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Development of Rotary Fixture on Laser Engraver Machine

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ABSTRACT (10 PT)

In the Mechanical Engineering Laboratory of Pasundan University there is a laser engraver machine that is able to perform the gravir process on materials that have a flat surface. The laser engraver has the disadvantage of not being able to do the gravir process on cylindrical workpieces. To overcome this weakness, it is necessary to make a workpiece holder tool specifically for holding cylindrical workpieces. The purpose of this research is to improve the ability of the laser engraving machine, so a rotary fixture model is made on the laser engraver machine. The rotary fixture is directly connected to a stepper motor. The stepper motor is controlled by the axis controller on the laser engraving machine. The rotary fixture has been successfully made and has undergone a testing process. The letter gravir process produced on a cylindrical gravir surface with workpiece dimensions Ø66 mm with a workpiece thickness of 6 mm requires a power modulation of 250 and an engraving speed of 200 mm/min and produces gravir with a letter width of 16 mm, a letter height of 5.50 mm and a spacing distance of 9.50 mm stated with ideal results. In general, the rotary fixture has been successfully made and improves the performance of the laser engraver machine to perform the gravir process on cylindrical workpieces. From the test results it can be concluded that the rotary fixture mechanical system can be operated to gravir letters, names, and batik motifs. With the rotary fixture, it is hoped that craftsmen can increase creativity in carrying out the gravir process using laser engraver.

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1. INTRODUCTION

Here The tourism industry is a sector that needs to be developed, given that Indonesia has many tourist destinations that attract both local and international visitors. Tourists often purchase souvenirs or unique mementos from the regions they visit, making it important to produce these items in a way that is both easy and affordable. One such souvenir product is wood engraving crafts [1].

Currently, wood engraving is done either manually or automatically. Manual engraving uses a tool similar to a soldering iron, which is manually applied to the workpiece surface to create images or text. This process requires specialized skills and, while the tools are easy to obtain and inexpensive, it is time-consuming and the results may vary in consistency, with a rougher texture compared to those created by automatic laser engravers.

The limitations of manual engraving have led to the development of automatic engraving machines, such as laser engravers, which are widely used in industries for making company logos, numerical patterns, cutting, embossing, stamping, and engraving [2].

At the Mechanical Engineering Laboratory of Pasundan University, there is a laser engraver machine. Its working principle is similar to that of a regular printer, but instead of ink, it uses laser combustion to create images or text by burning the material's surface. This process does not require a craftsman with special skills. However, the current laser engraver at the laboratory cannot engrave on cylindrical objects. Therefore, a rotary fixture is needed to rotate the workpiece during the engraving process.

This research focuses on designing and developing a rotary fixture for the laser engraver machine. The rotary fixture functions as a holding aid on the laser engraver to rotate cylindrical materials (particularly hollow materials) during the engraving process. The control for the rotary fixture is derived from one of the axes on the laser engraver machine, with all axes controlled using Laser GRBL software.

2. MATERIAL AND METHODS

2.1. Research Stages

The stages of designing and manufacturing the rotary fixture for the laser engraver are illustrated through a flowchart. The flowchart of the design and manufacturing stages of the rotary fixture for the laser engraver can be seen below.

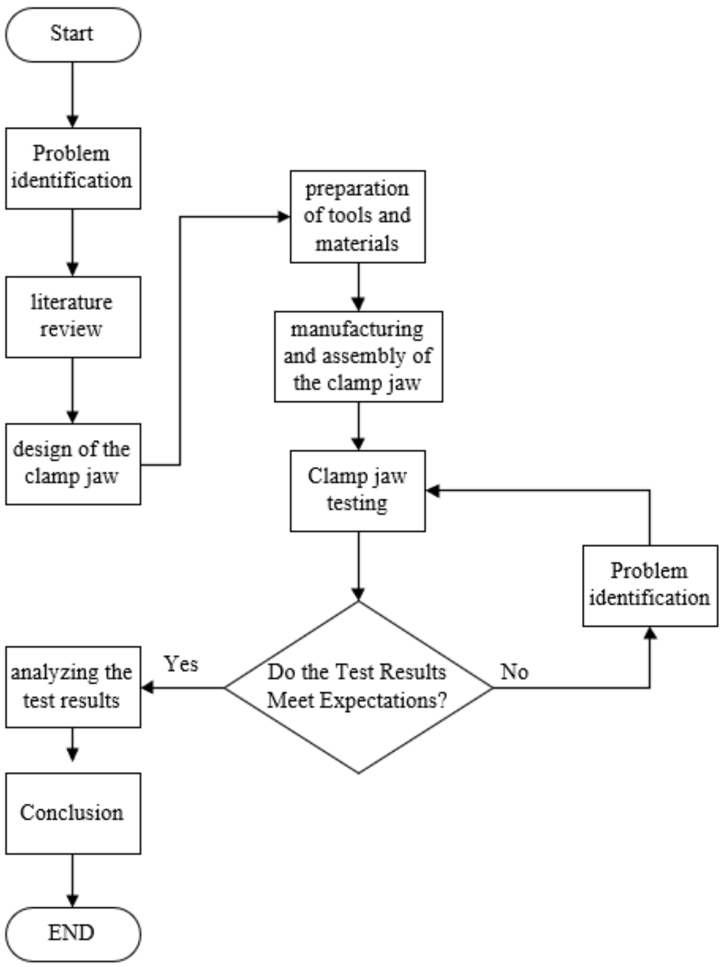


Figure 1. Flowchart of the Research Process

Problem identification is a part of the research process that can be understood as an effort to define the problem and make that definition more measurable as the starting point of the research. A literature review is the process of examining relevant studies related to the problem being investigated. This may involve reviewing established theories, analyzing personal or others' research findings, scientific journals, seminar results, discussions, field surveys, scientific magazines, library studies, including reputable internet sites, and consulting statements from authoritative figures in the relevant field based on the expertise derived from the research itself.

The design of the clamp jaw involves the process of designing and developing a mechanical system that functions to meet specific needs. The preparation of tools and materials is a crucial stage in carrying out various types of work, including the design of the clamp jaw. During the preparation of tools and materials, it is important to ensure that all tools and materials used meet the necessary safety standards and the quality required for the design process. The manufacturing and assembly of the clamp jaw involve the precise and accurate installation and integration of mechanical components according to the previously developed mechanical system design.

Clamp jaw testing is the process of examining whether the mechanical system functions according to the desired specifications. Some general steps in clamp jaw testing include visual inspection, functional testing, static testing, dynamic testing, performance testing, and final testing. After testing is completed, the next step is to analyze the test results. Some general steps in analyzing the test results include reviewing the test review, evaluating the test results, identifying errors, and making corrections or modifications. The analysis of test results is the process of analyzing and interpreting the data obtained from testing or experiments to draw conclusions or make decisions based on the information found. The conclusion represents the outcome of the tests conducted [3].

2.2. Mechanical System Design of the Rotary Fixture

Creating the rotary fixture design aims to determine the shape of the product or the construction of the rotary fixture that will be made. The rotary fixture design process consists of designing the clamp jaws and the bracket. The rotary fixture design can be seen in Figure 2. The components that will be used can be found in Table 1. Detailed designs of the rotary fixture can be found in the appendix.

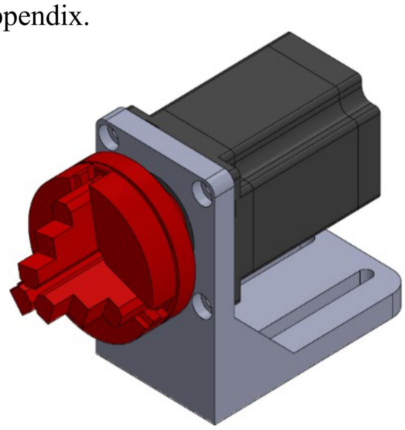
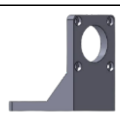
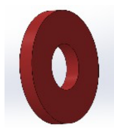
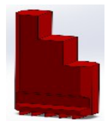
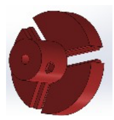
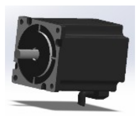


Figure 2. Rotary Fixture Design

Table 1. Components to be Used in the Rotary Fixture

No	Constuction Component	Design	Spesification	Total
1	Number of Item		Material: Plastik ABS Dimension:100x60x100 mm Thickness: 10 mm	1

2	Main Jawboring		Material: Plastik ABS Dimension: 70x70 mm Thickness: 10 mm	1
3	Jaw		Material: Steel Dimension: 70x10mm Thickness: 10 mm	3
4	Jawboring Spiral		Material: Plastik ABS Dimensi: 70x70 mm Thickness: 10 mm	1
5	Snapring		Material: Plastik ABS Dimensi: 20x20x40 mm Thickness: 20mm	1
6	Stepper Motor		Material: Steel Dimensi: 56x56 mm Thickness: 1 mm	1

3. RESULTS AND DISCUSSIONS

3.1. Engraving Test of a Square on a Wooden Cylinder

Engraving Test of a Square on a Wooden Cylinder. This test aims to find the relationship between the calibration factor of the Y-axis and the diameter of the workpiece. The test is intended to determine the number of steps required by the stepper motor for both the X-axis and Y-axis for every 1 mm of length. This test is conducted to ensure that the device created functions properly and to identify any advantages or limitations that may occur in the rotary fixture's movement. The rotary fixture's control is derived from the Y-axis control, which was previously linear and has been converted to rotary motion. The test is performed by determining the calibration factor and then comparing the engraving results with the planned design. The testing steps are as follows: a) Prepare the laser engraver machine, b) Prepare the rotary fixture, c) Prepare the Laser GRBL software and control system, d) Connect the motor to the control system derived from one of the axes on the laser engraver machine, e) Operate the motor on each axis of the laser engraver machine and connect one axis of the motor to the rotary fixture, and f) Observe, and the test is completed.

The engraving test of a 2x2 cm square is carried out to test the rotary fixture's movement to determine whether it functions correctly. This test is repeated several times with the stepper motor set to 30,000 steps on the X-axis and the Y-axis adjusted according to the diameter of the wooden cylinder. The calibration factor of the wood diameter relative to the Y-axis can be seen in Table 2. The test graph on the wooden cylinder can be seen in Figure 3. The test results can be seen in Figure 4.

Table 2. Calibration Factor of Wood Diameter to Y-Axis

Wood Diameter	Y-axis step
10	40000
20	25000
25	20000
30	13000
40	10000
70	5500

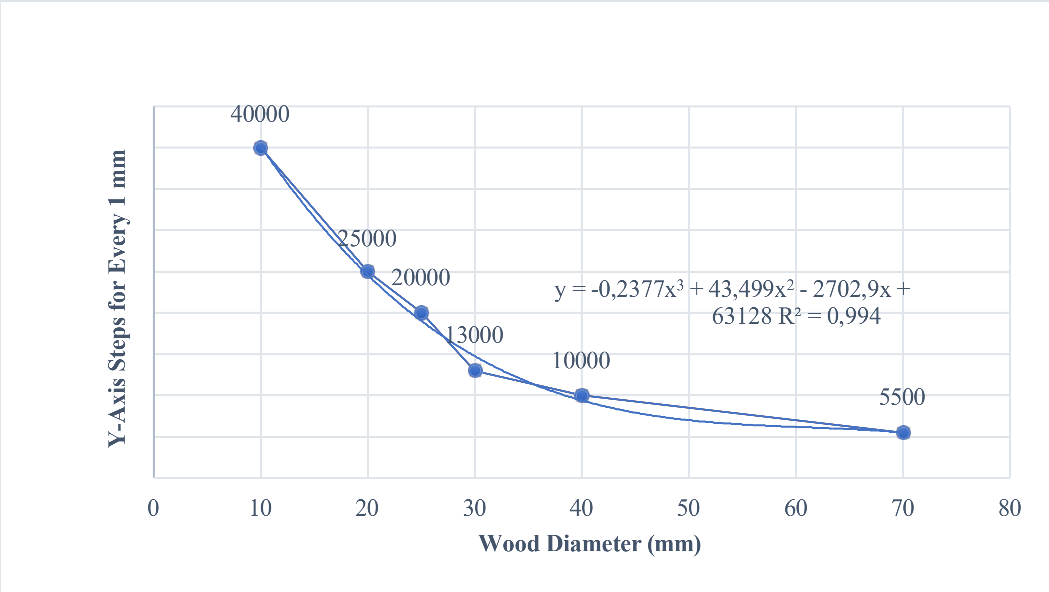


Figure 3. Wood cylinder testing graph.

Figure 4. Square engraving test on wooden cylinder.

3.2. Engraving Test of a Square on a Wooden Cylinder

The batik engraving test on a wooden cup with a diameter of 70 mm was conducted after determining the parameters and adjusting the stepper motor driver settings to 30,000 steps on the X-axis and 5,500 steps on the Y-axis. The test parameters can be seen in Table 3.

Table 3. Testing Parameters for Batik Engraving on Wooden Cup

Testing	1	2	3
PWM	750	500	250
Engraving Speed	1000 mm/min	1000 mm/min	1000 mm/min
Engraving Plan	220 mm	220 mm	220 mm
Engraving Result	230 mm	225 mm	220 mm
Error	10 %	5 %	0 %

Based on Table 3 above, the difference/error in the batik engraving on a wooden cup with a diameter of 70 mm was observed in the first, second, and third trials. Although there was a difference/error of up to 8% between the planned design and the engraving result, the outcome was considered satisfactory. The results of the batik engraving test on the wooden cup can be seen in Figure 5.

Figure 5. Batik Engraving Test on Wooden Cylinder

After the tests were completed with different parameters, the differences among the three wooden cups that underwent the engraving process became apparent. Once the parameters used in the wooden cup engraving process were determined, further testing was conducted with a different image.

3.3. Landscape Photo Engraving Test on Wooden Cups

The landscape photo engraving test on a wooden cup with a diameter of 70 mm was conducted after determining the test parameters and adjusting the stepper motor driver settings to 30,000 steps on the X-axis and 5,500 steps on the Y-axis, with an engraving speed of 500 mm/min and power modulation of 250. The test parameters can be seen in Table 4.

Table 4. Testing Parameters for Landscape Photo Engraving on Wooden Cup

PWM	250
Engraving Speed	200 mm/min
Engraving Plan	120x60 mm
Engraving Result	125x60 mm
Error	5 %

Based on the table above, the difference/error in the landscape photo engraving was 5%. An error of 5% is considered very small, and the resulting engraving is quite satisfactory. The result of the landscape photo engraving on the wooden cup can be seen in Figure 6.

Figure 6. Landscape Photo Engraving Test

The mechanical system of the rotary fixture has been tested, and the test results have been obtained. The data from the mechanical system test of the laser engraver need to be analyzed. The following are some of the test result analyses: a) The mechanical system of the laser engraver and the rotary fixture can operate well, with all X and Y axes moving smoothly and being capable of performing text engraving, batik engraving, and photo engraving, b) The rotary fixture clamp can be operated to secure wooden cups and wooden cylinders, c) To produce clear and stable images, the engraving parameters used are an engraving speed of 250 mm/min and power modulation of 500, d) Calibration steps need to be performed to determine the number of stepper motor steps for a 1 mm shift on each axis to ensure that the results meet expectations, and e) The rotary fixture construction is equipped with legs to keep the rotary fixture balanced when clamping workpieces with larger diameters and workpieces that exceed the expected weight.

4. CONCLUSIONS

The design and manufacture of the rotary fixture have been successfully realized to perform engraving or drawing on wooden cups and cylindrical wood. The rotary fixture can hold workpieces with diameters ranging from Ø 10 x 100 mm to Ø 80 x 100 mm, with a maximum workpiece weight of 500 grams. Based on the test results, it can be concluded that the mechanical system of the rotary fixture is capable of operating to engrave text, batik patterns, and photos.

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REFERENCES

[1] A. B. Rafsanjani, “Pengembangan Produk Vandel Merchandise Teknik Industri Ums Menggunakan Mesin Laser Engrave Cutting,” 2021.

[2] N. A. Sutisna and H. Fauzi, “Rancang Bangun Prototipe Mesin Gravir Laser Berbasis,” *J. Ind. Eng. Sci. J. Res. Appl. Ind. Syst.*, vol. 3, no. 2, pp. 90–104, 2018.

[3] A. Muchlis, W. Ridwan, and I. Z. Nasibu, “Rancang Bangun Mesin CNC (Computer Numerical Control) Laser dengan Metode Design for Assembly,” *Jambura J. Electr. Electron. Eng.*, vol. 3, no. 1, pp. 23–27, 2021, doi: 10.37905/jjeee.v3i1.9228.