Remote MAG Welding System for Maintenance of Nuclear Facility

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1. Introduction

In nuclear facilities, the passive mechanical systems have been preferred for remote operation due to its reliability and the safety. Recently, automation and robot technologies has been rapidly evolved and widely spread to various industrial field. New active servo systems for nuclear application replaces the old passive remote systems. Korea Atomic Energy Research Institute (KAERI) is one of the research groups to study and develop new innovative devices for nuclear purpose, such as BDSM, PAVM, and MARTiN [1-3]. The MARTiN (remote control system for Maintaining And Repariring Tasks in NPP) was developed as a research platform for the high place remote operation in CANDU reactor. In order to access an emergency valve on ceil near at Calandria, it has a mobile base and a 10 meter telescopic mast. Originally, on the top of the mast, specialized tool for rotating the valve was attached. Currently, it was replaced to dual manipulators for research purpose as shown in Fig. 1, and several challenging tasks, such as closing valve, sawing pipe, and welding metals, are tested for future use.

Figure 1 . Overview of MARTiN system for remote operation.

2. Remote MAG welding

End-effector for welding

A new end-effector was designed for the manipulator of MARTiN, as shown in Fig. 2. A compact MAG torch and a wire feeder are integrated including wire spool. A welding camera was also installed side of a wire spool. The camera has a specially designed filter driven by pneumatic valve so that it can monitors the welding progress in real time. Because the welding torch keeps a distance from the actual welding spot, the distance should be considered when the trajectory is assigned. For convenience of teaching the welding trajectory, a physical probe was attached in the end-effector

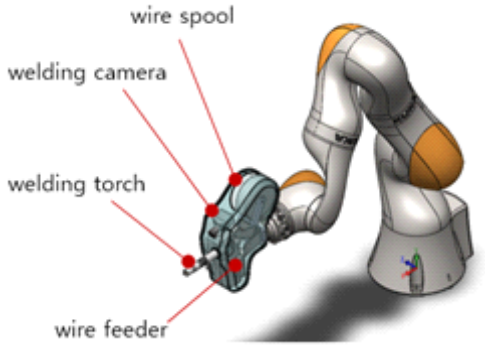

Figure 2. The integrated end-effector for MAG welding.

Welding Control User Interface and Procedure

Figure 3 shows the welding control user interface. Both a global view and a local view are provided. The global view helps to figure out the absolute posture of target material and overall progress. The local view from welding camera is moved with manipulator and focuses on the welding spot all the time. The user interface provides manipulator control functions also and allows real time intervention.

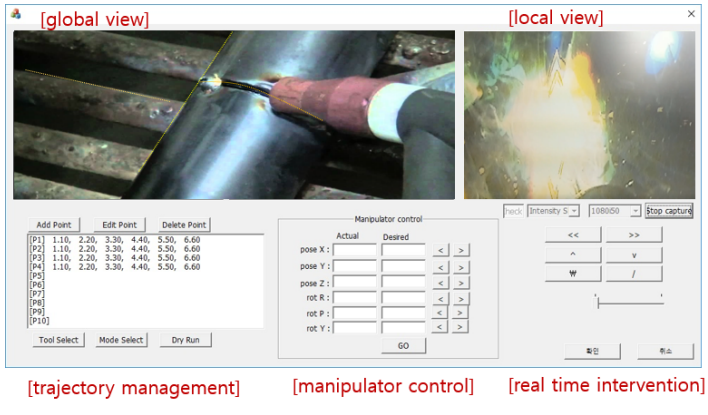

Figure 3. The Welding Control User Interface for MARTiN

Welding procedures is composed of 3 steps. The first step is to teach trajectory. The operator remotely controls the manipulator and assigns the start and end point of the desired welding trajectory including several via points. The probe is utilized for this step, and the tool frame is automatically calculated when the tool is changed to the actual welding torch. The saved via points are shown in the lower left of the UI, and also visualized on the global view. The second step is verifying the trajectory. The tool is changed to the actual torch, and carry out dry run. In this stage, the gap between the torch and the desired welding line is verified, and the welding speed is checked. The final stage is actual welding. Welding current is engaged whereas the soldering wire and the shieling gas are provided. The live streaming of welding camera showed on the local view. Simple interventions, such as shifting to side, speed override, adjustment attack angle, are allowed by the buttons on the user interface.

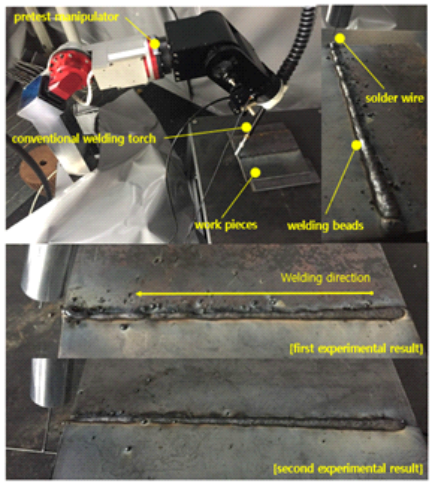

Figure 4. Welding beads patterns by remote manipulation.

The remote welding task was pretested by using another manipulator with conventional welding torch, and the results was shown in the Fig. 4. Welding beads are successfully made as wave patterns. In this research, integration of remote MAG welding system was introduced. Actual welding test of the integrated system is schedules on May 2019. The further experiments are in progress.

References

1. Dongseok Ryu, Jonghui Han, Sunghyun Kim, Kiho Kim, and Jong Kwang Lee, "PRIDE 3D Simulator for Virtual Verification of Remote Handling Procedures in Processing Cell," Journal of Nuclear Fuel Cycle and Waste Treatment, Vol.15 No.4 pp.333-341, December 2017.
2. Dongseok Ryu, Jonghui Han, and Seungnam Yoo, "Overhead Gantry System and Basket Handling for Pyroprocessing Automation Verifying Mock-up, " Proc. of HOTLAB 2018, Finland, 2018, pp. 41-43.
3. Hocheol Shin, You-rak Choi and Chang-hoi Kim, "Design of a Remote Control System for Maintaining and Repairing Tasks in NPP," Proc. of URAI 2017, pp.454-456.