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DESIGN AND DEVELOPMENT OF UCAV (DRONE) FOR SURVEILLANCE

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Abstract— Abstract—In this paper my main emphasis is on Uninhabited aerial combat vehicles also known as UCAV. Uninhabited Combat Aerial Vehicles (UCAVs) play a predominant role in the modern day warfare where emphasis is on surveillance, intelligence-gathering and dissemination of information. the importance of unmanned combat aerial vehicle is increasing in modern warfare and anti terror operations, Missions like surveillance, monitoring, acquiring, tracking and destruction of target with the use of advanced technologies and these machines has Ability to see, target, and destroy the enemy by providing actionable intelligence to the lowest tactical levels. UCAV can be used for aerial bombing, surveillance. These vehicles can be used to carry air armaments such as missiles and bombs to enemy positions.

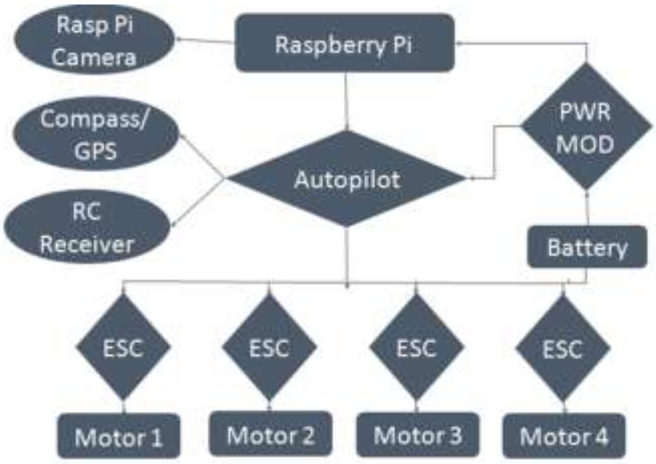
Keywords— **Drone, UAV, counter terrorism operations**

I. INTRODUCTION

The UCAVs are totally different from UAVs because the UAV can be only used for reconnaissance, command and control etc. whereas UCAVs are especially designed for air to air and air to ground combats. The main feature of UCAV can take flight by taking pilot out and they can be used both fighter and also bomber aircraft and can be optimized for combat performance with greatly increased Acceleration and higher maneuvrality at gravitational force much higher than human can tolerate. Combat tactics can be more aggressive than those intended to protect the lives of pilot. UCAVs can be developed, produced, and operated at lower costs compared to the cost of manned aircraft and relative savings in engines, airframes, fuel consumption, pilot training, logistics, and maintenance are enormous .There is no risk to human lives is most important advantage of UAV. In combat zone, the UCAVs is more difficult to detect due to its smaller size and greater stealth factor and also more difficult to strike with anti aircraft fire or missile. In this paper we will develop the multirotor drone with some sensors such as accelometer, gyroscope and camera fitted on the drone.

Drone for Representation

The drone has different modules as prescribed in the flowchart bellow.



Block Diagram

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Fundamental Aspects Required When Designing an Autonomous Quadcopter

Filter design: All of our sensors provide raw data, which contains unwanted noise. To reduce the noise levels, there are several different filters which can be applied to the sensor readings
Estimation of Roll and Pitch: In order to control the quadcopter roll and pitch angles, the angles must be known. None of the sensors measure the angles directly, therefore an estimate has to be obtained from the accelerometer and/or gyrogyroscope sensor

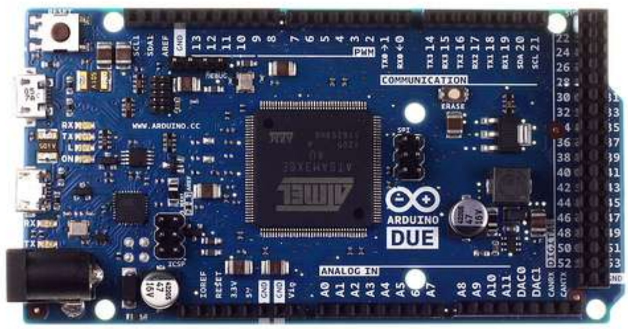
Estimation of Yaw: In order to control the quadcopter yaw angle, the yaw angle must be known. Since none of the sensors measure the yaw angle directly, an estimate has to be obtained from the magnetometer and/or scope sensors.

Estimation of position: The height above the ground is the most crucial information needed in order to control the quadcopter. This will allow the quadcopter to be manually controlled, using the desired height and tilt angles as input. We will use GPS for this purpose.

Control of motion: Using a stable attitude and altitude controller as a basis, more advanced control schemes can be devised. Depending on the objective, several guidance systems may apply, and several path generation methods exists. Some guidance systems will be explored along with trajectory generation methods and path generation methods. To control the speed of the quadcopter along the desired velocity given by the guidance systems, a speed controller will be devised.

PARTS REQUIRED FOR DEVELOPMENT OF DRONE

We require a board with sufficient computer power and memory to be able to compute extended Kalman filter as well as the optimal control input, while at the same time process input from the various sensors. And we have used the ardiuno due. Based on our requirements the Arduino Due is a good and suitable choice, it passes all requirements with clear margins, it is not expensive and it is deemed as a reliable board. The programming language used in Arduino is c, with a huge number of official libraries that can be used in the code.



Ardiuno due used in drone

Frame for drone

In this drone we will use X type in our multirotor it is very basic and important part for the quadcopter . all parts such as ESC, motors, control board are attached to the frame. The frame should have lesser vibrations and high strength that can lift the payload.we will use the X type frame for multirotor in which two motors are revolves anti clock wise. We also attached the GPS, Camera , gimble and AMP on the frame.

Motors

We require high quality reliable motors with rapid response in order to control the quadcopter. If one or several of the motors at some point during a flight experience any problems it would be devastating for the quadcopter, and can at worst endanger the drone itself, property and people. Furthermore it is important that the motors are powerful enough to be able to lift the drone and perform various aerial movements. We also require the motors to have a fast response in order to ensure a more stable flight. Finally we require that the motors are close to vibration free, as any vibration will cause noise in our IMU measurements. Based on these criteria we decided to acquire the SunnySky Angel A2212 KV800 Brushless Motor G638. It is a brushless motor designed for drones, and are considered to be highly reliable. . According to the specifications each motor can give a thrust of 820 grams at 136 watt, based on our ESC and propellers , which means that our drone could theoretically fly at approximately 35 percent capacity. This is more than enough to fulfill our requirements, ant it follows that we could perform quick movements if necessary, which will make the control sequence are simple.

BLDC motor used in Drone

Propellers

The requirements for the propellers are less strict than those for the motors. We require light propellers with size and lift potential such that the quadcopter can hover at less then 50 % of the motor capacity. It is also preferable if the propeller can

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survive soft bumps. For our quadcopter we choose plastic 10X4.5 propellers (254mmx114mm) with their light weight. This is a standard propeller used by many quadcopters. The total length of the propeller is 254mm while the pitch is 114mm.

Propellers 10*4.5 used in drone

Electric Speed Controller

An electric speed controller (ESC) is an electric circuit with the purpose to vary an electric motor's speed[20]. We require that the ESC is fast and reliable for the same reasons stated for the motors in section 2.3. We choose the SS series 18-20A ESC developed by Hobbyking which comes with a limited range of programming functions and are designed to be plug-n-play. This ESC is developed for airplanes as well as multicopters and are designed to be stable as well as reliable

and fast.

Electronic speed controller

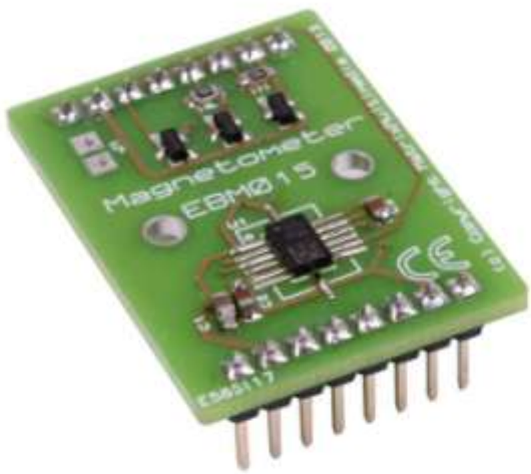
Inertial Measurement Unit

Precision and accuracy is important when it comes to Accelerometer and gyroscope measurement. We require a 3-axis accelerometer and gyroscope that provides reliable and accurate data. It is also an advantage if they can be on the same chip. For this reason we went with the MPU-600, which is a small, thin, ultralow power, 3-axis accelerometer and gyroscope. The device is very accurate, as it contains 16-bis analog to digital conversion hardware for each channel[9]. It measures the static acceleration of gravity in tilt-sensing applications, as well as dynamic acceleration resulting from motion or shock. The sensor has a "Digital motion processor" which can be programmed with firmware and is able to do complex calculations with the sensor values.

IMU used in our quadcopter

Magnetometer

We require the compass to be accurate and reliable, but we accept that it can be magnetic based since we operate far from the magnetic poles. We choose the MHC5883L Triple axis compass magnetometer designed for Arduino. This compass will provide suitable measurements for yaw, and can easily be implemented on our Arduino board.



Magnetometer used in our quadcopter for yaw estimation

Global Positioning System

In order to get some feedback on our estimated position we need a GPS. We require a reliable medium accuracy GPS, it is also preferable if the GPS antenna is small and light. We need a GPS that can provide position data with medium accuracy, and to be able to re-acquire satellite lock fast in the cases where it looses the signal. We choose the 3DR uBlox GPS. This is a high performance GPS designed for multicopters and rovers in particular where GPS accuracy is paramount. It uses a 5 Hz update rate, which is more than fast enough for the low speeds our quadcopter operates in.

Radio

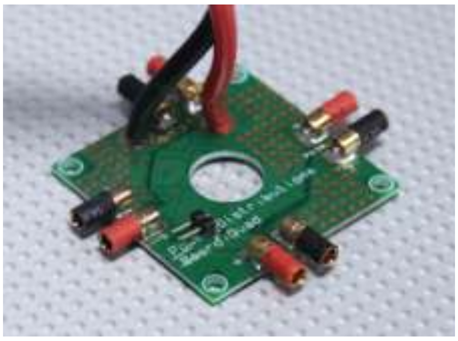
Radio communication is essential for controlling the quadcopter, as well as for tuning when testing the controllers and providing data during flight. It can also serve as a great tool when extending the usage for practical applications. The radio link needs to run on frequencies dedicated for private use in Norway, and is required to have 100 meter range, or more in open terrain. The 3DR Radio set runs on 433 Mhz, which is a standard frequency for private use in Norway. The range in open terrain is more then sufficient and is well suited for our use. The set comes with two antennas, one for the computer on the ground and one for the quadcopter.

Voltage Measurement

By measuring the voltage of the battery, we know how much power we have left. This allows us to land the quadcopter safely when the battery power is low, and not damage the LiPo battery by discharging it completely. According to the data sheet for LiPo batteries, a cell is at full power when measuring 4.2 Volt and at 20% power when measuring 3.7 Volt. Since we are using 3 cell batteries, this means that 100% power equals 12.6 Volt and 20% power equals 11.1 Volt across the three cells. To measure the voltage, we simply use an analog input pin on the Arduino board. where R is chosen as 3MΩ to reduce the power over the resistor voltage measurement

Power Distribution Board

In order to reduce the number of connections directly to the battery we acquired a Power distribution board developed by HobbyKing. This board provides a good solution for power distribution, and the PCB is gold plated for optimal efficiency. This is an easy ”plug and play” solution where we simply connect all four ESC to the board, and connect the board directly to the battery



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Battery

The quadcoter motors and sensors are all powered by using a battery pack. We require a battery that stays within the input voltage limits of the microcontroller, 14 and that the battery provides enough power to be able to sustain a flight for at least 10 minutes. We used Turnigy 5000mAh 3S 20C Lipo Pack delivered by HobbyKing. This is a 5000mAh battery which should allow us to have a normal flight for an estimate of 15 minutes, although the battery voltage needs to be checked in software. The battery is quire heavy; 412g [3], and is the tradeoff when choosing such a powerful battery.

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Autopilot-autopilot is very important part in autonomous flight it also gives higher accuracy we have used ardupilot in this drone**.**

Camera**-** the camera that is used and attached to the gimble is gopro and it has wide application and very useful in surviliance and aerial detection of unwanted elements.

Parts	**Specifications**
Control board	**Ardiuno due**
Motors	**SunnySky Angel A2212 KV800**
Battery	**Turnigy 5000mAh 3S 20C Lipo Pack**
GPS	**3DR uBlox GPS**
ESC	**SS series 18-20A ESC Hobbyking**
Magnetometer	**MHC5883L Triple axis compass magnetometer**
Propeller	**10*4.5 plastic**

AXES PROPERTY

Net forces must be balanced on a flying vehicle for a success flight. There are three axes on the quad copter on which the forces acts in space and time .These axes are YAW, PITCH and ROLL axes[1]. The motion of the quad copter is decided by the resultant of these forces. The axes can be explained as following**-**:

ROLL AXIS: **-** This axis is horizontally parallel to the quad copter plane from left to right .When the quad copter is moving in stable direction then the rotational force vector of the motors acts at the centre, thus cancelling out each other. The quad copter moves either right or left respectively when the resultant rotational force vector is either positive or negative respectively.

PITCH AXIS-: This axis is horizontally parallel o the quad copter plane from the front and the back. When the quad copter is moving in a stable direction, then the rotational force vector of the motors acts at the centre (thus cancelling out each other). The quad copter moves either forward or backward respectively when the resultant rotational force vector is either positive or negative respectively[4][3].

YAW AXIS-: This axis is vertically parallel to the quad copter plane. When the quad copter is moving in stable direction, then the rotational force vector of the motors acts at the centre (thus cancelling out each other). The quad copter rotates around this axis either clockwise or anti-clockwise respectively when the resultant rotational force vector is either positive or negative respectively

Movement

The motion of quad copter is a mechanism of unstable forces. The quad copter system remains stable at any point in the space at any time period when the net forces acting on the quad copter are balanced. When there is a change in the forces of any axis (roll, pitch and yaw), then the quad copter moves in the direction of the net force. That is how quad copter moves. The motion of the quad copter is explained in the following way:- UPWARD/DOWNWARD- The thrust generated by the propellers is responsible for this type of movement of the quad copter. Thrust is directly proportional to the altitude (more thrust high altitude). This is because the thrust is simply the downward force generated by the propellers.

FULL ROTATION- Yaw axes is responsible for this rotation .The rotation is done by increasing the thrust of two diagonally opposite motors with increase thrust than the thrust of the other diagonally opposite motors .

FORWARD/DOWNWARD- Pitch axes is responsible for this type of quad copter motion. When the thrust of the forward and backward pair of motors is increased or decreased then the quad copter moves in front and back direction respectively.

SIDEWARD MOTION- Roll axes Is responsible for the sideward (left or right) motion. When the thrust is increased or decreased in either side of the quad copter motors then the quad copter moves in the other direction. In other words if the quad copter is intended to go on the right then the thrust of the left motor pair is increased and vice-versa

II. CONCLUSION

The uav has very good capacity to perform dangrous task either it is in combat zone , disaster management and many other field , In present decade the graph for research in unmanned aircraft is rising very fast continously. The development and research in this field has started in the time of world war two. Uav will serve entire mankind in near future in various fields.

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