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RF Controlled Aircraft

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ABSTRACT

There has been a rapid inclination towards wireless communications at present because of the quick and successful developments in the supporting technologies. Flying of an aircraft using Arduino and RF transceiver modules is what we have focused upon in this paper. The project is a prototype of an unmanned aircraft that makes use of Radio frequency. It can also be used in the defense sector for several purposes. The prototype is controlled by the Transmitter circuit, which has been constructed manually. The motion of the aircraft is controlled by the Arduino. The result generates an efficient interfacing between the aircraft and the remote.
Keywords: Radio Frequency, Arduino.

I. INTRODUCTION

A radio frequency signal refers to a wireless electromagnetic signal used as a form of communication, in terms of wireless electronics. Radio frequencies range from 3KHz to 300 GHz. RF usually refers to electrical rather than mechanical oscillations.

Therefore, a radio controlled aircraft is a small flying machine that is controlled remotely by an operator on the ground using a hand-held radio transmitter.

The circuit of this project utilizes the RF module (Tx/Rx) for making a wireless remote, which could be used to drive an output from a distant place. RF module sends signals that are transmitted at a particular frequency and a baud rate. A receiver can receive these signals only if it is configured for that frequency. The outputs from the receiver can drive the aircraft.

A four channel wireless system has also been used in this system. The input signals, at the transmitter side, are taken through four switches while the outputs are monitored based on the movement of the aircraft.

The remote-controlled aircraft project based on Arduino modules and 2.4 GHz RF modules controlling a brushless DC motor and fourservo motors. It comprises an Arduino-based remote control at the transmitter's end and an Arduino-based aircraft at the receiver's end.

II. RELATED WORK

Qun Deng, Weiqiang Zhang, Jintao Jiang "Short-range Wireless Communication Based on AVR Microcontroller". In this paper, flying of the aircraft is implemented using the concepts such as peer to peer communication wherein the air interface is enough to transmit the signals to and from the devices. Besides, using AVR microcontroller and wireless chips CYWM6936 results in high reliability, low power consumption and low cost. To avoid interference, CYWM6936 has the built-DSSS baseband correlator, with the DSSS technology.

George N. Solidakis, Fanourios M. Tsokas, Michael C. Batistatos, Nikos C. Sagias, George V. Tsoulos, Dimitra A. Zarbouti, Georgia E. Athanasiadou "An Arduino-Based Subsystem for Controlling UAVs Through GSM". Here the high-gain antennas, antenna trackers or satellites are used for long distance and beyond line of sight communication between a ground control station and an Unmanned Aerial Vehicle (UAV). The control commands to the UAV are sent by the GSM or GPRS. The GSM/GPRS module is an Arduino GSM shield with Quectel M10 modem which provides fast and efficient communication.

III. METHODS AND MATERIAL

The circuits are built around Arduino Nano (board1 and board2), a pair of 2.4 GHz RF modules (TX1 and RX1), ESC (electronic speed controller) module, four servo motors, a BLDC motor and a camera kit.

The transmitter's side is driven by a 9V PP3 battery and the receiver's side by an 11.1V LiPo battery, which is used to power the brushless DC motor (BLDC motor) through the ESC module.

The Arduino board1 receives power supply from the 9V PP3 battery and Arduino board2 from the 11.1V battery at their respective Vin input pins.

There are five potentiometers on the transmitter's side which are used for sending different control signals to the receiver's side through the RF modules. The control signals received by the receiver are processed by the microcontroller in the Arduino, which in turn controls the BLDC motor, the servo motors for rudder, aileron and elevator of the aircraft.

IV. RESULTS AND DISCUSSION

A. Transmitter

The circuit is built around Arduino Nano, a pair of 2.4 GHz RF module, a battery and joysticks.The transmitter's side is driven by a 9V PP3 LiPo battery meaning thereby that the Arduino consumes the required power from the battery, takes the analog input signals from the joysticks, processes the signals digitally and then transmits the corresponding output signal to the receiver.

Amount of fuel (battery level in this case) is indicated and displayed on the LCD.

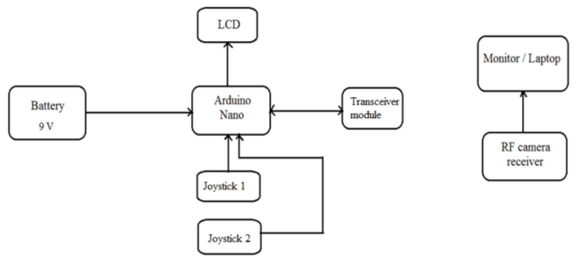

Figure 1. Block Diagram of Transmitter

B. Receiver

The Arduino in the receiver receives its power from the 11.1 V battery. It processes the signal received from the transceiver module and sends the output signals to the electronic speed controller and the servo motors. The ESC in turn drives the BLDC motor which serves as the basis for working of the propeller. The servo motors controls the motion of the ailerons, rudder and elevator.

A 2.4 GHz RF wireless camera is used to capture and monitor the surroundings whose footage can be viewed in any Wi-Fi or Bluetooth enabled devices. This serves the purpose of security.

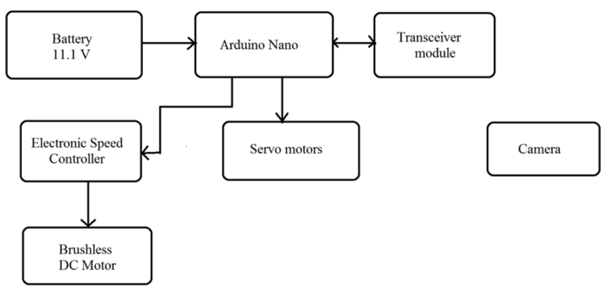

Figure 2. Block Diagram of Receiver

C. Software

The software of the project is written in Arduino programming language. The Arduino Nano is programmed using Arduino IDE. ATmega328P uses boot loader which communicates using the STK500 protocol. The Arduino IDE consists of pre-installed set of programs for one's reference.

D. Aircraft

The control surfaces considered in this project are Throttle, Ailerons, Rudder and Elevator.

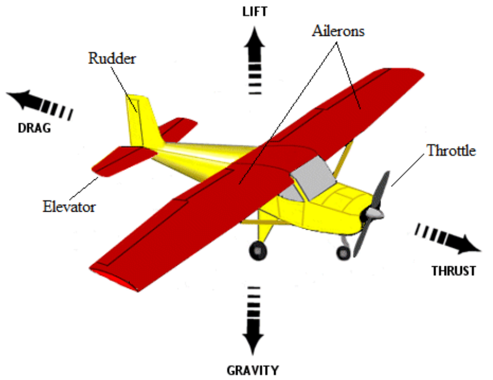

Figure 3. Control surfaces and force acting on an aircraft

The four aerodynamic forces acting on the aircraft are Thrust, Lift, Gravity and Drag[2].

Drag is the resistance of air molecules hitting the airplane (the backward force), thrust is the power of the airplane's engine (the forward force), lift is the upward force and weight is the downward force. Therefore for an airplane to fly, the thrust must be greater than the drag and the lift must be greater than the gravity. So, by this the drag opposes thrust and lift opposes gravity. This is the case when an airplane takes off. When it is in air, the opposing forces of lift and gravity are balanced. During its descent, the gravity exceeds lift and to slow down an airplane, drag has to overcome the thrust.

E. Design of the aircraft

The lift for an aircraft is given by the following formula:

Lift = $(C_L * \rho * v^2 * A) / 2$

where,

ρ indicates density of air, i.e. 1.225 Kg/m^3

v indicates velocity of the plane, i.e. 6m/s

C_L is the coefficient of lift, i.e. 0.5

A is the area of the wing

Since lift should be greater than weight, the weight is considered to be 1 Kg.

Substituting the values, we get A = 907 cm^2.

But the area should be greater than 907 cm^2, so A is considered to be 1170 cm^2 which can be written as 13*90 which is nothing but the chord and span respectively.

Aspect Ratio (AR) is a parameter to be considered for the designing of the wings.

Therefore, AR = wing span/wing's chord length

i.e. AR = 6.923

Fuselage length must be 70-90% of the wing. Therefore for an 80% of the wing, the fuselage length is 72 cm.

Horizontal stabilizer must be 20% of the wing area which stands to be 240 cm^2 in this case. Therefore, the dimensions for an elevator is 10*24 cm.

Vertical stabilizer must be 50% of the Horizontal stabilizer which stands to be 120 cm^2. Therefore, the dimensions for the rudder is 10*12 cm.

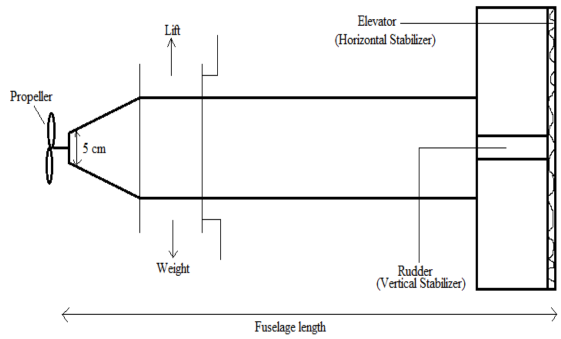

Figure 4. Design of the aircraft

V. APPLICATIONS

1. It can be used by defence for tracking the enemies.
2. It provides flight crew with weather location and analysis.
3. RF drones can be used for different purposes such as monitoring, delivery of military goods[1].
4. The aircraft can be Wi-Fi enabled so that they can broadcast the information to computer or smartphone.

VI. CONCLUSION

This paper is concluded by stating that it could fulfill the vision for military communication systems. The camera installed in this project could serve as a medium for security and information. Further enhancements could make the aircraft function for crowd control.

VII. REFERENCES

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