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

H A Kasdirin [1], M Herman Jamaluddin[2], A Zaki H Shukor[3], Alias Khamis[4] and Hairol N M Shah[5]

[1] H A Kasdirin, Faculty of Electrical Engineering UTeM, hyreil@utem.edu.my
[2] M Herman Jamaluddin, Faculty of Electrical Engineering UTeM
[3] A Zaki H Shukor, Faculty of Electrical Engineering UTeM
[4] Alias Khamis, Faculty of Electrical Engineering UTeM
[5] Hairol N M Shah, Faculty of Electrical Engineering UTeM

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/finding 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 unman 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.

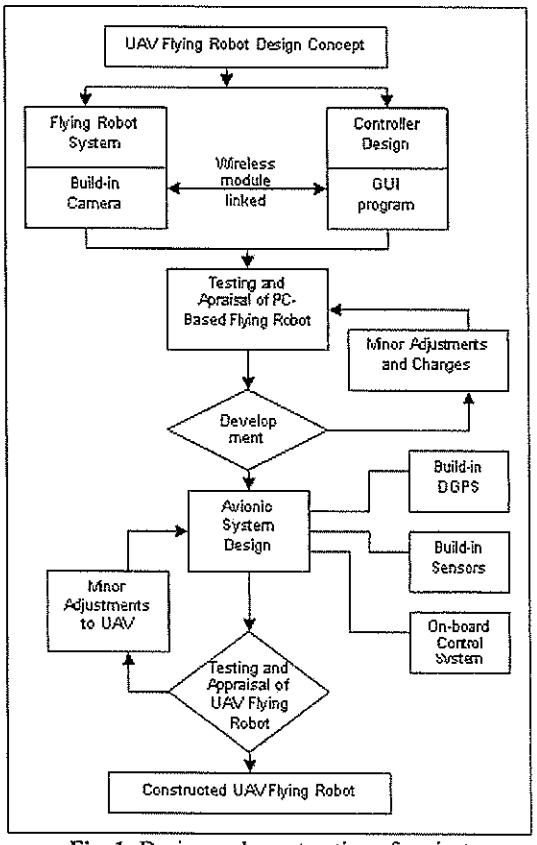

Fig. 1: Design and construction of project

The design and construction process of the UAV system is as shown in Fig 1 above. And, the general design of the flying robot system is mainly developing the wireless controller and the flying robot. The movement and the motion of the robot are controlled by the GUI program set in the PC. The final stage of the design is to build the avionic systems that build-in some actuators and sensors, DGPS, and also its own integrated control system.

All in all, this paper only concentrates on developing the PC-based wireless controller. It will discuss more detail about the constructions of the wireless controller with transceiver and the design and development of the GUI program. Furthermore, the interfacing between controller and PC is also the main issue and one of the problems arises.

For the application part, the mini-helicopter is used and its receiver module is a part of the controller. The wireless camera is attached to the robot for image capturing purposes and being tuned with the TV-card that inserted to the PC. The complete system of the flying robot is tested. The finding and observations is calculated and measured successfully.

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Wireless Controller Design

There are several aspects in Flying Robot system that electrical and mechanical design needs to be looked at closely so that the design will be successful. The development of the wireless controller is close-monitored by several design aspect as mention below. The Fig. 2 shows the electrical design of the project system functional design and development. The wireless controller design is centered on following descriptions, i.e. servo motor module, microcontroller, and GUI development.

1. Servo Motors

The mechanical blade rotates as the robot fly. It is moved using the dc motor that received the electrical signal from the receiver. The rotations of the DC motors are control by value given of potentiometer in the wireless controller. Hence, it means that increases the potentiometer value, the DC motor rotate faster and decreases otherwise. In the flying robot, there have two DC motor to make the 4-channel transmission. On the other hand, in the designed controller, the potentiometer is connected in serial to the DC servo motors that linked to the microcontroller circuit.

2. Microcontroller

The medium between the personal computer (PC) and the servomotor is the microcontroller board. It contains the microcontroller, the power supply circuit and the interfacing circuit between the microcontroller and the PC. The servomotor does not require any specific circuitry, due to its simple control scheme, which relies on a normal 5 Volts pulse. The pulse width is modulated by the microcontroller, and repeatedly given to the servo until it achieves its desired relative shaft position. There is no need of reading back the position value of the shaft, as it has its own position control circuitry equipped inside the servomotor's casing.

The algorithm for the control of the servomotor is shown in Fig. 3. This is the only function of the microcontroller, as it only waits for the input from the PC, whether to change position or not. Initially, the position of the servos will be at its center, so that the helicopter will not suddenly move. Once an input is detected, the input is then identified whether the instruction is to move up, down, left or right. Then, the increment or decrement of the pulse value will be given by the microcontroller to the servomotor. Then the microcontroller waits for the next input from the PC and the cycle repeats.

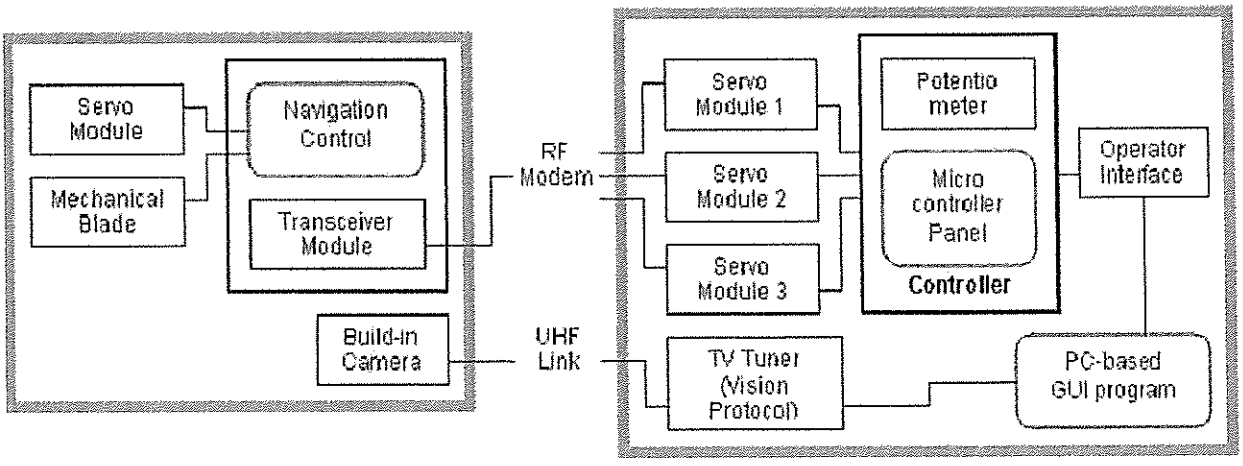

Fig 2: System Functional Block Diagram of the Project Development

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 scout. 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.

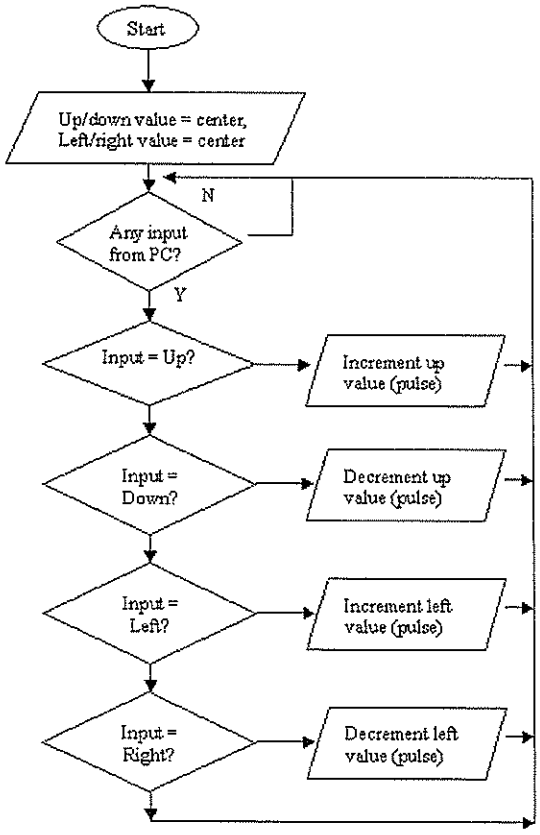

Fig 3: Flowchart of the controller algorithm

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.

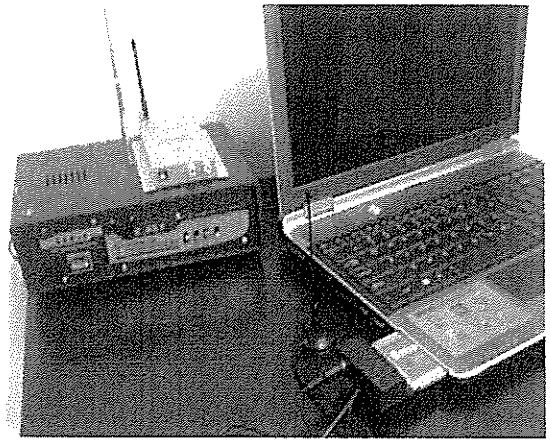

Fig 4: The Wireless Controller Design

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.

1. Assembling the Flying Robot System

The Fig 5 below shows the assembling of the flying robot system. A mini-helicopter is well connected with two DC motors, an RF receiver and mechanical blades used to fly the robot. A wireless camera is in placed in front of the body within the mini-helicopter structure. The battery of the camera is put under the body so that the weight of the structure is balanced easy to control later.

2. GUI Program Configurations

The GUI program is build using the Visual Basic 6.0 software. At first, the GUI only concentrated to communicate with the camera and some minor movement of the DC servo in the controller architecture. Fig. 6 below shows a simple GUI panel of the development. The left-hand side shows the picture captured from the camera that linked to the PCI TV tuner card via UHF communication. The result is very good and the movement of the servo is based on the left-right and up-down button on the panel.

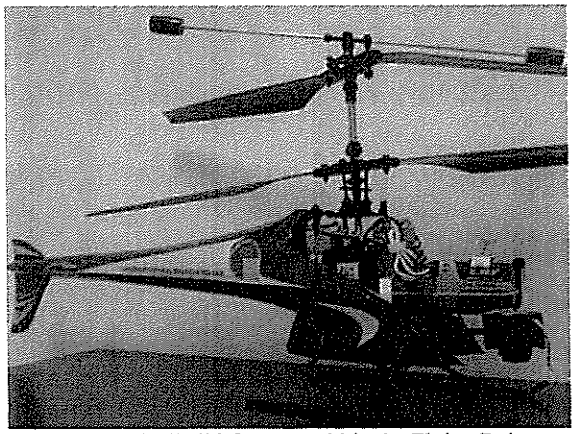

Fig 5: The In-Build Camera within the Flying Robot structure

3. Minor Adjustment and re-configurations

The wireless controller, the flying robot system and the GUI program are in-placed for real-time testing. In this part, interface communication is the main priority. The power supply of each device also plays its important role. This is because, if these priorities are not functioned, the system cannot work. Finally, the real-time GUI program is developed and Fig 8 below shows the result of the GUI panel. The need of re-configuration is important so that the panel could handle the movement of the flying robot manoeuvre.

The developed flying robot system has been tested successfully in manual operation and also by using the GUI panel shown in Fig. 6. The useful data captured by the camera has been obtained, which can be analysed and used in the next stage of the development. The GUI program and the wireless controller are useful to the future works for designing UAV complete system and also verification of designed flight control laws.

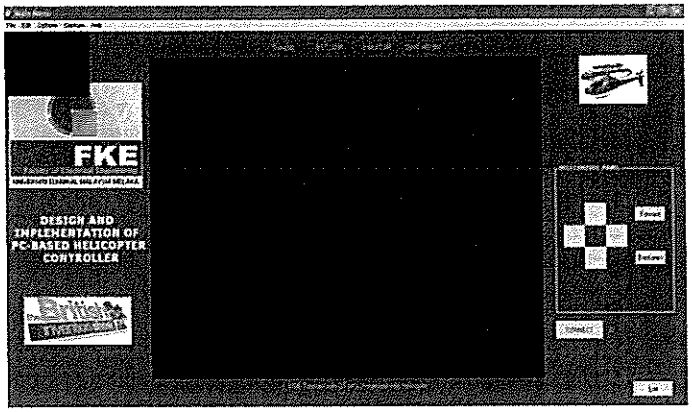

Fig 6: The UTeM's GUI Program of the Project

Conclusions and Future Work

Hence, this paper has discussed the development and implementation of a flying robot system for the purpose of survaillence. A mini-aerial helicopter has been chosen as the basic flying robot and attached with a build-in integrated wireless camera. The wireless controller is basically based on a couple of transceivers and some DC servo motors that is being manipulated by the GUI program in a PC. The program shows the real-time video captured with some GUI architecture for controlling and manipulating the flying robot.

The developed flying robot system has been tested successfully in the manual operation. Although the taking-off and taking-down analysis seems a bit shaky, the useful data captured from the video is very encouraging. The data obtained is essential to fulfill its objective to monitor and environmental surveillance. The GUI program and data analysis are useful mode for future works for advance avionic systems i.e. in building a UAVs where for a typical UAV consists of [1]

- An advance flying robot
- An avionic system
- A ground supporting system

In future, there are several upgrading work intended to be done by the researchers. This is including the use of different kind of helicopter such as methanol energized helicopter compared to currently use which battery energized helicopter. Furthermore, the use of Global Positioning System (GPS) could enhance and expand the capability and usage of the system. By applying the GPS, the tracking of current location, time, velocity and direction of the helicopter can be determined.

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