Intuitive 3D Flight Gaming with Tangible Objects

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(a) (b) (c) (d)

Figure 1: *Intuitive and tangible control of a 3D flight game through vision-based position and orientation tracking. (a) A depth camera is mounted above a LCD display. (b) Single-aircraft mode. (c) Aircraft-and-hammer mode. (d) Dual-aircraft mode.*

Abstract

Object movement in virtual 3D space involves 3D rotations and translations. Conventional desktop interfaces are difficult for a user to simultaneously control the variations of six degrees of freedom. In this paper, we present a vision-based user-friendly method for this purpose. A user can simply grasp one or more objects and fly the objects intuitively. The proposed system using an efficient method to detect and track the objects in the scene. The estimated object motions are used to drive the corresponding targets on the screen or to trigger predefined actions. This interface can track more than one objects at an interactive rate and is applied to a 3D flight shooting game.

Keywords: tangible interface, 3D game, tracking

Concepts: •**Computing methodologies** → **Graphics systems and interfaces;**

1 Introduction

Tangible user interface is regarded as one of the most intuitive interaction approach, since users can control a computing system by directly manipulating real objects in hand. Earlier work relied on specific devices, e.g. sensors within objects or a specially designed panel. Recently, with the popularity of RGB-D cameras and modern advances in tracking, several vision-based tangible interface systems were proposed. Held et al. [2012] estimated the poses of physical puppets to drive animation prototypes. Li et al. [2016] tracked multiple components in the scene and displayed augmented reality instructions for object assembly. Our work aims at intuitive aircraft control in 3D flight gaming.

2 Our Approach

To efficiently identify objects from a sequence of live depth images, we adapted an template-matching-based method. During the training stage, we captured the detph maps of target objects from sparse and distinct viewpoints. Since these target objects are of salient corners or texture on their sufaces, we also recorded the SIFT keypoints and descriptors [Lowe 2004] extracted from intensity images to form our template database.

During online gaming, the proposed system first uses a background subtraction method and hand-color region removal to extract foreground candidate regions. A voting based method [Lowe 2004] is used to detect objects and their identities within foreground candidate regions. An extended iterative closest point (ICP) method with K-d tree is used to efficiently estimate the orientation and translation of an object in the scene. Our current system, without careful code optimization, can estimate object poses for control at more than 20 frames per second. Moreover, in addition to aircraft, a user can train and control the system with other targets, e.g. a hammer or hand, and define reactions with respect to object trajectories. For more details and demo, please refer to the supplementary video.

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