실내 환경에서의 다수 드론 위치측정 정확도 향상 기법

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Enhancing Accuracy of Multi-drone Localization in Indoor Environment

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요 약

In this paper, we propose a novel approach to improve the accuracy for multiple low-cost drones in indoor environment. When the drones are flying, we employ sensors for checking their position in real-time. If the drones move out of their correct positions, the corresponding instructions are sent immediately. In another thread, we calibrate direction of the drones by checking yaw value. The adjustment is repeated until the drones locate at right position and direction.

1. Introduction

In many tasks, we use the multiple low-cost drones at the same time. However, the drones are easily moving out of their correct position and direction because of their physical ability and wind of the propellers. Even if each drone has a global positioning system (GPS) sensor for checking position, it is only suitable for outdoor environment. In addition, the accuracy of low-cost GPS sensor is not high. The deviations will make crashes if the drones fly in small area. In this research, we focus on how to maintain the correct position of the multiple drones in real-time in indoor environment.

At the present time, there are many done studies about multi-drone control. In paper [1], the authors compare two ways to control a drone. A few frameworks for controlling multiple drones are proposed in papers [2-5]. But these methods only work well with outdoor environment.

In our method, we attach a checking position sensor to each drone. In every frame, we mapping the real position of each drone with theory position in PC. If the position is not correct, the PC sent the corresponding commands for calibration. By the similar way, we rely on gyroscope sensor in each drone to check and correct direction.

2. Multi-drone control system

We correct the position and direction of each drone separately by implementing three steps: get real value, compare real value with theory value and send commands for correction. The framework of automatic calibration is illustrated in Fig. 1. Here, d is distance between real position of each drone and its theory position which we calculate in PC. We also define a sphere in space with radius r and center is the theory position. If a drone fly in the corresponding sphere, we conclude that the position of drone is exact. Otherwise, we send the commands to change roll, pith, yaw and speed of the drone. We stop sending the commands when the drone is placed in correct position.

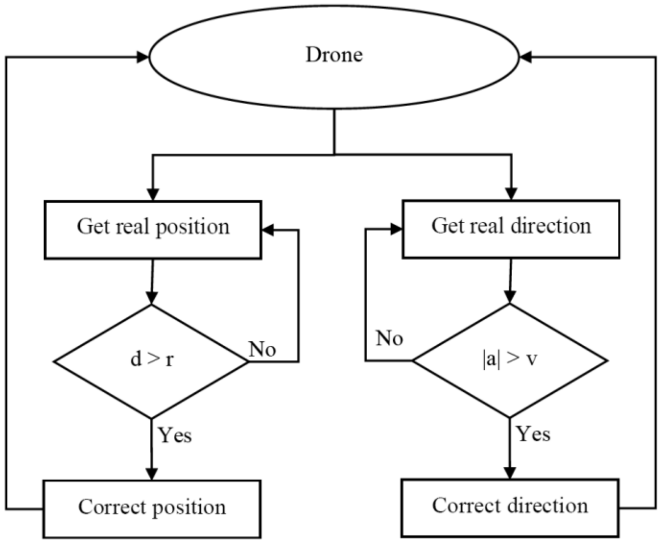

Fig. 1. Automatic calibration framework for each drone.

When drones take off, we get the yaw value of each drone called original yaw. When we control the direction of all drones, the original yaw values are updated. While the drones are flying, we obtain current yaw value in every frame. If the current yaw is different with original yaw, we send a command to drone for rollback direction. To calculate a, we use formula (1).

$$a = (current\ yaw) - (original\ yaw) \quad (1)$$

If a is larger than threshold v, we send a negative yaw value to the drone. And otherwise, if a is smaller than minus threshold, we send a positive yaw value to the drone.

3. Experiments and analysis

For our implementation, we used two Bebop drones as shown in Fig. 2. The sensor for checking position is TREK1000 from DecaWave Inc. We employed five sensors. S1, S2 and S3 create a local coordinate which origin is S1's position. S4 and S5 are attached in two drones. The radius of each sphere is 20cm and threshold v is 10 degrees. When we control two drones by keyboard or they run a scenario automatically, the PC send same commands to two drones via Wi-Fi connection. After each step, we also update the theory position and direction of each drone. Every 30 milliseconds, we compare real and theory values of each drone. After that, PC send the corresponding commands to each drone for calibration. Two drones worked well in small room. In Fig. 2, we show an example when theory and real position of each drone are different. For Drone 1, we send a positive roll value. Otherwise, we send the negative roll value to Drone 2. In the same way, we consider dY and set pitch value.

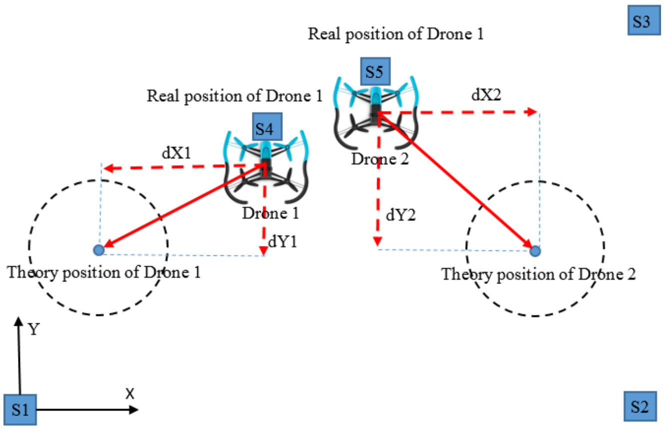

Fig. 2. Experiment with two Bebop drones.

4. Conclusion

In this paper, we proposed a novel approach for improving accuracy of Multi-Drone control in indoor environment. We focus on low-cost drone type which has low physical accuracy. We employed the checking position sensor in each drone. In addition, we also use the gyroscope sensor attached inside each drone by the manufacture. The experiments show that our method achieves good results in indoor environment. In future work, we will expand the system with more drones for both indoor and outdoor environment.

Acknowledgements

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