

Design and Development of a Golf Ball Cleaning Machine at UTHM Driving Range

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Abstract

A golf ball cleaning machine is a machine that can remove dirt that appear on the golf ball by using brush in a spiral. The goals are to identify parameter for cleaning the golf ball using engineering design approach. Other than that, to design a golf ball cleaning machine based on conceptual design process. Lastly, to fabricate the golf ball cleaning machine for proof-of-concept testing. In order to achieve the goals, the scope and limitation need to be set which are the first one is the place of the driving range is at UTHM Driving Range, the type of balls that are involves are the practice ball, and lastly focus on small category of driving range facility. Methods that are being used are by using the flow chart to structure the whole process to solve the problem. Then by stating up the problem identification, i was able to make a concept generation by using morphological chart. The morphological contain three alternative which can select to get a perfect combination. Then by concept evaluation, it entails a methodical approach to examining and analyzing the conceived ideas or concepts to ascertain their practicality, feasibility, and likelihood of success. After that, the concept will be selected at the concept selection. At the product architecture, the product modules will be set by using schematic diagram, cluster diagram, and incidentals interaction. Then, the modelling and simulation are done by using Solidworks 2023 and the simulation that are being used are the static analysis and the buckling analysis. In conclusion, I managed to to learn on how to design and develop using engineering approach and getting used to it. This project will able to solve the cleaning problem at the UTHM driving range.

1. Introduction

Golf, a sport with a rich and centuries-old history, has evolved from its early origins into a globally beloved pastime. Its roots can be traced back to 15th-century Scotland, where it was played on rudimentary courses with wooden clubs and leather balls. Over the years, golf has seen significant transformations in equipment, rules, and popularity. The formalization of the game is often attributed to the establishment of The Royal and Ancient Golf Club of St. Andrews in 1754, which helped standardize the rules. The 19th century saw the spread of golf to other parts of the world, most notably the United States, where the first golf course was founded in 1888. The game's appeal grew exponentially, and today it boasts a dedicated following and professional tours, including prestigious events like The Masters and The Open Championship. Golf's enduring charm lies in its combination of skill, strategy, and the picturesque settings of its courses, making it a sport that continues to captivate enthusiasts and players of all skill levels worldwide. [1] stated that now, everything in between is at your

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fingertips, provided you know where to look. If you're new to loving the game or at least new to digging deeper consider this a menu of the glories on offer. It's never been easier to spend every last moment of your free time falling ever more in love.

"A driving range is a special facility at most major golf courses where players can practice their swing without having to play out on the actual course" [2]. Typically, a driving range consists of an open area equipped with multiple hitting stations. These stations provide golfers with the space to practice their swings, with mats or tee boxes to position their golf balls. Some driving ranges also feature natural grass areas for a more authentic experience. In the range, various target areas are marked by flags, poles, or distance markers, enabling golfers to measure the accuracy and distance of their shots. To facilitate practice, special range balls are available for purchase, distinct from regular golf balls. Yardage markers aid in gauging shot distance, while practice aids like alignment sticks, nets, and video analysis systems assist golfers in refining their techniques. Golf driving ranges provide an essential platform for golfers to enhance their skills, make swing adjustments, and evaluate their progress before heading to the golf course.

Golf plays on the field. So, when the golf ball is at the field it often gets dirty moreover by the mud. At driving range, where golfer get to practice there are a lot of bays where each golfer is placed. The challenge within driving ranges lies in the sheer volume of golf balls that accumulate on the field each day due to numerous golfers practicing simultaneously. The traditional manual cleaning method involves placing the balls in buckets and cleaning them by hand, a time-consuming process that not only demands significant human labor but also results in a prolonged downtime for the driving range.

This inefficiency not only impacts the operational productivity of the driving range but also poses a financial burden in terms of labor costs and potential revenue loss during extended cleaning periods. Additionally, the reliance on manual labor for cleaning leaves room for inconsistencies in the cleaning quality, potentially affecting the performance and durability of the golf balls over time.

Therefore, the problem at hand extends beyond mere inconvenience, it is a multifaceted challenge that encompasses operational, financial, and quality assurance aspects. The development of an automated golf ball cleaning machine is imperative to address these challenges comprehensively. Such a solution would not only reduce the time and labor required for cleaning but also contribute to a more consistent and efficient maintenance process, thereby optimizing the overall functionality of driving ranges. In summary, the problem revolves around the inefficiencies inherent in the manual cleaning process, necessitating a technologically advanced solution to propel the golfing industry toward a more streamlined and effective future.

There are a lot of size of golf driving range that are available currently since there are no specific specification that are listed in order to make a golf driving range. However, a decent size of a driving range that are being stated by [3] are from 7 to 10 acres. However, [4] stated that the least size that a driving range can have is 1 acre for private driving range facility but at least 2 acres for commercialise. In UTHM, the driving range size is between 2 to 3 acres which is meet the minimum area for a driving range.



Fig. 1 UTHM Driving Range

At UTHM Driving Range as shown in Figure 1-1 there are total of 15 bays that are operated. Each bay will consist at least one bucket and one bucket contain 100 balls usually. Let say there are 15 bays, it means by the end of the day there could be hundreds or thousands ball are on the field. It means there are also hundreds or thousands of balls that need to be clean. The problem is at UTHM driving range, the cleaning method that have been use is by the conventional way by putting the balls in the bucket and clean it using hands which it will take forever to done as shown in Figure 1-2. Therefore, in this project I will design a machine that can clean the golf

balls and my golf ball cleaning machine will reduce the time to clean the ball where indirectly will increase the efficiency.



Fig. 2 Conventional golf ball cleaning

2. Methodology

2.1 Morphological Chart

Concept generation involves the collaborative process of brainstorming, devising, and refining diverse ideas or concepts to tackle a specific problem, challenge, or requirement. This stage is pivotal in both the design and innovation processes, as it entails the exploration of various potential solutions, approaches, or designs aimed at addressing the identified issue or meeting specific needs

Table 1 Morphological Chart

Required Function	Alternative solution		
	Alternative 1	Alternative 2	Alternative 3
Convert Energy	Motor	Generator	Pneumatic
Washing Method	Vibration	Rotation	Push& pull
Ball Entrance	Bucket	Open	Funnel
On/Off Switch	Push button	Toggle switch	Rotary switch

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Table 2 Concept Selection

Required function	Specification
Convert Energy	Motor
Washing Method	Rotation
Ball Entrance	Bucket
On/Off Switch	Toggle switch

Concept selection is a process where the best combination is selected. The highest score, according to the previously weighted rating system, represents the finest criterion combination that meets consumer needs. Combination I will be chosen as designing Egg Grading Machine because it achieves the highest total of weight

rating among these three-concept combinations. Table below shows the specification for the chosen combination.

2.2 Product architecture

Modelling the interactions between the modules and setting the performance characteristics for the modules are the most critical task in determining the product architecture.

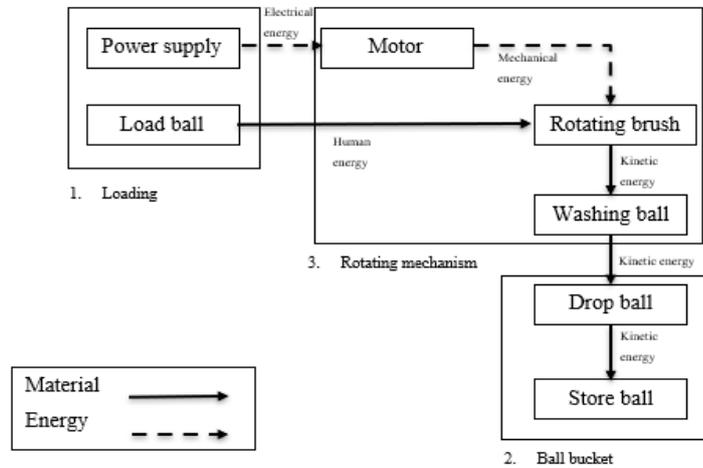


Fig. 3 Interaction between modules

3. Result

3.1 Assembly

An assembly drawing is a detailed illustration that reveals how individual parts interact or fit together to create a functional machine. It helps us pinpoint the precise connections between each component. A comprehensive assembly drawing serves as a visual representation of the fully assembled product or structure, displaying all parts in their operational positions. Such drawings are essential for any product or invention involving multiple components, as they list all the parts and sub-assemblies that make up the final product. An assembly working drawing consolidates all necessary structural information onto a single drawing, requiring the inclusion of adequate orthographic views and dimensions. As depicted in Figure 5.1 below, the Egg Grading Machine was assembled from 11 components using SolidWorks 2023 software.

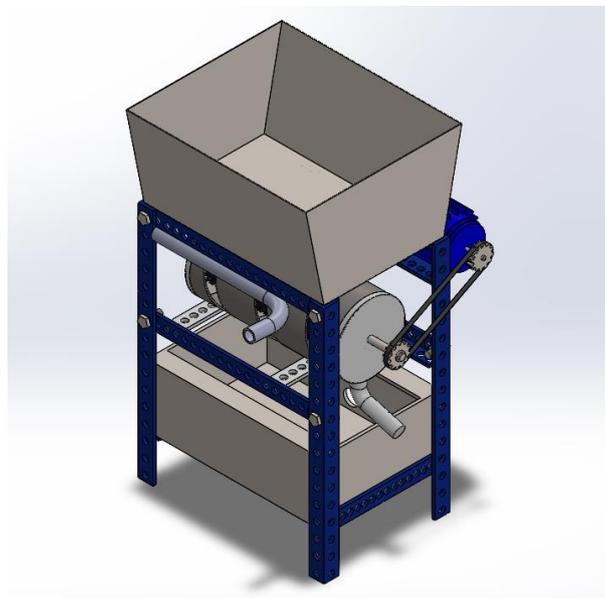


Fig. 4 Full product assembly

3.2 Machine Process Flow

First, the golf ball will be fill in the bucket. At the bucket there is a hole where the ball will drop by using the tube that are connected to the spiral. Then, the ball will enter at the entrance tube and will be directed to the main element which is the cleaner.

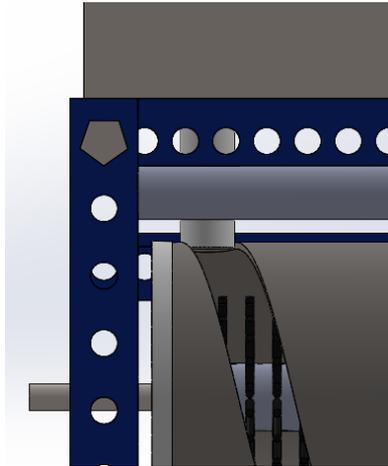


Fig. 5 Ball entrance

Then, when the ball is in the cleaner the motor will be the one that rotate the brush inside the spiral. The brush and the motor are connected by using gear and belting where the gear mechanism will transmitted the power from the motor to the brush

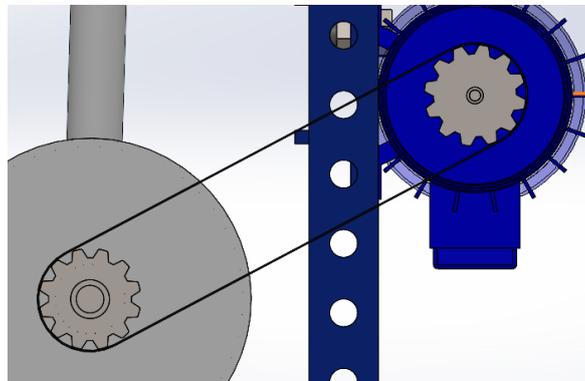


Fig. 6 Rotation mechanism

Inside the spiral the movement of the ball will be controlled by the path while the brush is rotating. This means the ball movement also in a rotation movement. There will be also a sprayer that spray the ball using water to remove the dirt on the ball surface.

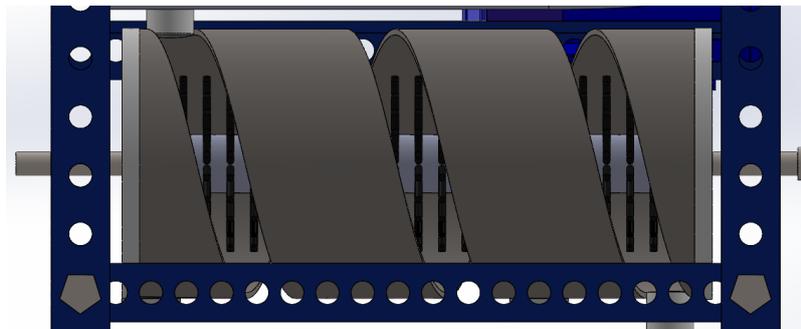


Fig. 7 Ball movement in the spiral

At the end of the spiral, the ball enter the exit tube after undergo the cleaning process. While the excessive water that are being used to remove the dirt will be flowing into the water container to maintain cleanliness.

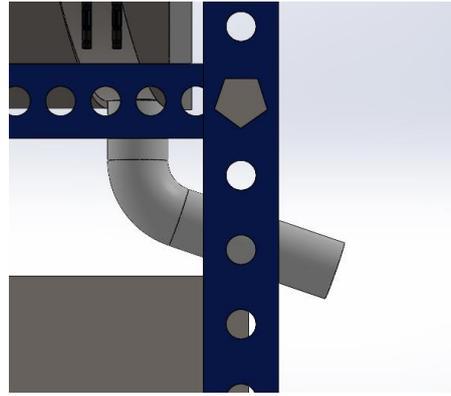


Fig. 8 Ball exit

3.3 Static analysis

In static analysis, there are three main component that need to be analyst in order to determined the safety of the product which includes the frame, bucket, and the water container. So, the analysis that are involves in the static simulation are stress, displacement, and strain analysis.

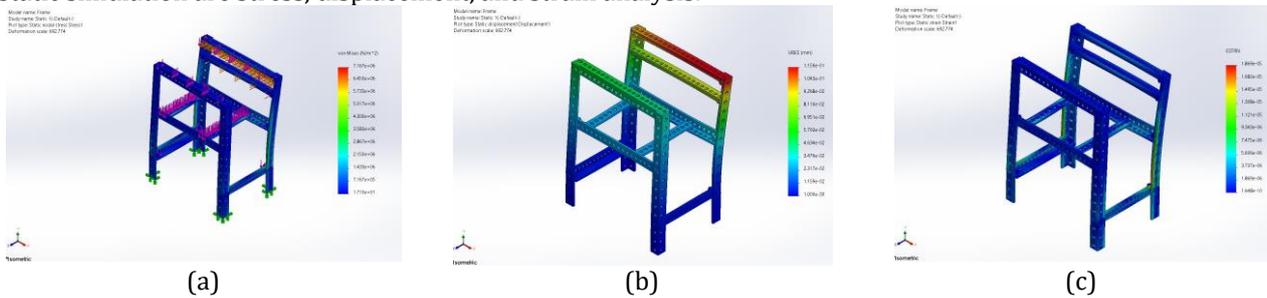


Fig. 9 Static analysis (a) Stress (b) Displacement (c) Strain for frame

Table 3 Maximum and minimum value for frame analysis

	Stress von Misses (N/m ²)	Displacement URES (mm)	Strain ESTRN
Maximum	7.167e06	1.159e-01	1.869e-05
Minimum	1.710e01	1.000e-30	1.648e-10

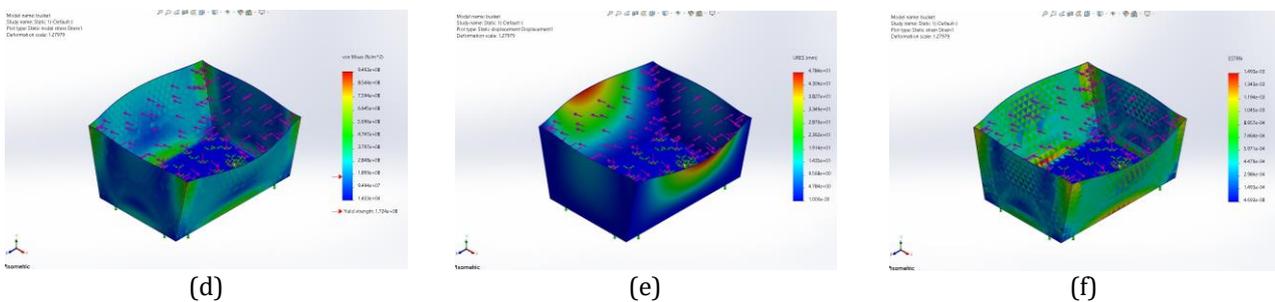


Fig. 10 Static analysis (d) Stress (e) Displacement (f) Strain for bucket

Table 4 Maximum and minimum value for bucket analysis

	Stress von Misses (N/m ²)	Displacement URES (mm)	Strain ESTRN
Maximum	9.493e08	4.784e01	1.493e-03
Minimum	1.403e04	1.000e-30	4.693e-08

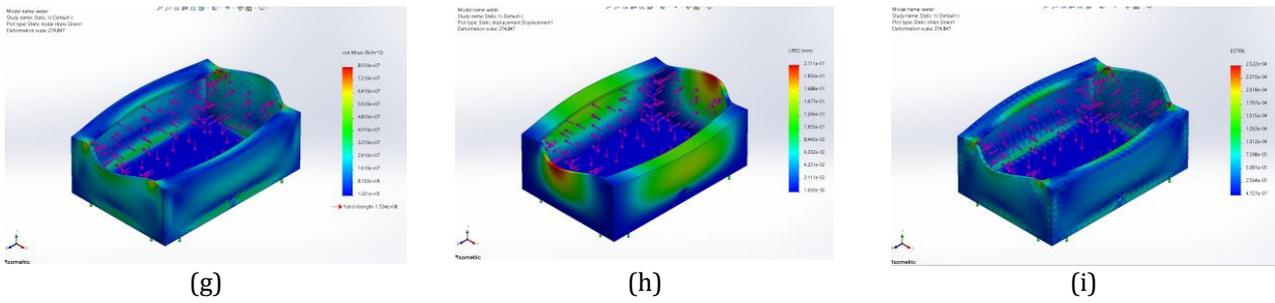


Fig. 11 Static analysis (g) Stress (h) Displacement (i) Strain for water container

Table 5 Maximum and minimum value for water container analysis

	Stress von Misses (N/m ²)	Displacement URES (mm)	Strain ESTRN
Maximum	8.010e07	2.111e-0	2.522e-04
Minimum	1.021e05	1.000e-30	4.727e07

3.4 Buckling analysis

In buckling analysis, the component that is undergo the simulation is the frame

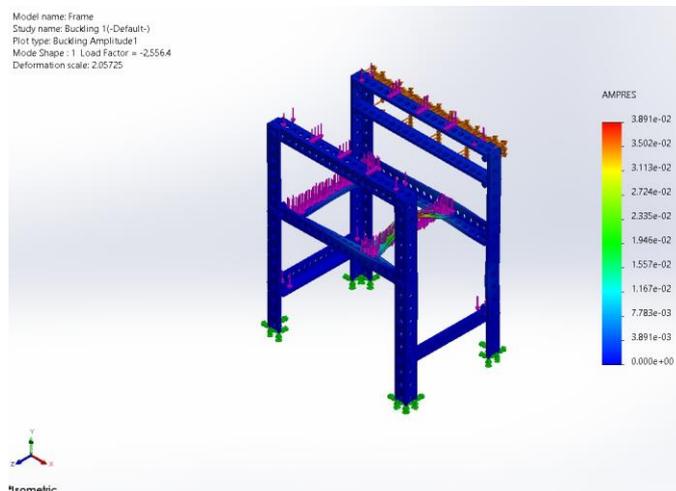


Fig. 12 Buckling analysis

Table 6 Buckling analysis for frame

	Buckling Amplitude AMPRES
Maximum	8.010e07
Minimum	1.021e05

4. Conclusion

This study completely addresses the three main objectives which are to design a golf ball cleaning machine based on conceptual design process and lastly, to fabricate the golf ball cleaning machine for proof-of-concept testing. By using the Solidwork Simulation, the engineering analyses have been effectively completed, leading to optimal performance and safety outcomes. With the user friendly machine, the golf ball cleaning machine will be in so much improves the facility in cleaning the ball. In summary, this project has delivered an effective and

practical solution to maximize cleaning efficiency towards the golf ball without consuming a lot of time and showcasing the effective utilization of engineering principles and design considerations.

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Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

Author Contribution

The author confirms sole responsibility for the following: study conception and design, data collection, analysis and interpretation of results, and manuscript preparation.

References

- [1] Riley, D., Schube, S., & Baron, Z. (14 July, 2022). *Why All Your Friends Started Playing Golf—and Why You Should, Too*. Retrieved from GQ Sports: <https://www.gq.com/story/golfs-new-no-rules-era>
- [2] Hamilton, B. (7 November, 2023). *What Is a Golf Driving Range and How It Improves Your Game?* Retrieved from Champ Golf: <https://champ.golf/what-is-a-golf-driving-range/>
- [3] Nwokoro, J. (n.d.). *How Many Acres Do You Need for a Driving Range?* Retrieved from Profitable Venture: <https://www.profitableventure.com/how-many-acres-driving-range/>
- [4] Rose, M. (31 January, 2023). *Golf Driving Range Design Regulations*. Retrieved from Sports Rec: <https://www.sportsrec.com/13732678/golf-driving-range-design-regulations-20448html>