

# Hexa-Copter with on board Computer Vision

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**ABSTRACT-** The paper describes hexa-copter model with both flying ability and heavy weight lifting that can bring revolution in defence sector increasing vigilance and spying capacity. It belong to the device of multi rotor with flying capacity that contains more than one rotors connected to a mechanical construction. Hexa-copter is flying devices which consist of multiple fixed rotors connected to mechanical construction. it also contains rotors attached to fixed pitch blades whose unique character is its in stability this makes the control algorithm significant as any fault in this can make the device inoperative. Here we designing a hexa-copter with appropriate mathematical models from classical newton law and making to fly without any board pilot in this design our drone is made to fly for height of 26 meters an about 15 minutes without any interruption. its also added with capability to lift the pay load 2 kg.

**KEYWORDS:** hexa-copter, rotor , pitch blade, payload Introduction

## I. INTRODUCTION

We present embedded dsign capable of autonomous flight using onboard processing for computer vision Our key contribution is a lightweight system design pattern which is capable of carrying loads and fly simultaneously for 10minutes.. Theis embedded system platform which enables full onboard processing on pixhawk allows the vehicle to be navigated fully autonomously without any external processing device..We show the validity of design with real flight results.



Fig 1: pixhawk elements

### A. INSTALLED ELEMENTS

Current hexa-copter gadget are utilizing either GPS/Inertial Navigation System (INS) route on a microcontroller or PC vision and laser extending utilizing off-board preparing for limitation and moving. Off-board handling viably makes the MAV snared in to the outer preparing unit and seriously constrains the security and activity

scope of the vehicle. furthermore , the physical remote transmission capacity confines the measure of vehicles which may work in equal. Consequently the swarm size is genuinely restricted to an extremely scarcely any vehicles. This essential constraint are frequently tended to by locally available PC vision.

As of not long ago just bigger frameworks (20 - 100 kg all-up weight) have handled pictures for vision-based restriction locally available. Our framework brings the multi-process engineering and locally available handling abilities from the 20-100 kg range to vehicles around 1 kg liftoff-weight. Rather than frameworks utilizing nearby adjustment approaches on particular microcontroller equipment (Parrot ARDrone), the framework is equipped towards worldwide restriction and self-ruling investigation of obscure situations utilizing stereo vision. The displayed beginning re-sults show that our framework devours at 30 Hz outline rate just 10 you take care the very pinnacle of CPU load (5 ms handling time for every edge) for independent marker based flight and 40-hour load (20 ms time interim for each casing) for stereo-based hindrance evasion and example acknowledgment, which leaves enough limit with regards to future work, including concurrent restriction and mapping.relatedwork

Ebb and flow MAV look into is utilizing either GPS/INS route on a microcontroller ([7], [6]) or PC vision/laser rang-ing and offboard preparing. As of not long ago, just bigger frameworks handled pictures locally available. Conte [3] et al. handled visual odometry at 4 Hz on a Yamaha RMAX helicopter UAV with more than 20 kg payload (94 kg greatest all out weight) and three .6 m distance across, however didn't utilize the yield for control . inside the MAV space past installed handling draws near ([4]) utilized straightforward optical stream mouse sensors to locally balance out the position and to attempt to basic hindrance evasion. Different methodologies utilized laser scanners and cameras however didn't process the information/picturesinstalled. The arrangement of [1] utilizes an Asctec Pelican Quadrotor with Hokuyo URG line scanner and onboard Intel ATOM processor to gather laser scan data and camera images for off-board processing. This data is shipped to an off-board notebook for processing the particular localization. The outdoor system of [7] uses an analog television camera for object tracking and GPS/INS for position control. The work of [2] et al. demonstrated visual localization employing a camera on a USB tether cable and processing on a notebook. The STARMAC quadrotor [6] features a PC104 form factor onboard computer, but doesn't utilize it for vision processing thanks to limited performance.

## **II. COMPUTER VISION FRAMEWORK**

Following the notable rule of stereo cameras, to gauge the measurement separation in 3D, two pictures with a known benchmark (separation of the camera places) are required. Along these lines the PIXHAWK quadrotor highlights an arrangement of 2x2 cameras in two stereo arrangements, pointed down.

5 cm pattern. Each of the four cameras are activated from the locally available inertial estimation unit. PC vision permits to remove both the 3D geometry of nature likewise as its surface/appearance. Along these lines various calculations are important to extricate all data of a picture, bringing about the need to convey the photos to different calculations in numerous procedures. Past methodologies ([1], [2]) didn't have the probability to run camera interface and picture handling pipelines isolated. The focal picture center point dis-tributes the consolidated pictures and IMU data to all or any associated PC vision calculations, including confinement and example acknowledgment calculations.

### *A. Vision-IMU Combination*

As the trigger system supports both monocular and stereo setups, any localization approach that uses one or two cameras can receive the vision-IMU data and process it. The attitude (roll, pitch, yaw speed) is out there as a part of the image metadata. this enables to hurry up the localization algorithms, either by providing an initial guess of the attitude or in closed form as direct contribution to the localization. just in case of the 3-point algorithm [5], the calculation steps for the triangulation are significantly simplified when substituting parts of the calculation by IMU roll and pitch, which accelerates RANSAC (see Fig. 2 for the geometric relation). For any non-global vision based localization approach IMU information can provide the gravity vector and heading as

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global reference. This property is vital when local vision information is employed as controller input.

### III. AERIAL ROBOTICS MIDDLEWARE

A few toolboxes for bigger unmanned ground, surface and air vehicles are generally used in inquire about. Miniaturized scale air vehicles with critical or complete locally available preparing are a somewhat new advancement, however. Existing toolboxes for ground mechanical autonomy incorporate ROS, CARMEN and CLARAty. The correspondence engineering fundamentally

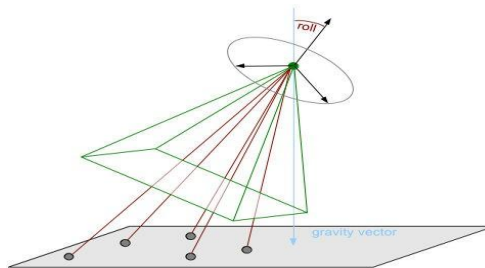
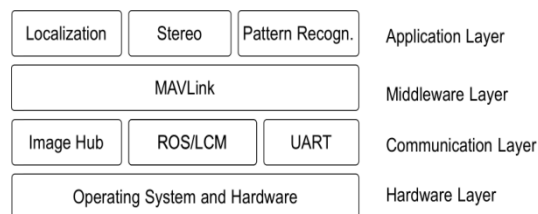


Fig 2 : scale air vehicles

squares ground mechanical toolboxes to be adjusted for little scope flying plat-structures. All toolboxes accept TCP/IP or UDP arrange joins, as IEEE 802.3 Ethernet and IEEE 802.11a/b/g/n WiFi. In any case, MAV locally available systems commonly incorporate a few gadgets associated by means of sequential connections. As these toolboxes don't downsize right to this connection type, each bundle must be transcoded by connect forms, bringing about superfluous exertion and framework multifaceted nature. Accordingly we propose a substitution commu-nication convention and engineering which will be straightforwardly utilized on various equipment



connects and limits the framework intricacy.

Fig 3 PIXHAWK Middleware Architecture Layers

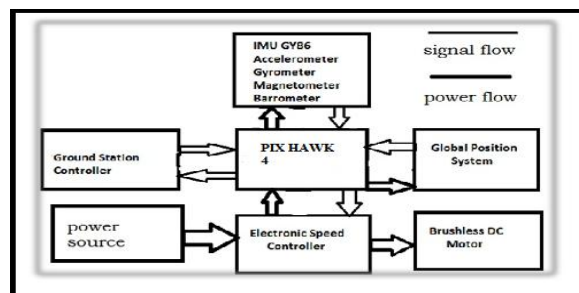


Fig : 4 block diagram

The PIXHAWK apply autonomy toolbox is predicated on a light-weight convention called MAVLink, which

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scales from sequential to UDP joins. It serves additionally as correspondence convention between flight PC (pxIMU) and locally available fundamental PC (pxCOMex/pxOvero). this is frequently additionally significant for the protected

activity of any mechanical airplane, as an individual's administrator ought to be prepared to mediate. the standard 30-100 m scope of WiFi doesn't sum up to most outside applications, which makes a correspondence engineering chopping down to radio modems likewise attractive for the off-board correspondence. As appeared in Figure 3, the PIXHAWK Linux middleware comprises of a few layers. This engineering permits to utilize the different base correspondence layers (ROS and LCM) and gives an advantageous elevated level programming interface (API) to the picture circulation server. MAVLink messages from the IMU and in this manner the correspondence framework station additionally can be legitimately gotten in any procedure.

#### A. MAVLINK PROTOCOL

Our MAVLink convention might be an extremely lightweight message marshaling convention advanced for miniaturized scale air vehicles. It has just 8 bytes overhead for each bundle, permits steering on a between framework or intra-framework level and has an inbuilt parcel drop identification. because of the low overhead, it's both appropriate for UDP and UART/radio modem transport layers. The productive encoding likewise permits to execute the convention on microcontrollers. These properties permitted assembling a ho-mogenous correspondence design over the PIXHAWK framework. MAVLink has been as of now received by assortment of different frameworks (pxIMU autopilot, ArduPilotMega autopilot, SLUGS autopilot, UDB autopilot). The MAVLink sentences are created bolstered a XML convention detail document inside the MAVLink position. The code generator guarantees very much framed messages and produces C89-good C-code for the message pressing and unloading. this empowers quick and safe expansions and changes to the correspondence convention and guarantees that no usage mistakes will happen for fresh out of the plastic new messages. Our present usage underpins the use of the lightweight correspondence marshaling library (LCM) or the Robot OS (ROS) as transport

### IV. VEHICLE DESIGN

The PIXHAWK Cheetah quadrotor configuration was worked without any preparation for installed PC vision. Alongside the business off-the-rack (COTS) engine controllers and cameras all elec-tronics and hence the mechanical edge is our hand craft. First the payload, comprising of the pxCOMEx preparing module and 4 PointGrey Firefly MV USB 2.0 cameras, was chosen. The framework plan at that point followed the needs of installed PC vision.



Fig:5: communication system

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**A. ELECTRONICS**

The installed hardware comprises of an inertial measurement unit and autopilot unit, pxIMU, and along these lines the locally available PC vision handling unit, pxCOMEx. Autopilot Unit: The pxIMU inertial estimation unit/autopilot board (Fig. 4) gives 3D direct quickening (accelerometer, ±6g), 3D precise speed (±500 deg/s), 3D attractive motion (± milligauss), air pressure (130-1030 Hectopascal (hPa)) and temperature. The installed MCU for sensor readout and sensor combination additionally as position and disposition control might be a 60 MHz ARM7 microcontroller. . it's interfaced by means of UART to the pc vision handling unit and it works at a most extreme update pace of 200-500 Hz

The preparing unit it the center bit of the framework and comprises of a two-board stack. The px-COMEx base board gives the USB and UART peripherals to interface machine vision cameras, correspondence framework and accordingly the pxIMU module. It can acknowledge any smaller scale COM express industry standard module. As of now, a Kontron etxExpress module with Intel Core 2 DUO 1.86GHz and several GB DDR3 RAM is utilized , however future update choices incorporate Intel i7 CPUs. With a load of 230 g including cooling and just 27 W top force utilization, the preparing unit are frequently effortlessly lifted by a decent scope of aeronautical frameworks, not constrained to the quadrotor exhibited here

Fig 6: pixhawk circuit board

**A.MECHANICAL STRUCTURE AND FLIGHT TIME**

Our custom mechanical structure viably ensures the installed preparing module just in the event of a framework crash and hence the fixed mounting of the four cameras permits between camera and camera-IMU alignment. since the handling board and 4 cameras speak to a similarly huge payload of 400 g for the modest distance across of 0.55 m (0.70 m for the bigger form) of the quadrotor, the general framework structure has been enhanced for low weight. this empowers a continuous flight time of 7-9 minutes with 8" propellers and 14-16 minutes with 12" propellers. The drive devours 150-180W for floating, while the highspeed locally available PC expends just 27 W top. Thusly flight time is represented by the heap of the framework



fig:7 :pixhawk ports

**V. LOCALIZATION AND FLIGHT CONTROL PIPELINE**

The confinement and control pipeline is simply one of the few installed pipelines. since the PIXHAWK middleware gives a specific time base, an ordinary reading material estimation and control pipeline as of now performs well for self-sufficient flight. the general pipeline, including camera interfacing and correspondence, devours just 10–15 you take care of the whole CPU power. Other actualized pipelines are stereo hindrance evasion and planar example acknowledgment. Singular pipelines are regularly actuated/deactivated at runtime

and singular pipeline parts are frequently supplanted by various calculations without changes to the general framework. Fig. 5 outlines the information handling and information be expected picture catch to control yield.

#### *A. VISION-IMU SYNCHRONIZATION*

As the vision-IMU combination relies upon estimations from a known timebase, the picture catch is constrained by the inertial estimation unit utilizing a shade signal. The IMU additionally conveys the present move, pitch and yaw gauge at the hour of picture catch with the shade time to the vision pipeline. Pictures are transmitted over USB to the camera access, while the IMU estimations and along these lines the screen timestamp are conveyed through a sequential interface. Picture transmission from camera to fundamental memory by means of USB takes around 16 ms, the transmission of the shade timestamp from IMU to primary memory through sequential/MAVLink takes roughly 1–3 ms. since it is ensured that the IMU information lands before the picture, the camera procedure can generally convey the total vision-IMU dataset legitimately to the confinement procedure

#### *B. VISION BASED LOCALIZATION*

Our custom mechanical plan successfully ensures the installed handling module just if there should arise an occurrence of a framework crash and along these lines the fixed mounting of the four cameras permits between camera and camera-IMU alignment. since the preparing board and 4 cameras speak to a relatively enormous payload of 400 g for the little width of 0.55 m (0.70 m for the bigger rendition) of the quadrotor, the general framework structure has been streamlined for low weight. this empowers a continuous flight time of 7-9 minutes with 8" propellers and 14-16 minutes with 12" propellers. The impetus expends 150-180W for floating, while the highspeed locally available PC devours just 27 W top. In this way flight time is administered by the heap of the framework.

The underlying flight tests were led utilizing a marker based methodology with an adjusted usage of ARToolkit+ [8] for the limitation. The marker positions are encoded during a worldwide world guide with the 6D position and disposition of each marker. By extricating the marker quadrangle, the overall marker position are regularly assessed by computing the homography on the four corner purposes of the quadrangle.

#### *C. OUTLIER REMOVAL*

The information is sifted with a Kalman channel in the following stage, which implies that the channel is parametrized with the mistake model of the pc vision approach. As IMU and vision both gauge the three level of opportunity disposition of the helicopter, this excess information are frequently wont to recognize and remove position exceptions created by the restriction step. Any mistaken vision estimation won't just contain an off-base position gauge, yet in addition wrong demeanor gauge because of the projective reliance of position and disposition. Position anomalies can along these lines be dismissed upheld the correlation of roll and pitch gauges from the IMU and from the visual confinement

#### *D. VISION BASED LOCALIZATION*

Our custom mechanical plan successfully ensures the locally available preparing module just in the event of a framework crash and hence the fixed mounting of the four cameras permits between camera and camera-IMU alignment. since the preparing board and 4 cameras speak to a relatively enormous payload of 400 g for the minor distance across of 0.55 m (0.70 m for the bigger variant) of the quadrotor, the general framework structure has been improved for low weight. this empowers a continuous flight time of 7-9 minutes with 8" propellers and 14-16 minutes with 12" propellers. The impetus devours 150-180W for floating, while the highspeed locally available PC expends just 27 W top. In this way flight time is administered by the with 8" propellers and 14-16 minutes with 12" propellers. The impetus devours 150-180W for floating, while the highspeed locally available PC expends just 27 W top. In this way flight time is administered by the heap of the framework..

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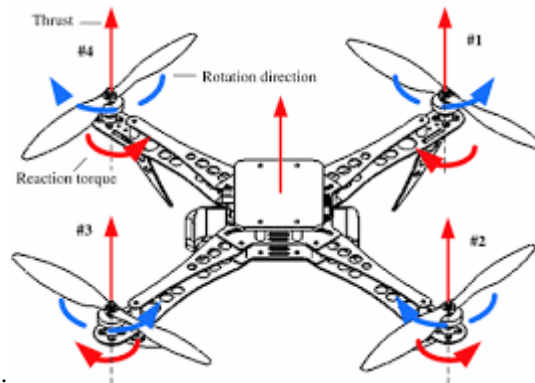


fig:8: propeller direction

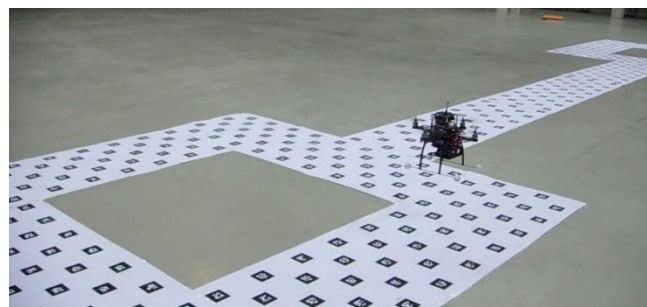


fig :9 : physical out put

#### E.POSITION AND ATTITUDE CONTROL

As effectively recognized, the x, y, z, yaw movement are frequently demonstrated as free. Along these lines, it's conceivable to manage the quadrotor's x-and y-position with the approach of the aggregate push vector by setting the predefined pitch plot for x and in this manner the ideal move plot for y. The z-position can be controlled with the segment of the aggregate push collinear to the gravity vector. The yaw edge at long last are frequently constrained by the distinction of rotor drag of the clockwise (CW) and counter-clockwise (CCW) rotor sets. since the past advance contributed a smoothened position and speed gauge with little stage delay, no model-driven/ideal control is required to represent the missing direct speed estimation. The controller would thus be able to be planned as an average PID controller, actualized as four autonomous SISO PID controllers for x, y, z, and yaw. Mentality control was actualized following the quality PID based demeanor control approach for quadrotors utilizing one PID controller for move, pitch and yaw each. The art is incited by straightforwardly blending the demeanor control yield onto the four engines.

#### VI. EXPERIMENTAL RESULTS / FLIGHT

Fig. 8 shows flight results utilizing fake marker based lo-calization. The plot shows a trip around an elongated way. the 2 opposite developments are self-sufficient startoff and landing. the best possible vertical direction is that the open-circle liftoff. As at first no PC vision based limitation is out there, the helicopter runs an open-circle move until it's 0.5 m height. The left vertical way is that the self-governing arriving after a concise time of drifting on a spot. The plot shows an area of the Figure-8 arrangement of the International Micro Air Vehicle Competition 2010, which is furthermore delineated in Fig. 6. As our framework is measured, we will likewise effectively supplant the ARToolkit-based restriction with different strategies for position control. Fig. 9 shows a direction coming about because of a flight utilizing a Vicon movement catch framework.

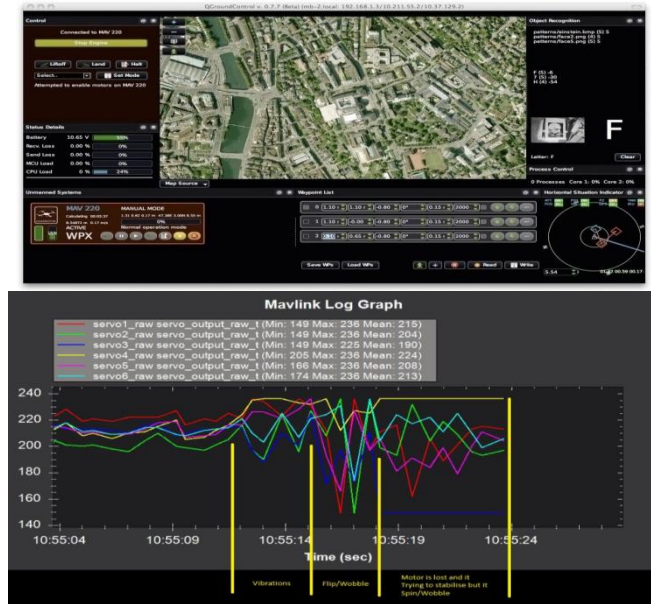


fig : 10:visual out put

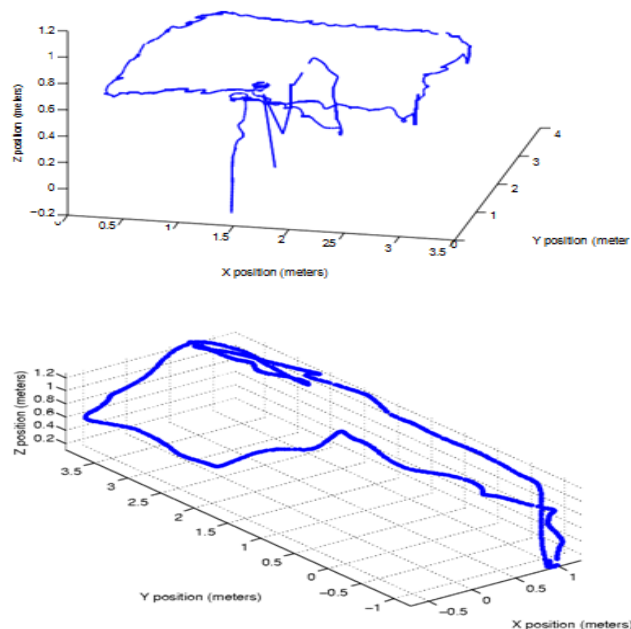


fig:11: flight results utilizing fake marker based

The onboard view of the helicopter during this flight is shown in Fig. 10. This illustrates the reliability and scalability of the system, as these experimental results include onboard stereo depth estimation, dynamic obstacle avoidance and pattern recognition operating in parallel on the onboard computer. Although sensors delivering a depth map



## **VII. CONCLUSION**

The application areas of multirotor UAVs have been increasing day by day all around the world. There are prospects of such new and emerging technology in Asia and Asia Pacific region for socio-economic development. For developing countries, employing helicopters and other large aircrafts for different purposes like surveillance, rescue mission, etc. is a challenge from the economic point of view. Similarly, such missions also involve great risk of human lives. As an alternative, the developed HEXA-Copter using the frame locally made of ACP and off-the-shelf purchased electronic parts is very stable, robust, easy to operate and maintained. After a number of successful test flights and public demonstrations, it is now fully functional and ready to take off the payload for different applications as mentioned above.

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