

Prototype Design and Research Collection

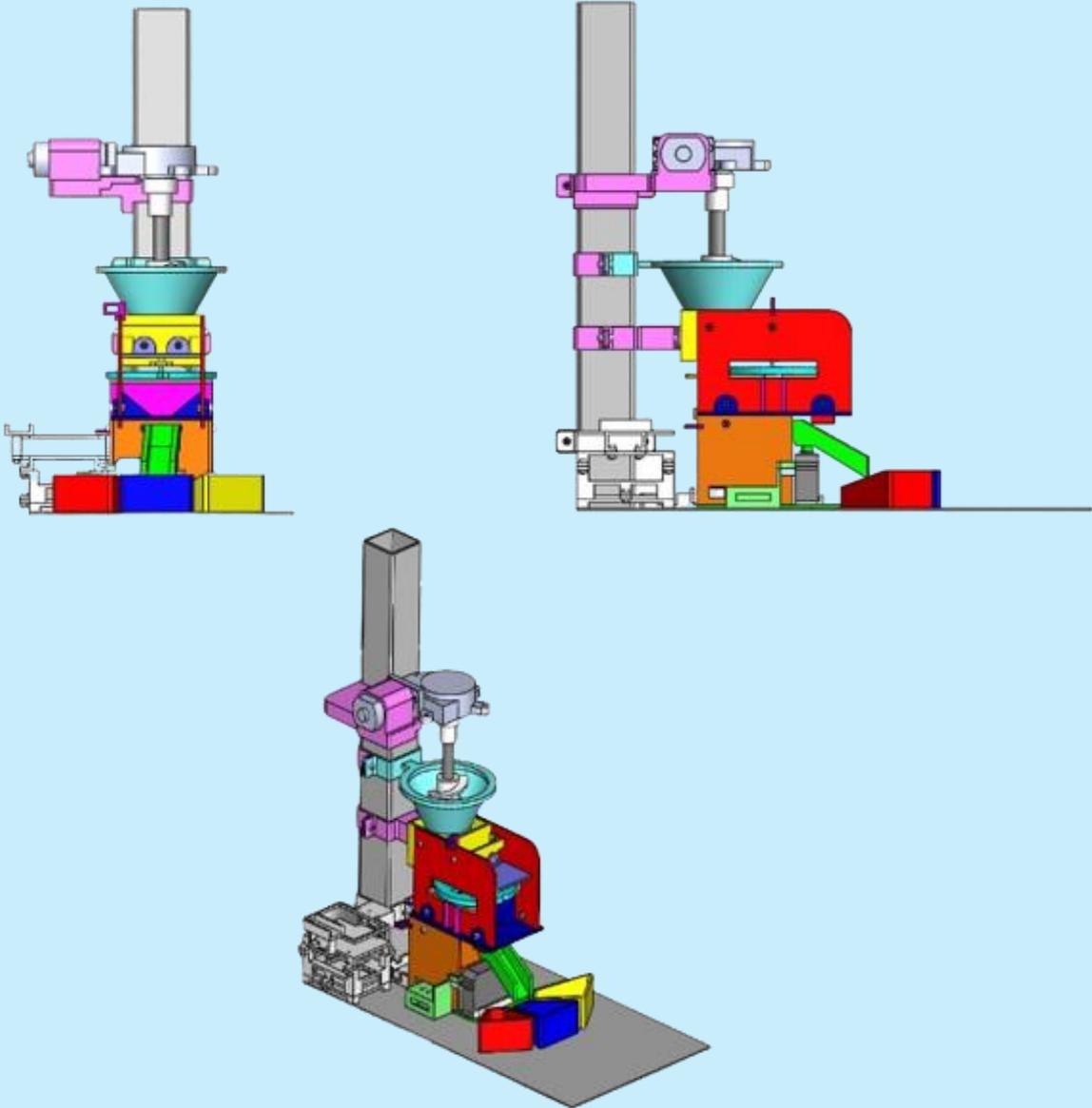
Series 1



Universiti Teknologi MARA
Pasar Gudang Campus

Prototype Design and Research Collection

Series 1



AHMAD NAJMIE RUSLI

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EDITOR:

Nurul Nadiyah Rasdi

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FOREWORD

This digital book on Prototype Design and Research Collection Series 1 (PDRC Series 1), is designed as a comprehensive reference for mechanical engineering students. The designs featured in this collection undergo an extensive analysis process, incorporating both prototype development and research to ensure a thorough understanding of design principles. Each project is carefully analysed before the prototype fabrication with detailed summaries of the project description and design parameters. The design and research products presented in this series cover a wide range of tools and equipment for various applications including household, workshop and entrepreneurial purposes.

This collection aims to foster innovation by offering students valuable insights into both the technical and research aspects of product design. It is hoped that this book will inspire future engineers and designers to approach product development with a deeper understanding of the design and research processes.

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CHAPTER 12

Design and Development of Mechanical Linkage Steering System for Go-Kart

Auni Azira Binti Abdul Razak¹ and Ab Aziz bin Mohd Yusof^{2*}

^{1,2}*Faculty of Mechanical Engineering, Universiti Teknologi MARA Johor Branch, Pasir Gudang Campus, Bandar Seri Alam, 81750 Masai, Johor Darul Ta'zim.*

**Corresponding author (e-mail): abaziz86@uitm.edu.my*

ABSTRACT

This project focuses on the design and development of a Go-Kart Direct Mechanical Linkage Steering System. Three initial design concepts were sketched, and the final design was modeled using SolidWorks software. After modifications, the system was fabricated over a 13-week period. The fabrication process included cutting, turning, grinding, welding, and assembly, ensuring the system's structural integrity and functionality. The fabricated steering system was tested at its maximum steering angle to evaluate performance, demonstrating reliability and precision in maneuvering the go-kart. The system offers simplicity, cost-effectiveness, and a direct mechanical connection, providing quick and responsive steering. However, it requires manual effort and regular maintenance. By analyzing the system's design, fabrication, and performance, this study contributes to optimizing mechanical linkage steering for go-karts, enhancing safety, durability, and efficiency. The findings provide insights into improving future steering systems for recreational and competitive applications.

Keywords: Design, Fabrication, Mechanical linkage system

1 INTRODUCTION

The evolution of go-kart steering systems has progressed significantly from their early designs, with mechanical linkage steering systems still in use today. Over time, advancements in design and technology have led to the development of more efficient and responsive steering mechanisms. Systems such as rack, pinion, and hydraulic steering have been introduced to enhance go-kart performance and control [1]. The steering system is crucial to the rider's safety and comfort. It ensures directional stability and controls the go-kart, even during sharp turns. The system achieves the angular motion of the front wheels through a series of linkages and steering gears, which convert the steering wheel's rotational movement into precise angular adjustments of the wheels. The rack and pinion system is widely preferred among various steering mechanisms due to its simplicity and efficiency. This system directly translates the steering wheel's rotation into linear motion, allowing for a smaller turning radius, which is essential for manoeuvrability and safety in specific driving conditions.

Key components of a go-kart steering system include the steering column, tie rods, steering knuckles, steering wheel, and the linkage mechanism, such as the rack and pinion. Each component contributes to the system's smooth operation by accurately transmitting the driver's input into precise wheel movements. This study explores go-kart steering systems' performance characteristics and applications by analyzing factors such as movement dynamics,

directional control, material selection, and the forces acting on the linkage. Additionally, it seeks to identify the most suitable components for an efficient steering system and evaluate the effectiveness of different steering mechanisms. The findings from this research will enhance the understanding and optimization of go-kart steering systems for improved performance and safety.

2 LITERATURE REVIEW

The go-kart mechanical linkage steering system is crucial in determining handling, performance, and overall driving experience. Different types of steering systems have been developed over the years, each offering unique advantages and limitations [2]. Understanding these systems is essential for optimizing steering responsiveness, precision, and ease of use [3]. This study explores the three main types of go-kart steering systems: direct steering, rack and pinion, and recirculating ball steering. The direct steering system, also known as the tie rod steering system, is the most straightforward mechanism, where the steering wheel is directly connected to the front wheels via tie rods. This system offers immediate response, making it highly effective for precise control. Its simple design, with fewer moving parts, ensures low maintenance and reduced repair costs. However, it requires more space for installation and is more prone to wear and tear, reducing durability over time. Despite these limitations, the direct steering system remains a cost-effective and widely used option in go-kart applications [4].

The rack and pinion steering system provides greater precision by translating the rotational motion of the steering wheel into linear motion. This system consists of a pinion gear that moves a rack gear, enabling smooth and responsive steering [5]. Compared to direct steering, rack and pinion systems offer better feedback and control, making them ideal for performance-focused go-karts. However, the added complexity of this system requires more maintenance, and its repair costs are higher. Despite these challenges, its compact design makes it suitable for go-karts with limited space.

The recirculating ball steering system is a more advanced mechanical linkage system commonly found in vehicles requiring high mechanical advantage. It uses a worm gear and sector gear mechanism to convert steering input into lateral wheel movement. The recirculating balls reduce friction and wear, ensuring smoother operation and increased durability. However, this system is mechanically complex, leading to higher maintenance and costs than the other two systems. While not as commonly used in go-karts, it remains a viable option for applications requiring greater steering force and longevity.

3 METHODOLOGY

Fabrication is a crucial aspect of this final-year project, ensuring the successful construction of the go-kart mechanical linkage steering system. It involves the process of manufacturing and assembling various components using multiple fabrication techniques as in Figure 1. The most common fabrication techniques are cutting and drilling, which shape raw materials into the necessary parts. The fabrication process differentiates itself from other manufacturing methods by combining multiple processes to create a functional and reliable system. Each step in this process is vital to achieving precision, durability, and overall performance.

The first stage involves measuring and cutting the required materials, primarily steel, to form the base components of the steering system. Steel bars are used as structural support,

requiring manual cutting for precise dimensions. Next, the turning process is performed on mild steel rods using a lathe machine to fabricate the steering column and shafts. This step ensures that each component has the required dimensions and functionality. The polishing and grinding phase smooths out the steel components, removing imperfections and ensuring a refined finish for better performance and aesthetics.



Fig. 1: Fabrication process of the steering

Once individual components are fabricated, the next step is spray painting to enhance durability and protect against corrosion. All parts are disassembled, sprayed, and left to dry thoroughly. After drying, the components are assembled, ensuring all parts fit together with the correct dimensions. This process is followed by welding, where mild steel rods are permanently joined at precise angles to provide structural support. Welding ensures a secure and stable connection between components, reinforcing the steering system for long-term use.

Finally, the testing phase is conducted to verify the functionality and reliability of the go-kart mechanical linkage steering system. This step ensures that all fabricated components work together seamlessly, allowing smooth steering and control. Any necessary adjustments are made to optimize performance before finalizing the project. Following this structured fabrication process, the steering system is developed to meet the required specifications, ensuring safety, efficiency, and durability in go-kart applications.

4 RESULTS AND DISCUSSION

Figure 2 shows the final fabricated prototype of the Go-Kart Mechanical Linkage Steering System that has been finished and manufactured. The Go-Kart Mechanical Linkage Steering System requires proper handling and maintenance to ensure safety and longevity. The first step involves checking and securing all bolts, nuts, and fasteners in the steering assembly to prevent any loose components that could lead to steering failure. The second step focuses on inspecting for wear or damage in key components such as tie rods, steering column bearings, and universal joints, ensuring that no critical part is compromised.

The third step is applying grease or lubricant to all moving components to reduce friction and minimize wear over time. Proper lubrication extends the lifespan of the steering system and enhances smooth operation. The fourth step involves manually turning the steering wheel

in the desired direction, ensuring the mechanical linkage responds accurately and smoothly to driver input. These operational steps will help maintain optimal steering performance and prevent accidents.



Fig. 2: Final prototype

The Go-Kart Mechanical Linkage Steering System offers various advantages and disadvantage. One of the primary benefits is its straightforward design, which makes it easy to maintain and repair. It is also cost-effective and more affordable than hydraulic or electronic steering systems. The direct mechanical connection ensures a quick and precise steering response, making it highly reliable. Additionally, the system's lightweight construction enhances the go-kart's overall efficiency.

However, there are notable disadvantages. The system requires more physical effort, especially at low speeds or tight corners. It also demands frequent maintenance to prevent excessive wear and tear. Another drawback is the lack of self-centring capabilities, meaning the driver must manually return the steering wheel to the centre position after turning. Lastly, while the system works well for standard go-karts, it is unsuitable for high-speed vehicles, requiring greater precision.

By understanding these advantages and disadvantages, users can make informed decisions about the suitability of the mechanical linkage steering system and take the necessary steps to ensure its proper function and durability.

5 CONCLUSIONS

A Go-Kart Direct Mechanical Linkage Steering System was designed and developed in this project. Three initial design concepts were sketched, and the final design was created using SolidWorks software. The system was fabricated after incorporating the necessary modifications, which took approximately 13 weeks to complete. The fabricated steering system demonstrated reliability and efficiency in manoeuvring the go-kart. It was tested at its maximum steering angle and performed well, ensuring smooth and precise control during turns.

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