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REPAIR OF WIRE FEEDER GEARS OF MIG 1300 WATT WELDING MACHINE WITH THE APPLICATION OF REVERSE ENGINEERING TECHNOLOGY

Anes Inda Rabbika[1,*], Muhamad Hanhan Nugraha[1], Andy Permana Rusdja[2], Mochamad Irlan Malik[2]

[1]Department of Mechanical Engineering, Faculty of Engineering, Universitas Mayasari Bakti, Tasikmalaya, 46196, Indonesia
[2]Department of Mechatronics Engineering, Faculty of Engineering, Universitas Mayasari Bakti, Tasikmalaya, 46196, Indonesia

[*]E-mail: anesinda348@gmail.com

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ABSTRACT

Material failure is a common occurrence in components subjected to continuous loads, often due to fatigue. In the MIG 1300-watt welding machine, the wire feeder gear transmission process continuously distributes energy, leading to eventual material failure. This failure disrupts the transmission of rotation to the feeder shaft, causing the wire exiting the torch to slip. To address this issue, reverse engineering technology is applied using computer-aided design (CAD), finite element analysis (FEA) assisted by computer-aided engineering (CAE), and computer-aided manufacturing (CAM), culminating in the production of prototypes with 3D printing technology. This research aims to repair the wire feeder gears by leveraging reverse engineering technology, which includes redrawing the gears and implementing developmental modifications using CAD/CAM tools. These modifications are then analyzed through FEA with CAE assistance, and the final prototype is produced using an Anet A8 V2 3D printer with Poly Lactic Acid (PLA) material.

Keywords: 3D Printing; CAD/CAM; Finite Element Analysis (FEA).

ABSTRAK

Kegagalan material adalah kejadian umum pada komponen yang mengalami beban terus menerus, sering kali disebabkan oleh kelelahan. Pada mesin las MIG 1300 watt, proses transmisi roda gigi pengumpan kawat secara terus menerus mendistribusikan energi, yang pada akhirnya menyebabkan kegagalan material. Kegagalan ini mengganggu transmisi rotasi ke poros pengumpan, menyebabkan kawat yang keluar dari obor tergelincir. Untuk mengatasi masalah ini, teknologi reverse engineering diterapkan dengan menggunakan computer-aided design (CAD), finite element analysis (FEA) yang dibantu oleh computer-aided engineering (CAE), dan computer-aided manufacturing (CAM), yang berujung pada produksi prototipe dengan teknologi 3D printing. Penelitian ini bertujuan untuk memperbaiki roda gigi pengumpan kawat dengan memanfaatkan teknologi reverse engineering, yang meliputi penggambaran ulang roda gigi dan mengimplementasikan modifikasi pengembangan dengan menggunakan alat CAD/CAM. Modifikasi ini kemudian dianalisis melalui FEA dengan bantuan CAE, dan prototipe akhir diproduksi menggunakan printer 3D Anet A8 V2 dengan bahan Poly Lactic Acid (PLA).

Kata Kunci: *Pencetakan 3D; CAD/CAM; Analisis Elemen Hingga (FEA).*

1. Introduction

The wire feeder gear in a MIG 1300-watt welding machine continuously distributes energy, leading to material failure over time [1-3]. This failure disrupts the transmission of rotation to the feeder shaft, causing the wire to slip as it exits the torch [4]. The simplest solution would be to replace the faulty component with a new one [5]. However, this approach presents challenges due to the rarity and compatibility issues of the specific gear type used in the welding machine [6,7]. Finding an exact match in national marketplaces is difficult, and ordering from multinational marketplaces introduces shipping delays, making it an impractical first choice [8].

A more effective solution involves applying reverse engineering technology, utilizing computer-aided design (CAD), finite element analysis (FEA) assisted by computer-aided engineering (CAE), and computer-aided manufacturing (CAM), with final production achieved through 3D printing technology [9,10].

Reverse engineering is a 3D geometry modeling approach that aids in the development and repair of components, often used in the prototyping process. Successful applications of reverse engineering include the investigation of biomechanical engineering of the equine forelimb MC3 [11], improvement of point clouds into CAD models [12], and component design in the shipping industry [13]. Further examples include the design of hip prostheses to estimate crack and fracture points [14], development of new primitive computation models [15], and fabrication of Valentine's heart shapes using 3D printing with natural hydrogel [16]. Additionally, reverse engineering has enhanced aircraft brake component analysis to improve safety [17], and the development of lawnmowers to reduce vibration and noise [18]. It has also modeled cast costumes for wrist fractures [19], reconstructed piping components for further development [20], and improved the flexibility and reliability of 3D models from an industrial perspective [21]. One notable application of FEA is the analysis of stress, stretch, and deflection in solid structures [12].

In the current research, the repair of wire feeder gears utilizes reverse engineering technology. This involves redrawing the gears and making developmental modifications using CAD/CAM tools, followed by analysis with FEA assisted by CAE. The final prototypes will be printed using the Anet A8 V2 3D printer with Poly Lactic Acid (PLA) material.

The working principle of a 3D printer involves printing three-dimensional objects by building layer upon layer of plastic, heated slightly above its melting temperature inside the nozzle. The nozzle extrudes the plastic while moving along the x and z axes with the help of a stepper motor, while the y-axis is controlled by a stepper motor driving the heated bed/printing table. The drive system follows commands from the firmware installed on the printer's motherboard to form a three-dimensional object corresponding to the CAD model. The basic process of 3D printing, from heating the PLA material block to the extrusion process at the nozzle, is illustrated in the figure 1.

The heater nozzle, a critical component of the 3D printer, melts the filament and maintains a temperature above its melting point to facilitate product formation. It works by rolling the solid filament and increasing the nozzle temperature to melt the filament, allowing it to form or print products according to the design.

2. Methods

The methods used in this research are experiments, design and literature studies. The experimental process carried out is Reverse Engineering including:

a) Analysis of machine elements to be made.
b) The design process uses CAD software with adjusted scale.
c) Finite element analysis methods are carried out to determine the internal force on the object to be created.
d) Manufacturing process with CAM.
e) Shaping using 3D printing.
f) It is then tested functionally as shown in figure 1.

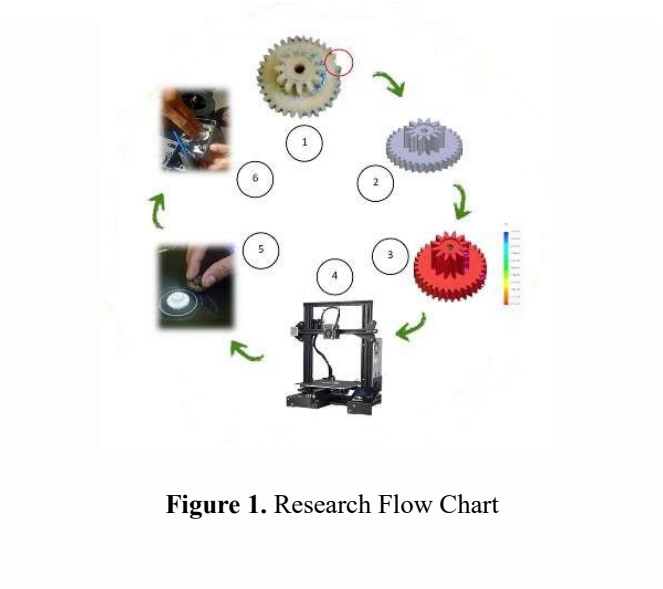

Figure 1. Research Flow Chart

The material used in this study is PLA (Polylactic Acid), which has good chemical and mechanical properties and is an environmentally friendly material.

3. Results and Discussion

Reverse Engineering has an essential role in design and manufacturing through data acquisition and processing technology in product development. The reverse engineering method is considered to have several advantages in its application, including reducing costs and time in product development. The working principle of reverse engineering is to extract information from a product in the form of geometric shapes and dimensions to the type of material, which is then used as a reference for modifying and producing products.

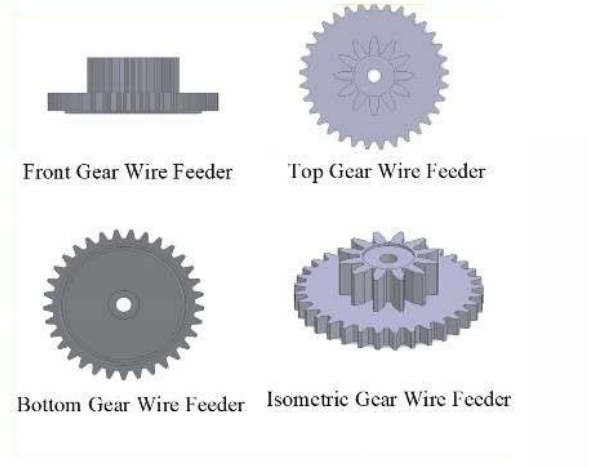

Figure 2. Virtual Shape of Gear Wire Feeder

In addition, it is applied to obtain information on the shape, geometry and dimensions of a centrifugal-type fan part used as a scooter-type motorcycle engine cooling system. The information is obtained from the digitization process of *the non-contact laser 3D scanning* method, which will later be used as an essential reference for redesigning gear designs in *Computer-Aided Design* (CAD) software.

This stage is the implementation stage of working drawings, known as technical drawings, shown in Figure 2. How digitally generated modelling designs are transferred to CAD-CAM software. The author uses SolidWorks, which is quite powerful, combining the stages of CAD *(Computer Aided Design) and CAM (*Computer Aided Manufacturing). The following is a working drawing in the CAD-CAM stage.

A 3D printer is one of the tools or machines used to make 3-dimensional objects, where these 3-dimensional objects from a design are digitally printed into 3D shapes that can be seen, held and also have volume.

3D printing can provide huge savings on assembly costs because it can print products that have already been assembled. With *3D printing,* companies can now experiment with new ideas and designs at a fraction of the cost. They can decide whether the product concept is worth allocating additional resources. 3D printing will impact many industries, such as automotive, medical, business and industry, education, architecture, and consumer products industries. 3D printing is one of the various processes in which materials are joined or compacted under computer control to create three-dimensional objects. Unlike materials removed from stock in the machining process, layered manufacturing builds up the solid volume of a CAD model by adding successive layers of material. Since parts are made layer by layer, orientation building plays an essential role in the layered manufacturing process as it can improve the quality of parts in terms of surface accuracy and finish, reduce the required support volume, support contact areas and construction time through a 3D scanner, or with a regular digital camera and photogrammetry software. 3D printed models created with CAD results reduce errors and can be corrected before printing, allowing verification of the design of objects before printing. The manual modelling process for preparing geometric data for 3D computer graphics is similar to plastic art, such as sculpting. 3D scanning is the process of collecting digital data on the shape and appearance of natural objects and creating digital models based on it.

Figure 3. Filament PLA Material

Figure 3 shows The materials used in this study use PLA Poly Lactic Acid) which is a type of polymer plastic made from biodegradable materials, such as corn flour, tapioca flour, or processed sugarcane. Because it is made of biodegradable materials, PLA is environmentally friendly.

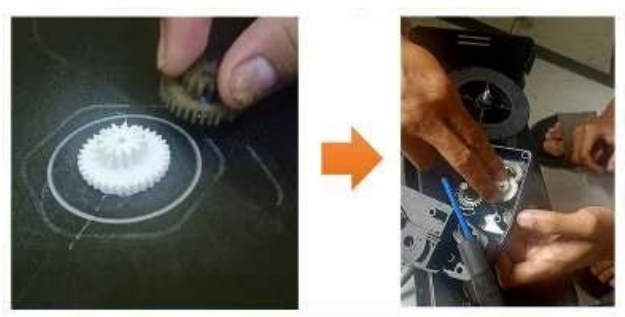

Figure 4. Assembly of the Gear Wire Feeder PLA

This material is increasingly gaining popularity due to its advantageous properties. PLA can produce substantial and elegant prints. Figure 4 shows when the gear wire feed was done to print, and the next step was assembling the welding machine.

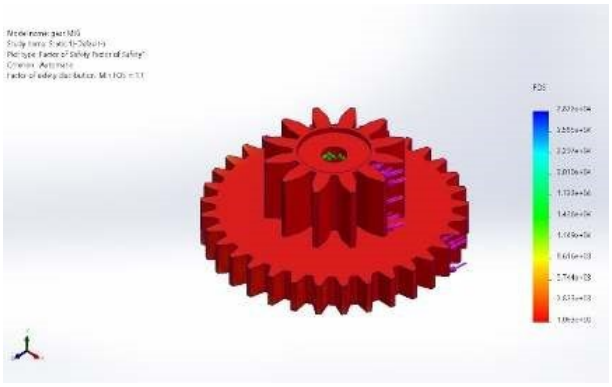

Figure 5. Factor of Safety

A factor of safety had been tested by Finite Element Analysis (FEA) Methods. The result showed that the value of FOS is 1.1, it means FOS >1 is safe.

4. Conclusion

This study successfully addressed the issue of material failure in the wire feeder gears of a MIG 1300-watt welding machine by applying reverse engineering technology. The research involved redrawing and modifying the gears using computer-aided design (CAD) and computer-aided manufacturing (CAM) tools. Finite element analysis (FEA), assisted by computer-aided engineering (CAE), was utilized to analyze the modifications. The final prototypes were produced using an Anet A8 V2 3D printer with Poly Lactic Acid (PLA) material.

The application of reverse engineering technology demonstrated its efficacy in the development and repair of complex components subjected to continuous loads. By integrating CAD, CAM, and FEA/CAE tools, the research provided a comprehensive approach to identifying and mitigating material failures. The successful production of functional prototypes through 3D printing highlights the potential of this technology in producing precise and reliable components, reducing dependence on external suppliers and mitigating delays associated with component sourcing.

Overall, this study underscores the viability of reverse engineering and 3D printing technologies in the maintenance and repair of industrial machinery components, offering a cost-effective and efficient solution to material fatigue and failure.

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