Evaluating the performance of quadcopters using Image processing

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Abstract- *Precision Agriculture and Remote Sensing are some of the current routines of land management. Remote sensing, is to not having to physically be present to take any measurements. Remote sensing can be achieved using quadcopters. We are comparing two devices, the 3DR Iris+ and the DJI Phantom 2. The quadcopters are assessed based on two tests, the drift test and the rectilinear motion test. The drift test involves the equipment to float over an object at three different altitudes. Equivalently, the rectangular motion test requires the quadcopter to follow along a straight line and images are taken every quarter of a second. Similarly, in the image processing results of the above test include measuring the displacement of the lines and object itself, for the rectangular motion test and drift test respectively. Ultimately, both results depict that both appliances are equitably similar in performance.*

Keywords- Quadcopters, drift test, rectangular motion test

I. INTRODUCTION

An unmanned aerial vehicle (UAV), commonly known as a drone, is an aircraft without a human pilot aboard. UAVs are a component of an unmanned aircraft system (UAS); which include a UAV, a ground-based controller, and a system of communications between the two. A quadcopter, also called a quadrotor helicopter or quadrotor, is a multirotor helicopter that is lifted and propelled by four rotors.

Quadcopters are classified as rotorcraft, as opposed to fixed-wing aircraft, because their lift is generated by a set of rotors (vertically oriented propellers). Quadcopters generally use two pairs of identical fixed pitched propellers; two clockwise and two counterclockwise. They use independent variation of the speed of each rotor to achieve control. By changing the speed of each rotor, it is possible to specifically generate a desired total thrust; to locate for the center of thrust both laterally and longitudinally; and to create a desired total torque, or turning force. There are multiple applications of quadcopters, some of them include aerial photography, farming, etc.

Agriculture is one the main areas impacted positively with the use of quadcopters. Routines like precision agriculture can be used to audit and supervise health and growth of crops. Whereas, remote sensing deals with taking measurements, without human requirement. Both above establishes not only prosperity in crop produce but also optimal use of resources.

Quadcopters have become the most economical yet rational approach for cultivators. The only objection is, however, choosing the appropriate equipment for the distinct application. Each rotor produces both a thrust and torque about its center of rotation, as well as a drag force opposite to the vehicle's direction of flight. If all rotors are spinning at the same angular velocity, with rotors one and three rotating clockwise and rotors two and four counterclockwise, the net aerodynamic torque, and hence the angular acceleration about the yaw axis, is exactly zero, which mean there is no need for a tail rotor as on conventional helicopters. At a small size, quadcopters are cheaper and more durable than conventional helicopters due to their mechanical simplicity. Their smaller blades are also advantageous because they possess less kinetic energy, reducing their ability to cause damage. For small-scale quadcopters, this makes the vehicles safer for close interaction.

It is also possible to fit quadcopters with guards that enclose the rotors, further reducing the potential for damage. However, as size increases, fixed propeller quadcopters develop disadvantages over conventional helicopters. Increasing blade size increases their momentum. This means that changes in blade speed take longer, which negatively impacts control. At the same time, increasing blade size improves efficiency as it takes less energy to generate thrust by moving a large mass of air at a slow speed than by moving a small mass of air at high speed. Therefore, increasing efficiency comes at the cost of control.

II. EXISTING SYSTEM

Satellite imagery has been used to monitor crops. However, the exorbitant price, low image resolution and low sampling frequency poses an issue. Satellite imagery consists

of images of Earth or other planets collected by satellites. Imaging satellites are operated by governments and businesses around the world. Satellite imaging companies sell images under license. Images are licensed to governments and businesses such as Apple Maps and Google Maps. The resolution of satellite images varies depending on the instrument used and the altitude of the satellite's orbit. For many smaller areas, images with resolution as high as 41 cm can be available. Satellite imagery is sometimes complemented with aerial photography, which has higher resolution, but is more expensive.

Manned aircrafts have also been tried to achieve remote sensing. Unmanned aircrafts also pose a problem as there are various sizes and shapes of them, available. The larger ones have their own disadvantages such as unmanned aerial vehicles contain overall budget problems, they are very expensive to produce and keep up. The larger drones are meant for warfare. The human mistake in the remote controls can cause the plane to crash and they have limited abilities. The computer systems or the software could break down resulting in loss of plane and/or casualties on the ground, losing the plane costs millions. The computer malfunction can take place resulting in the loss of control in the aircraft. There is the ethical question on the use of the autonomous system in the combat situations especially as the computer cannot take the initiative which can result in the civilian deaths. They are too easy. By making the drone warfare very like video games, the drone warfare makes combat too easy by diminishing ethical decisions.

III. PROPOSED SYSTEM

A. Physical structure and scheme

Quadcopters can be compared based on size, namely micro, small, medium and large quadcopters. Micro quadcopters are extremely small, about the size of a bug. The small quadcopters are comparatively greater than micro quadcopters. The medium ones can haul up to 200kg whereas the large quadcopters are applied in military combats. There are two ways of owning a quadcopter, one is do-it-yourself kits and the other is off-the-shelf. Off-the-shelf products are ready-to-fly devices and not much adjustments to be done as compared to the do-it-yourself approach. In extension, these off-the-shelf devices come with a pre-attached camera gimbal that is pivotal in agricultural auditing. The two quadcopters put under inspection are: i) 3DR Iris+ and ii) DJI Phantom 2. 3DR Iris+ is relatively wider compared to the DJI Phantom 2. The distance between the adjacent propellers is greater hen the distance between the front and back. Whereas, the propellers of DJI Phantom 2 are set proportionately, in a square. Both the devices have essentially the same camera setup.

B. Image processing for Performance Assessment tests

Based on applications of quadcopters, two performance assessment tests were conducted to find a contrast between the two off-the-shelf devices. The tests were the drift test and the rectangular motion test. In either of the cases, a GoPro camera is secured to the quadcopter's camera gimbal. The images captured by the GoPro were used to assess the performance of the quadcopters.

1) Drift test:

In this test, the quadcopters were granted to drift over a 2-m square pipe at three distinct altitudes: 5m, 15m, 25m. The quadcopter could hover over the square for 2 minutes and images were taken at an interval of 0.5 seconds. The result of this test was assessed based on the pixel resolution at each level: 5m-116 pixels/m, 15m-71 pixels/m, 25m-51 pixels/m. The midpoint of the area of the square pipe is used as the stability criterion, for assessing this test using image processing. Tracking this midpoint in the series of images is the basis for image processing, in the drift test. The actual square pipe acts as a set point for the subsequent images. Whereas, the images of the squares captured at different altitudes portray the subsequent images. The midpoint of each of the squares in the images were compared against the set point, and this is used to assess the stability of the quadcopters.

2) Rectilinear Motion test:

In this test, the quadcopter is set up to fly in a straight path. Like the drift test, the GoPro was registered to capture images at every 0.5 second interval. These images were then used calibrate the adherence in straight line motion. The start point of the quadcopter is considered as the field of view. The aimed path taken by the quadcopter is different from the ideal path. Like the drift test, the shift in position is calibrated to assess the quadcopters.

C. Test outcome

1) Drift test:

Position displacement is the difference between the mid-point of the set-point and the subsequent images. In 3DR Iris+ has a minimal displacement of 0.64m, at an altitude of 5m and a maximum displacement of 0.34m, at an altitude of

25m. Hence, the mean position deviation at 5m and 25m is 0.29m and 0.14m, respectively. Whereas, the DJI Phantom 2 has a minimal displacement of 0.79m, at an altitude of 5m and a maximum displacement of 0.34m, at an altitude of 25m. Here, the mean position deviation at the lowest and highest altitude is 0.36m and 0.11m. Both the results depict that lower the altitude, higher is the deviation. Increase in altitude reduces the pixel resolution. Position displacement can be brought about by multiple factors such as the on-board GPS sensors, wind pressure, etc.

1) Rectilinear motion test:

The maximum calculated deviation from the ideal path should be less than 1m. 3DR Iris+ has a maximum deviation of 0.85m whereas, the DJI Phantom 2 has a maximum deviation of 0.73m. Like the drift test, the deviation is liable to the GPS receivers, wind pressure, etc.

D. Advantages of proposed system

- These small drones can be easily flown and maintained with little training making them a great option.
- The price of these remote sensing quadcopters has become much more affordable and thus a realistic application.
- These drones help bring greater level of accuracy, consistency, safety and reliability.

IV. CONCLUSION

3DR Iris+ and DJI Phantom 2, two of the most favoured quadcopters in the market, is compared and assessed using image processing. The assessment is based on two tests namely the drift test and the rectilinear motion test. In the drift test, images are taken at three distinct altitudes and the position displacement of the entity is calibrated, to evaluate the stability of the quadcopter. Whereas, in rectilinear motion test, the assessment is based on the device moving in a straight line. The results of using image processing for the drift test depicted that 3DR Iris+ has its maximum deviation at 0.64m and DJI Phantom 2 at 0.79m. Similarly, in rectilinear motion test, maximum deviation of 3DR Iris+ is 0.85m and DJI Phantom 2 is 0.73m. This concludes that both the quadcopters are equally competent in fulfilling its purpose.

V. FUTURE ENHANCEMENTS

1. Multispectral measurements for site specific land measurements.
2. Environmental impact assessment and flood risk surveys.
3. Fertilizer and pesticide measurement.
4. Analysis of soil, health and vigour of crops.

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