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A Study on a Flight Safe System in Unmanned Aerial Vehicles

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Abstract

Recently, as the interest of unmanned aerial vehicles has increased, technological development of the drone has been progressing. Emergency situations can occur due to various environmental variables such as sudden loss of connection between flight and controller, instability caused by strong wind during the flight, and the lack of power supply between drone components. In this paper, we design and fabricate a drone based on a pixhawk FCC (flight control computers) with F450 class frame. The implemented drone aims to land safely back to the take-off point based on GPS when a fail safe mode is activated. The fail safe mode was applied to the situation where the connection between drone and the controller was suddenly disconnected. We tested an accuracy of the fail safe mode in fixhawk FCC.

INTRODUCTION

With the increasing interest in the field of unmanned aerial vehicles, technological advances have been made for drone [1]. The operation of drone was initially developed for military use and was used for missile defense. Recently, it has been developed for personal use and has been expanded to various fields such as personal media broadcasting, drone racing, delivery of goods, and transportation means [1] - [4]. As a result, this technology development of many companies are being advanced. The use of drones is also very diverse, and the service infrastructure for this is being expanded [4].

The structure of the drone can be divided into hardware and software. Depending on the number of propellers in the hardware, there are four wing drone (quad-copter) and eight wing drone (octocopter), which is called multi-copter. Numerous manufacturers are also launching parts for a variety of applications. The software aims to control a microcontroller through programming [5] - [7]. Currently, open sources such as Multiwii developed by an individual called "Alexandra" and released as open source and ArduPilot / APM developed and released by amateur drones are being actively shared. The research activities of users are actively performed [7] [8].

In order to control the drones, basically the body and the frame that make up the drone body should be properly balanced, and the software performance should be supported based on this balance. The software must be able to accurately grasp the state of the body frame and control it in real time. Therefore, most drones are equipped with an acceleration sensor, a gyro sensor, and an altitude sensor to measure the state of flight [8] - [10].

When manipulating the drones, you may occasionally encounter unexpected environmental variables. Typically, instability due to turbulance, a state where the power supply between drone components is not smooth, and a state where the connection between flight body and controller is suddenly disconnected. Such a situation can cause various problems. For example, if there are many obstacles in the place where drones flight, or where there are a lot of people, danger of human accidents may occur. In addition, the drones may fall or be damaged by impacts from obstacles, which can lead to costly accidents. Therefore, various works have been studied to solve these problems [9] [10].

In this paper, we test a fail safe mode that enables a drone to move to the place where autonomous take-off and land safely when the sudden loss of communication between flight FCC and controller occurred in the above unexpected situation. To this end, we designed a drone with additional functions and fabricated a drone with a fail safe function with an autopilot program.

The system we have configured for a safe mode testing is shown in the figure below. The flight stack was installed in fixhawk FCC and an autopilot program was set to active mode in fail safe and tested on a 1.5Kg / 45cm quad copter.

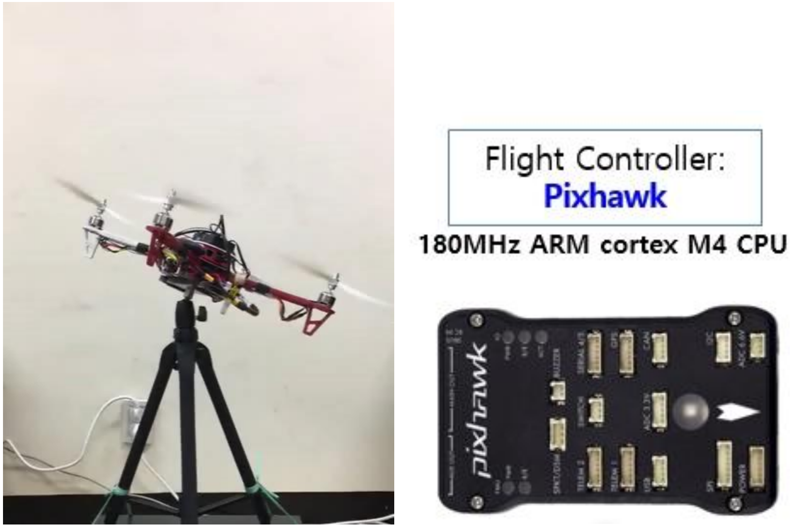

Figure 1. Drone configuration

Flight safe system

Fail safe is defined as a structure and function that maintains safety at all times even if a failure or malfunction occurs in the machine or its parts. Fail safe is basically divided into three stages: fail passive, fail active, and fail operation. The fail passive phase detects a functional fault and the fail active phase automatically performs control of the faulty machine. In the fail operation phase, it controls the time to perform the function until safety is secured.

First, the fault diagnosis algorithm performs FCC fault diagnosis algorithm on the signals managed by FCC, in particular, the variables that store the values of the signal which is the core of the drone control. On the PX4 Flight stack, periodically measure roll / pitch / yaw / throttle, the key variables of control related routines to determine non-response / partial anomaly. The FCC fault diagnosis algorithm is shown in figure 2.

Fail safe operation is performed when an emergency occurs in which the connection to the controller is disconnected based on the designed drones. When the fail safe operation is performed, the flying drone gradually moves from the GPS sensor to the recorded origin coordinates. At this time, the drone remember the trajectory of the flight and not fly in the reverse order. Since it stores only the coordinates of the starting point, it moves straight to the starting coordinates and then performs the landing process automatically. If the drone move to the starting coordinates without setting altitude information, they may collide with obstacles such as buildings, electric poles, etc., and be damaged. Therefore, the height of the drone is set to the value of the throttle, and the altitude of the drone is maintained at the altitude above the starting coordinates.

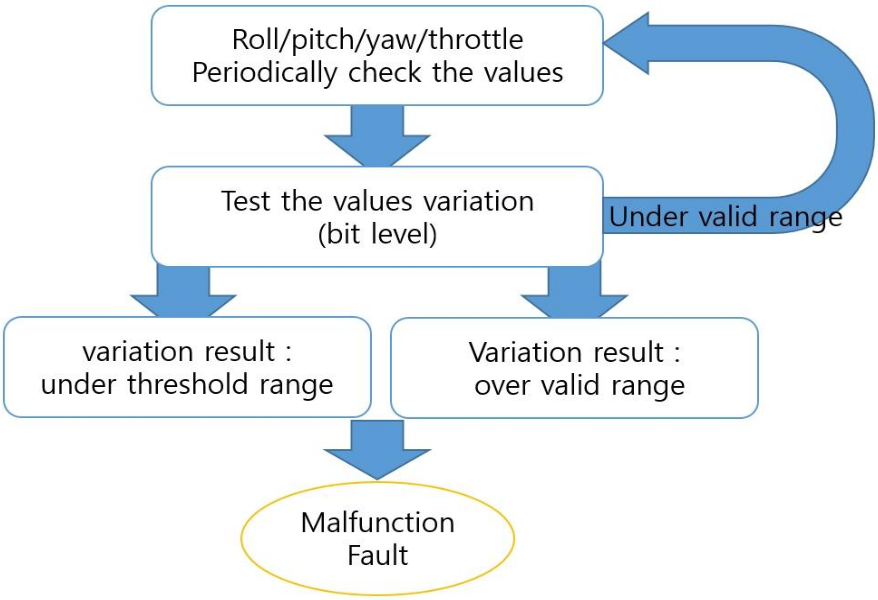

Figure 2. Fault or Malfunction detection process

Looking at the algorithm in Figure 2, FCC continuously compare key values such as roll, pitch, yaw, throttle during flight. Delay time is a time to distinguish an emergency situation such as communication disconnection or FCC malfunction. When the time that is longer than a set delay time and threshold key values are measured, the drone immediately performs the fail safe operation. At start, the flight starts at the starting point coordinates measured by the GPS sensor. However, there is a risk of a safety accident due to an obstacle or a collision with a person when flying from the starting point to the starting point in the coordinates of fail safe. To overcome these problems, return to launch function is used. It is implemented in a flight stack package.

The altitude of the drones is increased as compared with the altitude at the fail safe starting point and the preset safety altitude. When reaching altitude, it performs return to home function to move to starting point while keeping constant altitude. When you reach over the starting point, the drones take the landing phase. If you start to dive when landing, there is a risk of breakage of the drone, so you can make a slow landing at 50cm / sec by adjusting the descent speed. When you have finished all the steps, you will end the fail safe operation. We have tested the return to launch function several times. As a result, the accuracy of finding launch place was steadily decreased as the distance from the starting point in GPS measurement.

CONCLUSION

In this paper, we tested fail safe operation that returns to the starting point (launch place) of the drone itself in some emergency situation during flight of drones. For this purpose, a drone controlled by fixhawk FCC based arm processor with a frame size of F450 were designed and fabricated. In addition, a program for correcting the drones driving program and automatically returning when the communication between the controller and the drone is not smooth is programmed.

As a result of the experiment, it was confirmed that when the communication between the controller and the drone was cut off at each flight distance, the drones themselves landed at the starting point. In addition, the average distance of the landing point per flight distance was steadily increased. Future research plans are to increase the accuracy of the landing by combining the difference of the landing point by distance with some sensors like image processing camera and/or companion processors.

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REFERENCES

[1] Mustapa, Zaki, S. H. Husin, and N. Abas, "Altitude controller design for multi-copter UAV", In Computer, Communications, and Control Technology (I4CT), 2014 International Conference on. IEEE, Vol. 2, No. 4, pp. 382-387, Sep. 2014.

[2] Y. S. Lee, E. Kim, Y. S. Kim, and D. C. Seol, "Effective Message Authentication Method for Performing a Swarm Flight of Drones", Emergency Vol. 3, No. 4, pp. 95-97, Sep. 2015.

[3] S. Ross, N. Melik-Barkhudarov, K. S. Shankar, A. Wendel, D. Dey, J. A. Bagnell, and M. Hebert, "Learning monocular reactive uav control in cluttered natural environments", Robotics and Automation (ICRA), 2013 IEEE International Conference on. IEEE, Vol. 6, No. 10, pp. 1765-1772, May 2013.

[4] W. S. Maj and B. Butkiewicz, "Flying n-copter with fuzzy logic control", Signal Processing Symposium (SPS) 2013, IEEE, Vol. 7, No. 7, pp. 1-6, Jun. 2013.

[5] H. Robert, "A survey of indoor inertial positioning systems for pedestrians", IEEE Communications Surveys & Tutorials, Vol. 15, No. 3, pp. 1281-1293, Jan. 2013.

[6] H. Lim, J. Park, D. Lee, and H. J. Kim, "Build your own quadrotor: Open-source projects on unmanned aerial vehicles", IEEE Robotics & Automation Magazine, Vol. 19, No. 3, pp. 33-45, Sep. 2012.

[7] P. N. Patel, M. A. Patel, R. M. Faldu, and Y. R.Dave, "Quadcopter for agricultural surveillance", Advance in Electronic and Electric Engineering, Vol. 3, No. 4, pp. 427-432, 2013.

[8] K. D. Sebesta and N. Boizot, "A real-time adaptive high-gain EKF, applied to a quadcopter inertial navigation system", IEEE Transactions on Industrial Electronics, Vol. 61, No. 1, pp. 495-503, Jan. 2014.

[9] R. Szabolcsi, "The Quadrotor-Based Night Watchbird UAV System Used In The Force Protection Tasks", International conference Knowledge based Organization. Vol. 21, No. 3, pp. 749-755, Jun. 2015.

[10] M. B?umker, H. J. Przybilla, and A. Zurhorst, "Enhancements in UAV flight control and sensor orientation", Proceedings of the International Archives of Photogrammetry, Remote Sensing and Spatial Information Science (UAV-g 2013), Vol. 4, No. 6, pp. 4-6, Sep. 2013.