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Embedded System based Quadcopter using Ardupilot

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Abstract:- The main aim of our project is to build a fully autonomous Drone that is capable of transporting boxes of a particular weight and size from one place to another. Our project focuses on reducing human efforts for controlling an Unmanned Aerial Vehicle(UAV).We have first developed and deployed our application in a simulator and then we made the Hardware which fulfils our Requirements, this is to make the most efficient use of our development time and effort.We have developed certain python algorithms which can control the whole drone and accurately processing location of the box to grab it accurately.

Keywords:- *Machine Learning,Image Processing, PX4, Gazebo Setup, Power Management Board,ArduPilot, Global Position System, Telemetry Radios.*

I. INTRODUCTION

This Droneare a part large and active area of engineering, research,development, and deployment.UAV'S also colloquially called drones are self-powered flying vehicles without a human pilot onboard, they may have varying degrees of autonomy from fully autonomous to fully controlled by an offboard human pilot.Currently All Drones available in market are remote controlled with no or very less autonomous functionality.Drones are emerging as new helping hand for the common people, companies, government organisations, etc. As they offer multiple use cases and thus can be used in different scenarios.Our application focuses on the Automatic Delivery of Packages safely to the person in need.As we see that the building of drones in today's era is very common. But we are creating a drone which can automatically scan the box, grab it and drop it at the required location. For solving the problem, we used Ubuntu 20.04 LTS as an operating system, PX4 Autopilot ecosystem for controlling the UAV, Gazebo simulator, a robotics simulator, where the simulated environment and UAV's will reside, and ROS (Robot Operating System) for integrating various aspects of autonomy required in the solution.This paper proposes a complete idea and its implementation which is Automatic Delivery of Packages(boxes) via Droneto desired location without much human interference.Our Research Paper will conclude the way we implemented such a solution.This Quadcopter could be upgraded with some modification in design to provide more flight time at same or less cost.This Reduces human effort and saves a lot of time which results in development of the company or any organization using it.

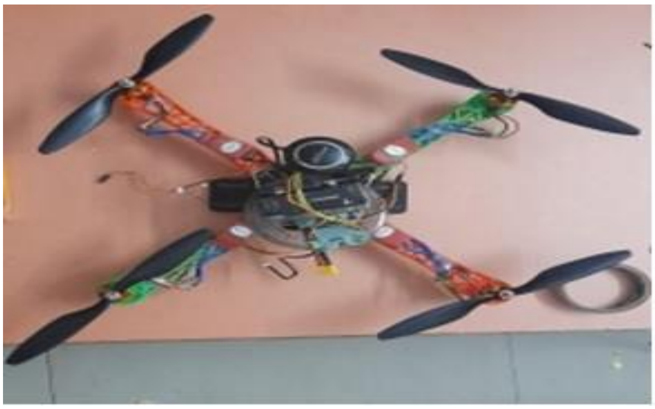

Fig. 1: Embedded System based Quadcopter

II. METHODOLOGY

As we see that the building of drones in today's area is very common, even-though everyonehas a skill to make a drone very efficiently. But we are creating a drone which can automatically scan the box (which must be picked up) and drop it at the required location. For this we use, Ubuntu 20.04 LTS as an operating system, ROS Noetic, PX4, Gazebo as the software and autopilot, power module, board with ESC, motors, propellers, battery, gripper, carbon fibre frame, fully APM and the camera as the hardware requirement.

OpenCV: OpenCV is an open-source programming library for pc vision and AI.OpenCV. was made to give a common foundation to application for pc vision and to accelerate fo machine insight in shopper items. OpenCV, as a BSD-authorized programming, simplifies it for organizations to utilize and change thecode. There are some predefined bundles and libraries the simplify our life and OpenCV is one of them. For Image acknowledgment, we will utilize a python library called OpenCV. OpenCV is a BSD-authorized library. We can think of OpenCV as the basic framework of Human Sight system (eyes + brain) which see the environment and then analyse its position in it with respect to a certain object [1], [4].

III. SOFTWARE

A. Identification of Boxes:

OpenCV is an open-source programming library for pc vision and AI. OpenCV was made to give a common foundation to application for pc vision and to accelerate for machine insight in shopper items. OpenCV, as a BSD-authorized programming, simplifies it for organizations to utilize and changethe code. There are some predefined bundles and libraries the simplify our life and OpenCV is one of them. For Image acknowledgment, we will utilize a python library called OpenCV. OpenCV is a BSD-authorized

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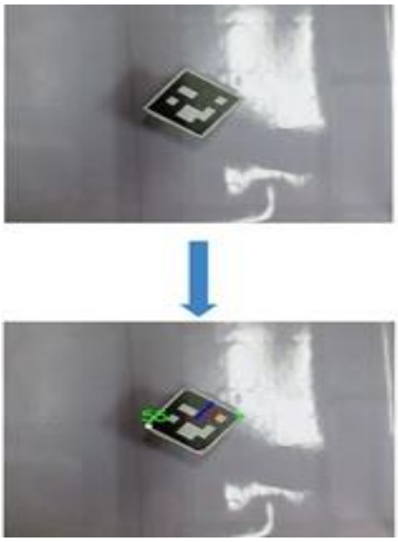


Fig. 2: Anti-Clockwise direction [6]

ArUco is an easy-to-use Python library for detection of ArUco markers. To know about the library functions of ArUcoWith this we can easily detect angle, orientation, size and via programming can feed desired details associated with particularid like address,other information related to delivery plan.ArUco Marker is showing Fig. 3 [5], [6].

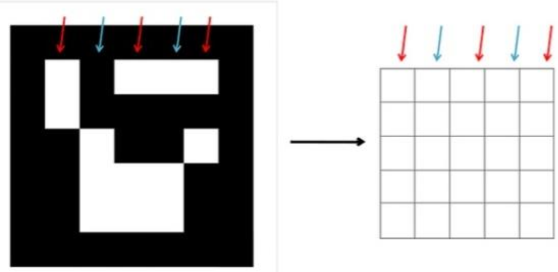


Fig. 3: ArUco Marker [5]

B. Software Block Diagram:

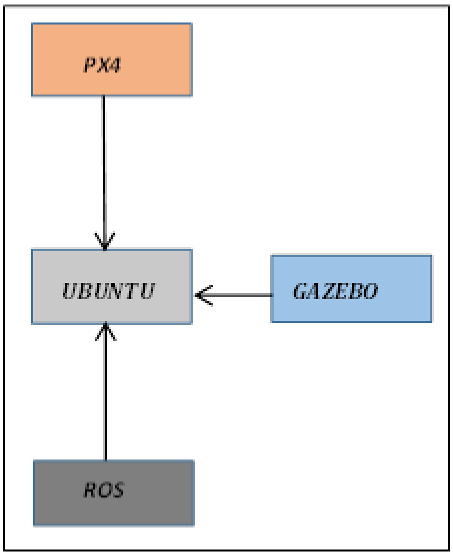


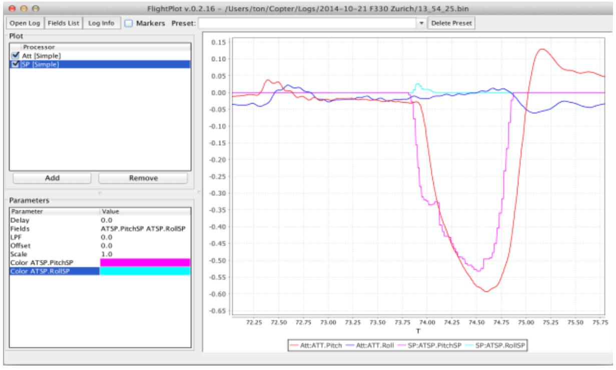
Fig. 4: Software Block Diagram.

This Research Paper we are covered both section so that in this software section we covered operating system like Ubuntu, this operating system is most power full and fully secure. In This operating system we covered my software which is help full crating the code. The software name is ROS, Gazebo, PX4[3],[4].So, we have integrated Gazebo with PX4,MAVlink,QgroundControl. QGC is the GUI. It is providing setup and control part. QGC have been created to fly for many vehicles like copter. In this Research Paper we are used QGC because QGC support ArduPilot and QGC provides flight controller ArduPilot Powered Vehicles [5].

C. Picking and Placing in Gazebo Environment:

First, choose a frame of the vehicle – In this case, we use the QuadcopterSecond, choose a flight controller – In this case, we choose the ArduPilot autopilot.Third, configuration of the vehicle – In this case, we use the QgroundControlfor configuration. Now, we have a drone and a box in the gazeboworld. We need to put the drone in the Offboard mode and publish the position of the drone as setpoints.After that We have Complete Following Points The gazebo world consists of a drone and a box with ArUco marker on it.You have to put the drone in Offboard mode and publish the positions of the drone as setpoints. The drone needs to do the following:

- Take-off at the initial position to the height of 3m
- Start moving towards the final setpoint 9m 0m 3m
- While travelling scan for the strawberry box with ArUco marker. As soon as the drone reaches above the box, land on it and pick up the box.
- Again, take-off to the height of 3m and continue to move towards 9m 0m 3m
- Land at 9m 0m 0m and drop the box
- Take-off again to height of 3m
- Head back to the start position ie 0m 0m 3m
- Finally land the drone at 0m 0m0m and then disarm[6].



FlightPlot v.0.2.16 – /Users/ton/Copter/Logs/2014-10-21 F330 Zurich/13_54_25.bin

Open Log | Fields List | Log Info | □ Markers | Preset: | Delete Preset

Plot

Processor
☑ Att [Simple]
☑ SP [Simple]

Add | Remove

Parameters

Parameter	Value
Delay	0.0
Fields	ATSP.PitchSP ATSP.RollSP
LPF	0.0
Offset	0.0
Scale	1.0
Color ATSP.PitchSP	🟪
Color ATSP.RollSP	🟦

Fig. 5: Complete all the following points

After landing on the box, I checked that the drone is above the box in the allowable range to pick the box. To do that, you need to subscribe to the rostopic /gripper check. If the value is true, we can now pick the box and if the value is false, the drone is not correctly placed, and you need to correct the position. If the result of gripper check is true, to pick the box, we need to call the rosservice /activate gripper and pass the value true to attach the box.

If the box is attached, we will get a result from the rosservice as true. If the result is false, which means the drone is not correctly placed over the box. To detach the box, we need to use the same rosservice /activate gripper and pass the value false. This will detach the box from the drone. Picking &Placing in Gazebo Environment is showing Fig.5.

IV. HARDWARE

A. *ArduPilot Flight Controller:*

It have a RC, SB,8,7,6,5,4,3,2,1,6,5,4,3,2,1 Pins. In this first four pins called by colour coded. This colour coded attached to the quadcopter. Similarly,It have a Power, ground, Signal Pins. This Pins is connected to Every ESC. This ESC provides to the output pins by motor number. Pins Diagram of ArduPilot Flight Controller is Showing Fig.6 [7],[10].

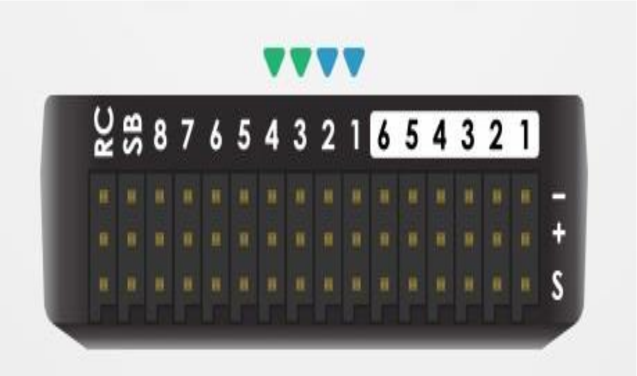


Fig. 6: ArduPilot Flight Controller [10]

B. *Motor:*

In this project we are used 1200Kv Motors. Figure7 is showing Motors Diagram and The Propeller is connected Clockwise (CW) and Counterclockwise(CCW). This Direction is Showing Fig.7 [8],[9].

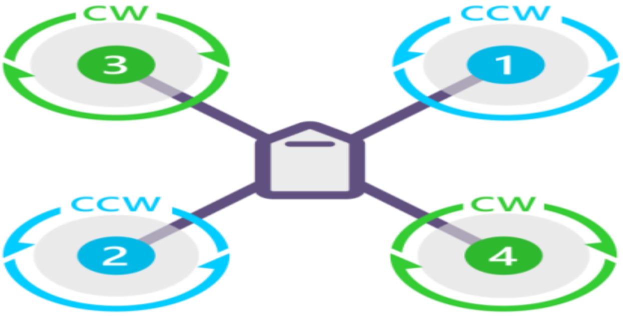


Fig. 7: Motor Direction [9]

C. *GPS:*

In This Research Paper we are used Holy Bro ArduPilot Neo-M8N GPS. This GPS have a ten pins connector This Connector used ArduPilot GPS1 Input Port [7].

D. *Telemetry Radio:*

In This Research Paper we are used Telemetry Radio. It is small platform. It has a 300m range. Telemetry Radio have a SI060 chip. There are two products. One is connected to the ArduPilot through the Wires, and another is connected to the computer through the USB cables. After that in this Computer we set the Graph using Qgroundcontrol. And upload to the Graph from the Telemetry Radio [8].

E. *Hardware Block Diagram:*

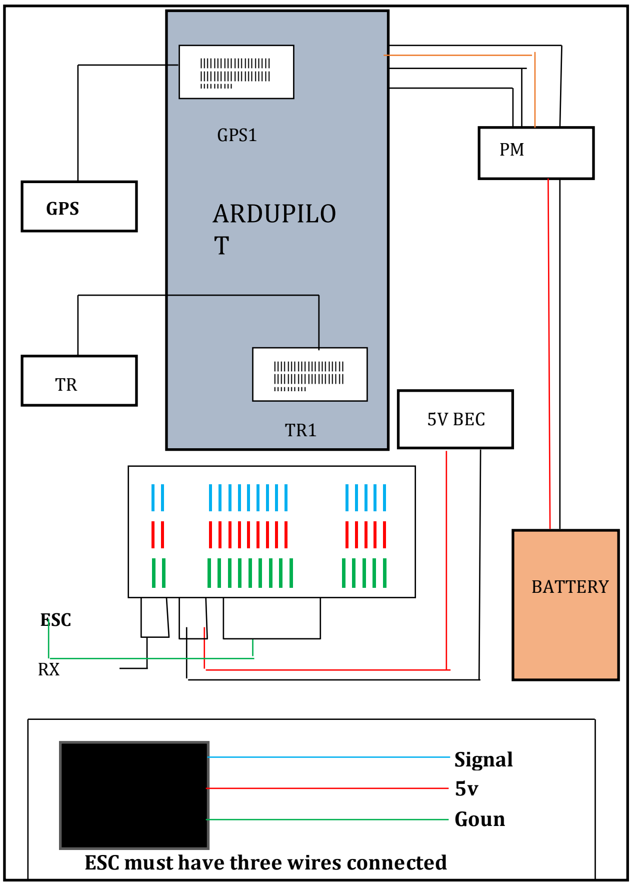


Fig. 8: Hardware Block Diagram

F. Power Management Board:

PNB is also called PDB (Power Distribution Board). It is used for providing the power to ArduPilot and ESC to the motors. PMB send the information ArduPilot, and It is also supplied to the current to the ArduPilot and Motors. After that Power ArduPilot connected to the PMB to the one the power bricks to the ASSSSrduPilot and The PMB supplied to the 12S will be connected to the Battery.After that ESC and Servo are connected to the PMB. It is showing the Fig.9 [11],[12].

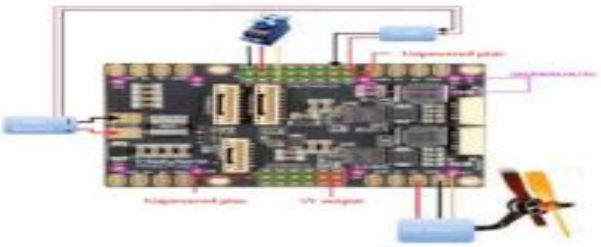


Fig. 9: Power Management Board [12]

G. Propellers:

In This Project We are implemented Quadcopter so that we are used four Propellers. This is two types: Clock wise (CW) and Counter clock wise (CCW) [7].

H. Camera:

In This Research Paper We are use Camera. Camera use for detecting the ArUco Marker and send the commend from gripper for activation [7].

I. Servo Gripper:

Servo Gripper is like a magnet. The Camera detection process have been completed after that gripper activate, attached to the box. If the box is attached so that We get the result [7].

J. Frame:

In This Research Paper We are use carbon Fiber material frame. It is so lighter and small weight. In this frame the size is 4mm.It is an X-Shaped [2].

V. RESULTANALYSIS

A Fully Autonomous Quadcopter is Developed which can help Delivery Agencies in delivering their packages without much human effort. The computing is done on the ground station, so it is easy to control and manage the drone for any modification during delivery if required. The copter can continuously work for a maximum flight time of 1hr and can carry 1kg of load. This Flight Time and load may vary according to the size of the battery and Quadcopter.

VI. CONCLUSION

In Conclusion, a Fully Autonomous Quadcopter is developed which is found to be effective in achieving accurate pickup and drop of boxes for delivery purposes and for managing the warehouses. This Reduces human effort and saves a lot of time which results in development of the company or any organization using it.

VII. FUTURE SCOPES

This Quadcopter could be upgraded with some modification in design to provide more flight time at same or less cost. And can be made to use for military, Surveillance, Disaster Management purposes with certain modifications. Industrial use is quite difficult but sooner or later it will happen.

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