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Unmanned Aerial Vehicle Technology in Irrigation Monitoring

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ABSTRACT

This study aims to develop new approach in doing irrigation systems monitoring in terms of getting accurate data at a reasonable cost in an essay and fast manner. The research was done at Molek Irrigation District in Malang, East Java, Indonesia on November 2014-March 2015. The workflow consists of: (i) preparation; (ii) flight planning; (iii) automated flight; (iv) data processing. Data analysis was done by comparison between satelite method and Unmanned Aerial Vehicle method. Result research show that irrigation monitoring can be done more precise using Unmanned Aerial Vehicle technology.

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INTRODUCTION

Irrigation is one of the most important components of the agricultural development in Indonesia [6].The main concerns on irrigation management are its efficiency and effectiveness. Most of the problems are derived from the lack of accurate data of irrigation systems for conducting best management practices. Unmanned Aerial Vehicle development has promised a new way to collect important irrigation systems data in an efficient and effective manner. The UAV makes data collection be done virtually anytime, anywhere at very reasonable cost. Some study has proven the potential use of UAV in agriculture, such as crop status mapping [3],vegetation sensing [2] or soil erosion monitoring [1]. Micro-UAV has advantages which almost impossible to get from conventional aircraft. i.e: it can fly at a lower altitudes so it able to provide a higher resolution image needed by site-specific farm management [4].

Managing irrigation system of paddy field is following a cycling steps starts from planning, operation, maintenance, monitoring, to evaluation and back to planning for the next season. The best start for improving an irrigation system is developing a good planning. However, reffering to the need of precise data in developing a good planning, the best start in improving running irrigation system is from evaluation step. The evaluation process will provide data for planning activities. The quality of data comes from evaluation activities, therefore, is a critical parameter for the whole irrigation management processes. A study on irrigation system based on airborne remote sensing found that it is possible to detect irrigation canal leakage [4].

This study aims to develop new approach in doing irrigation systems monitoring in terms of getting accurate data at a reasonable cost in an essay and fast manner.

Method:

Study Site:

The study area consisted of 41 Ha area of paddy land covered by a tertiary irrigation channel within Molek Irrigation System, Malang, East JAva, Indonesia (Figure 1). Molek Irrigation System has 9,625 Ha potential area and 6.500 functional area.

DI Molek Secara geografis berada di kabupaten Malang terletak antara garis bujur 112 17’11’’BT dan 122 57’50’’ BT serta antara garis lintang 7 44’56’’ LS dan 8 26’36’’ LS, berada pada ketinggian sekitar 335 m dpl. Curah hujan harian berkisar antara 0 sampai 174 mm per hari. Peta lokasi Daerah Irigasi Molek disajikan pada gambar 2.

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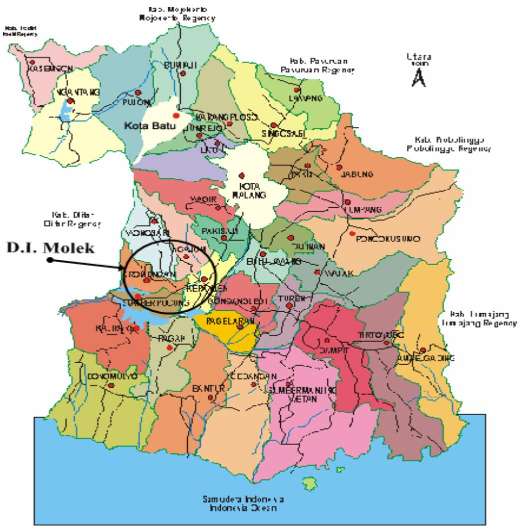

Fig. 1: Study site.

Equipments:

Hardware:

The UAV platform used in this study is developed based on Skywalker X8 airframe (Figure 2). The airframe is made from EPO foam with carbon enforcing spar. I has 2.2 m wingspan and equiped with 2 x 5,000 mAH battery at 14.8 volt. Total weight with 1 Kg payload is 3.5 Kg and capable to fly for more than 50 minutes. The aircraft has a DIY chute air braking system which allowing it to land safely using a parachute. The platform is implementing an open source flight controller namely Ardu Pilot Mega 2.5.2 (APM 2.5.2). The controller provides many flight automation to the aircraft such as stabilized flight, return-to-launch, auto take-off, auto landing, and automatic flight based on user defined waypoints. The aircraft also equipped with some sensors, i.e:

- Air speed sensor
- Global Position Systems and Magnetometer
- Current sensor

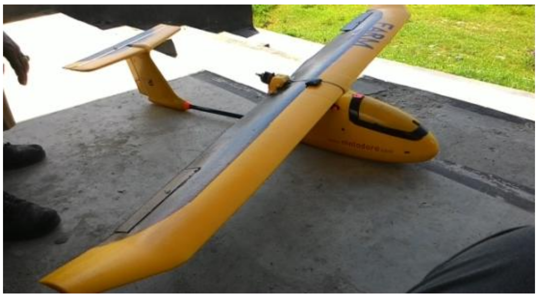

Fig. 2: UAV.

We used Canon® S100 PoweShot digital camera (12 Mpix CMOS sensor) with 24 mm focal length. The camera measures Red, Green, and Blue spectral bands and hereafter referred as RGB camera. The camera focus is set to infinite while the aperture sensitivity and shutter speed are determined by flight acquisition tests and adjusted manually to get the best picutre in term of sharpeness and light saturation. Camera shutting is controlled by a CHDK script to get a series of picture with certain time interval. The time interval is defined based on the speed of UAV flight which is determined during the flight planning.

Software:

We used APM Mission Planner V to plan and control the UAV flight, Agisoft® Photoscan to produce orthophoto and QGIS 2.0 to do spatial analysis.

Workflow:

The study employed a general workflow for mapping which similar to the one 8efine don8don man-based aerial mapping. The workflow consists of: (i) preparation; (ii) flight planning; (iii) automated flight; (iv) data processing. The fist phase is preparation which includes area definition and hardware setup. The second phase is flight planning using Mission Planner software. This step was done in the field to make the best plan 9efine d real terrain and weather condition. We defined the time lapse interval of camera shutting in this phase. Below are flight and data acquisition parameters:

- Altitude : 125 m
- Ground speed : 10 m/second
- Shutting intervals: 3.9 seconds
- Side overlap : 70%
- Forward overlap : 50%

Flights were done automatically 9efine d waypoints 9efine don the flight planning phase. Flight controller recorded all of flight parameters into a log file which will be used to determine data acquisition parameter such as camera viewing angle, position and orientation of sensors.

Data collected from previous phase the processed using Photoscan software to get georefferenced-orthophoto. We used available ground referrence point of GumbasaIrrigation System to georeferrence data captured by UAV. The georeferrenced-orthophoto then processed and analyzed spatially using QGIS software. The main focus of the spatial analysis was to evaluate acuration of documented functional area of targeted irrigation system.

RESULTS AND DISSCUSION

UAV and Satelite:

UAV acquisition image is better than using Satelite. Satelite acquisition image was shown at figure 3. UAV acquisition image was shown at figure 4. Gumbasa Irrigation District image using UAV was shown at figure 5. We can easily identify the tertiary irrigation from the image. Evaluation in irrigation system can be done more precise than another way.

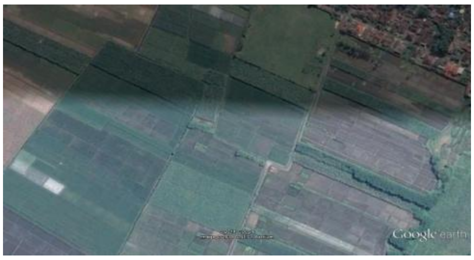

Fig. 3: Satelite acquisition image.

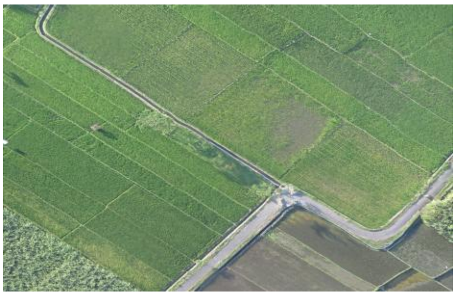

Fig. 4: UAV acquisition image.

Fig. 5: Image of Molek Irrigation District at tertiary using UAV.

Conclussion:

Monitoring of irrigation management can be done more precise using Unmanned Aerial Vehicle technology.

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