

Enhancing Inventory Efficiency through the Application of Drone Technology in Automation

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Abstract

Traditional warehouse operations are often inefficient and prone to risks. This research offers a cutting-edge system that integrates drone technology to overcome these challenges. Traditional practices rely heavily on manual methods or handheld devices, which are labor-intensive, prone to human error, and time-consuming. Additionally, manual inspections expose workers to hazardous environments, leading to inefficiencies and safety risks. The proposed system employs drones equipped with high-resolution cameras and advanced technologies such as Optical Character Recognition (OCR) and 3D scanning. These drones perform periodic inventory scans, reading barcodes and QR codes to update inventory data in real-time. Simultaneously, they monitor infrastructure conditions, identifying issues like cracks, rust, or misaligned shelves, enabling proactive maintenance and reducing risks of structural failures. A core feature of this project is the integration of artificial intelligence (AI) for data analysis. AI algorithms identify patterns in inventory discrepancies and infrastructure wear, facilitating rapid decision-making and actionable insights. The inclusion of collision avoidance systems and intelligent navigation ensures safe and efficient drone operation within complex indoor environments. Preliminary results demonstrate that the system can enhance operational efficiency by up to 60%, reduce labor costs, and improve data accuracy in Warehouse Management Systems (WMS). The project aligns with the Industry 4.0 paradigm, offering a scalable, sustainable solution to modernize logistics and supply chain management. Successful implementation addresses challenges in unstructured environments while advancing the transition to smart warehouses. This research underscores the potential of drones to redefine warehouse operations, providing safer, faster, and more efficient alternatives to traditional methods. Future work will focus on real-world testing, refining flight paths, and incorporating advanced AI models to further optimize performance and scalability.

Keywords

Drone Technology 1, Artificial Intelligence (AI) 2, Smart Warehouses3, Operational Efficiency 4, Inventory Management 5.

Biographies

Wejdan mohammed alamri is Senior Industrial engineering student at King Khalid University, Abha, Saudi Arabia, trained at the Saudi Electricity Company, worked in the Quality and Continuous Improvement Department in summer 2024, and I hold an OSHA certificate in Occupational Safety and Health Administration. A former member of the Engineering Club at King Khalid university.

Heba Saeed Al-Shahrani is Senior Industrial Engineering student at King Khalid University, Abha, Kingdom of Saudi Arabia. I gained experience through my training at the Saudi Electricity Company in the Transportation Projects Management Department in 2024, in addition to my training in the same year in the Ministry of Environment, Water and Agriculture in the Warehouses Department.

Bedoor Abdullah Alshehri is senior Industrial Engineering student at King Khalid university, Abha, Saudi Arabia. Member of IEOM club at King Khalid university. I trained at TU Berlin 2022 and gained sufficient knowledge in design thinking and intro to python programming, also trained at Al-Jazeera paint 2023 in warehouse and supply chain department.

Rana Saad AL Qahtani is a Senior Industrial Engineering Student at King Khalid University, Abha, Saudi Arabia. Currently training at Naqel Express Company in the Operations, Logistics Services, Quality, and administrative departments. Serving as the Development Programs Advisor at the College of Engineering, King Khalid University, and a former member of the Engineering Club.

Heba Ibrahim Elkhoully is an Assistant Professor at King Khalid University in the Industrial Engineering Department, with industrial and mechanical engineering expertise. She holds a PhD in Industrial Engineering from Fayoum University, focusing on optimizing mechanical properties of composite materials, an M.S. degree in mechanical engineering from Benha University, and a B.S. degree in industrial engineering from Fayoum University. Heba Ibrahim Elkhoully's research interests include experimental design methods (Taguchi and response surface methodology), Lean Six Sigma, data analysis, and material science, particularly eco-friendly and nanocomposite materials. Dr. Elkhoully has published extensively in international journals on composite material optimization, green energy systems, and advanced manufacturing techniques. She has supervised multiple theses and served as a reviewer for renowned journals. Additionally, her work contributes to integrating AI and data-driven methodologies in industrial applications.