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The Study of Gas Powered Automatic Satay Grill Machines

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Satay, Automatic, Grilling

Abstract

The present study focuses on the design, development, and performance evaluation of a gas-powered automatic satay grill machine for commercial food service applications. Satay, a popular Southeast Asian dish, involves grilling marinated meat skewers over an open flame. Traditionally, this process has been labor-intensive and time-consuming, posing challenges for high-volume food establishments. The objective of this project was to engineer an automated satay grill machine that can improve productivity and consistency in satay preparation, while maintaining the authentic charcoal-grilled flavor profile. The key design considerations included an efficient gas-powered heating system, a motorized skewer rotation mechanism, and intuitive control interfaces to streamline the grilling process. Through a systematic approach involving thermodynamic analysis, structural simulations, and prototype testing, an optimized gas-powered automatic satay grill machine was developed. The final design incorporates features such as adjustable heat zones, automated skewer rotation, and digital temperature monitoring to enable precise control over the grilling parameters. Performance evaluations demonstrated the machine's ability to consistently produce high-quality satay with reduced labor requirements and improved throughput compared to manual methods. The findings of this study suggest that the developed gas-powered automatic satay grill machine can serve as a valuable asset for commercial kitchens, enabling them to meet the growing demand for authentic satay dishes while enhancing operational efficiency. The insights gained from this project can also inform the design of similar automated food preparation systems for other traditional grilled delicacies.

1. Introduction

The development of an Automatic Satay Grill Machine stems from the growing demand for automation and efficiency in the food industry. Satay, a popular Southeast Asian dish, traditionally involves time-consuming manual grilling processes that often require skilled chefs to ensure consistent quality. As the culinary world evolves and businesses face challenges such as labor shortages and increasing operational costs, the need for innovative solutions becomes
apparent.

The project aims to address these challenges by creating a sophisticated machine capable of grilling satay skewers with precision and consistency. The Automatic Satay Grill Machine represents a fusion of culinary tradition and modern technology, providing a cost-effective and efficient alternative to traditional satay grilling methods. By automating this process, businesses can significantly increase their production capacity, reduce labor costs, and maintain the authentic taste and texture of satay, meeting the expectations of discerning consumers.

This project is driven by the recognition that the food industry's future lies in harnessing the power of automation to meet the demands of a fast-paced world. The Automatic Satay Grill Machine has the potential to revolutionize the way satay is prepared and served in various culinary settings, from street vendors to large-scale catering services. It is expected to bring significant benefits not only to the foodservice industry but also to the environment by reducing energy consumption and waste. Furthermore, this innovation underscores the importance of sustainability and responsible manufacturing practices, aligning with the broader global trend towards more eco-friendly and efficient food production.

1.1 Literature Review

Satay is a beloved Southeast Asian dish renowned for its tantalizing blend of flavours and its cultural significance. Originating in Indonesia but embraced across Malaysia, Singapore, Thailand, and beyond, satay consists of skewered, grilled meat (commonly chicken, beef, or lamb) served with a flavourful peanut sauce. The meat is typically marinated in a harmonious mix of spices like turmeric, coriander, lemongrass, and garlic, which infuse the meat with a fragrant and aromatic essence. This dish not only showcases the diversity of regional spices but also embodies the communal spirit of sharing food, often enjoyed as a street food delicacy or at festive gatherings.

Crafting satay involves a meticulous process of preparing the meat, marinating it to achieve an infusion of flavours, and then skewering the pieces onto sticks, traditionally made from bamboo or lemongrass stems. The marinated meat is threaded onto these skewers, allowing for even cooking and providing the quintessential presentation of satay. The grilling process is a crucial step, either done over an open flame or using specialized satay grilling machines. These machines are designed with adjustable skewer racks that rotate slowly, evenly cooking the satay to perfection. The slow rotation ensures that the meat retains its tenderness while acquiring a delightful charted exterior, enhancing its smoky essence and locking in the spices' flavors.

Utilizing a satay cooking machine streamlines the process and ensures consistent results. These machines often feature adjustable temperature controls, ensuring precise cooking without burning or undercooking the meat. The slow rotation evenly distributes heat, guaranteeing that each skewer receives uniform cooking. This method not only preserves the authenticity of the dish but also caters to commercial settings, where large quantities of satay can be prepared efficiently without compromising on taste or quality. Whether prepared traditionally over open flames or using specialized machines, the art of making satay remains a culinary delight cherished for its tantalizing flavors and cultural significance.

Figure: Satay product with peanut sauce.

1.2 Problem Statement

Manual satay skewering is a highly time-consuming and labour-intensive process, which places considerable demands on skilled kitchen personnel. Skewering each piece of meat individually consumes valuable time and resources, diverting skilled labour away from other essential kitchen tasks. This inefficiency results in prolonged customer wait times, reducing overall productivity in a restaurant or food service establishment. Moreover, the dependence on skilled labour introduces challenges during peak hours and can lead to increased operational costs, as higher wages are often required to retain or attract proficient skewering staff. This labour-centric approach risks service disruptions due to workforce shortages, impacting customer satisfaction and the business's bottom line.

The manual skewering process not only consumes time and labour but also results in irregular meat arrangement on skewers, leading to inconsistencies in cooking and flavour. Variability in the meat distribution can cause some pieces to be undercooked while others are overcooked, affecting the quality of satay and customer satisfaction. Additionally, manual skewering involves extensive handling of raw meat, raising significant food safety concerns. Maintaining proper hygiene and safety measures becomes challenging in a fast-paced kitchen, where the risk of cross-contamination is heightened. Addressing these issues is crucial to prevent foodborne illnesses, customer complaints, and potential legal liabilities, further intensifying the challenges posed by manual satay skewering.

2. Materials and Methods

From the flow chart show in Figure 1 has plan the entire project activities. Overall of the activities show in flow chart are the major important activities to be carry out. Beginning of the project is the introduction part of the project, second is the review of other research such as journal, conference paper, and other internet online process. After that most, of the activities are the designing method or engineering design process.

In the middle of the activities that require to make tough decision and redoing the activities is the concept generation part. This activity is repeating process until the project achieve a certain level of requirement by referring to the objective, scope and problem facing this project.

Next, the process is the evaluation process of the concept design. By evaluating the design will find out which design are suitable to protect the project problem. After this has known which design are suitable will process to the next final design this activity will start to compute 3D model design of the satay burner. Meanwhile, the project able to start purchasing process for the component used in the project and the following will be cost analysis.

Finally, the project prototype can start to fabricate and perform testing and specific experiment to validate the project design. In this testing process, also a repeating process to get a perfect suitable design for the project. In the end. The project has completed all the activities and can conclude to have further project benchmarking with other product design.

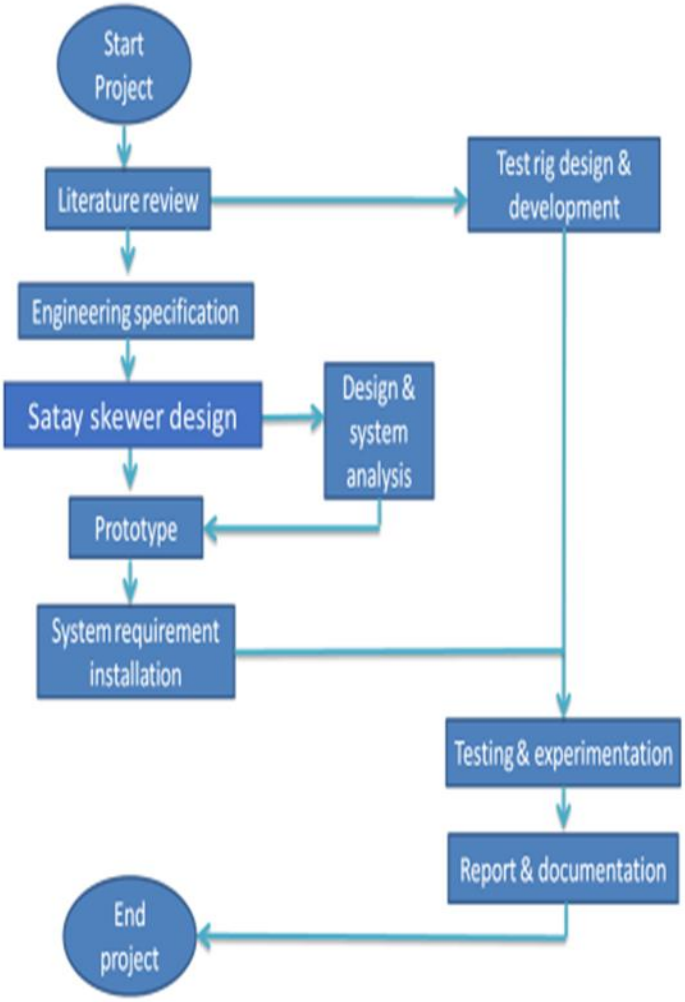

Figure 1: Project's flowchart

2.1 Benchmarking of Product Specifications

Benchmarking is the systematic assessment of the performance and features of a comparable product already available in the market. Additionally, the process involves designing a new product while evaluating the advantages and disadvantages of the current product. This analysis aims to ensure that the new product outperforms its predecessor (Fallis, 2013). Table 2.1 illustrates the process of comparing and evaluating commercial products against a standard.

SPECIFICATION	**PRODUCT 1**	**PRODUCT 2**	**PRODUCT 3**
COMPANY	ALPINA	Tan Far Machinery	Maid Wright
BRAND	Gas Grill G series	TF 600	ROTO-Q 360
PHOTO			
MATERIAL	Steel, Plastic	Steel	Steel
WEIGHT	12 kg	45 kg	4 kg
HEATING ELEMENT	Gas	Gas	Gas
CAPACITY	10 Pcs	40 Pcs	8 Pcs

3. Results and Discussion

3.1 Concept Generation

Product sketching entails the creation of preliminary, manual images depicting a product or design concept. The objective of product sketching is to expeditiously and effectively investigate many design alternatives, evaluate different concepts, and pinpoint potential concerns prior to allocating significant time and resources towards a more intricate design. It is a crucial component of the product design process and can effectively conserve time and resources in the future by enabling designers to refine their ideas before finalizing the design.

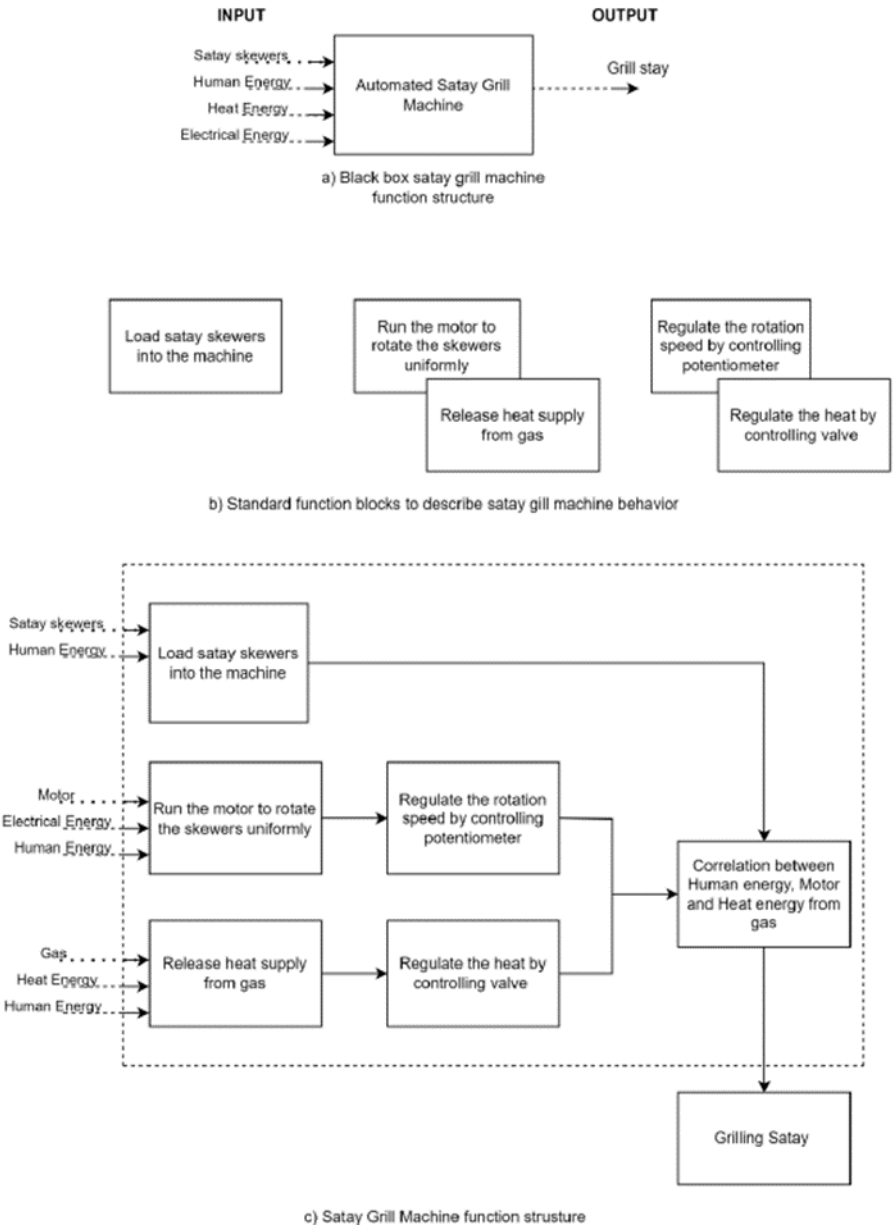

Figure 2: Function Structure of Gas Powered Automatic Satay Grill Machine

3.2 Concept Evaluation

After the initial stages of idea generation, analysis, and discussion in the brainstorming process, the concept evaluation phase begins. The main objectives of evaluation are to compare the developed concept with

the requirements that emerged from the brainstorming session and to determine how to meet those demands. Moreover, by utilising this often used approach in design decision-making, it is possible to choose the most suitable concept for the desired product. The concept evaluation stage corresponds to the convergence stage of design development. It begins with the review of concepts that were produced for the most basic level of functional decomposition.

3.2.1 Clarifying Objectives Tree

The figure illustrates the hierarchical organisation of the requirements for product design. These tools are used to ensure that the design product fulfils the client's requirements and remains on track. The aim tree facilitates the elucidation of the fundamental requirements in order to construct the machine according to the client's specifications. The utilisation of this chart is important to guarantee that these prerequisites are consistently taken into account during the construction of the equipment.

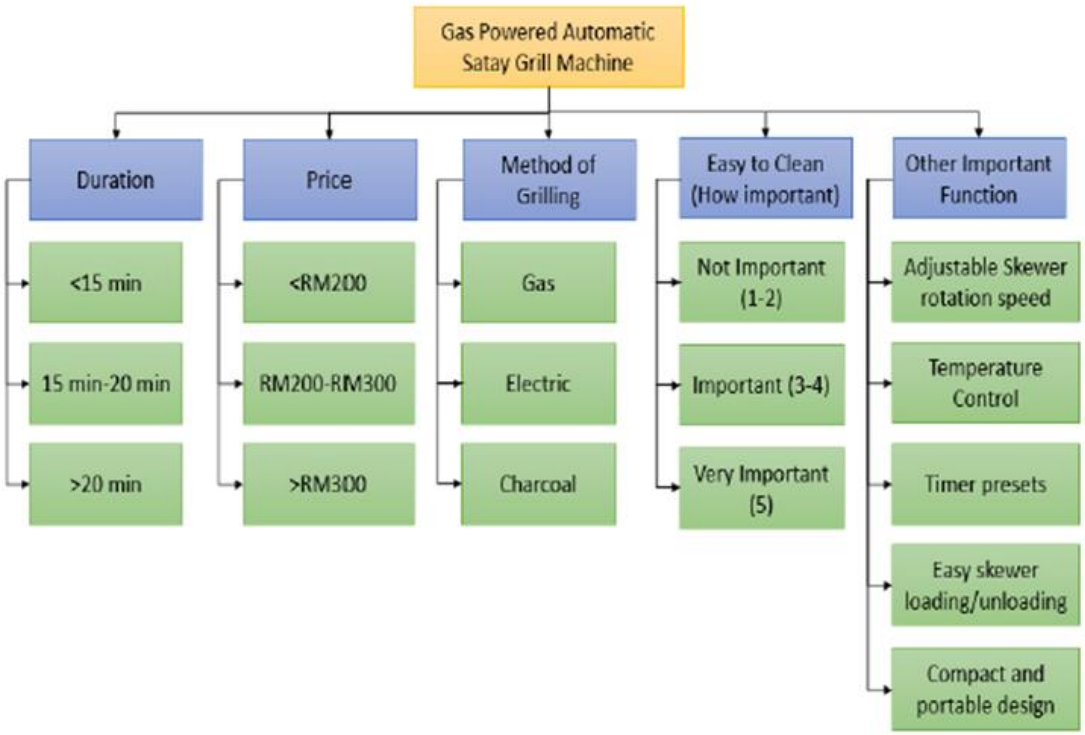

Figure 3: Objective Tree Diagram

3.2.2 Weighting Objective Tree

It has a weight importance and is related to the previous objective tree. It illustrates the significance of those goals for the advancement of the product. Figure displays the weighting objective tree.

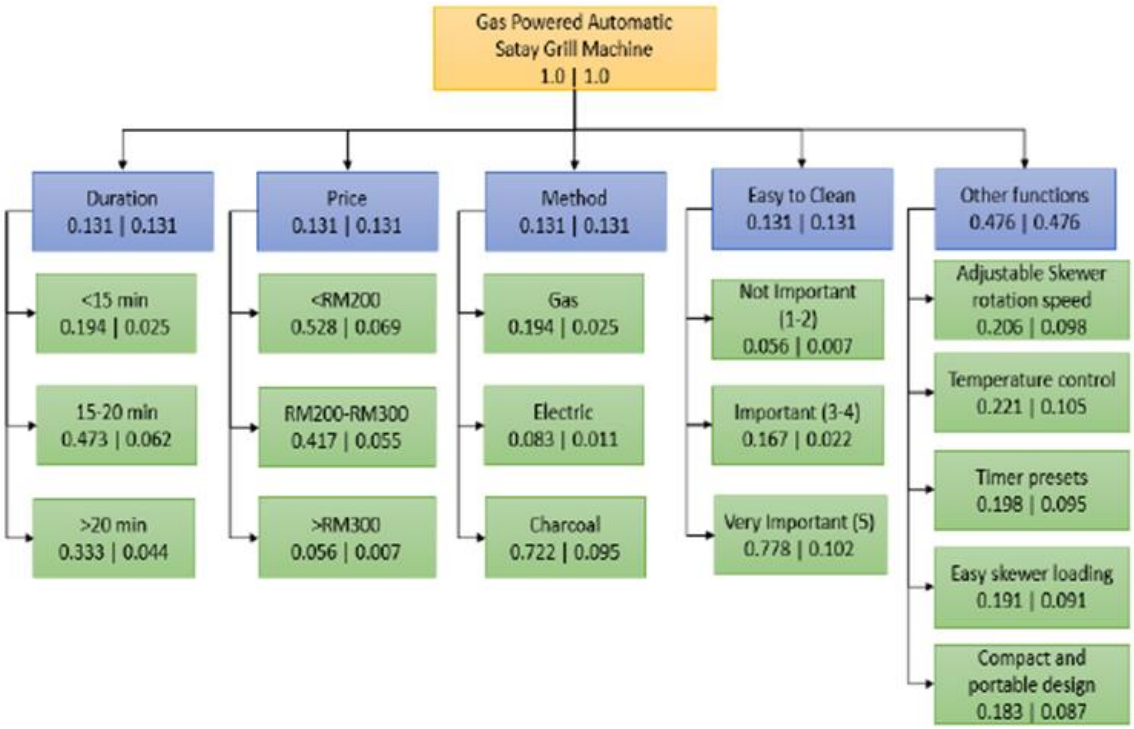

Figure 4: Weighted Objective Tree

3.3 Evaluation Matrix – Weighted Rating Method

Criteria	Important Weight Factor	Concept Alternative					
		Concept 1		Concept 2		Concept 3	
		Score	Rating	Score	Rating	Score	Rating
Duration to Grill (Minutes)							
<15	0.025	3	0.075	2	0.15	3	0.075
15-20	0.062	4	0.248	3	0.186	3	0.186
>20	0.044	4	0.176	4	0.176	4	0.176
Price (RM)							
<200	0.069	4	0.276	3	0.207	3	0.207
200-300	0.055	4	0.22	5	0.275	4	0.22
>300	0.007	3	0.021	4	0.028	4	0.028
Method							
Gas	0.025	5	0.125	3	0.075	3	0.075
Electric	0.011	3	0.033	4	0.044	4	0.044
Charcoal	0.095	3	0.285	3	0.285	2	0.19
Easy to Clean Importance							
Not Important	0.007	3	0.021	3	0.021	3	0.021
Important	0.022	4	0.088	4	0.088	4	0.088
Very Importance	0.102	5	0.51	4	0.408	3	0.306
Other Functions							
Adjustable Skewer Rotation Speed	0.098	4	0.392	4	0.392	3	0.294
Temperature Control	0.105	3	0.315	3	0.315	4	0.42
Timer Presets	0.095	5	0.475	4	0.38	3	0.285
Easy Loading	0.091	4	0.364	3	0.273	4	0.364
Compact and Portable	0.087	3	0.261	2	0.174	3	0.261
Total	**1**	-	**3.885**	-	**3.477**	-	**3.24**

3.4 Product Analysis & Simulation

After the assembly is finished, the performance of the product in good condition must be determined by evaluating the total kinematic analysis using the simulation approach. This will determine the product's safety

level and guarantee its robustness when assembled utilising our assembly guidelines. SolidWorks simulation offers critical simulation capabilities that are necessary for evaluating our projects and choosing quality control techniques. It is commonly recognised that material, interaction, and association simulation occurs throughout the design process. It is possible to extensively evaluate a product for strength and safety.

Essential simulator functionality for project review and quality assurance choices are offered by SolidWorks Simulation. Both the cinematics and the products can be thoroughly inspected for protection and durability. An additional benefit is a wide range of design forms that enable us to simulate the effects of solid, thin-walled, and structural components in real life.

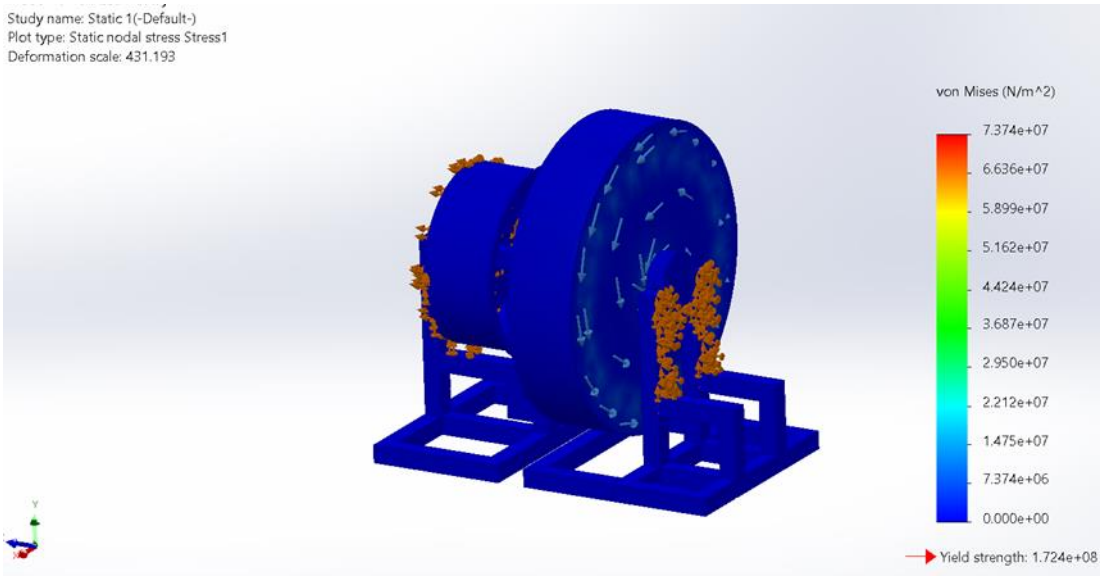

Figure 5: Stress Analysis using Solidworks

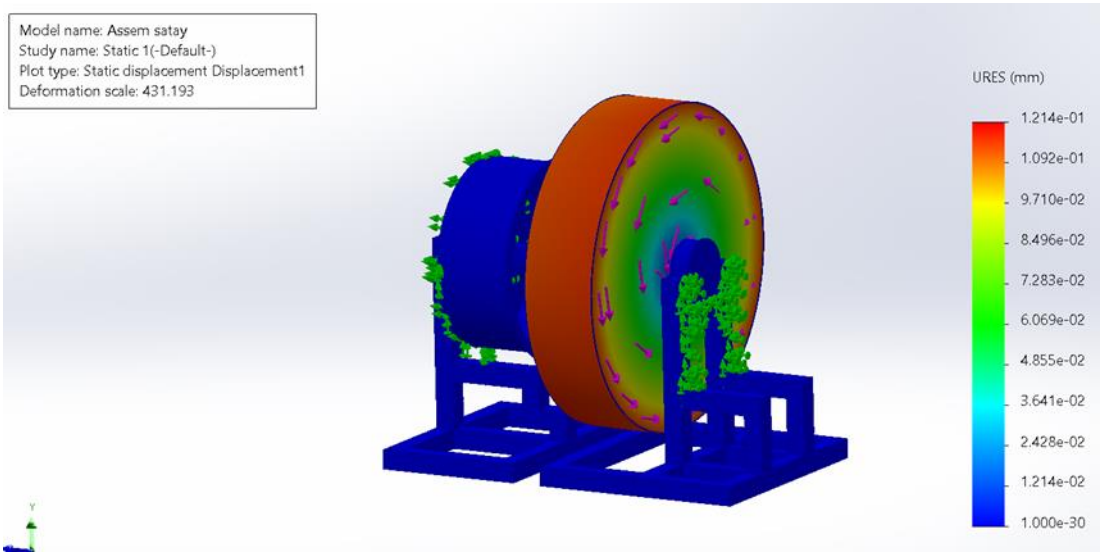

Figure 6: Displacement Analysis using Solidworks

(1)

4. Conclusion

Through this project, I have gained personal knowledge and experience in product design. Prior to finalising the work, I engaged in brainstorming and conducted thorough research on items that have the potential to assist

individuals in the future. The objective of my product should be to resolve the issue identified in our problem description. Through the process of brainstorming, I have devised several ideas and strategies that will allow me to successfully achieve my target.

It was noted that, apart from the production process, the ramifications of the product had to be taken into account. A product that does not effectively address any issues is said to have no value. A product cannot achieve sustainability if it poses risks to society, the environment, or the economy. Engineers face a continuous struggle in creating a product that encompasses all aspects of sustainability. Engaging in this venture allowed me to gain a comprehensive understanding of the design process and provided me with the opportunity to generate ideas that were highly sustainable.

The project is considered finished after the instructor receives the project report. Through my involvement in this project, I acquired a comprehensive comprehension of the engineering design process, encompassing the inception of a fundamental notion to the physical realisation of a prototype product. It is necessary to consistently enhance the design of this equipment in order to overcome any shortcomings.

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References

[1] Henao, H., Capolino, G., Fernández-Cabanas, M., Filippetti, F., Bruzzese, C., Strangas, E., Pusca, R., Estima, J., Riera-Guasp, M., & Hedayati-Kia, S. (2014). Trends in Fault Diagnosis for Electrical Machines: A Review of Diagnostic Techniques. IEEE Industrial Electronics Magazine, 8, 31-42. Https://doi.org/10.1109/MIE.2013.2287651.

[2] Nugroho, A., Hidayat, R., & Stefanie, A. (2022). IMPLEMENTATION OF STEPPER 28BYJ-48 AND SERVO MG996R AS A ROASTING ARM ROBOT IN AN ARDUINO UNO-BASED AUTOMATIC SATAY GRILL TOOL. JEEMECS (Journal of Electrical Engineering, Mechatronic and Computer Science). Https://doi.org/10.26905/jeemecs.v5i1.5166.

[3] Gorji, M., Ahmadkhaniha, R., Moazzen, M., Yunesian, M., Azari, A., & Rastkari, N. (2016). Polycyclic aromatic hydrocarbons in Iranian Kebabs. Food Control, 60, 57- 63. Https://doi.org/10.1016/J.FOODCONT.2015.07.022.

[4] Rochman, S., & Mukodah, R. (2020). AUTOMATIC FISH GRILLER BASED ON TEMPERATURE CONTROLLER. , 2, 33-36. Https://doi.org/10.36456/BEST.VOL2.NO2.3475.

[5] Suryani, D., Astuti, F., Indriyani, M., Suyitno, S., Maretalinia, M., & Yulianto, A. (2020). THE EXISTENCE OF ESCHERICHIA COLI ON GRILLED INTESTINES (SATE USUS) AND ITS RELATED FACTORS IN A TRADITIONAL FOOD STALL AT MALIOBORO TOURISM AREA, YOGYAKARTA, INDONESIA. Public Health of Indonesia, 6, 7-13. Https://doi.org/10.36685/phi.v6i1.325.