Mesoscale fixed point weather observation architecture by Drone fleet

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To know the generation mechanism of low clouds in the troposphere, we need to place a weather sensor with a certain density in the space of the radius from 2 to 20 km and from 1000 to 2000 meters altitude as the mesoscale meteorological observations. Such the studies of meteorological observations such as Mesonets (Rezaul. MAHMOOD, et. al., 2017) in the United States, and also studied in Japan (Kazuo SAITO, 2012), measure the weather information from the ground and satellites as the mesoscale meteorological observations. For practically, this information is used as a high-precision weather forecast with simulation (Kazuo SAITO, 2016). However, SODAR and LIDAR used for observation from the ground have limitations on the degree to measure wind direction and wind power (Dimitrios V. KANELLOPOULOS, 2016, Yoshiki ITO, 2009). Radiosonde is possible to measure the wind direction and force, but it has also limitation to sense from 2000 to 10000 meters because it cannot be placed directly at a specific point and can only obtain point information in chronological order. Although observations using aircraft can obtain temperature and humidity, it is difficult to correctly obtain wind direction and force based on the moving speed of the aircraft and turbulence of air current caused by the aircraft itself. The satellite sensor is one of the strong tool for large-scale meteorological measurement, but the spatial resolution is about 1.5 km and it is very difficult to sense a small area (Ryosuke NIWA, 2009).

In this research, in order to solve these problems by direct measurement, we propose a technique to measure using unmanned aerial vehicles at the same time. Specifically, six-propellers multicopter, generally called a drone which can hover for about 30 minutes per one and has a wind resistance of 20 m/s is manufactured, and a portable weather observation device utilizing ultrasonic wave is installed here. This meteorological observation device calculates the wind direction and wind force by calculating biaxial wind force by using ultrasonic waves. In addition, we install atmospheric temperature, humidity and barometer on weather observation equipment, and store on the payload computer a drone a measurement that is equal to or higher than the radiosonde. This meteorological observation device is raised by a mast to a height that does not affect disturbance of draft airflow measured in advance and measures it. In addition, the data accumulated in the payload computer are organized at about once every second, and it is transmitted to the ground from the 920 MHz compact power-saving radio station based on the LoRa modulation method and it is possible to display in real time. We can sense weather information at a fixed point on the mesoscale by aggregating this data at the same time at multiple sites through the Internet. In addition, since multi-copiers are out of the category of light aircraft of the aeronautical law up to 25 kg weight, we can easily skip to the altitude prescribed by the aeronautical law at the present time. However, since the altitude aimed for this research is to fly at a height where the clouds can reach from 1000 m to 2000 m, it is necessary to negotiate with the Ministry of Land, Infrastructure and Transport and air traffic control in advance.

As an actual demonstration, it was verified whether the drone of a single machine can be raised to an altitude of 500 m, 1000 m, 1500 m, 2000 m, respectively, and real time measurement can be performed. In the experiment conducted between 6:30 and 7:00 in the morning on 20, 21, 22 December 2018, the wind speed on the ground was about 3 to 5 m/s, but at the altitude of 1500 m it was 13 m / s For the first time. In addition, we confirmed that such information is transmitted to the ground in real time and can be

viewed directly. Moreover, using another drone equipped with the equivalent system, 27 drones flying into mesh type of 3 x 3 x 3 at intervals of 30 m in a space up to 100 m in height, verified to stay at the fixed point, succeeded doing. Using these combinations makes it possible to observe a fixed point in a wide area.

Keywords: Drone fleet, Simultaneous fixed point observation, Mesoscale weather observation