

Development of Robotic Welding System and Defects Inspection Devices for Railings

1. Background:

The Industries & Vocational Training (I&VT) Section of Correctional Services Department (CSD) provides work opportunities and engages persons in custody in useful work which reduces their idleness and tension, and therefore contributes to institutional stability. It also aims to provide vocational training for both young and adult offenders that help them gain accredited skills and recognised qualifications for enhancing their post-release employability. Currently, manually metal work and welding process are engaged in the correctional institutions for fabrication of metal railing for the Highways Department. As there is a trend in adoption of advanced manufacturing process in the industry, CSD would like to apply automatic welding process and defect inspection method to enhance the welding quality, productivity and, occupational health and safety.

2. Objectives

- To review the existing workflow and re-design the workflow and layout for fitting the automatic welding process.
- To develop the robotic welding system and defects inspection device for fabrication of steel railing.

3. Scope

The project will focus on the existing welding process in Tai Lam Correctional Institution for fabrication of steel railing that made of 40x15mm flat bars and 16mm round bars with outer dimension of approximately 1500mm x 900mm. The existing fabrication process comprises of 4 major steps – preparation of raw material, welding of outer frame, positioning of round bars to the frame by welding, final welding process. It is intended to apply automatic robotic welding approach to replace step 3 and 4 under this project. The loading and unloading of the workpiece to be conducted manually.

4. Methodology

The project comprises of three phases.

Phase 1: Workflow and layout review

- 4.1.1. To review the overall manual operation in fabrication of steel railing
- 4.1.2. To develop and propose a revised workflow and layout design to adopt automatic welding process (cover the design to adopt robotic welding system for positioning and final welding to be developed under this project, and also

consideration to adopt another system for outer frame welding for future expansion)

4.1.3. To propose potential equipment list including robotic welding system and other necessary auxiliary machine and/or equipment for facilitating automatic robotic welding process

4.1.4. To propose necessary foundation facilities list

Phase 2: Automatic robotic welding system

4.2.1. To develop the detail technical specification of the robotic welding system for round bar position and final welding process

4.2.2. To construct the robotic welding system and necessary auxiliary machine and/or equipment

4.2.3. To develop the acceptance test plan

4.2.4. To conduct Factory Acceptance Test (FAT) and modify design, if necessary

4.2.5. To install robotic welding system to Tai Lam Correctional Institution

4.2.6. To conduct User Acceptance Test (UAT)

4.2.7. To review the safety and provide recommendations for modification based on CE Machinery Directive

4.2.8. To provide on-site operation training

Phase 3: Defect inspection device

4.3.1. To evaluate on-site welding defect inspection methodology (e.g. ultrasonic waves or radiation beams for internal structure and magnetic particles for external surface)

4.3.2. To propose and suggest appropriate defect inspection approach to assist quality checking

4.3.3. To develop the detail technical specification of the defect inspection device

4.3.4. To construct the defect inspection device

4.3.5. To develop the acceptance test plan

4.3.6. To install the defect inspection device

4.3.7. To conduct User Acceptance Test (UAT)

Tentative implementation schedule

		Month											
Tasks		1	2	3	4	5	6	7	8	9	10	11	12
Phase 1													
4.1.1	Review overall manual operation	■											
4.1.2	Revise workflow and layout		■	■									
4.1.3	Propose potential equipment list			■									
4.1.4	Propose foundation facilities list			■									
Phase 2													
4.2.1	Detail technical specification				■								
4.2.2	Construct the welding system					■	■	■	■	■	■		
4.2.3	Develop acceptance test plan									■			
4.2.4	Conduct FAT										■		
4.2.5	install robotic welding system											■	
4.2.6	Conduct UAT											■	
4.2.7	Review safety											■	
4.2.8	On-site operation training												■
		Month											
		13	14	15	16	17	18						
Phase 3													
4.3.1	Evaluate defect inspection methodology	■											
4.3.2	propose defect inspection approach	■											
4.3.3	develop technical specification		■										
4.3.4	construct defect inspection device			■	■	■	■						
4.3.5	Develop acceptance test plan					■							
4.3.6	install defect inspection device						■						
4.3.7	Conduct UAT						■						

Tentative Design of the Automatic Robotic Welding System

Jig and fixture:

- To position the round bars to the frame structure by means of pneumatic or electric devices
- To ensure the round bars are positioned at the desired location on the frame structure
- To minimize the time and error during loading the workpiece

Rotational table

- To rotate the fixture and workpiece for allowing the welding robot to access the front size and rear size of the workpiece
- To minimize the required accessible stroke of the robot
- The robot can be positioned in a fixed location to ensure high repeatability performance

Robotic welding arm

- Install with welding torch and move the torch to the assigned coordinates to perform welding path
- Wire feeder transfer the filler wire to the welding torch
- External MIG welder

Control system

- Central control system for connecting jig and fixture, rotational table and welding arm
- To synchronizing the motion of rotational table and welding arm

Safety guard

- To totally enclose the welding system
- Equip with interlocked guard for operator to access the working area

Type of steel railing to be handled

