Quadcopter Aircraft using Arduino Mega

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***Abstract*—Quadcopter Aircraft is one of the multicopter that is lifted and propelled by four rotors at the end of the cross frame. It is controlled by electronic control system with different movement such as yaw, pitch and roll. The research focuses on how to design a model quadcopter from a scratch. During the process, the stabilization of quadcopter is one of another important need to measure as it will affect the quadcopter during flying. Arduino Mega is used for a microcontroller as the brain of the whole system with another important component. Transmitter is used to control the movement of quadcopter wireless with certain distance. Quadcopter can be flown indoors as well as outdoors. It has become popular in unmanned aerial vehicle (UAV) research because it can be controlled without having a person on board. However to due to the construction and control, quadcopter aircraft are often used as model aircraft project only.**

Keywords-movement of quadcopter, component

I. INTRODUCTION

Research and development of unmanned aerial vehicle (UAV) are getting high encouragement nowadays since it is an aircraft control by remote control without having a human pilot on board. The application of quadcopter can be apply in variety area such as for military, film making, agriculture, rescue mission and often preferred for missions that are too dangerous for manned aircraft [1].

Quadcopter are opposite from fixed wing aircraft because a set of narrow chord airfoils are used to lift quadcopter. A movement of quadcopter can be control by altering the pitch, roll and yaw by controlling the thrust. Thrusts and torque are produce in each rotor at the center of rotation and also a force opposite to the quadcopter's direction of flight. The rotor are aligned in a square as two rotor placed opposite move in counter clockwise direction while the other two rotate counter clockwise direction. The unbalanced torques will affect yaw. The torque of the first rotor pair will cancel out with the torque of the second rotor pair which rotate in the opposite direction. Equal thrust at all four rotors will cause the quadcopter to stay in the same direction. Figure 1 below show the reaction torques on each motor of a quadcopter due to the spinning rotors.

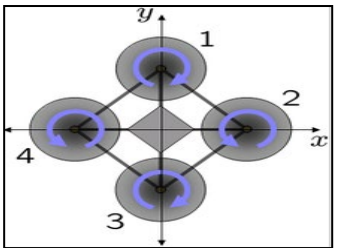

Figure 1: Schematic of motor

If all rotors turn in the same direction, the quadcopter will spin just like the regular helicopter without tail rotor. Moreover, if the only one rotor counter clockwise while the remaining rotating clockwise, the torque and the yaw axis will become zero which means that the yaw stabilize rotor is not needed.

Having four rotors are more advantages as it is easy to imbalance side to side thrust by having the rotors place in symmetry thus giving a roll movement.

Figure 2 below shows the movement of yaw, roll and pitch of airplane. Yaw is the movement of turning left and right. It is controlled by turning up the speed of the motor but reduce the power from the counter clockwise motor rotate. Roll is the movement of tilting left and right by reduce the speed on one motor and increasing the opposite one. Lastly, the pitch is move by moving up and down [2].

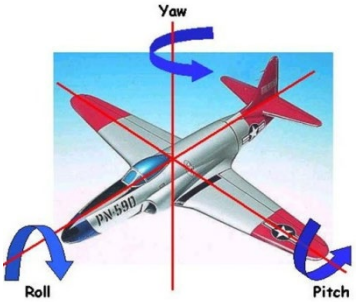

Figure 2: Movement of airplane

II. PROBLEM STATEMENT

There are many project have been done on quadcopter but there is not many project of quadcopter using Arduino Mega as a microcontroller since Arduino itself is still new in However, Arduino microcontrollers keep growing and there are many type of Arduino in the market nowadays. There are

many type of flight controller can be used for example Open Pilot and Copter Control multicopter, ArduiPilot and KK Multicopter. This project will go through how to make a quadcopter fly by using a Arduino Mega as flight controller [3].

III. METHODOLOGY

a) *Flowchart*

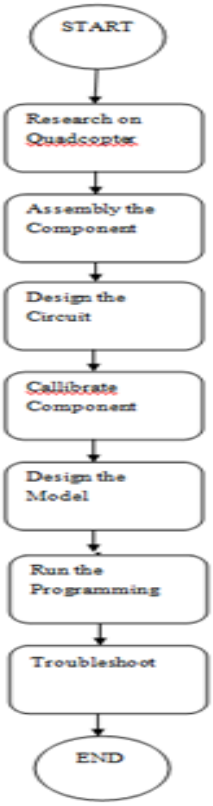

Figure 3: Flowchart of the design process

Figure 3 shows a flowchart of the design process of quadcopter aircraft. A research has to be done in the first step of the process in order to have a better understanding of the project. Next the components are needed in the project is assembly and the circuit is design. The component is calibrated to make sure the component is working before start flying. Design the model and run the programming. Lastly troubleshoot the project if there is anything wrong.

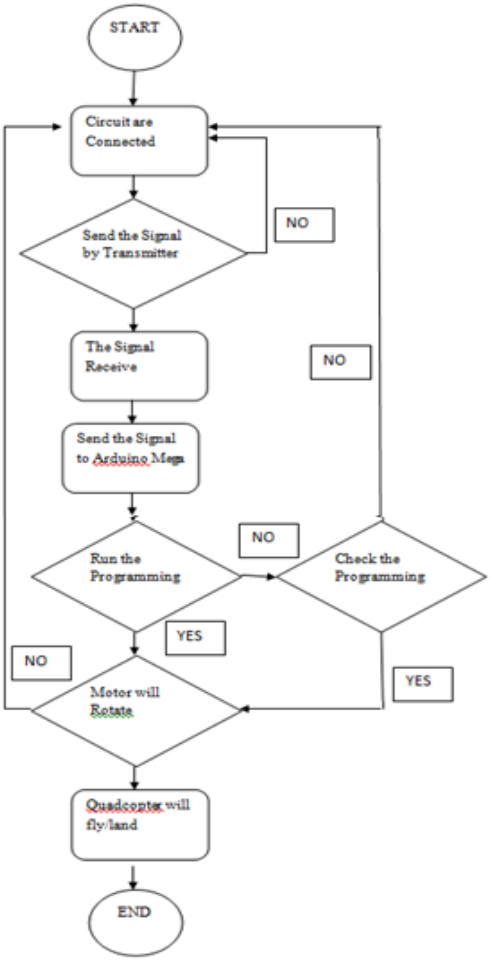

Figure 4: Flowchart of the operation quadcopter

Figure 4 shows a flowchart of the operation of quadcopter. After all the circuit is connected, on the transmitter and sent the signal by moving a throttle. The signal is receive by using a receiver wireless. A signal receives will sent to the Arduino Mega to execute the instruction. The motor will rotate according to the instruction and according the movement of the throttle. The propeller also rotate along with the motor thus the quadcopter will fly [4].

b) *List Of Component involved:*

Figure 5: Frame

The frame used is lighter, smaller and cheaper compare to another frame. It has the downside arm that is used to support the quadcopter for flying and especially during rough landing [8].

Figure 6: Brushless motor

Figure 6 show a brushless motor that used to rotate the propeller. It has 1000Kv which represent the RPM of the motor per volt with no load with the number of volt. This brushless motor used 10v thus the value of RPM is 10000 RPMs. This shows the max value of RPMs that this motor can reach under no load. A motor with a higher Kv will have more top end speed but the torque will reduce compare to a motor with a lower Kv. It will not be fast however it will accelerate faster [8].

Using brushless motor is more advantages instead of using a normal DC motor as it can produce high speeds and less power usage for the same speed. Furthermore, the brushless motors are more efficient because there is no power lost.

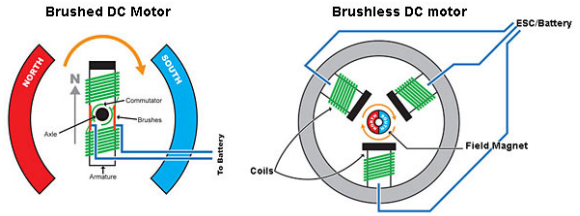

Figure 7: Brushed DC motor and Brushless DC motor

Figure 7 shows the cross section of DC motor and brushless DC motor. In brushless DC motor, the coil will rotate instead of the magnet.

Figure 8: Electronic Speed Controller

In order to make the brushless motor to spin, electronic speed controller (ESC) is used as it capable to generate high frequency signal and also able to source a lot of current as the motor can be very power hungry. Figure 8 shows the ESC used are 40A [8].

Figure 9: LiPo battery

The liPo battery is used to supply the power of quadcopter of motor. This liPo battery used 2200mAh with 11.1v and 25C. The 25C together with the battery capacity indicates how much current able to source from the battery byusing the formula MaxSource= DischargeRate × Capacity. For this battery, the maximum source is 25C× 2200mAh = 55A. Thus, the total amount of current drawn by motor (ESC) won't exceed 55A [7].

Figure 10: Propeller

Propellers are connected on top of the brushless motor. Since there are 2 motor rotates in the opposite direction to the other 2 motor, the propeller are also different into two also. One propeller used for motor that rotate clockwise and the other propeller used for motor with the opposite direction. The different of the propeller is it will have opposite tilting to indicate the clockwise [4].

There are variety type of diameter and pitches (tilting) in propellers but the one used in this project is 1045 which means 10 diameters with 4.5 pitches. This type propeller is commonly used in quadcopter project for mid-sized. The diameter and pitch represent the thrust of the propeller as if the larger diameter and pitch the more thrust the propeller can generate. Besides that, it will require more power to drive it but it will able to lift more weight.

Figure 11: Transmitter

Figure 11shows a transmitter used in this project. It have basic channel which is throttle, yaw, roll and pitch. The transmitter is used to control the quadcopter movement [5] [7] [10].

Figure 12: Receiver

Figure 12 shows a receiver as it will used to receive to signal wireless from a transmitter. A receiver usually comes as a package with a transmitter because not all receiver compatible with a transmitter. Thus it is easier to buy transmitter along with a receiver rather than too buy separately.

Figure 13: Arduino Mega

Arduino Mega is used as a microcontroller for this project. It is used to execute the command from the transmitter through the receiver. After execute the command, it will affect the movement of the brushless motor [7] [9].

c) List Of Component involved

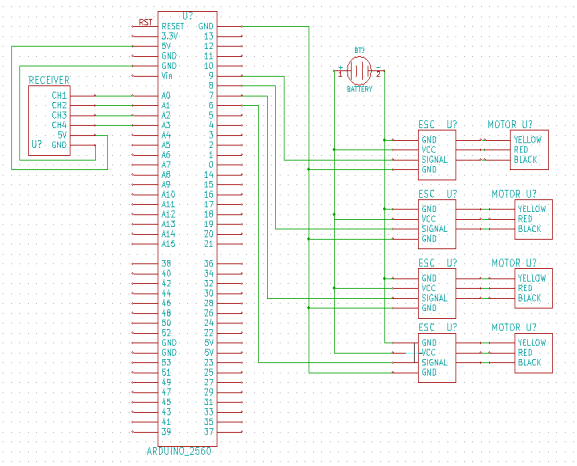

Figure 14: Circuit diagram of the project.

Figure 14 shows the circuit diagram of the project. The arduino mega is used as microcontroller to execute the instruction from the transmitter. All the pins in the receiver are connected to analog pin in the arduino mega.

IV. RESULT AND DISCUSION

Figure 15 below shows the wiring of quadcopter based on the schematics. Every part of the motor are connected to the ESC and ESC will connected to the LiPo battery to receive the supply. The connection of ESC which is ground and Vin are connected to the one pins which is why the veriboard is used. There are two pins from ESC which is ground and Vin go to the veriboard. The ground and Vin pin in the verilog goes to the arduino mega. The receiver will also connect to the arduino based on the schematics.

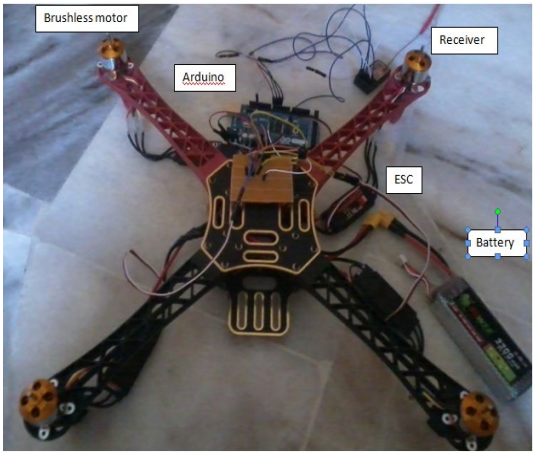

Figure 15: The wiring quadcopter

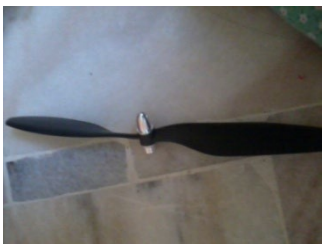

Figure 16: The propeller

The propeller in figure 16 will attach to the top of the motor. This step will go lastly after completed the run the coding to make sure that the propeller not broken and also for safety reasons.

Before start flying, ESC need to calibrate as it responsible for spinning the motor at the speed requested by the flight controller. Usually most ESCs need to be calibrating in order to know the minimum and maximum pwm values that the flight controller will send. To start the calibration make sure there is propeller attach to motor and there is no connection to the computer. Turn on the transmitter and set the throttle to maximum and also connect the LiPo battery to the ESC. While the transmitter throttle stick still high, disconnect the LiPo battery and reconnect back. Esc will emit the tone which the numbers of beeps represent the battery cell count and then as additional two beeps to indicate that the maximum throttle has been captured. Pull the transmitter throttle stick down to its minimum setting then the ESC will emit a long tone that shows a minimum throttle has been captured. There will be a long tone indicating a calibration is successful. To return to

the regular flight mode put the throttle low and disconnect and reconnect the battery back.

In order to stabilize the quadcopter during flying, the transmitters need to be controlled properly. The figure 17 shows take off movement which is a quadcopter lift from ground. Take off motion is control by increasing speed of four rotor simultaneously. The landing motion is the opposite of take off motion by decreasing the speed as shown in figure 18.

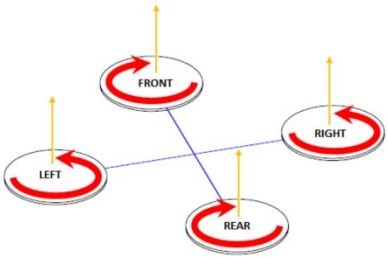

Figure 17: Take off motion.

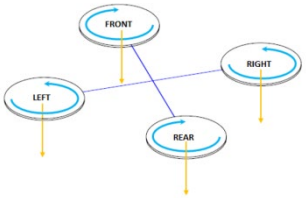

Figure 18: Landing motion

Figure 19 and figure 20 shows for forward and backward movement in the quadcopter. The forward motion is control by increasing speed of rear motor. The pitch angle of the quadcopter is affected due to thhe decreasing rear of the rotor. The backward movement is the opposite to the forward movement.

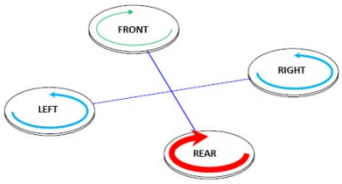

Figure 19: Forward motion

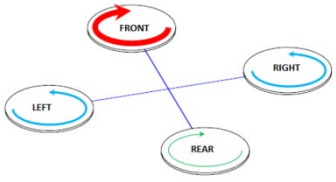

Figure 20: Backward motion

Figure 21 and figure 22 shows the right and left motion. The right motion is control by changging the yaw angle of quadcopter. The counter clockwise rotor speed need to increase to control the yaw angle while the clockwise retor speed is decreasing. The opposite speed of rotor will cause the movement to the left of th quadcopter.

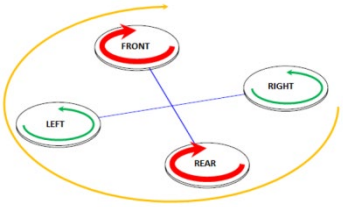

Figure 21: Right motion

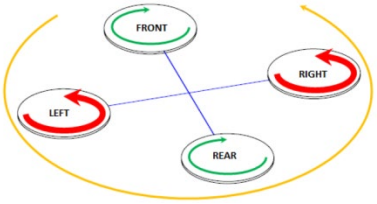

Figure 22:Left motion

V. CONCLUSION

A simple and cheap quadcopter is presented in this article. It is observed from the basic quadcopter on how it move theoretically and to the making of quadcopter. Every each of the part in the quadcopter give a big effect on the stabilization of quadcopter and making it fly as every part of the component play the important role. The purpose of this project is to make a cheap, simple and easy quadcopter aircraft. There are many application can be added through this project such as camera, GPS, sensor and many more but the cost of it will be much expensive.

VI. RECOMMENDATION

The objective of the project is to be simple, easy and cheap quadcopter but there are many applications can be added to make a quadcopter have more functions instead of just flying around such as having a sensor. A sensor is used to avoid any difficulties of quadcopter during flying. It will avoid a tree or wall or any movement so that the quadcopter does not crashed easily sensor typically used is rangefinders sensor which have a function to verify the distance and make sure the quadcopter does not crash during flight and landing. System GPS can be also added during the programming since the misprocessed used is arduino mega able to support. Besides that, a camera also can be added but the quadcopter must have the stability enough so that the camera can be function well.

VII. REFERENCES

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