclear facilities by robot arms.

In this study, researched are being conducted on the problem of remote manipulation by spatial perception and interaction technology. Interactive Robotics Division under CEA List is conducting research by approaching force feedback technology With regard to teleoperation technology of robot arms in the nuclear field [2].

2.2 Integrated control framework

The integrated control framework is a set of governing logic and data structures, and a testbed capable of emulating a target system is needed to develop the integrated control framework. The target systems is the advanced remote dismantling system which consists of various computer systems, PLCs, local controllers and sensor networks.

3. Configuration of testbed

The hardware and control framework is developed to be compatible with the concept of the Smart Factory for future scalability. The hardware of the testbed consists of three layers of actuator/sensor layer, controller/PLC layer, and process controller layer. The framework of the testbed is implemented to include the OPC server, which can collect all data from the control system and link data with the virtual commissioning system and nuclear dismantling simulation system.

3.1 Hardware setup of testbed

As shown in Fig. 1, the hardware configuration of the testbed with three layers could be assumed to be a prototype of the advanced remote dismantling system.

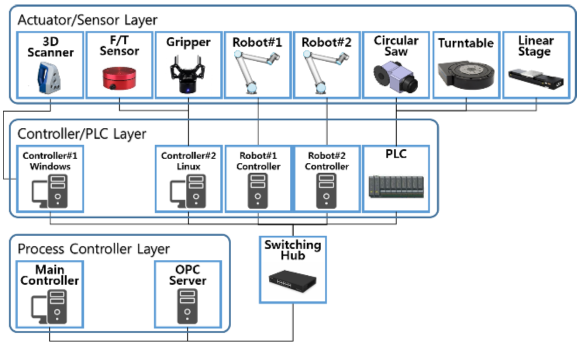

Fig. 1. Hardware configuration of testbed.

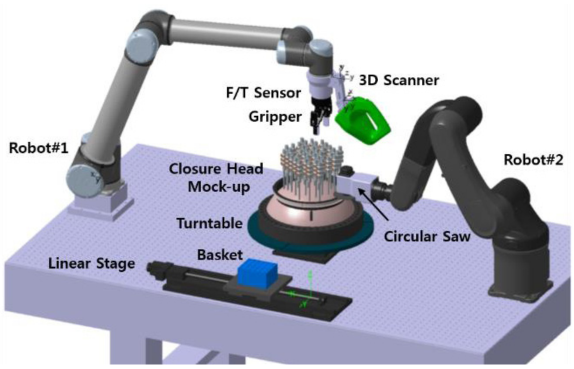

Fig. 2. Digital mockup of testbed.

As shown in Fig. 2, the testbed can perform cutting, gripping and transferring processes using two robot arms, a gripper, a circular saw, a turntable and a linear stage.

3.2 Control framework of testbed

The control framework of the testbed controls the basic processes in the order of 3d scanning, 3d registration, dynamic replanning and calibrated process generation. All actuator and sensor data are collected through the OPC server and transferred to the graphic update module and other module.

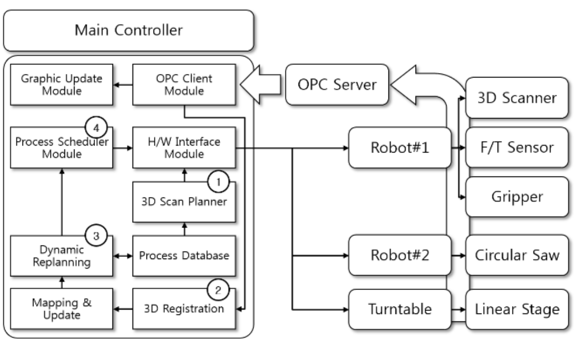

Fig. 3. Control framework of testbed.

4. Task running on testbed

In this testbed, the primary objective of the robot arm is to deliver an end-effector to the target position in the absolute coordinate system by only 3D scanning, not teaching. To achieve the objective, coordinate system configuration, calibration of the 3D scanner, and kinematic calibration of the robot arm are being performed.

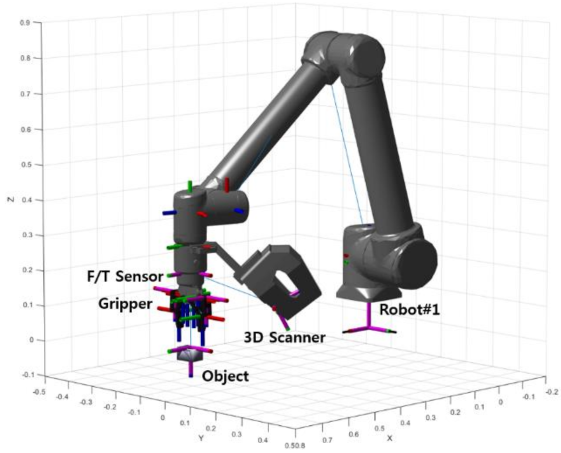

Fig. 4. Coordinate system of testbed.

5. Conclusion

The proposed testbed achieves previously mentioned goals capable of demonstrating spatial perception algorithms and control framework.

Acknowledgements

This work was supported by the nuclear research and development program (2017M2A8A5015146) through the National Research Foundation of Korea, funded by the Ministry of Science and ICT, Republic of Korea.

REFERENCES

[1] Hyun, D., Lee S., Seo Y., Kim G., Lee J., Jeong K., Choi B., Moon J., "Seamless remote dismantling system for heavy and highly radioactive components of Korean nuclear power plants", Annals of Nuclear Energy, 73, 39-45 (2014).

[2] Philippe Garrec, Yann Perrot, "Force feedback nuclear telerobotics in France: R&D results and industrial achievements", PURESAFE Final Conference Jan., 2015, Geneva.