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# Baggage Handling Conveyor System Employing Solar Power and Super Capacitor Using Matlab Simulation

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**ABSTRACT:** This study presents a MATLAB simulation model for analyzing the performance of a baggage handling conveyor system powered by solar energy and supported by super capacitor energy storage. The proposed system aims to enhance efficiency, reduce environmental impact, and optimize energy management in airport logistics. The simulation incorporates the dynamics of solar irradiance, energy conversion efficiency, super capacitor charging and discharging characteristics, conveyor operation, and variable baggage load profiles. By utilizing MATLAB simulations, various scenarios are evaluated to assess the system's feasibility, energy utilization, and operational reliability under different environmental conditions and traffic demands. The results demonstrate the potential of integrating renewable energy sources and advanced energy storage technologies to create sustainable and resilient baggage handling solutions for the aviation industry.

**KEYWORDS**: MATLAB, conveyor system, supercapacitors, K-Nearest Neighbours

## I. INTRODUCTION

The aviation industry, a cornerstone of global connectivity, transports millions of passengers daily, underscoring the critical need for consistent power supply, especially in vital areas like baggage handling. Disruptions in power, often due to severe weather or technical failures, can lead to significant delays and disruptions. To address this challenge, airports typically rely on backup generators. However, these systems have limitations, including fuel dependency and environmental impact. This thesis explores the feasibility and optimization of a sustainable solution: a solar-powered backup system for baggage handling in airports. Utilizing MATLAB simulations, the study aims to design and analyze a system integrating photovoltaic (PV) sources, supercapacitors, batteries, and conveyor systems to minimize power fluctuations, enhance energy efficiency, and ensure uninterrupted baggage handling operations. The study concludes with summaries of findings, contributions to knowledge, limitations, recommendations for future research, and implications for the aviation industry. By adopting solar-powered baggage handling solutions, airports can enhance operational resilience and reduce carbon footprints, contributing to a sustainable future.

## II. LITERATURE REVIEW

1. Solar Energy Applications in the Aviation Industry"(2020). by Smith study provides a comprehensive overview of solar energy applications within the aviation industry, highlighting its potential to address energy challenges in critical airport operations such as baggage handling. The paper discusses the benefits of solar energy, including its renewable nature and environmental sustainability, positioning it as a viable alternative to traditional fuel-based generators. The work covers Solar Based Regeneration of Electricity in Conveyor Belt Mechanism. This system is implemented using bucket elevator mechanism which works by connecting many buckets via chains or a conveyer belt around a Power pulley system. Solar energy is referred to as the energy that comes from the sun's rays. The need for hybrid energy sources, combining solar and wind power, is emphasized as a viable and socially acceptable solution. To address the problem of high energy consumption in belt conveyor systems, the paper proposes an innovative methodology. It suggests using renewable energy sources, specifically solar panels.

2. "Backup Power Systems for Airport Operations: A Review" by Johnson A and Brown K examines the role of

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backup power systems in ensuring uninterrupted airport operations, with a specific focus on baggage handling. The review identifies challenges associated with conventional backup systems and explores the potential of alternative energy sources, such as solar power, to enhance resilience and sustainability in airport environments. This paper introduces solar PV Application in Industrial Conveyor System. This project uses a smart technique for material movement which uses overall resistance to the motion of the conveyor line. This paper emphasizes the effective utilization of solar panels to supplement grid-connected energy in conveyor systems. It offers practical insights, proposing ways to drive conveyor systems entirely or partially through solar power, showcasing the feasibility, cost savings, and environmental benefits of such integration.

3. Wang, Q., & Zhang, L. (2018). "Recent Advances in Energy Storage Technologies for Renewable Energies. Wang and Zhang provide an in-depth analysis of recent advancements in energy storage technologies, including batteries and supercapacitors, and their applications in renewable energy systems. The review discusses the potential of supercapacitors to address challenges related to energy storage and management in solar-powered baggage handling systems. The primary focus is on modelling and simulating the dynamic behavior of conveyor belt systems using Matlab/Simulink, aiming to address the challenges associated with energy consumption in these systems. The paper proceeds to discuss the various components and factors affecting power consumption in belt conveyor systems, detailing the functional parameters and equations used to calculate the power requirements during different operational stages. The paper highlights the importance of adaptable speed control to optimize energy consumption based on varying material loads, potentially aiding in the selection of appropriately sized motors for specific operational conditions. this work introduces a methodical approach to model, simulate, and analyse the dynamic behaviour of belt conveyor systems, offering insights into optimizing power consumption through speed control and load adaptation, contributing to enhanced energy efficiency in industrial settings.

4. Garcia, M., & Martinez, P. (2014). "Design and Optimization of Battery- Supercapacitor Hybrid Energy Storage Systems. “Garcia and Martinez investigate the design and optimization of battery- supercapacitor hybrid energy storage systems. The study highlights the complementary characteristics of batteries and supercapacitors and their synergistic potential in enhancing energy storage and delivery capabilities in solar -powered applications. The primary focus is on modelling and simulating the dynamic behaviour of conveyor belt systems using Matlab/Simulink, aiming to address the challenges associated with energy consumption in these systems. The paper proceeds to discuss the various components and factors affecting power consumption in belt conveyor systems, detailing the functional parameters and equations used to calculate the power requirements during different operational stages. The paper highlights the importance of adaptable speed control to optimize energy consumption hased on varying material loads, potentially aiding in the selection of appropriately sized motors for specific operational conditions. this work introduces a methodical approach to model, simulate, and analyse the dynamic behaviour of belt conveyor systems, offering insights into optimizing power consumption through speed control and load adaptation, contributing to enhanced energy efficiency in industrial settings.

## III. METHODOLOGY

The proposed architecture for the solar-powered baggage handling conveyor system with supercapacitors involves the integration of key components to achieve a sustainable and efficient operation:

1. Principles of Photovoltaic Systems
   Photovoltaic (PV) systems convert sunlight into electricity using semiconductor materials such as silicon. When sunlight strikes the PV cells, photons are absorbed, generating electron-hole pairs and creating a voltage potential. This voltage is then converted into usable electrical power through an inverter. The output power of a PV system depends on factors such as solar irradiance, temperature, shading, and system configuration.

2. Battery Technology and Characteristics
   Batteries are electrochemical devices that store and release electrical energy through reversible chemical reactions. Common types of batteries include lead- acid, lithium-ion, nickel-cadmium, and nickel-metal hydride. Batteries have specific characteristics such as energy density, power density, cycle life, efficiency, and self-discharge rate, which vary depending on the chemistry and design of the battery.

3. Supercapacitors
   Supercapacitors are electrochemical energy storage devices that store charge electrostatically on the surface of electrodes. Unlike batteries, which store energy through chemical reactions, supercapacitors store energy in an

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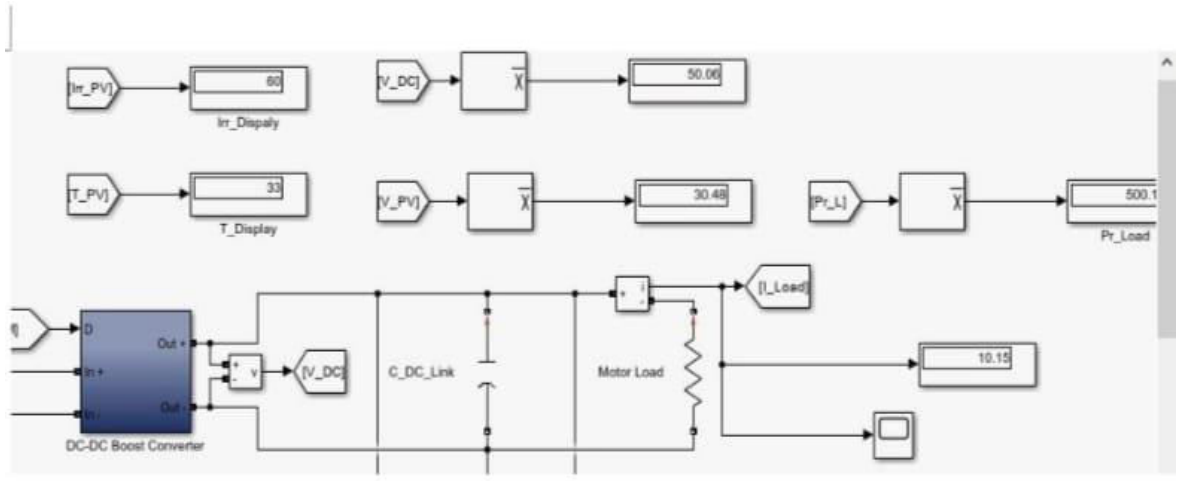
electric field, enabling rapid charge and discharge cycles. Supercapacitors consist of two electrodes separated by an electrolyte and exhibit characteristics such as high power density, fast charging/discharging rates, long cycle life, and low internal resistance.

4. Energy Management Techniques in Solar-Powered Systems
   Energy management techniques in solar-powered systems involve optimizing the generation, storage, and utilization of solar energy to meet the load demand efficiently. Common strategies include maximum power point tracking (MPPT) to optimize PV output, battery management systems (BMS) to control charging and discharging cycles, and load management algorithms to prioritize power allocation based on demand and system constraints.

5. System Design and Components
   The system design involves selecting appropriate components, including PV panels, supercapacitors, batteries, inverters, and conveyor systems. The integration of these components requires careful consideration of system requirements, performance objectives, and environmental constraints. Factors such as PV panel efficiency, supercapacitor capacity, battery chemistry, conveyor load capacity, and control system architecture are essential considerations in the design process.

## BLOCK DIAGRAM




## IV. CONCLUSION

The contributions of the research to the field of renewable energy, aviation industry sustainability, and energy management systems are highlighted. The thesis advances knowledge in solar-powered systems design, integration of energy storage technologies, and optimization of baggage handling operations in airport environments. The limitations of the research, including simplifying assumptions, model uncertainties, and data limitations, are acknowledged. Recommendations for future research are provided, including further experimental validation, field testing, system scalability studies, and integration with smart grid technologies. The implications of the research for the aviation industry are discussed, including potential cost savings, operational efficiencies, and environmental benefits associated with the adoption of solar-powered baggage handlers.

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