Gesture Control Method implemented for effective control of a Quadcopter.

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***Abstract*— This paper explains various mechanisms that can be implemented on a quadcopter to control it's motion and position accordingly. Three different types of control mechanisms were experimented and results have been obtained. The First mechanism is a dual sensor fusion and implemented through a glove as a gesture control. The Second mechanism is the joystick controller. The Third mechanism is controlling the GPS location of the quadcopter .We used an mpu6050 sensor and an HC-SR 04 ultrasonic sensor. The mpu6050 is already a fused sensor of accelerometer and gyroscope. We made a glove contained with these sensors fused with an Arduino Nano and nrf24l01 transceiver module. We used commercially available sensors and components in our project and tried to enhance its use in a meaningful way. So that at a long range of flight the quadcopter is provided with GPS coordinates and the flight path is also set, by LASER distance sensor the obstacles are overcome along the path to the desired GPS coordinates. At a close range the hand held glove is used to control the motion of the quadcopter.**

Keywords— quadcopter; sensor fusions; hand control; GPS location control; joystick control.

I. Introduction

Quadcopters are used in almost many fields for various purposes. Drones are a category of quadcopters that are used for surveillance and many drones are commercially available. These quadcopters are becoming advanced in terms of size, cost, usage, efficiency and different ways of controlling it's motion, etc.. Autonomous quadcopters are the most advanced form that are being researched nowadays. However for many applications the quadcopters needs to be controlled manually. Manually controlled quadcopters tend to have the joystick type of controller to determine its motion. This type of controller has many advantages, but it also gives the user certain limitations in the case of ease of use and stability. So we used some of the commercially available sensors and microcontrollers in obtaining a more effective way of controlling the quadcopter. We built the primary portion of the quadcopter using some readily available microcontroller, transceiver modules, motors, chassis, propellers, battery and flight controller. We then used two sensor modules, a microcontroller and a transceiver module for the controller portion.

We also designed a way to control the quadcopter to move to a particular location based on the GPS coordinates. We used a GSM module to transfer data through the 2G spectrum which is connected to the nearest mobile communication tower. It is used to transfer data to the quad

copter in a very long range and where the network's signal reception strength is sufficient. The GSM module obtains the data of the GPS coordinates through a message sent from the user's mobile and the quadcopter proceeds in the particular direction at a certain altitude. We have also designed an easily controllable joystick for the quadcopter in case of need for certain places. The receiver portion has been designed to obtain signals from the module which is being turned on and operated at the moment.

II. The Quadcopter

A. The Frame

The Frame we have used is the F330 which has a compact and sturdy design. It is easily compatible with many of the commercially available motors and drone cameras. It has a power distribution setup that supplies the power to all the four motors.

Fig. 1: Quadcopter Frame [1]

B. Motors

The 2212 BLDC motors were used for the required thrust. It has a power output of 1.4kV and has better efficiency. It is comparatively cheaper and is used in many quadcopters in research area.

Fig. 2 : Propulsion Motor [2]

C. *Electronic Speed Controllers*

We used 30 Amps SimonK commercial safe ESCs. It is used to operate the BLDC motors at the required RPM .

Fig. 3 : Electronic Speed Controller[3]

D. *Flight Controller*

Adraxx KK 2.1.5 is a flight controller board that has a preprogramed interface that helps to control the basic flight mechanisms of the quadcopter. Aileron, Elevate, Throttle, Rudder are provided by the board with an LCD screen interface. It has an self levelling auxiliary mode which self stabilises the quadcopter using the inbuilt accelerometer and gyroscope in the flight controller board.

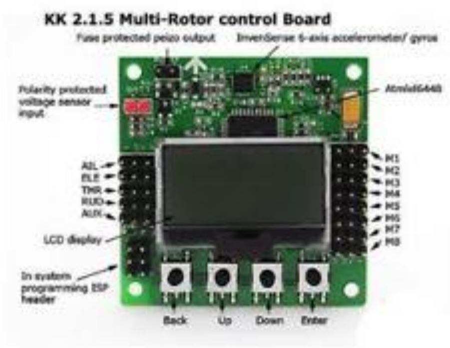

Fig. 4 : KK 2.1.5 Flight Controller Board [4]

E. *Microprocessor Unit*

We employed am Arduino Nano kit which utilizes an Atmega 328P microprocessor. It is a 30-pin Microcontroller kit. It has a easily programmable interface and can be used in a small places.

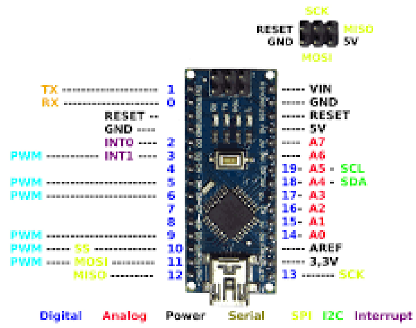

Fig. 5: Arduino Nano [5]

III. Different control mechanisms implemented

The aim of this project is to design an user friendly way of controlling a quadcopter with minimal requirements and hardware. We designed three different controllers and implemented two of them. The design, working mechanism and efficiency have been explained in the upcoming sections accordingly for each type of controller.

A. *Accelero-Gyro-Ultrasonic Sensor fusion Mode of control.*

- This method is our primary mode of control for the quadcopter. This method utilizes two different sensors. We used an HC-SR04 Ultrasonic sensor and an MPU6050 Accelerometer/Gyroscope combined sensor. These two sensors have been setup along with a Arduino Nano in a very compact and efficient PCB board that we designed for this purpose. The interfacing protocols are I2C and SPI for the sensors and the transceiver module. We used an NRF-24L01 transceiver module for data transmission in a short radius range from the user. The main PCB board on the transmitter side is fixed to a glove and the supply for it is provided through 3 lithium coin cells of 3 V each they have a capacity of 250mAh each. This supply is unregulated and directly provided to the Arduino Nano which regulates internally and provides the power for the sensors and transceiver modules. This setup has a good bypassing through capacitors and voltage regulators separately. The ultrasonic sensor requires a 5v regulated DC power supply which is provided from a 7805 Voltage Regulator. The transceiver module is fixed along with a breakout board through a LD33v voltage regulator which provides enough protection from the AC flickers occurring in the supply. The receiver portion consists of a transceiver and an Arduino Nano which is connected with the KK 2.1.5 Flight controller module which controls the quadcopter according to the data obtained from the Arduino Nano.

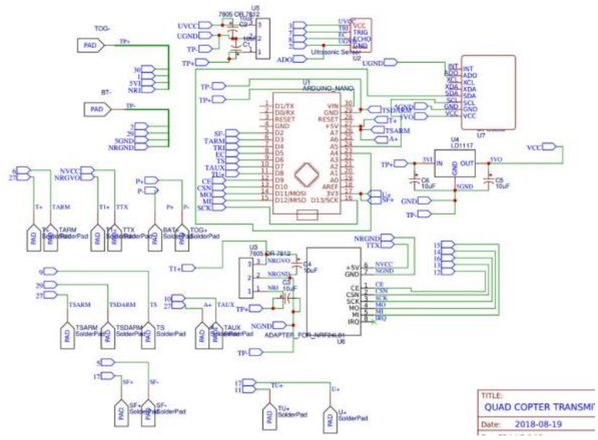

Fig. 6 : Quad Transmitter Schematic for PCB

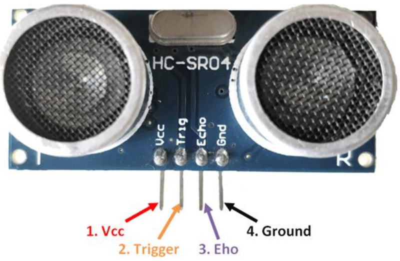

Fig. 7 : Ultrasonic Sensor (HC-SR04) [7]

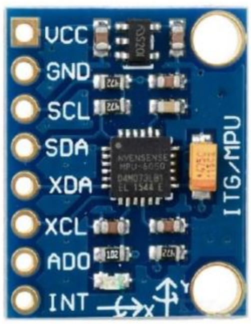

Fig. 8 : MPU6050 MODULE [8]

- The transmitter side has two sensors which are used for separate purposes. The HC-SR04 Ultrasonic Sensor which is used measures the distance from the hand to the ground and sends the data to the Arduino Nano in the transmitter side which converts the data to different PWM length signals accordingly. The Ultrasonic sensor is used to control the throttle of the quadcopter. It has two cylindrical shaped portion which transmits and receives ultrasonic waves and measures the distance which is converted to the altitude of the quadcopter in a particular constrain. Next we used the MPU6050 sensor to control the aileron, elevate and rudder motions of the quadcopter. It works on the principle of peizo-electric effect. It has an peizo-electric sphere inside a crystal cube. When the sensor is tilted the sphere produces an electrical signal when it comes in contact with the crystal walls and the acceleration is measured in reference with gravity. This data is converted into respective signals in order to control the movement of the quadcopter. These two data are used to control the overall movement of the quadcopter. When the gloves with the transmitter PCB is tilted or elevated the motion of the quadcopter is controlled in a close range with the help of the transceiver module.

Fig. 9: NRF 24L01 Transceiver Module [9]

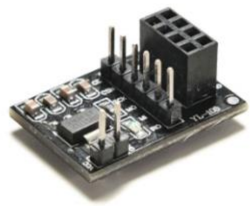

Fig. 10: Breakout Board for Transceiver Module [10]

This method of control is been setup and experimental results have been obtained and they are very effective at a particular range along with the sight of the user. This range can be increased effectively by using a camera and visual monitoring system.

METHODS UNDER FUTURE IMPLEMENTATION

B. *GSM-GPRS Mode of Control.*

- We have utilized the GSM and GPRS technology along with the required interfacing modules to design an long range and more user-friendly commendable control method. This method uses a GPRS module SIM6000 which has the ability to both receive and transmit data through the 2G Spectrum. The module has a inbuilt SIM card with a specified number which receives and sends the data. This module is setup along with the quadcopter. This module is programmed with Arduino Nano to enact according to certain commands it receives through predetermined SIM numbers. It can receive data from three different SIM numbers as a text or alerting call which can be used accordingly through the interfaced Arduino Nano microcontroller on the drone.

Fig. 11 : GSM MODULE – SIM800A [11]

- Now the data for initiation is given through a call or a determined text message from the mobile numbers. This module then sends the data to the Arduino Nano which processes the information accordingly and arms the quadcopter. After this the GPS coordinates of the quadcopter's current position is sent to the setup SIM numbers through the GSM module. This location is then spotted by the user through a map and the GPS coordinates of the destination location is found out. This GPS coordinates is then transmitted to the module from one of the user SIM as a text. The Arduino Nano on the other end will process the data and direction through a certain algorithm that determines the path of the quadcopter in fixed direction along a fixed line. At the start the quadcopter is placed at an open field and lifted of to a certain altitude. This altitude is fixed by taking the average of the heights of the buildings along the travel area approximately by the user. A long range LASER sensor is utilized to determine the presence of obstacles building along the path. When there is a presence of an building along the path, the LASER sensor senses the presence and halts the forward movement of the quadcopter and it begins to hover at the same position. Now the program initiates the throttle to the quadcopter and the altitude of the quadcopter is increased until the LASER sensor senses sudden drastic change in distance meaning the absence of obstacle along the path. After this the quadcopter starts to move forward repeating the same process until it reaches the destination coordinates.
- This mechanism has been designed and the control method is in the experimental stage at this point and results have not yet been obtained.

C. Joystick Mode Of Control

- This method is very primitive and basic and simple method for the control of the quadcopter this method uses the two potentiometers with an microcontroller and controls the movement of the quadcopter .
- Two potentiometers are used in this method where the four basic main movements of the quadcopter are programmed accordingly. In the joystick mode the potentiometer in the left controls the forward and backward motion of the quadcopter and the potentiometer in the right controls the throttle up and down .The quadcopter rudder motion is also controlled by the left joystick when it is moved in the right and left directions.
- This method is proved effective and also being used in many quadcopters we have also implemented this method in this quadcopter because of simplicity. But to overcome certain difficulties in rudder motion we designed the second control method.

REFERENCES

We have not referred many technical papers from other authors for our project, but referred some of the Arduino forums and github for details about the sensor modules.

Images taken from :

[1] Fig. 1 - https://bit.ly/2Ocepdx

[2] Fig. 2 - https://bit.ly/2zwwcUQ

[3] Fig. 3 - https://amzn.to/2NGIHWD

[4] Fig. 4 - https://bit.ly/2NM8SeA

[5] Fig. 5 - https://bit.ly/2R0OwMu

[6] Fig. 7 - https://bit.ly/2NIkO0R

[7] Fig . 8 - https://bit.ly/2QYgyIl

[8] Fig. 9 - https://bit.ly/2Qa2NFs

[9] Fig. 10 - https://bit.ly/2xGxICx

[10] Fig. 11 - https://bit.ly/2R1tHk4