무인 항공기를 활용한 원격 점검 작업 제스처 기반 인터페이스

A Gesture Based Interface for Remote Inspection Tasks with Unmanned Aerial Vehicles

응 개리
KAIST 산업디자인학과

Gary Ng
Dept. of Industrial Design, KAIST

석 다니엘
KAIST 산업디자인학과

Daniel Saakes
Dept. of Industrial Design, KAIST

• Key words: Human-Computer Interaction, Interface Design, Interaction Design, Virtual Reality

1. Abstract

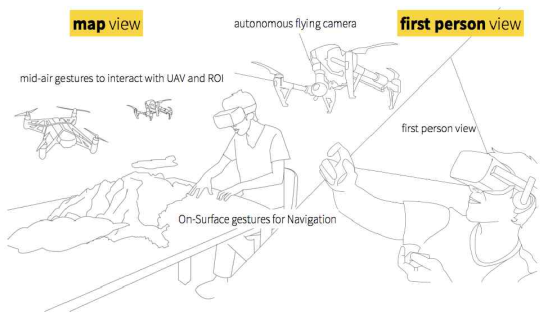
As the technology of autonomous unmanned vehicles advances, we can start thinking of user interfaces that focus on the immediate task instead of vehicle control and piloting. We explore such future interfaces with a virtual reality surveillance scenario using unmanned aerial vehicles (UAV), or drones, that we call "Street View Live". Similar to Google Maps with their Street View [Roman], we seamlessly combine a third-person, map-based navigation interface with a detailed first-person view of the area. However instead of satellite data, we use live video from simulated UAVs. We make use of a multi-touch tabletop combined with in-air gestures to navigate and control the system. This paper outlines our concept, an initial implementation, and challenges for future work.

2. Introduction

Recently, LG introduced a novel application for their robot vacuum cleaners which allows users to remotely pilot their vacuum cleaner from their phone as if it was a remote control (RC) vehicle. However, similar to the control of low-cost flying vehicles, all these interfaces focus on the piloting task: moving the vehicle around with a direct controlled joystick while the phone or tablet provides a first-person view from the vehicle. In contrast, map navigation software such as Google and Daum Maps allow users to browse over maps with familiar multi-touch gestures and switch between a top-down map view and a first-person camera view.

The popularity of UAVs in both industrial and domestic use is likely to increase. Therefore, in this paper we look into future user interfaces that abstract the piloting task and let users focus on the application. We present a concept and table-top interface for navigation and inspection scenarios as depicted in [Figure 1].

Navigation of a map view with regions of interests was combined with a first-person experience to explore that area in detail. The basic idea is that the user is presented with a 3D overview map with a number of UAV flying around. In



[Figure 1] A visualization of our concept.

this third-person map representation, the user can select UAVs which enables them to inspect the situation in first-person from the UAV's perspective.

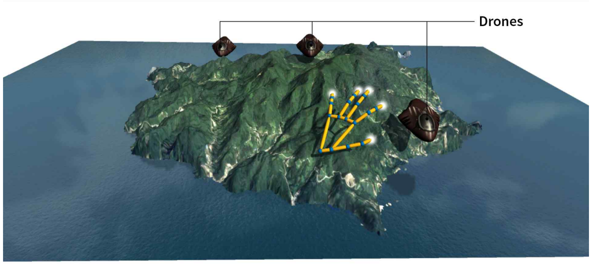
This concept can be useful for a variety of scenarios, such as professional inspection tasks for farming or in factories, as well as in domestic situations such as surveying property when not at home.

3. Design

The key design challenge is to combine familiar 2D surface gestures for map navigation with in-air gestures for 3D tasks in virtual reality. We build upon the work of [Hilliges], who introduced a 2D multi-touch tabletop interface for 3D interaction, and [Hincapie-Ramos], who explored the fatigue that arises from heavy use of in-air gestures.

Based on the work by [Wickens & Hollands], two operator viewpoints were utilized in our tabletop virtual reality environment. A third-person camera is used in the overview map to give the user a holistic and general view of the area as shown in [Figure 2]. In contrast, a first-person view is utilized in the detailed view to enable an immersive virtual reality experience as the user can move their head to explore the virtual environment.

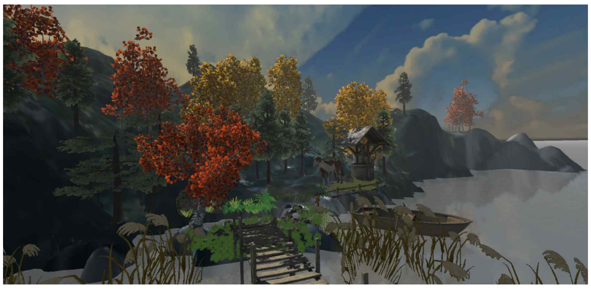
The overview map is where the user sees an island with various regions of interest. Touch commands were chosen to be the primary interaction method in this scene as they are more precise. With a single finger, the user can swipe



[Figure 2] The overview map with three selectable drones and a virtual hand indicating the user's in-air gestures.

the touch interface which pans the camera around. Two finger touch commands are used to rotate around the environment or to zoom into it by using a pinch or two-finger rotate gesture. Once the user has decided on a region of interest they would like to explore, the user reaches out with their hand to touch the corresponding object of interest, loading the detailed map.

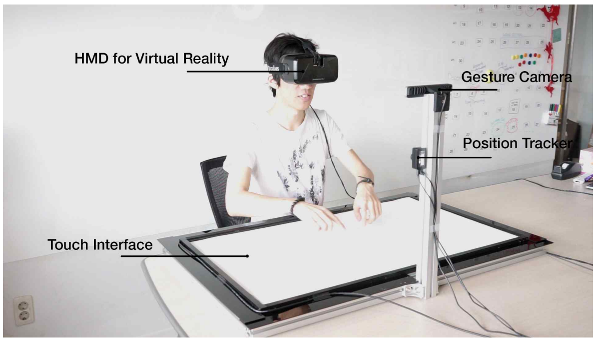
We present a detailed look at a selected region of interest through a virtual UAV moving along a pre-determined path. To simulate possible usage scenarios in the real world, such as drone surveillance or teleoperation, the camera is set to a first person point of view as shown in [Figure 3]. In this view, the touch interface is disabled and an in-air gesture is used to return to the overview map.



[Figure 3] A detailed closeup of the scene through a first person perspective.

4. Hardware Components

The Nexio 2D Touch Frame is the tabletop component in our system and was chosen so that it could be installed at workstations and used by professionals. With the proliferation of smartphones and other touch devices, touch interfaces are very commonly used and so a large touch surface was employed to provide a familiar and intuitive interface. We also used an Intel RealSense F200 depth camera in conjunction with the touch tabletop to track in-air gestures as depicted in [Figure 4]. As we are using an Oculus Rift DK2 to immerse the user in virtual reality, the depth camera allows us to simulate a physical presence in the virtual environment.



[Figure 4] The physical setup of our prototype with labelled components.

5. Discussion and Future Work

We developed a novel hybrid on-table and in-air gesture interface to a virtual reality environment. We demonstrated the result in a simulated surveillance scenario.

As self-flying UAVs become more commonplace we need to think about next generation applications that make use of map software with real-time camera feeds. In this paper, we have outlined a starting point to explore touch and gesture based interfaces to be used with UAVs for surveillance tasks. Our current prototype is a tabletop that is aimed for professionals and is not portable so a tablet version is under development for everyday users. The portable version will function on tablets and so additional factors and concerns must be addressed during the development such as accounting for movement and changing orientations. In addition, the existing tabletop system will be adapted to connect to a real UAV so that users can survey the real world. Video feed latency and safety concerns with real UAVs must be addressed as the prototype is developed.

6. Acknowledgements

This research was supported by the Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Science, ICT & Future Planning (NRF – 2015R1C1A1A01051808).

7. References

- Roman, A., Lensch, H P. Automatic Multiperspective Images. Rendering Techniques, 2006.
- Hilliges, O., Izadi, S., Wilson, A. D., Hodges, S., Garcia-Mendoza, A., and Butz, A. Interactions in the air: adding further depth to interactive tabletops. UIST 2009.
- Hincapié-Ramos, J. D., Guo, X., Moghadasian, P. and Irani, P. Consumed Endurance: A metric to quantify arm fatigue of mid-air interactions. ACM, City, 2014.
- Wickens C. and Hollands.J. Engineering Psychology and Human Performance. Prentice Hall, 1999.