

Design Development & Fabrication of Self Powered Operating Gate System by Application of Mechanized Four Bar Linkages

Dr. P. S. Chaudhari¹, Dr. V. M. Sonde² Harsh Borkar³, Ayush Bansod⁴, Prapti Bhaltadak⁵, Karan Bharatkar⁶

¹²Assistant Professor, Mechanical Engineering Department, Priyadarshini College of Engineering, Hingna, Nagpur, Maharashtra, India

³⁴⁵⁶Student, Mechanical Engineering Department, Priyadarshini College of Engineering, Hingna, Nagpur, Maharashtra, India

Abstract

The Automatic Gate Opening System project deals with limits and hassles of manual gate functioning in residential and commercial settings. This project utilizes modern technologies, including four bar link based automation and self-operated mechanisms to streamline property entry and exit. by enabling remote and hands-free gate operation, the advancement increases user efficiency and convenience. Load deflect the linkages and regulate gate movement for safety. The project conducts substantial research, including literature reviews, technology evaluations to guide system design and functioning. Regulatory compliance, user needs analysis, and benchmarking help create a system that fulfills industry standards and fits with user expectations. The focus is on energy efficiency, security integration, and user experience, including renewable power sources, encryption for remote control functions, and optimum human-computer interface. The project's methodology involves iterative testing, risk analysis, and community discussions to improve the system's architecture and ensure dependability.

1. INTRODUCTION

The need for innovative and energy-efficient systems has become increasingly essential in modern engineering applications, especially in areas like automation and control systems. One such innovation is the self-powered operating gate system, which aims to eliminate the dependency on external power sources while ensuring smooth and reliable operation. This paper explores the design and development of a self-powered operating gate system utilizing mechanized four-bar linkages. By leveraging the mechanical advantage provided by the four-bar linkage mechanism, this system can generate sufficient energy to operate the

gate, offering a sustainable and cost-effective solution for various applications, including residential, industrial, and security settings.

The four-bar linkage mechanism, renowned for its ability to convert input motion into desired output motion, plays a central role in ensuring the gate's efficient operation. By integrating energy-harvesting techniques and optimizing the linkage design, the proposed system can operate autonomously, reducing maintenance and operational costs associated with traditional powered gate systems. This introduction presents the foundational concepts of the self-powered gate system, discusses the role of four-bar linkages, and sets the stage for a detailed examination of the system's design, performance, and potential applications in the real world scenario.

2. LITERATURE REVIEW

Zorana Jeli, Dumitru et al. "Analysis of a Four-Bar Linkage Mechanism in Its Classical and Compliant Form".(Eds.): ICOME 2022, AHE 15, pp. 80–95, 2023. They designed the mechanisms do not have joints in a classical sense but the relative movement between linkages is accomplished through the deformation. In order to obtain relatively localised large deformation, some parts of the mechanism are thinned.

L.Roy, A. Sen, R. P. Chetia and M. J. Borah, "Examination and Combination of Four Bar Mechanism", International Journal of Theoretical and Applied Mechanics, ISSN 0973-6085, Volume 3, Number 2, 2008, pages 171–186, The working models use the intended path and obtained position, velocity, acceleration, and force at the coupler point at different input angles. A plot showing how the coupler point's acceleration, velocity, and link angles vary with crank

angle is produced. It is discovered that the coupler point experiences its highest acceleration when the ratio of crank to coupler point velocity ranges between 4.48 and 0.38.

Lairong Yin et al. "In 2019, Copernicus Publications published Synthesis Theory and Optimal Design of Four-bar Linkage with Given Angle Parameters, Mech. Sci. 10, 545–552. A synthesis approach for the 5-point-contact four-bar linkage that approximates a straight line with specified angle values is presented in this study. The ball point's location and angles were the specifications that were provided. Three groups of bar connections were obtained by deriving synthesis equations for three different scenarios: the Ball–Burmester point at an inflection pole, the Ball point that corresponded with two Burmester points, and a general Ball–Burmester point situation.

Onyinye Florence, "Design and Construction of an Automatic Gate", ABUAD Journal of Engineering Research and Development (AJERD) Volume 2, Issue 2, 123-131, One of the best tools for businesses, industries, universities, and schools is an automatic gate. In addition to designing, building, and mounting the gate, the control unit and power supply unit were also created and put into use. These various units were incorporated and implemented. The automatic gate was tested for speed and efficiency and from the generated results, it can be said that the gate is 90% efficient.

3. MATERIAL REQUIRED

1. Mild Steel Rod & Pipes
2. Vacuum Cylinder
3. Mild Steel Frame
4. Bearings
5. Rollers
6. Pute Mechanism

4. PROBLEM IDENTIFICATION

These days, several features have been added to and improved upon in automatic gate mechanisms. The cost of the device has gone up due to these features, and the installation fee is not included in this price. Many people couldn't afford to buy the gate mechanism, especially those with low incomes. Installing the gate mechanism requires a highly skilled or trained individual. A lot of labour is required to lay the track, and certain gate devices additionally require rails to be affixed to the ground. This seems inconvenient. The creation of

automatic gate mechanisms should contribute to lower costs and simpler installation.

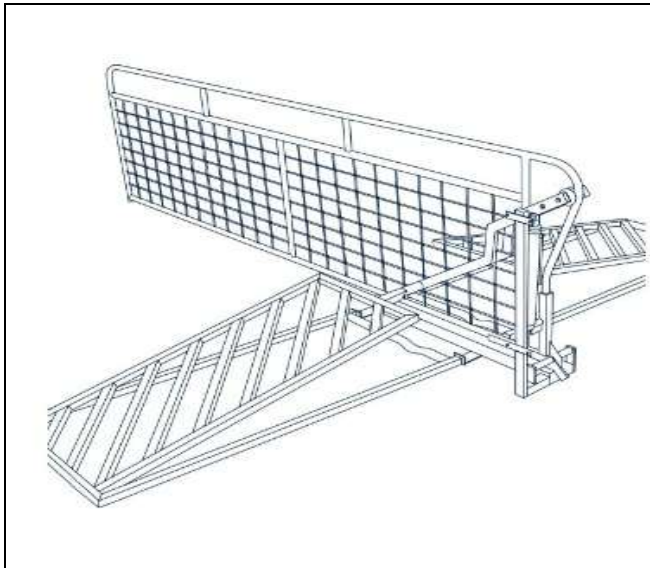
5. METHODOLOGY

This chapter will provide the detail explanation on the methodology that carries out for this project "Design of automatic gate mechanism" from the beginning till the end. Methodology 7 can properly refer to the theoretical analysis of the methods appropriate to a field of study or to the body of methods and principles particular to a branch of knowledge. The methodology act as the guidance or step that needs to be follow and this will ensure the project done according to the planning. Methodology as an algorithm that finds a solution in the given environment of the multi-layered finite space consisting of literature review, Identifying the suitable mechanism and design, creating a design model, identifying various components, and compiling a part list, Fabricating the mechanism, test run and documentation.

In the beginning of this project is receiving idea about the working principle. In order to have better understanding about this project several research on internet and market available product was perform. Environmental factors, location, ground water, elevation, flooding, reliability, maintenance, and cost are all taken into account while designing an automatic gate system. Determine the fundamental needs or particular features of the automated gate mechanism that the client can use with this design.

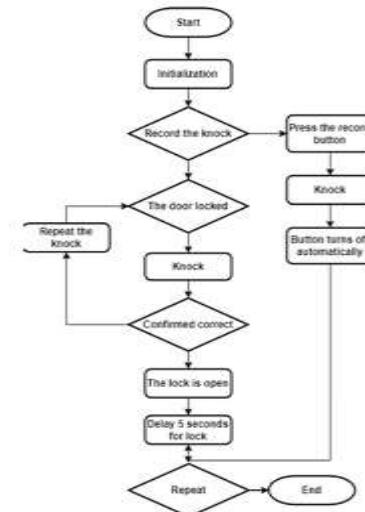
Define the function of device through explore and understanding the working principles of automatic gate mechanism. The automatic gate could work under static and dynamic condition and required different operating condition. State the design requirement that possible for this automatic gate mechanism system. The fundamental criterion should be dependable and able to meet the needs of the consumer. Propose several alternative design concepts, also called the invention of the concepts or concept design. Various schemes must be proposed in order come out with several option design selection.

Evaluate each proposed alternative design. Analysis performs to assess whether the system performance is satisfactory or better, and, if satisfactory, just how well it will perform. Evaluate and contrast the benefits and drawbacks. System scheme that do not survive analysis are revised or discarded, those with potential to optimize



and determine the best performance of which the scheme is capable. Competing schemes are compared so that the path leading the most competitive product can be chosen.

Complete the design with full dimension and specification so can proceed to the next step for fabrication. The documentation is the final stage by preparing a full report where consist of introduction, literature review, methodology, result and discussion and conclusion.



6. WORKING PROCEDURE

The working procedure of the self-powered operating gate system involves utilizing a mechanized four-bar linkage mechanism to convert mechanical input into gate movement. The system is designed to operate autonomously by harvesting energy from the gate's motion, eliminating the need for external power sources. The four-bar linkage ensures smooth and efficient operation, while components like mild steel rods, vacuum cylinders, bearings, and rollers are integrated to facilitate motion and stability. The gate's movement is regulated for safety, and the system is tested iteratively to optimize performance, ensuring reliability and cost-effectiveness for residential, commercial, and industrial applications.










7. CONCLUSION

The self-powered operating gate system utilizing mechanized four-bar linkages presents a significant advancement in gate automation. By integrating mechanical energy conversion and efficient linkage design, the system offers an environmentally friendly, cost-effective, and maintenance-reduced alternative to traditional gate operation methods that rely on external power sources. The use of a four-bar linkage mechanism ensures smooth, reliable motion while optimizing the mechanical efficiency and minimizing energy loss. Furthermore, this approach has potential applications in a variety of sectors, including agriculture, water management, and industrial settings. Future studies and refinements in material science and linkage configurations may enhance the system's capabilities, allowing for broader implementation and improved performance. This innovation contributes to the growing trend of sustainable engineering solutions, promoting both technological progress and environmental stewardship.

8. REFERENCES

1. Sliding Gate Opener System with Smartphone Control Using Bluetooth Connection" authored by A.Budhi, and A.Hamzah, published in the International Journal of Electrical, Energy and Power System Engineering, Volume 6, Issue 1, in 2023, on pages 120-125.
2. Hasibuan, Arnawan, Rosdiana and D.S.Tambunan. "An Arduino Uno-Based Internet of Things-Based Automatic Door Gate's Design and Development." Bulletin of Computer Science and Electrical Engineering 2.1 (2021): 17-27. Vol. 2, No. 1, June 2021, pp. ISSN: 2722-7324
3. Ahire, Dhiraj R., Aavesh R. Attar, Kunal P. Katore, Chaitanya N. Hake, and Dr. S. P. Mogal. "Automatic Opening and Closing of Institute Main Gate."
4. International Research Journal of Engineering and Technology (IRJET) 7.6 (2020): 1239-1243. Volume: 07 Issue: 06 | June 2020.
5. Bola-Matanmi Samiat, Emmanuel Chidiebere Uwaezuoke, Onyinye Florence, Ikpeze, Kola Michael Kareem, et al. "Design and Construction of an Automatic Gate." ABUAD J. Eng. Res. Dev 2.2 (2019): 123-131. ISSN: 2645- 2685, Volume 2, Issue 2, 123-131.
6. Balamurugan, C.R., Vijayshankarganth, P., Alagarraja, R., Subramanian, V. E., Ragupathy, R. "Automatic Railway Gate Control System Using 8051 Microcontroller." Int. J. ChemTech Res, 11, 63-70. ISSN: 0974-4290, Vol.11 No.04, pp 63-70, 2018.
7. Jackson, J. (2017). An Overview of Various Gate Motor Types. [Online] This article provides information on the many kinds of gate motors. 7f939a691d67. (5)
8. S. Vogel: Mechanical Worlds of Nature and Humans: Cats' Paws and Catapults, WW Norton & Company, New York (2000).
9. Howell L.L.: Compliant Mechanisms. John Wiley & Sons, Newyork (2001)
10. Zhu B., Zhang X.: Optimising the Topology of Compliant Mechanisms. Springer, Springer Nature, Singapore (2018). Circuits
11. Kota, S., Joo, J., Li, Z. et al. Design of Compliant Mechanisms: Applications to MEMS. <https://doi.org/10.1023/Sigal A:1011265810471> Processing 29, 7–15 (2001) Analogue Integrated.
12. Ananthasuresh, G. K., Kota S., Kikuchi N. Methods for synthesising compliant MEMS in a methodical manner. Proceedings of the Winter Annual Meeting of ASME, 1994. 1994; Chicago, IL.

9. BIOGRAPHIS

Name:	Dr. P. S. Chaudhari	
Designation:	Assistant Professor	
Email Id:	pschaudharipatil@gmail.com	
Mobile No:	9763099947	
Permanent Address:		
Name:	Dr. V. M. Sonde	
Designation:	Assistant Professor	
Email Id	mailtovivek@gmail.com	
Mobile No	9850495974	
Permanent Address:	Plot No.22 Gajanan Dham Near Sahakar Nagar Khamla road Nagpur (MH) 440025	
PROJECTEES DETAIL		
Name:	Harsh D. Borkar	
Email Id:	harshborkar441@gamil.com	
Mobile No:	8975798938	
Permanent Address:	At + Post: Ratnara Th + Dist: Gondia (MH) 441614	
Name:	Ayush G. Bansod	
Email Id:	ayushgaribdasbansod@gamil.com	
Mobile No:	9130746389	
Permanent Address:	Ward No.1 At Mendha Post Palasgaon Th Sidewahi Dist Chandrapur (MH) 441222	
Name:	Prapti R. Bhaltadak	
Email Id:	praptibhaltadak7@gamil.com	
Mobile No:	9022117320	
Permanent Adress:	Plot No.30 Kadu Layout Nari Road Nagpur (MH) 440026	
Name:	Karan Bharatkar	
Email Id:	karanbharatkar5558@gamil.com	
Mobile No:	9373349519	
Permanent Address	Samta Nagar Bondre Layout Jaripatka Nagpur (MH) 440026	