Dronible: Operating drones with Tangible objects

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Abstract

The goal of the **Dronible** workshop is to design and prototype interaction to fly and operate drones using tangible objects. This hands-on workshop will start with a video brainstorming for rapid and physical exploration of potential interaction. The workshop will continue with a digital prototyping phase with small-sized drones, motion sensors and haptic actuators. Finally, a presentation session will allow all participants to show off their prototypes and reflect on future Human-Drone Interaction perspectives.

Keywords

Human-Drone Interaction, Tangible User Interface, Haptic Feedback, Prototyping

Introduction

Drones are becoming more and more popular and widespread for professional or leisure applications. Most drones are either controlled via remote controllers, touch controls on screens or automated with dedicated ground control stations [3]. Recently, Human-Drone Interaction (HDI) has become an established field of research within the Human-Computer Interaction community [1]. In particular, various challenges for the control and communication with highly automated vehicles in public space are emerging among other ones.

Unfortunately, designing new forms of interaction with such devices can be complicated due to the specific nature of flying robots and the required technical challenges to achieve functional interaction techniques. as with Tangible Interaction or haptic feedback.

For the **Dronible** workshop, we would like to invite participants to envision how drones can be operated with tangible objects and provide haptic feedback for various use cases that will emerge from the participants interests. We will perform ideation and physical design activities as well as digital prototyping to invent and craft new forms of interaction with drones.

The workshop has three distinct goals:

1. Democratizing the field of Human-Drone Interaction
2. Developing the use of physical and digital prototyping techniques for HDI
3. Have fun in a creative and cooperative activity
4. Create future collaborations within the participants on Tangible Human-Drone Interaction.

Workshop Organization

Schedule

The workshop is planned to take place over a full day or possible two half days.

- Morning
  - Introduction to the workshop and participants round-table (30 minutes)
  - Group definition with mixed background (30 minutes)
  - Video Brainstorming session with physical prototyping (90 minutes)

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- Video prototypes presentations (30 minutes)

- Afternoon
  - Tutorial on the drones, sensors and actuators available (30 minutes)
  - Physical and Digital prototyping session (120 minutes)
  - Prototypes presentations and discussions (30 minutes)

Apparatus

We provided several small-sized programmable drones (BitCraze and Crazyflies). We also provided various physical prototyping material and inesensing modules from Bitalino RioT. The modules, which embed an inertial motion unit allowed the participants to retrieve acceleration or rotation data and other input data from external sensors such as force sensitive resistors or or potentiometers. For the haptic feedback part, we provided DFROBOT Bluetooth audio cards (DFR0720) and LRA vibrating motors. Programming sketcheswere provided in advance via GitHub[2] to facilitate the workshop.

The afternoon prototyping session took place at the ENAC flight hall to ensure participants' safety while testing their flying prototypes. The hall also features a recording system to document the results of the workshop.

Results

The workshop started with a brief overview of Human Drone Interaction research before moving to the video brainstorming phase.

Video brainstorming

During this first part, we split into two groups to brainstorm on tangible interaction to operate drones with vibrotactile feedback. We used video brainstorming techniques to record drone interaction enaction with minimal prototype designing efforts [2]. Each group came up with at least 10 ideas involving single or multiple users and various physical devices to operate drones such as:

- Performing musical instruments' motion and having drones creating auditory feedback while flying
- Various games involving throwing a ball to the player and the drone would follow the ball and after some time would buzz to indicate who lost
- A fitness assistant that would react to efforts performed to reach high altitude and slowly come back to the ground during breaks between workouts.
- Control of a fleet of drones by using tangible objects over a map to inform their target position and the constraints between the drones

Figure 1: Video brainstorming sessions

[2] https://github.com/jeremie-garcia/dronible

Physical and Digital Prototyping

After a quick demonstration of the available technologies for prototyping, participants voted for their favorite ideas from the video brainstorming sessions. The candidate ideas were:

- A drone as a dance partner that would react to performed dance moves and be integrated to the choreography. The design envisioned that the dancer would drop a ball attached to her wrist to make the drone take off. Then rotation motions would influence the speed and altitude of the drones, or the circular motions performed by the drones near the dancer.
- A physical remote controller using pressure and rotation to fly the drone. The two-pressure sensitive area controlled the lateral direction of the drone and its altitude.
- A fitness assistant reacting to efforts from the user. The user receives vibrotactile feedback to give rhythm information for the gestures that must be repeated. According to the energy of the motions sensed in the weights, the drone would increase its altitude. At the end of the workout, the drone would slowly land to indicate the remaining time before the next exercise.

The three groups managed to build physical prototypes but the digital prototypes using crazyflies were not very functional due to technical difficulties in operating the drones simultaneously.

Figure 2: Physical and digital prototypes

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