Industrial Robot Based Welding Application

Prof. Jagdish Patel
Electronics and Telecommunication
Sandip Foundation (SITRC)
Nashik, India

Ms. Prajakta S. Somvanshi
Electronics and Telecommunication
Sandip Foundation (SITRC)
Nashik, India

***Abstract*—Welding being the major asset and salvation for automotive industry. Now a days Robot automation systems are rapidly taking the place of the human work force for arc and spot welding. One of the benefits is that this gives welding production of high-quality and high-efficiency. It reduces the risk of physical damage to the individual.**

This paper explain in detail of automatic robotic system for continuous arc welding process and spot welding process. Automatic welding robot gives repetitive accurate output in minimum time with low damage risk to human. Less time consumption, efficient welding result, low human safety risk makes it as cost effective application for automotive industries.

Keywords: SCADA, Robotic arm.

1. INTRODUCTION

Automation and robotics are two closely related technologies. Meaning of automation or robotics is working with minimal or no human efforts. From an industrial aspect, we can apply automation as a technology that is concerned with the use of mechanical, electronics and computer based systems in the operation and controlling of the production, for example automation technology includes mechanized assembly machines, transfer lines, numerically controlled machine tools, feed-back control systems and robots. Similarly, robotics is a form of industrial automation.

Welding is a process of joining different materials. The large bulk of materials that are welded such as metals and their alloys. Welding is also applied to the joining of other materials such as thermoplastics. Welding joins different metals or their alloys with help of a number of processes in which heat is supplied either electrically or by means of a gas torch.

1.1 SPOT WELDING:

As the term suggests, spot welding is a process in which two metal sheets parts are fused together at localized points by passing the large electric current using two copper electrodes, hence producing the weld. For relatively small parts, a spot welding machine is used in which the parts are inserted between the pair of electrodes that are maintained in a fixed position.

Wherein for larger work such as in automobile bodies, a portable welding gun is used which consists of a pair of electrodes and a frame to open and close the electrodes.

1.2 ARC WELDING:

Arc welding is also known as a continuous process as opposed to spot welding which might be called a discontinuous process. Continuous arc welding is used to make long welding joints in which an air tight seal is often required between the two pieces of metals need to join. The process uses an electrode in the form of a rod or a wire of metal to supply the high electric current for establishing the arc. Currents are typically 100 to 300A at voltages of 10 to 30GV. The arc between the welding rod and the metal parts to be joined produces temperatures that are sufficiently high to form a pool of molten metal to fuse the two pieces together. For robot applications two types of arc welding processes seems to be most practical, namely: gas metal arc welding (GMAW) and gas tungsten arc welding (GTAW). Gas tungsten arc welding is also called MIG welding for metal inert gas welding.

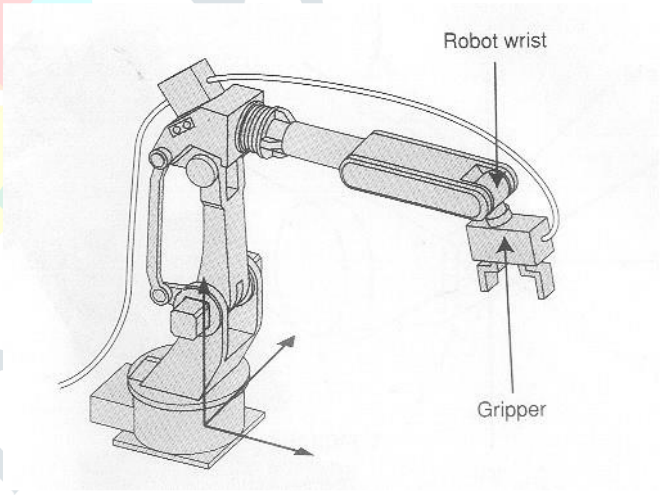


Fig.1. Robotic Arm

2. LITERATURE SURVEY

There are various techniques to provide the solution for effective use of industrial appliances. In most of papers manual welding used to operate the operation of industrial appliances. But this technologies have demerits over accuracy and productivity. As a result of the manual welding has low accuracy and precise problem. In the Automatic robot welding system this two problems are overcome and also increase the productivity.

1. "Design of Spot Welding Robot" Zelun Li, paper discussed about the design of spot welding[1], Welding robot has played an extremely important role in the welding production of high-quality, high-efficiency. The paper designed the hardware structure and software of spot welding robot. The hardware design mainly includes the major modules of arm and base; the hardware design includes two parts: manual mode and automatic mode. The welding robot uses PLC for controlling; the system runs faster and has a short production cycle.

2. "Arc Welding Robot Automation Systems", Beom Sahng Ryuh, paper discussed about the arc welding robot automation Robot[2] automation systems are rapidly taking the place of the human work force. One of the benefits is that this change provides the human work force with the time to spend on more creative tasks. The highest population of robots is in spot welding, spray painting, material handling, and arc welding. Spot welding applications are mostly in the automotive industry. However, arc welding and material handling have applications in a broad range of industries, such as, automotive sub-suppliers, furniture manufacturers, and agricultural machine manufacturers.

3. "Design, Analysis, and Simulation of a Pipe-Welding Robot with Fixed Plinth" A. Emami, paper discussed about the simulation of pipe-welding robot[3], Industrial Requirements concerning the increased efficiency and high rate of manufacturing result in the development of manufacturer robots, and a vast group of these types of robots is used for welding. This study presented the design, analysis, and simulation of a pipe-welding robot with fixed plinth for a constant circular welding around the pipes.
Design of a welding robot capable of keeping the electrode orientation, welding speed, and distance between electrode and pipe surface constant can improve the quality of welding; thus, a five-linked articulated robot was designed for this purpose.

4. "Robotic Welding Technology", Tang Sai Hong, paper discussed about the robotic welding technology[4], Since the first industrial robots were introduced in the early 1960s, the development of robotized welding has been truly remarkable and is today one of the major application areas for industrial robots. Robot welding is mainly concerned with the use of mechanized programmable tools, known as robots, which completely automate a welding process by both performing the weld and handling the part. Robots are quite versatile and hence have been used for a variety of welding types such as resistance welding and arc welding.

3. SYSTEM DEVELOPMENT

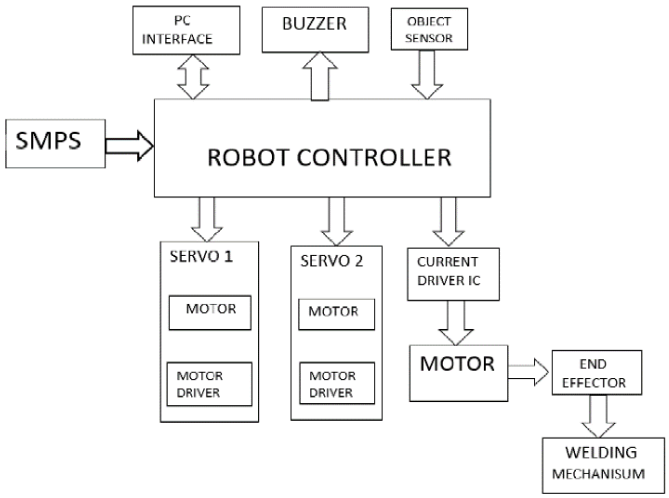


Fig. 2. Proposed System

Above is the proposed system of our project. The components involved in our project are: robot controller, object sensor, two servo motors, buzzer, PC Interface. In the proposed system the robot controller of KPM-2 is a high integrated functional computer system-on-a-chip. It contains of integrated memory and programmable input/output peripherals. Robot controllers often operate at very low speed. They consume relatively less power. It is used to controls the motor activation and deactivation operations and also reads sensor signals. The Object sensor is used to sense the object and pass the detected signal to the robot controller. The servo motor is consist of the motor and the motor driver circuit. Here we have not used the extra motor driver IC or motor driver circuit. Motor driver is a little current amplifier, its function is to take low current control signal and turns it into high.

3.1. HARDWARE :

3.1.1. ROBOTCONTROLLER (KPM-02) :

A robot controllers a high integrated functional computer system-on-a-chip. It consist of an integrated memory and programmable input/output peripherals. Robot controllers can be operated at very low speed. They consume relatively less power. It is used to controls the motor activation and deactivation operations and to read sensor signals.

- Threaded processor for controlling 2 servo motors
- All outputs Servo + USB REGULATED
- Cycle execution Time : 1MIPS (Million Instructions per Second)
- Parallel adder
- Connectivity to Computer

3.1.2. MOTORS (KPM-1) :

An electric motor is an electromechanical device which converts electrical energy into mechanical energy. Electric motors can be powered by direct current sources like batteries. Robot

controllers command these motors through the driver circuit to take the desired action.

- High torque (8 Kgcm) approx.
- Double ball bearing to output shaft
- Operating Voltage: 5- 6 VDC
- Metal gears
- Current Consumption: 1000mA
- Wattage: 6W
- TEMP RANGE: -10ºC to 60ºC.
- Weight: 100 gm approx.
- Velocity: 0.14Sec/60ºC

3.1.3. OBJECT SENSOR (HC-SR04) :

Here we are using the ultrasonic sensor for the sensing the object. To power the Sensor using a regulated +5V through the Vcc ad Ground pins of the sensor. The current consumed by the sensor is less than 15mA and hence can be directly powered by the on board 5V pins (If available). The Trigger and the Echo pins are both I/O pins and hence they can be connected to I/O pins of the robot controller. The trigger pin has to be made high for 10uS and then turned off to start the measurement. This action will trigger an ultrasonic wave at frequency of 40Hz from the transmitter and the receiver will wait for the wave to return. Once the wave is returned after it getting reflected by any object, the Echo pin goes high for a particular amount of time which will be equal to the time taken for the wave to return back to the sensor. The amount of time during which the Echo pin stays high is measured by the MCU/MPU as it gives the information about the time taken for the wave to return back to the Sensor. Using this information the distance is measured as explained above.

- Operating voltage: +5V
- Practical Measuring Distance: 2cm to 80cm
- Theoretical Measuring Distance: 2cm to 450cm
- Accuracy: 3mm
- Measuring angle covered: 15
- Operating Current: 15mA
- Operating Frequency: 40Hz

3.1.4. BUZZER :

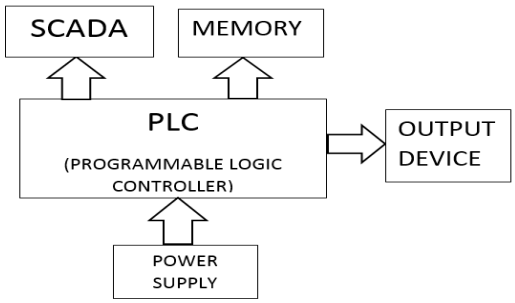
A buzzer or also known as beeper is an audio signaling device, which may be mechanical, elector mechanical, or piezoelectric [piezoelectric for short]. Generally uses of buzzers and beepers include alarm devices, timers, and confirmation of user input such as a mouse click or keystroke. In this project Buzzer is used when welding process is been completed.

- The PS series are high-performance buzzers that employ uni-morph piezoelectric elements and are designed for easy incorporation into various circuits.
- They consume low power in comparison with electromagnetic units.
- As these buzzers are designed for external excitation, same part can serve as both a musical tone oscillator and a buzzer.
- They can be used with automated inverters. Moisture resistant models are also available.
- The lead wire type (PS1550L40N) with both-sided adhesive tape installed easily is prepared.

3.2 SOFTWARE :

In the industrial design field of human-machine interaction, the user interface is where interaction between humans and machines occurs. The goal of interaction between a human and a machine at the user interface is effective operation and to control the machine, feedback from the machine which aids the operator in making operational decisions. A user interface is the system by which people interact with a machine. The user interface includes hardware (physical) and software (logical) components. User interfaces exist for various systems to provide a means of

- Input, allowing the users to manipulate the system.
- Output, allowing the system to indicate the effects of the user's manipulation.



After completion of the model of the automatic welding robot and selection of programming language both needs to be interfaced. The interfacing of robot and computer using the software is the most important aspect in the project. It should be interfaced using trial and error method, and then only final movement should be set using the software. The movement of robot should be precisely managed causing no harm to the operator.

Here we are using PLC (programmable logic controller). These are used for continuously monitoring the input values from sensor and produces the output for the operation of actuators based on the program. SCADA is a control system architecture that uses computers and PLC to interface with the process plant or machinery for management and operating. The operator interfaces that enable monitoring and issuing of process commands, such as controller set point changes, are handled through the SCADA computer system.

4. WORKING PROCEDURE

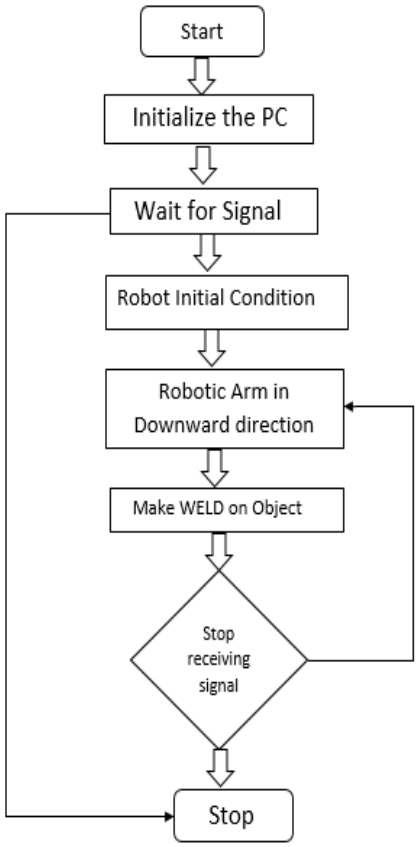
For this project, we are using two servo motors. Each be controlled by current driver IC. Two reference positions are selected. First reference position is where the arm has to weld on the object and second reference position is the place where

the robot has to stop the weld. First the robot controller signals the servo motor-1 via driver circuit one to make the rotation of the arm to the desired direction. Then the signal from robot controller is given to driver circuit 2 to drive the 2nd servo motor so that it can make up and move down. Next End effectors which is situated at the gripper is activated so that gripper holds the welding mechanism. Servo motor-1 is again activated to turn the motor towards destination direction, motor is then activated to make the down movement of the arm and finally, gripper motor is activated for welding the object. An Object sensor, which is connected to the robot controller is programmed in such manner that it senses the presence of the object. If no object found then buzzer will be buzzed out for the indicating the process is completed.

Fig. 3. Robotic arm based machine using PLC

5. WORK FLOW DESIGN

For the Robotic Welding following figure shows the work flow design. To start the welding first initialized the compute then press the start button on computer screen. This start signal send to the robot until robot received the start signal wait for it. After receiving the signal robot will start moving. The Robotic arm will move in the given angle in degrees and wait for next command. After receiving the weld command robotic arm move in downward direction and stop at given angle. Then welding is started between two metals. Once the given welding time finish robotic arm stop producing heat and move in upward direction. At the same time counter make count for welding and this count shown in the screen. If the count is not proper the signal received by robot is stopped and robot stop the welding process. Otherwise next operation will start and this process is continuously repeating until the given number of count is completed.



6. CONCLUSION

The social value of robotics is that these wonderfully subservient machines will permit human more time to do more challenging, creative, constructive, conceptual and co-operative work than at present. There is every reason to believe that the automation of work using robotics will lead to substantial increases in productivity and quality. These increased productivity with quality will permit humans to engage in activities that are cultural as well as recreational. Robotics will not only improve our standard of living, it will also improve our quality of life.

REFERENCES

1. Zelun Li, Zhicheng Huang, Youjun Huang, “Design of Spot Welding Robot ", College of Mechanical and Dynamic Engineering, Chaina, 2013.
2. Beom-Sahng Ryuh, Gordon R. Pennock, “Arc Welding Robot Automation Systems ", Division of Mechanical Engineering, Korea, 2006.
3. A. Emami, S. Khaleghian, M.J. Mahjoob, “Design Analysis, and Simulation of a Pipe-Welding Robot with Fixed Plinth", School of Mechanical Engineering, College of Engineering, Iran, 2011.

4. Tang Sai Hong, “Robotic Welding Technology "Department of Mechanical and Manufacturing Engineering, Malaysia, 2014.
5. Industrial Robotics by Mikell P. Groover, Nicholas G. ODREY, MITCHEL Weissl.
6. Industrial Robotics by Mikell P. Groover, Nicholas G. ODREY, MITCHEL Weiss.
7. Cary, Howard B. and Scott C. Helzer “Modern Welding Technology”, Upper Saddle River, New Jersey: Pearson Education. Page 316. ISBN 0-13-113029-3.,2005
8. Mustafa Suphi Erden, Bobby Marić “Assisting manual welding with robot” Article Robotics and Computer-Integrated Manufacturing, Volume 27, Issue 4, August 2011
9. Zhenyu Liu, Wanghui Bu, Jianrong Tan “Motion navigation for arc welding robots based on feature mapping in a simulation environment” Robotics and Computer-Integrated Manufacturing, Volume 26, Issue 2, April 2010
10. Doyoung Chang, Donghoon Son, Jungwoo Lee, Donghun Lee, Tae-wan Kim, Kyu-Yeul Lee, Jongwon Kim “A new seam-tracking algorithm through characteristic-point detection for a portable welding robot” Robotics and Computer-Integrated Manufacturing, Volume 28, Issue 1, February 2012
11. Jacobsen NJ. Three generation of robot welding at Odense steel shipyard. Proc: ICCAS. Pusan, Korea. 2005
12. www.faculty.washington.edu/robotweldengl:htmlwww:the tech:mit:edu=professionalrobot:html.
13. Jagdish Patel, “FPGA Based Efficient Implementation of Viterbi Decoder” in International Journal of Engineering and Advanced Technology (IJEAT), pp 84 – 89, Oct 2011, ISSN: 2249-8958.
14. Jagdish Patel. “War Field Robot Controlled By Android Phone” in International Journal of Innovative Research in Computer and Communication Engineering (IJIRCCE), pp.47 to 51,January 2015, ISSN: 2320-9801
15. Jagdish Patel, “A Research paper on Manual Fixture Automation using PLC” in International Journal for Scientific Research & Development (IJSRD), pp.1705-1707, April 2017, ISSN: 2321-0613.
16. Jagdish Patel, “5G: Evolution Convergence and Innovation Future Mobile Technology” in International Journal of Scientific Research & Education (IJSRE), pp. 3140 to 3149, March 2015,ISSN: 2321-7545.
17. Jagdish Patel, “FPGA Implementation of High Speed Viterbi Decoder” in International Conference at Gujarat Pollution Control Board held at SVNIT, Surat, pp,15-17, Dec 2011.
18. Jagdish Patel, “FPGA Implementation of Viterbi Decoder” in International Conference at ICCIA held at SITRC, Nashik, pp11-12, Feb 2012.