Control method for reducing errors prosessing of the SLS machine

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ABSTRACT:

This article presents a method of the error reducing control in SLS machine. When using SLS machine, there are many factors that cause the errors such as: temperature, trajectory, velocity and laser intensity. Therefore, we need to have a precise method control in order to have an accurate processing sample. This one presents the Fuzzy Control Method to help we achieve highly accurate results when process with SLS machine. We propose control method that establishs the criteria based on many influence processing parameters previously mentioned (*) rather than merely control position, velocity, trajectory as the CNC machines. The processing by SLS machine basse on the control MIMO model. Therefore, estimating and parameterizing control parameters to reducing.

Keywords: *SLS, 3D-printer, STL.*

X, Y-coordinates of the laser scanning space (mm) <+ / - 300mm

V- Movement velocity of the Laser (mm / s)

Vx- X direction moving velocity (mm / s)

Vy - X direction moving velocity (mm / s)

ax – X moving acceleration (mm/s2)

ay – Y moving acceleration (mm/s2)

f-focal length of Laser

P - Power of Laser source (50W max)

Ha- Halogen projector lamp signal intensity (100% = 6000W)

Tc-Temperature collected by sensors

1. OVERVIEW

The SLS machine creates 3D details by cutting each layer. SLS technology has two principles: o The first one: when the laser beam [1] impacts on the powder material layer, the details are being built. The impact of the laser on the powder player that increases the temperature of the powder to the melting point, resulting powder is formed above the previous layer and create shapes of the object. The second one: details will be created through each layer. Each layer of details includes the cross-section of one or more parts. The next layer is completed directly on the surface of the previously

sintered layer after a layer of powder is added by the rollers structure.

While processing the rapid prototyping, there are parameters that impact the SLS machine such as: temperature and volume, trajectory, velocity and laser intensity. Therefore, we need a these parameters coordinated control method to process more exactly. This paper presents The Fuzzy Control Method to help we achieve highly accurate results when process with SLS machine.

2. CONTROL METHOD

2.1. Model of SLS machine

SLS machine has major components as follows: laser scanning control block, laser source block, heater halogen lights block, heat sensors block, lifting block, roller blocks, machines block [3].

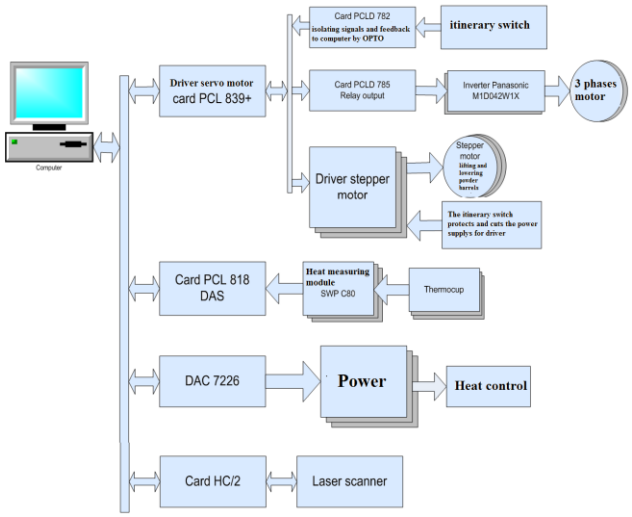

Figure 1. General scheme SLS machine control

Laser scanning control block will be controlled by XY orbit and focal distance. Thus the control parameters of the block are the X, Y coordinates and focal distance values f. The computer will transmit the signal includes coordinates and focal distance through the signal card follow the time cycle T.

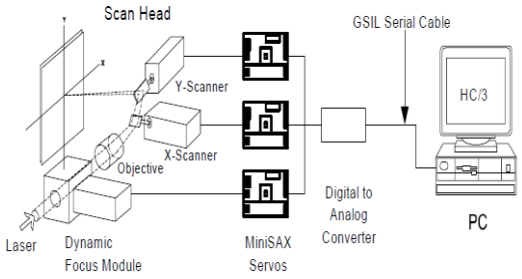

Figure 2. Diagram of laser scanning control block

In addition, the laser power is controlled via block uc2000, we characterized the power output is P (% power 0-100%). In the processing, the system is also heated by halogen lamps (Ha) and heat value (Tc) is fedback through the heat sensor.

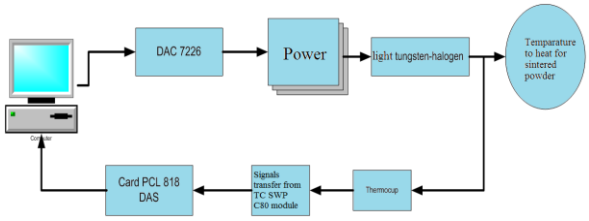

Figure 3. Diagram of halogen lights and heat sensor block

2.2.Fuzzy control method

In the Fuzzy control method, there are following control parameters: X, Y, F, P, Ha / Tc. We build control parameters as follows:

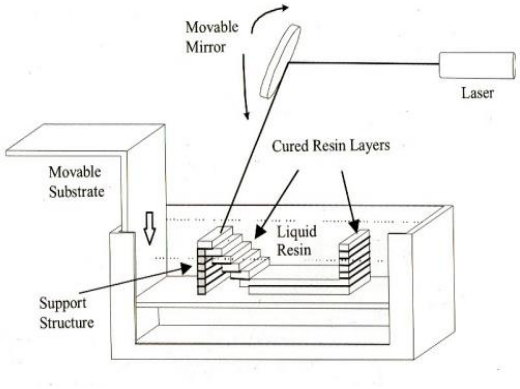

Figure 2. SLS machine control model [4]

- With the old control model [4], values is fixedly set and discretely controlled so generated errors are accumulated and accrued, not cancel each other out. We need to establish a relationship function to eliminate errors that are generated by the input parameter (*).

- With X, Y and the time cycle of the signal T. We set the parameters of velocity and acceleration as follows:

- $Vx = \Delta x / T$

- $Vy = \Delta x / T$

- $a = \Delta V / T$

- Setting the table for V as follows:

Table 1. Speed of processing

V	N2	N1	0	P1	P2
V(mm/s)	-300	-150	0	150	300

Table 2. Processing acceleration

a	N2	N1	0	P1	P2
a (mm/s2)	-2500	-1500	0	1500	2500

Next, we build tables similar to the focal distance block, power and heating:

Table 3. Processing focal distance

F	N2	N1	0	P1	P2
F/D (giá trị qui đổi thành đường kính ta Laser mm)	-30	-15	1	15	30

Table 4. Laser power

P	N2	N1	0	P1	P2
P (W)	0	5	10	15	20

Table 5. The heat of sensors

Tc/H	N2	N1	0	P1	P2
Tc (oC)	30	45	60	75	90

The objectives of the control functions are:

- Go over the plan point with the velocity V, acceleration a, the focal distance f, intensity P and the temperature accordingly T.

- But we know that when the focal distance is changed that will affect the power. So we need to establish the relationship F / P. Clearly when the F changes with ratio k, it will make the laser ray diameter is changed with k ratio and value of the area will be k^2, that means F / P is proportional to 1 / k.

- In the process, we will try to take the lowest acceleration for smooth surfaces ➔ amin

- So the function is f (V, A, F / P, T). Regarded as parameters V, A, F will be the information exported from the standard STL file of the control software, so we need to change the parameters P and Q signals suitable heating environment.

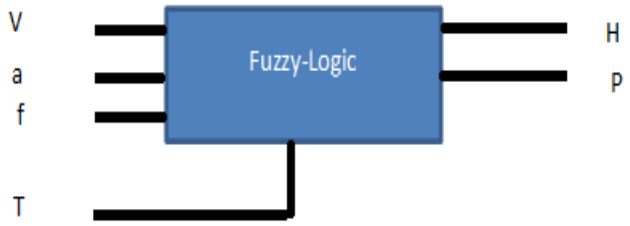

Figure 4. Diagram of Input/Output block

The result after processing with fuzzy method:

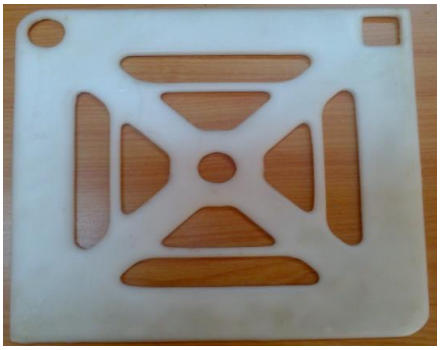

Figure 5. The result after processing

Fuzzy control method increased the precision: 1mm to 0.1mm by using calibration algorithm.

3. CONCLUSION

This article presents a method to reduce the control number that is Fuzzy Control Method for the SLS machine's blocks that coordinatedly work as they are affected by environment and processed-models. With this method, the achieved result is higher precision conventional and self-adapting to ambient temperature. With rapid prototyping methods such as SLS, FDM, the environmental factors, outsourcing model (running trajectory) are very important.

Errors reducing processing method helped the accurate processing by cancel out dependent independent accumulated and accrued; Insteading of them is errors that clear each other.

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Phương pháp điều khiển giảm sai số trong gia công bằng máy SLS

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TÓM TẮT:

Bài báo trình bày phương pháp điều khiển giảm sai số trong gia công bằng máy SLS. Khi gia công bằng máy SLS có rất nhiều yếu tố ảnh hưởng tới sai số: nhiệt độ, quỹ đạo, vận tốc và cường độ chiếu tia Laser (*). Do đó để có một mẫu gia công chính xác chúng ta cần có một phương pháp điều khiển chính xác. Chúng tôi đề xuất phương pháp điều khiển đặt tiêu chuẩn dựa vào nhiều thông số gia công ảnh hưởng ở trên (*) hơn là đơn thuần điều khiển vị trí, vận tốc, quỹ đạo như các máy CNC. Việc gia công trên máy SLS của dựa trên điều khiển mô hình MIMO, do đó rất cần ước lượng tham số hóa điều khiển để giảm phép toán.

Từ khóa: *SLS, 3D- printer, STL.*

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