Development of a PC-Based Mini-Aerial Helicopter Controller for Surveillance Applications

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Abstract This paper describes a design and development of a PC-based controller of a mini aerial helicopter for surveillance purpose applications. The mini-aerial helicopter comes with a build-in integrated camera that linked to a controller that manipulated by a Graphical User Interface (GUI) program from a Personal Computer (PC). The main objective is to building a flying robot system that could visualize high-performance image for the purpose for surveillance purpose or environmental observations. The image captured will be used for further image acquisition and analysis. The test result is well described and the vision data captured is encouraging for future development. Some problems are also being notified for further improvement of the flying robot system.

Introduction

Design and development of a flying robot systems is another step of motivation in building Unmanned Autonomous Vehicles (UAVs). Nowadays, UAVs are mostly used in military applications for recognition, environmental observation and maritime surveillance activities. Mean while for non-military applications are environmental surveillance, rice paddy remote sensing and spraying as well as infrastructure maintenance [1].

At the present time, there are many developments and research of a flying robot for the purpose of a flight control system has been done worldwide. Some of the examples such as MIT Draper’s DSAAV, Stanford University Aerospace Robotics Laboratory’s Hummingbird, Austria Schiebel Corporation’s Camcopter, Israel Ministry of Defence’s Steadicopter, and so on [5]. Most of these developments called it Sub-mini Unmanned Helicopters instead of a robot name.

This paper examines the flying robot development based on Personal Computer (PC) as its main control. This PC-based control technology now offers the reliability and functionality of the traditional equipment with capabilities that allow substantial productivity gains [3].

Thus, the paper successively describes the physical model of the mini-aerial helicopter as a test-bed of a flying robot system and its wireless PC-based controller, the development of the GUI is discussed, and testing/flying the flying robot with some circumstances. The results of several simulations performed in urban environments are then presented and discussed. Finally, possible improvements to the system are suggested.

General Design of The Flying Robot System

The PC-based controller system could realize a low cost and unmanned air surveillance operation. The mini-aerial helicopter is used as an actuator to the system since it can produce a stable static motion in the air as compared to the aircraft. Therefore, these are some of the motivations in developing the project. Basically, the flying robot system design is a part of designing an UAV system.

![Diagram of UAV/Flying Robot Design Concept](image_url)

Fig. 1: Design and construction of project
3. **Graphical User Interface (GUI)**

The PC-Based design will be focusing in developing the GUI program. The PC-screen design is part of the user interface development in which it means the visual elements of a program as the user sees them on screen. To create Graphical User Interface (GUI) layout there has three informal stages for specifying a screen layout. There informal stages are screen display look alike, identify common relationships in the screen layout and transform the information into scree. As the result, the development of the wireless controller is as shown in Fig. 4.

**Flying Robot Progress Applications**

The developments of the flying robot begin with re-designing its manual controller. Basically the flying robot is controlled by the remote controller via standard radio frequency (RF) wireless communication. The remote controller is attached with servo motor to maneuver the robot movement either takeoff or landing, move to left or right and forward or stop by adjusting the position of servo motor rotor as per user command.

![Flowchart of the controller algorithm](image)

The user command is done by interactive of user with the GUI developed by using the either Visual Basics/MATLAB software. The user only needs to press a keyboard key to control the helicopter movement. The servo motor is drive by using the PIC microcontroller. The key press signal received by the Visual Basics/MATLAB software will send to PIC microcontroller through the serial communication port before the signal is translated by the PIC in term of servo motor position. The servo motor rotor position will determine the type of flying robot movement and the signal will send to the robot via wireless communication using standard RF communication.

The digital camera is attached to the flying robot for purpose of image acquisitions. While the robot maneuvering, the camera is capturing the downside image. The image signal is transmit through wireless communication using standard RF communication to the image acquisition device. The image acquisition device used in this research is the PCI TV tuner card. The images received by the PCI TV tuner card will process using the Visual Basics/MATLAB software for user visualizes. The angle of image taken can be control by varying the position of robot as it in the air.

![The Wireless Controller Design](image)

Both the camera and the mini-helicopter are powered by battery. Hence, the design is not concentrating on the power consumption. Besides, the controller and the transceiver module also need the supply power. However, the problem has been noted and the researchers will try to improve the subject matter in the future development.

**Experimental Investigations / Results**

The experimental result is based on the design and the development of the overall system. Therefore, it can be divided by three (3) major progress; which are the assembling the flying robot system, the GUI program configurations and some minor adjustment with re-configurations of the overall development. The results of the development are described as stated below.
The developed flying robot system has been tested and evaluated. The system consists of control algorithms implemented on a MAV, wire-frame model shown in Front 5. The system comprises a flight controller, a camera, and a DC motor controller. The controller is used to control the MAV's flight. The system also includes a wireless communication module for transmitting data between the MAV and the ground station. The flight controller receives commands from the ground station and translates them into control signals for the DC motor. The camera provides real-time visual feedback to the ground station, allowing for precise control of the MAV's flight. The system has been tested in various conditions, including indoors and outdoors, demonstrating its effectiveness in maintaining stable flight. The future work will focus on improving the system's robustness and expanding its capabilities for autonomous flight operations.
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