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Design and Implementation of Flight Control Board for Quadcopter

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ABSTRACT—Unmanned aerial vehicles, or drones, have drawn extensive attention during the last decade together with the maturity of the technology. This paper presents the design of a flight controller using Arduino Uno and MPU 6050. Flight controller controls the quadrotor both manually and autonomously, is realized by integrating MPU 6050 microprocessor unit with selected gyroscope, accelerometer, magnetometer, barometer and GPS sensors. Flight control software is written in C programming language. Software, peripherals, and the drive mechanism are the three basic parts of a flight controller. The data from the sensors is processed by the microprocessor and produces an output signal using the motors control algorithms. The electronic speed controller (ESC) sends the produced PWM output signal to the motors.

I. INTRODUCTION

A drone or Unmanned Aerial Vehicle (UAV) is an aerial vehicle that does not require an on board pilot to perform the flight. The UAVs are controlled by the pilots through a controller, but self-controlling systems are becoming more common [1]. UAV's are mostly piloted by humans using a remote control known as a Radio Controller (RC). On the other side, the device integrator will operate it autonomously [2]. UAVs were originally designed for military purposes, but their use in civilian applications such as firefighting missions and civilian defence, such as surveillance of a large facility's pipeline, is gradually increasing. Finally, UAVs can be used in search and rescue operations, assisting in the recovery of missing or stranded people in inaccessible locations.

One such classification of UAV is Quadcopter. It is a multirotor air vehicle with four rotors. Unlike conventional helicopters, which use a special mechanism to adjust the pitch of their propellers, quadrotors use fixed-pitch propellers like airplanes [3]. It consists of only four propellers of equal diameter that raise and propel it forward. These four props are symmetrically mounted on a cross shaped skeleton, with the payload in the middle of the frame. Those props are rotated every two rotations and vice versa, resulting in zero torque applied to the drone.

In the current proposed paper, a flight controller is designed using aurdino uno and MPU6050. Software, peripherals, and the drive mechanism are the three basic parts of a flight controller. The data from the sensors is processed by the microprocessor and produces an output signal using the motors control algorithms. The Electronic Speed Controller (ESC) sends the output signal to the motors.

The idea of a quadcopter had come into existence in the beginning of the 20th century. The first attempt to build the quadcopter was made by Jacques and Louis Breguestin 1907 but this design was unstable so they couldn't build the rotating wings of quadcopter. After this Etienne Oehmichen was the first scientist who made the experiment on rotating wings and that managed to take off successfully [4]. This model was made up of steel tubes and at the end it had four rotor blades. He also inserted five double blade motors laterally to ensure that it is stabilized. Furthermore, the series of inventions have been done on the flight controller in which a number of sensors were introduced into the flight controller in order to increase the stability of the quadcopter.

II. SUBSEQUENT DEVELOPMENT

The incorporation of the advanced sensors helped in increasing the hovering stability of the drone. The hover control was achieved using a microcontroller and a PID controller configuration. This led to the increasing use of drones in the field of agriculture to monitor crops of an area. This was

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one of the major advantages of using the drone. However, the drones were still not sufficiently modified to perform complex task. So, scientists introduced few other sensors like tilt sensors, infrared sensors to increase the efficiency of drones in their task. The tilt sensor keeps track of the drone's pitch, while the infrared sensor uses the body's different radiation to distinguish the subject of interest of other objects. But there were no sensors to find the location where the drone is flying so the scientists introduced the Global Positioning System (GPS) module which will find the location of the flight and send this information to the remote controller. Mechanical flight control system become more complicated and heavier as the aircraft grows in size and performance.

III. RECENT DEVELOPMENTS

The development of intelligent control techniques for autonomous navigation is the most recent trend in UAV science. Pixhawk auto piolet, buzzer, safety switch, memory card and adapter, micro USB cable for device link, six wire cable known as X2 connector, power module, i2c splitter module, four position i2c splitter cable, three pin wires for serial bus and servo cables/connectors, mounting foam are the main components of the flight controller [5].

Several advancements have done on quadcopter to increase the efficiency. This has been achieved by using better microcontrollers along with some better sensors. With the passage of time, arduino became a popular microcontroller in making the drones because of its flexibility in programming. The closed loop system must meet the frequency domain stability margin index [6]. Along with that the additional sensors such as camera, ultrasonic sensors has been introduced in the drones. This helped the drones in calculating distance from the ground which previously were unable to achieve. This was the major development in the recently introduced drones.

IV. DESIGN AND CONSTRUCTION OF FLIGHT CONTROLLER

Flight control system has many sensors such as gyroscope, barometric pressure sensors, airspeed sensors, GPS. The gyros, in combination with accelerometers, are still the most important contributors in flight calculations. Accelerometers measure acceleration. Gyroscope measure the rate of rotation about an axis. The project uses the IMU MPU6050 gyro and accelerator module. It has an i2c communication where it only needs 2 pins from the arduino, clock and data. Without any external libraries the flight controller software is written in the C programming language with licensed microprocessor software [7]. The project built a quad-X shaped quadcopter which means that it will have 4 motors placed in a cruse shape. It consist two motors on the front side and two motors on the back side. The four rotors are placed on the four top of the cross frame.The rotational directions are same in relative position and opposite in consecutive positions. The quadcopter is controlling by the radio controller which is controlled through the altering the rotational velocity of four rotors. The angular rate controller is designed for the small high speed UAV angular kinematic model with uncertainties in order to minimize perturbation and uncertainty. Then, in the case of uncertainty with a small UAV angular kinetic mode, based on the inner ring on the attitude of the angular motion loop design [8].

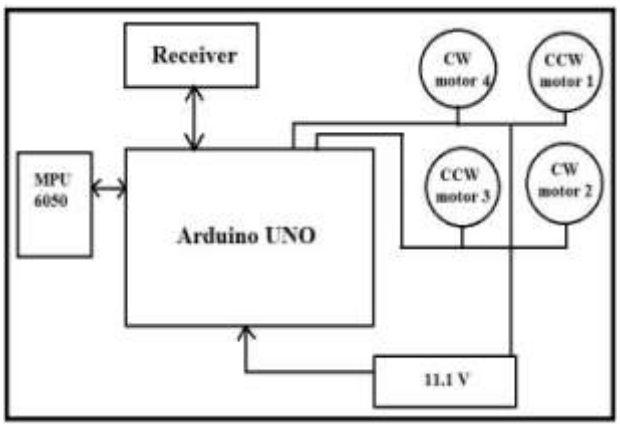

Fig 4.1. flight control board connections

In the figure each motor has a number. That number corresponds to the digital pin of the arduino. Eachmotor has one signal pin for the ESCs. Each motor rotates in a unique way inorder to create a special air vortex. Both back and front pair of motors spin toward the interior of the drone. The flight controller needs 4 output pins for each motor and a IMU (Inertial Movement Unit) connected to it. It also needs input from each of the radio receiver's 6 channels. All the sensors which are incorporated into the flight controller needs to be connected to the same pin on the arduino Uno. This project uses the programming platform called Multiwii. Multiwii is a flight control interface to suit a wide range of aircraft. Drones, planes,helicopters and so on. The flight controller should read the accelerations and gyro data from the MPU unit. Next it should calculate the real angle of the drone and using a PID operation controls the 4 motors and move the drone in the desired direction. A fuzzy interface is used to develop the robust adaptive PID controller [9].

V. CONCLUSION

The main goal of this project was to create a quadcopter device that included both hardware and software. The projects complexity was predetermined because we had to create our own programme and design every component of our structure from the ground up. The know-how was learned through a combination of theory and operations, allowing us to broaden our expertise on a range of topics in order to meet the needs of our customers. Since it uses a single microcontroller for control and orientation calculations, it is considered adequate for smooth flight and control. With regard to the use of a PID controller, either angular or angular velocity controller, its stabilization via the sequential controller implemented using an analogue P controller and a PID was considered optimal. High speed, high precision sensing can help communicate better with the complex world. Data collected by the quadcopter's sensors can used to investigate the flight dynamics this study lays a solid bases for the possible creation for fully autonomous flying robots [10].

Even though the quadcopter we designed is fully functional, it could be improved in the future by adding some important features, such as:

- Create a navigation device that is self-contained.
- To avoid obstacles, adjust sensor distances across the frame.
- Telemetry is used to keep track of all data when in flight.
- Various sensors, such as smoke, heat, CO2, and others, are placed, allowing it to be used in a variety of situations.

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