SOME ASPECTS OF AUTOMATED ELECTRICAL EROSION MACHINE WITH WIRE ELECTRODE

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ABSTRACT: The command with personal computer of electrical erosion machine with wire electrode can be realized with integrated hardware resources which fulfill This paper propose the description of some modern integrated systems which can to fulfill a lot of functions which must realized all in real time. It is showed some experiments with Sodick's electrical erosion mashine with wire electrode.

KEYWORDS: Electrical erosion_1, wire electrode_2, automation_3

1. INTRODUCTION

With the developments in Computer Numerical Control (**CNC**), the versatility of Electrical Discharging Machining (EDM) has reached tremendous heights and has become an indispensable process in modern manufacturing industry because of its ability to produce complex shapes with high degree of accuracy in difficult-to-cut materials.

Wire EDM machines always operate with extremely small electrode contact area. Because of this small electrode contact area the average current that may be applied to the Wire is small in comparison.

2. ELEMENTS ABOUT ELECTRICAL DISCHARGE MACHINING (EDM)

Electrical Discharge Machining (EDM) is one of the most accurate manufacturing processes available for creating complex or simple shapes and geometries within parts and assemblies.

Wire EDM started from scratch in the early-70's and has made steady progress, with the most rapid process improvements occurring from the mid-80's to the mid-90's.

In Wire Electrical Discharge Machining the electrode is a simple wire, typically .006" to .012" diameter, which follows a horizontal path through the workpiece, the wire and workpiece are submerged in an insulating liquid (dielectric fluid - deionized water). The process of stripping off material using a successive series of electrical discharges at short intervals. These discharges jump between two poles (electrode - or working tool - and piece to be machined).

- These use like tools the concentrated energies,
- The mobile of apparition – army industry,
- In general, what is new is un-conventional.

The Wire EDM today offers 4- or 5-axis (X, Y, U, V & Z) positioning capability in order to perform complex taper or three-dimensional machining.

This 4-5 axis is designed for high precision cutting with fast cutting speeds and has a fixed clamping system so that the weight of the workpiece rests directly on the frame, which results in the guidance system being subjected to only light mechanical forces

In plan it is possible to draw complex geometrics. For describes the wire trajectory, in plan, we must decompose in simple geometric forms (line, circle) and command two motors for move the wire. For motors we use two steppers motors and for command we use a PCB who it's based on L297D and L298 circuits.

A stepper motor is a special kind of motor that moves in individual steps which are usually 0.9 degrees each. Each step is controlled by energizing one or more of the coils inside the motor which then interacts with the permanent magnets attached to the shaft. Turning these coils on and off in sequence will cause the motor to rotate forward or reverse. The time delay between each step determines the motor's speed. Steppers can be moved to any desired position reliably by sending them the proper number of step pulses. Unlike servo motors,

steppers can be used "open-loop" without the need for expensive encoders to check their position. Stepper motors are much more cost-effective than servo systems due to their simplified control and drive circuitry. There are no brushes to replace in a stepper motor, eliminating the need for maintenance. Even though a stepper motor system can not achieve the speed of a servo motor system, their ease of use allows them to be the preferred solution for many of today's computerized motion control systems.

The PCB who command the motors have the principle electronic scheme in fig. 3. The L297/A/D Stepper Motor Controller IC generates four phase drive signals for two phase bipolar and four phase unipolar step motors in microcomputer-controlled applications. The L297 is intended for use with a dual bridge driver, quad darlington array or discrete power devices in step motor driving applications. It receives step clock, direction and mode signals from the systems controller (usually a microcomputer chip) and generates control signals for the power stage. The principal functions of L297 IC are a translator, which generates the motor phase sequences, and a dual PWM chopper circuit which regulates the current in the motor windings.

The translator generates three different sequences, selected by the HALF/FULL input. These are normal (two phases energized), wave drive (one phase energized) and half-step (alternately one phase energized /two phases nergised). Two inhibit signals are also generated by the L297 in half step and wave drive modes. These signals, which connect directly to the L298'senable inputs, are intended to speed current decay when a winding is de-energized. When the L297 is used to drive a unipolar motor the chopper acts on these lines. An input called CONTROL determines whether the chopper will act on the phase lines ABCD or the inhibit lines INH1 and INH2.When the phase lines are choppedthe non-activephase line of each pair (AB or CD)is activated(ratherthan interrupting the line then active). In L297 + L298 configurationsthis technique reduces dissipation in the load current sense resistors.

For moving the wire we must generate the signals for CLOCK input (Step clock) and for CW/CWW input (Clockwise/counterclockwise direction control input). An active low pulse on this input advances the motor one increment. The step occurs on the rising edge of this signal. Physical direction of motor rotation also depends on connection of windings. Synchronized internally therefore direction can be changed at any time.

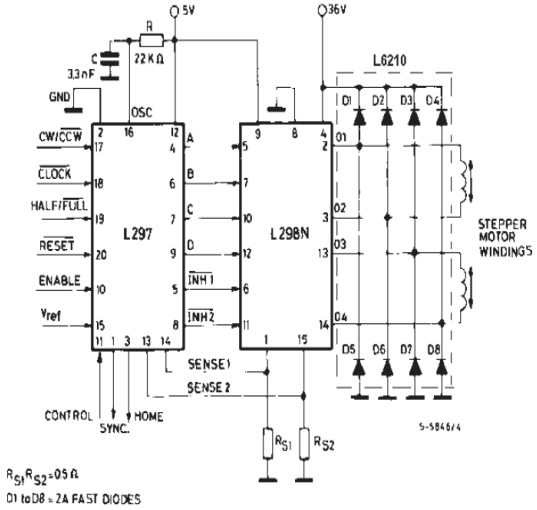

Figure 1. – Two phases bipolar stepper motor control circuit.

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When it want to control more axis we mast have more this module, each module for one axes. In this studies we want to controlled the wire in plan so we mast have 2 module. Every module is connected to the principal control module.

It is known how the Microsystems with microcontroller is connected to the PC, receive the position for X and for Y, and generate the command clock and direction signals for x and y, check the positions from positions sensor for x and y axes, calculate the errors and with program generate the corrections signals clock and direction for x and y.

With this system it can generate the wire trajectory with one of evaluate CAD/CAM, software on the PC, decompose the trajectory with two coordinates and command the Microsystems to move the wire. With the signal Ready send by Microsystems to PC, we now when the PC mast to command the new coordinate.

These principles want to improve the speed – The biggest advantage for most applications has been the improvement in nominal (ideal conditions) cutting speed which increased from about 1 sq. in. per hour in the early-70's to approximately 3 sq. in. per hour in the mid-70's and then surged about 800 percent to 28-30 sq. in. per hour in the mid-90's. The actual average cutting speeds achieved in real applications have always been less than the nominal speeds, but have also risen proportionately. The reasons for the speed increases are primarily: automatization for optimization of settings.

3. RESULTS AND DISCUSSIONS

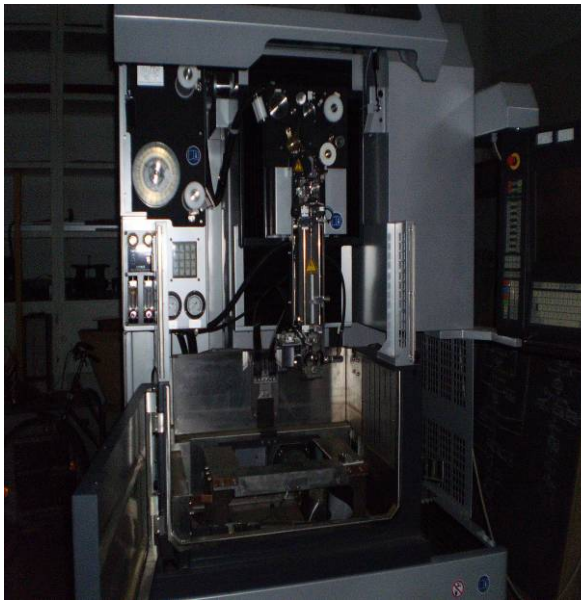

Figure 2. - Electrical erosion machine with wire electrode (type Sodick CNC Wire cut EDM, AQ750l LP33/34w)

For experiments it was used one machine type Sodick CNC Wire cut EDM, AQ750L LP33/34W, from the lab of Mechanical Faculty of U P Timisoara. (fig.2)

It was introduced one special soft applied for cutting some pieces like these from figure 3. It was studied the quality of the surface in concordance with the roughness and/or speed. The speed increased, the number of jobs that could be cut per hour or per day increased proportionately

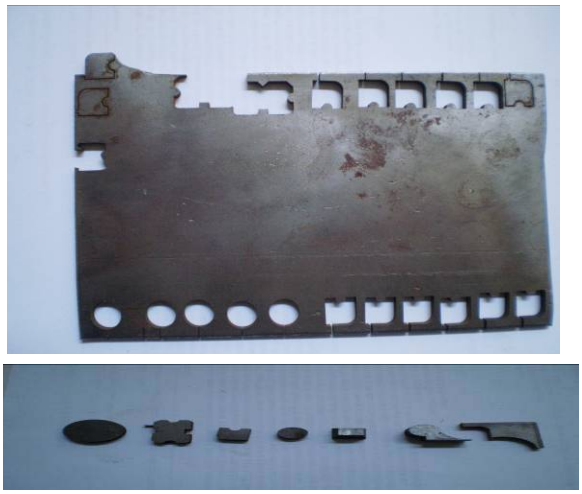

Figure 3. – Some samples studied.

To take advantage of the speed and avoid having the faster machines sitting idle at night, the EDM manufacturers introduced increasingly e ffective automatic threading systems, wire breakage prevention strategies and workpiece loading automation, the equivalent of tool changers, tool failure detectors and workpiece loading systems in machining centers.

The times of Wire cut process it's very important and for minimized these times we must to use preferment equipment for controlling the wire.

Its two important times in process: First time is when the generators generated the signal for sparks and when the sparks actually vaporizes the metal. The sparks create a succession of craters in the work piece.

The other time it's final time when between work piece and wire its 0V tension. In this time the deionised water must to flush the process zone for next sparks.

In this times CNC must to have a very exactly control of the wire and do the command for next wire movement.

The two times it's very short time because if the Ton time is to short the process it's have a low speed and if the first time is to big the power from generators it's big and the process have a good speed but CNC can't process a good algorithm for a very good precisely also if final time is to short the CNC can't do the verifications and it's possible to

have error of dimensional precision to piece but if final time is to big the process it's have a low speed but CNC can process a good algorithm for a very good precisely.

The microcontroller like PIC 16F8520 can do mathematical calculations for next step of the process in short time. With using microcontroller PIC 16F8520 for controlling wire in Wire cut Electrical Discharging Machining we can increase the productivity because we can minimize the final time.

The microcontroller it's easy to programming and it's possible easy to change the program for increase the productions or for increase the dimensional precision cutting.

4. CONCLUSIONS

The systems work for 2 axis but can be extended for 4 and 5 axis. In 4 and 5 axis case the personal computer must decompose the complex position for 4 or 5 axes. The precision cutting is now the precision position sensor and mechanical equipment for wire moving.

EDM can replace many types of contour grinding operations and eliminate secondary operations such as deburring and polishing.

In wire cut process the wire control it's possible even the process speed is high. The differences of necessary times to control the wire in low speed relative to top gear can be short time and the productivity can be the same.

It's impossible to touch the high precision and a big productivity for the first step. In first step it's possible to attain a high productivity but with a small precision process.

With modern machines, like used in our experiment, the precision and the productivity are good and its can be increasing if the soft is in very good concordance with the material and the real work conditions.

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Notations

PCB – Printed Circuits board
EDM – Electrical Discharge Machining
WEDM – Wire cut Electrical discharge Machining
IC – Integrated circuit
PWM – Power Width Modulation

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