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PROTOTYPING OF A TWO WHEELER CLUTCH HUB USING REVERSE ENGINEERING TECHNOLOGY

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Abstract - A clutch hub is a critical component in a two wheeler manual transmission system, responsible for transferring rotational power from the engine to the transmission gears and providing a mechanism for disengaging the gears to allow for smooth gear changes. The clutch hub is placed between clutch basket and pressure plate. The clutch plates are mounted on it. It has teeth at center hole which rotate with main shaft.

The prototyping of clutch hub using reverse engineering technique, making it essential to understand its design and functionality reverse engineering is employed to deconstruct an existing clutch hub, analyze its dimensions and materials, and create an accurate digital 3D model is created using computer aided design software, by scanning the part and prototyping of clutch hub is made by using 3D printing technology.

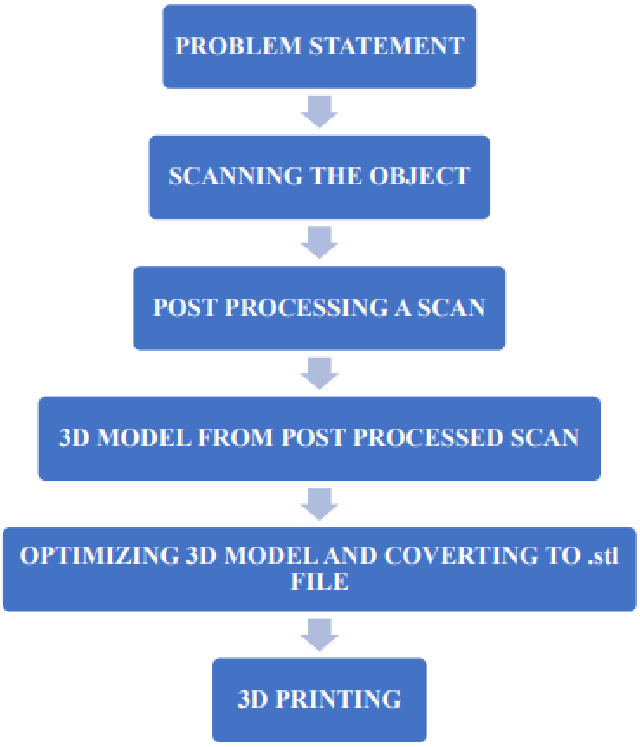
***Key Words*:** Clutch hub, Reverse engineering, 3D Model, Prototyping, 3D printing.

1. INTRODUCTION

Figure 1. Two Wheeler Clutch Hub

Clutch hub or clutch boss is a machine part on which the clutch plate and friction plate are mounted. The clutch hub rotates when the clutch gets engaged to the flywheel and due to spring force it starts rotating. The vehicle transmits a torque around 8.05 Nm. So the clutch hub provides the motion to the friction and clutch plate and friction plate. While the clutch is important part of the clutch assembly. While engaging and disengaging the clutch hub rotates with the same torque as that of the flywheel. And due to the friction plate and clutch plate are mounted on hub, it undergoes the tensile force and continuous rotation may result in failure and fatigue. So, the clutch hub plays important role in transmission and does not let the plates slip out of the grooves.

2. Methodology



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3. Introduction to Reverse Engineering

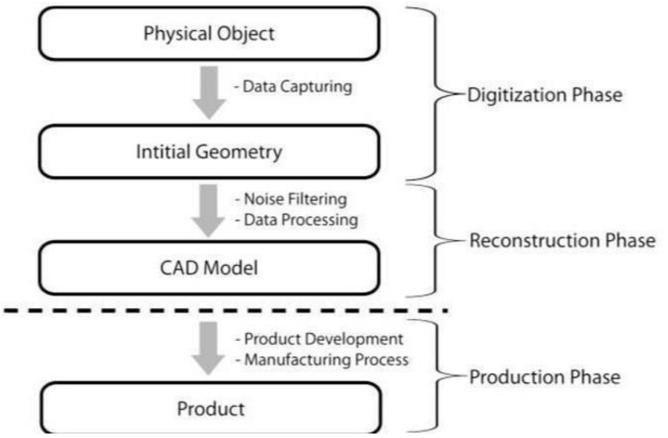


Figure 2. Reverse Engineering Process

Reverse engineering, sometimes called back engineering, is a process in which software, machines, aircraft, architectural structures and other products are deconstructed to extract design information from them. Often, reverse engineering involves deconstructing individual components of larger products. The reverse engineering process enables you to determine how a part was designed so that you can recreate it. Companies often use this approach when purchasing a replacement part from an original equipment manufacturer (OEM) is not an option

3.1 The Objective of reverse engineering

Reverse engineering provides manufacturers with information about the design of a product or component. When done successfully, reverse engineering gives you a virtual copy of the blueprint that went into the original design.

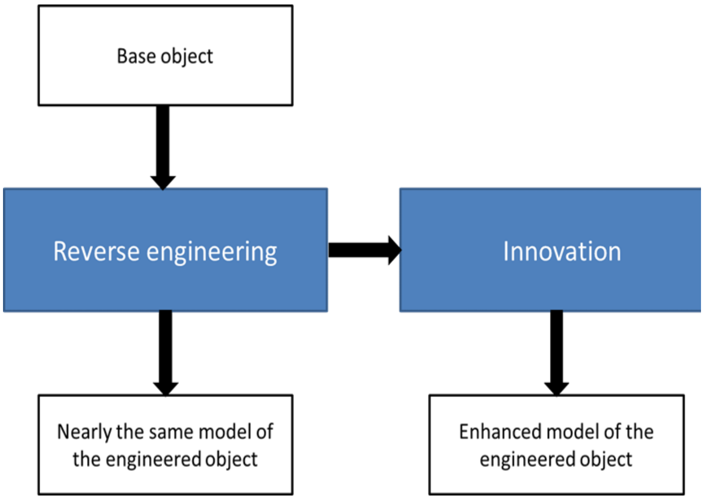


Figure 3. Objective of reverse engineering

4. Introduction to 3D Scanning

Figure 4. 3D Scanning Equipment

3D scanning is a technology that enables the capture of physical measurements of an object and converts them into a digital format, resulting in a 3D model or a 3D graphical rendering. This process is achieved through various methods, including laser scanning, white light scanning, and structured light scanning.

Laser scanning involves the use of laser beams to measure distances and create a point cloud representation of an object. The laser beams bounce off the object, and the reflected light is detected by sensors. By analyzing the time it takes for the light to return, precise distance measurements are obtained, which are then combined with the scanner's position and orientation to construct a 3D model of the object.

5. Introduction to 3D Printing

Figure 5. 3D Printer

3D printing, also known as additive manufacturing, is a revolutionary technology that builds objects layer by layer. Unlike traditional methods that carve away material, 3D printing uses a digital blueprint to create intricate shapes.

The process starts with a 3D model, which is sliced into thin layers. A 3D printer then builds the object by depositing material, such as plastic or metal, one layer at a time. This allows for complex designs that would be impossible with conventional manufacturing.

3D printing offers many advantages. It allows for rapid prototyping, minimizes material waste, and enables on-demand manufacturing. This technology is transforming various fields, from engineering and medicine to design and manufacturing.

6. Process

6.1. 3D Scanning of the Component

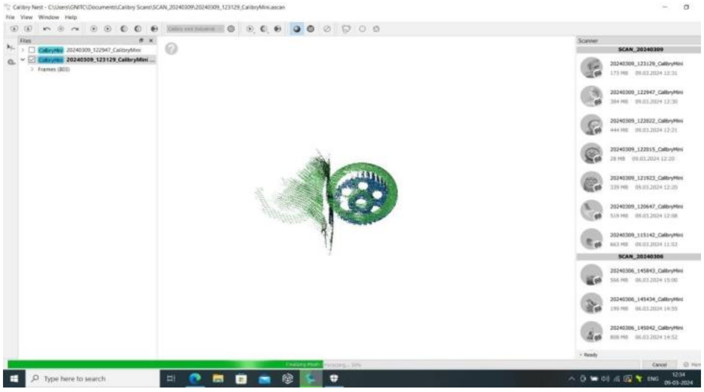
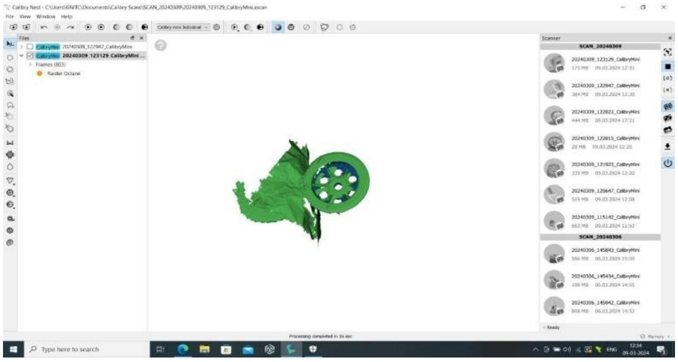


Figure 6. 3D Scanned Data

The part is scanned by using Calibry nest scanner preparing the part to be scanned, and performing the actual scanning to capture information that describes all geometric features of the part such as steps, slots, pockets, and holes. Three dimensional scanners are employed to scan the part geometry.

Scanners capture hundreds and even thousands of separate frames during each scan. These frames then should be stacked together in a consistent way to create a point cloud. Tracking refers to the way it is done and to the information used to achieve that. It is literally how a scanner keeps track of what it looks at and how it moves in respect to the object.

Depending on the type of object, its shape, material, size, color and other properties, you may want to use different types of tracking. Calibry scanners support all three of these: geometry tracking, marker tracking and texture tracking



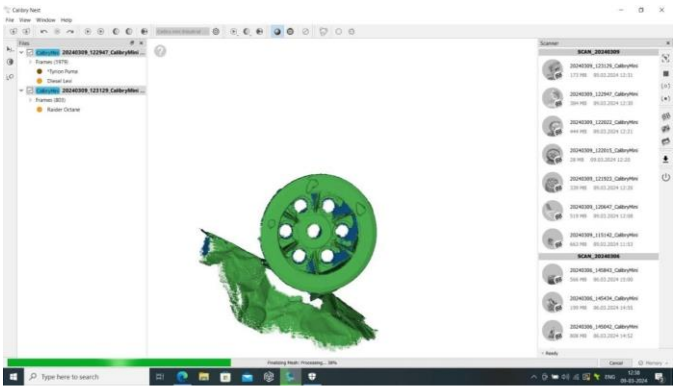


Figure 7. 3D Scanned Data after Rendering

1. After scanning, you'll get a point cloud, a vast collection of data points representing the object's surface.
2. Rendering is the magic that transforms this point cloud into a visually appealing and realistic image.
3. Rendering software acts like a light choreographer, simulating how light interacts with the 3D model to create a final image, just like a photograph.
4. Calibry appears to be a one-stop shop, handling both 3D scanning and rendering within its software suite.
5. Patience is key! Rendering times depend on your computer's muscle. Free up RAM and use a PC with a powerful processor for a speedier rendering process.
6. To capture the entire object, repeat the scanning and rendering process from multiple angles, ensuring both sides are covered.
7. The final rendered image should closely resemble the original scanned object.

6.2. Post Processing:

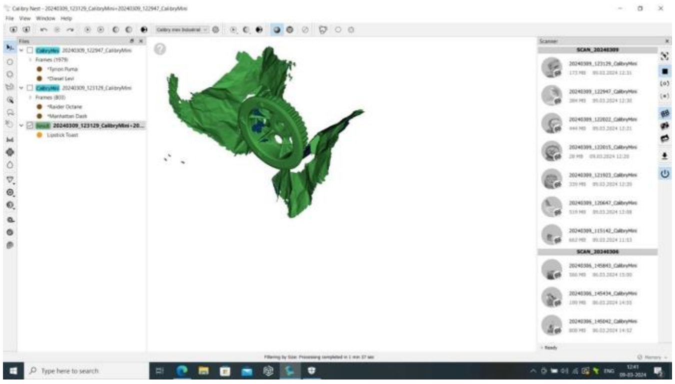


Figure 8. Component after Merging the scans

1. After rendering both sides of the object, you'll need to merge them into a single, complete 3D model.
2. This merging process involves selecting reference points on each side and joining them together.
3. Once merged, you can export the 3D model for further processing

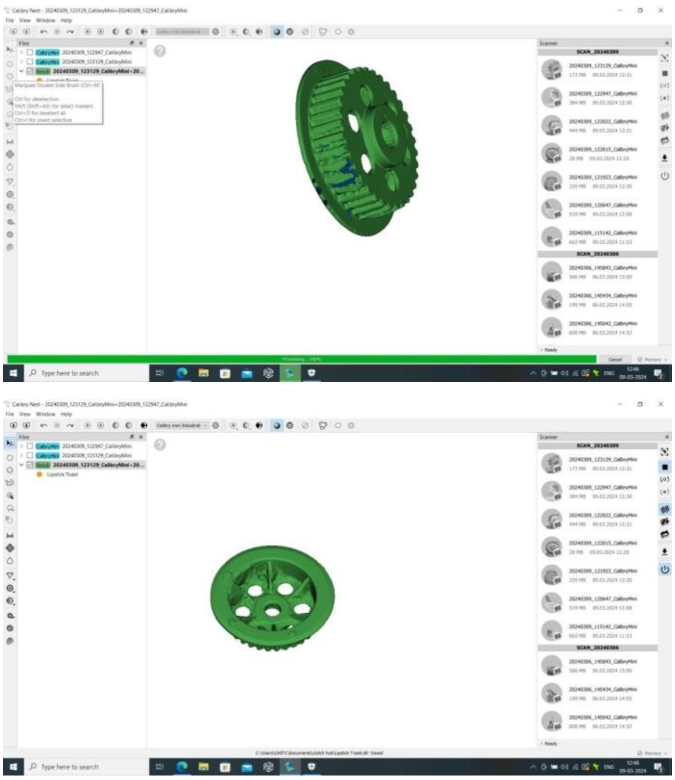


Figure 9. Post processed scanned

1. After scanning is finished, all captured frames are saved in a file with an .a scan extension. These files are saved on a PC/laptop a scanner is connected to. These files can then be processed either on the same computer, or can be transferred to any other computer to be processed in Calibry Nest.
2. Unprocessed scans may contain certain amount of noise picked up during scanning. This noise may appear due to glares, reflections or poor calibration. In most cases it is recommended to clean scans during registration. It is done by default, but cleaning may be deactivated in Settings.
3. When unprocessed scans are opened in Nest, the data may look noisy and layered. It is totally normal, especially if the scan was made without activating the Live3D mode.
4. In many cases it can be difficult to scan the entire object from all possible angles and capture all folds, mounting holes, and indentations. So, the final result may contain holes. In Nest holes can be filled either during finalization, or after finalization.
5. Resolution defines how detailed the resulting polygonal model will be. Its value is defined in millimeters or in fractions of a millimeter. The smaller this value is, the more detailed the final result will be.

6.3. Designing in Geomagic Design X Software

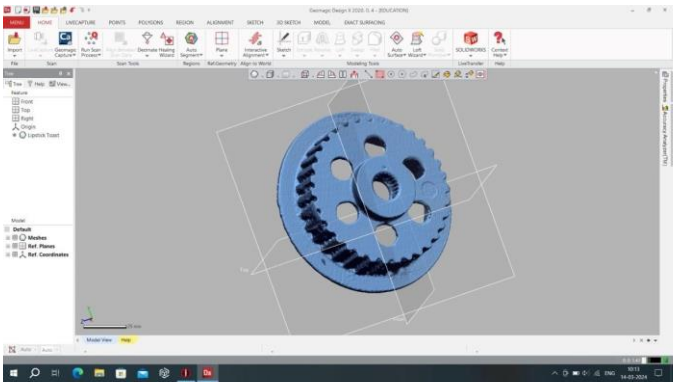


Figure 9. Creating the 3D Component

1. Once you have a complete 3D model, export it to software like Geomagic Design X for further processing.

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2. Within Geomagic Design X, use design tools to create a 2D sketch of the desired profile from the 3D model.
3. You can then extrude this 2D profile to transform it back into a 3D component.
4. With the 3D component in Geomagic, make any necessary adjustments to the design.
5. Finally, export the finalized 3D model to 3D printing software for creating a physical prototype.

6.4 Slicing

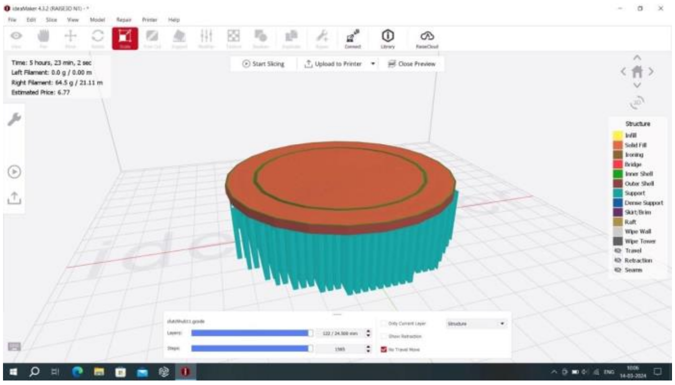

Figure 10. Slicing the model

Once a model is created, it's time to "slice" it. Since 3D printers cannot conceptualize the concept of three dimensions, like humans, engineers need to slice the model into layers in order for the printer to create the final product. Slicing software takes scans of each layer of a model and will tell the printer how to move in order to recreate that layer. Slicers also tell 3D printers where to "fill" a model. This fill gives a 3D printed object internal lattices and columns that help shape and strengthen the object. Once the model is sliced, it's sent off to the 3D printer for the actual printing process

We use Slicing software (Ultimaker Cura) to slice the file and determine the position of the object in which it is going to be printed. Once this is done then we generate G-codes from „Export G-code" option

6.5. 3D Printing

When the modelling and slicing of a 3D object is completed, it's time for the 3D printer to finally take over. The printer acts generally the same as a traditional inkjet printer in the direct 3D printing process, where a nozzle moves back-and-forth while dispensing a wax or plastic-like polymer layer-by-layer, waiting for that layer to dry. Then adding the next level. It essentially adds hundreds or thousands of 2D prints on top of one another to make a three dimensional object. There are a variety of different materials that a printer uses in order to recreate an object to the best of its abilities.

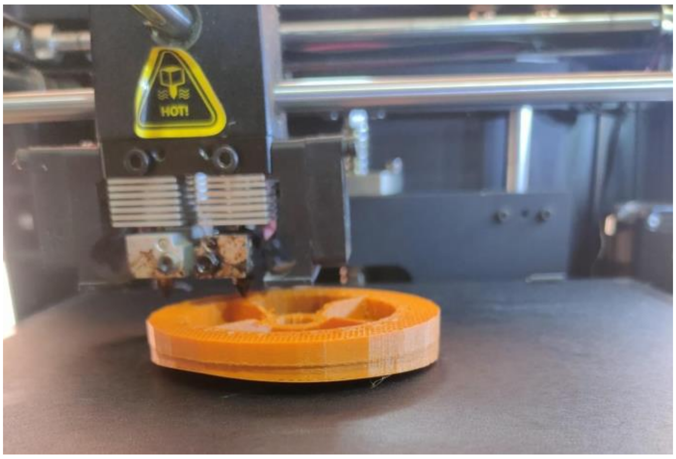

Figure 11. 3D Printing

7. Results

Figure 13. 3D Printed Component

Reverse engineering can be valuable for understanding how products and systems are designed and manufactured, and for identifying ways to improve them or resolve disputes related to intellectual property

8. Conclusion

We successfully achieved its objectives of dissecting the underlying structure and functionality of the target system. Through the application of advanced analysis methods and software tools, key insights were uncovered regarding its architecture and behavior. Despite encountering certain challenges, the accuracy and validity of the obtained information were confirmed, laying a solid foundation for practical application

Reverse engineering is the process of analsing a product or system to understand how it works and how it was designed. It involves taking apart the product or system and examining its components, functions, and interactions. It is a valuable tool for product development and innovation. It can help to identify areas for improvement, optimize existing designs, and ensure compatibility between different systems or products. However, it is important to note that reverse engineering can also raise ethical concerns, particularly if it involves copying or replicating an existing product without permission from the original designer.it can help to gain insight into how a product or system was designed, which can be useful for a range of purposes. For example, it can help to identify areas for improvement or optimization, or it can be used to create a new product that is based on an existing design and also it can be used to ensure compatibility between different systems or products. By understanding how a particular system works, it may be possible to create a new system that is compatible with it, or to modify an existing system to work with it.

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