Unmanned Aerial Vehicle (Uav) for The Outer Small Island Mapping as an Alternative Method for Collecting Geospatial Data

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Key Words: UAV, outer small island, mapping, geospatial information

SUMMARY

Indonesia is an archipelagic nation that has many large and small islands that spread from Sabang to Merauke and from Miangas to Rote Island. For the major islands mapping is relative no significant obstacles, however, for small islands mapping especially the outermost islands is not easy, especially regarding the accessibility to the location and other constraints such as cloud cover and so on. However, geospatial data and information of the outermost small islands should continue to be collected and constantly updated. Unmanned aerial vehicle (UAV) is used as an alternative for inventory and updating geospatial data, where the collecting data using drones controlled via remote control and computer. The purpose of the use of UAV is in order to get geospatial data of the outermost small islands, in accordance with the desired scale and location. For this paper, we will show Batek Island which is one of the 92 outer islands, which located at Kupang district, East Nusa Tenggara Province as a case study. The overall image of the result has a Spatial Ground Distance value smaller than 20cm, this size has met the requirements for map production scale 1:2.500.

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INTRODUCTION

Republic of Indonesia is an archipelago country which has a very wide area with coastline approximately 98. 988 km, with more than 15,000 islands. In managing such a huge state like Indonesia, would require geospatial data and information that can be trusted and reliable. Geospatial Information Agency (BIG) is the only institution in Indonesia as the organizer of the Basic Geospatial Information (IGD) and Infrastructure Geospatial Information (IIG), as well as a Board of Trustees and Executor integration of thematic geospatial information. The BIG vision is has become an institution and a leading mover in the organization of Geospatial Information in Indonesia that reliable, integrated and easily applied. One of its missions is to build quality and sustainable geospatial data and information in multi - resolution and multiscale in one single reference with easily and quickly utilized and accountable to support national development.

The Outermost islands is the gateway to enter Indonesian territory, which must be maintained both in terms of its security as well in terms of its existence. In general, the development of the outer islands of the region is still lagging behind, this is because the area is far from the center of government, whereas the existence and development is very important and should be given priority by the government. Therefore, the data and information is an important area to be inventoried and are updated within a certain time.

In order to inventory and updating data on the outermost small islands, we often met some problems. The constraints which often arise such as from natural factors, such as weather, disasters, and accessibility, it is very difficult to control by humans. While the technological constraints are also likely to occur, such as cloud cover constraints if the retrieval of data by using optical imagery, and limited availability of high-resolution imagery so that less get the desired information. Therefore, in this paper are given alternative in order to improve the technological constraint, namely the use of unmanned aircraft vehicle (UAV) to get the data and information outermost small islands, especially cloud cover constraints and the limited availability of data according to the desired scale.

PURPOSE

The purpose of this study is to conduct an inventory of geospatial data, especially the outermost small islands that using by alternative vehicle namely Unmanned Aerial Vehicle (UAV), and assess its accuracy of the result. The result of this assessment is expected can be a reference for further utilization of UAVs.

METHOD

The method for mapping of the outermost small islands is conducted by photogrammetric small format methods that is recording by using unmanned aerial vehicle.
The steps that used in this research include:

1. Administration Preparation: an initial step prior to data collection, including administrative proceedings, obtaining permits and insurance
2. Photo shoot preparation: this step is made preparations include preparing equipment to be used (including testing and preparing the vehicle for UAVs to be used to keep the vehicle on track to survive desired fly on the weather location shooting), preparing a base map, work map and supporting data, preparing flight path and GCP.

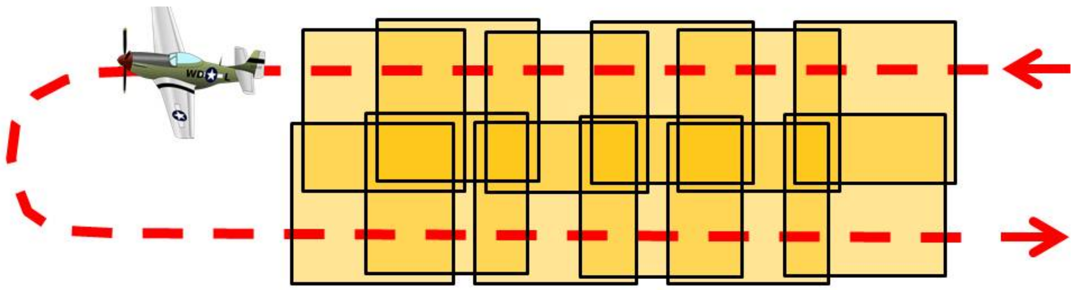


Figure 1. flight path illustration with overlap and sidelap

Figure 2. Preparation or setup the UAVs

3. Photo shoot:
    - The photo shoot step is intended to perform data collection. At this vase every flight path should be captured in sequence in every single shooting. If the flight path interrupted, because of cloud cover problems or other obstacles should be given a note. Furthermore, to complete the rest should be start from the starting point that has overlapping with previous flight path.

- Measurement of GCP using the PPP (precise point positioning) method. GCP distribution is noticed the presence of an existing control point of the result of a previous measurement accuracy that has Order-3 or higher, then the field survey for the placement of the monument so that it can be used for subsequent tasks. Survey of determining the coordinates of ground control points in this work is to determine the coordinates of the point to be used for controlling aerial triangulation through count block adjustment. The PPP technique will provide results that are bound to the GPS WGS 1984 datum for horizontal position, while the vertical datum referenced to the EGM96 geoid models.

Figure 3. Premark and GCP measurement

4. Data Processing:
   - Results of shooting automatically processed by a digital photogrammetry to produce and Photo and Line Map.
   - The process of aerial triangulation. Aerial triangulation in Photogrammetry is a method of determining and calculating the 3-dimensional coordinates of each object by means of photogrammetry, using any photos from different positions that covering the same object. With aerial triangulation, aerial photos are possible to calculate the 3-dimensional coordinates for each object element. In the process required some points with known positions that appear in some photos. These points are the control points that important part of the process of aerial triangulation. In general, these are several stages in the process of aerial triangulation implementation, namely:
     a. Identification of control points and tie points models.
     b. Observation point in the model coordinate system or through observation of photo coordinates were then calculated the coordinates of the model.
     c. Preparation of the observation equation.
     d. Preparation of normal equations.

e. Solving the normal equations to obtain the definitive coordinates of the tie point (and the transformation parameters when required to calculate point the other models).

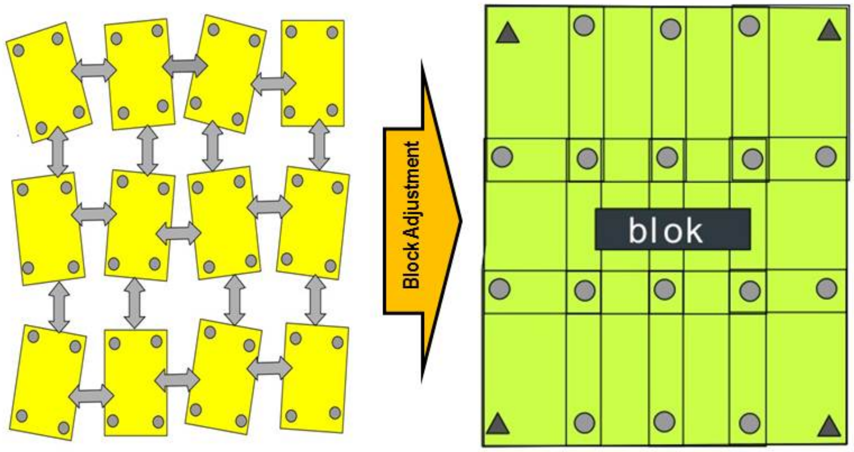


Figure 4. Aerial Triangulation Process

- Establishment of Digital Terrain Model (DTM)
  DTM is a Data 3-dimensional object that represents the state of the surface covered. DTM is a raster data with 1 mm cell size on the scale of the map, which is obtained automatically by a stereo matching technique, followed by semi-automated data editing. Data editing activity of stereo matching is done to discard data that does not represent the ground terrain. So editing activities are intended to change the stereo matching process results which data that is still in form of digital surface model (DSM) to digital terrain model (DTM). From generated DTM will formed contour line with contour interval 1/2000 of the denominator of scale map (in meters) and to auxiliary contours at intervals of 1/4000 of the denominator scale map (for a relatively flat area).

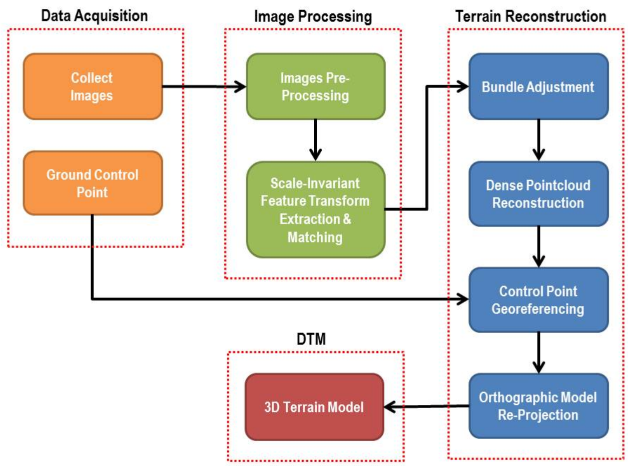


Figure 5. Flowchart DTM establishment

- Ortho-Rectification

  Orthorectification is a process of removing the effects of image perspective (tilt) and relief (terrain) effects for the purpose of creating a planimetrically correct image. Rectification is conducted when the ground surface was relatively flat, assuming Δ h at each observation point <0.5% x high fly to the average height of these photos. Developping of photos map for mountainous areas is done by orthophoto process. This process is done by re-exposure of orthogonal per small parts of the photo, so the slope, scale and shift relief can be corrected. This Orthophoto process will make the images in orthogonal projection and only has one scale (although in diverse terrain), and presents the terrain with real picture (not in lines and symbols). Orthophoto is conducted when the ground surface was mountainous, with assuming Δ h at each observation point > 0.5% x high fly to the average height of these photos.

5. Field Surveying

   This survey is intended to collect field data that must be completed from UAV captured. These field surveys include to collect data about administrative boundaries and toponimi (name of the village, the name of the river, and other geographical names are required) as outlined in the F6-NG form that has been legalized by the local government.

6. Finalization

   the finalization of this activity in the form of plotting of the photo shoot and completeness of field survey.

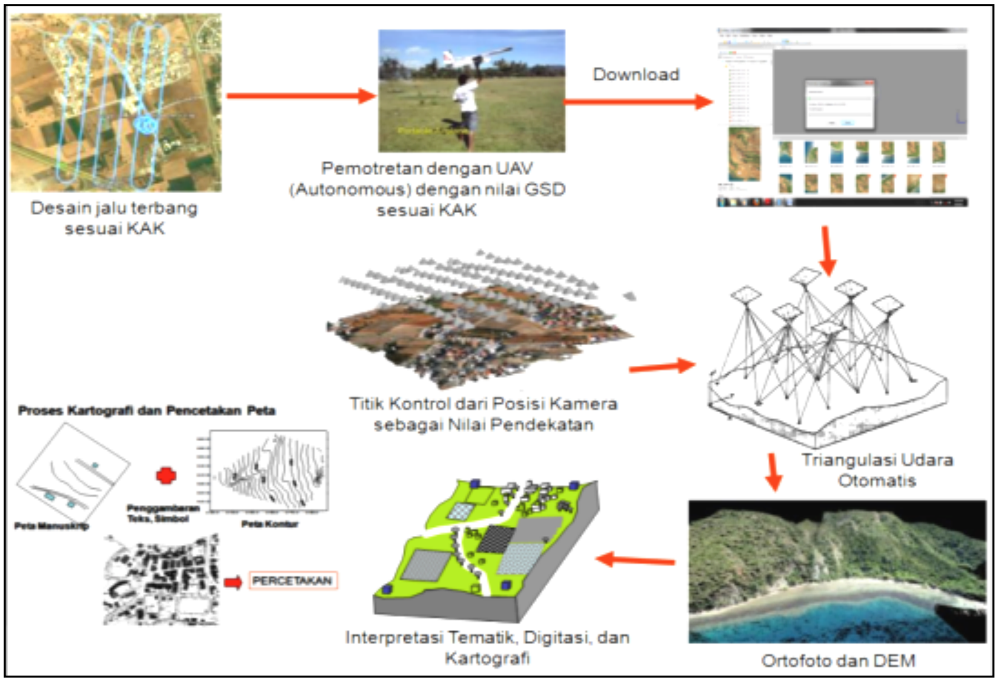


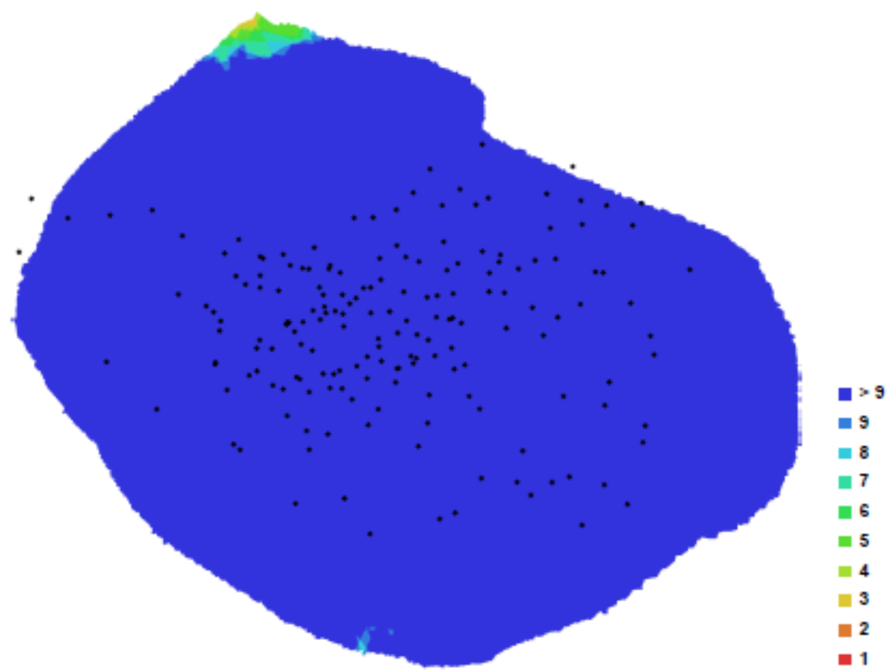
Figure 6. Flowchart of all activities

RESULTS AND DISCUSSION

The major constraint in the work using unmanned aerial vehicle is the weather conditions in the field. The wind was blowing hard which causes difficulty in maintaining an unmanned aircraft to fly in accordance with the planned flight path. High waves to the location of the island to be photographed. Constraints permit shooting at certain locations.

Overall aerial photos taken from this UAV have met the specifications of the overlap area of> 60% and sidelap> 20%. Windy weather conditions in coastal areas that caused an unmanned air vehicle is difficult to follow the flight path. This condition have to add the value of overlap and sidelap in order to reduce the risk of deficiencies of photos. The average value of the overlap between the aerial photos is 80%. More higher overlap between photos which leads become better correlations. In every location is taken shooting of photographs more than 500 images of aerial photographs. As a consequence of the number of photos, the processing of aerial photographs should be done automatically. High correlation between the value of aerial photographs will add to the quality of process automation in the process of aerial triangulation.

Utilization of GPS technology (Global Positioning System) allows obtainment of the planimetric coordinates of the reference and is expected to obtain good accuracy, in the fraction SUB-Meter. This accuracy is adequate for map scale of 1:5,000 and larger. In the implementation these work using a Precise Point Positioning method. This technique will provide results that are bound to the GPS WGS 1984 datum for horizontal position, while the vertical datum referenced to the EGM96 geoid models. The whole GPS observations with static methods for more than 1.5 Hours observation can meet the precision target <1.5m for horizontal position. The overall image of the result has a Spatial Ground Distance value smaller than 20cm, this size has met the requirements for map production scale 1:2.500.



Number of images:	188	Camera stations:	178
Flying altitude:	256.155 m	Tie-points:	45197
Ground resolution:	0.062713 m/pix	Projections:	175444
Coverage area:	0.381487 sq km	Error:	2.06683 pix

Camera Model	Resolution	Focal Length	Precalibrated
Canon PowerShot A2200	4320 x 3240	5 mm	EXIF

Figure 7. Results counting of aerial triangulation produces precision <2.5 pixels equivalent to <0.63m

Label	X error (m)	Y error (m)	Z error (m)	Error (m)	Projections	Error (pix)
point 1	0.001567	-0.009115	0.002770	0.009655	29	0.000000
point 2	0.003073	0.018735	-0.003796	0.019361	25	0.000000
point 3	0.004591	-0.002682	-0.000559	0.005346	26	0.000000
point 4	-0.009233	-0.006938	0.001586	0.011658	28	0.000000

Figure 8. GCP position dan its precision

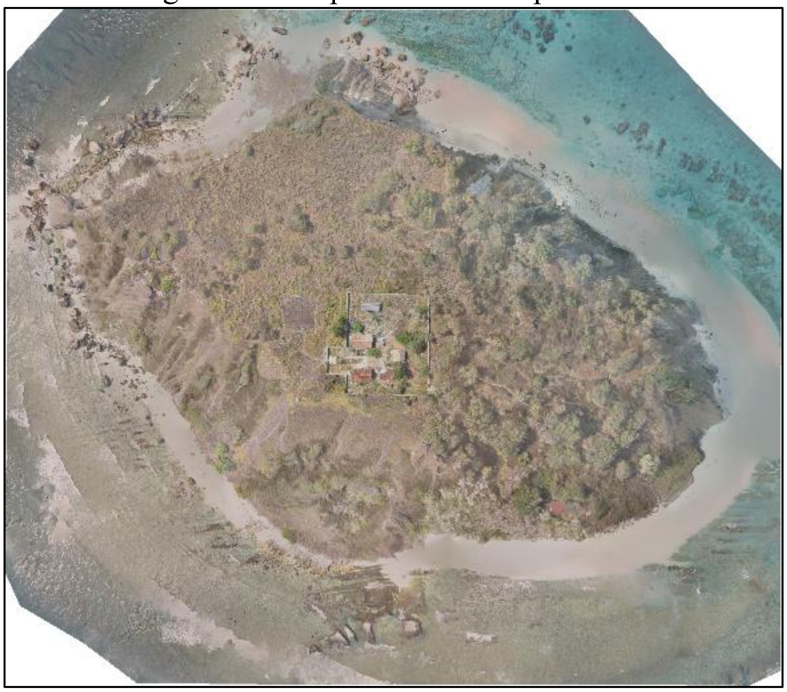


Figure 9. Batek Island captured by UAV after processing

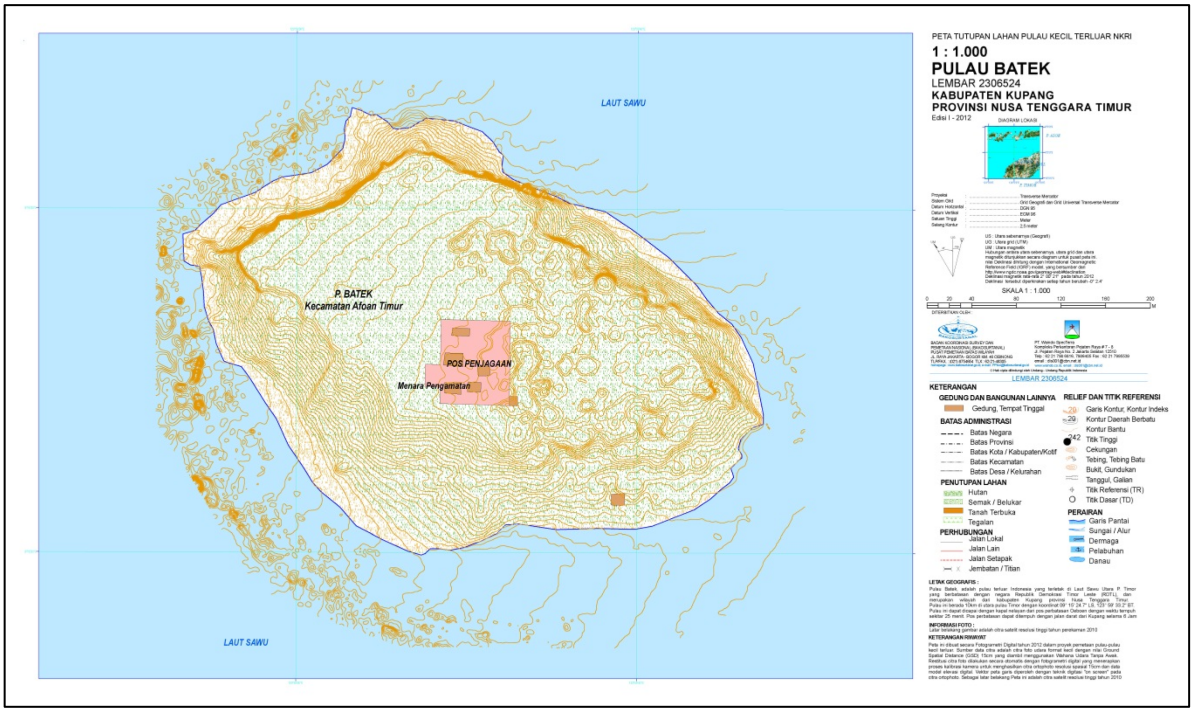


Figure 10. Final of Line Map of Batek Island

CONCLUSION

By using unmanned aircraft vehicle (UAV):

1. Provide alternative sources of data in remote areas and difficult to reach, such as the outermost small islands.
2. Possible to obtain the corresponding geospatial data according to desired scale and cloud cover free.
3. Being an alternative for providing data according time period desired
4. Getting the data with high accuracy (less than 1 meter)

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BIOGRAPHICAL NOTES

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