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Unmanned Aerial Vehicle for Surveillance

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Abstract

Nowadays, the security and surveillance is important element for any industry. The experiment aims to provide secure-effective solution for surveillance systems. There were several stages such as component design, hardware assembly, calibration, flight board modification, defined flight plan and verification and validation. The experiment prototype was consisting mechanical system and electrical system. The mechanical was propulsion system contained motor, electronic speed controller, batteries and propeller while electrical system contained flight control board, vision system, sensors and communication hardware. The system assembly and component connection was done using reference schematic. The mission plan was tested in university campus, the quadcopter had followed pointed path in the map as expected. The face classifier had been trained to analyze input image and detected faces. The upper body classifier had been trained to analyze same input image and detect upper body on the image. This classifier had been applied in different images from an aerial view with different distance.

Keywords:- *surveillance; mission; unmanned; aircraft; quadcopter*

1. INTRODUCTION

Unmanned aerial vehicle (UAV) generally refers to any type of flying vehicle with no pilot on board [1-3]. UAVs are remotely piloted. This could be an aerial autonomously fly based vehicle on the pre-entered program or on its own recognition of the surroundings using pre-programmed flight plans or a remote- controlled aircraft. In general UAV could be either under remote control by a human operator or autonomously by onboard computers. By 2022, drone store for business application expects reached 22.15 billion $. There is 20.7% developing at a Compound Annual Growth Rate (CAGR) from 2015 to 2022 [4]. The drones usage is expected to grow for the public security together with military applications [4]. A few drone stages have been created by industries and the community to empower its engagement in different life viewpoints such as farming, transport, power and security in the previous couple of years, a few open-source UAV platforms (Hardware, Software, or both) have been produced by com-munities and research

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undertakings to test and actualize various UAV applications [5].

A quadcopter is an extraordinary kind of helicopter. Quadcopter is small UAV used for aerial photography, drone racing, surveillance and rescue operations [6]. The quadcopter have four arms that are joined to the fundamental body and motors with rotors in each arm. PWM signals are produce from control board and run the motors which is brains and unmanned aerial vehicle primary parameter. The swash-plate in the helicopter is utilized to increase thrust, to expand the thrust on a quadcopter the angular velocity of the motors is expanded that the pitch of each rotor is settled. Moreover, the tail rotor is dispensed with so the helicopters are utilized to settle the helicopter about the yaw axis.

In additions, global positioning system (GPS) is actively serving for outdoor autonomous navigation [7]. The advancement of a GPS-based position control framework helped the four rotor helicopters ready to keep positions within given destinations. Furthermore, the novel control framework empowers permanent full speed flight with reliable altitude continuing considering that the subsequent lift is decreasing while changing pitch or angels of roll for position control [8].

The experiment aims to provide secure-effective solution for surveillance systems. This experiment purpose to design and implement UAV with surveillance capability, the quadcopter drone was selected due to high expandability, stability and manoeuvrability. The quadcopter was equipped with video camera and GPS sensor. In additions, PC base station with remote-controlled (RC) transmitter and receiver interface module. The base station contained mission planner for target location and VLC media player to receive video streamed from the quadcopters.

2. METHODOLOGY

The experiment prototype was consisting mechanical system and electrical system. The mechanical was propulsion system contained motor, electronic speed controller, batteries and propeller while electrical system contained flight control board, vision system, sensors and communication hardware.

Meanwhile, a wireless camera was used to deliver real image and aerial surveillance through separated transmitter and receiver to send image and display inside ground station. The image was employed to specific classifier using MATLAB to gather some data about human population in target area.

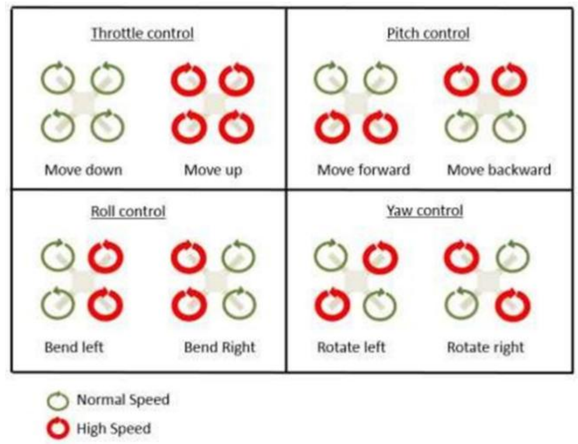

Figure 1. Quadcopter movement

A quadcopter was helicopter which had four arms connected to main body and there were motors were attached with arm and propellers, both motor and propeller combination created vehicle movement. The basic quadcopter movement involved two motor movement in clockwise direction while another motor was moved in an anti-clockwise direction with each direction had specific propeller.

The methodology was divided into two parts such as hardware and software. The hardware involved designing propulsion system and assembled drone components and tested mechanical part included motor. The software was calibrated system component and test each subsystem and run mission planner software which contributed quadcopter control itself during the flight.

Table 1. Subsystem and component.

Drive system	Communication	Surveillance
Pixhawk controller	Reviser	Camera
Motors	Transmitter	Monitor
Electric speed controller	GPS	GPS

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Power distribution	Battery	Battery

First, the whole drone maximum weight was measured to make sure motor, propellers and battery were able to drive motor.

$$Motor_{rotation} = Kv\ x\ voltage = 850x\ 11.1 = 9.435\ RPM$$

Meanwhile, thrust per motor was calculated as below:

$$Maximum_{thrust} = (Weight + 20\%\ of\ weight)x2$$

$$Thurst\ for\ each\ motor = \frac{Drone_{weight}x\ 2}{Number\ of\ motors} = \frac{1.3x2}{0.65} = 4$$

$$Motor\ output\ powere = Power\ absorption\ of\ propeller$$

$$Power = Kx\ RPM^3 x\ Diameter^4 x\ Pitch$$

$$= 5.3x10^{-15} x\ 9.435^3 x10^4 x\ 4.5 = 200.32W$$

The torque was influenced movement and controlling of aircraft.

$$Force = mg \sin 90 = \frac{650 + 650x0.1}{1000} x\ 9.81 = 7.01415\ N$$

$$Radius = \frac{length\ of\ prop}{2} x\ 0.0254 = \frac{5x0.0254}{2} = 0.127M$$

$$Torque\ (\tau) = \mathrm{Force\ (F)} x\ Radius\ (R) = 7.01415x\ 0.127 = 0.89N.M$$

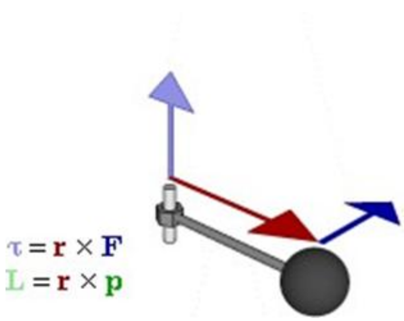

Figure 2. Torque

Maximum current rating was another important factor and ESC Ampere rating value was 20% greater than ampere rating of motor for safety margin.

The system assembly and component connection was done using reference schematic. The flight controller only required a 5.5 volt for operation, hence necessary to use a voltage regulator between battery and flight controller. Meanwhile, 11.1 volts was supplied by 3 cell LiPo battery was sent to the distribution board that delivered power to all four ESC in same time. The ESC input signal was connected to the flight controller output pins. The two wires was switched and motor rotation direction was reversed. A safety switch was provided in the system to stop motor spinning manually.

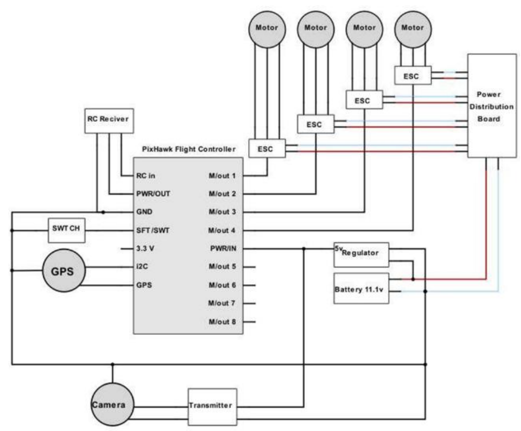

Figure 3. System schematic

In this experiment. ground-based control station (GCS) was used to calibrate system component, set the vehicle flight and defined flight plan. The QGroundControl was used to provide flight control and mission planning for any MAVLink (Micro Arial Vehicle Link) enabled vehicle.

Meanwhile, remote-control calibration was important steps in this experiment. The flight modes had been specified in the remote-control transmitter were manual, altitude and mission modes.

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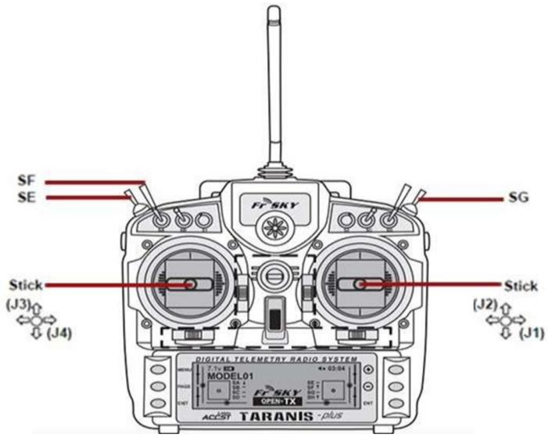

Figure 4. Remote-control transmitter

The Qgroundcontrol software was used with remote-control transmitter for each switch position to be functioned. Once switches in position 100, the quadcopter was operated in manual mode, if SF switch was moved to position 0 and altitude mode was started, while position -100 of SF switch operate vehicle for start saved mission in the flight controller. The SG switch was assigned to be kill switch that stops all motor immediately.

In additions, five different sensors in the system which each sensors to be calibrated with flight controller. The accelerometer calibration required measurement for six vehicle orientations. Meanwhile, campus calibration needed rotation measurement for each orientation. The magnetometer measurement used to determine North. South, East and West orientation. The results were automatically written to the parameters file once sensor calibration process was completed. Once all calibration and test was completed, the vehicle was ready to fly

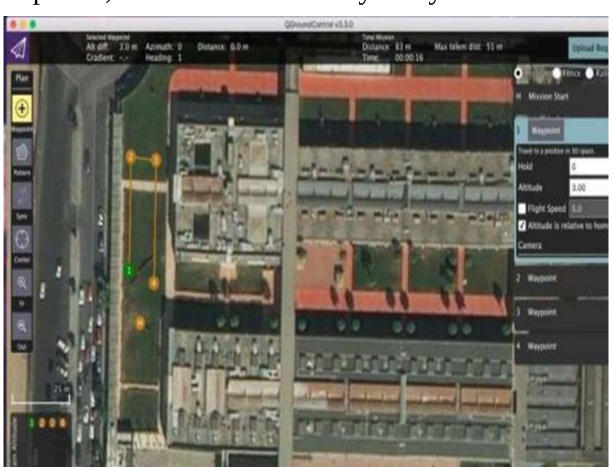

Figure 5. Mission planner

RESULT AND DISCUSSION

Figure 6 showed side view of constructed quadcopter prototype. The black board in middle of quadcopter was Pixhawk flight controller. Four motor with attached ten-inch propellers were clearly visible at frame arms end. The remote controller receiver and GPS receiver was separated as far as possible to avoid signal noises, GPS was located on front of quadcopter and remote-control receiver was placed backward.

Figure 6. Experiment prototype

The mission plan was tested in university campus, the quadcopter had followed pointed path in the map as expected.

Figure 7. Flight planner

The face classifier had been trained to analyse input image and detected faces. The upper body classifier had been trained to analyse same input image and detect upper body on the image. This classifier had been applied in different images from an aerial view with different distance as shown in Figure 8. The tested classifier showed good result in most images as expected.

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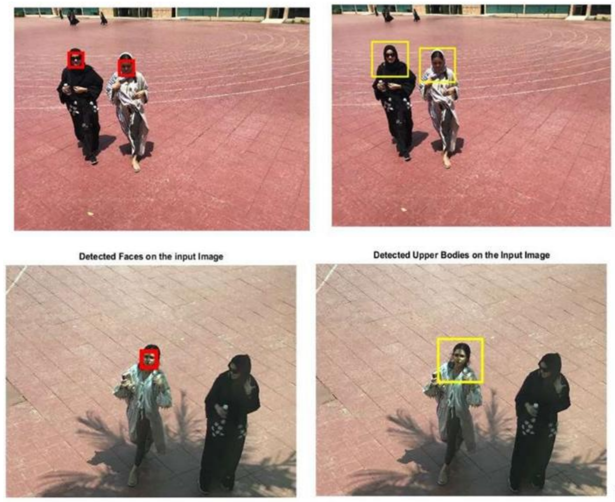

Figure 8. Face and upper detection result

3. CONCLUSION

In conclusions, unmanned aircraft system provided ultimate solution to the limitation faced by other surveillance methods. In this experiment, a simplified model of unmanned aerial vehicle had been obtained. The prototype had a surveillance capability contained live stream surveillance and face and upper body detection. The drone surveillance presented easier, faster and cheaper in data collection method. The future of Unmanned Aerial Vehicle (UAV) is purpose to deliver greater ability to provide a secure-effective solution for surveillance systems.

4. REFERENCES

[1] Agbeyanig, A. O., Odiete, J. O and Olorunlomerue, A. B. Review on UAVs used for aerial surveillance. Journal of Multidisciplinary Engineering Science and Technology. 3,10 (Oct.2016), 5713-5719.

[2] Finn, R.L and Wright, D. 2012. Unmanned aircraft systems: surveillance, ethics and privacy in civil applications. Computer Law and Security Review, 28,2012, 184-194.

[3] Tatum, M. C. and Liu, J. 2017. Unmanned aircraft system applications in construction. Procedia Engineering, 196, 167-175.

[4] Ebeid, E., Skriver, M. and Jin, J. 2017. A survey on open-source flight control platforms of unmanned aerial vehicle. In 2017 Euromicro Conference on Digital System Design (DSD) (Vienna, Austria, Aug 30, 2017). DSD'17.DSD, Vienna.

[5] Nam, C. and Danielson, S. 2011. Development of a Small UAV with real-time video surveillance. ASEE Annual Conference and Exposition, Conference Proceedings.

[6] Cibiraj, N. and Varatharajan, M. 2017. Chattering reduction in sliding mode control of quadcopters using neural networks. In 1st International Conference on Power Engineering, Computing and Control. (Chenai, India, March 4, 2017).

[7] Padhy, R.P., Verma, S., Ahmad, S., Choudhury, S.K. and Sa, P. K. 2018. Deep neural network for autonomous UAV navigation in indoor corridor environment. International Conference on Robotics and Smart Manufacturing. 133, 2018, 643-650.

[8] Puls, T., Kemper, M., Küke, R. and Hein, A. 2009. GPS_based position control and waypoint navigation system for quadcopters. In 2009 IEEE/RSJ International Conference on Intelligent Robots and Systems (St.Louis, USA, October 10-15, 2009).