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Application of Artificial Intelligence in Drones for the Analysis of Agricultural Land Use in the Mining Lease

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The utilization of artificial intelligence (AI) has facilitated the automation of drone control, which includes the management of navigation and movement. This application can be accomplished through several methods, including GPS tracking, computer vision, and machine learning algorithms. Drones exhibit a distinctive combination of spatial coverage and resolution, rendering them indispensable for land survey and mapping. The incorporation of multiple ground-control points has the potential to yield high precision georeferencing for the Orthomosaic product.

In conjunction with field observations, drones provide a prompt and precise means of recording land data and its use. A drone survey and mapping operation was conducted within a mining lease situated near the village of Kanthariya, in the Tehsil and District of Chittorgarh, covering an area of 64.75 hectares, for the analysis of agricultural land use in the mining lease.

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1. INTRODUCTION

Nowadays, numerous industries are embracing technological advancements such as drone technology instead of conventional surveying methods. Drones offer a cost-effective, safe, and rapid solution for aerial surveys and data collection, proving particularly useful for industries such as agriculture, civil engineering, and mining, which require constant monitoring [1-3].

Agricultural and mining operations, often located in remote areas with limited human accessibility, frequently face challenges in decision-making and suffer from low work efficiency due to insufficient information [4-6].

As drone technology continues to evolve and become more affordable, and regulations become more defined, their use in the industry sector is anticipated to increase substantially [7-9].

The data captured from unmanned aerial vehicles (UAVs) can enable surveyors and engineers to make predictions and projections about regional development. Drones provide valuable information about the above-ground area's condition, thereby enhancing land use planning.

Artificial intelligence can play a significant role in automating drone control, including navigation and movement, using various techniques such as GPS tracking, computer vision, and machine learning algorithms [10-13].

Artificial intelligence gives machines the ability to interact intelligently. This is why the fusion of drones and AI is becoming increasingly important in aerial imagery and has the potential to revolutionize sectors such as energy, construction, security, and agriculture. In this research, we are utilizing AI-powered drones for the analysis of agricultural land use in mining leases.

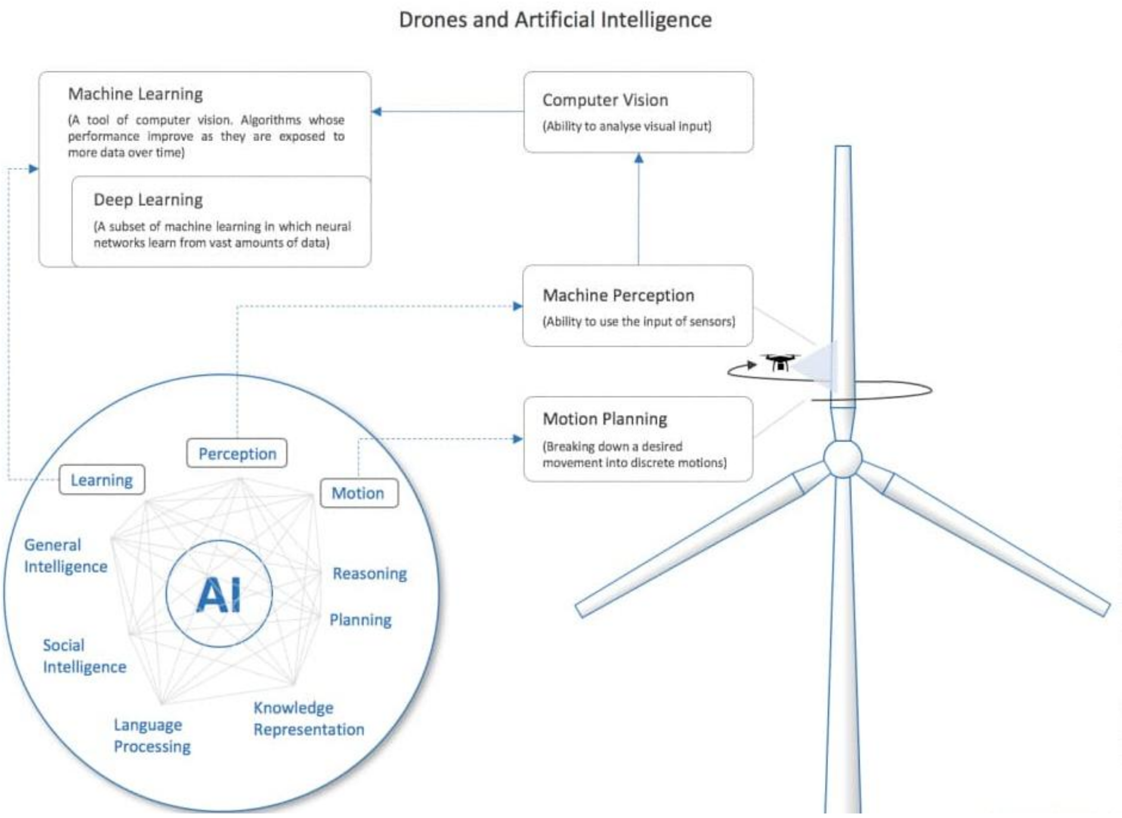

Fig. 1. Shows the application of artificial intelligence in drones

2. MATERIALS AND METHODS

2.1 Scope of Work

The scope of work includes conducting a survey of the mining lease using UAVs (unmanned aerial vehicles) equipped with cameras and other sensors. The data collected from the UAVs will then be processed using artificial intelligence algorithms to provide accurate outputs in the desired formats for analysis of agricultural land use in the mining lease.

Some of the specific tasks that may be included in this scope of work could include:

1. Conducting a pre-flight check of the UAV to ensure it is ready for use.
2. Defining the flight path and parameters for the UAV to ensure complete coverage of the mining lease area.
3. Operating the UAV and capturing images or video footage of the mining lease from various angles and altitudes.
4. Processing images by using artificial intelligence algorithms to identify different types of crops, vegetation, or other features, mining pits, haul road design and volumetric assessment of stockyards.
5. Creating maps or other visualizations of the data collected to provide an overview of the agricultural land use in the mining lease.
6. Delivering the final outputs in the desired formats for analysis, such as spreadsheets, maps, or other data visualizations.
7. The goal of this work is to provide accurate and detailed information about the agricultural land use in the mining lease, which can be used by stakeholders to make informed decisions about land management, mine planning, mine management, road planning, drainage pattern and other factors that impact the overall productivity and sustainability of the mining lease.

2.2 Field Work

The research project involved conducting a drone survey and mapping of a mining lease near the village of Kanthariya, located in the Chittorgarh tehsil and district in India. The mining lease had a total area of 64.75 hectares.

During the survey, data was captured using drone instruments within the mining lease and up to 100 meters from its boundary. The data was used to create 3-dimensional models of the mining lease. The survey area and flying path were created using KML in software applications, which allowed for precise planning and execution of the drone flights.

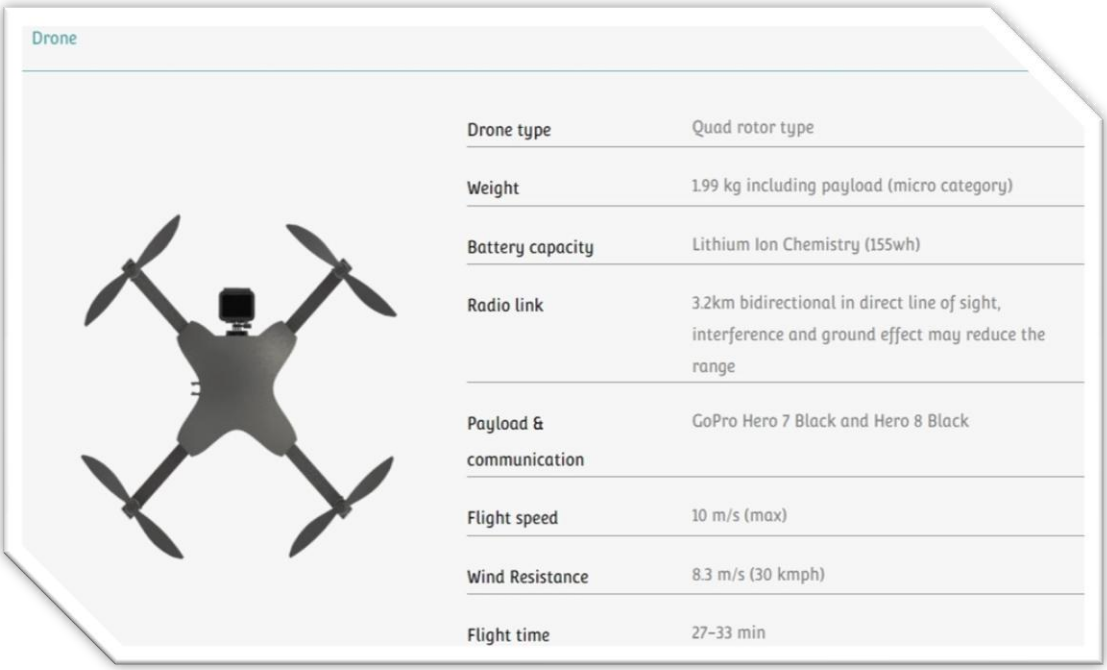

Fig. 2. Technical description of drone used for survey & mapping

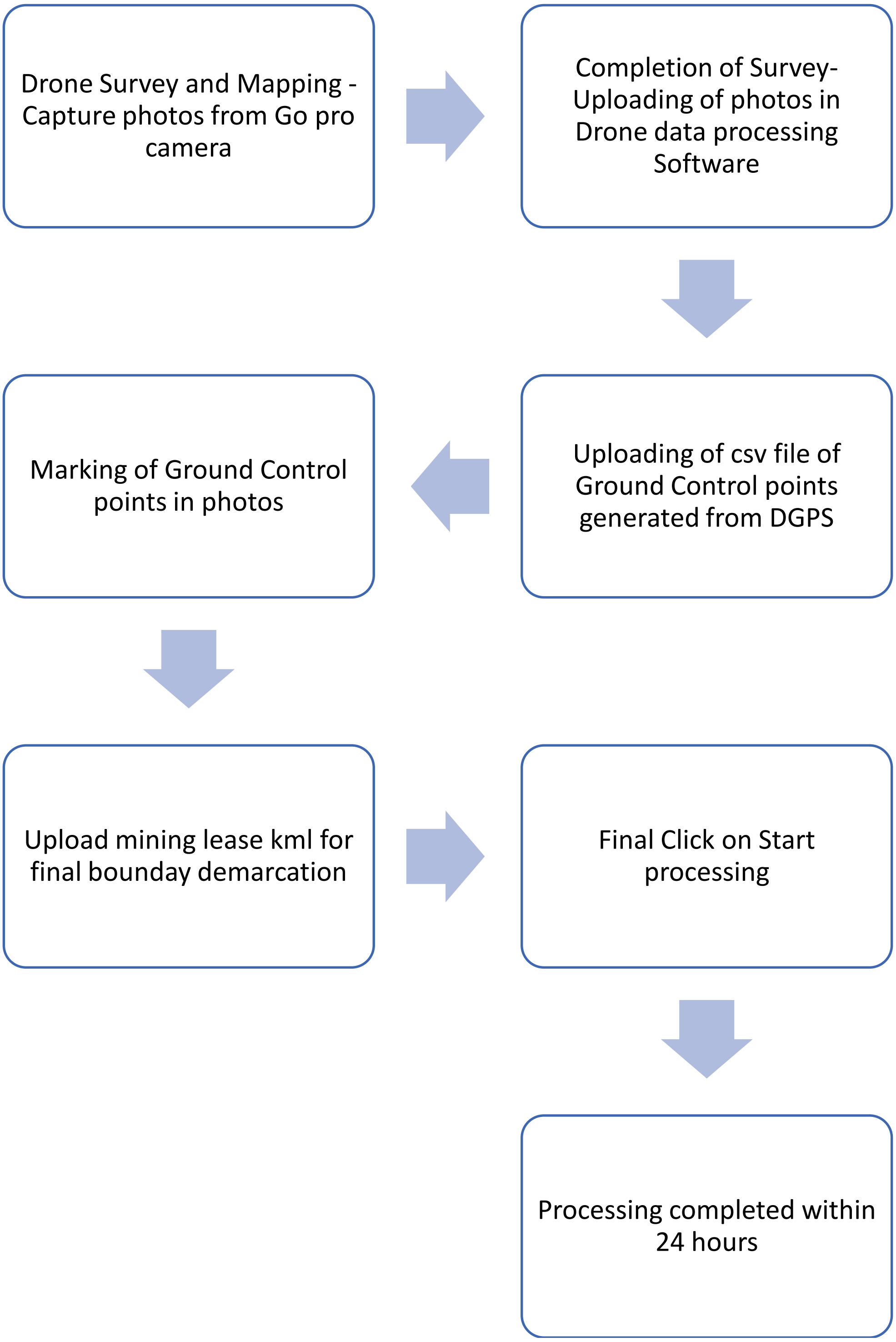

Chart 1. Flow chart of drone data processing

The drone was flown at a maximum height of 100 meters above the ground to capture high-resolution images and videos of the mining lease. To ensure accuracy, ground control points were marked using DGPS (differential global positioning system).

Overall, the fieldwork involved the use of advanced drone technology and precision planning to capture detailed data on the mining lease. This data will be used to analyze the agricultural land use within the mining lease, providing valuable insights for land management and decision-making.

2.3 Defining Drone Survey Flying Path

A drone flight plan is a predetermined combination of instructions, including coordinates, speed, altitude, direction, heading, gimbal actions, camera actions, and more that serve the purpose of guiding a drone in accomplishing a flight, and carrying out a particular mission:

1. Flight path: Determined most using a series of longitudes/latitudes and altitudes (waypoints) that automatically navigates the aircraft.
2. Speed: you may want a lower, consistent speed throughout the flight plan, ideal for mapping, or you may want to zoom to specific waypoints to perform specific tasks, such as ‘hover’ or ‘360.’
3. Heading: the drone does not have to face in the direction it is moving; for example, you may want to orient it toward a Point of Interest (POI) which can be set in some flight applications.
4. Gimbal actions: depending on whether you are mapping, inspecting, filming, live broadcasting, etc., you may want to automate gimbal actions or retain manual control.
5. Camera actions: video/image and choosing the right camera settings for your purpose.
6. Situational behavior: Set action to Return-to-Home or Hover, set the proper return altitude, and be aware of all obstacles that could be present between you and the drone’s flight path

2.4 Processing & Orthomosaic

The photogrammetry software "surveyaan" was used to process the photographs obtained from the drone survey. Orthophotos were created from the images captured during the survey. These orthophotos are useful for measuring actual distances and creating a highly accurate representation of the earth's surface in the surveyed area. The orthophotos were created by stitching together a collection of images captured from the drone survey and geometrically rectifying them to form a map of the area. The resulting map is referred to as an orthomosaic map. Orthomosaic maps are highly detailed and provide an accurate representation of the area surveyed. They can be used for a variety of applications, such as land management, crop monitoring, and planning. In this project, the orthomosaic map will be used to analyze the agricultural land use within the mining lease, providing valuable insights for decision-making and land management. The use of a powerful aerial surveying drone in capturing the images allows for highly accurate and detailed mapping of the area.

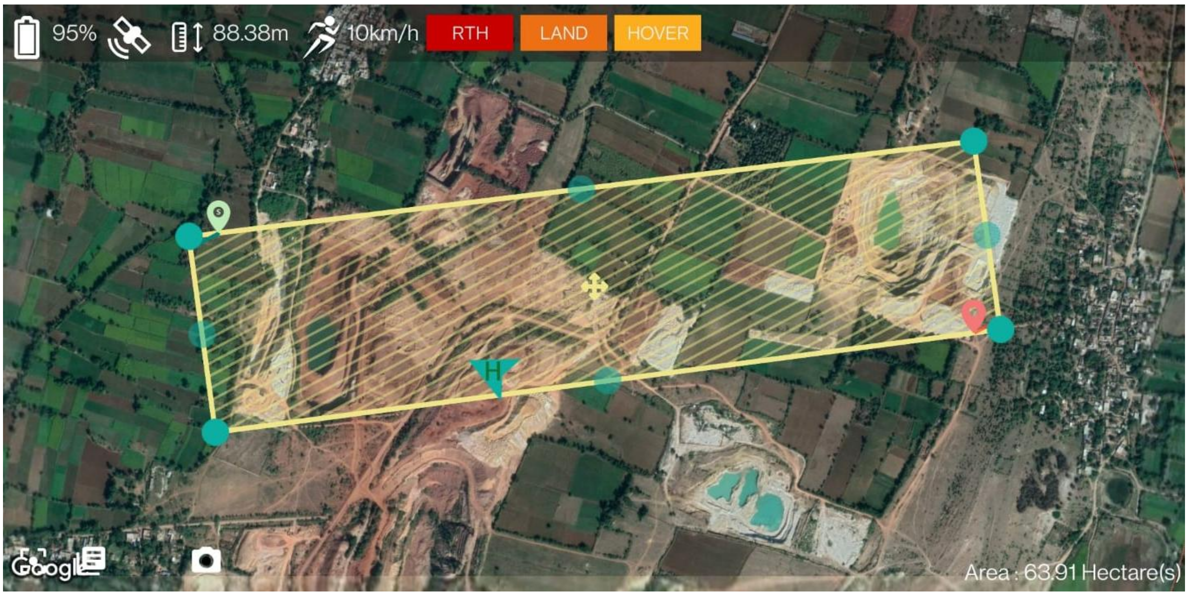

Fig. 3. Drone flying path of the study area mining lease

Fig. 4. Processed Image or Orthomosaic of the mining lease

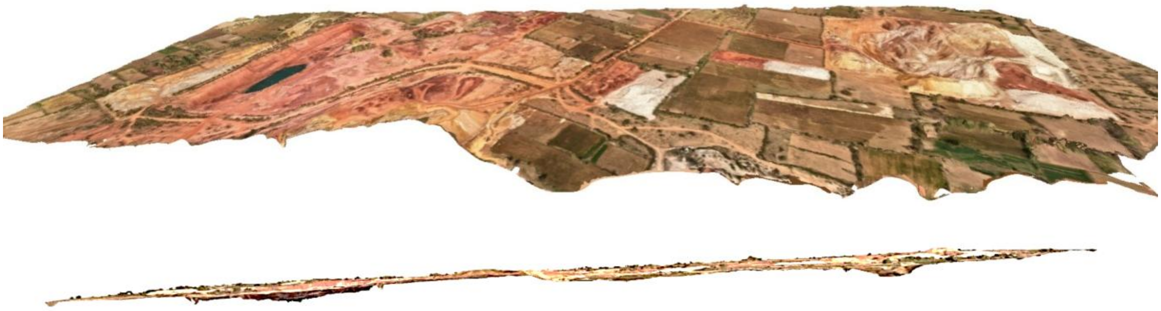

Fig. 5. 3d model, digital surface model of the mining lease

Fig. 6. Measurement tool used for analysis

Digital Surface Model (DSM) is also created which represents the elevation or terrain of the survey area as well as above-ground features like buildings, towers, houses, vegetation, and other infrastructure. DSMs are 2D representations of a 3D image that uses different colors or shades to highlight different elevation values.

A point cloud is a set of data points in space that typically represent a 3D shape or object. Each point in this cloud corresponds to the X, Y, and Z positions of a single data point that was collected or generated during the survey. Point clouds can be edited, scaled up or down, or colorized depending on your needs.

The surveyaan processing software is used for measurement and analysis of the Agricultural land use in the mining lease.

3. RESULTS AND DISCUSSION

1. The use of artificial intelligence to automate the control of drones is an application of AI in the field of drone technology. This technology can improve the accuracy and efficiency of drone operations, including navigation and movement.
2. DGPS (Differential Global Positioning System) is a high-precision GPS technology used to mark ground control points for mapping and surveying purposes. By using multiple ground-control points, we were able to achieve high geo-referenced accuracy for the Orthomosaic product, which is a type of aerial image that is geometrically corrected to be a true representation of the Earth's surface.
3. Photogrammetry software is used to create Orthomosaic products from drone images. This software uses the overlapping images captured by the drone to create a high-resolution map of the area. By using CAD (Computer-Aided Design) software, we were able to define area-specific activities, which could include activities such as mining or agriculture.
4. The use of drones for survey and mapping purposes has provided more accurate and authentic data than traditional methods, such as ground-based surveys. Drones use has also reduced the time and cost associated with traditional survey methods, making them a more cost-effective option for many applications.

We have presented a table in our results that shows the breakdown of the mining lease area into various categories, including pits and quarries, storing minerals, dumps, roads, and plantations on fresh ground. The total mining lease area covers 64.750 hectares, with 38.7392 hectares allocated for mining-related activities and 26.0108 hectares for agricultural land.

This table provides a detailed analysis of the land use within the mining lease. Our research results demonstrate that the analysis was accurate, time-saving, and cost-effective.

Table 1. Shows the Land use analysis of agricultural land in mining lease with its graphical representation

Particulars	Area in hectares
Pits & Quarry	13.6620
Storing Mineral	19.0650
Dumps	0.4576
Road	1.5546
Plantation on fresh ground	4.000
Sub Total	38.7392
Agriculture Land	26.0108
Total Mining Lease Area	64.750

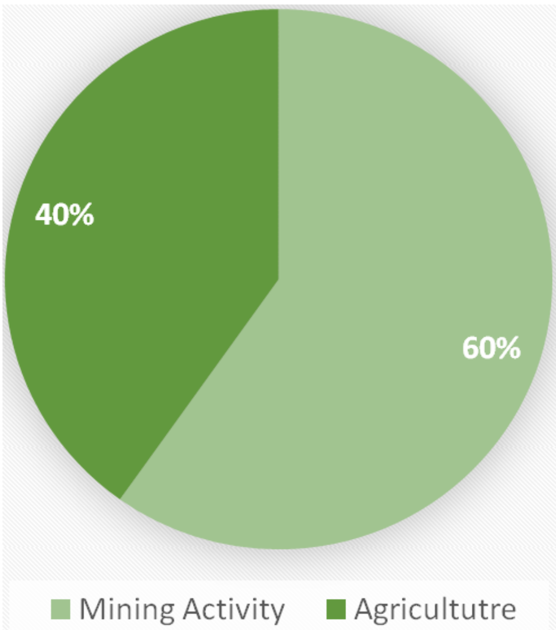

Fig. 7. Area in hectares

4. CONCLUSION

Drones are also employed in the pesticide spraying of the crops in the fields. The spraying platform is synchronized and paired with the imaging, analyzing, and automatic processor functions to effectively address affected plants or areas. The approach results in improved dosage in the infected section and reduced overall chemical utilization within the portion.

CONFERENCE DISCLAIMER

Some part of this manuscript was previously presented in the conference: 3rd International Conference IAAHAS-2023 "Innovative Approaches in Agriculture, Horticulture & Allied Sciences" on March 29-31, 2023 in SGT University, Gurugram, India. Web Link of the proceeding: https://wikifarmer.com/event/iaahas-2023-innovative-approaches-in-agriculture-horticulture-allied-sciences/.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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