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Design and Implementation of Quadcopter Multirotor Uncrewed Aerial Vehicle

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Abstract: An Uncrewed Aerial Vehicle (UAV) also known as drone is an aircraft with no pilot on board. Science and Technology always make life easier by creating a device that allow human reach a risky, inaccessible or stressful region. Therefore, an Arduino based Quadcopter Multirotor Aerial vehicle, with transmitter and receiver that can help human life to control and perform some activities at high region was designed. The construction of the Quadcopter UAV involves the use of some Electronic Components and software. The device was programmed prior to flight to do a specific set of tasks on a specific flight path. A Bluetooth module was used to control the movement of the Quadcopter. The Quadcopter balancing and stability condition was sensed by using the MPU 6050 sensor on the Arduino pro mini microcontroller board. The system was able generate an up-thrust for a complete flight time. It was deduced from the result obtained that the Quadcopter Multirotor Uncrewed Aerial vehicle is sensitive and globally reliable.

Keywords: Quadcopter, Uncrewed Aerial Vehicle (UAV), controller, transmitter, receiver. Arduino, Geographic Positioning System (GPS).

1. Introduction

An Uncrewed Aerial Vehicle (UAV) is an aircraft with no pilot on board. The aircraft vehicle has a ground-based controller, and a system to communicate. The movement of UAV can be at various degrees of autonomy, by remote control or onboard computer. Compared to conventional crewed aircraft, UAV useful in many applications such as military applications, commercial, scientific, recreational agricultural, policing, peacekeeping, surveillance, product deliveries, weather monitoring, firefighting, aerial photography, videography and drone racing (Raghavendra, 2013). A drone is a flying robot that can be controlled or fly autonomously using software-controlled flight pprogrammed in embedded systems and GPS (Koparan, 2019). There are different technical characteristics of drone. The most notable characteristic is the drone is called such as fixed-wing systems, Multirotor systems, and other systems like the hybrid systems, which are both multicolor and fixed-wing systems, ornithopters, and drones that use turbo fans.

Science and technology always try to make life easier; the main purpose of this project is based on creating and enhancing the reach of Humans to regions that are either risky, inaccessible or stressful. The problem that often faces Human race is losing lives to carry out task in heights, or unsafe regions with limitations in the military, Health, Creativity, Agriculture and other sectors. Therefore, there is need for a more robust automated system that will not involve the risk of human life in reaching endangered regions.

Different drones are discussed in the literature for different purpose; among such are Delfly Explorer, Hubsan x4 Drone, Parrot AR Drone, DJI Phantom and Raven. Explorer is an ornithopter drone that flies like a dragonfly and is being developed by Delft University of Technology in the Netherlands. The drone can take-off and fly fully autonomous within a closed environment. Drones tend to get smaller and lighter (Decroon *et al.*, 2015). Hubsan drone is a small multirotor, fairly simple in design and operation. It has four rotors and can be operated with a controller. Users can preprogram the drone with a task and settings like maintaining a particular altitude, after which it carries out the given task by itself (Carmigniani, et al 2011). The Parrot is similar to Phantom, both in applications and functions (Phantom, 2016). The two drone are equipped with film and photography software, and gaming software for recreation purposes. The Raven is a fixed-wing drone which is designed with an optic and infrared camera. Raven lands by gliding toward a preprogrammed landing site and can compensate for the impact when hitting the ground by falling apart (Alex, 2015).

3. Materials and method

Some of the materials used in the construction of the multirotor quadcopter vehicle are shown in figures 1 to 5:

Figure 1: A Quadcopter Frame

Figure 2: Brushless Motor

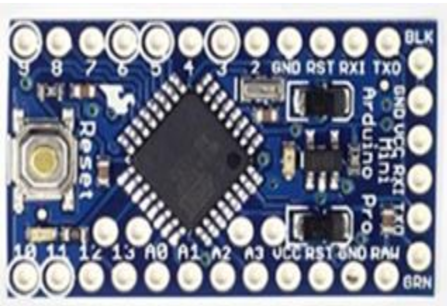

Figure 3: Arduino Pro Mini (ATmega328P)

Figure 4: Propeller

A propeller is a type of fan that transmits power by converting rotational motion into thrust. Thrust loads on the blades, in reaction to the force pushing the air backwards, act to bend the blades forward.

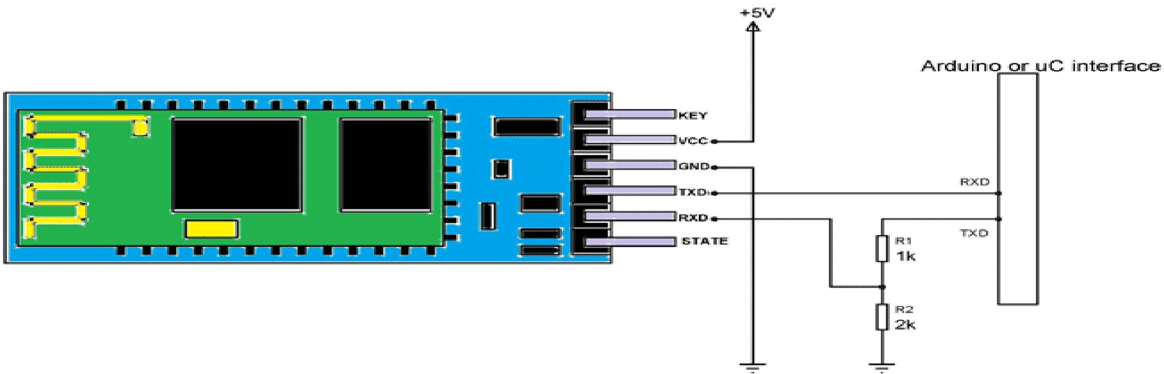

Figure 5: HM-06 Bluetooth module

The construction of the Quadcopter uncrewed aerial vehicle involves the use of some Electronic Components and software. The device was programmed prior to flight to do a specific set of tasks on a specific flight path. The device used a Bluetooth module to control the flight of the Quadcopter. The Quadcopter balancing and stability condition is sensed by using the mpu 6050 sensor. All signals from the sensors are processed by Arduino pro mini microcontroller board and the output is implemented to direct the movement of Quadcopter motors.

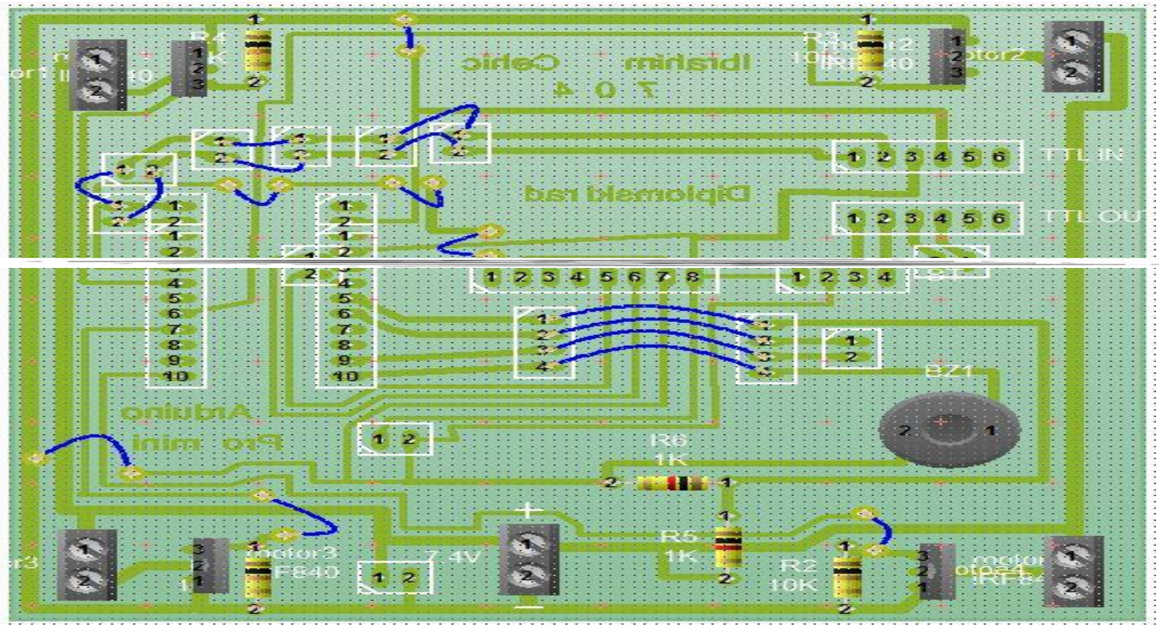

Figure 6: Printed Circuit Diagram of Quadcopter Uncrewed Aerial Vehicle

The complete simulated circuit diagram of Quadcopter Uncrewed Aerial Vehicle is shown in Figure 6. The Programming Language used is the Arduino Programmer 1.8.10. The interface of this programming language is as shown in Figure 7.

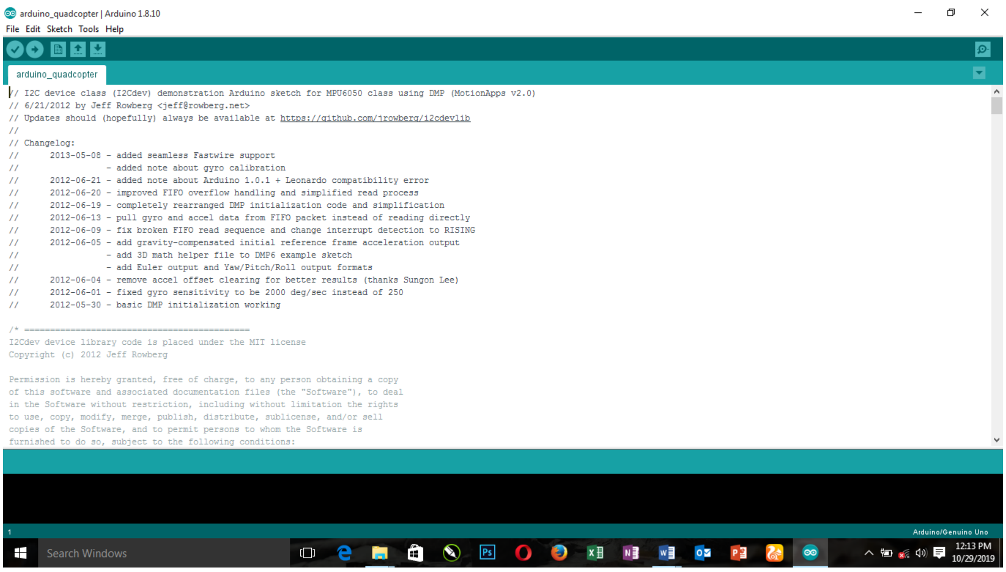

Figure 7: Interface of an Arduino Programmer

The Transmitter used in the design is an Android application known as Nova drone. This application is interfaced with the Bluetooth device of the android Device. The Bluetooth of this device communicate with the Bluetooth module HM-06 and is used to control the drone both in flight and statically as shown in Figure 8.

Figure 8: Nova drone Android Application User interface

4.0 Results and Discussion

This section discusses the resulst obtained from the testing and implementation of the Quadcopter Multirotor Uncrewed Aerial Vehicle. The abbreviations used in the tables are represented below:

$Ws \leq 1.7m/s$ =Wind Speed less than or equal to 1.7 Meter per second

$Ws > 1.7m/s$ (i.e. Ws = 1.75m/s) = Speed greater than 1.7 meter per second

FT =Flight Time, NFT = No Flight Time, TP = True Positive, FP = False Positive, TN = True Negative,

FN = False Negative.

The Quadcopter vehicle was tested for Ten (10) days under different Wind conditions and represented with alphabet 'A-J'. The Testing was performed at $Ws \leq 1.7m/s$ and $Ws \geq 1.7m/s$ (i.e. Ws = 1.75m) as shown in Tables 1 to 3.

Table 1 : Result of testing of the Quadcopter Multirotor Uncrewed Aerial Vehicle

Wind Speed/Day	A	B	C	D	E	F	G	H	I	J
At Ws ≤ 1.7m/s	FT	FT	FT	FT	FT	FT	FT	FT	FT	FT
At Ws>1.7m/s (i.e. Ws = 1.75m/s)	NFT	NFT	NFT	FT	NFT	NFT	NFT	NFT	NFT	NFT

Table 2 : Metric representation from testing of the Quadcopter Multirotor Uncrewed Aerial Vehicle

Wind Speed/Day	A	B	C	D	E	F	G	H	I	J
At Ws ≤ 1.7m/s	TP	TP	TP	TP	TP	TP	TP	TP	TP	TP
At Ws>1.7m/s (i.e. Ws = 1.75m/s)	TN	TN	TN	FP	TN	TN	TN	TN	TN	TN

Table 3 : Performance Evaluation of the Quadcopter multirotor Uncrewed Aerial Vehicle

Metrics	Results	Sensitivity (%)	Accuracy (%)
TP	10	100.00	95.00
FP	1		
TN	9		
FN	0		

It was observed that during flight time the blinking LED indicates the direction of the Quadcopter Vehicle. The Quadcopter Multirotor Uncrewed Aerial Vehicle with the principle of up-thrust was able to complete a flight time of five minutes. The response of the drone to the atmospheric condition (i.e. Wind Speed) was tested for ten days as shown in Table 1. The metric interpretations of the responses are shown in Table 3. The number of True positive from the Table 2 showed that the design is active and reliable at any wind speed less than or equal to 1.7m/s at time flight. It can also be deduced from Table 3 that the sensitivity of the Quadcopter Multirotor Aerial Vehicle is 100% which indicates that the system is sensitive. Also the overall accuracy which measured the global reliability of the quadcopter Multirotor Aerial Vehicle is 95% which indicates the efficiency of the system.

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5.0 Conclusion

The design of Quadcopter Multirotor Uncrewed Aerial Vehicle for flight. The system was able generate an upthrust for a complete flight time. It was deduced from the result obtained that the Quadcopter Multirotor Uncrewed Aerial vehicle is sensitive and globally reliable.

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