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# Unmanned Aerial System

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***Abstract*— The project aimed to design autonomous, inexpensive, lightweight, and easy to manufacture UAV. The drone was designed as an aeroplane UAV that houses microcontroller based wireless transmission system and has communication with the ground station remote control. The drone met size and cost standards, and could successfully take the flight of reasonable altitude and distance. Additionally, its controls are understood through simulation and testing. The future developments for our project would be made by providing facility to carry more payload as per required application.**

***Index Terms*— Introduction, System Overview, Sytstem Implementation, Conclusion.**

## I. INTRODUCTION

Surveillance is critical for military, law enforcement, and search and rescue operations. In the past, stealth aircraft and helicopters were used for these types of missions. Recently, unmanned aerial vehicles (UAVs) have grown in popularity for surveillance missions. Since this is a common capability of drones, *this project sought to create a generic UAV platform for application like surveillance*. An unmanned aerial vehicle (UAV for short; also known as a drone) is any aircraft that does not have a human pilot on board. UAVs have their origins as early as 1915 when Nikolai Tesla wrote a dissertation in which he described "an armed, pilotless-aircraft designed to defend the United States." UAVs come in a variety of sizes, designs and purposes. Initially, UAVs were merely remotely piloted; however, autonomous control is becoming more widely utilized. Developing an unmanned aerial vehicle has been one of the main points of concern by many counties all over the world; about 70 different countries have some sort of UAV technology.

UAVs are used to gather information from the air in hostile areas. They can also be used in devastated areas where man support may not be available. These types of UAVs must be portable by ground and very reliable for recurrent use. With these types of uses by the military the UAVs designed are very costly and have very specific uses. *The goal for the project is to design a lightweight, low cost UAV platform for application like surveillance and reconnaissance.*

## II. SYSTEM OVERVIEW

### A. System Design

#### i. UAV Design

The entire body of UAV is made of many parts like wings, rudder, ailerons and so on. All parts assembled together gives us the airframe of an aircraft. The wing may be considered as the most important component of an aircraft, since a fixed-wing aircraft is not able to fly without it. Since the wing geometry and its features are influencing all other aircraft components, we begin the detail design process by wing design. The primary function of the wing is to generate sufficient lift force or simply lift (L). However, the wing has two other productions, namely drag force or drag (D) and nose-down pitching moment (M). While a wing designer is looking to maximize the lift, the other two (drag and pitching moment) must be minimized. In fact, a wing is considered as a lifting surface that lift is produced due to the pressure difference between lower and upper surfaces.

Basically, the principles and methodologies of "*systems engineering*" are followed in the wing design process. Limiting factors in the wing design approach originate from design requirements such as performance requirements, stability and control requirements, producibility requirements, operational requirements, cost, and flight safety. Major performance requirements include stall speed, maximum speed, takeoff run, range and endurance. Primary stability and control requirements include lateral-directional static stability, lateral-directional dynamic stability, and aircraft controllability during probable wing stall.

One of the decisions a designer must make is to select the number of wings. The options are:

1. Monoplane (i.e. one wing)
2. Two wings (i.e. biplane)
3. Three wings

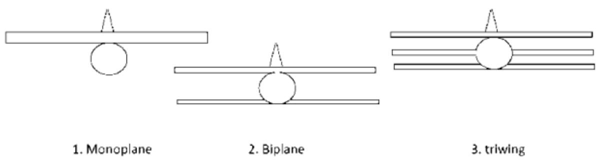


Figure 1: Wing Configuration flight

A single wing (that includes both left and right sections) is almost the only practical option in conventional modern aircraft. A single wing usually has a longer wing span compared with two wings (with the same total area).

One of the wing parameters that could be determined at the early stages of wing design process is the wing vertical location relative to the fuselage centreline. This wing parameter will directly influence the design of other aircraft components including aircraft tail design, landing gear design, and centre of gravity. In principle, there are four options for the vertical location of the wing. They are:


Figure 2: Vertical location of Wing

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The primary function of the wing is to generate lift force. This will be generated by a special wing cross section called airfoil. There are two ways to determine the wing airfoil section:

1. Airfoil design
2. Airfoil selection

The design of the airfoil is a complex and time consuming process and needs expertise in fundamentals of aerodynamics at graduate level. Henceforth here we have used Airfoil Selection. Two reliable airfoil resources are NACA and Eppler.

Design Used in Project is NACA2412 Design. Details of Design are as follows:

- (naca2412-il) NACA 2412
- NACA 2412 airfoil
- Max thickness 12% at 30% chord.
- Max camber 2% at 40% chord

We evaluated the performance and characteristics of an airfoil by looking at the following graphs.

1. The variations of lift coefficient versus angle of attack
2. The variations of drag coefficient versus angle of attack.
3. The variations of lift-to-drag ratio versus angle of attack

### ii. Remote Control Design

The Remote plays the crucial role for the project. The movement of UAV is controlled using Remote. The Remote is designed using:

- 2 axis analog Joystick
- Xbee Pro
- Aurdino 328P
- Battery 7.4V

*Working of Joystick:*

The 2-Axis analog Joystick used here provides a simple and convenient way to add X-Y control to a project. A (10K) potentiometer attached to each axis provides proportional feedback of the up/down and left/right positions. The joystick is spring-loaded, so that it always returns to its centered position when you release it. The plane movement Pitch, Yaw and Roll is controlled using Joystick while the Throttle is controlled using potentiometer attached on Remote. The Joystick is connected to ATMega328P. The microcontroller receives the data from joystick and transmits it using Xbee Pro.

Figure 3: Designed Remote Control

### B. *System Block Diagram*

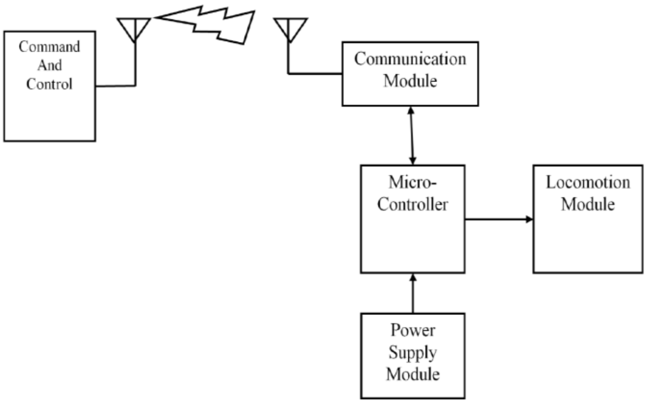



Figure 12: System Block Diagram

### i. Command and Control:

The ground station for the autopilot system has a joystick connected to a "XBEE PRO 900 XSC" module, working at a baud rate of 57600 and working at a frequency of 900MHz. The XBEE is connected to a 2.1dbi rubber duck antenna. A similar XBEE with a similar antenna is also mounted on the UAV which is connected to the ATMega2560 Development Board. The XBEE modules are paired before flight so that there is no interference from other similar devices. This setup gives a range of about 1mile.The controller used in joystick is ATMega 328P.

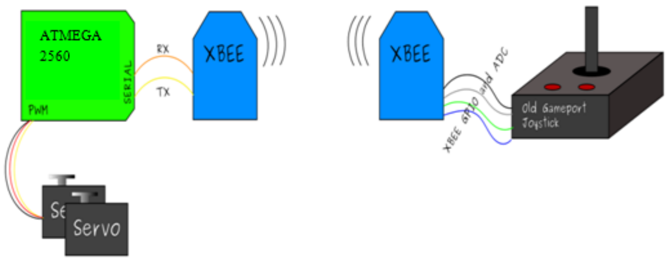



Figure 13: Communication between UAV and Command and Control

### ii. Communication:

"XBEE PRO 900 XSC" is used to receive the commands from the command and control block. The received command is forwarded to the controller.

### iii. Battery Support:

Our system can rely on single battery for flight operations. The 11.1 V, 2200 mAh Lithium Polymer battery powers the 12V payload.

### iv. Microcontroller:

ATMega 2560 is the heart of the system. It processes the commands received from communication module and act likewise. The entire control system will be designed using controller.

### v. Actuators:

The propulsion is provided using Brushless DC Motor.Servo Motors are used to actuate all the control surfaces.

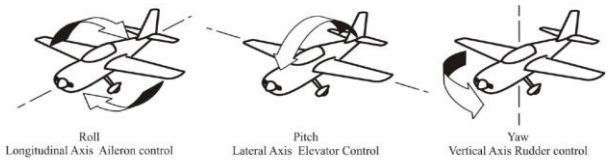
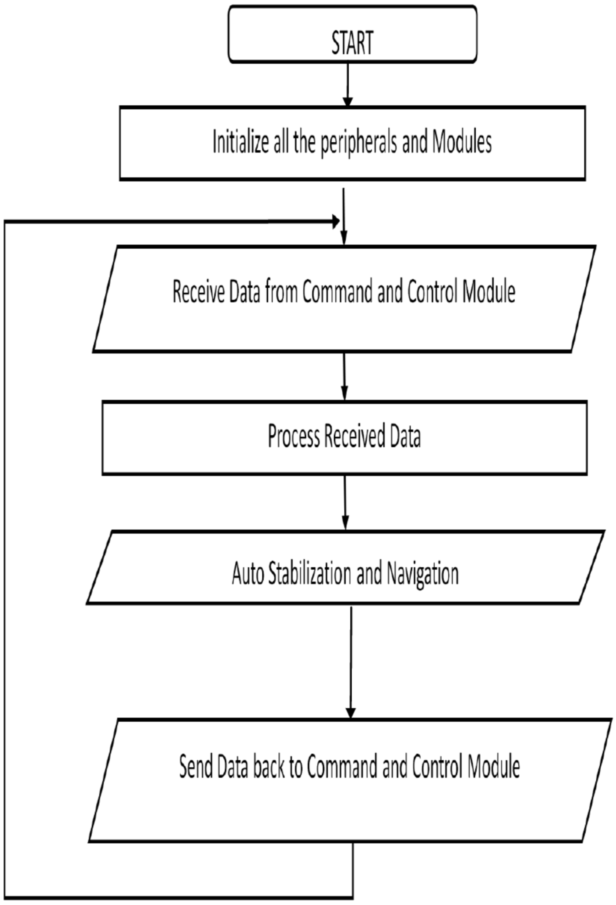



Figure 14: Flights Movements

Table: Flight Movements

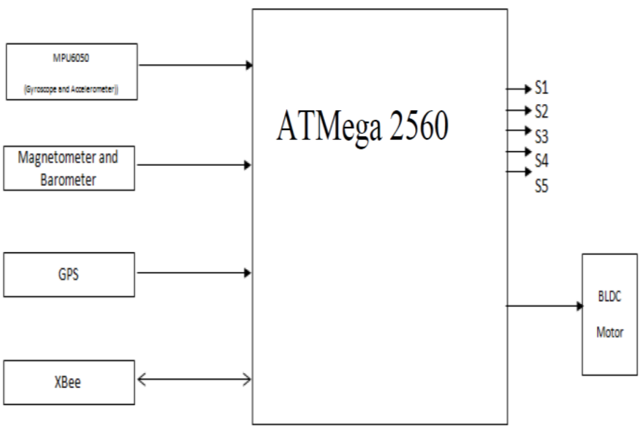
| Primary Control Surface | Airplane Movement | Axes of Rotation | Types of Stability |
|---|---|---|---|
| Aileron | Roll | Longitudinal | Lateral |
| Elevator / Stabiliator | Pitch | Lateral | Longitudinal |
| Rudder | Yaw | Vertical | Directional |

C. System Flow Chart

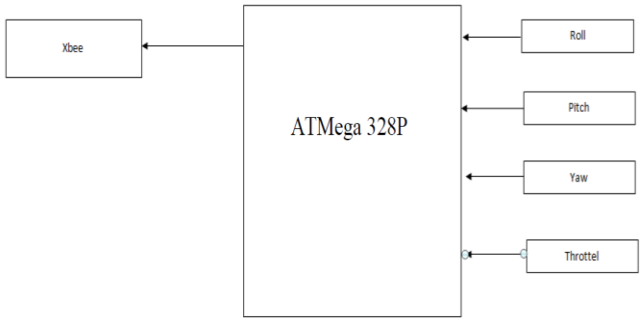



## III. System Implementation

### A. Receiver Side Configuration




B. Remote Side Configuration




## IV. System Testing

### A. *XBee Testing:*

XBee was tested using XCTU. XBee were first configured and were then made to communicate with each other.

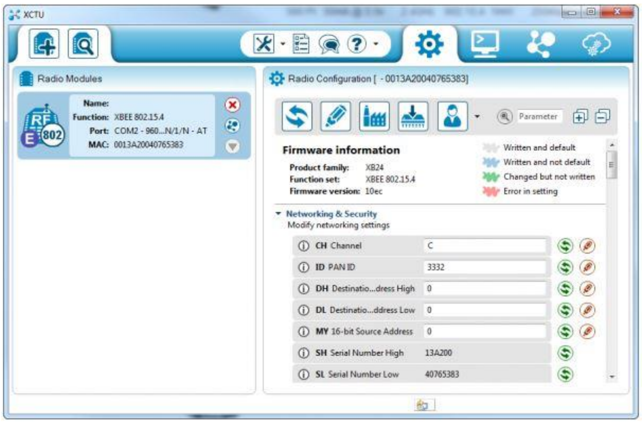



Figure 16: Xbee Configuration on XCTU

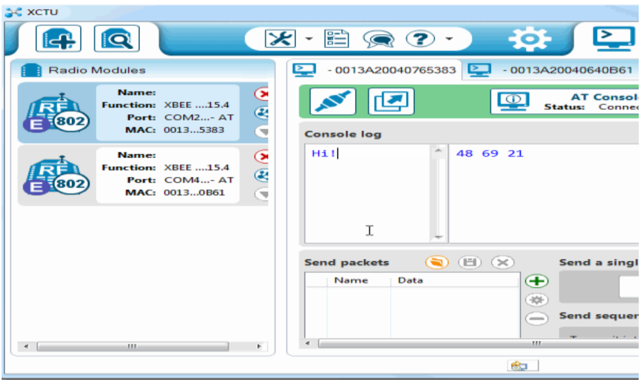



Figure 17: Xbee Communication using XCTU

### B. *MPU 6050 Testing*:

MPU6050 was tested by connecting it with Aurdino and output was observed on Serial Monitor and was tested OK.

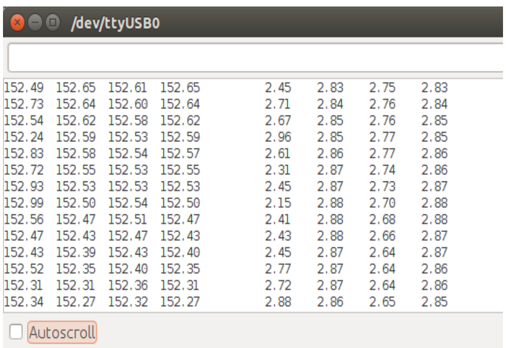



Figure: MPU6050 output on Serial Window

*C. BMP085 Testing:*

BMP085 was tested by connecting it with Aurdino and output was observed on Serial Monitor and was tested OK.

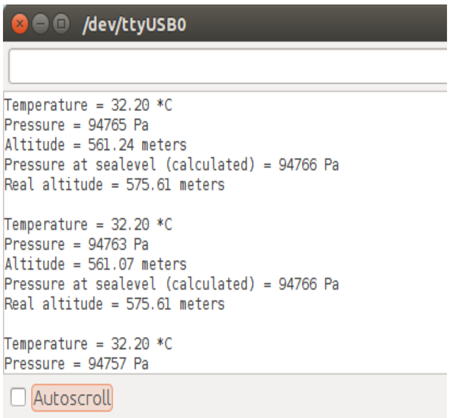



Figure: BMP085 output on Serial Window

*D. HMC5883L Testing:*

HMC5883L was tested by connecting it with Arduino and output was observed on Serial Monitor and was tested OK.

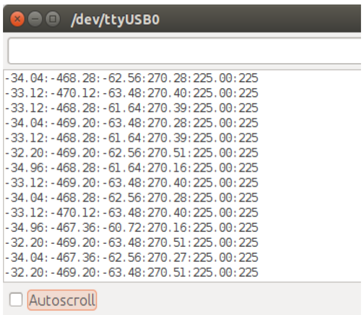



Figure: BMP085 output on Serial Window

*E. Flight Testing:*

Figure: Assembly

Figure: Balance testing

*F. Testing Results:*

- The drone was able to take the flight and was able to achieve reasonable height. Although several flight tests were done, the drone was not stable enough to safely attempt reaching the desired altitude.
- The drone was able to meet the weight requirements. The total drone was approximately 1kg and the power from the motors offered enough thrust for a 0.8 kg payload.
- The drone met the requirement to have One propeller.
- The 10 foot drop test was conditionally met. The landing gear and rods did not survive the fall, but the sensor module was protected and remained undamaged.

## V. Conclusion

The UAV demonstrated it has potential and power to fly at high altitude. The flight is able to fly at reasonable height and communicate through remote control. The team made significant development towards creating a low-cost, lightweight unmanned aerial vehicle demonstrating capability to become generic platform for applications such as surveillance. To create an UAV with aluminum rods used for lightweight aircraft frame. Foam and thermocol sheet for lightweight wing design.

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