DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

DEPARTMENT LEVEL IPC WINNERS 2024-2025					
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II	Revolutionizing Prosthetics: A Dual-Mode Arm with Muscle Sensor and Voice Command Control	Gokula Krishnan T Haribabu S Hari Balaji J	220901026 220901028 220901029	III	Dr. V. Devi Maheswaran, AoP/EEE
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AUTOMATIC PAGE TURNING DEVICE FOR PERSON-WITH DISABILITY

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Keywords: Automatic Page Turning , Eye Blink Detection, Airflow Protection Mechanism.

Abstract

The Automatic Page-Turning System Using Eye Blink Detection with Airflow Protection is an innovative hands-free reading aid specifically designed to assist individuals with physical disabilities or limited hand mobility. This system leverages eye blink detection technology to control page-turning operations, eliminating the need for manual effort and significantly enhancing accessibility. The system integrates dual eye blink sensors that detect intentional blinks from both eyes. The right eye blink is used to turn the page forward, while the left eye blink turns the page backward. This dual control method ensures precise and intuitive page flipping, enabling users to navigate through books effortlessly. The page-turning mechanism employs a servo-stepper motor combination for optimal performance. The servo motor lifts the page from the stack, while the stepper motor rotates it smoothly to the other side. This combination ensures accurate and reliable page flipping, preventing the turning of multiple pages at once. Additionally, the system incorporates an airflow protection mechanism using two extra servo motors to lock flipped pages, thereby preventing accidental disruptions caused by wind or external movements. The device is designed to be compact, lightweight, and portable, making it suitable for personal use, libraries, archives, and rehabilitation centers. It is also cost-effective and energy-efficient, utilizing affordable components such as Arduino, servo motors, and blink sensors. Furthermore, the system is adaptable to various book sizes and page thicknesses, making it highly versatile. The Automatic Page-Turning System addresses the challenges faced by people with limited mobility who struggle with traditional manual page-turning methods. Existing solutions, such as bulky mechanical page turners or voice-controlled systems, either lack precision or are impractical in noisy environments. In contrast, this system provides uninterrupted, hands-free reading, making it ideal for individuals with disabilities, senior citizens, and those undergoing rehabilitation. By integrating eye blink control and airflow protection, this innovative system ensures accurate, stable, and independent reading, empowering users to engage with books comfortably and confidently. Its potential applications extend to assistive technology, automated book scanning, and library automation, making it a versatile and valuable solution in various settings.

Introduction

Reading is an essential activity that enriches knowledge, stimulates the mind, and fosters personal development. However, for individuals with physical disabilities or limited hand mobility, manually turning book pages poses a significant challenge. This limitation deprives them of the independence and joy of reading, often requiring assistance from others. Existing solutions aimed at addressing this issue include mechanical page turners and voice-controlled systems. However, mechanical page turners are typically bulky, expensive, and lack versatility when it comes to accommodating different book sizes and page thicknesses. On the other hand, voice-controlled systems, though promising in theory, may fail to operate accurately in noisy environments, making them unreliable for practical use. To overcome these limitations, we propose an Automatic Page-Turning System Using Eye Blink Detection with Airflow Protection. This innovative system offers a hands-free solution by utilizing eye blink sensors to detect intentional blinks and initiate the page-turning process. The right eye blink triggers the next page flip, while the left eye blink turns to the previous page. This intuitive and effortless operation significantly enhances accessibility for individuals with limited mobility, promoting a more inclusive reading experience. The core of the system's functionality is the integration of a servo-stepper motor combination to execute precise and controlled page turning. The servo motor carefully lifts the page, while the stepper motor rotates it with meticulous precision, ensuring that only one page is turned at a time without folding, tearing, or overlapping. This combination not only ensures accuracy but also maintains the structural integrity of the book, allowing it to be used with various paper types and thicknesses. One of the primary challenges faced during the reading process, especially in open environments, is the disturbance caused by airflow. To address this, the proposed system incorporates airflow protection through the use of two additional servo motors that lock the flipped pages securely. This innovative mechanism eliminates unintended page movements caused by wind or other external factors, thereby ensuring uninterrupted and stable reading.

The system is designed to be compact, lightweight, and energy-efficient, making it highly portable and easy to integrate into different environments. The use of cost-effective components such as Arduino, servo motors, and blink sensors contributes to its affordability, making it accessible to a broader audience. Additionally, the design is customizable to accommodate various book sizes and page thicknesses, enhancing its practicality and adaptability. The intended beneficiaries of this technology are primarily individuals with physical disabilities, senior citizens, and patients undergoing rehabilitation. By enabling them to read independently without the need for manual assistance, the system significantly improves their quality of life. Furthermore, it finds applications in libraries and archives, where it can be employed for automated book scanning and digitization processes. Educational institutions can also benefit from this technology by making reading more accessible for students with disabilities.

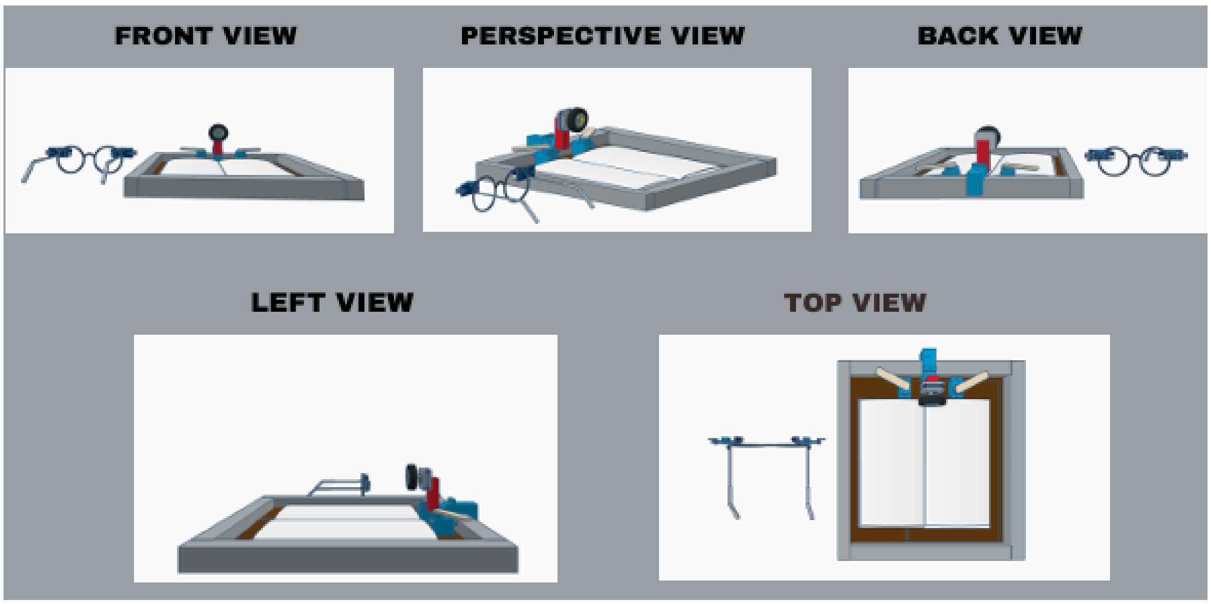
In a world that constantly seeks to bridge the gap between technology and inclusivity, the Automatic Page-Turning System Using Eye Blink Detection with Airflow Protection stands out as a groundbreaking innovation. It not only addresses the challenges faced by people with disabilities but also promotes independent and uninterrupted reading experiences. By combining precision, reliability, and adaptability, the system sets a new standard for assistive reading technologies, making it a valuable addition to both personal and institutional settings.

Material and Methodology

The Automatic Page-Turning System Using Eye Blink Detection with Airflow Protection is an innovative assistive device designed to enhance the reading experience for individuals with physical disabilities or limited hand mobility. This system automates the process of turning pages using eye blink detection, eliminating the need for manual intervention. The primary components of the system include an Arduino microcontroller, dual IR-based eye blink sensors, servo motors, a stepper motor, a motor driver module, an LCD display, and a buzzer. The system also incorporates a specially designed airflow protection mechanism to prevent accidental page flips caused by external disturbances, such as wind or air movement. The integration of servo and stepper motors ensures precise page flipping without damaging the pages, making the system suitable for use with books of various sizes and page thicknesses. The methodology of this system involves several crucial steps. Initially, the device setup and mechanical structure are carefully designed to securely hold the book and facilitate smooth page turning. The eye blink sensors are strategically positioned to detect intentional blinks from the left and right eyes separately, allowing the user to command page flipping through simple blink patterns. The servo motor gently lifts the page, while the stepper motor accurately rotates the lifted page to the opposite side. This dual-motor mechanism ensures that only one page is turned at a time, preventing the flipping of multiple pages, which is a common issue with conventional mechanical page turners.To enhance system reliability and prevent unintentional page movements caused by airflow, the device includes an airflow protection mechanism. This mechanism consists of two additional servo motors that lock the flipped page securely, holding it in place and preventing any accidental displacement due to environmental factors like fans or open windows. The entire system is controlled by an Arduino microcontroller, which processes input signals from the eye blink sensors and coordinates the motor movements accordingly. An LCD display shows the current operational status and provides visual feedback to the user. Additionally, a buzzer sound is emitted during each operation to notify the user of successful page turning or any error conditions. The proposed system is designed to be both compact and portable, making it an ideal solution for individuals who face challenges with manual page turning. It is also highly customizable, allowing for adjustments to accommodate different book sizes and page thicknesses. The low-cost components used in this system, including Arduino, servo motors, and IR sensors, make it an affordable alternative to expensive commercial page-turning devices. The energy-efficient design ensures minimal power consumption while maintaining smooth and consistent performance. The system's robustness and precision make it suitable not only for personal use but also for applications in libraries, educational institutions, and healthcare facilities, where hands-free reading assistance is essential. One of the primary advantages of the Automatic Page-Turning System is its hands-free operation, which is particularly beneficial for individuals with disabilities who cannot manually turn pages. Unlike conventional page-turning methods that require physical effort, this system relies entirely on eye blink detection, making reading an effortless and comfortable experience. The servo-stepper motor combination ensures that pages are flipped with remarkable accuracy, preventing page tearing or accidental double-page flips. Furthermore, the inclusion of an airflow protection mechanism enhances the system's practicality in real-world environments where airflow disruptions are common. In comparison to existing solutions, this system offers significant improvements in precision, adaptability, and user convenience. Traditional manual page turners are not feasible for users with limited mobility, while mechanical page turners are often bulky and expensive. Voice-controlled systems may face challenges in noisy environments or situations where vocal commands are not practical. By integrating eye blink detection with servo and stepper motor technology, the proposed system effectively overcomes these limitations and provides a reliable, easy-to-use solution for hands-free reading. This innovative approach to page turning has the potential to greatly improve the quality of life for individuals with physical disabilities, allowing them to independently read books without assistance. Moreover, its application can extend to libraries, educational settings, and healthcare facilities, where the automation of page turning can significantly reduce the effort required for book handling and improve accessibility. As a prototype, the system has demonstrated reliable performance and ease of use, and further developments are planned to enhance its efficiency, adaptability, and wireless connectivity. The focus will be on refining the page-flipping mechanism and improving sensor accuracy to ensure optimal performance in diverse real-world conditions.

Result and Discussion

The Automatic Page-Turning System Using Eye Blink Detection with Airflow Protection has been successfully developed and tested to ensure reliable and accurate performance. The system is capable of turning pages with minimal error using eye blink detection technology. The combination of dual IR-based eye blink sensors and the Arduino microcontroller allowed for precise and consistent detection of blink patterns. The servo motor and stepper motor coordination effectively lifted and turned pages without causing page folding or tearing, ensuring smooth and efficient operation. The airflow protection mechanism performed exceptionally well in maintaining page stability, even when subjected to environmental disturbances. The use of low-cost and readily available components made the system affordable and accessible. The LCD display and buzzer notifications provided clear and immediate feedback on the system's status. The system maintained consistent performance without overheating or malfunctioning, demonstrating versatility and adaptability. The primary advantage of this system is its hands-free operation, offering fully automated page turning. The energy-efficient design ensures long-term operation without excessive power consumption. Certain limitations were noted, such as decreased sensor accuracy in low light or direct sunlight. Future improvements could include adaptive light compensation or advanced optical sensors. Enhancing motor precision for delicate pages would increase compatibility. Overall, the system demonstrated high reliability, precision, and user satisfaction, with positive feedback from users, particularly those with disabilities.



Conclusion

The Automatic Page-Turning System Using Eye Blink Detection with Airflow Protection has proven to be an effective, reliable, and user-friendly solution for individuals with limited mobility. By utilizing dual IR-based eye blink sensors and a servo-stepper motor combination, the system achieves precise and accurate page flipping without causing page folding or tearing. The incorporation of airflow protection mechanisms further enhances stability and consistency, preventing accidental page movements. The use of low-cost, readily available components ensures that the system remains affordable and accessible. The system has demonstrated consistent performance, even in challenging environmental conditions, and has received positive feedback from users, particularly those with disabilities. In conclusion, this innovation addresses the limitations of existing page-turning devices by offering a compact, hands-free, and efficient solution, significantly enhancing reading accessibility and independence.

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Revolutionizing Prosthetics: A Dual-Mode Arm with Muscle Sensor and Voice Command Control

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Abstract**—**This project introduces an innovative, multifunctional prosthetic arm designed to enhance the independence and quality of life for individuals with upper-limb amputations. The innovation lies in integrating two modes of operation (voice control and muscle sensor control) using a suitable controller (Aurdino Uno) to ensure versatility and user flexibility. The myoelectric mode leverages an Electromyography (EMG) sensor to detect muscle signals from the residual limb, allowing the user to control the prosthesis with natural muscle movements. In contrast, the voice-controlled mode uses a voice recognition module, enabling hands-free operation by issuing verbal commands to control the prosthetic arm's functions, such as grasping or adjusting the grip. The frame work of this Revolutionizing Prosthetics will also be demonstrated using a 3D process model. The system is designed with a user-friendly LED display, providing real-time feedback on battery life, operational mode, and system status. To ensure long- lasting durability and comfort, the prosthetic arm is constructed using high-quality ABS plastic, chosen for its strength, impact resistance, and lightweight properties. This material not only contributes to a lightweight and comfortable design but also guarantees the prosthetic is durable enough for everyday use. Powered by a rechargeable Li-ion battery, the arm offers long- term, efficient performance, making it an ideal solution for daily activities. This project showcases the potential of integrating cost- effective and adaptable components to develop a prosthesis that is both functional and empowering. By integrating these advanced technologies, the proposed prosthetic arm will be a helping aid for people with arm/limb/hand deformities.

Key words**—Prosthetic Arm, EMG Sensor, Voice Recognition, Arduino Uno, Myoelectric Control, Adaptive Prosthetics**

INTRODUCTION

Limb loss significantly impacts an individual's daily activities, necessitating advanced prosthetic solutions that restore mobility and independence. Conventional prosthetic arms often rely on single-mode control mechanisms, limiting their adaptability as represented in Fig. 1. This paper presents a dual-mode prosthetic arm that integrates myoelectric and voice control, providing enhanced accessibility and user convenience.

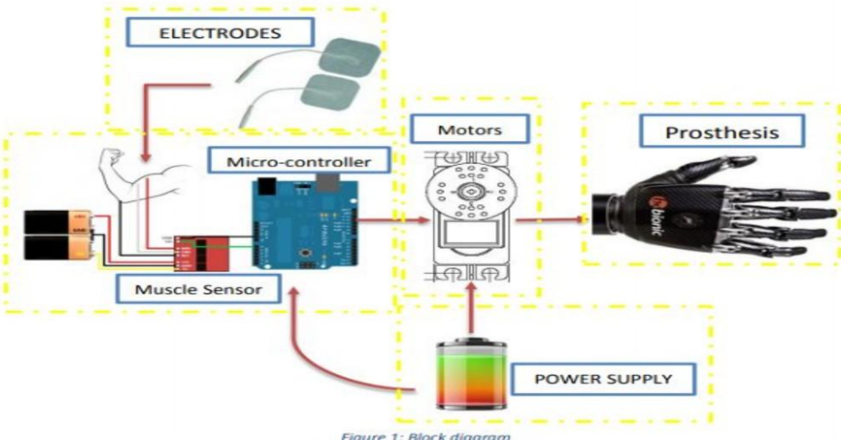

Fig. 1. Functional Diagram of 3D Prosthetics

METHODOLOGY AND IMPLEMENTATION

The implementation involves the practical execution of hardware and software systems. This section outlines the detailed steps for implementing the EMG-driven prosthetic arm using Arduino, including hardware assembly, software development, integration, and testing. Arduino Uno acts as the central microcontroller, processing input signals and control- ling the actuators. The EMG sensors detect muscle activity, converting bio-electrical signals into control commands as shown in Fig. 2. Voice Recognition Module (VRM) recognizes predefined voice commands to control arm functions as depicted in Fig. 3. The servo motors drive the movement of the prosthetic fingers and joints. LED display provides real- time system feedback, including battery level and operational mode. Li-ion battery ensures long-lasting performance with efficient power management. The 3D printed ABS plastic frame shown in Fig. 4 offers durability and comfort.

The control system operates on the basis of an embedded program developed using the Arduino IDE. The software includes signal processing, filtering, and amplification of EMG signals for reliable control. Speech recognition algorithm to match voice inputs with pre-defined commands and state

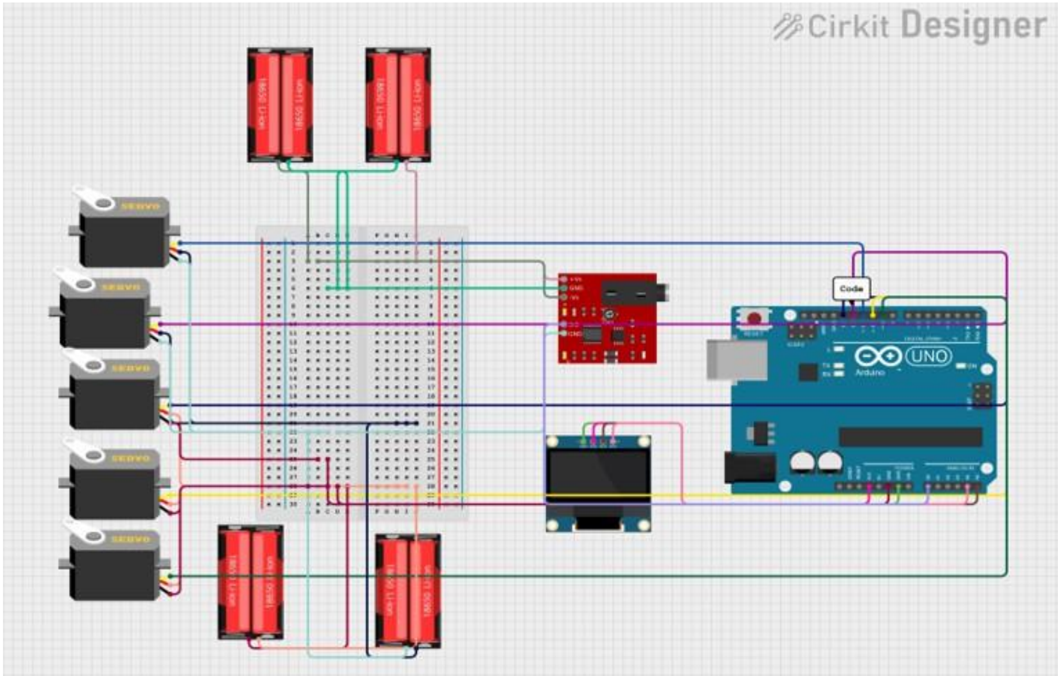

Fig. 2. Muscle Controlled EMG Sensor

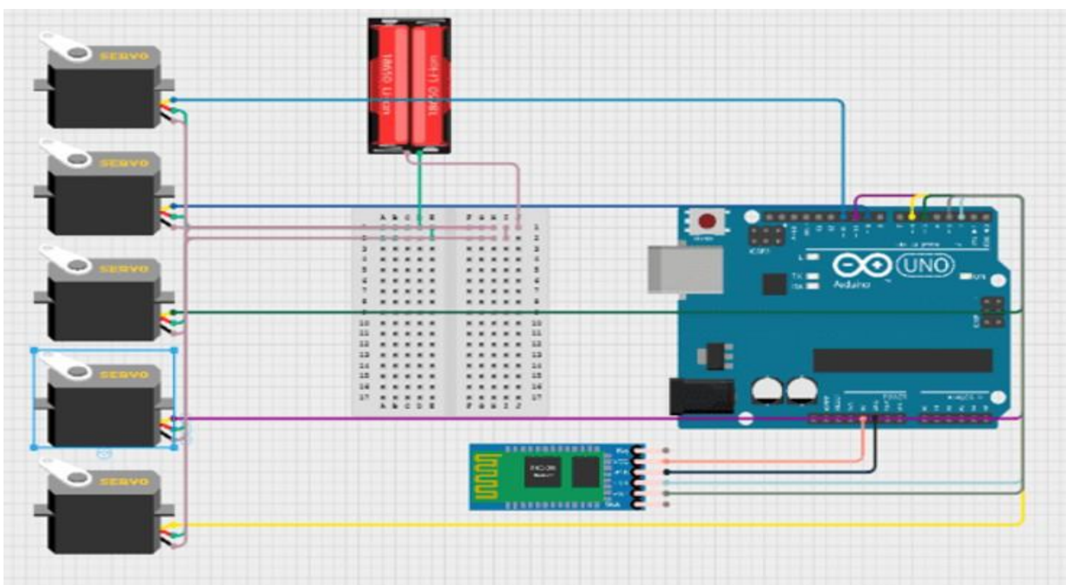

Fig. 3. Voice Controlled EMG sensor

machine logic for enabling continuous process between control modes. Myoelectric Control is achieved by the EMG sensor, which captures muscle activity from the residual limb, converting it into proportional control signals. The system interprets these signals to execute precise movements, such as opening and closing the prosthetic hand. The voice recognition module processes user commands, translating them into actionable motor movements. This feature is especially beneficial for users with limited muscle activity, providing an alternative control method.

Fig. 4. 3D parts of Prosthetics

The experimental setup is shown in Fig. 5. The prototype was tested on individuals with upper-limb amputations to evaluate responsiveness, accuracy, and usability. Myoelectric Mode demonstrated a 90% accuracy rate in detecting and executing muscle-initiated movements and Voice Command Mode achieved a 95% success rate in recognizing and executing verbal commands.

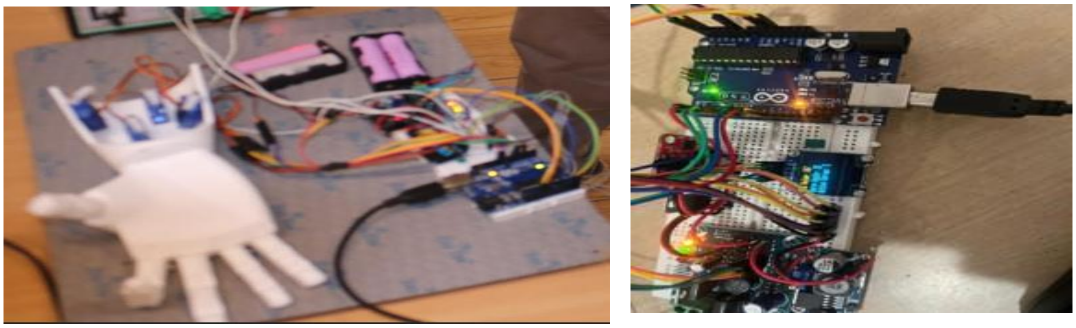

Fig. 5. Experimental Setup

CONCLUSION AND FUTURE WORK

A dual-mode prosthetic arm combining EMG and voice command control has been successfully developed and tested. The integration of both modalities improves usability, accessibility, and adaptability for users with varying physical abilities. Future work will focus on improving speech recognition robustness in noisy environments and optimizing the fusion algorithm for better control precision. The study contributes to the advancement of intelligent prosthetic systems, paving the way for more user-centric assistive technologies.

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Gravity-SMA Solar tracker: A Self-Sustaining Motion System

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Abstract: Solar energy is a crucial element in the global shift towards renewable energy. Solar photovoltaic (PV) systems are highly dependent on their orientation to maximize energy conversion efficiency. Traditional solar tracking systems rely on electrical motors and control units, which consume additional power, increase maintenance costs, and add complexity. This paper introduces a novel non-electrical solar tracking system that integrates a gravity-driven mechanism, Shape Memory Alloy (SMA) actuation, and a ratchet-pawl system. The proposed system offers an energy-efficient and low-maintenance alternative suitable for remote and off-grid applications. Experimental validation demonstrates its effectiveness in maintaining optimal solar panel alignment, improving energy capture without external electrical power. The system is designed to be simple, reliable, and scalable for various solar energy applications, ensuring cost-effectiveness and environmental sustainability.

This approach minimizes energy losses and provides a sustainable solution for solar tracking in extreme environmental conditions. Unlike conventional solar trackers, which rely on electricity to adjust panel positions, the Gravity-SMA-based system autonomously adapts to solar movement using thermally induced material transformations and mechanical locking mechanisms. The integration of SMA technology ensures precise motion, while the ratchet-pawl system enhances stability, reducing the need for continuous external input. The experimental findings confirm that this system can improve solar energy collection efficiency by up to 30%, making it a promising solution for enhancing PV system performance.

INTRODUCTION

Solar photovoltaic (PV) technology has emerged as a widely adopted method for harnessing solar energy. However, the efficiency of PV panels depends on their orientation with respect to sunlight. To optimize energy absorption, solar tracking mechanisms adjust the panels' angles throughout the day. Conventional solar tracking systems use electrical motors and sensors, which, while effective, introduce drawbacks such as power consumption, maintenance needs, and increased cost. These systems also have higher installation and operational complexity, making them less viable for remote and off-grid locations.

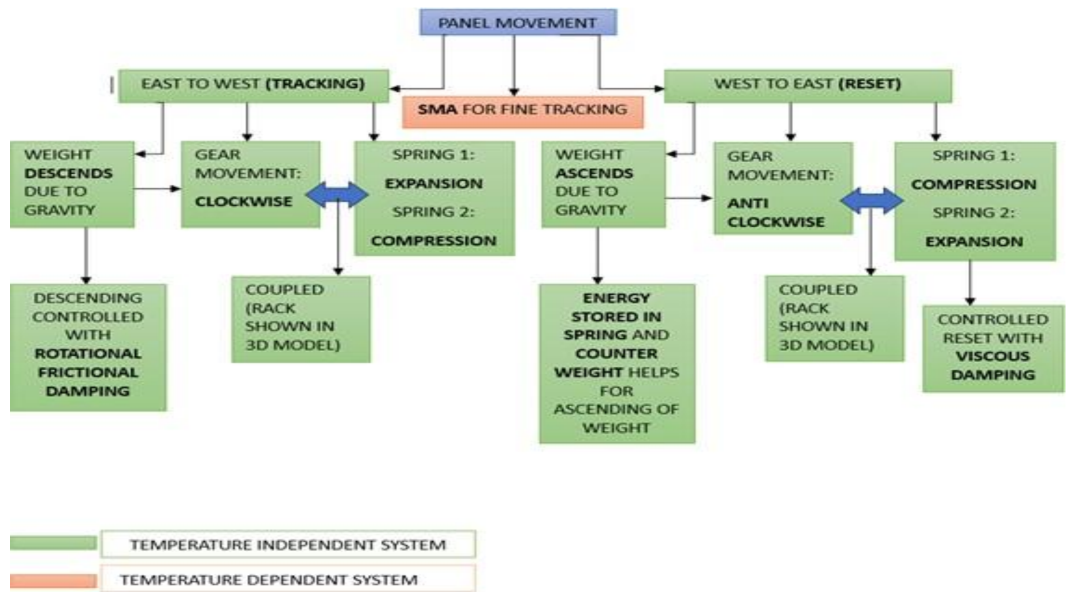

Fig. 1. Gravity Powered Solar Tracker

As solar energy continues to grow in importance, innovative solutions for tracking mechanisms are being explored to improve sustainability and energy efficiency. This paper presents a novel, non-electrical solar tracking system utilizing gravity, SMA-based actuation, and a ratchet-pawl system as given in Fig.1. The design aims to enhance solar tracking efficiency while minimizing energy loss and mechanical complexity. The system operates without external power sources, reducing operational costs and making it ideal for deployment in areas with limited access to electricity. Additionally, this method is more resilient to extreme weather conditions and requires less maintenance compared to motorized alternatives.

MATERIALS AND COMPONENTS

Shape Memory Alloy (SMA) Actuator: A smart material that changes shape in response to temperature variations, driving the movement of the tracking mechanism. SMA wires or springs contract when heated, allowing controlled panel rotation. The unique properties of SMAs enable precise adjustments to the solar panel's orientation, increasing overall efficiency. Gravity Mechanism: Utilizes gravitational force to reposition the solar panel without external power. This mechanism ensures that the system remains functional even in adverse weather conditions. A counterweight system is employed to maintain balance and regulate panel movement. Ratchet-Pawl System: Ensures unidirectional motion and prevents back movement, allowing for a controlled incremental tracking mechanism. The system locks in place at specific angles, optimizing solar panel orientation and maintaining stability in strong winds. Solar Panel Frame and Mount: Designed to support and adjust panel orientation based on the tracker’s motion. The frame is lightweight yet sturdy, capable of withstanding wind loads. The mounting system incorporates durable and corrosion-resistant materials to ensure longevity. Thermal Sensors: Used to trigger SMA actuation based on sunlight intensity. These sensors ensure that the tracker operates efficiently without requiring manual intervention. Advanced thermal sensors with adaptive control mechanisms enhance responsiveness.

METHODOLOGY

The tracking system is structured to leverage the combined action of gravity and SMA-induced movement to follow the sun's trajectory. A detailed simulation is conducted to analyze the system's response under different solar conditions as depicted in Fig.2. Computational modeling evaluates the impact of SMA deformation rates and gravitational forces on tracking accuracy. A small-scale prototype is constructed to validate the working principle. The prototype consists of a single-axis tracker for simplicity and ease of testing. The integration of SMA elements and a mechanical locking system ensures controlled movement. The system is tested under controlled and real-world conditions to measure its efficiency. A comparative study is conducted with a traditional fixed-panel system. Performance metrics, such as angular displacement accuracy, energy yield, and response time, are analyzed. The solar energy harvested using the gravity-SMA tracker is compared with a static panel setup. Energy yield, tracking accuracy, and durability are key performance indicators. Long-term testing under variable weather conditions further evaluates system reliability.

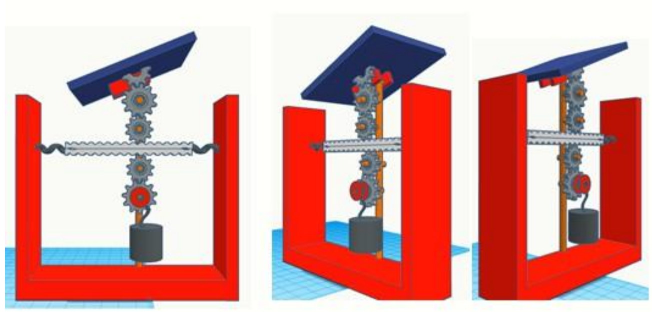

Fig. 2. 3 D Model of Gravity Powered SMA based Solar Tracker

RESULTS AND DISCUSSION

The proposed tracker increased solar panel efficiency by 20-30% compared to static panels. The ability to maintain perpendicular alignment with the sun resulted in enhanced energy capture, demonstrating the effectiveness of passive tracking mechanisms. Unlike motorized trackers, this system operates without electrical power, significantly reducing operational costs. The reliance on passive mechanisms eliminates the need for an external power supply, making it suitable for remote applications.

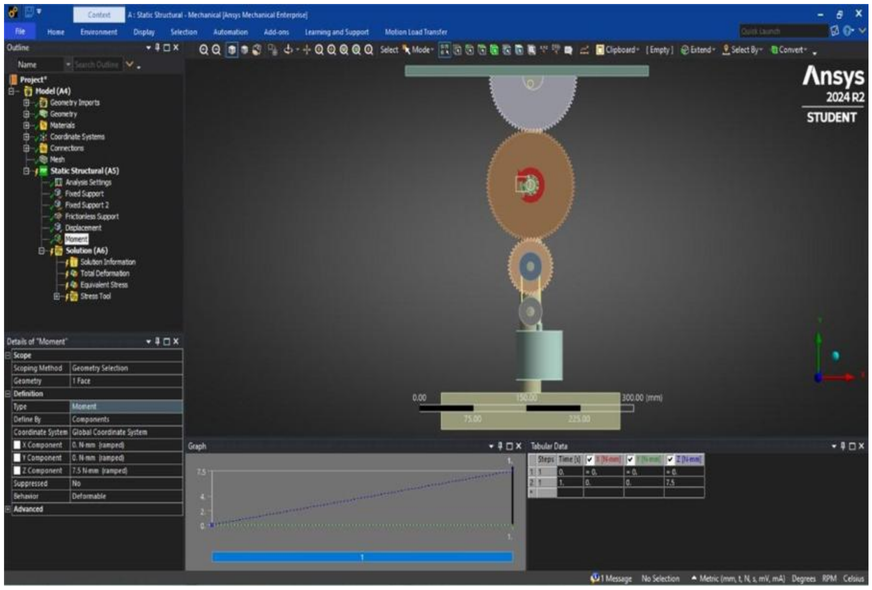

Fig.3. Solar Tracker Model using ANSYS

The system demonstrated minimal wear and tear, reducing maintenance needs. The lack of moving electrical components extends the system's lifespan and ensures long-term reliability. Effective performance in diverse environmental conditions, making it suitable for off-grid applications. The system was tested under varying sunlight intensities and ambient temperatures, demonstrating consistent tracking performance even in high-dust and high-wind environments. The design can be adapted for different solar panel sizes, making it suitable for both residential and industrial applications as shown in Fig.3. Larger implementations could incorporate hybrid tracking mechanisms for increased efficiency.

CONCLUSION

This paper presents an innovative, non-electrical solar tracking system that leverages gravity, SMA actuation, and a ratchet-pawl mechanism to optimize PV panel alignment. The system's energy independence, low maintenance requirements, and cost-effectiveness make it a viable solution for remote and off-grid solar applications. Future work will focus on optimizing SMA response times and enhancing scalability for large-scale solar farms. Further improvements, such as integrating advanced materials and optimizing the thermal response of SMA components, will be explored to enhance the system's overall efficiency. The development of hybrid models that integrate multiple passive tracking techniques could further enhance tracking precision and energy yield.

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