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ROBOTS APPLICATION FOR WELDING

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Abstract

In this work, the authors give an overview of the advancement of industrial robots and show the mechanization of welding processes, step by step. As manual welding is a physically exhausting professional work, engineers have sought to improve work conditions since the industrial revolution. Unfortunately, even today, many procedures can only be performed manually. In the welding process, the highest level of mechanization is represented by the use of robotics. The entrance of Robots in the history of welding is recent, though their spread and development are rapid.

Keywords*: welding, robot, sensor, security, danger.*

1. Introduction

The idea of robots or automated machines has a long history. Ancient Greek texts talk about Talos, the gigantic brass automaton (**Figure 1.**), protecting Crete and Europe from pirates and invaders by walking three times around the island daily and throwing boulders at the approaching ships **[1]**.

The ancient pieces (77–100 bc.) of a mechanical calculator, found under the sea, also prove humans have long been able to construct automatic machines. For example the organs and water clocks of Ctesibus (270. bc.) and other mechanical devices we have used in robotics. Heron, the physicist and engineer, created an automatic mobile theatre. Heron and Philon even wrote books about automation and the basics of robotics.

Leonardo Da Vinci created a multitude of mechanical constructions in the renaissance era. One of his most important creations was the mechanical lion (**Figure 2.**) **[1]**.

The mechanical calculator of Blaise Pascal was a significant advancement in mechanical devices. This very useful machine was called Pascaline, although only 50 copies were ever created.

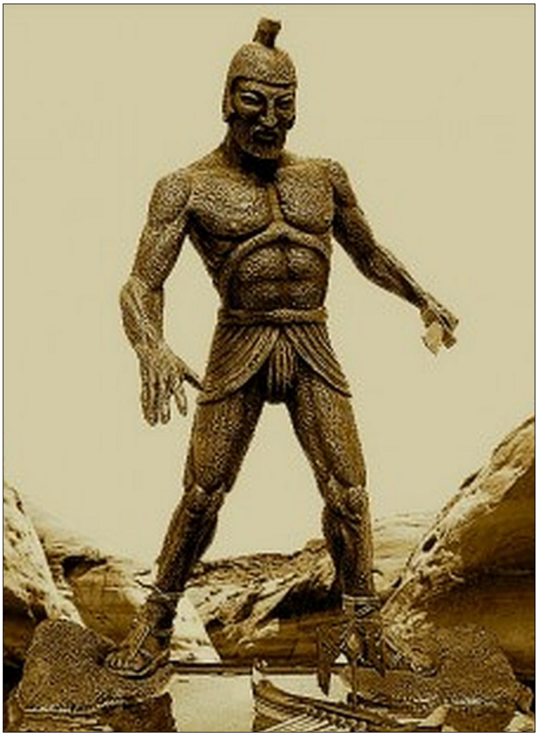

Figure 1. *Talos,the giant robot of Hellas* **[1]**

Figure 2. *Leonardo Da Vinci's mechanical lion* [2]

Mechanical devices built in the 18th century could be seen as primitive robots, these were mainly made for entertainment. For example, the likes of the Swiss watchmaker, Pierre Jaquet-Droz's humanoid robots or Jacques de Vaucanson's robot duck.

The first industrially feasible robot was named Unimate and it was created by George Charles Devol in 1954. A few years later Devol and his companion Joseph F. Engelberger founded their own company, the Unimation [3] was born. This is the point where the science of robotics started to form.

2. The basics of robotics

The name „robot" originates from Karel Čapek Czechoslovak writer. He created the word from the abbreviation R.U.R. or Rossum's Universal Robots (1921.). Since then, common and professional terminology has adopted this designation [4].

Later, the three laws of robotics were created by (1942) by Isaac Asimov:

1. A robot may not injure a human being or, through inaction, allow a human being to come to harm.
2. A robot must obey the orders given it by human beings except where such orders would conflict with the First Law.
3. A robot must protect its existence as long as such protection does not conflict with the First or Second Laws.

The cornerstones of the science of robotics are these laws. Robotics is an interdisciplinary field of engineering sciences, containing the fields of mechanical engineering, electrical engineering, and computing studies, and to this list has been added informatics science because the robot is required to receive instruction and programing from afar.

In the case of industrial robot systems, there is no limit of force or velocity because of increased performance. Industrial robots work automatically, can be programmed and can utilize multi-axis movement.

With the implementation of industrial robots, new ergonomic and safety regulations became necessary, as a human working alongside a robot, has to operate within abnormal work conditions.

During industrial processes, the human workforce's safe working condition has to be created. Furthermore, the robot also has to be protected as machine abuse is well known to have been prevalent throughout the industrial revolution, when people saw machines as a threat to their jobs, and destroyed industrial machines. Of course, damage can occur without ill will – by the lack of knowledge of the operations, or by accident. The operator has to be a well trained professional, in many cases an engineer, with wide-scale knowledge of the robot's operation, programming, and the applicable safety regulations.

3. Automatization of welding

Welding is an industrial process that has a strong history. For a long time, manual welding was the only option. The quality of the welded joint was dependent on the welder's skill. Manual welding inflicted serious physical stress on the worker, therefore continuous activity was not tolerable, the work had to be interrupted for periods of rest. Industry, however, required increased performance, and that could only be realized through automation.

Different levels of mechanization are known.

From the tools of mechanization – by application features – manipulators stand out, just as the flexibly programmable, industrial robots working alongside peripheries (Figure 3.). Their application leads to increased productivity, decreased cycle of production time, better quality, and the amount of hard and monotone works can be decreased, with their help human activity can be replaced in environments that are dangerous to health [5, 6].

Welding is a relatively new use of robotics, the industry was created by the robots itself. In 1962, General Motors used resistance spot welder robots on the welding production line.

Robotic welding procedures have come a long way since the first spot welding robot in 1962. Now implemented across varied industries, manufacturers recognize the benefits of robotic welding to keep them competitive in an ever-expanding and highly competitive global marketplace. [7]

The automotive industry has used spot welding robots the most, which have become very popular since the '80s. Recognizing GM's success, other automakers have also started using welding robots. The investment soon paid off, and as a result, robots began to be used in other metalworking technologies. This was followed by very rapid development.

And the development of sensors has further increased the productivity of robots and expanded their range of applications.

Some of the main benefits of robotic welding include:

– Quality: Robots can make high quality, precise welds. They are also able to repeat these welds with the same quality. The result is consistent, reliable welding.
– Productivity: Robots improve productivity on an assembly line. They are capable of complicated simultaneous welds; they work fast, without sacrificing quality; they have reliable repeatability, and they work tirelessly 24 hours a day.
– Manual welding raises several of ergonomic issues, which are solved by robot welding. Toxic gases generated during welding, ergonomically incorrect posture, and heat and ultraviolet radiation do not damage the robot. Another advantage is that the robot works cheaper, reproducibly and efficiently.

4. Welder robot application

Cloos international also manufactures and develops welding equipment, including power supplies and robots. For high-performance processes, robot welding processes have been developed. Besides, various sensors help the work of the welding robots.

The welding robot is shown in Figure 4. can achieve displacement around 7 axis. The robot's workspace can be described by a hemisphere, each point can reach by the robot.

During our welding experiments, we checked that the robot can weld in all positions. The robot presented and used by us is digitally controlled. The programming must be implemented in the programming language developed by Cloos, during which, in addition to the knowledge of coordinate geometry, welding knowledge is also required.

Welding is performed by a robot with gas metal arc welding technology. The welding current

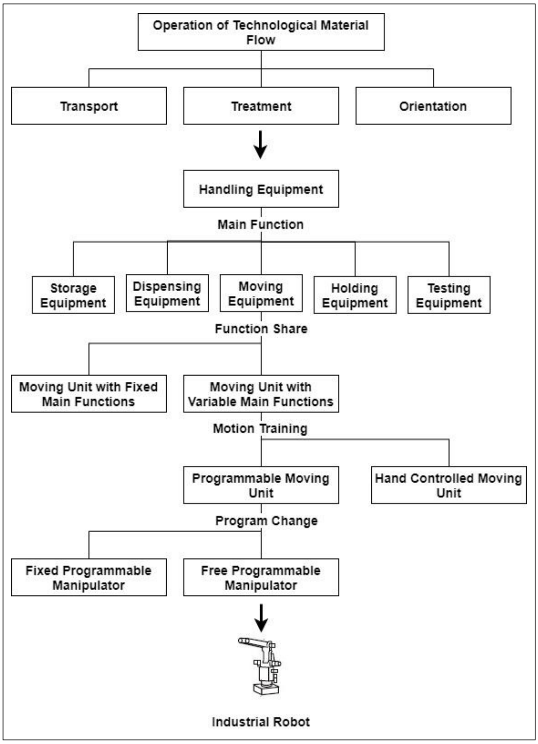

Figure 3. *The tool kit of the welding automation* [8]

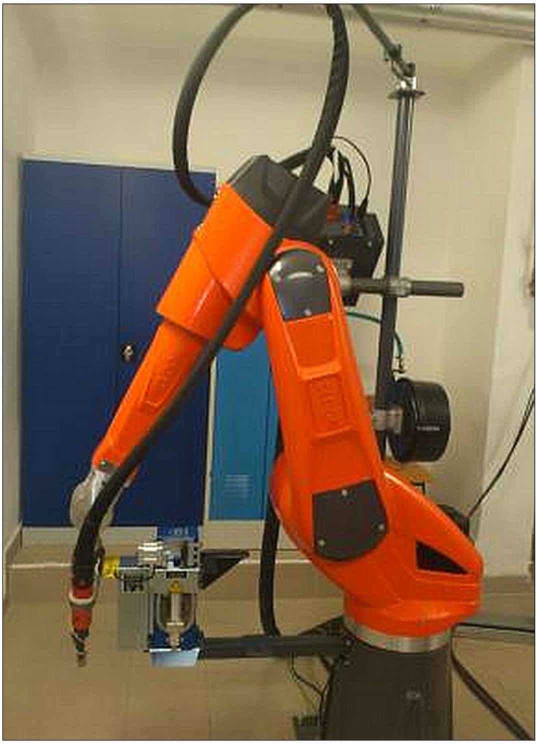

Figure 4. *Cloos welder robot*

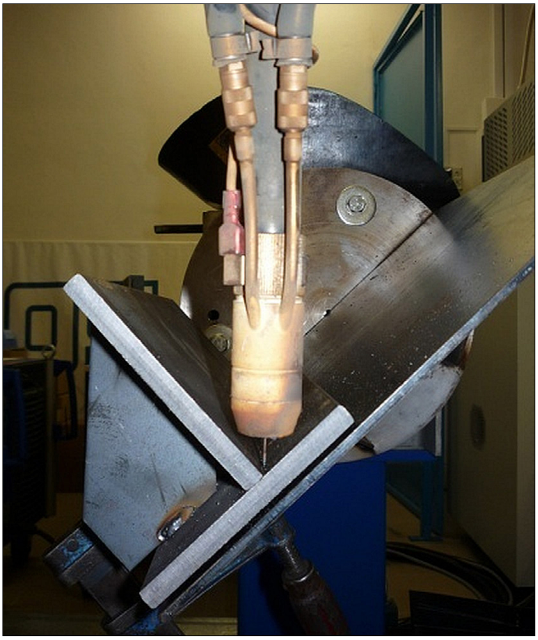

Figure 5. *Flat welding position (PA) welding* [9]

Figure 6. *PA result of the welding* [9]

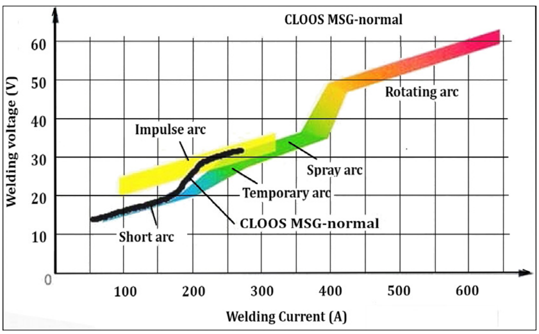

Figure 7. *The used robot power synergy curve in the case of the MSG normal mode* [10, 11]

achievable is significantly higher than in the case of the hand welding, incorporating a welding speed resulting in higher productivity that significantly exceeds manual welding.

During welding, our results showed that the quality of the finished seams performed in the flat welding (PA) position (**Figure 5.**) is advantageous.

Therefore, during welding, it is advisable to weld the workpieces in this position (PA).

During welding, gas protection is also more effective than in other positions.

It can be seen in **Figure 6.** that the welding in the PA position was successful.

When setting the parameters, it was necessary to know the arc characteristics of the power source.

Based on the synergy curve (**Figure 7.**), the welding current can be determined. The welding position (PA) can be achieved in the flat position by using the outer axis. The shielding gas used for gas metal arc welding is recommended by Linde (M23). The steel (S235JR) plate used in the experiment was 8 mm thick.

5. Conclusions

It can be concluded that robot welding is also advantageous in terms of productivity and ergonomics. When selecting the position, an attempt is made to move the workpiece to the PA position, to which external axe can also be used, so that the quality of the welded joint is adequate.

In order to ensure the quality of the welded joint, it is necessary to determine the appropriate current according to the Synergy curve of the welding current source.

We plan to conduct further experiments to analyze the limitations of robot welding.

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