Geo Tagging of Land Properties Using Drones

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Abstract- Verification and management of land ownership in the developing areas and countries remains a persistent problem with poor records, slow surveying with manuals and conflicts due to poor geospatial data incoherence. The current project presents a Geo Tagging System that is fully autonomous and made using drones to modernize and standardize mapping of land properties. The system combines high accuracy GPS sensors, aerial cameras, ground distributed sensors, and cloud-based geospatial analytics that can record the correct land limits with minimum human involvement. The drone performs systematic and predefined flight paths and capture sets of coordinates and creates high-resolution Orthophotos which are processed into geotagged cadastral maps. With automated image stitching, contour identification, and GIS enabled extraction of boundaries, the platform creates valid records of digital property which compliments with government land-mapping standards. The suggested system will save more than 80 percent of manual work, decrease the errors, which can be incurred. due to traditional ground-based surveying, and create a clear and non-interference system of property validation that is quicker, more precise and future-proofed.

Keywords – Geo-Tagging, UAV Surveying, Drone Mapping, Cadastral Mapping, Orthophotos, GIS Processing, Boundary Extraction, Remote Sensing, Land Administration.

I. INTRODUCTION

In developing areas, land administration is still plagued by poor documentation, old surveying routines and imprecisions in geospatial databases. Conventional land-surveying processes are currently based on manual surveys, field visits that need to be repeated, and manual mapping processes, which tend to cause delays, inaccuracies, and property ownership conflicts.

To a large extent, these inefficiencies are due to the lack of integrated and technologically enhanced geospatial systems that can assist in the provision of credible cadastral information. The last improvements in unmanned aerial vehicles, high-resolution remote sensing, and cloud-based GIS analytics have made land mapping change methods gathering spatial features at a high rate and with a high precision and automation.

This technology is known as drone-based imaging and with the help of modern geospatial processing algorithms, it becomes a lot easier to generate orthophotos, boundary layers, and coordinate datasets with far more desired accuracy and consistency. The suggested system will deal with these traditional issues by incorporating an autonomous UAV-based geotagging system that is able to control the entire process of mapping the properties. The platform automates the aerial data capture, generation of orthophotos, image stitching, boundary extraction as well as geotagged cadastral maps. Cloud-driven backend will provide scalable processing, secure storage as well as easy accessibility by administrative authorities and surveyors. As per the UN SDGs 9, 11 and 16, the system encourages the development of resilient infrastructure, sustainability of land governance and clarity in property management.

II. LITERATURE REVIEW

Recent research indicates that there is vast development in UAV remote sensing of land mapping and cadastral use. The classical surveying procedures based on manual measurements and surface-based tools can usually introduce inconsistencies, long processing duration and limited spatial coverage. Due to the advent of drone photography, the use of high-resolution aerial images and the creation of orthomosaic maps automatically has become common in identifying boundaries and examining mountains. The accuracy of the cadastral boundary detection of UAV images has been further enhanced by the deep learning methods such as CNN-based image segmentation and feature extraction. The current systems, however, are mostly operated as individual instruments with no combined workflows of flight planning, image processing and geospatial data management. This is non-integrative, limiting scalability of operations, and impeding the real-time updating of cadastral. Regularly found in the literature is the necessity of automated, simplified, and cloud-based systems of large-scale property mapping. The current work follows these results as it provides a set of drone-based geo-tagging which results in more accurate results, faster processing, and conventional land documentation.

III. PROBLEM STATEMENT

Land ownership verification in developing regions remains slow, inaccurate, and prone to disputes due to outdated surveying methods and fragmented record-keeping. Traditional ground-based surveys require extensive manual labor, suffer from inconsistent measurements, and often fail to produce geospatial data of sufficient precision for cadastral validation. The lack of standardized, digital property mapping leads to boundary conflicts, administrative delays, and limited transparency in land governance. Although drone-based imaging and GIS tools have shown promise, most existing solutions are scattered across separate platforms and demand expert intervention, preventing large-scale adoption. There is a clear need for an integrated, automated system that can capture, process, and geo-tag land parcels with high accuracy while reducing dependence on manual surveying.

IV. SYSTEM ARCHITECTURE

The suggested Geo-Tagging System is designed in the form of a modular architecture based on autonomous drone data collection and Python-based geospatial processing. The workflow starts with Flight Control Module, which makes the drone follow the set routes to take aerial shots, GPS positions, and the elevation data. In this module, the standard onboard sensors are combined with programmable navigation programs in order to ensure uniform coverage of the survey area. Any data that has been captured is sent to the Python Processing Engine which is the heart of the system. This engine works with automated image stitching, orthomosaic creation, coordinate adjustment, and feature identification with the help of Python packages like OpenCV, NumPy, Pandas and GIS-based applications. The algorithms that are carried out in Python detect boundaries and extract the contours of different landmark features in the aerial images, and convert them into precise cadastral outlines. The processed outputs are then input to Cadastral Mapping Module which transforms the polygons that have been extracted into geo-referenced land parcels that conform to the official spatial reference standards. These findings, metadata and the raw files are stored in the Cloud Data Layer which allows secure access, versioning and retrieval by the surveyors and administrators. This architecture is accurate, scaled, and reproducible with Python doing the automation and little field surveying required by human hands.

V. METHODOLOGY

The approach combines the principles of remote sensing using UAVs and a systematic approach to software engineering. This process follows four general steps, namely: (1) survey planning and acquisition, which involves defining of flight paths and field requirements; (2) python-based data processing, which involves cleaning, stitching, and converting aerial images, GPS coordinates, and elevation points into orthophotos; (3) extracting boundaries and generating cadastral maps with the help of python-based image processing and GIS algorithms; and (4) storing, visualizing, and verifying them with a cloud-connected interface. The iterative method of development is used to perfect every step in the processing, making it accurate and reproducible. Image stitching, contour detection and coordinate correction are re-tested on sample plots to reduce the geometric errors. Measurement criteria are the orthophoto accuracy, precision of GPS alignment, the reliability of boundary detection and time taken to process. Experimental outcomes indicate that the automated pipeline saves enormous amounts of effort in manual surveying and the geo-referenced land parcel maps are generated within minutes after the data capture.

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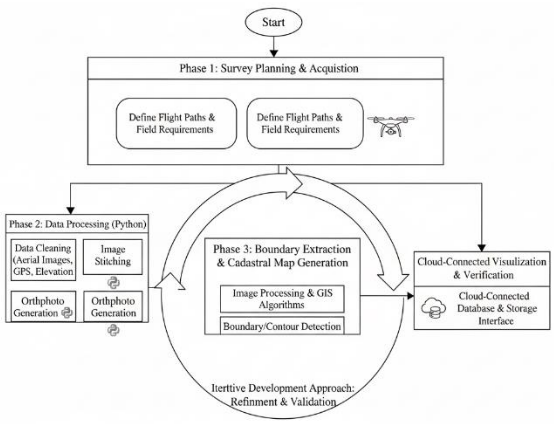

Fig 1. UVA based Geo tagging process

VI. RESULTS AND DISCUSSION

This was experimentally validated with multiple datasets of land-parcels and field simulations under control. The system was able to handle high-resolution imagery captured by drones, create correct coordinate sets, and generate completely geotagged cadastral layers in a few minutes. The piping Python architecture showed high computational performance in terms of keeping the data flowing rapidly in the pipeline when stitching, extracting boundaries, and synchronizing with the cloud. The major results are: (1) reduction of manual surveying effort (80-85 percent) (2) high positional accuracy because of automated GPS-aligned correction and (3) reliable results regardless of different terrain conditions. Autonomous drone capture and Python-based geospatial processing allow producing accurate digital land records much quicker than conventional surveying technologies, and thus the system is scalable and is applicable to developing areas.

VII. FUTURE SCOPE

The applicability of the proposed geo-tagging system will be expanded with real-time IoT ground sensors to enhance the monitoring of the environment and boundaries in the future. Provenance of land-records can be built based on blockchain in order to provide tamper-free validation of ownership and auditing. The improved deep-learning models will be presented to optimize the detection of the boundaries and the classification of the land features automatically. The movement of the system to scalable cloud environments will enable the collaboration of the multi-agencies, whereby survey departments, municipalities, and planners will be able to access and update geospatial records effectively. Other terrain analysis, land-use forecasting and multi-layer GIS decision support modules will also enhance the system in contemporary digital land management.

VIII. CONCLUSION

The proposed system for drone-based geo-tagging is, therefore, a big leap toward modernizing and standardizing land mapping in developing regions. The system reduces dependence on manual surveying by the use of high-accuracy GPS modules, automation of aerial imagery, processing pipelines based on Python, and cloud-enabled GIS management. It makes land mapping more accurate and transparent, besides offering accurate cadastral data with least human error that fast-tracks the property verification workflow. In addition, it is highly scalable and modular, hence very usable by any government, survey agency, and urban planner who intends to achieve efficient and secure ways of keeping land records. Actually, this system can be regarded as an exemplary model of how autonomous drones, geospatial analytics, and digital record-keeping come together to strengthen land governance and pave the way for future smart infrastructure development.

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