UAV Used for Payload Carrier System

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Abstract— This paper presents an approach for a self-navigating quad copter stabilization using PID controller which is used for product delivery purpose using robotic arm. It can greatly reduce the labour in commercial purpose. The UAV is capable of sustained without a human operator on board which can be controlled by autonomously. In this active world, the product does not reach the consumer in time due to some bad infrastructure (such as, traffic). In order to rectify the drawback here the UAV is used for delivery purpose. It can also deliver the consumer product even to the urban areas setting without against any type of infrastructure. After the delivery process is successfully completed. The UAV is return back to its starting place.

Key words: Self Navigation, return to Origin, Barometer based Altitude hold, GPS, Wireless, Arduino Nano

I. INTRODUCTION

Quad copter also usually known as drone or Unmanned Aerial Vehicle (UAV) is either an autonomous or remote controlled aerial flying vehicle without a human on board. Quad copters have the VTOL (Vertical Take Off landing) characteristic unlike the other conventional flying objects or the Unmanned Aerial Vehicles which allows hovering at a particular point. They are highly suitable for environments (i.e. indoor or congested environment) where human access is at difficult situation. Quad copters are 6 degree of freedom unmanned air vehicles (UAVs) which generally use 4 rotary blades for propulsion. Compared to other UAVs, quad copter have the advantage of increased stability while hovering (in comparison to controlled helicopters) and manoeuvre ability in close quarters or tight turns. The main focus of this paper is to design payload carrier system by using autonomous robotic arm which can carry the load. The formulation of this design is inspired by the concept application of a quad copter by Amazon as a product-delivery system. The aim of this project is to develop a real-time system for detecting and tracking the specific place and delivering the specific object and in this regard, the PID controller using sensors data and robotic arm using object detecting sensors is designed. Quad copter routing decisions would always be dynamic, meaning an intelligent network would redistribute all resources in real-time, depending on the load and urgency of certain shipments. When an assignment for emergency transport comes in (e.g., time-critical delivery of blood from a blood bank), this is prioritized. This system would use GPS data for shipping the good from logistic company to destination.

The paper is divided into several sections. Section II represents the related works done regarding quad copters, section III describes about a flight dynamics, section IV gives the concept of its control system. Section V demonstrates about the sensors for balancing and tracking and also deals with wireless transmission. Section VI presents the design of autonomous robotic arm and Section VII represents the experiment and results obtained and finally the conclusion and future work is given in Section VIII.

II. REALATED WORK

Drones came into first use after World War II when unmanned jets, such as the Ryan Firebee started field operation. The quad copter concept started as early as the 20th century and the earliest work were started by George DeBothezat and Etienne Oemichen . Their work failed due to lack of proper lifting power, instability, unresponsive and susceptibility to reliability issues. After putting efforts in recalculations and redesigning, the mentioned issues were overcome. Until the mid-1950s the quad copter designs done by Marc Adam got into its true shape and structure which was also the first quad copter designed to have flown forward successfully. Many hobbyists also give contribution to the designing of quad copter. Some of the successful work found are Arducopter, KK Multicopter, MultiWii, Microkopter, DJI Naza Lite and other various Open Source Projects. Early quad copters would typically have the engine sitting somewhere centrally in the fuselage of the copter, driving the 4 rotors via belts or shafts. Belts and shafts however are heavy and importantly, subject to breakage. As the 4 rotors of a quad copter are all slightly different from each other, a quad copter is not naturally stable, simply running 4 rotors at the same speed, while producing enough lift to hover the copter, does not produce stable flight. On the contrary, quad copters have to be constantly stabilized. In the absence of computers, this meant a monumental workload for the pilot. As a result, multicopter designs were abandoned in favor of single, or on rare occasions for very large transport helicopters, double rotor designs. With the advent of electric motors and especially microelectronics and micromechanical devices, a few years ago it became possible to build reliable and efficient multirotors. Modern multicopters have an electric motor mated to each rotor, sitting directly below or above it. A flight computer constantly monitors the orientation of the copter and corrects for instability by changing not the pitch of the rotors but simply the rpm of the individual motors/rotors. This fixed pitch design is much simpler than the complex swash plate mechanics that are required for single rotor helicopters. This design has proven to be hugely successful and most modern VTOL drones and hobby aircraft are now multicopters rather than single copters. The scaling up of this to aircraft that are able to carry people has only just begun and Krossblade is part of this development.

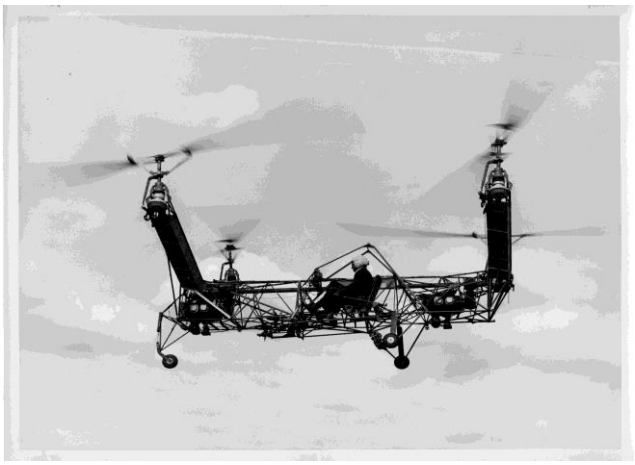

Fig. 1: Convertawing Test Quad rotor, March 1956

III. QUADCOPTER DESCRIPTION

Quad copters use four motors with four propellers to create thrust to give the aircraft lift. Two of the motors rotate counter clockwise and the other two rotate clockwise. This configuration causes the torque from each motor to cancel by the corresponding motor rotating the opposite direction

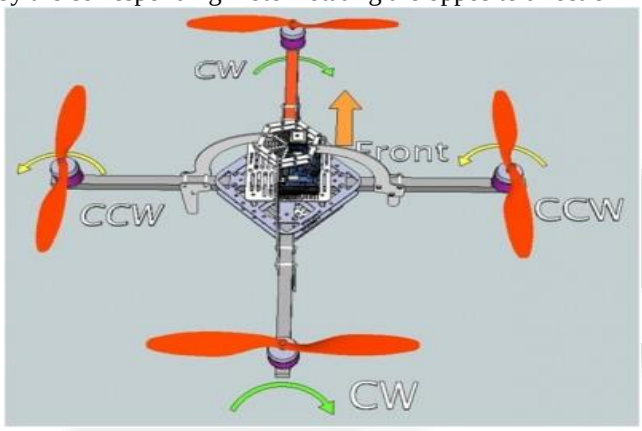

Fig. 2: Quad copter motor configuration

What is very different about quad copters from other vertical takeoff and landing aircraft (VTOL) is that in order to control pitch, yaw, and roll the pilot uses variable thrust between the four motors. We use fiber plastic body which have four rod of equal length for holding motors and in our project.

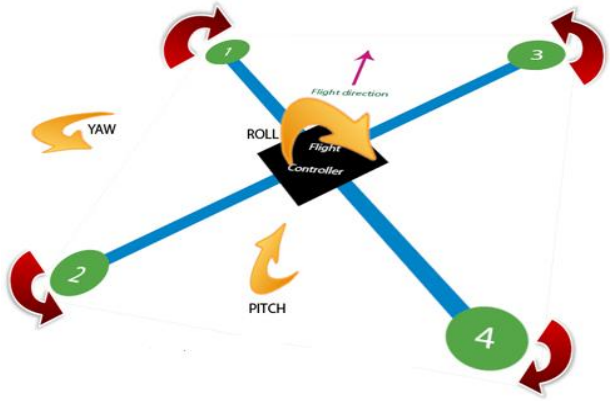

Fig. 3: Flight Dynamics

To achieve the desired autonomy, first and foremost a stable flight needs to be attained. The symmetrical design of the quad copter also allows an easy control in stabilizing the flight. To manipulate the thrust exerted by the motors, controllers are required which can be done by using a microcontroller. An electronic device called Inertial Measurement unit (IMU) is used which includes combination of the sensors– accelerometer, gyroscope and a barometer sensor. An IMU is used to determine the angular rotation as well as the linear acceleration of data that are given as input to a microcontroller. Each of these sensor devices can determine 3 axes of coordinates (x, y and z). For instance, combination of accelerometer and gyroscope will give number of different independent parameters that describe the state or configuration of the system which is called 6 Degrees of Freedom (6 DoF). A gyroscope is commonly used in quad copter control boards as it gives the angular rate around the 3 axes of space and to get the orientation of pitch and roll, a 3-axis accelerometer can be used.

IV. FLIGHT SYSTEM AND FLIGHT CONTROL SYSTEM

Quad copters propeller's having various dimension depends on thrust and weight it can carry. Each propeller is attached to the motors. The motors are chosen depending on the weight of the quad copter. motors capacity can be calculated by turns per volt and it is specifying by kV rating. The thrust that each motor will exert can be determined by the rule.

General rule of thumb is

Required Thrust per motor = (AUW x 2) / 4 (1)

Power is supplied by high capacity lightweight Lithium-Polymer batteries. They can supply high amount of current in short time which is required by the motors for the lift. Microcontroller which has at least 4 digital input/output pulse width modulation (PWM) is essential for the quad copter controlling. This microcontroller is connected to the motors through electronic speed controller (ESC). The microcontroller should also have an interface like Inter-Integrated Circuit (I2C) to connect to the IMU device so that the numbers of ports necessary to attach multiple sensor devices are reduced. Accelerometer is required to sense the orientation, position and velocity. Gyroscope utilizes angular momentum to determine orientation and change of direction. When the 3-axis accelerometer is combined with a 3-axis gyroscope, an output have maximum accuracy so that it's data is useful for better controlling of quad copter .We use DJI NAZA M-lite flight controller to control the quad copter as it have more accuracy and it is easy to use. Proposed designed block diagram as follows:

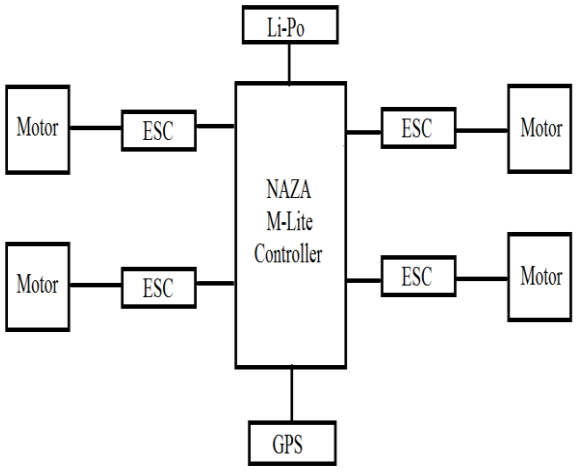

Fig. 4: Block diagram of proposed system

The NAZA M-Lite controller have accelerometer, gyroscope and barometer sensors are interface with controller. GPS sensor is added on interface to the controller.

V. SENSORS AND WIRELESS TRANSMISSION

The stability of a quad copter flight is induced by using PID controller which enables a feedback loop mechanism. This mechanism gives back the resulted output as input causing a loop. It can help in overcoming disturbances, uncertainties in model, reducing sensitivity to parameter variations and hence improve stability. This PID controller works on data of sensors like gyroscope, accelerometer. To generate the lift, each of the four motors requires exerting the same thrust simultaneously which also depends on the external factors such as wind in order to attain the stability of the lift. The IMU obtains the values acquired by the sensors – accelerometer and gyroscope and thus in turn provide the feedback to the PID. To obtain the process equilibrium of the lift and then maintain the balance, the weighted sum of these three Proportional, Integral and Differential values is used to minimize the error. By using PID we can balance the quad copter. Controller also have barometer sensor to get the altitude data to lock the quad copter up to certain altitude.

Also for achieving specific target tracking system is required. This need of system can be fulfilled by using GPS sensor. GPS sensor is GPS receiver also known as GPS navigation device. A GPS navigation device is a device that accurately calculates geographical location by receiving information from GPS satellites. GPS satellites continuously transmit their current time and position. A GPS receiver monitors multiple satellites and determines the exact position of the receiver and its deviation from true time.
To control quad copter manually or autonomously it needs wireless transmission system. Transmitter, receiver and antenna are the basic parts of the transmission system .In this project we use 2.4GHz radio channel transmitter/receiver system for the communication with the quad copter controller.

VI. PAYLOAD CARRIER SYSTEM

The Payload carrier system consist of robotic arm which will be used to pick up and drop the object which is to be deliver from source to destination. The idea of attaching robotic arm to quad copter is based upon the amazon delivery drone. Robotic arm is developed so as to its can pick and drop the object of any shape and any size with some weight limitations. We can also move the arm in many directions so it cannot be restricted to particular plane of motion. We used robotic arm in our payload carrier system as it doesn't required any special system or surface to pick up the object.

Robotic arm is made up from mechanical links which are controlled by electronic components. The mechanical links are made up from aluminium sheets which 2.5mm thickness to provide strength and stiffness. Special aluminium sheets are used because of its low weight which is main requirement of the system. To control this arm we used arduino Nano board as a controller because of its low weight and ease of access. For the movement of arm servo motors are used. Micro gripper is used for holding the object, which is made up from aluminium sheet which will work as gripping mechanism and gear assembly is used for aligning the gripping mechanism. The main requirement of arm designing is to make arm as much as flexible so as to its movement does not affect the stabilisation of the flying quad copter. Payload carrier system is autonomous as it senses the object and controller take the action with respect to the data of the sensor.

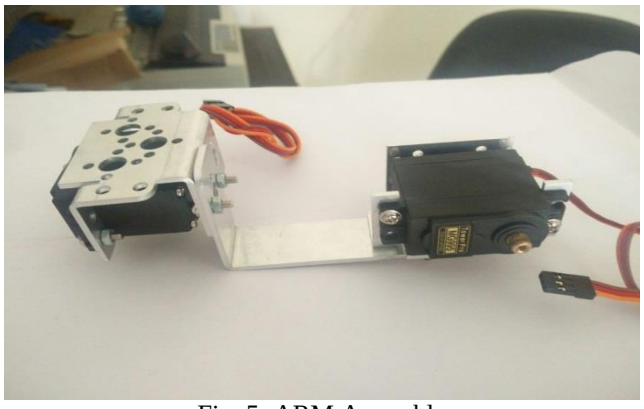

Fig. 5: ARM Assembly

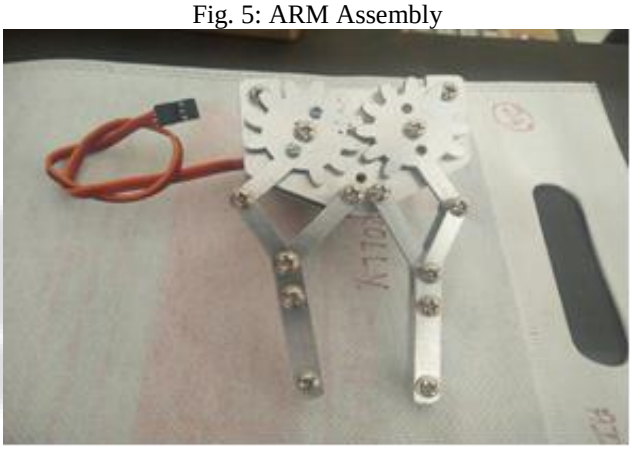

Fig. 6: ARM Assembly

VII. RESULT

Arduino Nano is used as controller for controlling Arm so its program output is as follows

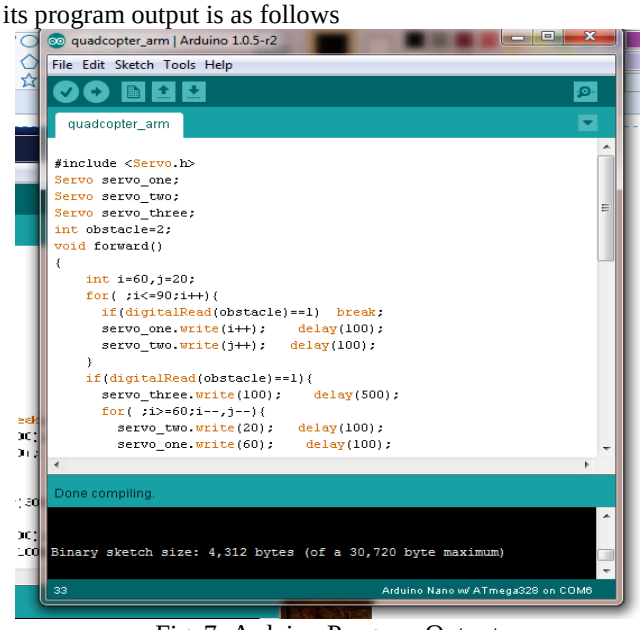

Fig. 7: Arduino Program Output

Fig. 8: Final Design of system

VIII. CONCLUSION

The goal of this project was to develop a system able to pick and drop the object by the use of a robotic arm which is attach to the UAV. The system developed is robust and reliable systems able of conducting both pick and drop operations. Quad copter is used in this system as a transporting vehicle which take much less time and expenses compare to all other carriers systems. We can make this system autonomous by using GPS navigating system. This paper can provide many opportunities for designing much accurate and more flexible payload carrier system. Quad copter is a future approach for many things which require time bounded services. By using arm as object carrier system can pick the object of any type and size so in future we can expand its movement and can be used in various tasks and applications.

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