Development of Microcontroller-based Control of a Mini-Flying Robot Application

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Abstract— **This paper elaborate on the development of controller using a PIC-based controller for a flying robot application. The mini-flying robot is consists of a mini-aerial helicopter with a build-in integrated camera. The flying robot is linked to a controller that is being manipulated by a GUI Panel program developed. A couple of full duplex transceivers are used to provide wireless communications between the controller and the flying robots. The main objective is building advanced GUI panel that could simulate and visualize high-performance robot systems 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.**

Keywords—**Mini-Flying Robot, PIC-based controller**

I. INTRODUCTION

Design and development of a flying robot system is another step of motivation in building Unmanned Autonomous Vehicles (UAVs). UAVs are mostly used in military applications, however for non-military applications, it is also used for environmental surveillance, rice paddy remote sensing and spraying as well as infrastructure maintenance [1].

At present, 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 GUI panel development by using Visual Basics Program for flying robot 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 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.

II. FLYING ROBOT SYSTEM DESIGN

The design and construction process of a basic Flying Robot UAV system is as shown in Figure 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.

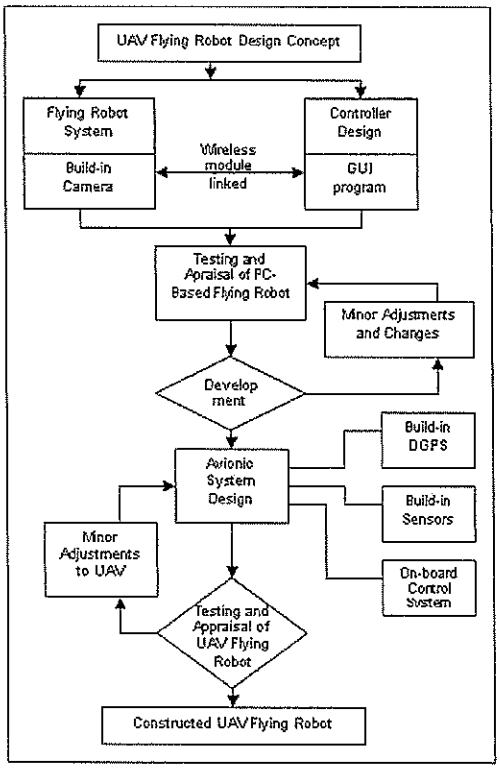

Figure 1. Design and construction of project

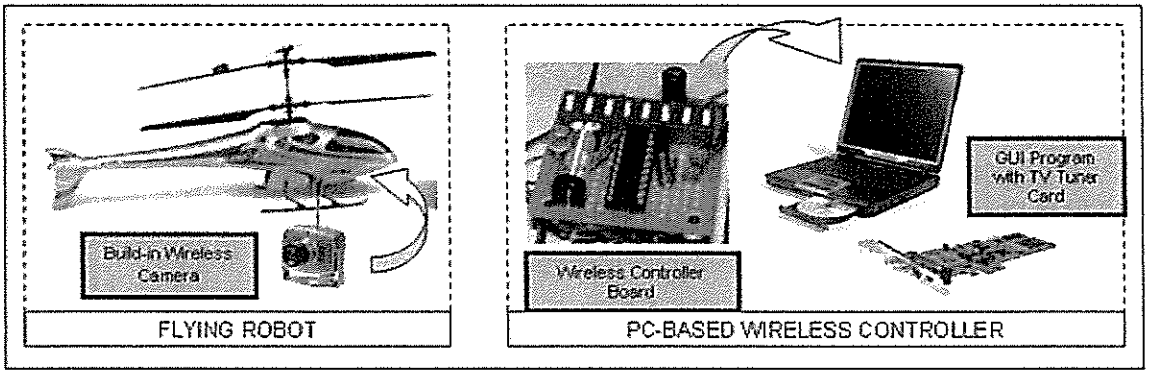

Figure 2: The Overall Block Diagram of PC Based Wireless Controller for Flying Robot

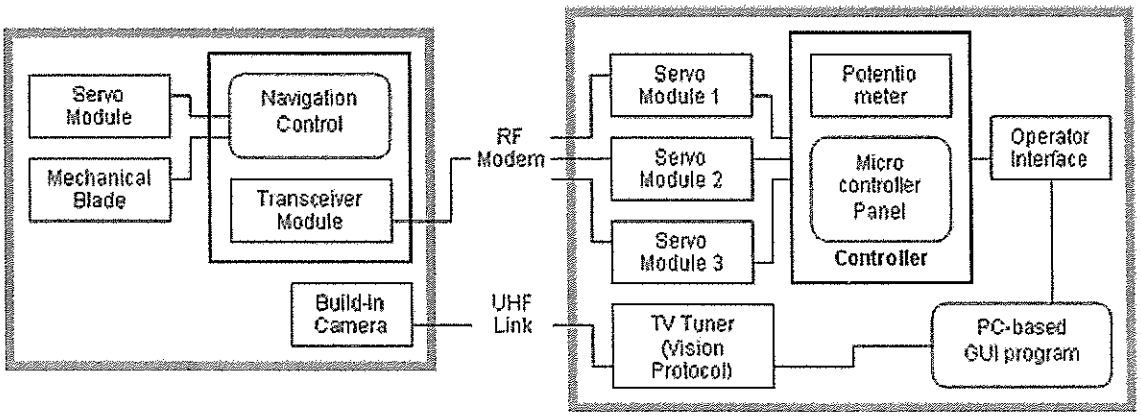

Figure 3: System Functional Block Diagram of the Project Development

All in all, this paper only concentrates on developing the GUI panel for microprocessor-based 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. Figure 2 and 3 shows the overall block diagram of the project.

III. MICROCONTROLLER-BASED DEVELOPMENT

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 Figure 3 shows the electrical design of the project system functional design and development.

The flying robot motions available for the remote controlled helicopter is up, down, left and right. A simple up and down movement of the helicopter is done by turning the blades in a particular motion, and the same applies to left and right. There are two layers of blades, and these two layers control the overall motion of the helicopter. The remote operator has to only adjust the two controls, one for up and down and the other for left and right. Both these hand-controlled devices can be done simultaneously.

The controller will increase sliding the remote control to increase or decrease the speed of the blades rotation. Every touch increases or decreases the resistance of the device, as the slider is connected physically to the potentiometer. For the two sliders, two potentiometers are used concurrently.

The whole idea of controlling from the GUI panel that comes from the Personal Computer (PC) is by attaching the hand-operated sliders to Remote Control (RC) servos. RC servos are small and practical DC motors with internal feedback for position control. The signals have to come from either the PC or another microcontroller. These signals are pulse width modulation signals and the position of the shaft is determined by the width of the signal within a certain limit.

The medium between the 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

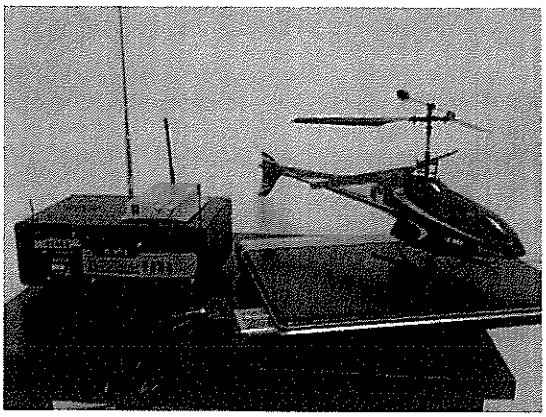

Figure 4. UTeM's Flying Robot System Development

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. Figure 4 above shows the actual development device of the PC-based wireless controller with flying robot applications

IV. Experimental Result

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.

A. Assembling the System

The Figure 6 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.

B. Configuration of GUI Program

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. Figure 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

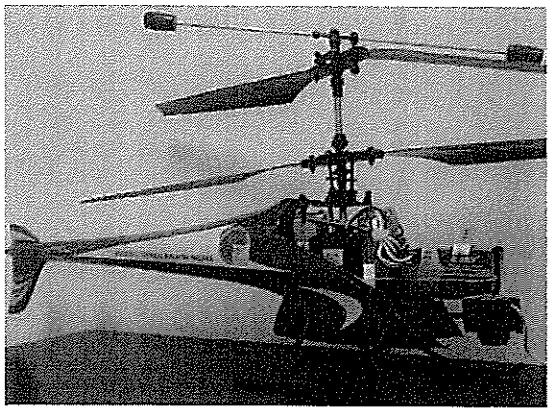

Figure 5. Build-in Camera within the System Structure

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.

C. Adjustment and Minor 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 Figure 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

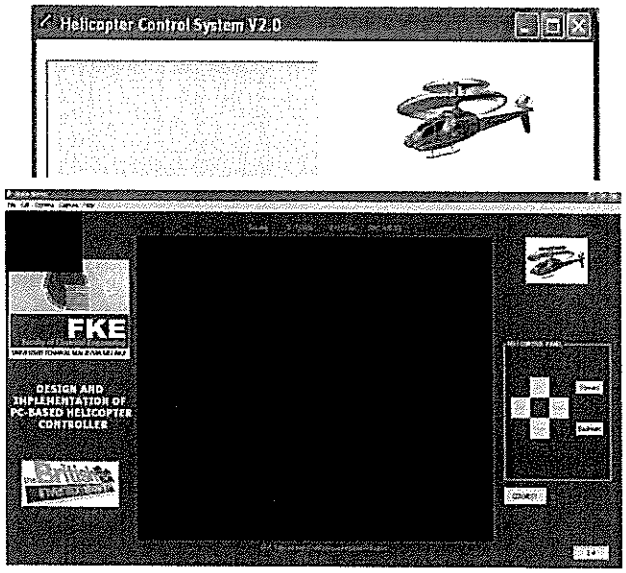

Figure 7. The GUI Program of the Project

GUI panel shown in Figure 7. 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.

V. Conclusions And Suggestions

In this paper, the design and implementation of a GUI panel for a flying robot system is discussed. 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.

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.

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