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Autonomous Navigation for Flying Robots

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Abstract– ***The project goal is to design a semi-autonomous Quadcopter capable of self-sustained flight via wireless communications while utilizing a microcontroller. The Quadcopter is designed to be small enough so that costs would be minimized, which is why small motors and propellers are being used. While a microcontroller, accelerometer and gyroscope are communicating between each other to maintain control. To achieve flight, two of the motors must apply downward force and the other two motors have to apply an upward force. To turn, one pair (left or right side) of motors slows down to turn the copters. To ascend, all motors will increase in speed and will all decrease in order to descend. To move forward, the front two motors will decrease while the back two motors will increase and vice versa in order to move in a backwards direction.***

Keywords–Microcontroller, Accelerometer, Gyroscope, Motors, Propellers

I. INTRODUCTION

A Quadcopter, also called a Quadrotor helicopter, Quadrotor, is a multirotorhelicopter that is lifted and propelled by four rotors. Quadcopters are classified as rotorcraft, as opposed to fixed-wing aircraft, because their lift is generated by a set of rotors. Unlike most helicopters, Quadcopters use 2 sets of identical fixed pitched propellers, 2 clockwise (CW) and 2 counter-clockwise (CCW). These use variation of RPM to control lift and torque. Control of vehicle motion is achieved by altering the rotation rate of one or more rotor discs, thereby changing its torque load and thrust or lift characteristics. Quadcopter configurations were seen as possible solutions to some of the problems in vertical flight; torque-induced control issues can be eliminated by counter-rotation and the relatively short blades are much easier to construct. These vehicles use an electronic control system and electronic sensors to stabilize the aircraft. With their small size, these Quadcopters can be flown indoors as well as outdoors.There are several advantages. First, Quadcopters do not require mechanical linkages to vary the rotor blade pitch angle as they spin. This simplifies the design and maintenance of the vehicle.Second, the use of four rotors allows each individual rotor to have a smaller diameter than the equivalent helicopter rotor, allowing them to possess less kinetic energy during flight. This reduces the damage caused should the rotors hit anything. Some small-scale Quadcopters have frames that enclose the rotors, permitting flights through more challenging environments, with lower risk of damaging the vehicle or its surroundings.

II. MOTIVATION

The Quadcopter, is able to take off without a runway, take video from afixed hovering position, and finally maneuver through tight spaces as required. The Quadcopter also provides a superior payload capacity when compared to the helicopter and is a more stableplatform.

III. METHODOLOGY

Quadcopter or quad rotor aircraft is one of the major focuses ofactive researches in recent years.Quadcopter has advantages over the conventional helicopter where themechanical design is simpler. Besides that, Quadcopter changes direction bymanipulating the individual propeller's speed and does not require cyclic and collectivepitch control

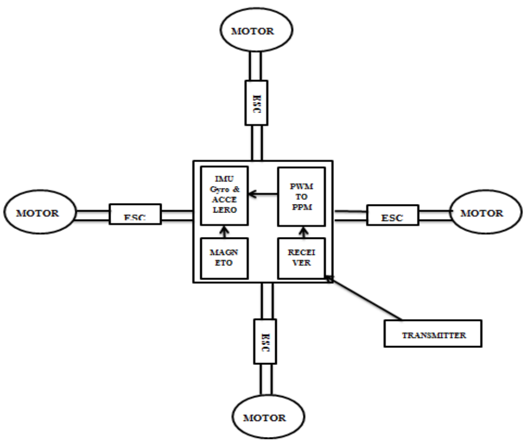

Fig. 1 The Block Diagram of Quadcopter

A. COMPONENT DESCRIPTION

1) Motor: Motors are a bit similar to normal DC motors in the way that coils and magnets are used to drive the shaft. Though the motors do not have a brush on the shaft which takes care of switching the power direction in the coils, and so it is called as brushless motors. Instead the brushless motors have three coils on the inner of the motor, which is fixed to the mounting. On the outer side it contains a number of magnets mounted to a cylinder that is attached to the rotating shaft. So the coils are fixed which means wires can go directly to them and therefor there is no need for a brush.
2) ESC: Electronic Speed Controller. As the brushless motors are multi-phased, normally 3 phases. The motors requires some special phase-control electronics that is capable of generating three high frequency signals with different but controllable phases, but the electronics should also be able to source a lot of current as the motors can be very power-hungry.
3) PPM: For the control it is usually just a simple PPM signal that ranges from 1ms to 2ms in pulse width. The frequency of the signals does also vary a lot from controller to controller, but for a QuadCopter it is recommended to get a controller that supports at least 200Hz or even better 300Hz PPM signal, as it should be possible to change the motor speeds very quickly to adjust the QuadCopter to the stable position.
4) PWM: Shows you how our code generates PWM signals so each ESC knows how fast to spin the motor.
5) Propellers: On each of the brushless motors there are mounted a propeller. The 4 propellers are actually not identical the motor torque of and the law of physics will make the QuadCopter spin around itself if all the propellers were rotating the same way, without any chance of stabilizing it.
6) Battery: The power source for the whole device.
7) IMU: The Inertial Measurement Unit is the sensor system of the QuadCopter. The main purpose of the Inertial Measurement Unit is to calculate the orientation of the quad – the three orientation angles, Roll, Pitch and Yaw.

Fig. 2 Top view of Quadcopter

Fig. 3 Side view of Quadcopter

B. QUADCOPTER MOVEMENT MECHANISM

Quadcopter can described as a small vehicle with four propellers attached to rotorlocated at the cross frame. This aim for fixed pitch rotors are use to control the vehiclemotion. The speeds of these four rotors are independent. By independent, pitch, roll andaw attitude of the vehicle can be control easily.

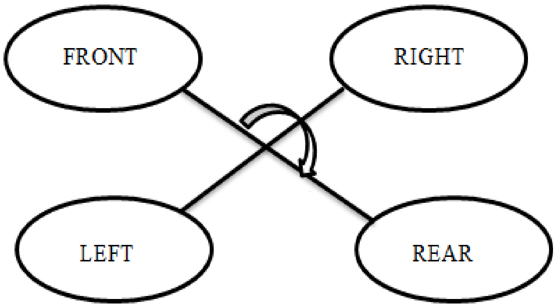

Fig. 4 Pitch direction of Quadcopter

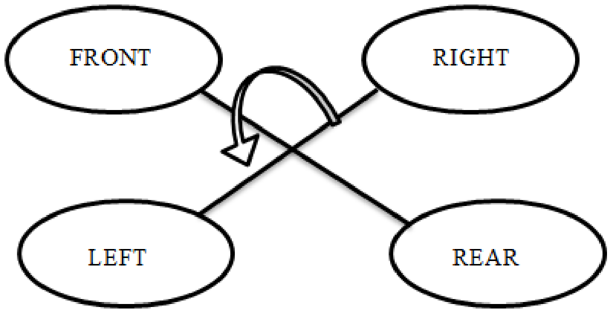

Fig. 5 Roll direction of Quadcopter

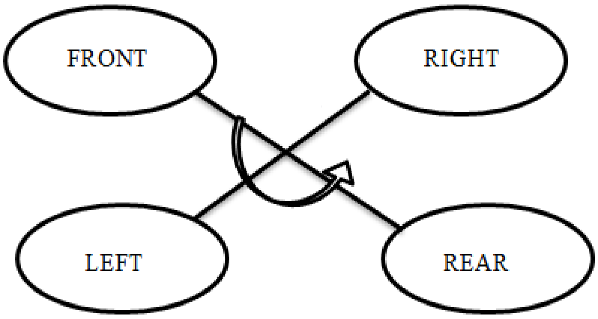

Fig. 6 Yaw direction of Quadcopter

C. TAKE-OFF AND LANDING MOTION MECHANISM

Take-off is movement of Quadcopter that lift up from ground to hover position andlanding position is versa of take-off position. Take-off (landing) motion is control byincreasing (decreasing) speed of four rotors simultaneously which means changing thevertical motion.

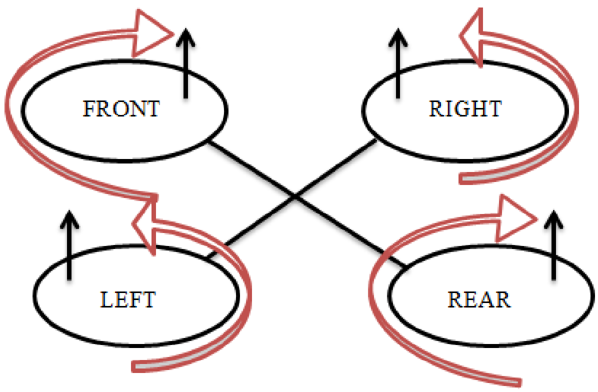

Fig. 7 Take-off motion

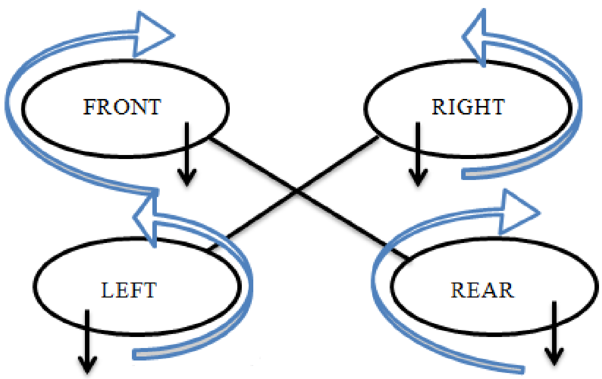

Fig. 8 Landing motion

D. FORWARD AND BACKWARD MOTION

Forward (backward) motion is control by increasing (decreasing) speed of rear (front)rotor. Decreasing (increasing) rear (front) rotor speed simultaneously will affect thepitch angle of the Quadcopter.

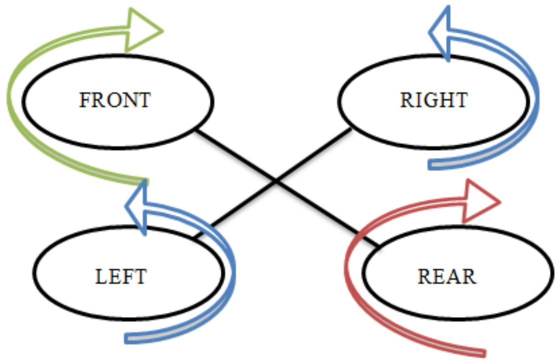

Fig. 9 Forward motion

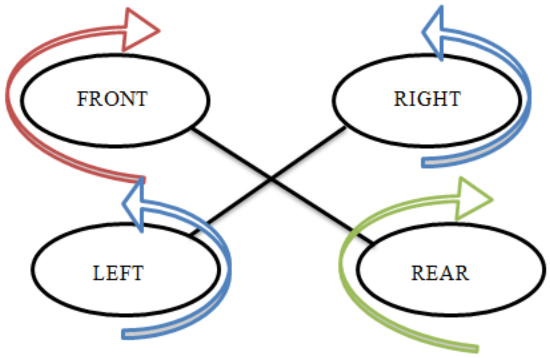

Fig. 10 Backward motion

E. LEFT AND RIGHT MOTION

For left and right motion, it can control by changing the yaw angle of Quadcopter. Yaw angle can control by increasing (decreasing) counter-clockwise rotors speed while decreasing (increasing) clockwise rotor speed.

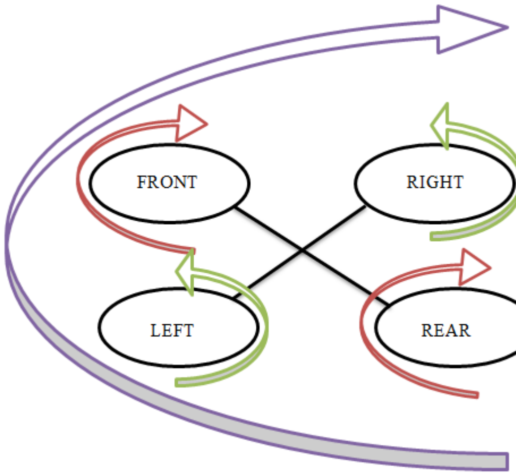

Fig. 11 Right motion

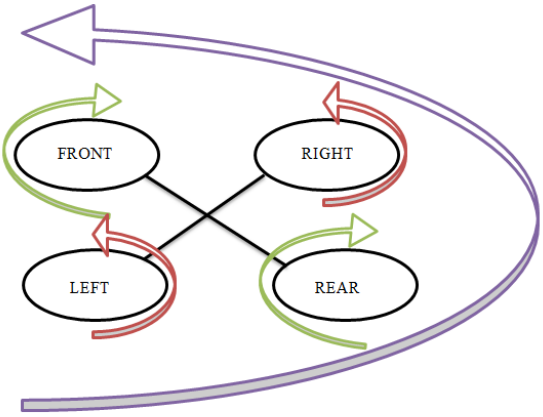

Fig. 12 Left motion

F. HOVERING OR STATIC POSITION

The hovering or static position of Quadcopter is done by two pairs of rotors are rotatingin clockwise and counter-clockwise respectively with same speed. By two rotorsrotating in clockwise and counter-clockwise position, the total sum of reaction torque iszero and this allowed Quadcopter in hovering position.

IV. ARCHITECTURAL DESIGN

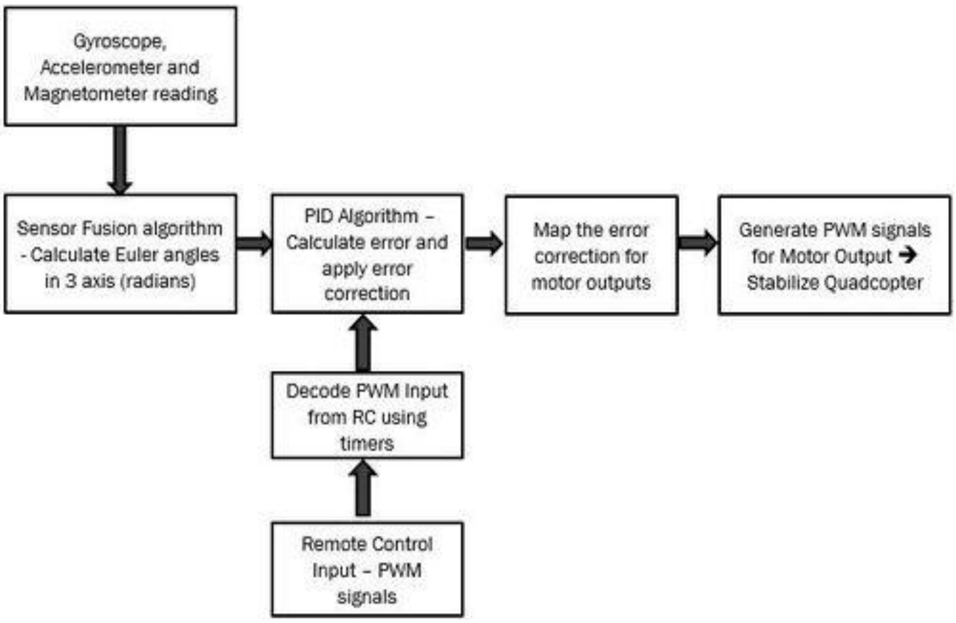

Fig. 13 Architectural Diagram

The architectural diagram explains about the working principle of the autonomous navigation for flying robot where in the initial stage is receiving the signal from the Bluetooth which is connected to the android mobile device and operates based on the directions which is given by the user who is handling the device. Basically it checks for the particular device and creates a connection between the device. The main board which has controller which controls the speed of the robot and the motor which actually works as DC motors and finally the flying robot starts flying and it has some particular distance in which it has to fly that is only 6 feet and not more than that.

Fig. 14 Raspberry Pi Connection

V. LITERATURE REVIEW

To know the working principle of the quadcopter [1] is referred and based on the hardware requirements that are the hardware parts as well as their connectivity and also their working principle of each of the circuits referred to [2]. The explanation for each circuit is known in [3] website. To know their functional requirements [4] is referred. To switch the mode from one angle to another we referred to [5] and to control the flying of robot referred to [6].

VI. CONCLUSION

The project could go in a variety of directionssince the platform seems to be as flexible as we initially intended. This flexibility allowschanging the functions it performs and also allows integration of any technology that wouldprove to be useful. This project has clearly demonstrated the goals of proving that small scaleUAVs are useful across a broad range of applications.

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