Problem

As personal drones are becoming popular, we need to create natural interaction techniques to best support users. The problem is how to design the interaction with personal drones. As drones have different characteristics than ground robots, it is not clear whether the flying robots can be supported by current Human-Robot Interaction (HRI) techniques. The authors design a Wizard-of-Oz (WoZ) elicitation study to understand how users naturally interact with drones.

Related work

Research work of the nature of HRI includes exploring multimodal, gestural, and prop-based interactions techniques. Some researchers find people feel comfortable using a variety of interaction techniques. There are many HDI applications, including running with drones, filming, creating flying displays, and looking at dynamically rechargeable flying objects. Some researchers investigated communicating feedback, such as intent and directionality. Some researchers explored controlling a drone using face poses and hand gestures as well as a multimodal falconry metaphor. Others investigated upper-body gestural interaction in a controlled lab where users were given specific interaction metaphors. User-defined interaction techniques and gesture elicitation research for new technology have been widely explored, such as tabletops, mobile devices, and TVs. But as there are main differences between traditional robots and drones, new interaction techniques are required for drones.

Methodology

To explore interactions and better understand the metaphors and relationships that occur when users interact with drones, the authors ran a user-defined interaction elicitation study. 19 volunteers took part in this experiment as users. This experiment was simulated that the drone autonomous behavior and reactions to user input. The experimenter using the remote stayed behind the user but could not be fully hidden to keep direct sight of the drone and participant for safety reasons. They found that even with the WoZ, users felt in control of the drone. Each task was described on a card to avoid verbally biasing the users' actions and modality choices (Table 1). One experimenter filmed and interviewed participants while another controlled the drone. Participants were informed of the WoZ and we emphasized that they should ignore the experimenters' presence when interacting with the drone. After each task, the participant was prompted to recall and explain their actions using a post-task think-aloud technique. Participants also rated their interaction in terms of suitability

and simplicity. After completing the 18 tasks, the participant was given a sheet with suggestions for interaction techniques. They were then asked to complete a second time 4 representative tasks that covered a range of category types and complexity. They looked at whether participants changed their interaction strategy after given suggestions.

Results

The authors showed the experiments results that the users preferred gestures, but the sound was also an important interaction methods. In the 418 interaction tasks, which 4 of them were misunderstood by the users, they found 216 unique interactions: 96 gestures, 59 sounds, 53 combinations of gestures and sound, and 8 with a prop. At the beginning, the users didn't feel comfortable to speak with drone, but after some instructions, the users adopted more sound command to drones at the second part of experiment. What's more, the survey data was also convincing. 90% of the participants felt they were in control and 95% felt it naturally.

In the "design insights" section, the authors summarized the interaction metaphors in the experiments. They found the users treated the drone as a person, a group of people, or even a pet. Finally, the authors also talked about the safety of the experiments.

About the future work, the authors wanted to implement HDI with the best technical solution. At the same time, they also decided to explore the human emotion towards drones and the interaction differences between drone and ground robots.

Evaluation

The paper surveyed the interactions between drone and human, and gave directions to improve the HDI between human and drone. Actually, authors should add introductions to the DJI Phantom 2 Drone, which was the experimental drone used in the paper. Because the readers couldn't know what gestures and sound, which the drone could recognize.