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CONSIDERATIONS REGARDING AUTOMATION OF A LASER SYSTEM

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Abstract: *Laser materials processing has found utilization in many areas of industry, from machine-building to shaving blades. By using laser in a production process must be considered many aspects, both economic and technical. This article presents an integration of Trumpf laser HL54P, from TCM department of the Technical University of Cluj, in an automated system processing.*
Key words: *laser, Nd:YAG, automation, welding.*

1. INTRODUCTION

Laser processing of metals is part of unconventional processing technologies and presents several advantages such as: Processing speed, high precision, high automation, and reduced heat affected zone. In the processing of metals most commonly used lasers (about 95% of all applications) are Neodymium lasers (λ = 1.06 μ m, P = 10...2000s W) and CO2 (λ = 10.6 μ m, P = 0, 1 ....100 kW), lasers capable of working both in continuous wave mode and pulse mode. Neodymium laser is part of the active medium solid lasers and CO2 laser active medium of gas lasers category. The Nd: YAG (Neodymium-doped Yttrium Aluminum Granat) lasers emit light in the near infrared range, at a wavelength of 1.06μm. This means that the light emitted by Nd: YAG lasers is almost in the visible range. The laser light of an Nd: YAG laser can be routed through glass optics and optical fibers. In processing, the laser power absorbed by the material causes the latter to heat up rapidly and if the intensity is sufficiently high - results in melting or even vaporization of the material. The better a material can absorb the wavelength of a laser, the greater the amount of energy that can be introduced into the material. This means that the efficiency of the laser beam increases proportionately with the capacity of the material to absorb the laser wavelength. Useful radiation wavelength (λ) of a laser is a very important parameter for various applications due to the interaction between laser radiation and different materials which are selective, meaning that for certain applications will be used different types of radiation with different wavelengths.

Industrial production without laser welding installations would be inconceivable. It is increasingly used in the manufacture of vehicles, machines and plants as well as in energy installations, pipe-line construction, in the space and aviation industry and even in the manufacture of jewelry. In many cases, laser welding has completely replaced manual welding. The many fields of application demand variable machine concepts designed to meet the specific requirements of the processing tasks. The most important factors are those concerning movement. A one-dimensional motion (1D machine) suffices for processing straight lines of rotationally symmetric workpieces. To process flat components, two-dimensional processing is required (2D machine). For processing spatial components, motions in all three directions are needed (3D machines or five axis machines).The following distinctions are made according to the motion involved:

- machines with movable optics ("flying optics")
- machines with movable workpieces
- hybrid machines (machines in which both workpiece and optics are moved)

Modular installation concepts allow the installation to be perfectly matched to the processing task. Work area, axis arrangement, focusing optics and laser device are specifically selected to meet the demands of the processing task.

2. EQUIPMENTS

2.1 Trumpf laser HL 54 P

The laser Trumpf HL 54 P was donated by the German company Trumpf to Department of German language teaching of the Machine Building Faculty. It is a solid-state laser with an Nd: YAG rod (Neodymium-doped Yttrium Aluminum Granat). The Nd: YAG lasers emit light in the near infrared range, at a wavelength of 1.06 μm. The laser radiation is released in form of pulses. The pulse power of the laser is determined by the power of the flash lamp which irradiates the laser rod. A higher lamp power leads to a higher pulse power. The laser light is generated by optical pumping. The pulsed HL solid-state lasers are ideal for spot welding, seam welding and for cutting.

The wavelengths of the Nd: YAG laser in the near infrared spectrum makes it possible to employ glass as optical elements and therefore guide the beam through laser light fiber cables complimented by coupling and decoupling optics. In conjunction with robots, this type of laser becomes a flexible tool.

Other parameters of the laser are presented in Table 1.

Table 1

Parameters of the laser HL54P(Trumpf)

Parameter	
Average laser power [W]	50
Maximum laser power [W]	65
Minimum pulse power [W]	300
Maximum pulse power [W]	5000
Pulse energy [J]	0.1 … 50
Pulse duration [ms]	0.3 … 20
Maximum pulse duration frequency [Hz]	100
Beam quality [mm·mrad]	16

The laser unit is adjusted via the various optical components so that it suits the desired application precisely. The flexible laser light cables that guide the laser beam from the machine to the workstation are connected to the integrated optic.

Laser, optical components, power supply, cooling unit, and control are all housed in a protection type IP 54 safety cabinet. The laser unit is of modular design, and power supply, cooling unit and control all feature insertion technology, making them maintenance as well as service friendly. It goes without saying that the laser units also conform to CE regulations and fulfill the latest EMC requirements.

The LCB has a user friendly control panel with display where laser parameters are set and status and system messages received. For communication with external systems the LCB offers a comfortable PLC interface. Up to 25 sets of parameters can be stored for simple and fast operation. Up to 600 system parameters are continuously monitored, and can be accessed at any time.

Fig. 1. Laserwelding optics with flexible laser light cable.(Trumpf)

On pulsed lasers from HAAS-LASER, the spot weld diameter can be varied between 0.1 and 2.0 mm by the processing optics, while maintaining a constant working distance. Penetration depth, which depends on pulse power and pulse duration, can be as high as 2 mm.

Materials with high melting temperatures as well as with high thermal conductivity can be

welded. The combination of the small melt zone, short controlled fusion time, and excellent material absorption allows welding of materials with high melting temperatures and high thermal conductivities. In some cases these factors combine to weld materials that cannot otherwise be welded. Filler material can be used if necessary.

2.2 Festo components

The Machine Building Department holds, also, 3 servo driven positioning systems, from manufacturer Festo.

Two products spindle axis with recirculating ball bearing guide, model DMES-25-200-KF and an model DGE-25-200-SP. These models have the following features:

Table 2

Festo spindle axis parameters(Festo)

Characteristic	Values	
	DMES-25-200-KF	DGE-25-200-SP
Working stroke	200 mm	200 mm
Size	25	25
Spindle diameter	12 mm	12 mm
Pich	2,5 mm/rev	10 mm/rev
Mountig position	any	any
Guide	Recirculating ball bearing guide	Recirculating ball bearing guide
Constructional design	Electromechanical axis with lead-screw spindle	Electromech. axis with spindle and recirculating ball bearing guide
Max. acceleration	2,5 m/s2	6 m/s2
Max. speed	0,05 m/s	0,5 m/s
Repetition accuracy	+/-0,05 mm	+/-0,02 mm
Duty cycle	100%	
Protection class	IP40	IP40
Ambient temp.	0 - 50 °C	0 - 40 °C
Max. driving torque	0,9 Nm	0,45 Nm
Max. radial force on drive shaft	75 N	
Max. feed force	Fx 500 N	Fx 250 N
Position rigidity	2.300 N/mm	
Max. no-load driving torque	0,2 Nm	0,15 Nm

Three step by step servo motors *MTR-ST-57-48S-AA* for drive positioning system. These models have the following features:

Table 2

Motors parameters(Festo)

Characteristic	Values
MTR-ST-57-48S-AA	
Nominal voltage [V]	48
Nominal current, motor [A]	3.1
Holding torque, motor [Nm]	1.27
Stepper angle (full step) [°] x	1.27
Winding resistance [Ω]	1 ±10%
Winding inductance [mH]	3.8 ±20%
Drive mass moment of inertia [kg cm2]	0.48 0.5

A motor controller SEC-AC-305/P01 model with the following technical characteristics:
working voltage: 230V; frequency: 50…60 Hz; voltage command: 24V; current command: 0,35 A; nominal power/max: 1000/3000

FESTO products presents the following advantages: the components are mounted easily, the same components can be used in different variants, good precision positioning systems, have lower prices when used for teaching, have an teaching department.

3. LASER POSITIONING SYSTEM DESIGN

Design of an automated system which integrate the three axes Festo and the Trumpf laser HL 54 P, will be achieved using the design software Autodesk Inventor. Autodesk Inventor is the foundation of Digital Prototyping concept (Digital Prototyping) based on creating of accurate 3D models, assemblies and assembly operation analysis of products before they are physical realized.

The system will be achieved as follows:

a) Building a welded frame, from square pipe 40x40x2,5, which is the frame of the system. On this frame will be 2 pairs of plates welded perpendicular to each other, on which will be mounted the positioning systems DMES-25-200-KF.

b) In the horizontal plane is mounted the guide DMES-25-200-KF (Fig. 2.) wich is the X-axis of the system. On this guide will be fixed through two centering pins and four screws, an anodized aluminum plate, with dimensions L 300 x W 180 x H 22.5. This plaque, produced by Bosch Rexroth will be at the same time the

table of the system and is provided with T channels, very useful for catching and fixing the part.

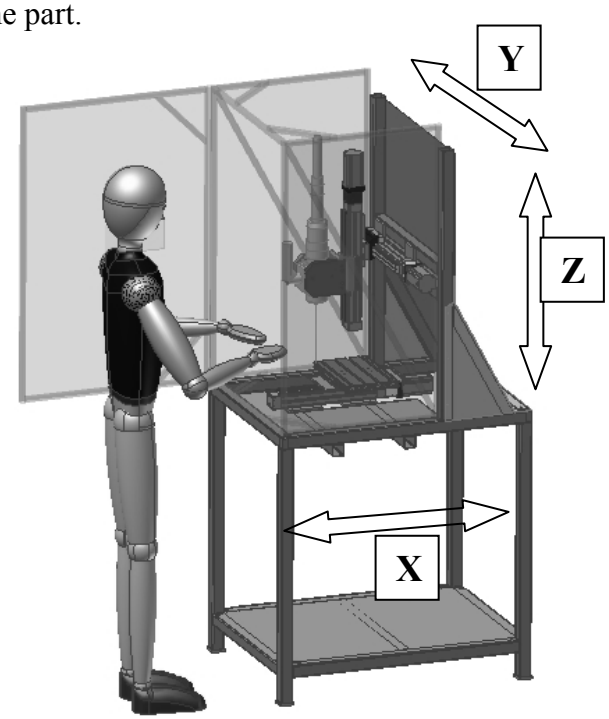

Fig. 2. System positioning concept

c) In the vertical plane of the frame is mounted the 2nd guide DMES KF-25-200-KF wich is the Y axis of the system. On this guide is mounted trough an mounting plate, the 3rd Festo guide DGE-25-200-SP - perpendicular to the axis Y.

The HL 54 P laser head is mounted on the Z axis by attaching a U-shaped part.

The working space will be isolated, locked and protected with sheets of 1 mm thickness. To access the table, the installation will be provided with a door equipped with safety glass for viewing the process.

4. CONCLUSION

The continuous growth of laser welding can be attributed to high productivity, high quality welding, manufacturing process flexibility, automation and offers the possibility to design products and processes in a different manner than the traditional.

Laser welding has great potential for technological processes in the near future.

For development of optimal laser processing technology is necessary a good knowledge of physical phenomena that occur in the process, and also a good integration of lasers in automated processing systems.

This is the motivation for research and development of laser machining processes.

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Considerații privind automatizarea sistemului laser

Prelucrarea materialelor cu fascicul laser şi-a găsit utilizare în multe domenii ale industriei, de la constructia de automobile pana la lamele de ras. La folosirea laserului într-un anumit proces de producție trebuie luate in considerare mai multe aspect, atat economice, cat si tehnice. Acest articol prezinta o modalitate de integrare a laserului Trumpf HL54P, din cadrul catedrei TCM a Universitatii Tehnice din Cluj, intr-un sistem automatizat de prelucrare.

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