Land Boundary Delineation to Supporting of Program
Systematic Complete Land Registration (PTSL) Using
Multicopter-RTF Data (Case study: Wotan Village, Panceng
Sub District, Gresik district)

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Abstract. According to statutory regulation issued by Ministry of Land and Spatial Planning/Head of National Land Agency (BPN) number 35/2016, Comprehensive Systematic land registration is a sequential activity of which continuously and systematically carried out by the government ranging from collecting, processing, recording and presenting, as well as maintaining the physical and juridical data in the form of map and list of land-plots and flats, including the transfer of legal title for land plots and flats with their inherent rights. Delineation is one method to identify land plots by utilizing map image or high resolution photo and defining the boundaries by drawing lines to determine the valid and recognizable boundaries. A guideline to delineate the unregistered land plots may be determined from this two methods’ accuracy result, using general boundary applied to aerial photo taken by multicopter RTF. Data taken from a height of 70 meter on an area obtained a number of 156 photos with 5 GCP resulting in an photo map with GSD 2.14 cm. The 11 samples parcels are selected in the sites of ± 7 ha. There are 11 samples of land parcels are tested. The area difference test for every parcel using a average standard deviation of 17,043 indicates that there are three land parcels which have significant area difference and 8 others do not have significant area difference. Based on the tolerance of National Land Agency, among 11 parcels studied, there are 8 parcels that fullfill the tolerances and three others do not fullfill tolerances. The percentage of area difference average between land registration map and orthophoto is 4,72%. The result shows that the differences in boundaries and areas that may be caused by a systematic error of method in describing the boundaries of the ground.

Keywords: Delineation, Land Registration, Multi Copter

1. Introduction
To carry out the tasks and functions of BPN in the region formed Regional Office BPN in the province and Land Office in the district/city. Land Office can be established more than one Land Office in each district / city (Presidential Regulation of The Republic of Indonesia Number 20 of 2015 article 7). Currently, the Gresik District Land Office establishes a land-based database per village called a complete cadastre (KAKAP) where data from each plot of land is obtained from measurements and...
delineations for uncharted fields. The stages in the construction of complete cadastre (KAKAP), among others, are 1) Provision of large-scale basic map for viewing maps of air with a scale of 1: 1000; 2) Graphical Index Mapping (GIM) of all parcels registered to the corrected map; 3) Delineation of all parcels of land not yet registered; 4) Validation of land books, textual letters, spatial measurements, and registration maps; 5) Zonation making based on KAKAP field boundary (map of land value zone and spatial zoning map); and 6) Updating of land value in new zones. Land delineation is one of the components in complete cadastral construction where delineation is performed on high resolution imagery for unregistered terrain. The photo map is a map depicting the detail of the field from aerial photography / satellite imagery to a certain scale. The photo map has been through the process of photogrammetry mapping, therefore the measurements on the photo map are correct, so the detail on the photo map and can be identified in the field has the correct position on the map [1]. The delineation of the parcels is done by identifying the plots of land using the photo map and drawing the measuring line for clear and eligible plot boundaries. There are two types of boundary categories that can be used as a reference in the delineation method, including fixed boundary and general boundary. Fixed boundary is a line defined by authorized through a formal survey and expressed mathematically by relationship and distance, or by coordinates. While the general boundary is a line that appears to exist in reality but has not been established by the authorities, usually the limit is physical, natural or man-made appearance such as fences, ditches, or roads (Enemark, et al. 2010). The boundaries of parcels identified on the map should be measured in the field [2]. The existence of technological advances in the field of photogrammetry, especially the UAV RTF; the more cheap, easy and ready to use needs to be a study, especially to know the accuracy by comparing with the results of size in the field. With the research on the analysis of the delineation method of the area of land in the image image with this type of UAV is expected to be known geometric and wide position of the resulting field and the accuracy of the use of the delineation results that have been done. This is mainly in finding the extent of the land area in accordance with the standard of wide accuracy that has been issued by BPN. So, it is expected that this wide delineation of land can be one of the factors to support the acceleration in the program of Systematic Complete Land Registration (PTSL).

2. Photogrammetry UAV TRF System

Currently drones have a variety of shapes, sizes, configurations, and functions. The presence of a camera device with a lightweight and compact size but has good quality. DJI Phantom Aerial UAV Drone Quadcopter one that weighs not more than 2 kilograms where there is already a camera installed safely and neatly. The drone can be controlled by remote control within 1000 meters. Ready To Fly: Complete fuselage ready to be directly flown consists of Aircraft Kit, servo ESCMotor, BrushlessTx/Transmitter/RemotRx Receiver, Propane Rover, Adapter, Propeler, Battery Charger and AutoPilot. Phantom version 3 is a drone that have models waypoint navigation and can now be used for photogrammetry. This quadcopter uses the latest IMU, flight control stabilization technology to fly super still along with a 4k stabilized integrated gimbal and camera. This will create accurate point clouds and perfect 3D maps stitched together using software. Waypoint navigation is very important for creating accurate 3D photogrammetry images. The Dji Phantom 3 Advance used the “Draw Waypoints” for it’s autonomous programmed flight.

This type of drone is known as Rotary-wing or Vertical Take-Off and Landing type which is currently commonly used by the public because it does not require special skill in controlling it as well as a lot of market with affordable price. But now it has been equipped with various high-tech features that make it possible to do photogrammetric mapping with ease. Among them is the ability to autopilot the waypoint tracking that will make it easier when making the flight path. As a complement in this system also has many types of data processing from the Open Source (VSFM, MeshLab, etc.) to the license software (Agisoft, Pix4D, Menci, etc.) to get the results of orthophoto [3].

Figure 1. Specification Drone Dji Phantom 3 Advanced. Weight (Battery & Propellers Included) : 1280 g. Diagonal Size (Propellers Excluded) : 350 mm. Max Flight Time : Approx. 23 minutes. Satellite Positioning Systems : GPS/GLONASS. Sensor : 1/2.3” CMOS. Effective pixels: 12.4 M (total pixels: 12.76 M). Camera Sony EXMOR FC300S, Focal length : 3.64 mm. Lens : FOV 94° 20 mm (35 mm format equivalent), f/2.8. Electronic Shutter Speed : 8 - 1/8000 s. Image Size : 4000 x 3000. Range distances of up to 3.1 miles (5 kilometers).

3. Results and Discussion
The location used in this research is in Wotan Village, Paceng District, Gresik Regency Geographically the Gresik District is located at geographic coordinates within latitude 6 ° 49’- 7 ° 24’ South and its longitude 112 ° 22’- 112 ° 40’ East. The first preparation of the image acquisition and GCP measurement, a reconnaissance activity to get an overview of the location was conducted. The important element which might affect the image acquisition procedure and GCP measurement such as land cover.

Premarking activities begin by installing a quadrilateral premarking made of plastic in contrasting colours (orange) with its surroundings. The markers consist of 4 pieces of rectangular sized use 20 cm x 40 cm rectangular. To connect to be united then sewn. While the GPS stop and go positioning survey have a centimetre to decimetre accuracy. Based on the post-processing of data using software Topsurv software, the GCP point consisting of 5 points has an accuracy of 1.00 cm – 6.00 cm.

| Name | Grid Northing (m) | Grid Easting (m) | Elevation (m) | Std Dev a (m) | Std Dev e (m) | Std Dev u (m) | Std Dev Hz (m) |
|------|------------------|-----------------|--------------|---------------|--------------|--------------|---------------|
| Base | 923073.422 | 664275.126 | 66.687 | 6.067 | 0 | 0 | 0 |
| GCP 1 | 923073.416 | 664275.795 | 66.682 | 0.001 | 0.002 | 0.001 | 0.002 |
| GCP 2 | 923069.400 | 664313.805 | 66.399 | 0.001 | 0.001 | 0.003 | 0.002 |
| GCP 3 | 923054.727 | 664331.164 | 62.072 | 0.001 | 0.002 | 0.003 | 0.002 |
| GCP 4 | 923055.282 | 664256.779 | 64.819 | 0.001 | 0.001 | 0.003 | 0.001 |
The next step UAV and the remote control as the ground station was set up, the flight parameter was established, such as 70 m height; percentage of overlap (80% overlap and 70% sidelap); and size of the area to be captured. The area of the field was divided into one block. The whole area of fieldwork ± 7 ha. But to make a better result in the residential area then 1 more blocks were added, therefore in total 2 flights with 156 images were executed. The UAV flew for around 12 minutes for each flight, but to avoid the chance of the falling due to low battery, every time the UAV was flown, it was taken back to the base to change the battery. The processing aerial photo processing by structure from motion algorithm and bundle adjustment with self-calibration has been done with 5 GCP and 4 check points.

The analysis is done by comparing the area and the field distance that has been registered, between the results of the delineation method fixed boundary and general boundary methods. Delineation method fixed boundary is performed on the Land Registration Map of the data plots of land obtained from the results of registration measurements land in the field. While delineation method of general boundary performed on orthophoto UAV image.

| No | Parcel (NIB) | Area (m²) Existing Maps | Ortho Photo |
|----|--------------|--------------------------|-------------|
| 1  | 470          | 103,977                  | 105,118     |
| 2  | 472          | 191,202                  | 203,853     |
| 3  | 473          | 89,571                   | 71,663      |
| 4  | 10015        | 86,233                   | 104,581     |
| 5  | 478          | 153,645                  | 160,895     |
| 6  | 479          | 269,446                  | 265,910     |
| 7  | 538          | 152,858                  | 156,226     |
| 8  | 532          | 181,624                  | 186,118     |
| 9  | 468          | 163,407                  | 185,118     |
| 10 | 1014         | 211,021                  | 207,896     |
| 11 | 470          | 103,977                  | 135,118     |
Data which is used as a reference is the data area and distance of results delineation of the fixed boundary method. Comparative analysis of area to know the difference of area is done by using paired t-test (paired sample t-test). The large value of the residuals illustrated the disparities of the boundaries and areas of the parcel which might have caused by the systematic error of the method to delineate the boundaries. From the visual comparison of the digitized output and the referenced parcels observed with the existing method, some of the points were missed to be marked or marked in the different location with the referenced one. Table 2 shows the comparison of area calculation the methods. The comparison between the existing maps and orthophoto shows that there are some significant differences exist in the parcel boundary with the NIB 10015, 468 and 470 with a different area of 18.334 m², 22.021 m² and 32.132 m². According to [4], some of the causes significant area difference, among others; (1) the one side of the corner boundary grow large trees that pre-mark is not visible, (2) some of the boundary monument has been move, and (3) the physical parcel of paddies rice in the field is not clear. In this research the statistical test show that there are significant differences between the results of UAV data processing and a land registration map. The area difference test for every parcel using an average standard deviation of 17,043 indicates that there are three land parcels which have significant area difference and 8 others do not have significant area difference. Based on the tolerance of National Land Agency, among 11 parcels studied, there are 8 parcels that fulfil the tolerances and three others do not fulfil tolerances. The percentage of area difference average between land registration map and orthophoto is 4.72%.

4. Conclusions
By using UAV Multicopter RTF type rotary wing or multicopter model can be generated an orthophoto map which can be used as data for delineation of land boundaries. The important thing is about the regulation of technical regulations, this is because more and more public that use this tool for mapping. For the problem of accuracy achieved, many studies have shown that with orthophoto maps shooting with this technology can achieve the accuracy of GSD to 5-10 cm [4] or 3 cm [5] where the results have sufficient standards to be used as a base map. The residuals between the observed and predicted value from the result represent the model fitness towards the data, the smaller the value means the closer the result is to the data. It is remarked that the result generated from both boundaries and areas of the parcel has shown a significance discrepancy between the parcels. For future research will be applied the research about automatically boundary delineation calculations with UAV data, that is currently being developed in some countries about boundary delineation algorithm [6].

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