IJRAR.ORG E-ISSN: 2348-1269, P-ISSN: 2349-5138

INTERNATIONAL JOURNAL OF RESEARCH AND ANALYTICAL REVIEWS (IJRAR) | IJRAR.ORG
An International Open Access, Peer-reviewed, Refereed Journal

LONG RANGE UNMANNED AERIAL VEHICLE FOR FORESTRY MONITORING USING LIDAR

[1]Pranit Jadhav, [1]Rajendra Pawar, [2]Nachiket Marne, [2]Adhiraj Garg, [2]Aakash Padval
[1]UG Student, [1]Assitant Professor, [2] UG Student,
[1] School of Computer Engineering & Technology,
[2] School of Mechanical Engineering
[1, 2] Dr. Vishwanath Karad, MIT World Peace University Pune, India

Abstract: Research in forestry is one of the areas where drones have recently found application, thanks to the high-resolution data that can be obtained in a short period of time and at a low cost. While manned air-craft and satellite remote sensing have their place, drones can fill in many of the gaps left by these methods, particularly when it comes to forest management and land use. The goal of this research is to provide a brief overview of the many UAV (Unmanned Aerial Vehicle) applications in forestry, such as forest mapping, forest management planning, canopy height model generation, and mapping forest gaps. This study. They have a wide range of potential applications in the near future and should be implemented quickly in a variety of settings for forest management sustainability**.**

***Index Terms* - Drones, UAV, remote sensing, forest management.**

I. INTRODUCTION

1.1 Drone in the Forestry Industry

A wide range of positive externalities can be gained from natural, semi-natural, and planted forests. [1] Goods (wood and food), ecosystem services (carbon storage, water quality, air quality, and wildlife habitat), and social and cultural components are only a few examples of these advantages (recreation).For the purposes of this discussion, we'll use the term "sustainable forest." As a result of climate change, there is a need to modernize the framework for forestry inventory [3]. When conducting regular inventory, a handheld device is necessary for collecting information on the ground. Typical inventory processes necessitate the collection of data from the field labor-intensive, time-consuming, and, most importantly, expensive data collection methods Furthermore, the campaign's field efforts are confined to a small geographic area to maximize its impact. An acceptable number of field inventories is severely constrained [2].

Precision forestry techniques must be deployed promptly even when the forest structure is altering in unanticipated ways as a result of climate change. Pressure can come from biotic or abiotic sources [3]. Sensor- equipped specialized planes and unmanned aircraft systems (UAS) are gradually becoming more commonplace. They're still there, though. Researchers are looking into various aspects of forest.management and optimization, including the importance of decision support for forestry managers, entrepreneurs, and other decision- makers is growing, as are researchers [4]. To accommodate forest modelling in a variety of situations and for a wide range of management objectives, RS provides data with multiple spatial, spectral band, and time resolutions (economic, monitoring, conservation, and restoration). This means that data on a number of basic forestry characteristics can be obtained from RS platforms rather than traditional field- based inventories [1]. Regardless, RS is widely used in forestry. High temporal resolution photos are required [5]. Achieving regional or local forestry objectives with the geographical and temporal resolutions afforded by satellite-based data is often not possible when compared to the traditional technique of flying, while space- borne RS platforms do not have the capability to meet these objectives. Aircraft are expensive, despite the fact that they generate things with a more appropriate spatial scale. Time-series monitoring should be done on a regular basis [6]. Overcast sky conditions [7], which limit electromagnetic radiation, make data from piloted aircraft and satellite platforms subject to information loss and data deterioration. Drones (also known as unmanned aerial vehicles, or UAVs) with GPS and digital cameras are excellent. Because of their excellent spatial resolution and processing speed, they are perfect at a lesser cost and with shorter lead times [8]. Because of their versatility, unmanned aerial vehicles (UAVs) have become increasingly popular. As one of the most important technological instruments, they can be used in a wide variety of ways in the future steadily expanding applicability [9] and consequently increasing use in small-scale precision forestry. On a local level, they have surpassed traditional RS platforms New advances in UAV technology, as well as computer vision and other related research topics, have opened up a slew of new possibilities for practical forest management, including the ability to collect and analyze field data more easily, as well as the ability to create bespoke datasets tailored to the specific needs of each project [10]. There are a few issues with using UAVs instead of more traditional RS platforms that have nothing to do with forest ecology Surov and Kuelka [10], to their knowledge, are the only sources reporting an accurate scope. It can only be used in a small precise UAV data and the high resolution required. In order to collect high- frequency data over a large area, it is not possible. Forest. The primary drawbacks of UAV flights are their short flight times, which means they can only cover a small area [11], and their vulnerability to certain environmental factors. Unfavorable weather conditions include wind, rain, and sudden and bright light conditions. All of this requires a lot of computing power and time, which means that UAV photography products require a lot of money and time to produce [1]. Unmanned aerial vehicles (UAVs) are likewise subject to policies and rules that control their use (restriction on airspace use).

The researchers' inability to investigate all possibilities is due in large part to this. Civil unmanned aerial vehicles (UAVs) are employed [7]. Although the disadvantages of using UAV technology over other RS systems have been described, it is clear that the advantages outweigh the disadvantages. Unmanned aerial vehicles (UAVs) can be a very valuable tool when utilized appropriately and in conjunction with on-the-ground surveys and local experience. In response to the increased demand for forest monitoring and mapping, especially over small regions, Data that is more precise is required. Unmanned aerial vehicles (UAVs) have seen a substantial increase in utilization in recent years. Unmanned aerial vehicles (UAVs) are likewise subject to policies and rules that control their use (restriction on airspace use). The efficiency, security, and portability of these vehicles make them an excellent alternative to traditional automobiles. [5, 7] On-demand data acquisition and precise positioning are just a few of the perks of using a GNSS system.

1.2 **FOREST REMOTE SENSING UAV RESEARCH TOPICS, VEHICLE TYPES, AND SENSORS ARE DISCUSSED IN THIS SECTION**

The use of smart and low-cost instruments in precision forestry, such as unmanned aerial vehicles (UAVs), has expanded tremendously in recent years, according to a large number of studies published between 2018 and the middle of 2020. When looking at papers, systematic reviews, conference proceedings, and books, a search for "UAV" and "forest" yielded in over 600 references [18]. Several scholars are presently investigating the use of unmanned aerial vehicles (UAVs) in conjunction with other real-time systems (RS) platforms in order to address a diverse variety of academic difficulties [4, 5, 13, and 19]. There are two categories of research questions: dendrometric parameter estimations and monitoring and conservation strategies. In some applications, such as predicting fundamental physiological parameters, it is feasible to deploy unmanned aerial vehicles (UAVs) in 2d images and 3d images mapping, with various degrees of effectiveness estimation of the height, lai, chlorophyll content, and the size and location of the crown of each tree, as well as the estimation This cluster can be linked to a subset of items related to the estimation of derived dendrometric parameters. Plant growth, density, and other forestry duties are all monitored. Deter-mine marketable biomass; identify species; and inspect forestry operations are all necessary steps in the process. Post-harvest data and infection detection and control. Climate change and changes in woodland biodiversity are driving the use of un-manned aerial vehicles (UAVs) for conservation and restoration efforts in the second cluster. Using unmanned aerial vehicles (UAVs) in particular, ecologists can map and control weed vegetation? Deforestation assessment and monitoring, as well as the presence of invasive alien species In order to aid in the prevention of fires and post-fire monitoring, it is necessary to use gap identification, forest wildfire detection and management, in particular to identify and create risk maps and to monitor after a fire. UAVs and their sensors can also be used to measure quantities. It's a good idea to monitor changes in aboveground biomass (AGB) over time to see how climate change affects it. Changes in land use affect forest ecosystems' global carbon cycle. RGB sensors can be used to estimate fractional vegetation cover, expose object in a specific area, and recognize items when using UAV sensors in forestry. The term "invasive species" refers to organisms that have spread into a new area and become established there. When it comes to LAI, the most commonly used sensors are those in the visible and near-infrared spectrums. These include multispectral, infrared, and hyper spectral sensors, as well as those that can detect disease and water stress. Sensors. When it comes to water stress detection [6, 7], forest fire monitoring [8, 9], and animal monitoring in the wake of a fire [10], multispectral imaging has been used. It is possible to use sensors to identify burnt areas- Lidar sensors, which can provide exact measurements of ground objects and can also gather data below the canopy, are essential for a successful forest inventory [40, 41]. Given that Lidar can penetrate the forest canopy, it is a very useful instrument for taking direct 3D measurements of many tree attributes, even at a fine-grained scale [1]. In order to determine carbon dynamics [48], it is feasible to identify individual trees and their crowns, gather inventory information such as diameter [5, 6], height [7], and biomass [48], and analyze the data. Several studies have demonstrated that LIDAR measurements are physiologically and management-relevant, including their application in over story characterization [9], forest restoration [20], wildfire prevention [21], and post- fire monitoring [12]. The comparatively ex-pensive cost of LIDAR technology, in spite of this, makes comparisons with optical sensors necessary on a regular basis. As an example, optical measurements can be used to measure the height of plants.

1.3 COMPONENTS AND THEIR SPECIFICATION

Chassis: Figure (2) shows the chassis, which can be seen in more detail. This is the quadcopter's skeleton; it serves as the vehicle's foundation. Specifically, the quadcopter's design and stability. The quadcopter's skeleton is its chassis. In order for the frame to function properly, it must be both strong and light. Ideally, it should be sturdy enough to bear the weight. An adequate weight and lightness make it capable of taking off and landing. It is possible to construct it out of Based on the efficiency, stiffness and the operation to be performed, two different materials are used. Carbon fiber and aluminum are examples of these materials.

Fig. 1. Quadcopter Frame

Fig. 2. Motor

Motor: Figure 2 shows an engine. One of a vehicle's most critical components is its motor. Those are the numbers 12 and 13, respectively. In a formalized paraphrase each propeller has its own motor. Each propeller has its own motor .It must have the same dimensions and be calculated in kV. Speed increases with increasing kV. It is possible for the motor to turn the flight time decreases as a result of this, as does the speed of the motor. a greater amount of battery life.

Propeller: To get the plane airborne, a motor powers the propellers. A Quadcopter has four propellers. All four propellers rotate in the same direction. [13] Figure 3 shows propellers. The rotational speed and load-carrying capacity of an aircraft are controlled by the propellers. Longer Propellers require more time to accelerate and decelerate, but they can produce more lift low speed. Speed can be varied more quickly with shorter propellers, though. In order to spin, you need more energy.

Fig. 3. Propeller

Fig. 4. Flight Controller

Flight Controller: Figure 4 shows the flight controller. It's similar to the flight controller in that I'm referring to the numbers 12 and 13. The motherboard of a quad-copter. RPM of each motor is controlled by the controller input has been provided. Flight control is delegated by means of a pilot order to the multirotor. The motors are then moved forward or backward in accordance with the given command. Transmitter and Receiver: A Transmitter and a Receiver Messages are exchanged between the transmitter and the receiver. The quadcopter receives and transmits the signals. The pilot transmits a message to the ground crew. In order for a quad-copter to perform a specific action while flying, the receiver receives the signals and processes them. It is controlled by the flight controller. Each transmitter and receiver combination is one-of-a-kind. 'There is no way to modify the quadcopter. The receiver has a variety of channels that can be used for different purposes. You can do a variety of things such as hovering, flying, and changing direction. A variety of other options are also available to you.

Fig. 5. Transmitter-Receiver

Fig. 6. ESC

Fig. 7. Battery

Electronic speed controller: Figure 6 shows an ESC (electronic speed controller). An ESC (electronic speed controller) regulates the speed of a motor by supplying the exact amount of electricity that the motor requires [12]. The size of the ESC varies from one motor to the next depending on the size of the drone's chassis and the motors themselves. Instead of using the battery directly, the transmitter can be connected via the ESC's battery eliminator circuit.

Battery and Battery Charger: Figure 8 shows a sample battery. The battery [7] is the quadcopter's primary power source. The quadcopter is typically powered by a Lithium Polymer (Lipo) battery. A drone's battery life is influenced by the weight of the drone, the size of the drone, its weight, and its size. It all depends on what the drone is doing.

II. WORKING:

The systematic design and connections of all the components is shown in figure 8.

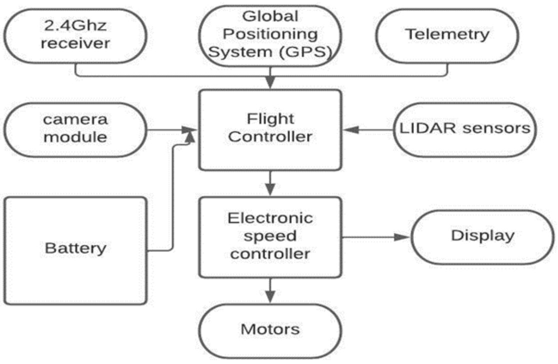

Fig. 8. System Design

III. Literature Review:

The majority of the time, engineers re-invent the wheel [6]. Many strides have been made in these specific areas. Because of its role as a guardian of Earth's ecosystems, the forest is considered one of the most valuable and important resources. Harmony with the natural world Unrestrained human action or natural variables that influence social activity in a unique way do cause forest fires on occasion. It is one of the most dangerous natural disasters [7]. By detecting wildfire smoke, Simon Philipp Hohberg [8] demonstrated that CNNs are a promising solution for improving camera-based systems for automatic camera detection [9]. Smoke-inducing locations can be identified by trained algorithms with an FPR of about 1%. About 60% of all smoke sequences are detected, despite the fact that some smoke sequences are not picked up by the system. There are many important things to know about the effects of fire on the earth's mantle as well as how to detect it. A forest fire sparked the underlying blaze. In order to cover as much ground as possible, the sensor network needs to have a large number of sensors. Nodes [9] necessitate low-priced sensors. Fire and other hazards can be detected with the help of high-sensitivity video cameras. There were a total of 23 alarms that were not true. Materials and methods Development and operation of drones The Conservation Drone uses the 'ArduPilot Mega' for its autopilot technology (APM). Among other things, the APM is equipped with a computer processor, a GPS, a data recorder, pressure and temperature sensors, airspeed sensors, a triple-axis gyro, and an accelerometer. To transform most remote control model aero planes into autonomous drones, the APM and open-source mission planning software may be used together (APM Planner). The design of our first drone was inspired by a well-known model plane. There is enough space in the fuselage for the APM and an on-board camera to be installed in this plane, which costs just $100. A 2200 mAh (mille ampere-hour) battery has been shown to allow drones to fly for up to 25 minutes each mission and 15 kilometers in total during field testing. It is possible to equip the drone with a recording device as well. With a shock- resistant housing, a GoPro HD Hero camera captured the action (gopro.com). On the plane's belly, this camera was angled 45 degrees forward and down. For our test flights, we recorded all of the footage at a quality of 1080p and a frame rate of 60 fps. Using the APM Planner, we selected waypoints on a Google satellite map to create the flight paths for each mission. You can programmer the drone to fly off and land on its own, or to circle a specific point for a predetermined amount of time. Ground speed and other flight parameters can also be programmed.

Study Area: In Mulshi, Maharashtra, the drone was tested in a research area near Pune. Regrowth lowland rainforest has been selectively logged for most of the vegetation at our research site. There are only a few remaining contiguous lowland rainforests in both of our study sites. Boars, livestock, and poultry farms are just a few of the animals that call this ecosystem home.

Missions: In December 2021, we had a total of five successful drone flights. The primary purpose of these trips was to document land use and human activity in our research area through photographs and videos. To begin, the drone was programmed to fly a simple transect trip of 3 kilometres at a height of 150 to 500 metres above ground. An important part of this mission was to demonstrate the drone's capabilities for tracking wildlife activity in and around forests.

IV. RESULTS AND DISCUSSION

Mapping of land use and cover Photographs taken during our transect expedition reveal distinct land uses, including oil palm plantations, maize crops and habitations as well as logged regions and forest paths Because the flight path of each mission, as well as the geo-tagged photos, are shown on Google Earth, the location of points of interest in the photographs may be readily seen.

Table 1. Weight

Drone Weight	Battery Weight	Equipment Weight	Total Weight
875 gram	100 gram	-75 gram (negligible)	900 gram

Table 2. Thrust

Power to weight ratio	Number of motors	Total Thrust	Thrust per Motor
3.111:1	4	2800 gram	700 gram

DETECTING HUMAN ACTIVITIES: Conservation Drone video footage, in addition to still images and mosaics, may be used to detect active human activity in addition to the other methods. It was possible to see individual forest trees and animals in video footage captured at quite low elevations (150-200 m above ground).The drone was able to track the activities of the surrounding environment, such as fires and recent logging, while flying at 200 metres above the ground. Smoke plumes could be seen rising from various locations across the terrain in footage from the transect expedition, for example. Using this information, local rangers could better target their patrols in trouble spots.

Table 3. Thrust and Weight

Type of drone	Weight	Thrust	Total Thrust
Quadcopter	900 grams	700 gram/motor	2800 grams

DRONE OPERATION: Conservation drones must be easy to use for non-specialists, such as conservationists and field ecologists, to ensure their success. Prototype systems are already meeting this criterion when using the APM Planner to plan each mission. In order to man oeuvre the drone in a tight (100 m) space while avoiding trees and other obstacles, it requires a significant amount of manual control. The drone performed flawlessly in our field tests, which included five missions and re-turned it safely to its launch site on each occasion. We encountered no difficulties. Stalls were seen while the drone was flying against severe headwinds (more than 20 km/h). Instead of flying straight forward, it will zigzag between waypoints. The drone should only be used in windy conditions with a wind speed of less than 10 kilometres per hour, according to the manufacturer.

PHOTO AND VIDEO QUALITY: A drone's image resolution is influenced by a number of factors, including altitude, focal length, and the camera's sensor size. The camera's metering and focusing should be adjusted to be automatic in order to correct for the drone's movement while in flight.

LAND USE CHANGE AND HUMAN ACTIVITY DETECTION: Observations made during testing have shown that the conservation drone is capable of tracking and monitoring changes in land usage. It was possible to identify even the tiniest of crops by looking at the images. Apart from collecting information on logging routes and forest fires, the Conservation Drone may also collect information about human activities in the area. Since limited conservation resources have led to illegal logging and encroaching on protected areas, the drone could aid in enforcing their boundaries. In addition, because of the low operating costs of the drone, target areas could be inspected more frequently in order to keep tabs on possible land use changes and activities. Another possible use for the drone is "ground trothing." Land use and cover classifications based on satellite data must be validated on the ground before they can be considered accurate or reliable. Local employees can only cover a small portion of the area being classified due to logistical and financial constraints (and the fact that this is nearly impossible in the most remote and inaccessible locations).Using conservation drones to verify satellite-based land use classification might theoretically be more efficient and effective than using local researchers on the ground since they can be deployed more rapidly and across wider areas.

Biodiversity surveys in other Ecosystems: Using the photographs and videos we collected during our test trips, we were able to distinguish between large and small animals. Forests and savannahs, for example, which are both open environments, might possibly benefit from the usage of conservation drones in addition to the ones mentioned above. They could gather important data on the abundance and distribution of animals and resources in the ecosystems. Marine species such as turtles and dugongs can also be scanned by drones in shallow waters using their footprints on the beach.

Commented [1]:

V. CONCLUSION

While UVS, or unmanned aerial vehicles, have been around since the early 20th century, their widespread use didn't come into fruition until the beginning of this century. After a few creative minds began to use them in real-world situations, their design became more and more advanced and complex. After 2010, when the burgeoning academic excitement finally spilled over into the general public, drones began to make their way into retail stores. Despite the fact that drone research applications have been steadily improving for well over a decade, my bibliometric study shows that around 2015 was the turning point when steady growth transformed into exponential development, taking the industry by storm. A 5200 mAh battery, which has been tested in the initial stages, may be able to extend the new drone's flight time (up to 30 minutes) and range (up to 5 kilometres). Surveillance Local conservationists and researchers could save a great deal of time, money, and effort if they used drones to conduct forest and wildlife surveys in the emerging tropics. Surveillance when it comes to conservation and research in tropical regions, we believe that drones hold enormous promise.

REFERENCES

[1] Gómez, C.; Alejandro, P.; Hermosilla, T.; Montes, F.; Pascual, C.; Ruiz, L.Á.; Álvarez- Taboada, F.; Tanase, M.A.; Valbuena, R. Remote sensing for the Spanish forests in the 21st century: A review of advances, needs, and opportunities.

[2] Goodbody, T.R.H.; Coops, N.C.; White, J.C. Digital Aerial Photogrammetry for Updating Area-Based Forest Inventories: A Review of Opportunities, Challenges, and Future Directions. Curr. For. Rep. 2019, 55–75.

[3] Iglhaut, J.; Cabo, C.; Puliti, S.; Piermattei, L.; O'Connor, J.; Rosette, J. Structure from Motion Photogrammetry in Forestry: A Review. Curr. For. Rep. 2019, 5, 155–168.

[4] Pádua, L.; Vanko, J.; Hruška, J.; Adão, T.; Sousa, J.J.; Peres, E.; Morais, R. UAS, sensors, and data processing in agroforestry: A review towards practical applications. Int. J. Remote Sens. 2017, 38, 2349–2391.

[5] Raparelli, E.; Bajocco, S. A bibliometric analysis on the use of unmanned aerial vehicles in agricultural and forestry studies. Int. J. Remote Sens. 2019, 40, 9070–9083.

[6] Pádua, L.; Marques, P.; Silva, N.; Peres, E.; Sousa, J.J. Forestry remote sensing from unmanned aerial vehicles: A review focusing on the data, processing and potentialities. Remote Sens. 2020, 12, 1046.

[7] Xiang, T.Z.; Xia, G.S.; Zhang, L. Mini- Unmanned Aerial Vehicle-Based Remote Sensing: Techniques, applications, and prospects. IEEE Geosci. Remote Sens. Mag. 2019, 7, 29–63.

[8] Chianucci, F.; Disperati, L.; Guzzi, D.; Bianchini, D.; Nardino, V.; Lastri, C.; Rindinella, A.; Corona, P. Estimation of canopy attributes in beech forests using true colour digital images from a small fixed-wing UAV. Int. J. Appl. Earth Obs. Geoinf. 2016, 47, 60– 68.

[9] De Rango, F.; Palmieri, N.; Santamaria, A.F.; Potrino, G. A simulator for UAVs management in agriculture domain. Simul. Ser. 2017, 49, 149–15

[10] Surovỳ, P.; Kuželka, K. Acquisition of forest attributes for decision support at the forest enterprise level using remote-sensing techniques —A review. Forests 2019, 10, 273.

[11] Baccini, A.. 2012 Estimated carbon dioxide emissions from tropical deforestation improved by carbon-density maps. Nature Clim. Change in press.Google Scholar

[12] Koh, L. P., Miettinen, J., Liew, S. C., Ghazoul, J. 2011 Remotely sensed evidence of tropical peatland conversion to oil

palm Proc. Natl. Acad. Sci. USA 108:5127–5132.

[13] Koh, L. P., Wilcove, D. S. 2008 Is oil palm agriculture really destroying tropical biodiversity? Conserv Lett 1:60–64.

[14] Hardus, M. E., Lameira, A. R., Menken, S. B. J., Wich, S. A. 2012 Effects of logging on orangutan behavior Biol. Conserv. 146:177–187. Google Scholar | Crossref

[15] Broich, M. 2011 Time-series analysis of multi-resolution optical imagery for quantifying forest cover loss in Sumatra and Kalimantan, Indonesia International Journal of Applied Earth Observation and Geoinformation 13:277–291.

[16] Hansen, M. C.. 2008 A method for integrating MODIS and Landsat data for systematic monitoring of forest cover and change in the Congo Basin Remote Sens. Environ. 112:2495–2513.

[17] Gardner, T. A.. 2008 The cost- effectiveness of biodiversity surveys in tropical forests Ecol. Lett. 11:139–150. Google Scholar

[18] Meijaard, E., Wich, S., Ancrenaz, M., Marshall, A. J. 2012 Not by science alone: why orangutan conservationists must think outside the box Ann. N. Y. Acad. Sci. 1249:29–44.

[19] Palace, M., Keller, M., Asner, G. P., Hagen, S., Braswell, B. 2008 Amazon Forest Structure from IKONOS Satellite Data and the Automated Characterization of Forest Canopy Properties Biotropica 40:141–150.

[20] Abdulhadi, R., Mirmanto, E., Kartawinata, K. 1987 A lowland dipterocarp forest in Sekundur, North Sumatra, Indonesia: five years after mechanized logging. Proceedings of the Third Round Table Conference on Dipterocarps, ed Kostermans,AJGH), pp 255–273.

[21] Wich, S. A.. 2008 Distribution and conservation status of the orang-utan (Pongo spp.) on Borneo and Sumatra: how many remain? Oryx: 329–339