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UNMANNED AIRCRAFT SYSTEM

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ABSTRACT
The objective of this paper is to develop an automatic aircraft, control by remote station known as the unmanned aircraft vehicle (UAV). The system can be used for security, search, rescue, monitoring, disaster management, crop management, communications and survey. The unmanned aircraft consist of two mainly parts one is the air station and the other is the ground station, the UAV captured the data from camera or other device and transmit it to ground station where further commands can be performed. The UAV can also be flying autonomously by using pre-programmed flight plan or by complex dynamic automation system. In our system we use a technique called linear quadratic regulation (LQR) to convert the non linear response of a system into linear one, this method generate best gain to remove errors in system.
Keywords: Aircraft Pitch Controller, LQR Controller.

INTRODUCTION

The unmanned aircraft system is a concept to perform certain tasks done without using man power on that environment dangerous to human life. Its great advantage is that it can use to rescue people, provide them services and for geological surveys. UAV further use for searching, UAV's could be use to find humans lost in forests, trapped on places, or stack at sea. UAV's history was starting in 1900s, and was used by the military for personal purposes. It was further worked by military during World War I. The first pilotless aircraft made by Dayton Wright Airplane Company [2]. In 1915 Nikola Tesla gives the concept of unmanned aircraft combat [3]. In 1935the first Remote Pilot Vehicle was made by film star and model airplane Reginald Denny [4]. More aircrafts were invented during the World War II these aircrafts were used to train aircraft gunners and to attack on missions.

In the year 2013 February, it was report that 50 countries were used UAV's, most of them make their own: for example China, Israel and Iran [1]. In the year 2014, Sense Post Company made a security conference in Singapore in which a quadricopter UAV is introduced which could steal data from smart phones - such as overall online data. The software attacked smart phones with WIFI switched on by impersonating a previously used network [5].The rest of the paper is organized as section II contain the overall working of the system in diagrammatical aspect, section III contain

arduino made ardupilot AT Mega 2560 controller, section IV contain AC 2830-358 850 kv motor, section V contain 3DR Pixhawk auto pilot and section VI contain conclusion.

MATERIALS AND METHOD

SYSTEM MODEL:

In this section we describe the total system model which contains ground station , air station, radio transmitter, radio receiver and controller that how they are working.

AIR STATION:

Air station model consist of a GPS unit for tracking location, modem for encoding and decoding, camera for making video, video amplifier to control overshoot and step response, video transmitter for transmit the recorded video and antenna to broadcast the signals. Camera taking images and make video while GPS unit track the location of UAV which is transmit through antenna.

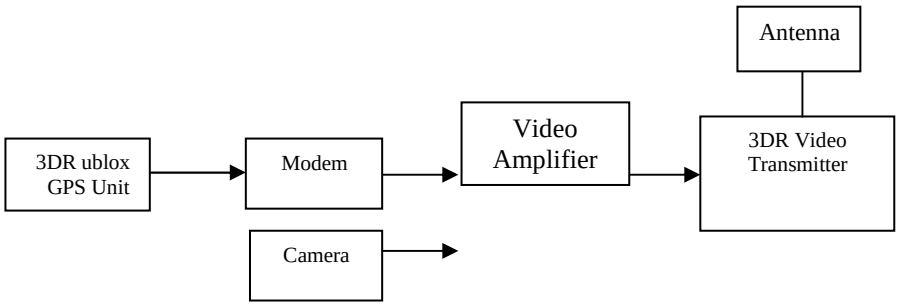

Figure 1: Air station block diagram

POSITIONING SERVO:

Positioning contains the servo motor to control the direction, gear box to provide torque and speed, position sensor for position measurement and control pulse to sending PWM (pulse width modulation) signal to motor. Control pulse generate the PWM signal, error amplifier calculate the error and send a signal to motor which then control the direction and speed through gear box whose output is connected with position sensor, again position sensor and control pulse send a signal which is calculated by error amplifier and the system work in close loop.

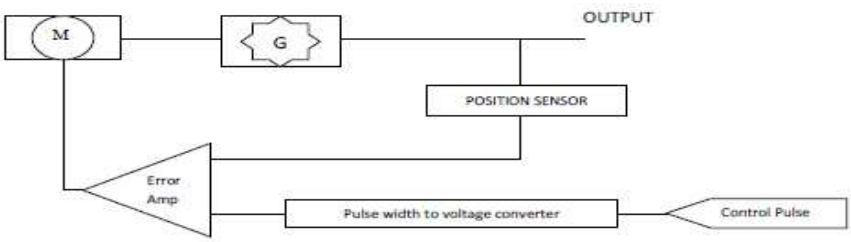

Figure 2: Positioning servo block diagram

RADIO RX:

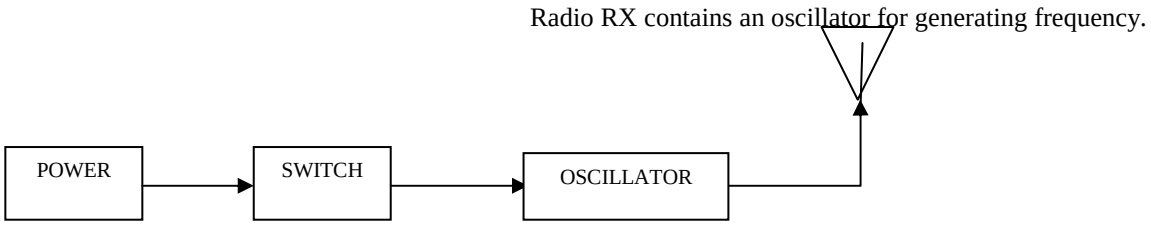

Figure 3: Radio RX block diagram

RADIO TX:

Radio RX contains oscillator for frequency, buffer to amplify power of signal, RF amplifier to increase the power of radio frequency signal, modulator to done modulation, antenna to broadcast the signals and microphone that convert audio to electrical signal. Oscillator provide oscillations which further go through buffer and RF amplifier to increase the power of the signal to transmit it larger distances.

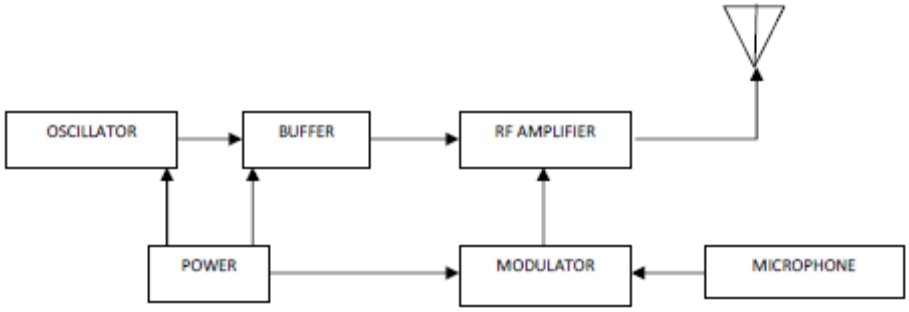

Figure 4: Radio TX block diagram

ARDUPILOT:

Ardupilot board contains ardupilot AT mega 2560 kit which transmits and receive signal from air station, DSP kit using Matlab for simulations, IDE (Integrated development environment) platform for arduino ardupilot using C language and LCD for camera display.

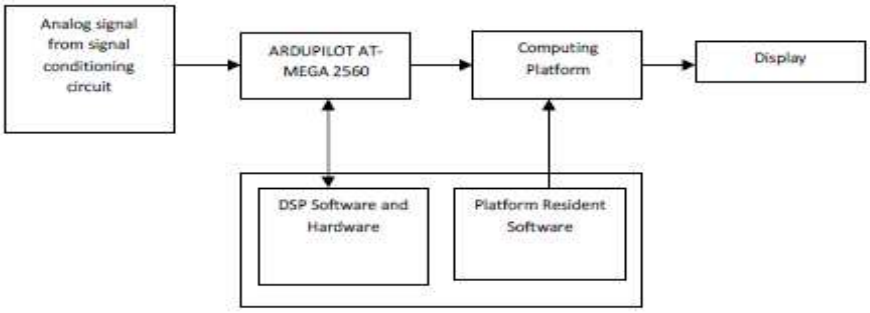

Figure 5: Ardupilot block diagram

GROUND STATION:

Ground station model contains antenna for receiving broadcast signals, AVR for receiving video signals, filter to remove noise present in signal, modem for decoding, and monitor to display and pc to save information. The antenna receives video signals capture from camera of air station and display it on monitor through on the other hand store the data in pc.

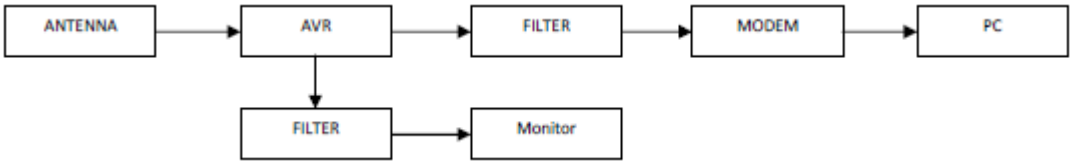

Figure 6: Ground station block diagram

WORKING OF THE SYSTEM:

The controlling station or ground station give commands to UAV to perform certain tasks, controlling station connects to pc and satellite to monitor the working of the UAV. Controlling station is connected to UAV via ardupilot which control the vehicle and the vehicle receives the information through camera or other portable device and transmits it to controlling station.

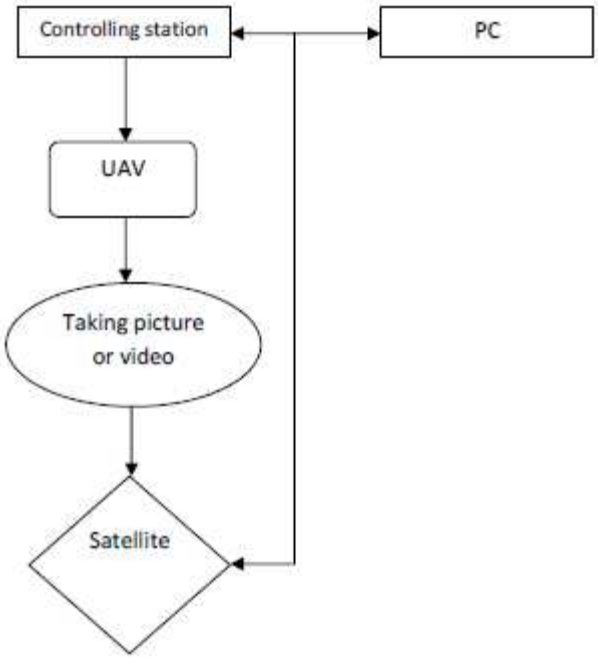

Figure 7: Working block diagram

ARDUPILOT AT-MEGA 2560:

To develop an efficient unmanned aircraft we use Ardupilot AT Mega 2560. It is available in moderate price with greater efficiency. It is a microcontroller board with 54 digital I/O pins, 4 UART serial ports, 16 MHz crystal oscillator, usb connection port, power jack, reset button and an ICSP header. In short it contains everything for an efficient controller.

AC 2830-358 850KV MOTOR:

The servomotor used in efficient UAV is AC 2830-358 850 kV motor. This is not much costly and have shorter shaft. It is very reliable in nature and creates nice thrust with 10 x 47 propellers. Size of this motor is 28 x 30 mm with RPM/V 850 and 62 gram in weight.

AUTOPILOT 3DR PIXHAWK:

The autopilot kit use in efficient unmanned aircraft is 3DR Pixhawk. This kit is expensive in cost but contain best features. It contain advance features integrated multithreading, programming environment Unix/Linux, contain new autopilot functions like flight behavior and lua scripting of missions. By using this autopilot there are no limitations in autonomous vehicle. It also contains peripheral options, digital airspeed sensor, and magnetometer and multi color LED indicators.

SOFTWARE INVOLVED IN WORK:

1) **MATLAB:**

Matlab (Matrix Laboratory) is a 4th generation computing platform contains all other programming languages. In our work Matlab is used to simulate the responses of the UAV model solving close loops and transfer functions and find the stability of the system.

2) **IDE:**

IDE (Integrated Development Environment) is a software program use to synchronize between software and hardware. In our work IDE is used for the programming of ardupilot using c language.

CONTROLLER STRATEGY:

We assume that the aircraft is in steady-cruise at constant velocity and altitude. The weight, thrust, lift forces and drag balance each other in x and y directions. We also assume that a change in pitch angle will not change speed of aircraft under any circumstances. Under those conditions, the longitudinal equations of motion can be written as:

$$\dot{\alpha} = \mu\Omega\sigma\left[-(C_L + C_D)\alpha + \frac{i}{(\mu - C_L)}q - (C_W \sin\gamma)\theta + C_L\right] \quad (1)$$

$$\dot{q} = \frac{\mu\Omega}{2i_{yy}}\{[C_M - \eta(C_L + C_D)]\alpha + [C_M + \sigma C_M(1 - \mu C_L)]q + (\eta C_W \sin\gamma)\delta\} \quad (2)$$

$$\dot{\theta} = \Omega q \quad (3)$$

The transfer functions of an UAV:

$$T.F = \frac{-2.22\, e^{-016}\, s^2 + 1.996\, s + 0.2182}{s^3 + 0.273\, s^2 + 2.076\, s}$$

State Space Model:

$$\begin{bmatrix} \dot{\alpha} \\ \dot{q} \\ \dot{\theta} \end{bmatrix} = \begin{bmatrix} -0.131 & 22.1 & 0 \\ -0.0931 & -0.142 & 0 \\ 0 & 22.1 & 0 \end{bmatrix} \begin{bmatrix} \alpha \\ q \\ \theta \end{bmatrix} + \begin{bmatrix} 0.021 \\ 0.0903 \\ 0 \end{bmatrix}$$

$$y = [0 \quad 0 \quad 1] \begin{bmatrix} \alpha \\ q \\ \theta \end{bmatrix}$$

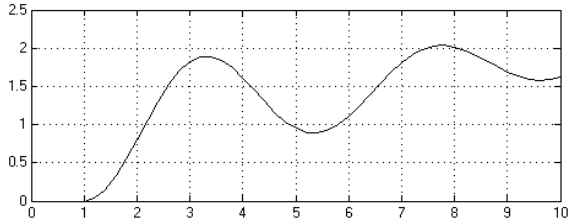

Figure 8: LQR Controller response with step input.

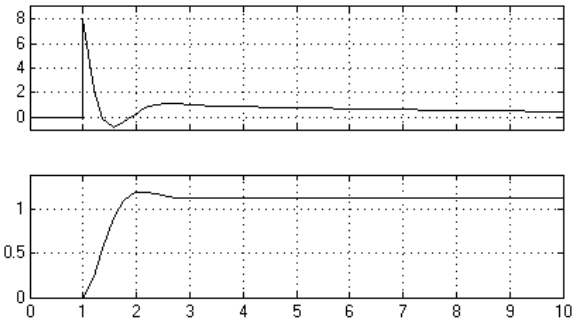

Figure 9a & 9b: LQR Controller with Feedback step input.

CONCLUSION

The above discussion will conclude that if we use the above system we can develop an efficient UAV. It will help in reduce the man power in that places where humans could not get there. This system is helpful in pollution monitoring and control, geographical surveys, Gas and oil exploration and hazards places. If the UAV is used in this manner it can be serving to mankind. The future enhancement in UAV system could be using the DSLR cameras instead of ordinary cameras which can give the HD result of the minor places of target place and by using automatic GPS system the vehicle will find the base station or targeted place via satellite easily.

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