

# Research on the Application of Robot Welding Technology

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**Abstract**— The application of robot welding technology is analysed in welding applications. The importance, applications, advantages and disadvantages are analysed in this welding operation. The main type of welding analysed are electron beam welding, ultrasonic welding, high frequency induction welding, electric arc welding and resistance welding in which robotic welding technology applications are analysed. Here these welding technologies are analysed for its process of application and benefits of using it. The welding technologies processes are also explained and robotic technology application procedure are also analysed in describing this process. The main types of robot which are analysed for carrying out this welding process are six arm robots. The arms which are controlling the welding process from starting to ending of welding process are explained for each type of welding.

**Keywords:** Robot Welding Technology, Six Arm Robots, Electron Beam Welding, Ultrasonic Welding, High Frequency Induction Welding, Electric Arc Welding, Resistance Welding

## I. INTRODUCTION

Robot welding technology is the latest technology developed and implemented in the industry with the use of different programming codes and different electrical circuits. This is used to automate the welding technology process and is capable of handling all jobs from welding machines to forming new components. These robots are developed with the aim of performing complex welding tasks including resistance and electric arc welding. This uses an already developed programmable code which is used to control every action and motion of robots with also automating the industrial process of welding technology. This robotic technology is used to enhance the productivity and accuracy of product development in an industry.

## II. ROBOT WELDING TECHNOLOGY

A robot which is used for welding process constitutes of several mechanical programmed tools and this helps in automating the welding process in industries. This type of robot is used for automating the welding technology developed and used in an industry for the purpose of joining two material components by enhancing their melting point temperatures (Hong *et al* 2019). This technology is used to perform resistance spot welding and gas arc welding which are most common in the industry. The most common type of robot used in an industry is a six-axis industrial robot which comprises of three axes lower arm and a three-axis wrist arm.

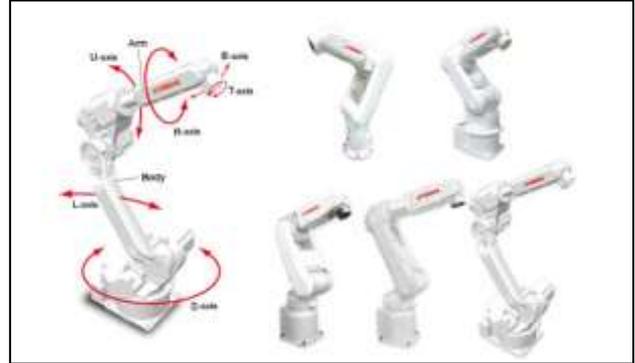


Fig. 1: 6 axis industrial welding robot  
(Source: <https://global.yamaha-motor.com/business/robot/lineup/ya/ya-6/>)

## III. APPLICATIONS OF ROBOT WELDING TECHNOLOGY

The applications of robot welding technology are described below -

- 1) The robot welding technology is used to automate the welding process in an industry. This automation takes place with the help of mechanical programmable codes and these codes are formed to control the actions of a robotic arm and structure during the welding process (Chen *et al* 2021). If a mechanism for manufacturing process is continuous and same then this can be easily replaced with robotic technology which is used and implemented in an industry.
- 2) This robot welding technology is used to save time consumed in the welding process. If a welding manufacturing process is continuous and follows the same process of manufacturing then also this process takes a longer time for human skills to perform in the industry (Xu *et al* 2020). This robot welding technology takes action with help of developed programs and codes so their actions are fixed which is performed by robots within less duration of time.
- 3) The robotic welding technology is used vastly in an automotive industry. Here maximum welding process used is electric arc welding, spot welding and resistance welding. The spot welding and resistance welding uses electric current with a resistor to perform welding process (Pashkevich *et al* 2019). Here electrical energy is used to heat up the material body and hence the body starts to melt after its temperature reaches up to a melting point. The robotic arm is used to carry out the welding process by properly setting the types of equipment and material components in their proper place after then also performing welding process. This is used to control all activities in a welding process from starting of welding, increasing its required melting point to finally welding of body components and finally joining them.

- 4) The robotic welding technology is also used to perform electric arc welding in which electric arc is used to carry out the welding process. Here inert gas like Argon is used to prevent the reaction of the final product with outer atmosphere. All these processes from setting up of equipment and tools to finally ending the welding process is controlled by the use of a robotic arm (Ribeiro *et al* 2019). As robotic actions are fully programmed and controlled so they perform it very fast with negligible chances of errors during manufacturing process.
- 5) A six-axis industrial robot is used to carry out electric arc welding process in an industry. This welding process has a full setup of electrical circuits and power supply from initial. Here the main role of a welder is to control workpiece and torch which feeds inert gas position at the right place during its operation. This process is carried out very slowly with also any skilled labors but this takes place very fast with use of robots. The role of robotic arm here is to control the movement of welding torch and workpiece at the right position during performing welding operation.



Fig. 2: Welding operation by 6 axis robot

(Source: <https://www.automate.org/blogs/benefits-of-robotic-welding>)

- 6) Laser welding is a process in which the energy emitted from laser light is used to perform a welding operation. The laser light is provided between two materials which are needed to be welded. These components are fixed at their position and here only the movement of laser gun takes between two components. This process increases the temperature between two components and when its temperature reaches to melting point then weld pool is developed between two components which on solidification joins two material components permanently. Here the use of a robotic arm is only to control the to and fro motion of laser gun between two components and suspending the supply of laser light upon completion of welding process.
- 7) Arc welding is the most popular welding that is used in an industry and performed with the help of robots. This type of welding is mostly used in automotive industry where welding of car components are to be carried out on a large scale and also with higher accuracy. The car components manufacturing process is used with batch production where there is a requirement for the formation of a huge quantity of components. The six-axis robot is used here to carry out arc welding process and is also in high quantity. This has the advantage of saving time and increasing productivity in the industry by reducing the chances of errors during production.



Fig. 3: Arc welding industrial robots

(Source: <https://www.kuka.com/en-us/industries/metal-industry/arc-welding/kuka-arc-welding-robots>)

- 8) A robot welding technology is also used in the small parts manufacturing industry including production of electric appliances and some mechanical components. Here friction welding is also used to join any two small components with the help of thermal energy generated from friction produced between two components (Wang *et al* 2020). Here one component is made to rotate and move relative to another component with a high velocity which produces friction between them and also higher temperature zones. After reaching of material's melting point, the lower part of a component which is in contact with other components melts its materials chemically. On solidification, these two components join together and this operation is performed with help of a robotic arm very fast and with high accuracy. This also makes welded joints with uniform surface and with no any defects.
- 9) The welding processes are automated with help of robotic technology in an industry which helps to reduce the time consumption of manufacturing, increases productivity and also enhances efficiency of production. The most common industrial robot used is a six-arm robot that helps in manufacturing with arc welding, spot, resistance and friction welding processes. This welding technology by use of robots has now become most common in any industrial sector.
- 10) The maximum use of this technology is seen in automotive sectors because here many parts and components are needed to be rejoined by a welding process and there is also a need for high level of accuracy in performing the welding process (Dahari *et al* 2019). The robotic arms are used to control activities in welding processes and this includes controlling motions of equipment and also welding torch. This controls all welding actions from initiating of welding process to ending of welding process.
- 11) The robot welding technology is also used to carry out high frequency induction welding in industries. This high frequency welding technology is used to form welded joints of very high strength and is helpful in making components and parts in the automobile industry. This technology is used to carry out joining of welded joints using high frequency electromagnetic force. The materials are heated and it is acted in a high pressure area due to which the parts of the materials are melted and joined together to form melting of materials components (Benakis *et al* 2019). The robot welding technology is used to carry out this welding process with controlling all

its activities. Here heat is not generated on an outside body part of the material and hence there is a less chance of causing defects on the surface of materials. After its cooling process, the weld parts are solidified and hence these two materials parts are joined together with forming welded parts. This process results into forming of very strong welded joints which exists for a very long period of time in also high pressure and temperature environment. There are many advantages of using this welding process like rapid welding process, inexpensive tooling and clean manufacturing process. The important factors that influence the welding process are applied pressure, welding time, electrical power input and its solidification time (Huang *et al* 2018). The high pressure welding is applied with a high frequency generator device as energy is applied at high frequency. This high frequency increases power input to the welding processes and this enhances welding time and its formation. The external force is applied to above welding material as this causes friction and heat generation between materials. This also causes melting and fusion of materials between metal pool which is formed and this results into forming of welding process. The robotic technology is used to control all activities in welding process and this includes from starting of welding to ending of welding process. The robot welding technology is used to power on the device for welding and also exerting force on the material body (Horváth *et al* 2018). This technology is very fast and hence this process causes rapid welding technology with also enhancing its efficiency.

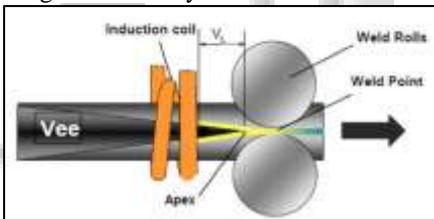


Fig. 4: High frequency induction welding process  
(Source: [https://www.phase-trans.msm.cam.ac.uk/2010/pipe\\_Alberta.net](https://www.phase-trans.msm.cam.ac.uk/2010/pipe_Alberta.net))

- 12) The robotic technology is also used to carry out ultrasonic welding which forms welding process with the use of ultrasonic vibration which is above 20,000 Hz. This technology is used to enhance speed and accuracy of welding process. The types of equipment used here in the welding process are generator, transducer, booster, horn and anvil. These pieces of equipment are used to carry out the welding process with the effect of ultrasonic vibration (Banga *et al* 2021). The power generator is used to provide power to the transducer device which is also used to convert the electric energy received from generator to mechanical ultrasonic vibration. This ultrasonic vibration is about in the range of 20,000 Hz to 30,000 Hz which causes the to and fro motion of horn that is attached to the lower power of transducer. This vibration is transmitted by booster device which causes enhancing of vibration which is caused in the body. This horn is continuously making to and fro motion on the material placed on the anvil. The plastic parts are melted

with heat energy generated from friction process and this causes welding process (Kangru *et al* 2019). The weld pool is formed on material and hence this causes melting of parts and upon solidification, it causes welding of material components. The robotic technology is used to carry out welding process with the help of robotic arms which are used during welding process (Farkas *et al* 2018). The robotic arms are used to make power on and off during manufacturing process and also to control the positions of material placed on anvils which are needed to be welded.

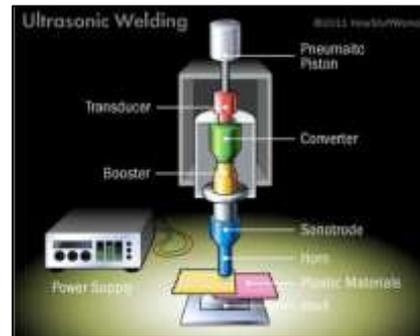


Fig. 5: Ultrasonic welding technology  
(Source: <https://www.nexpcb.com/blog/the-basics-of-ultrasonic-welding-technology>)

- 13) The robotic welding technology is used to carry out electron beam welding process in which material is placed at an anode and power is supplied from cathode during the welding process. The power is continuously supplied from cathode from where a high voltage electric current is passed and it forms an electron beam in a welding process (Zych *et al* 2021). The deflection coil is used to deflect the direction of the electron beam formed from cathode. The coil is also placed in between so that an electric magnetic field should be produced. The vacuum pump is used to extract out scrap materials that are formed during the welding process. The electron beam is placed in space between two material components and hence higher thermal energy is produced between them which melts material between them and upon solidification it two materials components join together (Gullino *et al* 2019). This welding forms a strong between them which forms a permanent welding process. Robotic welding technology is used to feed electric beams between materials components. This technology also controls extraction of scrap material during formation of material weld. The robotic welding technology is used to carry out this welding process within a very short period of time and also with higher accuracy. The coding and programs are used in robots to instruct them to perform a certain type of operation which is used during the welding process.

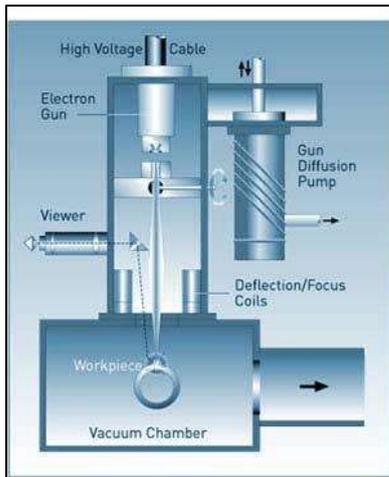


Fig. 6: Electron beam welding technology

(Source: <https://www.ebpglobal.com/the-electron-beam-welding-process-explained/>)

- 14) The robotic welding technology is used to enhance formation of welding pools and welded joints with more accuracy which will prevent failure of material during its application. The different types of robots are used during manufacturing process and most famous of this robotic technologies are the six arms robot (Zhang *et al* 2021). The six arms robots are useful in the manufacturing of welded joints as they can form multiple operations at the same time during manufacturing and welding process. The activities to be performed by robots are preprogrammed and hence there is a minimal chance of error formation during manufacturing process.
- 15) This technology is used in explosive welding to weld materials with the help of an explosion during manufacturing process. Explosion welding is used in many industries where welding processes are needed to be carried out very fast and with higher accuracy. The explosive material is placed on a buffer plate which is attached to a detonator. The distance between the flyer plate and base plate is separated by a stand-off distance. The detonator is first made active with help of robotic arms and this causes an explosion on buffer plate which is provided to prevent damage to the flyer plate (Yan *et al* 2019). A high amount of pressure is created on flyer plate due to which top plate flies and gets attached to the base plate. This is carried out with a high amount of pressure formation on a base plate which is followed by melting and fusion of material on the base plate. This process on solidification causes welding of flyer plates with base plates and this causes strong weld pool formation on a base plate. The robotic technology in this welding process helps to control all stages of welding including activating of detonator to ending of the welding process.

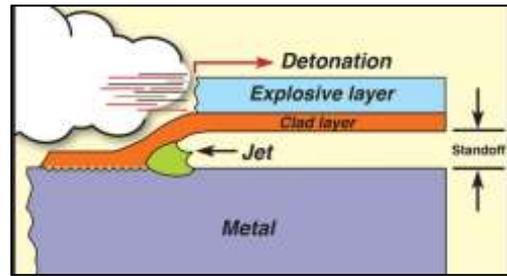


Fig. 7: Explosive welding

(Source: <https://fastenerengineering.com/what-is-explosion-welding/>)

#### IV. ADVANTAGES OF ROBOTIC WELDING PROCESS

The advantages of robotic welding process are as follows -

- 1) The robotic welding technology forms a more consistent and higher quality of welds that is formed between two materials. The higher consistency of welding process is useful to carry out repetition of same welding process regularly in industry to enhance its productivity. This consistency will cause a better amount of weld pools and this will also create a strong welding joint. The qualities of welds are higher and good as this is carried out by preprogrammed a robot which creates welding with zero chances of errors during its operation. This welding technology is used to enhance productivity and maintains the delivery of products with proper time in the industry.
- 2) The robotic technology is used to enhance effectiveness and reduce waste in welding processes. There are minimal chances of errors occurring when the welding process is carried out by robots. The robots are well pre-programmed about all stages of welding and activities to include during welding process (Epping *et al* 2018). The pre-programmed activities are helpful in controlling all activities well in advance which will enhance the welding process during manufacturing process. The effectiveness and in advance decision of welding activities reduce waste during performing of welding processes.
- 3) The reduction of wastes formation during welding reduced the operation of post-welding cleaning up which are due to scrap and waste formed during welding process. This higher effectiveness of welding technology produces no any scrap during welding process and this also creates implications of a reduction in demand for energy required in cleaning up of wastes formed during the welding process.

#### V. DISADVANTAGES OF ROBOTIC WELDING PROCESS

The demerits of robotic welding technology are as follows -

- 1) The cost of incurring robotic welding technology in any industry is higher due to which price of a product also goes higher which are affecting sales of the company. The cost analysis is carried out by any industry to sustain in competition with also enhancing its revenue. The robots which are capable of welding process are very costly and hence to cut the cost of product most of companies are still not using it.
- 2) There is a lack of flexibility in robotic welding technology due to which it is still not in use in most of industries. This flexibility comes with adapting to new

technologies and robots are pre-programmed which causes it difficult to adapt to a new welding technology (Romeo *et al* 2020). The process of using this technology should be again pre-programmed in robots to control all its activities and this will again consume a lot of time during welding process. This causes a lack of flexibility in welding process and hence there causes a time gap between the welding processes.

- 3) There is a risk associated with using robots for welding technology. This risk includes the condition that if robots fail due to mechanical failure reasons then there will be an issue in carrying out further welding in the industries. Hence, the industry should not be fully dependent upon robots for welding operations that should be carried out in the industry.

## VI. CONCLUSION

The robotic welding technology is analyzed for carrying out welding process in an industry. This welding technology is analyzed to be used in much large scale to small scale industries and this major application in the automotive industry. The different types of welding technology carried out in industry are electron beam welding, ultrasonic welding, high frequency induction welding, explosive welding, electric arc welding and also friction welding. The maximum uses of six arm robots are used in industry to control all welding processes. This welding technology helps in meeting market demands of products very easily during welding process. The time when market demand is always at a peak then there raises a high demand for products and then this process helps in fast production of production with also launching it into the market.

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