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Implementation of Aerial Cargo Transporter

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Abstract— *The research aims at finding a helpful application for quadcopters and we have brought a new way to transport light weight cargo fast and simple. The system called Aerial Cargo Transporter will deliver any light weight cargo from source to destination automatically with less time with the help of quadcopters.*
This paper will discuss all the processes that this system goes through to make its purpose possible. Other topics include the advantages comparing with traditional delivery methods and disadvantages this system will face. But the applications of drones won't end here and will further explain the future scope and modification that will make this idea better

Keywords—*Quadcopter; PID; multirotor; GPS; PWM;*

I. INTRODUCTION

A quadcopter is a four-rotor flying machine that can easily navigate in air. We can exploit its easy navigation capability and compactness to our advantage. The Aerial Cargo Transporter is a new idea of transporting cargo, mail and anything else that fits in a quadcopter from one place to another. This new technology would bring a great change in the way things would be sent and received. It basically uses a quad copter that will carry the intended object from one place to another. The Quad copter will fly navigate itself to the destination without human intervention. This system would be fully automatic and will reduce human effort greatly [1]. The most important points which make this system stand out like advantages and efficiency of the system will be elaborated in the upcoming chapters.

II. LITERATURE SURVEY

Nowadays we have the delivery man method of delivering consignments to customer door steps. This method may seem very cost effective comparing with drone delivery because the weight that a truck can carry is significantly far more than a drone can carry. So, for transportation of goods in bulk is still cheap for delivering consignments to customer door steps. This method may seem very cost effective comparing with drone delivery because the weight that a truck can carry is significantly far more than a drone can carry. So, for transportation of goods in bulk is still cheap in this case. But as online shopping has gained a large amount of popularity in recent years most of the items that a customer orders are less than 3 kg. Considering the global E-Commerce giant amazon.com 86 percent of its packages are under 2.6 Kg. So, considering these facts it's clear that using a drone for delivery will be very well helpful [5].

The person who is intended to receive the consignment will only receive it with the help of an OTP making the delivery system more secure. All this system is monitored in real time to get effective feedback on the system performance. We have implemented this idea of using quadcopters for delivery purpose based upon the facts mentioned before and added some extra features to make it more reliable and fast. Also, considering the American mall Walmart most of its customers live just below 2.6 km of the mall.

III. PROPOSED SYSTEM

The entire system is controlled from a control centre situated at the warehouse of the company which is deploying the system. The control centre monitors the quadcopter in real time about its performance. The system works by first inputting the location to which the cargo has to be delivered through Bluetooth interface. This is fed into the system by the staff at the control centre based on the order received from the customer. This system is only used if the net weight of the order is less than 3 Kg [3]. The cargo is loaded into the quadcopter. After loading the cargo, the control centre initiates the start sequence by pressing start button. The quadcopter flies to that location where the delivery should be made with the help of GPS. At the same time an SMS message is sent to the customer which contains information like estimated time of delivery. When the quadcopter reaches its destination, the quadcopter notifies the control centre that it has reached its destination. At that time an OTP is generated and sent to the customer. The customer can pick up the consignment by entering the OTP provided. When the OTP is verified with the control centre the cargo box lock will be released and customer can pick up their ordered item. This also notifies the system that the delivery has been successfully

made. Now the quadcopter flies back to its starting point. Once it reaches the starting point i.e. the warehouse the quadcopter is inspected for any damages. The quadcopter will be ready to deliver another consignment after this inspection and battery recharge. The system is also equipped with obstacle avoidance system which helps the quad copter to stay safe in air during flight. This helps the entire system to stay safe from birds and other obstacles when airborne [4].

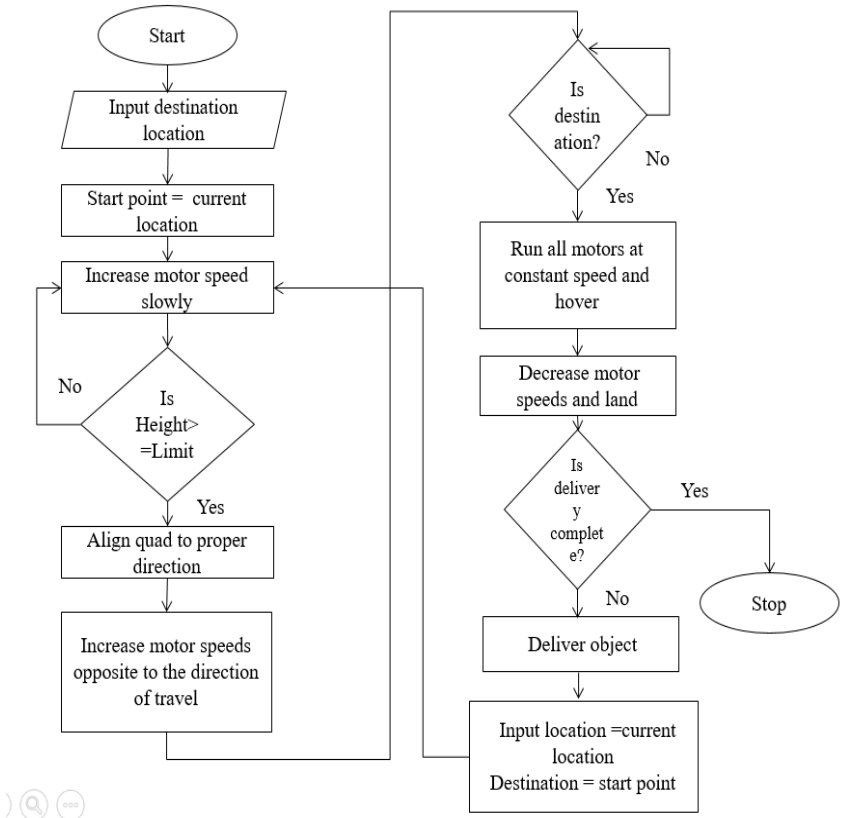
When this system becomes widely used it may come under air traffic control. This is because a large number of aerial cargo transporters will be in use. There is a chance of these quadcopter being a threat for other aerial vehicles such as aircrafts.

3.1. Flow Chart

As we have already discussed the system starts by giving start command and entering the destination location. Now the system sets the current location as its starting point. This will be the place where all delivery operations are initiated. Now the system increases motor speeds slowly and increase height. Now the quadcopter aligns itself to the required direction using the sensors. At all times the PID controller will be functional and stabilizing the quadcopter constantly. Now the quadcopter is ready to travel. It increases the motor speeds accordingly so as to travel in that direction. Now GPS location information is checked to see if destination has arrived. The quadcopter keeps travelling until destination is reached.

When destination is reached it first hovers over that location and then decreases the motor speeds equally and land the system. When the system has landed the person, who requested for the consignment can it and give received command by entering the OTP when that person ordered the item. If the OTP matches the quadcopter will unlock the consignment from the quadcopter.

Fig.1 Flow Chart



Now the system starts its return journey. The previous steps from start is now repeated this time and lands at initial point.

IV. HARDWARE IMPLEMENTATION

The system consists of mainly 8 components. The brain of our system is the STM32F100RB microcontroller. It controls all other components. The system starts by inputting the GPS location where the cargo has to be transported. To input the location a Bluetooth interface is used to enter data serially. It can also be used to start the whole system and give special commands. The quadcopter is propelled up by 4 brushless DC(BLDC) motors running at a maximum of 1000 rpm. These motors are controlled by an electronic speed controller (ESC). The ESC produces a three-phase supply

based upon the Pulse width modulated wave produces by the microcontroller. The whole system is powered by a 12V 3600mAH battery. But all components do not run at 12V. For this we also have a voltage regulator circuitry.

After the quadcopter, can hover in the air it needs to navigate. For this we used a u-box GPS module. This allows the system to have an accuracy location of 3 meters. Navigation also requires in finding the north direction. For this an HMC5883 sensor is used as the compass. We also require a balancing algorithm so that the system can stabilize itself in mid-air. For this a PID controller is required. The PID controller works by taking input from an accelerometer and gyroscope which is in our case is the MPU6050.

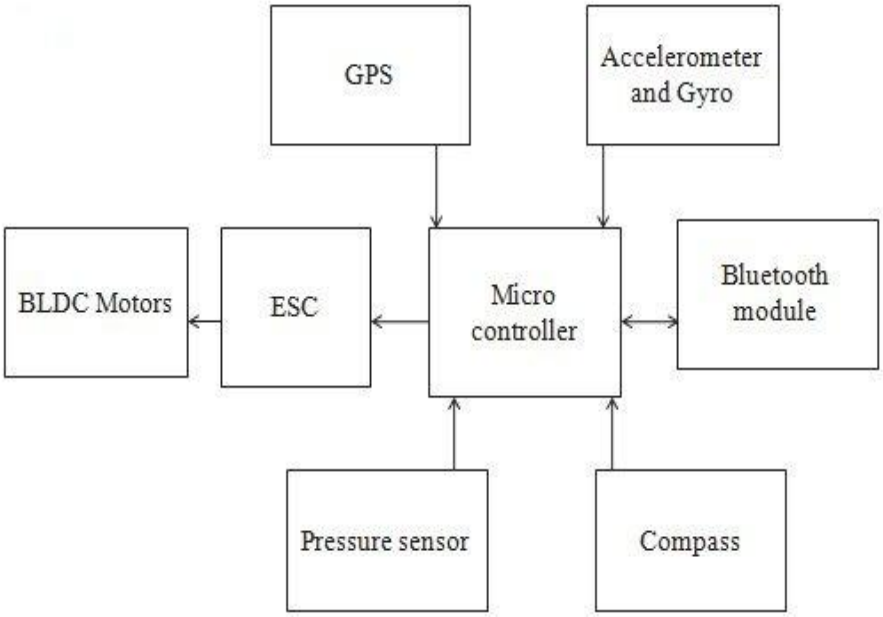


Fig.2 Block Diagram

We will further discuss about PID controllers in the upcoming section. These sensors are used to find the pitch and roll of the system. The aerial cargo transport also needs to fly at a safe height so that it won't collide with obstacles. We can solve this problem by using a barometric pressure sensor. The BMP180 was a good choice. This sensor finds height by the principle that as height increases the atmospheric pressure decreases. All these components work hand in hand to make the system work [2].

4.1 PID Controller

A PID controller is a software program that help the aerial cargo delivery system to balance itself in the air. To balance the system, we need to constantly check the tilt of the system.

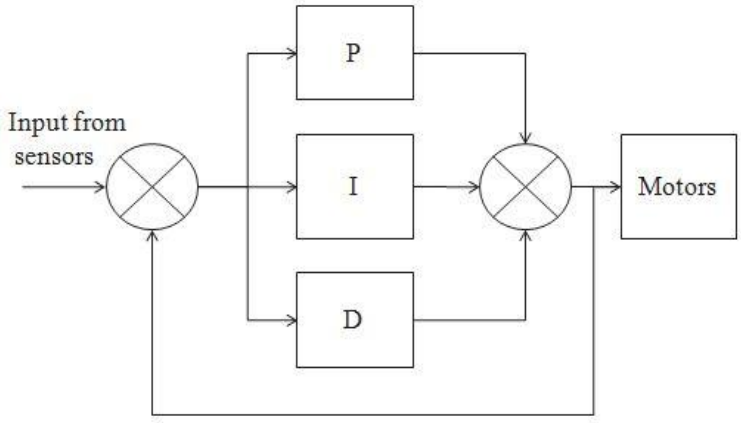


Fig. 3 PID Controller

We already discussed about tilt measurement using gyroscope and accelerometer. The quadcopter has to realign itself if a tilt is found. This is by changing motors speeds according to which direction the quadcopter has tilt. Basically, we are finding the pitch and the roll of the system. This is why we need a PID controller. These blocks are a part of a complex control system represented by equations given below. The error is the difference between the tilt of the system

and the balancing position represented by e(t). Each block requires its own tuning constant. This would vary with respect to size and shape of quadcopter and application.

"P" stands for proportional. The proportional part handles the current error or change in tilt with respect to the normal position which is the zero pitch and roll position.

$$P = Kp.e(t) \quad (1)$$

The "I" stands for integral part. This part handles the accumulated errors in the past. This is because the proportional part can itself deviate.

$$I = Ki \int_0^t e\,(T)dT \quad (2)$$

Finally, we have the derivative part indicated as "D". The derivative part predicts Future errors based on current change in error.

$$D = Kd\ (de(t))/dt \quad (3)$$

V. RESULTS

The system works well when in normal conditions. The GPS system used has an accuracy of 3 meters but more accuracy can be attained by using better GPS system on the quadcopter. The system also showed a battery life of 20 minutes. This can be further increased by using higher capacity battery. The system cannot pick up more than 2 Kg of weight at this stage but making the system bigger is an option. It has lesser performance at windy and harsh conditions

Overall the system worked as expected. The consignments are safe because of the inbuilt locking mechanism and the GPS which allowed tracking of system even if it was stolen.

VI. CONCLUSION

We have successfully developed a drone based aerial cargo transporter. The system does its job well. Further research on this topic will make this system more accurate and reliable. We could also include an obstacle avoidance system to avoid birds hitting to the aerial cargo transporter. The operation of the system was very good and this could be the next generation delivery method. The application of this system does not limit to E-commerce but can also be used in other transportation such as mail delivery, Transportation within an a very big organization.

VII. FUTURE SCOPE

As future scope the quad copter can be made available for flight during severe weather conditions like thunderstorms and hailstorms. By using the weather forecast from several agencies the quad copter can either terminate the current flight and return back to the warehouse or choose an alternative path to avoid the bad weather. In order to increase the performance more advanced motors can be used. Also, we can consider about using a powerful light weight engine to power up the quad copter hence increasing its flight time and payload capacity

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