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Quick and Concise Land Boundary Mapping Using a Drone at Villa Buccu, Kerobokan, Badung, Bali

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Abstract

The effective measurement and mapping of the land is the retrieval of accurate data according to position, in accordance with mapping provisions, and efficient in both cost and time. One way that data can be retrieved effectively and efficiently is by using a drone, commonly called an unmanned aerial vehicle (UAV). Drone is a vehicle equipped with a wave control system, precision navigation (Global Positioning System/GPS) and flight control electronics so that it is able to fly according to flight planning (autopilot). This drone makes it possible to track the position and orientation of sensors implemented in local or global coordinate systems. With the drone itself, it saves time because it can have an image of an area. Premark / Ground Control Point (GCP) is a point that is commonly used to improve measurement accuracy in mapping using drones, in this case using the Global Positioning System (GPS) Geodetic / RTK Hi Target tool. Mapping Using Drones was then used by many people, including for the purposes of villa spatial planning, so to support this activity a land boundary mapping was carried out at Villa Buccu, Kerobokan, Badung Bali. The boundary of the land which is limited by the adjacent building can be mapped quickly and concisely, thus saving time and effort in its implementation, the total area of the land is 4,235.2 m2 or 42,352 are.

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1 Introduction

The need for measuring and mapping land parcels in Indonesia is still very high where there are still many uncharted land parcels. Since 2016 the government has accelerated completely systematic land registration until 2025 all land parcels in Indonesia have been registered. In 2018 alone the government is targeting 7 million fields, and in 2019 it is targeting 9 million fields (Yuntarto, 2017). For this reason, an effective and efficient method of measuring and mapping land parcels is needed to support the implementation of the mapping of land parcels.

Agrarian affairs that have not been resolved so far, namely there are 24 (twenty-four) million parcels of land out of 44 (forty-four) registered land parcels (more than 50%) registered land parcels that have not been mapped on the BPN Registration Map (Kusmiarto, 2017). One way that data can be retrieved effectively and efficiently is by using a drone, commonly called an unmanned aerial vehicle (UAV). The drone is a vehicle equipped with a flight control system through waves, precision navigation (Global Positioning System (GPS), and flight control electronics so that it is able to fly according to flight planning (autopilot).

Through drones, the scale of data detail becomes very high and the data collection process becomes easier (Zarco-Tejada et al., 2014). Drones are aircraft without pilots, these aircraft are controlled automatically through a computer program designed Mapping Using Drones was then used by many people, including for villa spatial planning purposes, so to support this activity, a land boundary mapping was carried out at Villa Buccu, Kerobokan, Badung Bali, where there was already a villa building at that location (Yanmaz et al., 2018; Wesnawa & Sudirta, 2017).

2 Materials and Methods

The research implementation is generally carried out in the form of information collection (secondary and primary data collection), field surveys, problem analysis, inventory formulation, and performance evaluation of digital data processing (Kuemmerle et al., 2013; Mogili & Deepak, 2018). The research work steps are outlined in the form of a research diagram that describes the complete stages from beginning to end sequentially to the end with a duration of one year of research. The complete research flowchart can be seen in the image below:

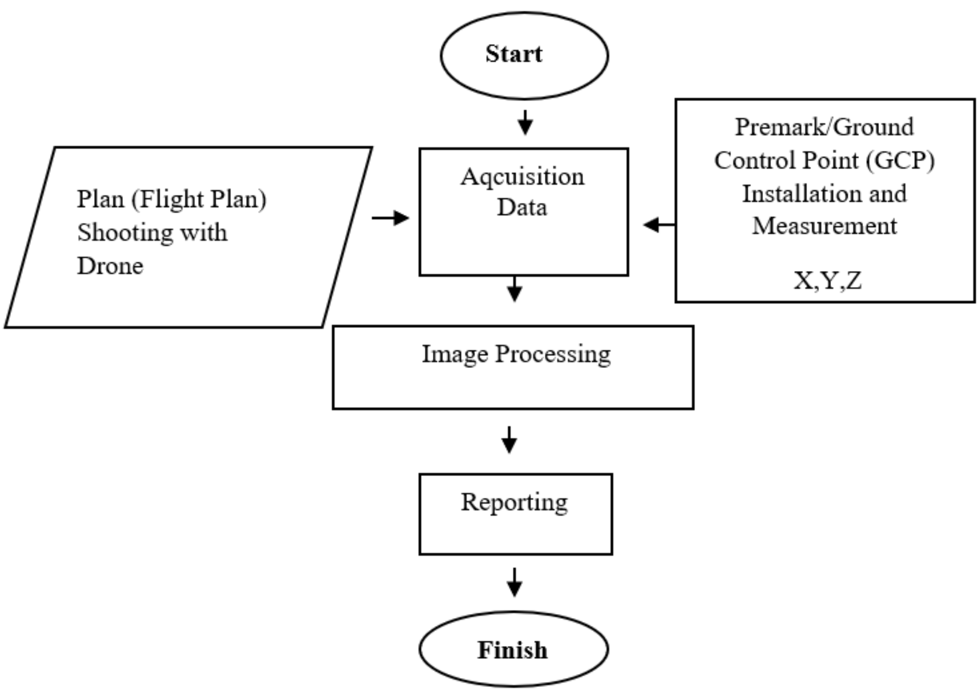

Figure 1. Flowchart of a quick and concise land boundary mapping using a drone at Villa Buccu, Kerobokan, Badung, Bali

Conducting field surveys, including among others

a) Flight Preparation
Before operating the drone, it is necessary to pay attention to the condition of the drone, the location of the flight, and whether there are many obstructions from trees, buildings, and so on. Here are some components to watch out for before, during, and after a flight.
   1) Preparation at home, including:
   Check the weather, Drone battery is full, Application is ready, Aviation area research, Memory card available, Remote battery full, Get surrounding area permit, Mission checked (mapping)
   2) Before take-off
   The compass is calibrated, the GPS drone is ready, Installing the battery and memory card, Check GPS signal strength, Gimbal is already calibrated, the RTH mode is already set, Installing the propeller correctly, No warning.
   3) During Mission/Flight
   Ensure the drone stays connected (mapping), Movement of the drone according to the direction of the mission (mapping), Drones visible to pilots (if possible), Weather remains good (wind, cloudy)
   4) After Landing
   Check photos and videos that have been taken, Turn off the drone and remote, Check the condition of the drone, Cleaning up drones and other equipment.

b) Planning (Flight Plan) Shooting with Drones.
Before mapping using drones, we must make a flight plan. A flight plan can be made by taking into account the boundary/ area to be photographed.

c) Collecting data by measuring ground control points in the field/ Premark with the Global Positioning System (GPS) Geodetic/RTK Hi Target. Pre marks are usually made in the form of a cross with the premark point being right at the intersection of the mark (Prayogo et al., 2020).

d) Data Acquisition, in this step 2 mapping methods are carried out, namely small format photogrammetry using drones, and careful measurements with geodetic GPS to get the premark coordinates. Premark functions as a binding point and reference for the map coordinate system. The same is true for polygon functions in measurements with total stations.

e) Image Processing.
At this stage, data processing is carried out by combining premarked data obtained with geodetic GPS, aerial photography with UAV, and processed with Agisoft Metashape Pro software, namely a microstation in which there is a Terrasolid Terrascan module. The stages of processing are orthomosaic image, premark registration, map layout and reporting.

One-Way ANOVA method

ANOVA, or also referred to as F test, was used to analyze the significant differences between data groups. The main purpose of ANOVA is to analyze whether the error between different data groups is significant If there is a significant difference between the different groups, then the mean is clearly different between the two groups. On the other hand, the mean difference between the groups is not significant (Agüera-Vega et al., 2017; Martínez-Carricondo et al., 2018).

In this research, there are two hypotheses to be analyzed using ANOVA at 95% CI (confidential interval), namely:

$$H0: \mu 1= \mu 2= \mu 3= \mu 4 \text{ (the average of each group of drone flying heights is the same);}$$

Ha: the average is not the same.
Meanwhile, to make a hypothesis decision, the rule is that if the F count > F critical then H0 is rejected. The formula for calculating F is: (Sullivan, 2019)

$$F = \frac{\Sigma n_j(\bar{X}_j - \bar{X})^2/(k-1)}{\Sigma\Sigma(X-\bar{X}_j)^2/(N-k)}$$
…………….………………….....(1)

Where nj = number of samples in the jth group,
Xj = the average sample in the jth group,
X = overall sample mean,
X = sample,
N = total of sample,
K = many groups

The critical F value used is 3.10 which comes from the F critical value table (df1=3, df2=20).

Analysis

The analytical work carried out includes analysis as a unit. The analysis carried out includes:

1) Analysis of the tools used
2) Measurement analysis of ground control points
3) Analysis of the accuracy obtained in the digitization of the map

Research sites

This research is located in Kerobokan Village, North Kuta District, Badung Regency, Bali

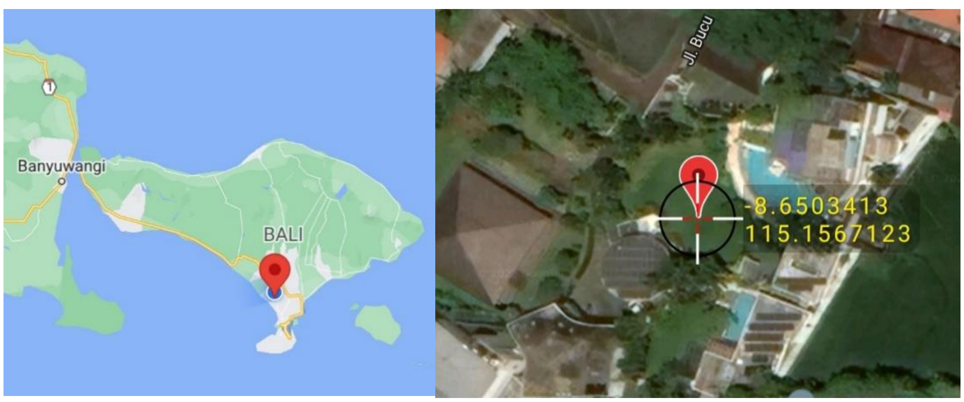

Figure 2. Research location in Kerobokan Village, North Kuta District, Badung Regency, Bali

3 Results and Discussions

Measurement of ground control points

The stages in measuring ground control points are:

a) Prepare the Global Positioning System (GPS) Geodetic/RTK Hi Target V60 GNSS tool, including the completeness of the battery to be used


Figure 3. Setting up a GPS device for ground control point measurements

b) Preparing Premarks in the field.
   The premark is made in the form of a cross with the premark point at the intersection of the mark. Ground control points (GCPs) are measured using GPS/GNSS to get the coordinates of the points. GCP has an important role to correct data and improve the overall image so that the aerial photos have high accuracy.

In this research, GCP points with premarks were obtained in the field as shown in table 1 below:

Table 1
GCP points with premarks

POINT	EAST	NORTH	ELEVATION
P	E	N	E
1	297146,9993	9043300,9120	64,99
2	297121,2072	9043312,9610	63,90
3	297150,1743	9043322,4400	66,18
4	297159.8921	9043304,1170	65,31
5	297162,8464	9043291,6140	65,31


Figure 4. Setting up premarks for ground control point measurements

c) Set GPS coordinates to UTM (Universal Transverse Mercator) coordinates
d) Prepare an existing initial base map to facilitate the search for points in the field

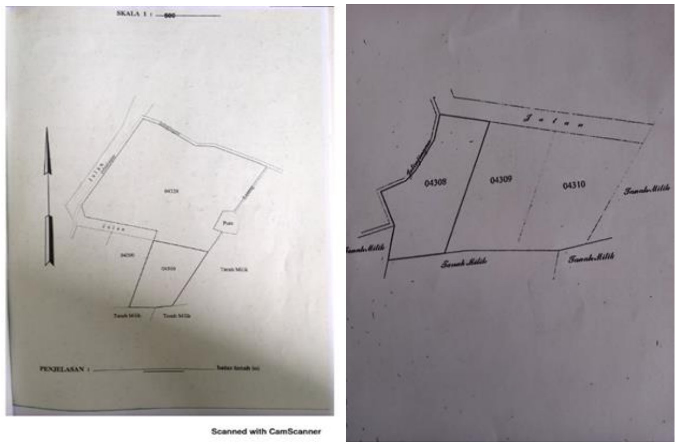

Figure 5. Initial base map (land certificate) for land boundary search

e) Perform additional GCP coordinate measurements in the field so that UTM coordinates (x, y, and z) are obtained as shown in table 2 below:

Table 2
GCP coordinate measurements in the field so that UTM coordinates (x, y and z)

POINT	EAST	NORTH	ELEVATION
P	E	N	E
1	297156,6917	9043315,3290	65,38
2	297177,2343	9043346,7570	69,43
3	297193,6289	9043337,4880	68,37
4	297200,1445	9043337,4810	65,37
5	297206,4131	9043334,6840	68,85
6	297205,7795	9043333,1860	68,27
7	297215,9637	9043328,9480	68,30
8	297204,5284	9043312,3470	65,92
9	297201,6414	9043313,3410	65,93
10	297144,3391	9043292,5270	65,47

Shooting with drone

Considering that the area being photographed is not too wide, one can get coverage for one shot by a drone as shown in the image below:

Figure 6. The original results of aerial photos with drone tools

Data analysis and discussion results
Input points ground control point

After the Align Photos process and the results are in the form of a sparse point cloud, then the control point or GCP input process is carried out which has previously been measured with GPS in order to get good accuracy and meet the job criteria. The GCP input process can be skipped for certain jobs that do not require high accuracy (Nath et al., 2022; Kumar & Agrawal, 2021; Antara, 2015). Select the Reference menu then click the import symbol to enter the GCP measurement data in the form of a *.csv file format.

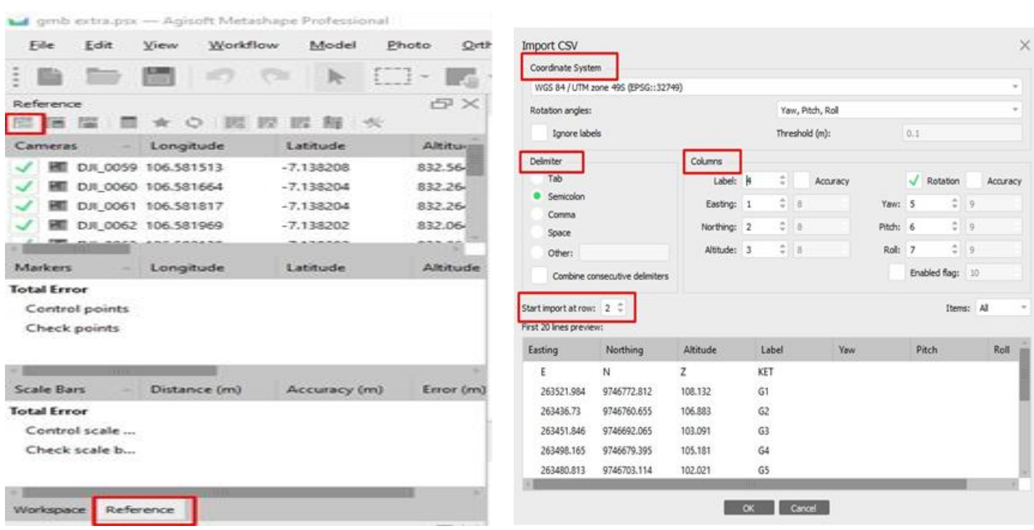

Figure 7. GCP input

Delineation of land boundaries from drone photos

Aerial photo data processing is carried out using software with an algorithm based on Structure Form Motion (SFM), which is a method of object formation based on the points of a moving photo, namely the Agisoft Metashape Pro program. The process of inputting control points or GCP that have previously been measured with GPS in order to get good accuracy and meet job criteria (Kansanga et al., 2019; Guang & Weili, 2011).

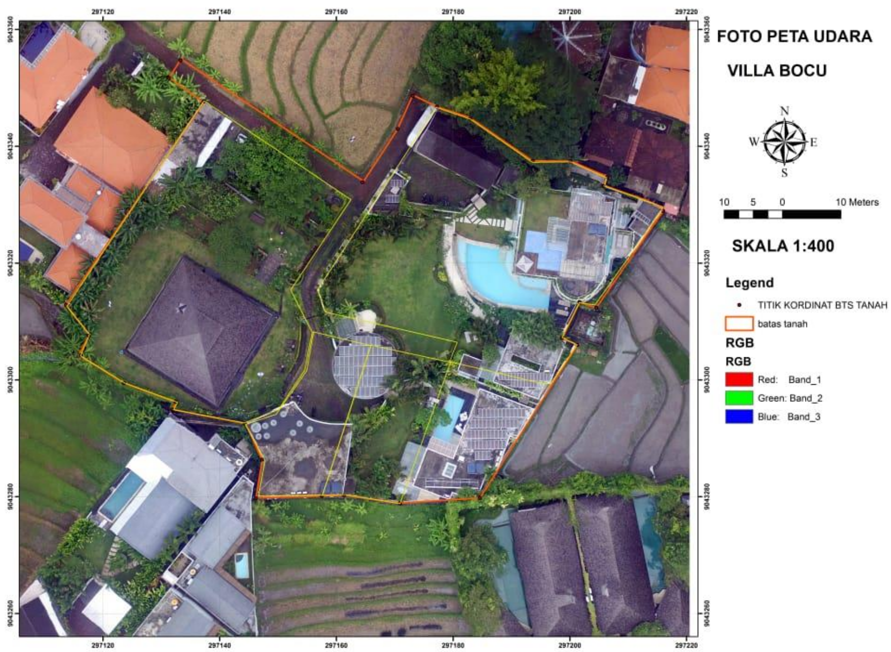

Figure 8. The results of drone photos that have been inputted by GCP

Transfer drawing to autocad program

To facilitate a spatial planning, it is necessary to transfer images from the Agisoft Metashape Pro program into the AutoCAD program as shown in the image below:

- After drawing in the autocad program, the land boundaries have been adjusted to the land boundaries from the existing land certificates.

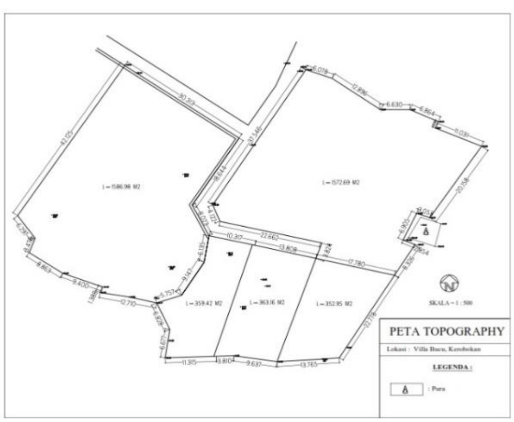

Figure 9. Land boundary map in autocad program

- After adjusting the land boundaries from the measurement results to the land certificate, the total area of the land is 4,235.2 m2 or 42,352 are.

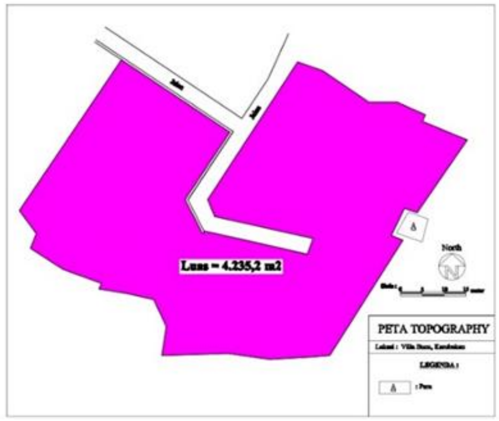

Figure 10. Map of land boundaries and their total area

4 Conclusion

The conclusions from the research of a concise and fast land boundary mapping using a drone at Villa Buccu, Kerobokan, Badung, Bali are:

a) The boundary of the land which is limited by the adjacent building can be mapped quickly and concisely, thus saving time and effort in its implementation.
b) The total land area after being calculated using the AutoCAD program is 4,235.2 m2 or 42,352 are.

Conflict of interest statement
The authors declared that they have no competing interests.

Statement of authorship
The authors have a responsibility for the conception and design of the study. The authors have approved the final article.

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