Abstract - The quadcopter system is an extremely maneuverable and versatile platform for many applications especially surveillance and aerial photography which can be used to monitor and survey important areas as well as areas which are normally very difficult to access or dangerous locations. This work is proposed to build a quadcopter using the Arduino Uno. Arduino Uno is an open source physical computing platform used for building digital devices and interactive objects that can sense and control objects in physical world. Transmitter is used to control the movement of the drone and an onboard camera is used for streaming the aerial view of the place. Radio transmitter uses radio signal to remotely control quadcopter in wireless way, the commands given by transmitter are received by a radio receiver connected to Arduino Uno controller.

Keywords - Accelerometer, Arduino Uno microcontroller, BLDC Motor, ESC’s (Electronic speed controller), Propellers, Transmitter and Receiver.

1. INTRODUCTION

Quadcopter is an assistive device, which has a high demand in the industrial & surveillance sector. The arena of application for quadcopter is escalating day by day. Quadcopter finds its application everywhere. Today quadcopter is used for aerial surveillance, pesticide sprinkling, delivery purpose, ground mapping etc. Multirotor comes under various sizes and based on the application and requirements we can construct our drone. The present work includes the design of the quadcopter using ATMEGA328. This system will be controlled by a remote system or a transmitter by sitting inside our home, office, or any place within its transmitter range. The most important aspect is that it can be used for effective surveillance at places where human being cannot reach. Evolution in information technologies in recent years leads not only to a significant improvement of hardware performance but also to offering new hardware solutions not possible before, like unmanned aerial vehicles drones. Such devices are now widely spread and usable not only for industry and commercial application but also for free time fun applications in a personal usage.

The goal of our application is to design and construct a flying robot capable of outdoor and indoor flight and hover. With an integrated system, the vehicle would be capable hover capabilities, through pre-programmed flight paths and carry certain payload. A flying robot is a quadcopter whose lift is generated by four rotors. Here, we have used F-450 frame as the base and the flight controller is built using the Arduino UNO board. Stabilization technology of the gyro gives the smoothing of the Quadcopter abilities enabling them to take aerial view of the place. The gyroscope works almost instantaneously to the forces moving against the drone. The brain of the drone is the Arduino Uno controller, MPU6050, which is a vital component in the flight controller, detects changes in rotational parameters like pitch, roll and yaw using the gyroscope. MPU6050 senses the present positioning data, which is gathered by the flight controller.

The data is sent to the electronic speed controller (ESC) which sends signals to the motor about the level of thrust and speed needed for the drone to fly or hover. The motors used in drone will have huge influence on the payload the multirotor can lift as well as the flight period. 1200g is the maximum payload that can be lifted by the four motors. Motors and propellers work in pairs with 2 motors rotating in counter clockwise (CCW Propellers) and2 motors rotating in clockwise (CW Propellers). Pusher propeller is used for clockwise motor while a normal propeller is used for counter clockwise propeller.
2. LITERATURE REVIEW

In order to run "wireless control quadcopter and self-balancing system" several theoretical approaches are proposed. This review includes the technology development and control method that used in quadcopter. Sandeep Khajure, Vaibhav Surwade, Vivek Badak proposed a design process by using arduino controller which designs the Quadcopter which is easy to use in both hardware and software and it is also designed a metal rod for the quadcopter frame to increase vibration. Due to the vibration the quadcopter often gets imbalanced, hence quadcopter designed by using the thick plastic material. It may reduce the weight and as well as vibration in the body of the copter [1]. Santos et.al. works on intelligent fuzzy controller of Quadcopter. A fuzzy Control is designed and implemented to control a simulation model of the Quadcopter. The inputs are the desired values of the height, roll, and pitch and yaw (moving ship or aircraft). The outputs are the power of each of the four rotors that is necessary to reach the specifications [2]. Pratik Kumar, T. Stephen John A highly stable vehicle is designed and fabricated with all these various applications. Implementation of sensing devices such as motion sensor, LDR sensor, Fire sensor & temperature sensor in the networks using KEIL software with the use of GSM Module as a communicating device for data transmission [3]. Kim Hartmann, Keir Giles This presents both opportunities and challenges to future operations combating hybrid threats. Actual operations in eastern Ukraine, in combination with studies of potential criminal or terrorist use of UAV technologies, provide indicators for a range of aspects of UAV use in future conflict. However, apart from the direct link to military usage, UAVs are rapidly approaching ubiquity with a wide range of applications reaching from entertainment purposes to border patrol, surveillance, and research, which imposes an indirect security and safety threat [4]. Floriano De Rango, Nunzia Palmieri Drones or Unmanned Aerial Vehicles (UAVs) receive a growing interest for agricultural purposes. The aim is to provide inspiring insights in this domain from a technological and computational point of view. The work presented many coordination techniques both for monitoring the area and both for coordinating the actions of the drones in the presence of parasites in order to analyse how the performance can significantly change if more constraints, such as energy, communication range, resource capacities, are accounted [5]. Ankit L. P. S Renduchintala, Abdulshahib The essential major log parameters of the autonomous drone and proposes comprehensive drone-forensics related software architecture with preliminary results. The development software will provide a user-friendly graphical user interface (GUI) to allow users extract and examine the on-board flight information. This would provide the forensic science community with a tool for investigating drone-related crime cases [6]. Young K. Kwag, Chul H. Chung

Based on the assessment of various sensors, small-sized radar sensor is selected for the suitable candidate due to the real-time range and range-rate acquisition capability of the stationary and moving aircraft even under all-weather environments. Through the performance analysis for the system requirement, the conceptual design result of radar sensor model is proposed with the range detection probability and collision avoidance mode is established based on the time-to collision, which is analyzed by collision scenario [7].

3. DESIGN AND METHODOLOGY

Quadcopter is an aerial vehicle, which is operated to fly independently. It is a type of a small representation of an Unmanned Aerial Vehicle (UAV). And an assistive R3 device, which has a high demand in the industrial & surveillance sector, which is aircraft lifted and propelled by four horizontal rotors. Each rotor consists of two or three rotor blades. The present work includes the design the quadcopter using ATMEGA32. Quadcopter is controlled manually with a hand-held radio control transmitter, which manually controls the propellers. The transmitter can observe the radio signals and send them to the receiver through air. Once the receiver accepts the information from the transmitter then it fed to the Arduino Uno controller, which make the quadcopter move accordingly. The Fig.1 shows the quadcopter using Arduino Uno controller.
Quadcopter requires a flight stability sensor that stabilizes quadcopter during its flight mode. Radio transmitter uses radio signal to remotely control quadcopter in wireless way, the commands given by transmitter are received by a radio receiver connected to Arduino uno controller. BLDC motor are synchronous motor powered by DC electricity. It is used to rotate the propellers of the Quadcopter.

### 3.1 Arduino UNO

Arduino Uno is an open source physical computing platform used for building digital devices and interactive the objects that can sense and control objects in physical world. The quadcopter use an Arduino microcontroller Atmel328 as the core controller. This Arduino Uno is used to control the quadcopter movement. It is a circuit board that is equipped with sensors which senses any change in orientation. It can receive different commands sent by user to control speed of motors so that quadcopter could be stable in fly mode. The controller board and ESC's work together. FCB gives the command to ESCs. ESCs receive command from micro controller circuit board and further give command to the motors for rotation. FCB generates various commands for ESC and motors according to the need of user. This controller board controls the whole system. It also includes the accelerometer, gyro meter. Arduino Uno microcontroller acts as the brain of the quad-copter, it's responsible for all actions a quad can perform from take-off and landing to autonomous flight as well as camera and sensors control.

### 3.2 ESC (Electronic Speed Controller)

ESCs are used in proposed Quadcopter. It convert the PWM signal received from flight controller or radio receiver and then drives the brush less motor by providing required electrical power. Thus ESC is electric circuits that control the speed and direction of electric motor by varying the magnetic forces created by the windings and magnets within the motor.

### 3.3 Gyro and Accelerometer (MPU6050)

Quadcopter requires flight stability sensors that stabilize quadcopter during its flight mode. MPU6050 is low power sensor with a sensing element and an IC interface. It is complete 6-axis motion tracking device it combine 3-axis gyroscope, 3-axis accelerometer and digital motion processor all in small package. It has I2C bus interface to communicate with the micro controllers. 3-axis gyroscope is used to detect rotational velocity along the X, Y, Z-axis. 3-axis accelerometer used to detect angle of inclination along the X, Y, Z-axis. The embedded digital motion processor is used to compute motion-processing algorithms. It takes data from gyroscope, accelerometer and process the data. It provides motion data like roll, pitch and yaw. The designing flow of the Arduino based quadcopter as shown in Fig.2.

### 3.4 Working Principle

Quadcopter system works on the principle of air lifting phenomena with high pressure. The propellers force the air in downward with high pressure due to
which an uplift force is created and as a result action
reaction law is applied on the whole system. When
this uplift force dominates the earth's gravitational
force, the whole system start flying in the air. If we
rotate the propellers in clock wise direction then due
to this rotation, a torque will be applied over the whole
system in one direction and similarly if we rotate the
propellers in anti-clock wise direction then also a
torque will be produced.

There are 3 rotations are observed while flying a
Quadcopter such as yaw, roll and pitch which is shown
in the Fig.4

![Fig. 4. Yaw, Pitch and Roll Rotation](image)

**Yaw Rotation (ψ)**

Yaw is defined as movement of quadcopter either
to left or to right and it is controlled by throttle stick
of transmitter. Yaw decides the direction of
quadcopter.

**Pitch Rotation (θ)**

Pitch is defined as the whole movement of
quadcopter either in forward direction or in backward
direction. It's also controlled by throttle of receiver.
Moving the throttle in forward direction moves
quadcopter in forward direction while moving throttle
backward moves quadcopter in backward direction.

**Roll Rotation (φ)**

The movement about the longitudinal axis of
quadcopter is known as roll motion. Left or right
motion of throttle stick is followed by quadcopter, it
moves in towards right when throttle move to right
and moves to left when throttle stick moves in left
direction. This parameter thus makes quadcopter to
fly in left or right direction.

### 4. RESULT AND DISCUSSION

The Arduino, based Quadcopter is calibrated by
using IDE tool of the Arduino. Yaw, roll and pitch are
the three positions, which are used to control the
movement or direction of the Quadcopter. Yaw is
defined as movement of drone either left or right and
rolls for longitudinal axis of the drone and pitch for
the forward or backward direction. The Fig.4 shows
the mid-level and high-level of the flying quadcopter.
Quadcopter is controlled by using transmitter and
receiver in the range of 2.4GHz.
Based on contrast of flying style, price and specs from the popular quadcopter flight controllers, some important differences are discovered, that helps to choose the controller. The Table 1 shows that the proposed work is more efficient compared to other quadcopters that uses the different control boards. Compare to other flight controllers, Arduino is less cost and it is simple for interfacing the sensors and other components. It is easy to install the libraries and software for interfacing sensors compare to other flight controller.

Table 1. Comparison between Arduino flight controller and other flight controller [9].

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Arduino</th>
<th>Acro Naza32</th>
<th>Crazepony F3</th>
<th>Multiwii SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost</td>
<td>Low</td>
<td>High</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Modeling</td>
<td>Simple</td>
<td>Complex</td>
<td>Complex</td>
<td>Complex</td>
</tr>
<tr>
<td>Peripheral support</td>
<td>More</td>
<td>Less</td>
<td>Less</td>
<td>Less</td>
</tr>
<tr>
<td>Performance</td>
<td>High</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>I/O pins</td>
<td>More</td>
<td>Less</td>
<td>Less</td>
<td>Less</td>
</tr>
<tr>
<td>Configuration</td>
<td>Very easy</td>
<td>Bit difficult</td>
<td>Very difficult</td>
<td>Difficult</td>
</tr>
</tbody>
</table>

Arduino can provide on-board storage but other controllers do not have storage on board. The Arduino boards are just plug and play device, if power is connected it starts running the program and if disconnected it simply stops but the other controller should properly shutdown otherwise there is a risk of files are corrupted and the software will get problem.

Arduino have a lot of peripheral support and it includes 3-axis Gyro, Accelerometer and Magnetometer, it have a very good performance compare to other controller boards. It has a number of input/output pins and very easy to configure and set up.

5. CONCLUSION

The proposed Arduino based Quadcopter can be produced with cheaper and affordable cost and it is lightweight, which can be easily made from on shelf components. Compare to the other drones or multirotor the designed quadcopter is low cost and easy to design. This development platform can be used as a low cost alternative to many applications like pesticide sprinkling, end-to-end delivery within the transmitter's RF range, surveillance in defense and other sensitive places, mapping through remote sensing.

REFERENCES