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User-centric Drone Controller for Preventing Operation Mistake

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Abstract

Recently, a variety of businesses have appeared not only in the drone's military market but also in the consumer market and the service market. The reason for the rapid growth of the market is that it is possible to produce cheap drones using open source. Although there are lots of system for controlling drones, people still experience accidents due to inexperienced user who purchased drones. These accidents occur from the difference between the viewpoint of the user and the drones. Therefore, in this paper, we propose a User Centric Drone Controller (UCDC) to reduce accidents caused by clumsy manipulation.

Keywords— **Drone, Drone Controller, Viewpoint, flight controller,**

I. Introduction

The 'Drone' is helicopter for the military target machine which is commonly used by the general public to refer to the unmanned aerial vehicle. Unmanned aircraft, which is a generic term, refers to aircraft without pilots. besides name drones, it is also called such as UAVs(Unmanned Aerial Vehicles), UAS(Unmanned Aircraft System), RPAS(Remotely Piloted Aircraft System), Autonomous Aircraft. [1]

The drone market grew not only to the military market but also to the consumer market and the service market, and various related industries have appeared. First of all, it is necessary to carry out public works for monitoring forest protection activities in drone consumer market, agricultural business for spraying pesticide and pesticide, construction project for monitoring construction progress, broadcasting work for Aerial shooting and close shooting, Logistics business for transportation, traffic system for traffic situation, and so on. In addition, in order to develop the drone business, it is affecting parts business and platform business such as high performance camera, sensor, small lighter and high performance battery. In these drone markets, specialized drone market suitable for service area may be formed, so various drone companies will be able to make their own business model. [2][3]

Drone could not enter the market because of the high price and technological approach. However, the market for drones has expanded as it has been able to produce affordable drones based on open source. The most notable consumer drones in recent years are DJIs in China. The representative model of DJI is Phantom, which is about $ 500 million in sales in 2014 and is growing to become the hottest company in the world with more than $ 10 billion in corporate value.

However, in spite of these growth and efforts, users still have accidents due to Inexperienced control. In this paper, we propose the UCDC to reduce accidents caused by Inexperienced control.

II. Related works

A. *Drone Structures*

Drones are based on open source and have various forms. The quad copter, which is a general type of drones, has the structure shown in Fig. It consists of a total of six components, including a radio receiver, a flight controller, a speed controller, brushless motors & propellers, an airframe, It is battery lead & power distribution. This explains the role that each component plays in Table 2. In addition, the drones can be equipped with a barometer, an ultrasonic distance sensor, a geomagnetic sensor, a camera for photographing, a GPS, etc.

Figure 1. Drone's basic structure

TABLE I. DRONE'S BASIC STUCTURE COMPONENT

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Component	Content
Readio receiver	Parts for receiving control signals from drone operators or computers
Flight controller	Parts for carrying out calculation for stable flight with built-in gyro sensor
Speed controller	Parts for stable and immediate motor speed control
Brushless motors & propellers	The thruster is generated by rotation to float the drones and move the part in the desired direction
Airframe	The drones are less influenced by the flow of air and the components for maintaining the shape to rigidly mount the drone's parts
Battery lead & Power distribution	Parts that can be powered by drones

B. Drone Operation

Drone calculates direction and position via a flight controller. For this reason, the drones can collect state information of the aircraft from sensors such as a gyroscope, an accelerometer and the like and perform stable flight. For example, as shown in Fig. 2, a quad copter having four propellers is rotated in two different directions, each of which is surrounded by a propeller opposed to each other with a quad copter of the shape of "+" You can float in place while the Antitorque is canceled and maintaining the body without rotating. For forward / backward movement, if the output of the motor (motor) 1, 2 is relatively raised from the motors 3, 4, it can rotate in the pitch direction and execute this. For the left and right movement in the same way it is possible to rotate in the output roll direction matching motor 1, 3 and motors 2, 4 and do this. This is as shown in FIG. 3. The rotational motion can be mounted by rotating the motors 2 and 3 faster than the motors 1 and 4. Make a diagonal propeller symmetrical to constant pitch propeller or reverse pitch propeller. Each motor can return in opposite directions and can receive a force rotating counterclockwise or clockwise along the direction of rotation. In other words, with this characteristic, the output of the motor can be adjusted so that the rotational motion can be controlled.

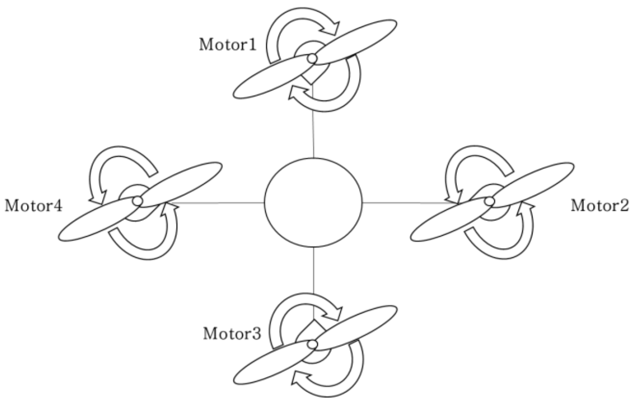
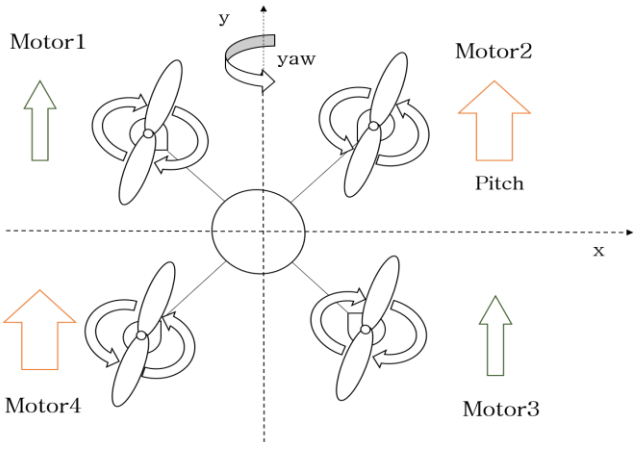
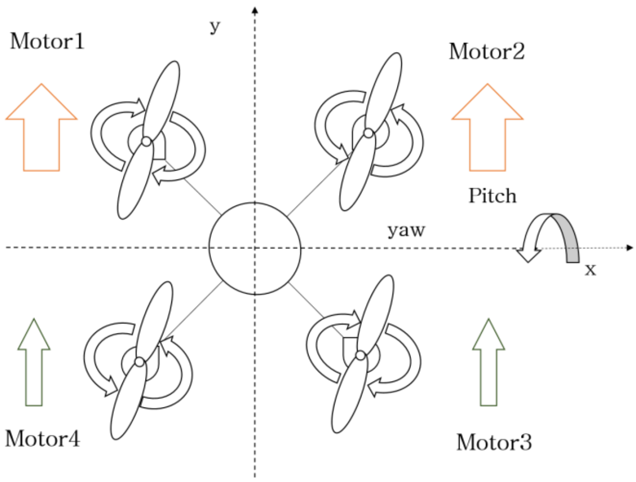


Figure 2. Quad Copter Rising Principle



(a) Drone linear motion



(b) Drone rotational motion

Figure 3. Quad Copter Linear and Rotational Motion: (a) Linear Motion, (b) Rotational Motion

C. Drone Interaction

The drone control method is an internal piloting method, and a separate cockpit is provided, which is used in a military drones in such a manner as to view and control the image captured by a camera mounted on the body. It aims to minimize the training of the user by mimicking the actual airplane cockpit and to maximize the performance of the remote control. Another method is External Piloting, which uses a remote control to look at the gas directly, and is used for RC (Radio Control) products including civilian drones. The controller is similar to the hobby radio remote control. The former is a first-person perspective, such as a map presented in a vehicle navigation, from a driver's perspective, and the latter is a third-person perspective, which observes the vehicle moving from the outside. Therefore, the user has difficulty in understanding the space depending on which reference axis is used. This means how to control the drones from the mechanical position through the camera and from the point of view of the user.[4][5]

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III. User-Centric Drone Controller

A. *Viewpoint Coincidence Problem*

The way the user controls the drones can be divided into the way of moving through the screen provided by the drones' camera and the method of judging and controlling the position with eyes. The control method through the camera is that the user moves from the viewpoint of the drones, and The control method through the eyes of the user is a method of operating the drone according to the user's gaze. These two methods are not a problem if the direction of the drone and the direction of the user coincide as shown in Fig.4 That is, the user's advance, left and right direction, and up and down directions coincide. In Figure 4 below, the yellow circle represents the viewpoint of the user and the drones. Due to the nature of the drones, the up and down directions do not pose any problems for the user's position and for the control of the drones.

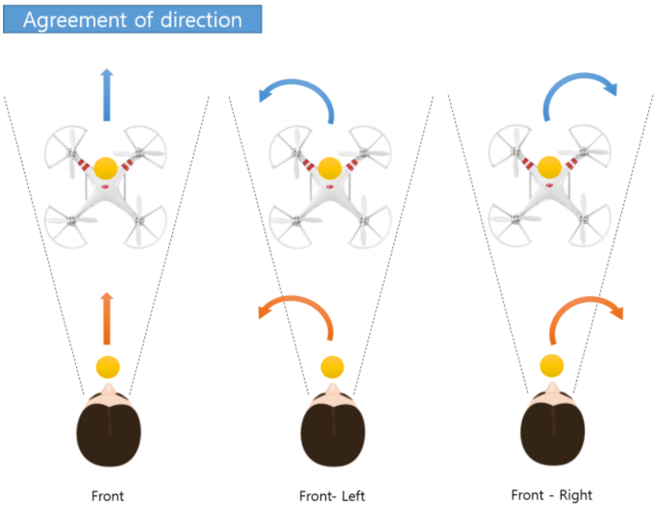

Figure 4. User-to-drones match point

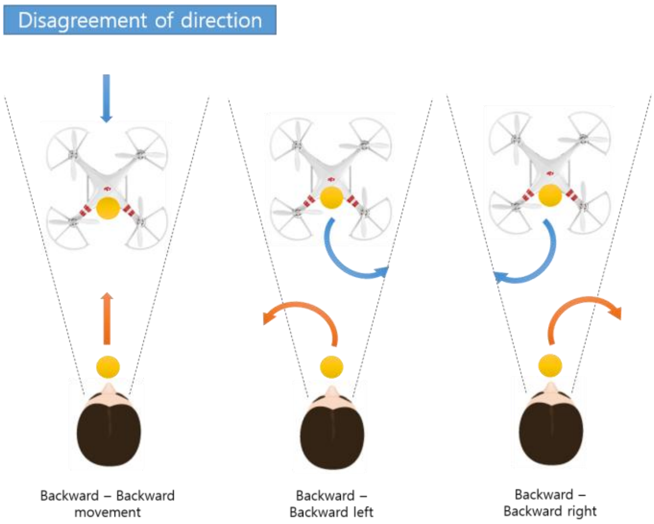

Figure 5. User and drones viewpoint inconsistency problem

The direction of the user and the direction of the drones may not coincide with each other. The user may have a problem as shown in Fig 5. As shown in Fig. 5, when the direction of the drone is different from the direction of the user, if the user does not recognize the direction of the drone, the direction of the actual drone for forward is equal to the direction of the backward direction from the user This is because the user thinks that the left side is the right side of the drones and the right side is the opposite side of the drones. This is in contrast to the direction in which the user thinks, and therefore, the operation is difficult. In order to reduce this mistake, it is only possible to improve the cognitive abilities of the drone and his position. If the direction of the user is the same as the direction of the drone, it can have the same direction from the user's point of view as shown in Fig.5. In this case, the directionality of the user and the drones coincides with each other. Therefore, there is nothing to consider for the user to control the drones.

B. *Viewpoint Problem Solution*

In order to match the direction of the user and the drones, firstly an absolute position reference value must be presented using the geomagnetic sensor for obtaining the all-azimuth with the user and drone. This value is a reference for the directionality of the user and the drones. Secondly, it is possible to detect the direction of sight via the gyro sensor (Mems gyroscope: smartphone) that detects the direction and detect the line of sight seen by the user, which can be applied to the drone. In this way, as shown in Fig. 6, the direction of the user and the drones can coincide if the user can provide the drone with the user's rotational angular velocity according to the motion of the user. In other words, This is a method using the yaw or rudder value of the drone manipulator. If the yaw or rudder value of the controller matches the user and the drones, the values entered in the other controls are Throttle up / down, Roll or Aileron (left and right), Pitch or Elevator (forward and backward) Match.

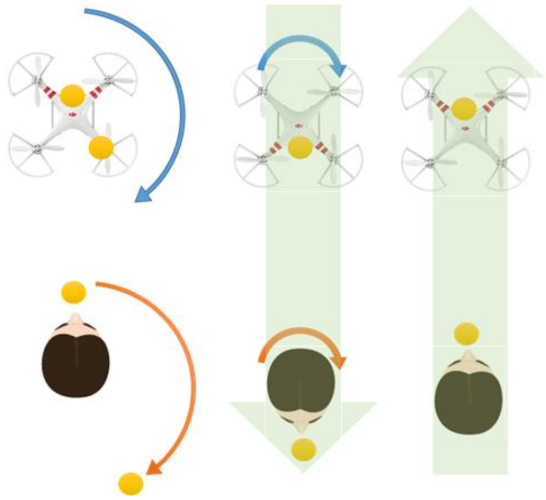

Figure 6. User-to-drones viewpoint matching

In a state of the direction of the user and the direction of the drones are matched, If you move the drones to the right, the directions of the user and the drones are inconsistent based on absolute coordinates. But, in this case, since the user changes gaze along a moving object, the direction angle can be extracted from the gyro sensor attached to the user's drone manipulator. Based on this, it is possible to guess the direction of the user at the absolute position in the geomagnetic sensor. By transmitting the extracted direction angle to the drones (through 2.4GHz, Bluetooth, etc.), the drone can readjust their direction based on the presented data using their geomagnetic sensor and gyro sensor. Through these methods, directionality can always be matched through geodetic sensors and gyro sensors attached to the user's drone manipulator and drone. This allows the user to always operate the controller from his point of view and overcome the directional heterogeneity of the drones and the user.

The user's controller and drone are provided with measured values from each sensor (Geomagnetic and Gyro) for absolute directional measurement, which can compare the direction of the user's controller with the direction of the drone and adjust it within a tolerable threshold value. The controller transmits the directionally measured data and the drone can reconcile this by repeating the control to check whether the adjusted value matches the current absolute direction by the controller. Figure 8 shows the data and exchange of data between the controller and the drone.

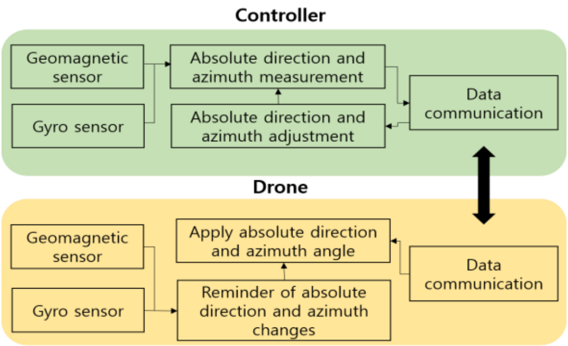

Figure 7. Directional measurement structure in the Controller and Drones

IV. Result

In this paper, we propose the UCDC as a method for users' control immature Using the UCDC on the drones can also reduce the incidence of inexperienced drones due to inconsistencies between the user and drones. Also, beginners who are not proficient in using the controls will be able to navigate easily. Future research will produce a controller that can be easily used by users through the proposed system design. Experiments on user convenience will be conducted using the controller made through this.

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