Chapter 5
A Perceptual Computing Based Gesture Controlled Quadcopter for Visual Tracking and Transportation

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ABSTRACT

One of the fundamental challenges faced by an inexperienced user in portable unmanned aerial vehicle (UAV) such as quadcopters is flight control, often leading to crashes. Addressing this challenge, and leveraging upon the technological advancement in perceptual computing and computer vision, this research presents a modular system that allows for hand gesture based flight control of UAV, alongside a transport mechanism for portable objects. In addition to ascertain smooth flight control by avoiding obstacles in navigation path, real-time video feedback is relayed from the UAV to user, thus allowing him/her to take appropriate actions. This paper presents the design implementation by discussing the various sub-systems involved, inter system communication, and field tests to ascertain operation. As presented from testing results, the proposed system provides efficient communication between the subsystems for smooth flight control, while allowing for safe transport of portable objects.

DOI: 10.4018/978-1-5225-8365-3.ch005

1. INTRODUCTION

In the recent years, there has been tremendous research in the development of miniature unmanned aerial vehicles with a broad range of applications for both military and civilians (Achtelik, 2009, Moranduzzo, 2014). In situations where a given task might be either too complex or monotonous, it may be desirable to use these miniature UAVs. The advantages provided by these miniature UAVs led to the implementation in several applications such as law enforcement, security patrols in private property, agricultural surveillance, communications relay, aerial mapping, severe weather telemetry, search and rescue, disaster relief, industrial surveillance, remote sensing, and historical site surveillance to name a few. Of the diverse UAV's proposed over the past few years, quadcopters have received a board attention due to the several advantages it provides such as ease of implementation, relatively inexpensive to manufacture, great maneuverability, ability to carry small payload for variety of applications. While these quadcopters have a broad range of applications in aerial surveillance and monitoring, they suffer from the fundamental challenge of user interface and maneuverability.

One other recent technological advancement that has garnered interest and gaining popularity in the recent times is perceptual computing (Mendel & Wu, 2010). It is an application that provides the computer an ability to recognize what is going around it, and assists people to make subjective judgments accordingly using human gestures. This human gesture recognition is classified into two types: near-field and far-field, and required different depth cameras. When combined with effective computer vision software such as Intel Perceptual Computing SDK (Intel, 2015), some applications of these depth camera include close-range depth tracking to recognize position of each of user's hands, fingers; facial analysis for face detection and recognition through smiles, blinks etc., augmented reality to combine real-time images from camera and close-range tracking, and speech recognition. When efficiently implemented, this perceptual computing has the ability to simplify tasks that are relatively complicated for general public. Human gestures such as hand waiving and swiping are primitive communication methods, and when combined with perceptual computing leads to applications in diverse fields such as medicine distribution, surveillance of construction sites, assistive devices for object retrieval, aerial transportation etc.,

Infusing the advancements in both aerial quadcopters and perceptual computing, this paper presents the development and evaluation of a gesture controlled quadcopter system with advantages such as, improving usability to minimize user training for flight, modular system for broad applicability to diverse hardware, providing the ability for real-time video feedback for position accuracy and maneuverability. This paper is organized as follows. Section 2 presents the previous work in perceptual computing. Section 3 presents the design implementation of proposed system, and respective sub-system operation. Section 4 presents the preliminary results to prove the system feasibility. Section 5 presents details of extended distributed deployment testing, and conclusions are presented in Section 6.

2. PREVIOUS WORK

Perceptual computing is a new technology that is in its early stages of development. There are some consumer products that utilize this technology. The most prevalent and well known of these devices is Microsoft's Kinect sensor for the Xbox 360 (Kinect, 2015). This device is used as a game controller and interprets the user's large motion gestures, i.e. arm swinging and bending of the limbs, and is also used for localization of objects (Yelamarthi, DeJong, & Laubhan, 2014). This project is intended for use in a