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# INTELLIGENT SYSTEMS IN WELDING PROCESSES

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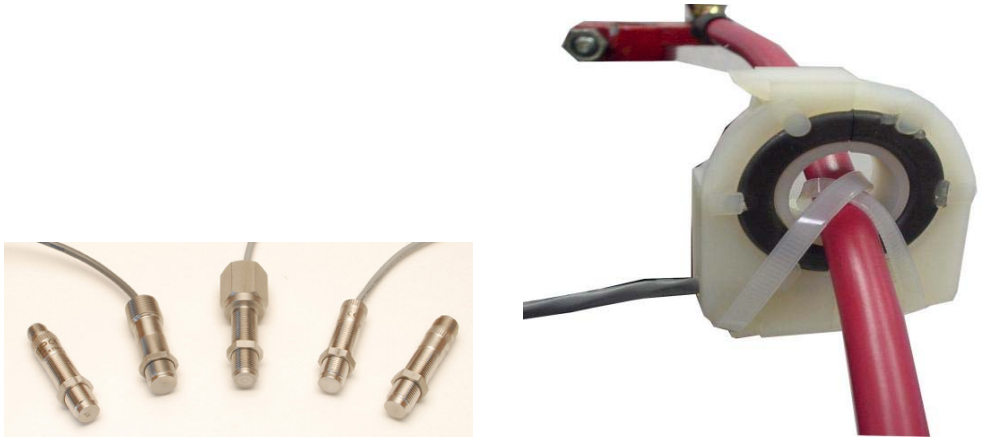
## ABSTRACT
*The demand for better control and sensing in welding has increased with automation and welding processes involving new and advanced materials. This requires precise control of the welding process to produce the desired weld with respect to productivity and quality. This papers describes sensors for technological and geometrical parameters for welding process.*
**Keywords:** welding, intelligent systems, robotics, sensors

## 1. INTRODUCTION
Basic assignment of sensors is data communication to control system which generate adequate actions to complete results which are compatible with specified data[1,2]. In the welding process it is not simple to achieve as one may think so. Welding process is made of two subsystems: welding equipment and robot. Welding equipment includes: power source and devices that transfer the energy from the source, such as wire feed system, conduit, welding torch. The robot execute relative positioning of the torch and working part and the torch is positioned on the gripper [1,2]. Allocation an the way the sensors are used is affected by sensor specification which can be divided in to two groups technological and geometrical sensors. Technological parameters are measured including the welding process, geometry parameters and the weld joint geometry.

## 2. SENSORS FOR TECHNOLOGICAL PARAMETERS MEASURMENT
Sensors for technological parameters measurement are used for welding voltage measurement, welding current and wire feed speed. Basically, there are two types of sensors for welding current measurement: hall effect and current shunt. Hall effect sensor has made of cast-iron circular core on top of which is cable leading the current [2]. Advantage of hall effect sensors is the fact that they are no contact sensors and are not in the collision with the welding current source. Current Shunt is basically obstacle for the current by the resistor measuring the voltage drop.
Important parameter for controlling and welding process stabilization is the wire feed speed. Measuring the wire feed speed is a very large problem and the laboratory testing can use contact tube speed measurement [2].



*a) Hall Effect Sensor* *b) Current Shunt*

*Figure 1. Sensors for welding current measurement*

Next to above mentioned sensors there are so called multi-sensors.


*Figure 2. Micro ADM Transducer*

Example of that kind of sensor is MicroADM Transducer made of incorporated microcontroller which enables necessary data processing, signal processing and communication to achieve technological parameters of welding process[10].

## 3. SENSORS FOR GEOMETRICAL PARAMETERS MEASURMENT

Sensors for geometrical parameters must be able to obtain information about the weld that relates to the geometry of the weld joint. Most frequently used sensors are optical sensors and through-arc sensors. Optical sensors use laser light source on the weld joint and sensor with narrow filter for interesting information selection. Through-arc sensors use electrical parameters of arc together with information about welding movement controlled by robot [1,2,8].

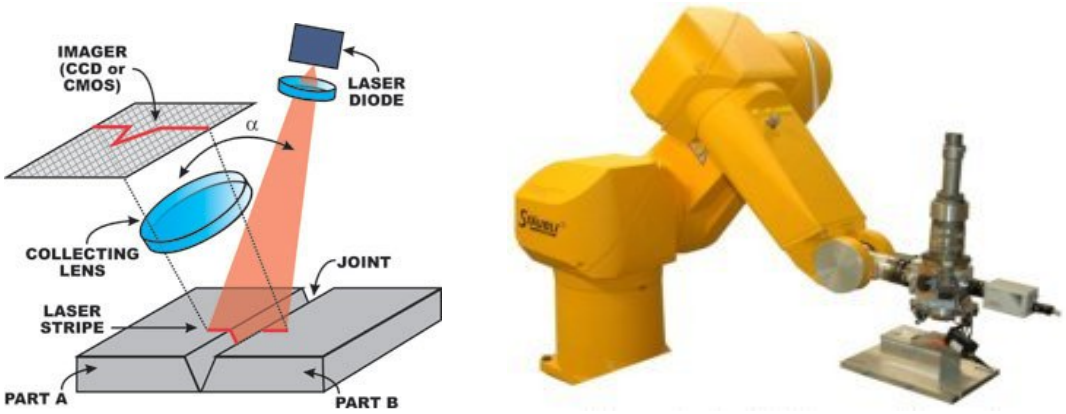



*Figure 3. Triangulation principle*

Cameras for joint control use triangulation principle. Laser beam of low power is projected on the surface of working piece and reflected spread light makes picture on CCD or CMOS sensor.

## 4. INTELLIGENT SYSTEMS FOR WELDING JOINT DETECTION

SmarTac is universal flexible system which uses touch sense for locating weld joint position. Welding robot trace programmed path placed in his memory and as long as working piece is correctly placed results will be great. If the working piece is dislocated significant problems in welding joint quality accrue. To overcome this problems robot must be able to readjust his movement relatively to working piece [9]. In other words robot needs adaptive control system. SmarTac system uses standard nozzle on the torch as a sensor he those not take to much space. The system works by energizing the gas nozzle with an electric charge during the search mode. A closed circuit is made when the nozzle and work piece make contact, sending a stop signal via a converter unit to the robots control system. After comparing the actual position of the programmed position in its memory the system calculates the differences between the two positions and adapts the program to the objects actual position [9].

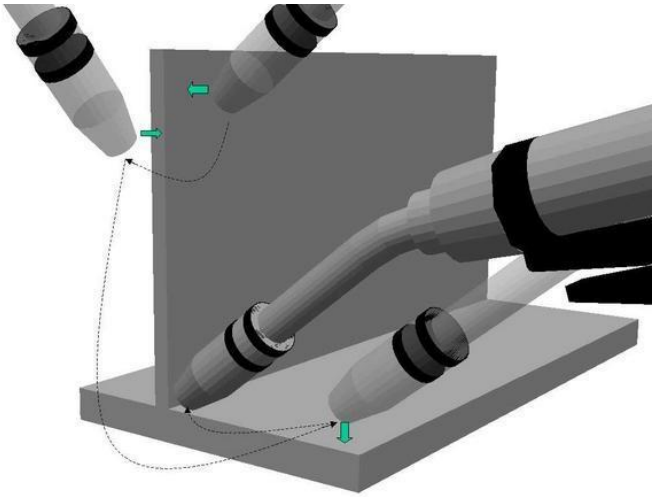


*Figure 4. Welding joint detection process*

The start and end points on welding joint can be specifed using threedimensional path. Searching and detection are done before the welding process starts so the programm can consider rotation, angular movement and working piece movement. On the welding joint it is possible to locate as many point as it is necessary.

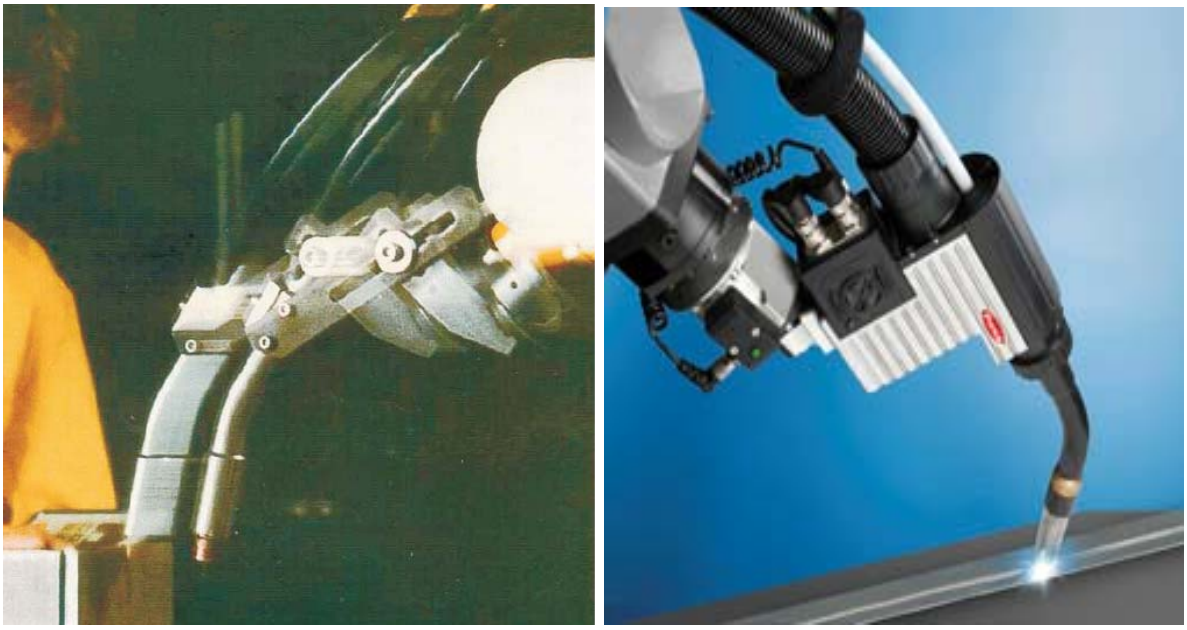


*Figure 5. Searching and detection of welding joint*

The nozzle is primarly used for searching on open surfaces but with a sensor accessory attachment the searching function can also locate edges, for instance lap joints or outer corners.

## 6. CONCLUSION

Information acquired from technological and geometrical sensors are the basic for qualitative control of welding process and enables adjustment to defined specifications of welding procedures considering quality and productivity measurement. Very important result of sensor usage is problem mapping between visible and controlled parameters. Ability to track welding joint quality is shown in the area of production cost reduction and welding quality improvement. Systems for automatic detection should enable different errors in welding joint classification such are: porosity, metal spatter, irregular bead shape.

## 7. REFERENCES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