Real time measurement of laser welding process

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This paper describes the evaluation methods of welding qualities in manufacturing the laser welding parts for automobile body. A study of quality evaluation and monitoring technology for the laser welding process was conducted. The laser welding and industrial robotic systems are used with robot-based laser welding systems. Korean auto manufacturers are developing and applying the laser welding technology using a high output power Nd:YAG laser and a 6-axes industrial robot. The laser system used in this study was 1.6kW fiber laser, while the robot system was Industrial robot (payload:130kg). After and during laser welding the qualities of welding parts is studied to estimate the defects of welding parts. The welding qualities are evaluated from the intensities of plasma generated during welding. The detecting system is consisted of UV and IR sensor. The quality testing of the laser welding was conducted by observing the shape of the beads on the plate and the cross-section of the welded parts, analyzing the results of mechanical tension test, and monitoring the plasma intensity and temperature by using detectors. This paper proposes the quality monitoring system as a means of resolving the accuracy of conventional laser welding systems.

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1. Introduction

Laser welding is one of the important technologies used in the manufacturing of lighter, safer automotive bodies at a high level of productivity; to that end, the leading automotive manufacturers have replaced spot welding with laser welding in the process of car body assembly. Korean auto manufacturers are developing and applying the laser welding technology using a high output power Nd:YAG laser and a 6-axes robot[1,2]. The conventional spot resistance welding used in the car body assembly process has been an obstacle to car design and manufacturing due to the limited applicability and lower welding efficiency resulting from the geometry and welding characteristics of spot welding machines. As such, the automotive industry has been trying to develop new welding and joining technologies[3-4].

This study was conducted to develop a remote car body laser welding technology, a welding quality inspection technique, and a robot control. In particular, due to the characteristics of laser welding - where the laser beams have to be directed perpendicularly to the welding surface - it is very difficult to instruct the robot to direct the laser beam perpendicularly on to a curved surface. Indeed, many studies have been performed to improve the speed of the robot laser welding process and the quality of welding parts[5,6]. In this study, these problems were addressed by applying the remote laser welding method and the quality monitoring method.

2. Experimental ResultsContent1

Fig. 1 shows a schematic block diagram and the developed system of the entire remote laser welding control system. The beam from the laser generator is transmitter via an optical fiber to the welding head at the end of the robot's arm. The laser welding can be achieved by manipulating the axes of the robot system. The laser generator used was 1.6kW fiber laser system and the robot system was the 6 axes industrial robot. To conduct a basic study of the weldability of the remote laser welding system, butt welding and lap welding were conducted with common steel plates and galvanized plates. The weld joints were inspected and tested for tensile strength to determine the optimal welding parameters. In order to devise a technique of measuring the quality of the laser welding on a real-time-basis, basic experiments were conducted with a technique capable of determining the quality of welding by monitoring plasma and temperature. Pattern welding tests were conducted to examine the accuracy of the entire remote laser welding system.

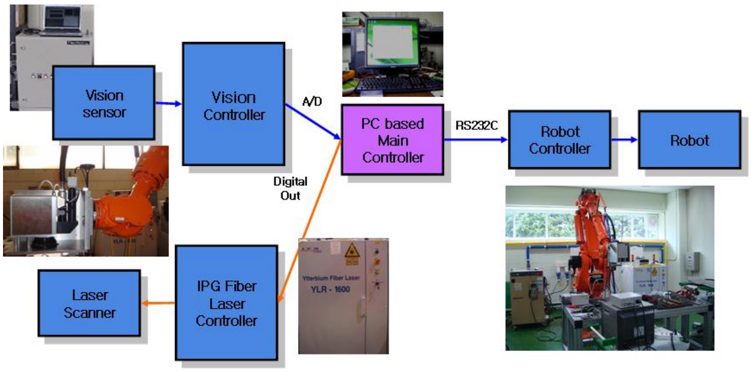
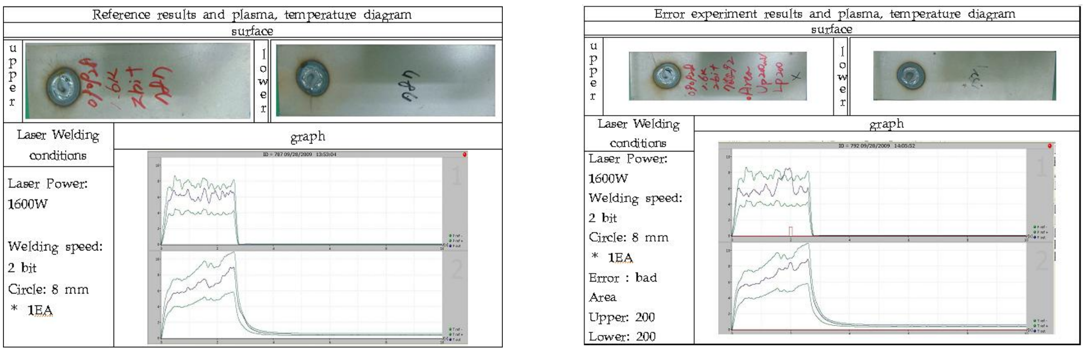


Fig. 1 Robot based remote laser welding system

During laser welding on a real-time-basis, basic tests were conducted to develop a technique which facilitates the evaluation of weld quality by monitoring plasma and temperature. To monitor weld quality using plasma flux intensity, the initial criteria of plasma intensity - which itself determines the critical weld quality - needs to be determined. When the plasma intensity lies between the maximum and minimum values of the standard range as Fig. 3, the weld quality can be judged to be acceptable. Tests were conducted using a fiber laser.

Fig. 2 show the test results of the welding quality monitoring using a fiber laser on the basis of the test results of the Nd:YAG laser. The results were obtained by scanning the steel sheet many times with the laser scanner of the remote laser welding system. The plasma and temperature signals could be detected at the appropriate values, confirming that real-time-based quality monitoring can be implemented.



(a) shielding gas; nitrogen, good weld (b) no shielding; error

Fig. 2 The experimental results of quality monitoring during remote laser welding for a circle pattern.

4. Conclusions

The remote laser welding robot system was built on the basis of the interfacing between the laser system and the industrial robot system. Using the remote laser welding system, butt and lap welding of common and galvanized steel sheets were conducted and the tensile strength of the samples was tested to determine the optimal welding parameters. The remote laser pattern welding tests were conducted with car body parts and the weld joints and defects were analyzed. During the laser welding, the plasma intensity signals were measured and analyzed to assist the development of a technique which enables evaluation of the quality of laser welding in real time. On the basis of the remote laser welding quality tests, the lap welding of galvanized steel sheets and the algorithms for evaluating the quality of laser welding will be tested in further studies.

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