Long range unmanned aerial vehicles simple method for monitoring and mapping

B S Widartono¹, T H Purwanto¹ and S T V Andi¹

¹Department of Geographic Information Science, Faculty of Geography, Universitas Gadjah Mada, Indonesia

E-mail: barandi@ugm.ac.id

Abstract. Remote monitoring is the solution and is also widely used to many problems that rely on surveys that require speed of information such as disaster, security, health, environment, and many more. Sensor images obtained from aerial imagery will provide an overview of a broad area with relatively reliable results. Remote monitoring is often constrained by various system devices that exist on unmanned vehicles. The development of simple techniques can increase the accessibility of vehicles in remote areas by chain-control so that field and system limitations can be overcome by developing this technique. The aims of this research are 1) to modify the vehicle system so that its cruising range and monitoring can be increased; 2) to conduct a study on the results of trials of cruising power enhancement techniques. The method that will be used is the chain-control technique so that the control of the vehicle for monitoring (aerial photography) can be carried out by a multi-operator.

1. Introduction

The use of unmanned aerial vehicles is growing with various models and types. Unmanned Air Vehicles (UAVs) has also developed into Unmanned Air Systems (UAS), where various additional devices are remote controllers and are combined with various sensors and increasingly advanced air navigation. In addition to aviation technology, which is developing rapidly, the techniques and control methods are also developed to maximize their capabilities, such as software and data acquisition methods. The increase in profit points and various obstacles encountered in the field caused many methods and shooting techniques to be developed. Both of these things have a positive impact on further development. For example, VTOL (Vertical Take-Off and Landing) was developed to anticipate the narrowness of open land; Parachutes to anticipate failed landings and emergency safety systems; to anticipate operations in the waters, and so on [1].

The utilization of each interest has a different need for UAS. For example, mapping activities require a vehicle with stable flight capability capable of flying for a large area, long duration, good camera, high flight capability that adjusts to the desired scale or spatial resolution requirements, and others. Meanwhile, surveillance activities require a stable vehicle in flight, have a long duration, has adjustable mounting angles, and so on. The abilities mentioned earlier can anticipate environmental conditions such as weather and obstacles in the field [2].

The constraint in cruising range, the immediate need, and the difficult conditions in the field make it difficult to mobilize the vehicle to the location where the aerial photography is operational. The limited mobilization by road can hinder important moments in data acquisition, such as disasters, for example, which have a golden moment in carrying out first aid, delays will impact the difficulty of further anticipation. Likewise, in wildlife, observations can be made by conducting general monitoring with far-reaching observations until the desired population is monitored, even though high dynamics will result in a change in the existing situation. The importance of long cruising ranges can often only be overcome by vehicles that have a long duration of flight time, as well as adequate telemetry coverage capabilities, which sometimes becomes an obstacle to the existing limited resources.
2. The VTOL UAVs application potential in monitoring and mapping
UAVs have been rapidly developed as their application for remote sensing. The UAVs remote sensing with high-resolution data is becoming an important big data source nationwide [3]. Therefore, UAV technology evolved quickly to find out low-cost and effortless solutions. The Vertical Take-Off and Landing (VTOL) UAVs class requires no take-off or landing run operating at varying altitudes (predominantly low altitudes), making it effortless for the monitoring and mapping that can anticipate the environmental condition in the difficult terrain [1]. The Pluma Long Range is a VTOL UAVs with long-range flight capability within 50 minutes flight time, a flight range up to 5 km (Table 1).

Table 1. Specification of The Pluma Long Range UAV
Source: Inderaja Teknik Indonesia

| Parameter                        | Capability                  |
|----------------------------------|-----------------------------|
| Wingspan                         | 900 mm                      |
| Weight                           | 750 gram                    |
| Propulsion                       | Low Noise, Brushless        |
| Material                         | Survey Grade EPP Foam       |
| Data link range                  | 3 km (optimal), up to 5 km  |
| Detachable wings                 | Yes                         |
| Camera                           | Sony RX-0                   |
| Accesory Options                 | Radio Tracker               |
| Flight & Geotagging Software     | M-Pilot                     |
| Compatible Image Processing      | Pix4Dmapper/Agisoft Photocan |
| Image Processing Output Compatibility | Autocad, ArcGIS, Trimble Business Center, ERDAS, & more |
| Cruise Speed                     | 30 – 90 km/h (10 – 30 m/s)  |
| Wind Resistance                  | Up to 46 km/h               |
| Max Flight Time                  | 50 minutes                  |
| Automatic Landing                | Yes                         |
| Manned Assist Navigation         | Yes                         |
| Hand Launched                    | Yes                         |
| Nominal Coverage at 122 m (400 ft)| 151 ha                     |
| Ground Sampling Distance at 122 m (400 ft) | 4.4 cm                     |

3. Fundamental system control of long range UAV
The UAVs can be controlled autonomously or manually by piloting using radio control. The same systems can fly UAVs, and it is required ground control station (GCS), although it has different GCS and locations [4]. The different GCS allows the UAVs to be controlled by the different operators after the UAVs flies above the overlap coverage area between GCSs.

The pre-flight preparation of the Pluma Long Range UAVs simulation includes control management, system management, and mission planning (Figure 1). Control management is a technical checking of UAVs hardware and operators such as the connection between UAVs to MPilot and remote control (flight control stability), movement of flaps (maneuverability), communication between operators (telecommunication), and throttle up and down (power distribution). System management is a step to ensure both software and hardware are running properly, such as path or motion planning and
navigation. Mission planning is a step to arrange flight waypoint and placement of GCSs around the area that wants to map.

4. Result and Discussion
The Pluma Long Range UAVs control is carried out using automatic and manual flight. The take-off team does the automatic flight using Mpilot software from take-off to a certain waypoint. The waypoint is according to the different ground control systems (GCSs) at a different location. The take off site (GCS A) is on the Tiban Field, Slarongan, Minggir, Sleman Regency, Special Region of Yogyakarta. While the landing site (GCS B) is on the Sumberarum Field, Moyudan, Sleman Regency, Special Region of Yogyakarta. The distance between take-off and landing site is about 2,5 km, and the flight time is 10 minutes long. The overlap coverage area allows to switch off the GCS so that the different operators can carry out the UAVs control (Figure 2). After overtaking the UAVs control inside their GCS area, an operator has control authority for monitoring and mapping purposes. After the fifth waypoint near the landing site, the spotter informs the pilot to take over the UAVs control switching to manual flight using a remote control that connects to UAVs’ telemetry. The landing process is a fully manual flight done by the pilot.

Applying multiple GCSs into the flight mission of the VTOL UAVs allows operators to expand their range area. This method also allows the operators to combine both automatic and manual pilots. Although its advantages, this method has one risk of technical error when in critical condition. The critical condition happens when the UAVs control switch from GCS A to GCS B or when the UAVs is flying above the overlap coverage area. If GCS B fails to connect with UAVs, the UAVs will return to GCS A. At this time, the team on GCS A must be on standby to ensure that the vehicle does not lose control completely.
5. Conclusion
The long-range UAVs using an operating method with multiple GCSs can increase the value of the benefit for the long-range monitoring and mapping, it is also can optimize acquisition data time, but there is still a problem to be solved. The critical condition can happen when the control of the UAVs is switching. It is still necessary to further study to develop a safer and more effective UAVs control mechanism to solve this problem.

6. Acknowledgement
This research was supported and funded by the Faculty of Geography Universitas Gadjah Mada. The authors also wish to thank the Inderaja Teknik Indonesia Team and the Data Acquisition Team of Remote Sensing Laboratory Universitas Gadjah Mada for their help throughout the monitoring and mapping simulations.

References
[1] Adam C W, Vincent G A and Everett A H 2012 Unmanned aircraft systems in remote sensing and scientific research: classification and considerations of use. Remote Sens. 4: 1671 – 1692 doi:10.3390/rs4061671
[2] James A, Irene M and Johannes R 2010 Small-Format Aerial Photography Principles, Techniques and Geoscience Applications (Amsterdam: Elsevier)
[3] Xiaohan L, Huping Y, Chench X, Junming T and Huanyin Y 2020 Potentials of UAV remote sensing data carrier – a case of application in UAV low altitude route – planning. IOP Conf. Ser. Earth Environ. Sci. 502: 012009 doi:10.1088/1755-1315/502/1/012009
[4] Abdulhadi S, Haitham M A, Muhammad F A S and Ernesto D 2018 Drone pilot identification by classifying radio-control signals. IEE Trans. Inf. Forensics Secur. 13: 2439 – 2447 doi:10.1109/TIFS.2018.2819126