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Design And Simulation Of Finite Element Analysis (Fea) 360º Rotating Table For Video Display Using Autodesk Inventor Software

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Abstract.
A turntable is a mechanical device that allows an object, in this case a video screen, to rotate in various angles and directions. Although turntables offer attractive visual capabilities, there are various technical issues that can arise related to their design and construction. One common problem is the inability of the turntable frame to withstand certain loads or instability when exposed to external pressure. So an analysis was carried out using the FEA method on a 360° rotary table design with stainless steel 304 and Iron Plate SS400 materials. The results of static analysis using Autodesk Inventor software show a maximum von Mises value of 139.2 MPa, displacement of 0.175 mm and safety factor of 1.49 ul. These results are considered safe because the safety factor value is within the value range (1.25 – 1.5 ul). So the 360° turntable is able to withstand loads during use.

Keywords: *360° turntable, FEA, Stainless Steel 304.*

1 Introduction

In the ever-growing digital era, video has become one of the most dominant media in conveying information, entertainment and creative messages. As technology advances, software and hardware have evolved to support more realistic and impressive video reproduction [1], [2].

One important supporting tool in presenting interesting videos is a turntable. The turntable allows video displays to be played from a dynamic and interactive perspective, creating a richer visual experience [3], [4], [5].

In this context, the design and quality of the turntable frame plays an important role in ensuring the video display remains stable, impressive and safe for the user[6], [7].

A turntable is a mechanical device that allows an object, in this case a video screen, to rotate in various angles and directions. Its existence not only improves the aesthetic aspect of displaying videos, but also provides interactivity for users in controlling the display [8],[9],[10]. Although turntables offer attractive visual capabilities, there are various technical issues that can arise related to their design and construction. One common problem is the inability of the turntable frame to withstand a certain load or instability when exposed to external pressure. In addition, the turntable frame material also tends to be susceptible to corrosion due to the use of the wrong type of material [11], [12].

One effort to overcome the problems above is to design the turntable so that it has a stable and strong frame, apart from that, consideration is also given to selecting materials that can

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reduce corrosion problems [13], [14], [15]. One appropriate method is to carry out a Finite Element Analysis (FEA) simulation. The FEA method can be used to solve complex structural problems in solid objects and produce solutions such as stress, strain, deflection and fatigue life of the material [16], [17], [18]. Many complex cases have been successfully resolved using this method.

2 Method

In this research, the method used to obtain, process and analyze data is descriptive, design and case study with the Finite Element Analysis (FEA) simulation method using Autodesk Inventor software [19], [20], [21]. The method used in carrying out this research is summarized in Figure 1 below.

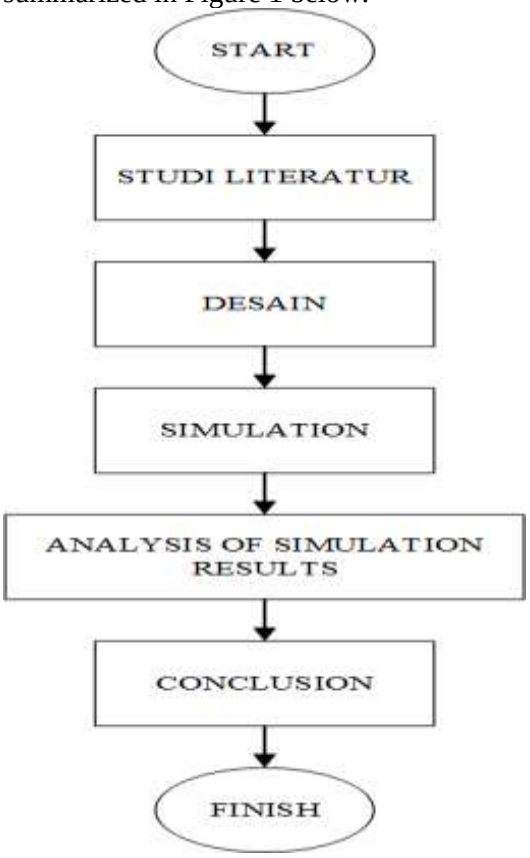


Fig. 1. Research Flowchart

2.1 360° Turntable Design

Design or drawing is one of the means/tools to convey information about what will be designed or made. The design process was carried out using the Autodesk Inventor Professional 2020 software [22].

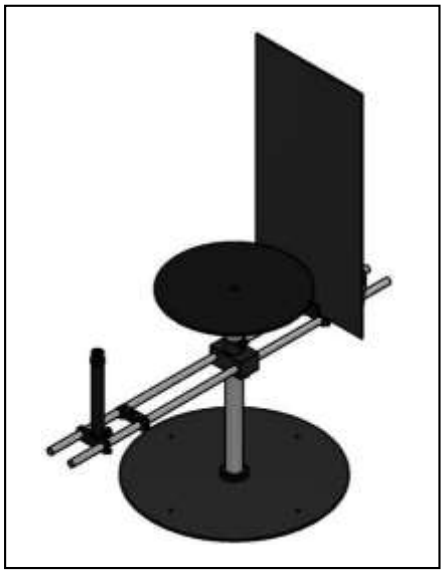
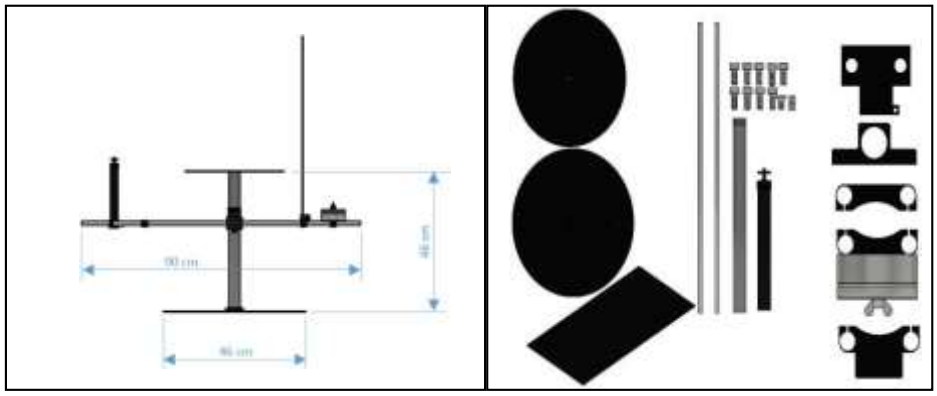


Fig. 2. 3D 360° turntable

The dimensions of the 360° rotary table frame are as follows [23]: Dimensions (L x W x H) or size of the frame, namely 90 cm x 46 cm x 46 cm. It can be shown in figure 3.



(a) (b)

Fig. 3. (a) Side Image of 360° Turntable Design (b) Part List

2.2 360 turntable frame material

• **Stainless Steel 304**

SS 304 alloy steel is an austenitic stainless steel with a composition of 0.042% C, 1.19% Mn, 0.034% P, 0.006% S, 0.049% Si, 18.24% Cr, 8.15% Ni and the remainder is Fe: tensile strength 646 Mpa, yield strength 270 Mpa, elongation 50%, hardness 82 HRB. Type 304 stainless steel is the most versatile and widely used stainless steel. Chemical composition, mechanical strength, weldability and corrosion strength are very good at a relatively affordable price [24]. Type 304 stainless steel is widely used in industry and small scale. Its uses include: tanks and containers for various kinds of liquids and solids, mining equipment, chemicals, food and medicine [25].

- **Iron Plate SS400**

SS400 light steel plate, also known as SS400 JIS 3101, in ASME Part IIA, JIS steel plate specifications for general construction belongs to the SA-36 category. In JIS (Japan Industrial Standard), "SS" is the abbreviation of structural steel and grade 400, similar to AISI 1018. SS400 light steel plate is one of the commonly used, most varied grades of hot-rolled structural steel [26]. Typical carbon steel materials, relatively cheap, good for welding and machining, and SS400 steel materials can undergo different heat treatments [27].

Table 1. Chemical Composition of SS400 Steel.

C≤ 16mm max	C>16mm max	Mn max	Si max	P max.	S max.
0.17	0.20	1.40	-	0.045	0.045

From the chemical composition of the elements contained in the SS 400 material, there are no visible characteristics of stainless steel material containing chromium (Cr) and nickel (Ni). Type 304/SS304 stainless steel has a minimum Cr-Ni content of: 18-8, namely: 18% Chromium and 8% Nickel [25].

2.3 Loading Properties

The assumed load given to the 360° Rotary Table covers 2 areas with different load assumptions for each part [24], so the assumed load that will be given to each area is listed in table 2 below:

Table 2. Assumed Loading Area

Component	**Mass**
Area 1	
Product Sample Weight	68.6 N
Total	**68.6 N**
Area 2	
Camera	19.6 N
Balancing	19.6 N
Total	**39.2 N**

Area 1 is the load area that supports the weight of the product/object to be shot in the video of 7 kg or 68.6 N. The location of the loading points can be seen in Figure 3.1 below. Area 2 is the load area that supports the camera and counterweight totaling 4 kg or 39.2 N. The location of the loading points can be seen in figure 3.1 below

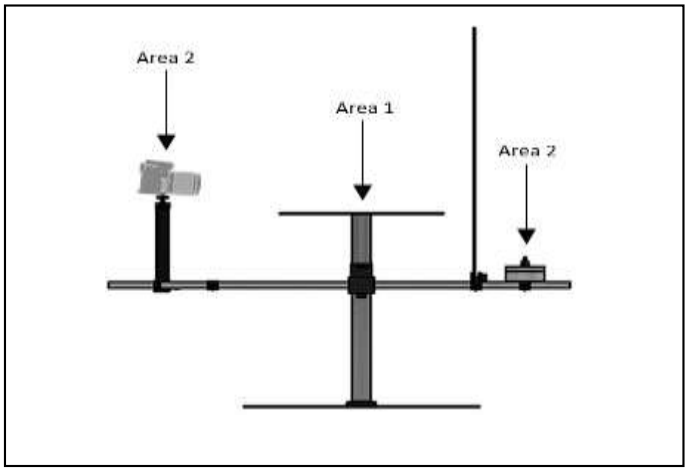


Fig. 4. loading area

2.4 Finite Element Method

Finite Element Method (FEA) or Finite Element Method is a numerical method used in various structural analyzes to solve complex mathematical equations in the form of small elements [28]. In Autodesk Inventor, FEA is used to perform a more comprehensive analysis of the model structure [29]. You can perform FEA analysis on 3D models using different types of elements (e.g., triangular, quadrilateral elements) and identify structural freezes, stresses and leaks in more depth [30], [31], [32].

3 Result and Discussion

From the results of static analysis using Autodesk Inventor 2022 software [33], simulation values were obtained regarding the strength of a 360° rotary table using stainless steel 304 and Iron Plate SS400 materials. Data from static simulation results are as follow:

3.1 Von Mises Simulation Data Results

Results of von mises simulation analysis on a 360° turntable. Figure 5 below shows the results of the von misses simulation analysis [28]. In this figure, the colors displayed represent the magnitude of the von misses value associated with the 360° turntable. The camera bracket section shows the largest von misses stress, marked in brownish yellow, with a von misses value of 139.2 MPa [34]. On the other hand, the light blue color indicates the smallest von mises stress.

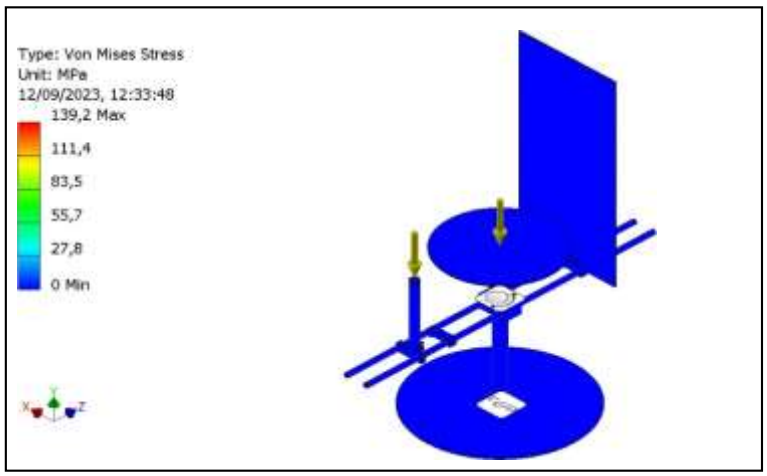


Fig. 5. Von mises results on the 360° turntable

3.2 Displacement Simulation Data Results

Figure 6 shows the maximum displacement that occurs on a 360° rotary table of 0.175 mm. The displacement at this value is relatively small [35]. This is because the Von Misses stress is below the yield stress or material strength so that the deformation that occurs is elastic deformation [28]. The biggest displacement occurs in the background of the photo table which is marked in red,

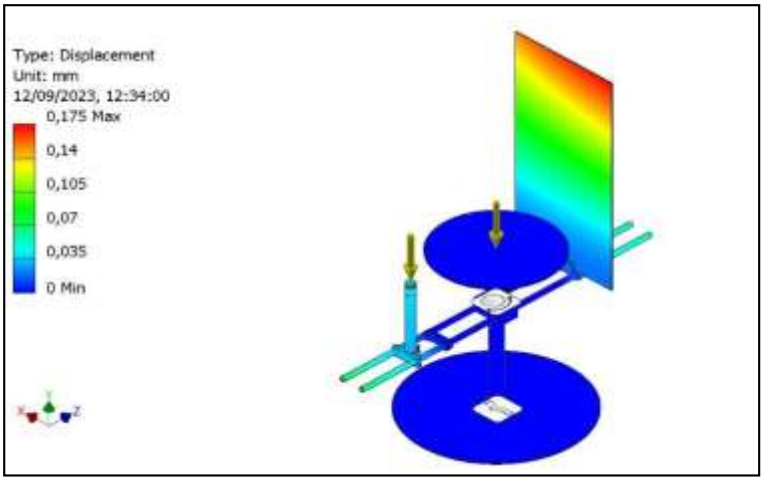


Fig. 6. Displacement results on the 360° turntable

3.3 Safety Factor Simulation Data Results

Based on the static simulation results as in Figure 7, the safety factor value is 1.49 ul [26]. This value is included in the static load safety standard range, namely 1.25 – 1.5 ul [36], [37], [22]. Figure 7 shows the 360° turntable design in blue, which means the 360° turntable design is able to withstand loads during use.

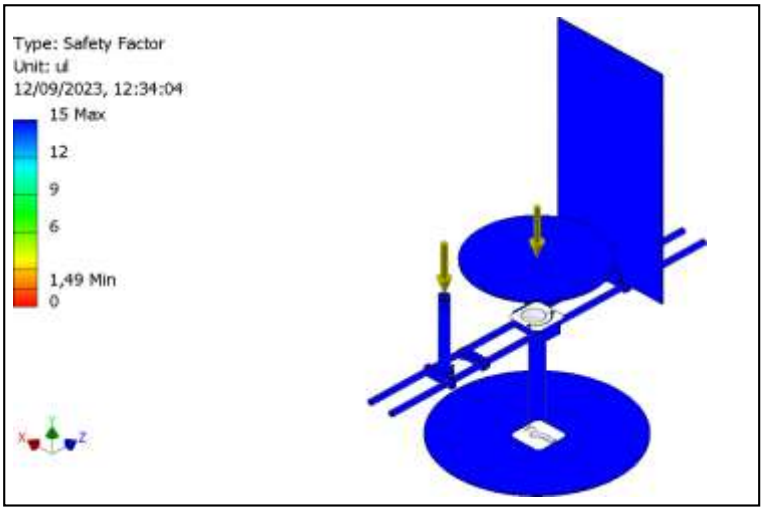


Fig. 7. Safety Factor results on the 360° turntable

Judging from Figures 5 to 7, the FEA test results show no significant construction changes in stress, strain and deformation values [38]. The design results are in table 3 below.

Table 3. Recapitulation of FEA result

Simulation	**Minimum**	**Maxsimum**
Volume	2226430 mm^3	
Mass	14,3967 Kg	
Von mises stress	0,00000000735724 MPa	139,237 MPa
Displacement	0 mm	0,174995 mm

Safety Factor	1,48667 ul	15 ul

4 Conclusion

Based on the results of the research that has been carried out, the following conclusion can be obtained: Stainless Steel 304 and Iron Plate SS400 materials are suitable for use as structural materials for 360° rotary tables. Based on the modeling carried out, the voltage obtained by the entire 360° rotary table design shows that the voltage is still below UTS and YS so it is safe to use, which is also supported by a safety factor that is within the safe range.

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