Aerial Photogrammetry and Object-based Image Analysis for Bridge Mapping: A Case Study on Bintan Bridge, Riau Islands, Indonesia

Husnul Kausarian[1], Muhammad Zainuddin Lubis[2], Primawati[3], Dewandra Bagus Eka Putra[1], Adi Suryadi[1] and Batara[1]

[1]*Department of Geological Engineering , Universitas Islam Riau, Pekanbaru, Indonesia*

[2]*Department of Informatics Engineering, Politeknik Negeri Batam, Batam-Kepulauan Riau, Indonesia*

[3]*Mechanical Engineering, Engineering Faculty, Universitas Negeri Padang, Padang-West Sumatra, Indonesia*

Keywords: Photogrammetry, Unmanned Aerial Vehicle (UAV), Bintan Bridge, Structure, Specify Second Distance.

Abstract: Photogrammetry is a good method for determining the geometric properties of an object from the images. The geometry of the object obtained from two or more drawings that are overlaid. It is completely autonomous, ultra-lightweight so-called Unmanned Aerial Vehicle (UAV) which has been commercially available at very economical prices in the community or researchers, and photogrammetric applications. The study area was located at Bintan Island, Riau Islands Province, Indonesia, collecting data on 8th may, 2017 (1° 3'45.98"N - 104°27'49.22"E), with DJI phantom 4 including control range small format air photography (SFAP) which is a low-cost, cost-effective solution for obtaining bridge surface imagery and can also be proposed as a long-distance bridge inspection technique to complement the current bridge visual inspection in Indonesia. Some examples of evaluations on bridges using SFAP are presented to provide remote sensing information and capabilities that serve as an essential tool for monitoring and assessing the construction of the bridge. The measurement of Bintan Bridge is 193 m, the photos were taken from the airplanes around 70 meters and providing top-down views. Bintan Bridge's structure have specify second distance in left wide is $1.057 < 1560$, and specify second distance in right wide is $0.9981 < 1570$.

1 INTRODUCTION

Modelling on object information with building instances becomes a famous technology for some infrastructure such as bridges, road systems, tunnels, dams, water, and sewage networks. In the Riau Islands, Bintan Island does not have much information on mapping air information using remote sensing techniques on building any object, and buildings modelling information is very limited. The latest mapping information on the Riau islands is still dominantly small, and still in the general mapping of objects such as sea grass beds, settlements, seafloor (Lubis and Daya, 2017; Lubis et al., 2017; Farizki and Anurogo, 2017; Kausarian et al., 2016b; Kausarian et al., 2016a; Kausarian et al., 2017; Kausarian et al., 2018; Kausarian et al., 2019).

In terms of the image analysis, the contemporary and existing construction is one of the significant problem (Agapiou et al., 2015; Patraucean et al., 2015; Tang et al., 2010; Volk et al., 2014; Cuca et al., 2014; Kausarian et al., 2017). The mapping on the current geomorphology field relies more and more on automatic techniques that serve to classify an image from the results of remote sensing techniques and a digital elevation model (DEMs) (Lardeux et al., 2016). Parameters are seen in the morphometric section, such as the slope or curvature of the region or the inherited object for the result of characterization of the shape and result of the geomorphological process. Arithmetic in the process of operation with the drawing band can clarify the class on a particular object. The vegetation index is often also used to classify vegetation and separate objects from other classes in a remote sensing data. In the object image of the entity on the basic technique in the drawing (in our case is the bridge), in each group of objects in the image, the pixel results consist of the same digital value, and has a relationship to the intrinsic size and shape, and the intrinsic ecology real-world scene component is a model (Hay et al., 2001). In the results of a recent study informed by the American Civil of Society

Kausarian, H., Lubis, M., Primawati, ., Putra, D., Suryadi, A. and Batara, .
Aerial Photogrammetry and Object-based Image Analysis for Bridge Mapping: A Case Study on Bintan Bridge, Riau Islands, Indonesia.
DOI: 10.5220/0009185802370242
In *Proceedings of the Second International Conference on Science, Engineering and Technology (ICoSET 2019)*, pages 237-242
ISBN: 978-989-758-463-3

(Chen et al., 2009) indicate that conditions improve on all systems in the current infrastructure, with objects such as roads and bridges.

UAVs have been used successfully in a research, for mapping (Hardin and Jackson, 2005; Kausarian et al., 2018), for the nitrogen and biomass measurement in a plant object (Izumi et al., 2018; Izumi et al., 2019; Widodo et al., 2018; Widodo et al., 2019), for document the crop at the value of water pressure (Berni et al., 2009), and for results on rangeland vegetation mapping. In this study, we were interested in the utilization of aerial mapping object-based image (Bintan Bridge) for structure and position analyst in Kepri islands, Indonesia

2 DATA AND METHODS

2.1 Study Location

Our study site was located on Bintan Island, Riau Islands, Indonesia, collecting data on 8th May 2017 (1°3’45.98”N - 104°27’49.22”E) (Figure 1). The area over which imagery was acquired was located within 1.5 km of is Bintan Bridge.

2.2 Study Location

Agisoft Photoscan Professional version 1.2.7 build 3100 64 bit was used to extract all mosaic from quadcopter DJI phantom 4 (Figure 2) and the tiles of point cloud data converted into photogrammetry images. The 1-m resolution DTM used for normalizing the terrain model on the object based images (Bintan Bridge) height, and photo captured of Bintan Bridge with altitude 70 meters can be seen in Figure 2.

2.3 Flight Planning

The take-off and landing operations are strongly linked to the vehicle and the level of characteristics employed, but can usually be controlled from the ground by the pilot (e.g. with a remote controller). Research mission (aviation and data acquisition) is planned in laboratory with special software, starting from the area of interest (AOI), the distance of required soil sample (GSD) or path, and knowing what is the intrinsic parameter of camera digital installed from DJI Phantom 4. During the flight process, the platform is usually observed with a control station showing real-time flight data such as position, speed, stance and distance, GNSS observations, battery or fuel status, rotor speed, altitude, etc.

3 RESULT AND DISCUSSION

Nearly 325 images (Figure 4) obtained through photogrammetry and object-based image analysis (Bintan Bridge) in Figure 3. 4-rotor quadcopter DJI phantom 4 with GNSS addition system equipped with 12 MP pixel camera, GPS & GLONASS satellite system, -90° to + 30° Pitch Gimbal Control Range. The measurement of the Bintan Bridge is 193 m, measured by Agisoft software, in solid mode and in shaded mode as shown in Figure 4.

Image objects for each individual on the bridge are simultaneously archived for viewing in a geographic information system (GIS) (Ellenberg et al., 2016; Yeum and Dyke, 2015; Reagan et al., 2018). The technique used in the results is ”manually matching features” with mosaic images already available from ArcMap 10.2 and Agisoft Photoscan Professional. The classification process is used to extract the information performed by clarifying different colours to each object class to distinguish them by rapid identification. Figure 4 shows the results of the object detection of the bridge structure shown as a feature with darker pixels than surrounding adjacent images and may be marked as possible identification objects. By viewing the surface with visuals and other surface conditions may also appear like cracks seen in bridge structures and figures. The same problem will arise if the colour identification technique used on the surface of the concrete. The flight crew must function after the process of airing and flying near the point of the camera direction that has been set for each bridge. Accurate communication of the cockpit and air traffic control officer is essential in completing the research safely. Identifying the large and wide bridge objects on the surface is relatively easy to observe. Analysis of the bridge object and counting the width using the method of air photography effectively identifies the width which is 6 m and signed as a yellow colour in Figure 5 which is also shows the condition of the bridge connection and expansion.

The length of Bintan Bridge is 193 m from image processing using Agisoft Software (Figure 4). Extensive recapitulation of the entire procedure for generating the same 3D cloud point as the results of this study can be found on applying the Scale Invariant Feature Transform (SIFT) to perform button detection as introduced (Lowe, 2004). The existence of field process that occurs in traffic on the highway is always outside the control of the flight pilot to take the photos. The area of the sweep by the pilot in the process of traffic can be such that large areas on the road surface are not blocked by car objects. When performing aerial photography analysis for this study, 2 (two) cars were

Figure 1: The Map of Research location and Object Based (Modified from Google Earth).

Figure 2: The image of Bintan Bridge, captured by Quadcopter DJI Phantom 4.

Figure 3: The point cloud computed with PhotoScan.

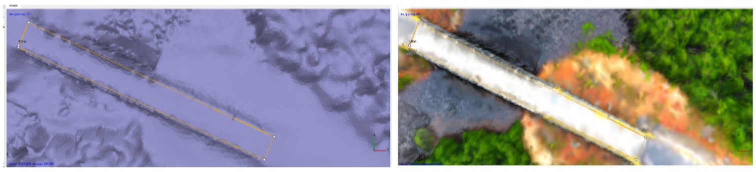

Figure 4: Automated image perspective 30 0 results for the UAV, left: with solid mode, right: with shaded mode.

present at the bridge statically. Taking vehicles from

aerial photography is required (Figure 6). Structure

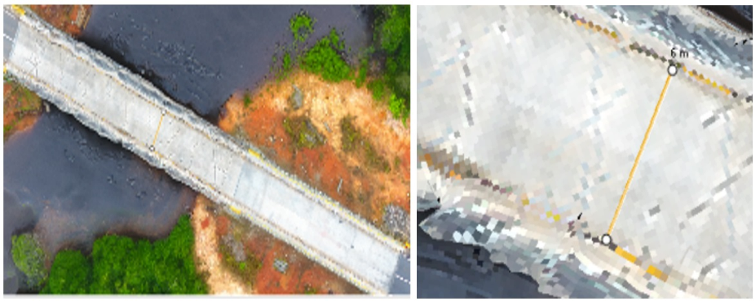

Figure 5: Aerial track object identification, left: original image, right: zoomed image.

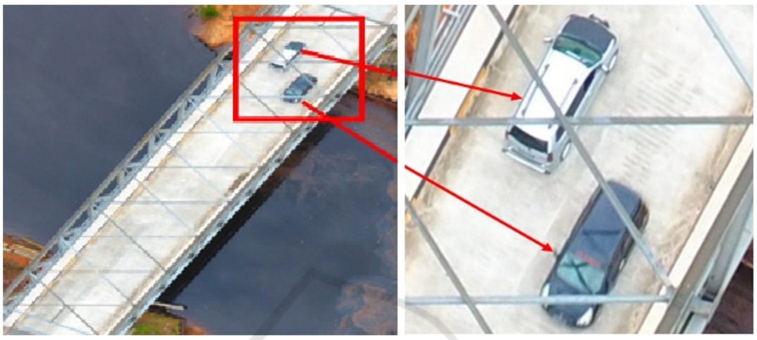

Figure 6: Detection of two vehicles, left: original image, right: zoomed image.

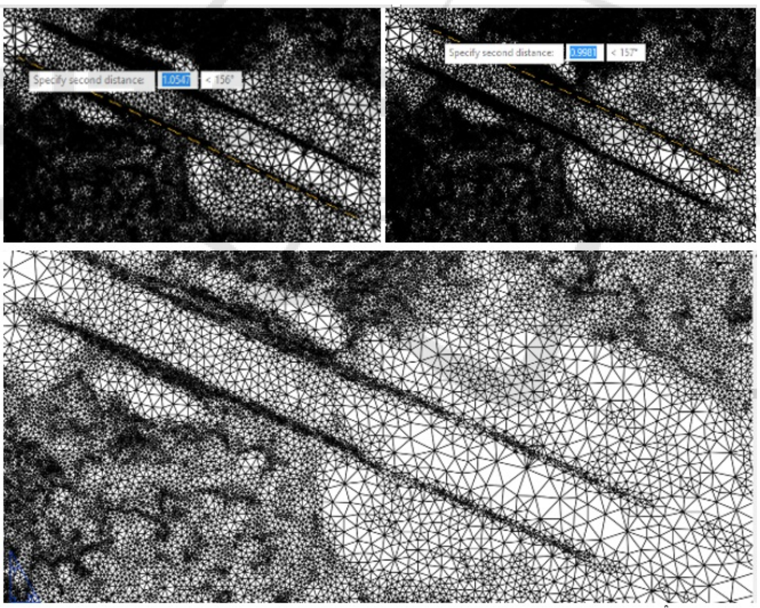

Figure 7: Above: Structure of Bintan Bridge, left below: Specify Second Distance in Left Wide (1.057 < 1560), right below: Specify Second Distance in Right Wide (0.9981 < 1570).

of Bintan Bridge can be seen in Figure 7 that have specify second distance in left wide in range 1.057 < 1560, and specify second distance in right wide is 0.9981 < 1570.

4 CONCLUSIONS

In this study, remote sensing is used as a tool in order to see the structure of Bintan Bridge with high-resolution air photography. The procedures of image processing and data collection as a detailed process are described. The results of this study indicate that the technology of remote sensing is able to detect very clear objects and bridge structures. Accurate positioning and tracking results through bridges are done without a robust test and the use of GPS units included in the Instruments used on the correct scale to suit the needs. It is necessary for pilots to remember that the wide area augmented system (WAAS) enables GPS accuracy of up to 6-8 inches/pixels. In this paper, we discuss the process of making the whole drawing on the object of the bridge by separating other objects, including plants, etc. to keep in view the focus of the Bintan bridge structure results, and the vehicles of the aerial photogrammetr.

ACKNOWLEDGEMENTS

This study is supported by P2M, Geomatics Engineering Program, Batam State Polytechnic, Kepulauan Riau, Indonesia, and Engineering Geological Program, Universitas Islam Riau.

REFERENCES

Agapiou, A., Lysandrou, V., Alexakis, D. D., Themistocleous, K., Cuca, B., Argyriou, A., Sarris, A., and Hadjimitsis, D. G. (2015). *Cultural heritage management and monitoring using remote sensing data and GIS: The case study of Paphos area*. Cyprus.

Berni, J. A., Zarco-Tejada, P. J., Surez, L., and Fereres, E. (2009). *Thermal and narrowband multispectral remote sensing for vegetation monitoring from an unmanned aerial vehicle*. IEEE Transactions on Geoscience and Remote Sensing.

Chen, S. E., Hauser, E., Eguchi, R., Liu, W. Q., Rice, C., Hu, Z., Boyle, C., and Chung, H. (2009). Bridge health monitoring using commercial remote sensing. In *Proceedings, 7th International Workshop on Structural Health Monitoring, Stanford, CA*.

Cuca, B., Agapiou, A., Kkolos, A., and Hadjimitsis, D. (2014). *Integration of innovative surveying technologies for purposes of 3D documentation and valorisation of St*. Herakleidios Monastery in Cyprus.

Ellenberg, A., Kontsos, A., Moon, F., and Bartoli, I. (2016). *Bridge related damage quantification using unmanned aerial vehicle imagery*. Structural Control and Health Monitoring.

Farizki, M. and Anurogo, W. (2017). *Pemetaan kualitas permukiman dengan menggunakan penginderaan jauh dan SIG di kecamatan Batam kota*. Batam.

Hardin, P. J. and Jackson, M. W. (2005). *An unmanned aerial vehicle for rangeland photography*. Rangeland Ecology & Management.

Hay, G. J., Marceau, D. J., Dube, P., and Bouchard, A. (2001). *A multiscale framework for landscape analysis: object-specific analysis and upscaling*. Landscape Ecology.

Izumi, Y., Widodo, J., Kausarian, H., Demirci, S., Takahashi, A., Razi, P., Nasucha, M., Yang, H., and J., T. S. S. (2019). *Potential of soil moisture retrieval for tropical peatlands in Indonesia using ALOS-2 L-band full-polarimetric SAR data*. International Journal of Remote Sensing.

Izumi, Y., Widodo, J., Kausarian, H., Demirci, S., Takahashi, A., Sumantyo, J. T. S., and Sato, M. (2018). Soil moisture retrieval by means of adaptive polarimetric two-scale two-component model with fully polarimetric ALOS-2 data. In *IGARSS 2018-2018 IEEE International Geoscience and Remote Sensing Symposium. IEEE*.

Kausarian, H., Lei, S., Lai, G. T., Cui, Y., and Suryadi, A. (2019). *A New Geological Map of Formation Distribution on Southern Part of South China Sea:; Natuna Island*. Indonesia, In IOP Conference Series.

Kausarian, H., Sumantyo, J. T. S., Kuze, H., Karya, D., and Panggabean, G. F. (2016a). *Silica Sand Identification using ALOS PALSAR Full Polarimetry on The Northern Coastline of Rupat Island*. Indonesia.

Kausarian, H., Sumantyo, J. T. S., Kuze, H., Karya, D., and Wiyono, S. (2016b). *The origin and distribution of silica mineral on the recent surface sediment area*. Northern Coastline of Rupat Island, Indonesia.

Kausarian, H., Sumantyo, J. T. S., Putra, D. B. E., Suryadi, A., and Gevisioner (2018). *Image processing of alos palsar satellite data*. small unmanned aerial vehicle (UAV), and field measurement of land deformation.

Kausarian, H., Sumantyo, S., T., J., Kuze, H., Aminuddin, J., and Waqar, M. M. (2017). *Analysis of polarimetric decomposition*. backscattering coefficient, and sample properties for identification and layer thickness estimation of silica sand distribution using L-band synthetic aperture radar.

Lardeux, P., Glasser, N., Holt, T., and Hubbard, B. (2016). *Glaciological and geomorphological map of Glacier Noir and Glacier Blanc*. French Alps.

Lowe, D. (2004). *Distinctive image features from scaleinvariant keypoints*. International Journal of Computer Vision.

Lubis, M. Z., Anurogo, W., Khoirunnisa, H., Irawan, S., Gustin, O., and Roziqin, A. (2017). *Using Side-Scan Sonar instrument to Characterize and map of seabed identification target in punggur sea of the Riau Islands*. Indonesia.

Lubis, M. Z. Z. and Daya, A. P. (2017). *Pemetaan Parameter Oseanografi Fisik Menggunakan Citra Landsat 8 di Wilayah Perairan Nongsa Pulau Batam*. Jurnal Integrasi.

Patraucean, V., Armeni, I., Nahangi, M., Yeung, J., Brilakis, I., and Haas, C. (2015). *State of research in automatic as-built modelling*. Advanced Engineering Informatics.

Reagan, D., Sabato, A., and Niezrecki, C. (2018). *Feasibility of using digital image correlation for unmanned aerial vehicle structural health monitoring of bridges*. Structural Health Monitoring.

Tang, P., Huber, D., Akinci, B., Lipman, R., and Lytle, A. (2010). *Automatic reconstruction of as-built building information models from laser-scanned point clouds: A review of related techniques*. Automation in Construction.

Volk, R., Stengel, J., and Schultmann, F. (2014). *Building Information Modeling (BIM) for existing buildings Literature review and future needs*. Automation in Construction.

Widodo, J., Izumi, Y., Takahashi, A., Kausarian, H., Kuze, H., and Sumantyo, J. T. S. (2018). Detection of dry-flammable peatland area by using backscattering coefficient information of ALOS-2 data L-band frequency. In *2018 Progress in Electromagnetics Research Symposium (PIERS-Toyama), IEEE*.

Widodo, J., Izumi, Y., Takahashi, A., Kausarian, H., Perissin, D., and Sumantyo, J. T. S. (2019). *Detection of Peat Fire Risk Area Based on Impedance Model and DInSAR Approaches Using ALOS-2 PALSAR-2 Data*. IEEE Access.

Yeum, C. M. and Dyke, S. J. (2015). *Vision-based automated crack detection for bridge inspection*. Computer-Aided Civil and Infrastructure Engineering.