

Advanced Drone Technologies for Intelligent Monitoring Systems

Fabio Giudice

Professor, University of Catania, Italy

Abstract

Advanced drone technologies have emerged as important tools for intelligent monitoring systems because of their ability to provide aerial sensing, rapid data acquisition, autonomous navigation, high-resolution imaging, and real-time environmental observation. The integration of drones with artificial intelligence, computer vision, Internet of Things technologies, edge computing, global navigation systems, and advanced sensors has expanded their applications across agriculture, infrastructure inspection, environmental monitoring, disaster management, industrial surveillance, and public safety. This paper examines advanced drone technologies for intelligent monitoring systems through a conceptual and literature-based research approach.

The study focuses on autonomous flight, multisensor integration, AI-based image analysis, real-time data processing, communication systems, navigation, and intelligent decision support. The analysis identifies autonomous perception, sensing capabilities, communication reliability, data-processing efficiency, energy management, and operational safety as important dimensions of intelligent drone monitoring. Advanced drones can reduce the time and human effort required for monitoring large or difficult-to-access areas while improving the availability of visual and spatial information.

However, limitations involving battery capacity, weather conditions, communication range, cybersecurity, regulatory compliance, data privacy, and autonomous decision-making remain important challenges. Future research should emphasize energy-efficient drone platforms, edge-based intelligence, swarm monitoring, advanced computer vision, autonomous navigation, secure communication, digital twins, and sustainable drone operations. The study concludes that the integration of intelligent technologies with advanced drone platforms can establish more responsive, efficient, scalable, and adaptive monitoring systems for future applications.

Keywords: Advanced Drone Technologies, Intelligent Monitoring, Unmanned Aerial Vehicles, Artificial Intelligence, Computer Vision, Autonomous Navigation, Remote Sensing, Edge Computing, Drone Monitoring, Intelligent Systems.

1. Introduction

Drone technology has developed rapidly from remotely operated aerial platforms into increasingly intelligent systems capable of autonomous navigation, environmental sensing, image acquisition, communication, and automated decision support. Unmanned aerial vehicles (UAVs) can access locations that may be difficult, expensive, or dangerous for conventional monitoring teams. Their

flexibility and mobility make them valuable for infrastructure inspection, agriculture, disaster response, environmental observation, industrial monitoring, and other applications requiring aerial information.

The integration of artificial intelligence has further expanded the capabilities of modern drone systems. Computer vision algorithms can analyze images and video to identify objects, detect anomalies, classify environmental conditions, and support automated monitoring. Machine learning can assist drones in interpreting complex visual information, while autonomous navigation technologies allow them to plan routes and respond to changing environmental conditions. These capabilities are contributing to a transition from manual drone operation toward intelligent aerial monitoring.

Advanced sensing is another important component of intelligent drone systems. Cameras, thermal sensors, LiDAR, multispectral sensors, inertial measurement units, and positioning technologies can collect different forms of information. Combining multiple sensors can provide more comprehensive representations of monitored environments. Sensor fusion can consequently support applications where ordinary visual imagery alone may not provide sufficient information, particularly in agriculture, infrastructure inspection, environmental monitoring, and emergency response.

Despite these developments, intelligent drone monitoring involves several technical and operational challenges. Battery limitations can restrict flight duration, while weather conditions may influence flight stability and sensing quality. Communication interruptions can affect real-time monitoring, and autonomous operation introduces additional requirements for safety and reliability. Data generated by drones can also create cybersecurity and privacy concerns, particularly when monitoring populated areas or sensitive infrastructure.

Advanced drone technologies therefore require integrated frameworks that combine aerial mobility with intelligent sensing, autonomous control, data analytics, communication, and secure information management. This paper examines advanced drone technologies for intelligent monitoring systems, focusing on their technological foundations, application areas, analytical characteristics, implementation challenges, and future research opportunities. The study provides a conceptual perspective on how intelligent drone systems can support more efficient and responsive monitoring operations.

2. Objectives of the Study

2.1 Primary Objective

The primary objective of this study is to examine advanced drone technologies for intelligent monitoring systems and to evaluate how autonomous navigation, artificial intelligence, computer vision, advanced sensing, communication technologies, edge computing, and intelligent analytics can improve the efficiency, responsiveness, accuracy, and scalability of monitoring operations across diverse application environments.

The study also seeks to identify technological factors influencing intelligent drone performance. Particular attention is given to flight autonomy, sensor capabilities, data-processing speed, battery capacity, communication reliability, navigation accuracy, cybersecurity, safety, and environmental conditions. These factors are considered important for establishing reliable and effective drone-based monitoring systems.

2.2 Examination of Advanced Drone Technologies

The first objective is to examine major technologies supporting intelligent drone monitoring, including UAV platforms, autonomous navigation, GPS/GNSS positioning, computer vision, artificial intelligence, machine learning, LiDAR, thermal imaging, multispectral sensing, edge computing, and wireless communication. The study considers their contribution to intelligent aerial observation.

The objective further examines how these technologies can operate collectively within drone monitoring architectures. Sensor fusion can combine multiple information sources, while AI-based analytics can transform collected data into actionable information. Edge processing can support rapid local analysis, reducing dependence on continuous communication with remote computing infrastructure.

2.3 Assessment of Intelligent Monitoring Applications

The second objective is to assess the application of advanced drones in agriculture, infrastructure inspection, environmental monitoring, disaster response, industrial surveillance, transportation, and public-safety monitoring. The study considers how aerial platforms can improve information collection across large or difficult-to-access areas.

The objective also evaluates operational factors affecting application effectiveness, including monitoring accuracy, flight endurance, weather resistance, communication availability, data quality, safety, and regulatory requirements. The study seeks to identify how advanced drone capabilities can be aligned with application-specific monitoring requirements while maintaining reliable and responsible operation.

3. Review of Literature

3.1 Drone Technologies and Intelligent Monitoring

Drones have become important remote-sensing platforms because they can collect high-resolution spatial information at relatively flexible operational scales. Colomina and Molina describe UAV systems as increasingly relevant for photogrammetry and remote sensing because of their mobility and ability to acquire detailed aerial information. Their use has expanded from mapping toward monitoring applications requiring repeated observations and rapid data acquisition.

The integration of artificial intelligence has increased the analytical capabilities of drone platforms. AI-based computer vision can process aerial imagery to identify objects, classify surfaces, detect anomalies, and support monitoring decisions. Recent research on UAV-based monitoring demonstrates increasing use of deep learning for object detection, image classification, environmental analysis, and automated inspection.

3.2 Autonomous Navigation and Sensor Integration

Autonomous navigation is essential for drone systems expected to perform monitoring missions with limited human intervention. Navigation technologies combine positioning information, inertial measurements, environmental perception, path planning, and control algorithms. Autonomous systems can therefore follow predefined routes while responding to obstacles and changing flight conditions.

Sensor integration further strengthens drone monitoring capabilities. RGB cameras, thermal cameras, LiDAR, multispectral sensors, and other instruments can collect complementary information. Sensor fusion allows multiple datasets to be combined for improved environmental understanding. In agriculture, for example, multispectral imaging can provide information related to vegetation conditions, while thermal sensing can support additional environmental assessments.

3.3 AI, Edge Computing, and Drone Intelligence

Edge computing provides an opportunity to process drone-generated information closer to the source. Instead of transmitting all raw imagery to centralized cloud infrastructure, selected analytical operations can be performed directly on the drone or at nearby edge devices. This can reduce communication requirements and support faster responses for time-sensitive monitoring tasks.

AI-enabled drones can also support increasingly autonomous monitoring workflows. Computer vision can identify objects and anomalies, while machine learning can assist prediction and classification. The combination of AI and edge computing is particularly relevant when communication bandwidth is limited or rapid decisions are required. Future drone intelligence is therefore likely to involve greater integration between onboard processing, intelligent algorithms, and connected monitoring infrastructures.

4. Research Methodology

4.1 Research Design

This study adopts a conceptual and literature-based research design to examine advanced drone technologies for intelligent monitoring systems. The research focuses on unmanned aerial vehicles, autonomous navigation, artificial intelligence, computer vision, advanced sensors, communication systems, edge computing, and intelligent analytics. The conceptual design supports systematic examination of technological relationships influencing drone-based monitoring.

The study does not introduce fabricated experimental observations or unsupported performance measurements. Instead, relevant academic literature concerning UAV technology, remote sensing, autonomous systems, computer vision, AI-based monitoring, and drone applications is reviewed thematically. This approach enables identification of recurring technological capabilities, application patterns, implementation limitations, and future research directions within intelligent drone monitoring.

4.2 Literature Collection and Organization

The literature was organized according to major technological dimensions, including drone platforms, navigation, sensing, image processing, artificial intelligence, communication, edge computing, and monitoring applications. Studies were considered relevant when they addressed UAV-based observation, autonomous flight, intelligent data analysis, or real-time monitoring.

The literature was further grouped according to application domains including agriculture, infrastructure inspection, environmental monitoring, disaster management, industrial surveillance, and public safety. Recurring themes such as autonomous operation, sensing accuracy, battery limitations, communication reliability, data processing, cybersecurity, safety, and regulatory requirements were

identified. This organization provided a structured basis for analyzing the role of advanced drone technologies.

4.3 Analytical Framework

The analytical framework evaluates intelligent drone monitoring through five dimensions: aerial sensing, autonomous navigation, intelligent data processing, communication, and monitoring decision support. Aerial sensing concerns the collection of visual, thermal, multispectral, or spatial information. Autonomous navigation addresses positioning, route planning, obstacle avoidance, and flight control.

Intelligent data processing concerns artificial intelligence, computer vision, machine learning, and edge analytics. Communication involves data transmission and connectivity between drones, operators, edge devices, and cloud systems. Monitoring decision support represents the conversion of processed information into actionable observations. Cross-cutting considerations include energy efficiency, safety, cybersecurity, reliability, and scalability.

4.4 Data Analysis Approach

A thematic analytical approach was used to identify recurring patterns across the reviewed literature. Technological capabilities, application benefits, operational limitations, and emerging research directions were examined comparatively. The analysis emphasizes relationships among drone autonomy, sensing, computational intelligence, communication, and monitoring effectiveness rather than reporting a single experimental dataset.

The identified themes were subsequently organized into technology and application categories. This approach enables the study to compare different components of intelligent drone monitoring and determine how they contribute to operational efficiency. The resulting analysis provides a conceptual foundation for understanding the opportunities and challenges associated with advanced drone-based monitoring systems.

5. Analysis

5.1 Core Technologies for Intelligent Drone Monitoring

Advanced drone monitoring depends on the integration of aerial platforms with sensing, navigation, computation, communication, and artificial intelligence. Each technology performs a distinct function, but effective monitoring requires coordinated operation among these components.

Autonomous navigation enables drones to follow monitoring routes, while sensors collect environmental information. AI and computer vision transform collected information into meaningful observations. summarizes major technologies supporting intelligent drone monitoring systems.

Table 1: Core Technologies Supporting Intelligent Drone Monitoring

Technology	Primary Function	Monitoring Contribution
UAV Platform	Aerial mobility	Flexible area coverage
GPS/GNSS	Position determination	Navigation accuracy
Computer Vision	Image interpretation	Automated detection
Machine Learning	Pattern recognition	Intelligent classification
LiDAR	3D sensing	Spatial mapping
Thermal Imaging	Heat detection	Condition monitoring
Multispectral Sensors	Spectral observation	Environmental assessment
Edge Computing	Local processing	Rapid data analysis
Wireless Communication	Data transmission	Real-time connectivity
Obstacle Detection	Environmental awareness	Safer autonomous flight

Interpretation: demonstrates that intelligent drone monitoring requires a combination of complementary technologies. UAV platforms provide aerial mobility, while GPS/GNSS supports navigation and positioning. Computer vision and machine learning enable automated interpretation of collected imagery. LiDAR provides spatial information, whereas thermal and multispectral sensors contribute additional environmental information.

Edge computing can support local data processing and reduce dependence on remote infrastructure. Wireless communication enables information exchange between drones and monitoring systems. Obstacle detection further supports safer autonomous operation. Together, these technologies establish an integrated technical foundation for intelligent aerial monitoring.

5.2 Application Areas of Advanced Drone Monitoring

Advanced drone technologies can support monitoring across multiple sectors where rapid aerial observation and high-resolution data are valuable. Their mobility allows them to monitor large, remote, or hazardous areas while reducing the need for continuous physical inspection. AI-based analytics can further automate the interpretation of collected information. Table 2 presents major application areas and corresponding monitoring functions.

Table 2: Applications of Advanced Drone Technologies

Application Area	Monitoring Function	Potential Contribution
Agriculture	Crop and field observation	Precision monitoring
Infrastructure	Structural inspection	Early condition identification
Environmental Monitoring	Land and ecosystem observation	Environmental assessment
Disaster Management	Damage assessment	Rapid situational awareness
Industrial Facilities	Asset and site monitoring	Operational oversight
Transportation	Road and traffic observation	Infrastructure monitoring
Mining	Site and terrain monitoring	Area assessment
Coastal Monitoring	Shoreline observation	Environmental surveillance
Forest Monitoring	Vegetation and land observation	Resource protection
Public Safety	Aerial situational monitoring	Operational awareness

Interpretation: illustrates the broad applicability of advanced drones in intelligent monitoring. Agriculture can use aerial sensing for crop observation, while infrastructure applications can support inspection of structures and facilities. Disaster-management teams can use drones to obtain rapid information from affected areas.

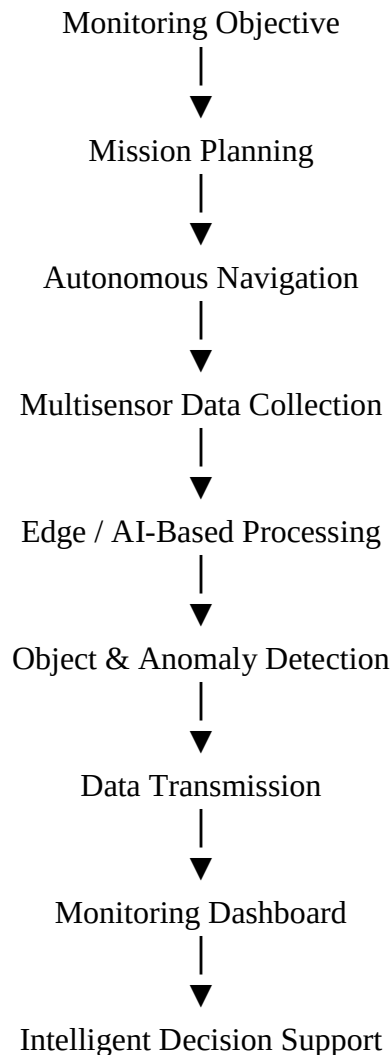
Environmental and forest monitoring can benefit from repeated aerial observations across large territories. Industrial and mining applications can use drones for asset and site monitoring. Transportation and public-safety operations can use aerial information for situational awareness. Across these sectors, drones can improve monitoring flexibility, coverage, and information availability.

5.3 Intelligent Monitoring Workflow

An intelligent drone monitoring system generally follows a sequence beginning with mission planning and ending with decision support. The drone first receives a monitoring objective and flight route. Sensors then acquire visual, thermal, spatial, or multispectral information.

Processing systems analyze the collected data using AI and computer vision. The resulting information can be transmitted to monitoring platforms or used locally for immediate response. This workflow supports continuous transformation of physical observations into digital information.

Figure 1: Intelligent Drone Monitoring Workflow



Interpretation: The workflow demonstrates how advanced drone technologies can connect aerial data collection with intelligent monitoring decisions. Mission planning establishes the monitoring requirements, while autonomous navigation supports controlled flight. Multiple sensors collect information from the target environment, after which edge or AI-based processing can identify relevant patterns and anomalies.

The processed information is transmitted to monitoring interfaces where users can interpret results. Intelligent decision support represents the final stage, enabling monitoring teams to respond to identified conditions. This integrated workflow reduces separation between data acquisition, analysis, and operational decision-making.

6. Discussion

Advanced drone technologies provide an effective platform for intelligent monitoring because they combine mobility, sensing, computing, and communication within a single system. Unlike conventional ground-based monitoring, drones can rapidly access large or difficult-to-reach areas and collect detailed information from multiple perspectives. The integration of computer vision and artificial intelligence can

further automate the analysis of aerial imagery. This combination creates opportunities for faster detection of environmental changes, structural conditions, operational abnormalities, and other monitoring indicators.

Autonomous navigation and edge intelligence are particularly important for future drone systems. Autonomous flight can reduce the level of continuous human control required during routine monitoring missions, while edge computing can enable selected analyses to occur close to the data source. These capabilities can improve responsiveness when communication links are limited. However, autonomous operation must be supported by reliable navigation, obstacle detection, flight-control mechanisms, and appropriate safety procedures to prevent unintended behavior.

The application of advanced drones across agriculture, infrastructure, disaster management, environmental monitoring, and industrial operations demonstrates their broad technological potential. Nevertheless, successful implementation depends on more than technical capability. Battery endurance, weather conditions, data security, communication reliability, regulatory requirements, and public acceptance can influence operational effectiveness. Future intelligent monitoring systems should therefore combine technological innovation with responsible data management, safety engineering, energy efficiency, and application-specific system design.

7. Challenges

7.1 Battery Capacity and Flight Endurance

Battery capacity remains a major limitation for many drone monitoring applications. Monitoring missions may require extended flight durations, but onboard sensors, processors, communication equipment, and propulsion systems consume considerable energy. Advanced AI processing can further increase computational power requirements, potentially reducing operational endurance.

Limited flight duration can affect monitoring coverage and mission continuity. Frequent battery replacement or recharging may interrupt monitoring operations and increase logistical requirements. Energy-efficient processors, lightweight sensors, optimized flight paths, improved battery technologies, and intelligent power-management strategies can help address this challenge. Future drone platforms should therefore consider energy consumption during hardware selection, mission planning, and AI model deployment.

7.2 Communication and Data Transmission

Intelligent drones often generate substantial quantities of imagery, video, sensor measurements, and spatial information. Transmitting this information continuously can require reliable and high-bandwidth communication connections. Remote or geographically challenging environments may not provide stable connectivity, potentially interrupting real-time monitoring.

Communication limitations can also affect remote control and coordination between drones and monitoring centers. Edge computing provides one possible solution by allowing selected data-processing functions to occur locally. Instead of transmitting all raw information, drones can send processed results or relevant events. Future research should investigate resilient communication architectures combining wireless networks, edge processing, adaptive data transmission, and temporary communication infrastructure.

7.3 Autonomous Navigation and Safety

Autonomous drones must operate safely in environments containing buildings, trees, power infrastructure, vehicles, people, and other obstacles. Navigation errors can result from inaccurate positioning, sensor limitations, changing weather, or unexpected objects. Autonomous monitoring therefore requires reliable perception, localization, path planning, and flight-control mechanisms.

Safety becomes particularly important when drones operate near populated areas or critical infrastructure. Systems should be capable of detecting obstacles and responding appropriately when normal operation becomes unsafe. Redundant sensing, geofencing, emergency landing mechanisms, fault detection, and human oversight can improve operational safety. Future research should focus on robust autonomous navigation under uncertain and dynamically changing environmental conditions.

7.4 Cybersecurity, Privacy, and Regulation

Connected drones can collect sensitive visual and spatial information and communicate with external systems. Unauthorized access could potentially affect flight operations, monitoring data, or connected infrastructure. Cybersecurity is therefore an important component of intelligent drone architecture. Secure authentication, encrypted communication, protected software, and access management can reduce potential vulnerabilities.

Privacy and regulatory requirements also influence drone deployment. Monitoring populated areas may involve collection of identifiable information, creating concerns regarding responsible data use and storage. Aviation regulations can further define operational limitations. Future drone frameworks should integrate cybersecurity, privacy protection, data governance, and regulatory compliance into system design rather than treating them as separate post-deployment considerations.

8. Future Research

Future research should investigate energy-efficient intelligent drones capable of performing advanced AI inference with reduced power consumption. Lightweight neural networks, specialized AI accelerators, adaptive sensing, and intelligent mission planning could improve flight endurance. Research should also explore autonomous drone systems capable of adjusting monitoring routes according to detected events or changing environmental conditions.

Further research should examine multi-drone and swarm-based monitoring architectures. Coordinated drone teams could divide large monitoring areas into smaller regions and share information through communication networks. Such systems require reliable coordination, collision avoidance, task allocation, and distributed decision-making. Edge-cloud cooperation could also provide a flexible architecture in which time-sensitive processing occurs locally while computationally intensive analysis is performed remotely.

Future empirical studies should evaluate drone monitoring systems using standardized indicators such as detection accuracy, flight endurance, navigation reliability, processing latency, communication performance, energy consumption, coverage area, and operational safety. Research should also investigate digital twins, explainable AI, secure autonomous navigation, privacy-preserving monitoring, and environmentally sustainable drone operations to support responsible long-term deployment.

9. Conclusion

Advanced drone technologies have become increasingly important for intelligent monitoring because they provide flexible aerial mobility, high-resolution sensing, autonomous navigation, and rapid information collection. Their integration with artificial intelligence and computer vision can transform aerial observations into useful monitoring information. These capabilities create opportunities across agriculture, infrastructure, environmental monitoring, disaster management, industrial operations, transportation, and public safety.

The analysis demonstrates that intelligent drone monitoring depends on the coordinated operation of multiple technologies. UAV platforms provide mobility, while positioning systems support navigation. Cameras, LiDAR, thermal sensors, and multispectral technologies provide complementary information. Artificial intelligence and edge computing can support local interpretation and rapid detection, while communication technologies connect drones with monitoring platforms and decision-support systems.

Several challenges continue to influence practical deployment. Battery limitations, communication constraints, autonomous navigation, safety, cybersecurity, privacy, and regulatory requirements can restrict drone operations. These challenges demonstrate that technological capability alone is insufficient for successful intelligent monitoring. System designers must consider energy efficiency, reliable communication, safe autonomy, secure information management, and application-specific operational conditions.

Overall, advanced drone technologies provide a strong foundation for next-generation intelligent monitoring systems. Future development should emphasize energy-efficient platforms, autonomous navigation, AI-enabled perception, edge intelligence, swarm coordination, secure communication, digital twins, and responsible data management. With appropriate integration and systematic validation, drone-based monitoring can become more responsive, scalable, efficient, and adaptable across diverse technological and environmental applications.

References

1. Colomina, I., & Molina, P. (2014). Unmanned aerial systems for photogrammetry and remote sensing: A review. *ISPRS Journal of Photogrammetry and Remote Sensing*, 92, 79–97.
2. Eisenbeiss, H. (2009). *UAV photogrammetry*. ETH Zurich, Institute of Geodesy and Photogrammetry.
3. Everaerts, J. (2008). The use of unmanned aerial vehicles (UAVs) for remote sensing and mapping. *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, 37, 1187–1192.
4. Finn, R. L., & Wright, D. (2012). Unmanned aircraft systems: Surveillance, ethics and privacy in civil applications. *Computer Law & Security Review*, 28(2), 184–194.
5. Floreano, D., & Wood, R. J. (2015). Science, technology and the future of small autonomous drones. *Nature*, 521(7553), 460–466.
6. Grenzdörffer, G. J., Engel, A., & Teichert, B. (2008). The photogrammetric potential of low-cost UAVs in forestry and agriculture. *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, 37, 1207–1214.

7. Hassanalian, M., & Abdelkefi, A. (2017). Classifications, applications, and design challenges of drones: A review. *Progress in Aerospace Sciences*, 91, 99–131.
8. Jensen, J. L. R., & Mathews, A. J. (2016). Assessment of imagery acquired by small unmanned aerial systems for precision agriculture. *Journal of Unmanned Vehicle Systems*, 4(3), 127–138.
9. Lucieer, A., Robinson, S., Turner, D., Harwin, S., & Kelcey, J. (2012). Using 3D spatial information from structure from motion and multi-view stereopsis to improve precision in unmanned aerial vehicle remote sensing. *Remote Sensing*, 4(12), 3692–3712.
10. Matese, A., Toscano, P., Di Gennaro, S. F., Genesio, L., Vaccari, F. P., Primicerio, J., Belli, C., Zaldei, A., & Gioli, B. (2015). Intercomparison of UAV, aircraft and satellite remote sensing platforms for precision viticulture. *Remote Sensing*, 7(3), 2971–2990.
11. Nex, F., & Remondino, F. (2014). UAV for 3D mapping applications: A review. *Applied Geomatics*, 6, 1–15.
12. Pajares, G. (2015). Overview and current status of remote sensing applications based on unmanned aerial vehicles (UAVs). *Photogrammetric Engineering & Remote Sensing*, 81(4), 281–329.
13. Rango, A., Laliberte, A., Herrick, J. E., Winters, C., Havstad, K., Steele, C., & Browning, D. (2009). Unmanned aerial vehicle-based remote sensing for rangeland assessment, monitoring, and management. *Journal of Applied Remote Sensing*, 3(1), 033542.
14. Remondino, F., Barazzetti, L., Nex, F., Scaioni, M., & Sarazzi, D. (2011). UAV photogrammetry for mapping and 3D modeling—Current status and future perspectives. *International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, 38, 1–6.
15. Siebert, S., & Teizer, J. (2014). Mobile 3D mapping for surveying earthwork projects using an unmanned aerial vehicle (UAV) system. *Automation in Construction*, 41, 1–14.
16. Turner, D., Lucieer, A., & Watson, C. (2012). An automated technique for generating georectified mosaics from ultra-high resolution UAV imagery. *International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, 39, 55–62.
17. Wallace, L., Lucieer, A., Watson, C., & Turner, D. (2012). Development of a UAV-LiDAR system with application to forest inventory. *Remote Sensing*, 4(6), 1519–1543.
18. Watts, A. C., Ambrosia, V. G., & Hinkley, E. A. (2012). Unmanned aircraft systems in remote sensing and scientific research: Classification and considerations of use. *Remote Sensing*, 4(6), 1671–1692.
19. Westoby, M. J., Brasington, J., Glasser, N. F., Hambrey, M. J., & Reynolds, J. M. (2012). ‘Structure-from-Motion’ photogrammetry: A low-cost, effective tool for geoscience applications. *Geomorphology*, 179, 300–314.
20. Whitehead, K., & Hugenholtz, C. H. (2014). Remote sensing of the environment with small unmanned aircraft systems (UASs), part 1: A review of progress and challenges. *Journal of Unmanned Vehicle Systems*, 2(3), 69–85.