Drones are Used to Improve Work Efficiency

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Abstract— **Drones enhance work efficiency by automating repetitive tasks such as inspections and data collection, providing faster and more consistent results than manual methods. Equipped with high-resolution sensors, they deliver accurate, real-time data across large or hard-to-reach areas, improving decision-making and reducing errors. Their use increases safety by accessing hazardous locations without risking workers, accelerates project timelines through streamlined monitoring, and lowers operational costs by minimizing reliance on manual labor and costly equipment. Integration with AI and analytics further optimizes workflows, while their scalability allows deployment across diverse industries. Effective implementation requires task identification, regulatory compliance, operator training, data management, and system integration.**

Keywords: **Agriculture Thailand unmanned**

I. INTRODUCTION

Unmanned aerial vehicles are aircraft that are designed to fly without a pilot. It is one of those flying machines that don't have pilots and can fly as high as very small compartments. An operator from the ground can pilot the flying device, and it can also autonomously fly with different cargo to house various services, like those in medical, military, campaigning, and even logistics industries, for urban, suburban, inner mountain terrains, or thick jungles. (Harris, 2023).

Tasking such us surveillance, exploring uncharted and treacherous terrains, agriculture, and situations where human intervention is either too costly or hazardous are considered prime example of drones' utility. The most interesting work is often done by drones in the air; however, the one picture depicts here in its military and deep-space rendezvous, campaigns to hunt for missing people. Drones have seen multiple radical implications, and they are currently being held up as one of the most important instruments in a majority of areas ranging from sociological and to economic sectors the world over as a new concept. (Rejeb, Abdollahi, Rejeb, & Treiblmaier, 2022)

There are clearly defined distinctions on the types of platforms a particular drone will be used for, the objective for which such applications are prepared to carry out, and the nature of the mission it will perform. Suggesting groupings of drones will place them into different natures, and categories. (Dekoulis,2018) The groupings were expected to be found advantageous in their specific purposes and users' needs as they relate to their scientific inspections. No matter how varied the genus of drones may be, it would be conclusive about their true

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form in military and civil scientific explorations establishment.(Lewis, 2011).

To make sure each kind of little unit has an appropriate name, we can call it that way: MAVs (Micro or Miniature Air Vehicles), NAVs (Nano Air Vehicles), VTOL (Vertical Take-Off & Landing), LASE (Low Altitude, Short-Endurance), Close, LALE (Low Altitude, Long Endurance), MALE (Medium Altitude, Long Endurance), HALE (High Altitude, Long Endurance), and several more. Classification is as per the weight the drone can withstand during takeoff and the purpose to which it has to perform.

The first drones were conceived and engineered specifically for the operations of the military. As time went on, however, improvements in drone design have enabled them to be applied in areas outside the military (such as civil applications). Military drones are not commonplace in, say, the AEC-Architecture, Engineering, and Construction industries mainly due to associated costs and difficulties in deploying them within civilian contexts. The ones that are intended for application in the above sectors are more likely to be called civil drones or commercial drones. There is a classification of drones as shown in the above paragraph according to their configurations. Most of these classes, or categories of drones, are multirotor drones which are most popular because of their simplistic use and low purchase and maintenance costs, as they are quite easy and flexible to use. So too with the multirotor drones where the quadcopter is the most favorite of them all as well as in use. Personal or rather commercially aimed non-military drones can be examined in two broad categories which are known as consumer or hobbyist drones and enterprise or corporate grade drones. Users of consumer or hobbyist drones are people who fly drones strictly for fun purposes while enterprise or corporate drones are meant for business.

II. TECHNICAL PERSPECTIVE

Types and Design Multirotor drones: Stability, ease of control, hovering capability, limited flight duration. Fixed-wing drones: Aerodynamic efficiency, longer flight times, higher speeds, need for runways or catapults for takeoff/landing. Hybrid VTOL drones: Vertical takeoff and landing combined with endurance of fixed-wing, complexity of design and control systems. Navigation and Control Systems GPS integration and reliance on satellite signals. Autonomous flight algorithms and obstacle avoidance sensors. Remote piloting challenges like latency, signal interference, and cybersecurity risks. Payload and Sensors Cameras for photography, thermal imaging, LiDAR, multispectral sensors. Payload capacity differences across UAV types affecting mission capabilities

III. ECONOMIC PERSPECTIVE

Service Cost and Pricing Models Initial investment vs operational costs (maintenance, battery replacement, software updates). Cost-effectiveness compared to manned aircraft or ground-based alternatives. Market pricing for UAV services in sectors like agriculture, surveillance, delivery, and inspection. Return on Investment (ROI) Efficiency gains in industries such as agriculture (precision farming), construction (site monitoring), and logistics (last-mile delivery). Cost savings from reduced labor, faster data acquisition, and minimized risk to human operators. Economic Barriers High upfront costs for advanced UAV types (hybrid VTOL) Regulatory compliance costs and insurance premiums Impact of economies of scale as UAV adoption grows.

1) Regulatory and Legal Perspective Airspace Management Integration of UAVs into controlled airspace alongside manned aircraft. No-fly zones, altitude restrictions, and flight path regulations. Privacy and Data Protection Concerns over surveillance and data collection by UAVs. Legal frameworks governing data storage, sharing, and consent. Certification and Compliance Pilot licensing requirements for remote operators. UAV registration and operational permits. Liability and accountability in case of accidents or damages. (Pratelli, Brocchini, & Petri, 2024)

2) Environmental Perspective Energy Consumption and Emissions Battery-powered multirotor drones vs fuel-powered fixed-wing drones. Potential for reduced carbon footprint compared to traditional vehicles. Wildlife and Habitat Impact Noise pollution and disturbance to animals, especially in sensitive ecosystems. UAV use in environmental monitoring and conservation efforts. Waste and Lifecycle Materials used in UAV construction and recyclability. Disposal challenges of batteries and electronic components. (Nikhil, Shreyas, Vyshnavi, & Yadav,2020).

Social and Ethical Perspective Public Acceptance and Perception Concerns about drones invading privacy or being used for unauthorized surveillance. Positive perceptions related to disaster response, search and rescue, and medical deliveries. Ethical Use Cases Military applications and autonomous weaponization debates. Use in law enforcement and potential for abuse or bias. ob Market Impact Automation replacing certain manual inspection or delivery jobs. Creation of new roles in UAV operation, maintenance, and data analysis. (Gevaert, Sliuzas, Persello, & Vosselman, 2018)..

IV. DRONES ARE USED TO IMPROVE WORK EFFICIENCY

Drone technology offers immense benefits and opportunities across a wide range of fields. Drone technology provides enormous benefits and opportunities in various fields, including economics, society and security. (Yafoz, 2024)

These can be summarized as follows: Agriculture: Surveying cultivated areas, precisely spraying fertilizers and pesticides, and analyzing plant health with aerial photographs to reduce costs, increase productivity, and save time. (Candiago, Remondino, De Giglio, Dubbini, & Gattelli, 2015)

Rescue and disaster relief: Surveying disaster-stricken areas such as floods, wildfires, and earthquakes; searching for missing persons in dangerous areas; and delivering medical supplies to hard-to-reach areas. Security and safety: Monitoring border areas, unusual events, and military missions. Business and industry: Taking photos and videos for marketing, real estate, and media; inspecting infrastructure such as power poles, gas pipelines, and factories; delivering parcels in some countries; surveying and urban planning; creating 3D maps; surveying construction sites; and planning urban development. (Al-Dosari, Hunaiti, & Balachandran, 2023)

Education and research: Used as a learning tool in engineering and technology and for collecting environmental and ecosystem data. In short, drone technology increases efficiency, reduces risks to humans, and opens new business opportunities. However, its use should be within the law and consider the safety and privacy of others. Drones support various tasks, such as surveying, humanitarian work, disaster risk management, research, and transportation. In agriculture, drones can provide real-time imagery and data from sensors in fields that are not readily accessible on foot or by vehicle. Global Positioning Systems (GPS) and customizable applications for smartphones and tablets have increased flight time, reliability, ease of use, and the capability to utilize cameras and other sensors necessary for drone applications in agriculture and natural resources. Mohanty, Ravindra, Narayana, Pattnaik, & Sirajudeen, 2023).

The use of drones is becoming increasingly critical in various sectors of both developed and developing economies worldwide. (Obiuto, Festus-Ikhuoria, Olajiga, & Adebayo, 2024) The loss of control can have widespread or even catastrophic consequences. Popular medical applications of drones include, but are not limited to, disaster assessment when other access methods are severely limited; the delivery of relief kits, medicines, vaccines, blood, and other medical supplies to remote areas; the safe transport of disease test samples and test kits in high-risk areas; and the potential for rapid access to automated external defibrillators (AEDs) for cardiac arrest patients to save lives during health emergencies. (Ling, & Draghic, 2019)

During the COVID-19 pandemic, drones were used to deliver personal protective equipment (PPE), test kits, vaccines, medicines, and laboratory samples. They can also help to monitor social distancing in public places easily and automatically. As a novel technology, drones offer customizable solutions for severe emergencies, hilly terrain, and transportation infrastructure. (Mohsan, Zahra, Khan, Alsharif, Elhaty, & Jahid, 2022)

The use of drones to deliver vital and life-saving medicines to all citizens within the economy can help achieve the goal of universal health coverage. The potential benefits of drones in the transportation sector include logistics and passenger transport. (Aggarwal, Balaji, Gupta, Mahajan, Nigam, Singh, Bhargava, & Panda, 2024)

The expansion of drone use from a military perspective to a civilian context also brings regulatory hurdles that must be

overcome to fully utilize the potential of drone technology in agriculture. It is pointed out that to achieve the full potential of drones, a regulatory regime is needed while simultaneously ensuring the safety and privacy of citizens. Misuse (e.g., terrorism), privacy violations, and military use are concerns for some members of the public. However, these issues demonstrate that drone technology can create jobs for young people who can use drones to provide services to rural farmers. (Doggalli, Srivastava, Barigal, A., V, A., Ameen, & Kundu, 2024).

V. DRONE IN AGRICULTURE

Drone technology has been a comprehensive revolution in agriculture. Drones or UAVs have provided farmers with novel tools to enhance yields, monitor crops, manage resources, and make data-based decisions. note, drones represent one of the key areas of precision agriculture wherein they can obtain live information to update farm operations. One of the chores, namely, aerial surveying, crop monitoring, and spraying, done traditionally either by man or through heavy machinery, can be taken over by drones. Therefore, with the use of drones, labor costs and time are saved, combined with much more accurate, minute data collection for altogether more sustainable farming practices. Drones have had a significant impact in precision agriculture by way of technology, and managing crop and soil variability. At this stage, drones have been pivotal in delivering great resolution data to farmers to understand the situation within their crops, soil analysis, and proper decisions regarding irrigation, fertilizers, and pest control applications. One of the main applications of drones is monitoring crop health with the use of multispectral, hyperspectral, and thermal imaging. The sensors of the drones are able to capture plant vigor, chlorophyll levels, and water stress data. It makes it possible to detect the presence of nutrient deficiencies, diseases, or pests earlier and helps farmers take necessary actions at the right time. Turner et al. used drones to monitor some vineyards in Italy by assessing the health of vines with the use of NDVI (Normalized Difference Vegetation Index). The drones collected data, and the managers controlled waste during fertilizing and pesticide spraying, thus improving the overall yield. The use of drones helped create maps for study on soil in the UK's wheat fields. The data captured by the drones enabled farmers to make fertilizer applications that were effective, reducing their application by 25% with no reduction in crop yields. Such practices as poor land management remain one of the significant setbacks facing the agricultural sector, especially concerning matters of erosion and soil degradation. Drones could come in handy in identifying some spots prone to erosion and soil degradation, thus allowing for action on the part of farmers before disaster strikes. For instance, drones have been applied in rice to estimate yield by considering the canopy structure and leaf area index. Study Pantazi et al. (2020) indicated that there was an increase in the accuracy level in yield estimates that exceeded 20% of the conventional method. Crop yield optimization and maximum water efficiency will depend on proper water management. Drones with thermal sensor attachments can be flown over large fields to monitor the soil moisture status. Usage of precision irrigation(Kreps, & Rogers, 2025).

VI. TECHNOLOGICAL EVOLUTION

Historical and Technological Evolution: The Origins of Drones as Military Tools: Initial Design Priorities (Surveillance, Reconnaissance, Combat); Technological Advancements Enabling Miniaturization, Autonomous Flight, and Improved Flight Control; The Transition from Military-Specific Use to Civilian and Commercial Applications; The Impact of Innovations such as GPS, AI, and Sensor Technology on Drone Capabilities; and Differences in Design Requirements Between Military and Civilian Drones (Robustness, Stealth, Payload). Classification and Types of Drones: Military Drones vs. Civilian/Commercial Drones: Differences in Purpose, Design, and Regulations; Multirotor Drones are Dominant for Civilian Use Due to Their Simplicity and Cost-Effectiveness; Focus on Quadcopter Drones: Reasons for Their Market Dominance (Stability, Agility, Ease of Control); Broader Classification: Fixed Wing, Monorotor, VTOL, Hybrid, and Comparative Advantages of Each Type; Consumer/Hobby Drones vs. Enterprise/Company Drones: Application Contexts, Features, and Performance Levels. Economic and Operational Limitations Cost Barriers to Adopting Military-Grade Drones in Civilian Sectors (e.g., AEC); Challenges in Operating Military Drones in Civilian Airspace Due to Regulatory and Logistical Issues; Differences in Maintenance and Operational Complexity Between Military and Commercial Drones. Cost-Benefit Analysis of Civilian Drones in Industry: Return on Investment (ROI), Performance Profitability, and Scalability. Market Segmentation: Affordability and Accessibility for Hobbies Versus Enterprise Investment. Regulatory and Ethical Considerations: Airspace regulations affecting military and civilian drone use; privacy and security concerns specific to civilian drone use; certification and licensing requirements for commercial drone operations; ethical debates regarding surveillance, data collection, and automated decision-making; impact of regulations on market innovation and growth. Diverse Applications: Military Applications: Intelligence Gathering, Target Attack, Battlefield Support; Civilian/Commercial Applications: AEC (surveying, mapping, and inspection), agriculture (Crop Monitoring), Delivery Services, Media and Entertainment; Limitations on AEC Implementation due to Cost, Training, and Integration with Existing Workflows; Emerging Applications in Disaster Management, Environmental Monitoring, and Urban Planning; Drone Potential in Public Safety and Law Enforcement. (Mohanty, Ravindra, Narayana, Pattnaik, & Sirajudeen,2023).

VII. Conclusion

User Perspectives and Market Dynamics: Consumer/Enthusiast Motivations: Recreation, Photography, Learning; Enterprise User Priorities: Reliability, Payload Capacity, Integration with Business Processes. Training and skill requirements for different user types; Market trends: Growth in consumer drone sales versus enterprise drone adoption; The influence of technology accessibility on consumer drone adoption; Design and engineering challenges:

Balancing payload capacity, flight time, and agility in drone design; Adaptations required for industrial environments: Dust, weather, electromagnetic interference, battery technology limitations, and energy efficiency; Software challenges: Navigation, obstacle avoidance, data processing, customization, and modularity to meet specific sector needs; Future trends and innovations: Integration of AI and machine learning for operational automation; Development of swarm drone technology and collaborative missions; Advances in drone delivery and logistics systems; Potential of hybrid drones combining multirotor and fixed-wing features; Increased emphasis on sustainability and environmentally friendly materials in drone manufacturing

REFERENCES

[1] Aggarwal, S., Balaji, S., Gupta, P., Mahajan, N., Nigam, K., Singh, K. J., Bhargava, B., & Panda, S. (2024). Enhancing Healthcare Access: Drone-based Delivery of Medicines and Vaccines in hard-to-Reach Terrains of Northeastern India. Preventive Medicine: Research & Reviews, 1(4), 172–178. https://doi.org/10.4103/pmrr.pmrr_73_24

[2] Al-Dosari, K., Hunaiti, Z., & Balachandran, W. (2023). Systematic Review on Civilian Drones in Safety and Security Applications. Drones, 7(3), 210. https://doi.org/10.3390/drones7030210

[3] Candiago, S., Remondino, F., De Giglio, M., Dubbini, M., & Gattelli, M. (2015). Evaluating Multispectral Images and Vegetation Indices for Precision Farming Applications from UAV Images. Remote Sensing, 7(4), 4026–4047. https://doi.org/10.3390/rs70404026

[4] Dekoulis, G. (Ed.). (2018). Drones: Applications. BoD–Books on Demand.

[5] Doggalli, G, E, S., H G, M., Srivastava, M., H S, G., Barigal, A., V, A., Ameen, A., & Kundu, R. (2024). Drone Technology for Crop Disease Resistance: Innovations and Challenges. Journal of Scientific Research and Reports, 30(8), 174–180. https://doi.org/10.9734/jsrr/2024/v30i82237

[6] Gevaert, C., Sliuzas, R., Persello, C., & Vosselman, G. (2018). Evaluating the Societal Impact of Using Drones to Support Urban Upgrading Projects. ISPRS International Journal of Geo-Information, 7(3), 91. https://doi.org/10.3390/ijgi7030091

[7] Harris, D. (2023). Single-pilot airline operations: Designing the aircraft may be the easy part. The aeronautical journal, 127(1313), 1171-1191.

[8] Kreps, S. E., & Rogers, J. P. (2025). Drones: What everyone needs to know®. Oxford University Press.

[9] Lewis, M. W. (2011). Drones and the Boundaries of the Battlefield. Tex. Int'l LJ, 47, 293.

[10] Ling, G., & Draghic, N. (2019). Aerial drones for blood delivery. Transfusion, 59(S2), 1608–1611. https://doi.org/10.1111/trf.15195

[11] Mohanty, S. N., Ravindra, J. V. R., Narayana, G. S., Pattnaik, C. R., & Sirajudeen, Y. M. (Eds.). (2023). Drone technology: future trends and practical applications. John Wiley & Sons.

[12] Mohanty, S. N., Ravindra, J. V. R., Narayana, G. S., Pattnaik, C. R., & Sirajudeen, Y. M. (Eds.). (2023). Drone technology: future trends and practical applications. John Wiley & Sons.

[13] Mohsan, S. A. H., Zahra, Q. U. A., Khan, M. A., Alsharif, M. H., Elhaty, I. A., & Jahid, A. (2022). Role of Drone Technology Helping in Alleviating the COVID-19 Pandemic. Micromachines, 13(10), 1593. https://doi.org/10.3390/mi13101593

[14] Nikhil, N., Shreyas, S. M., Vyshnavi, G., & Yadav, S. (2020). Unmanned Aerial Vehicles (UAV) in Disaster Management Applications. 140–148. https://doi.org/10.1109/icssit48917.2020.9214241

[15] Obiuto, N., Festus-Ikhuoria, I., Olajiga, O., & Adebayo, R. (2024). REVIEWING THE ROLE OF AI IN DRONE TECHNOLOGY AND APPLICATIONS. Computer Science & IT Research Journal, 5(4), 741–756. https://doi.org/10.51594/csitrj.v5i4.1019

[16] Pratelli, A., Brocchini, L., & Petri, M. (2024). Optimising Drone-Assisted Logistics for Urban Last-Mile Delivery: An Overview of Applications, Methodologies, and Emerging Trends. Journal of Urban Development and Management, 3(3), 188–197. https://doi.org/10.56578/judm030304

[17] Rejeb, A., Abdollahi, A., Rejeb, K., & Treiblmaier, H. (2022). Drones in agriculture: A review and bibliometric analysis. Computers and electronics in agriculture, 198, 107017.

[18] Yafoz, A. (2024). Drones in Action: A Comprehensive Analysis of Drone-Based Monitoring Technologies. Data and Metadata, 3.https://doi.org/10.56294/dm2024.364