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Exploring The Capabilities of an AI-enabled Multipurpose Octocopter

ASTRA-X8

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Abstract –

Now a day's multi-rotor commonly known as drones, are attracting much attention in media and research. Many industries are interested now in using drones because they are fast, cost-effective and efficient solutions. There are many different applications for drones such as parcel delivery, rescue operations, construction drones, infrastructure inspection, military operations, agriculture monitoring and many more. This is very attractive opportunity for entrepreneurs and drone market is growing very fast. Whetherit is a new initiative within a company or a new start-up, theproblem really is what drone application is worth to develop. At present, drone application is many in 21st century but thecost of the drones is very high, so in this paper we are trying to reduce the cost of the frame and we are focused only on frame of heavy Octocopter drones which will replacing the Carbone fiber pipe to the aluminum pipe with simple design concept of the drone and compacting the overall size of the drone frame and joining with the 3D printed plastic parts. Our aim in this paper work is we are trying to reduce as much as possible weight and cost for the Octocopter drone frame and easy to manufacturing and assembling the frame are consider while designing the frame of the drone. The design is arranged in a simple way such that multi- functional frame design is arranged with the all parameters are consider such that payload, battery, motors, propellers andelectronic control units etc. The frame is design in AUTOCAD software and static analysis is done in mission planner software and find out the total deformation and stress in theframe body of the drone.

Key Words: Octo copter drone, APM2.8, AI CV IMAGE PROCESSING, Mission planner, ANSYS.

1. INTRODUCTION

Drones are now being used in a variety of industries, including agriculture, mining, surveillance, mapping, and reconnaissance. Drones' adaptability has increased as a result of today's highly improved electronics.
Imaging sensors, thermal sensors, passive infrared sensors, obstacle detection are some of the most commonly used ones today. Infrastructure surveillance and maintenance is done with less use of manpower using drones. Critical structures that require a lot of energy and time for inspection such as cable towers, wind mills, solar farms, industrial buildings walls and dams, can be easily inspected with the help of drones.

Drones come in a variety of designs, such as a fixed-wing drone, which looks like a plane, or a rotorcraft drone, whichlooks similar to a helicopter, though often with multiple rotors (usually up to eight). The latter has vertical takeoff and landing capabilities and it can hover, which makes this design particularly attractive in close quarters, such as crowded urban areas. Tilt-wing drones combine features of fixed-wing and rotorcraft drones using wings that can be swivelled. Drones can use a variety of propulsion systems, such as internal combustion engines, electric batteries, and solar and hydrogen fuel cells

Literature Review

The literature on unmanned aerial vehicles (UAVs), particularly those with advanced functions like computer vision (CV) and image processing, provides useful insights into the design, development, applications, and breakthroughs in this sector. Several major research have helped us grasp these subjects.

Redde, Kulkarni, and Patil (2018) [1] conducted a study on vibration analysis of drone frame and propeller, highlighting the necessity of understanding and improving structural integrity and performance. Kumar and Shivam (2018) [2] investigated the use of thermal imaging technology in UAV- based search operations and shown its usefulness in identifying heat signatures for search and rescue missions.

Sagari and Mundada (2017) [3] gave significant insights into the design and development of rotorcraft UAVs, focusing on critical areas like as aerodynamics and propulsion. According to the current research [4], cost assessment of drone components from www.robu.in assisted budgeting and procurement considerations.

Aggarwal and Kumar (2020) [5] conducted a detailed analysis of route planning strategies for UAVs, focusing on algorithmic approaches for optimizing flight paths while taking topography and mission goals into account. Ullah et al. (2020) [6] investigated the broader uses of artificial intelligence (AI) and machine learning (ML) in smart cities, offering contextual insight for integrating AI and ML technologies into UAV operations in urban contexts.

Mellinger et al. (2011) [7] gave more insights on recent advances in quadrotor capabilities, focusing on improvements in stability, mobility, and sensing methods.

These investigations together contribute to the research and development of the ASTRA X8 AI UAV, which is positioned to use CV and image processing skills to improve navigation, object identification, and mission execution in a variety of operational settings. This study intends to add to the expanding body of knowledge about the integration of AI technologies into UAV systems, particularly in the areas of computer vision and image processing, by integrating findings from various studies.

Essentially, there is an 8-propeller layout in the design of a square or rectangle around the body.

Fig -1: OCTO copter drone

The one obvious benefit is that with 8n propellers, theproduct has a lot more power to be able to lift off of the ground this allows for more payload or overall weight to beadded.

Drones often use this design simply because it can hold a lot of weight without raising the price of the product drastically

- **Structure and USP**

The octocopter has all of the benefits seen with the hexacopters, but with even more power. These models are not cheap by any means and are often seen capturing the best aerial footage available. If you're a professional videographer, you may want to hold onto your hat because what the octocopter has to offer is simply stunning. Design- wise, this copter features 8 motors and propellers. These 8 motors provide the same benefit that the hexacopter provides over the quadcopter

Fig -2: Octo copter drone

- **Speed:** Much faster than the competition and reach higher altitudes
- **Control:** Terrific control that is not hindered as much by wind or rain and more powerful and reliable
- **Safety:** You can lose any one motor and still fly these copters just as well as you could a hexacopter.Furthermore, you may be able to lose 2 or 3 motors without the craft crashing down, depending on positioning and the overall payload and very stable flyers, handle better in adverse weather conditions

- **Case study**

In this study, the focus is on the use of drones for industrial works and more specifically for multi-purpose application as per the customer required to use in differentconditions like heavy and light payload operating of drone for the industrial works and it should be easy and simple designas per the customers required to assembling the drone part frame and others all parameter of the drone.

As per the previous studies, the payload observed for the drone in Indian manufacturing sector was restricted. So, I was given a task of improving the payload capacity for the drone. To ensure the same, I was asked to go through the various aspects of design concepts and manufacturing processes to beused.

In the above-mentioned figures 3 and 4, the quadcopter frame is combined to create an octocopter frame, as illustrated in the image below, which was created using CATIAV5 CAD software. The offset distance between the upper and lower motors is 80mm, as seen in the side view of the octocopter, and the overall length between the two motors is 600mm, as shown in the top view. It is illustrated in fig. 5 and 6, and all other parameters are also considered while building the frame design, such as greater capacity and specifications are adopted for standard, such as

- To design simple and multi-functional frame for higher weight capacities (Here – 2.5 kg)
- Simple yet aesthetically appealing design
- Should be cost effective
- Easy to assemble and dissemble
- Relatively cheap to manufacture.
- Great maneuverability.
- Powerful enough to add accessories.
- Greater thrust and power versus tri/Quad-copters

- **Methodology and design**

"The ASTRA-X8 octocopter, powered by AI, is designed with cutting-edge technology to deliver unrivaled performance. The ASTRA-X8, which incorporates powerful Artificial Intelligence algorithms, has excellent stability, agility, and autonomous capabilities." [3] Its octocopter design provides redundancy and improved

Fig -3: Upper copter drone frame

flight control, assuring dependability in a variety of environmental circumstances. To enhance strength and agility, the frame is carefully designed from lightweight yet strong components. The ASTRA-X8 is outfitted with cutting-edge sensors and cameras that enable accurate navigation and high-resolution photography for a variety of applications, including aerial surveillance and filmmaking. With its innovative design, the ASTRA-X8 sets a new standard for unmanned aerial vehicles, offering exceptional versatility and efficiency in aerial operations.

Fig -4: lower copter drone frame

Fig -5: Octocopter top view

16000mah battery and for propeller are use in quad/octocopter are 10inch diameter with using standard DJI motors are used, all other remaining parameters of electronic such as ESC, flight control, , transmitter /Receiver, Camera & Gimbal.

Copter Flight Times =

(Battery Capacity x BatteryDischarge /Average Amp Draw) x 60
Quadcopter Flight Times = (5200 × 4 1000) × (80% 30amps) x 60mins = 165.9mins

payload is considering as 3-5 Kg for the octocopter drone frame, and propellers are 4 clockwise and 4 anti-clockwise propellers are used by color combination red and blue in isometric diagram of octocopter.

Fig -6: Octocopter isometric view

Table No. 1

Approximately Cost & weight of Octocopterdrone [4]

Sr No.	Component Name	Qty.	Price	Total Pricein Rs	Wt. in gm
1	Electronic Speed Controller	8	679	5432	184
2	Brushless motor	8	749	5992	280
3	Lithium polymer battery	2	8389	16778	1440
4	10-inch Propellers	8	446	3568	360
5	Ardupilot APM 2.8 Flight Controller Board	1	5627	5627	43
6	(6061-T6SP40-100-133) Seamless Aluminum Pipe	4m.	250 /m	1000	600
7	3D Printed Joints	16	280	4480	110
8	GPS, transmission System and Other			17000	100
	Approximately Total Cost			59877	3207

4.1 Flight Time Calculation

Obviously, this copter battery calculator is a very simplistic calculator base on steady hover. For aerial photography work or FPV flying which the motors will have to spin faster, and thus pull more current. This higher current draw will reduce flight time and your flight times will degrade dramatically with about 75% or up to 50% of the calculated quad copter flight time.

So, 50% is considering as per safety so we get 165.9mins/2= 82.95mins and for Octocopter Drone 82.95mins/2= 41.4mins (self-weight & without Payload capacity of electronic system) While considering the self-weight of system is 3207gm and payload 4000gm is taken we get by analytical iteration calculation chart of Flight time Vs. Payload for Drone hence practically we get 22.5mins flight time with self-weight of the system and 9mins flight time at maximum payload capacity.

For checking the above calculation, we have compared with xcopterCalc - Multicopter Calculator form Internet putting all above parameters and conditions for Octocopter drone in that calculator we got results as below shown.

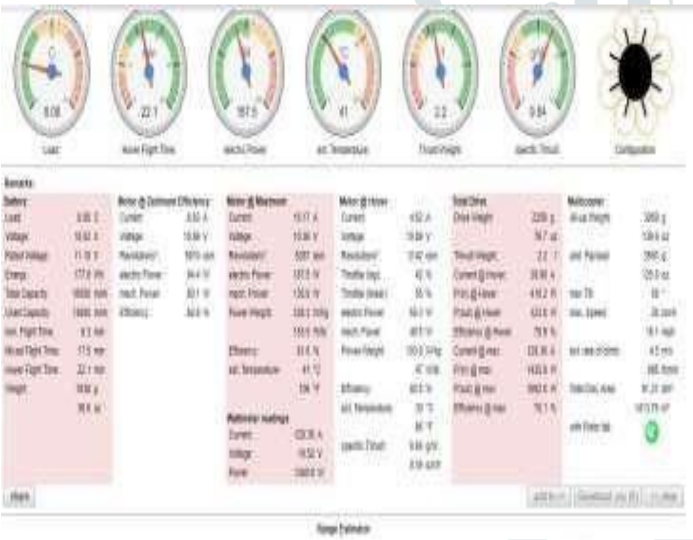


Fig -7: Compare with x-copter Calc – Multicopter

- **ANALYSIS &, IMAGE PROCESSING (AI/CV)**

"The ASTRA-X8 uses advanced AI algorithms and machine learning approaches to evaluate data in real-time. This comprises algorithms for image processing, object identification, categorization, and tracking, which allow the UAV to recognize targets, detect abnormalities, and make intelligent judgments on its own." The UAV can detect patterns, forecast outcomes, and improve its performance over time by using machine learning models learned on massive datasets.

The ASTRA-X8's AI algorithms enable autonomous flying tasks such as take-off and landing, waypoint navigation, and obstacle avoidance.

"By evaluating sensor data and environmental inputs, the UAV may adjust its flight route and behaviour in real time to avoid obstacles and dangers, guaranteeing safe and efficient operation in dynamic situations." [(5)]

The ASTRA-X8 uses AI-powered mission planning algorithms to optimize flight parameters, including route, altitude, speed, and cargo distribution. By assessing mission goals, environmental circumstances, and resource limits, the UAV can create optimal flight plans that can be dynamically adjusted throughout mission execution. Furthermore, AI-powered decision-making algorithms allow the UAV to prioritize activities, distribute resources, and dynamically adjust to changing mission requirements, increasing operational flexibility and adaptability.

Real-time Data Analysis and Decision Making: "AI-powered image processing algorithms on the ASTRA-X8 scan live video streams and sensor data to identify objects, detect abnormalities, and extract actionable insights in real time. This feature allows the UAV to make autonomous choices, such as recognizing targets of interest, monitoring environmental conditions, and detecting possible dangers." [(6)] During mission operations, the ASTRA-X8 improves situational awareness and allows proactive decision-making through real-time data analysis.

The ASTRA-X8 uses adaptive learning methods, including reinforcement learning, to constantly increase performance over time. By gathering and evaluating input from prior flights, the UAV may improve its flying tactics, navigation pathways, and decision-making processes for future missions.

- **IMAGE PROCESSING (AI/CV)**

The addition of computer vision (CV) and artificial intelligence (AI) models to the ASTRA X8 UAV improves its capabilities for a variety of applications such as surveillance, reconnaissance, object detection, and environmental monitoring. Here's a summary of the CV and AI models utilized by the ASTRA X8 UAV:

Computer Vision (CV) algorithms identify and recognize items in a UAV's range of vision. This involves identifying individuals, cars, structures, and other pertinent elements.

Feature Extraction: CV approaches are used to extract useful features from images captured by the UAV's onboard cameras.

Image Processing: Basic image processing techniques such as filtering, edge detection, and image enhancement are used to improve the quality and clarity of photographs.

- **AI Models [(8)]:**

Deep learning models, particularly convolutional neural networks (CNNs), are utilized to conduct sophisticated image processing operations.
These models are trained on big datasets to identify patterns, objects, and abnormalities in photos recorded by the UAV.

Object Recognition: AI models are taught to detect certain items or classes in photos, allowing the UAV to accurately identify and categorize numerous targets.

Semantic Segmentation [8]: AI systems use semantic segmentation to divide pictures into various areas that correspond to certain items or classes. This enables more exact identification and localization of targets.

Anomaly Detection [2]: AI-based anomaly detection models are used to detect strange or unexpected patterns in the UAV's environment. This can aid in spotting possible dangers, irregularities, or anomalies in the surroundings.
The CV and AI models interact smoothly with the ASTRA X8 UAV's onboard systems, enabling real-time analysis and decision-making during flight.

"The processed data from CV and AI models may be utilized to autonomously operate the UAV's navigation, flight route, and mission execution in response to specified objectives or user-defined instructions" [2]

Applications include surveillance and security monitoring of key infrastructure, borders, and public events using the ASTRA X8 UAV with CV and AI models.

Search and Rescue [10]: AI-powered object detection and identification algorithms help locate and identify missing people or survivors during search and rescue operations. Environmental Monitoring: The UAV's CV and AI capabilities make environmental monitoring chores easier, such as measuring animal populations, tracking forest health, and identifying environmental changes.

Circuit diagram and block diagram:

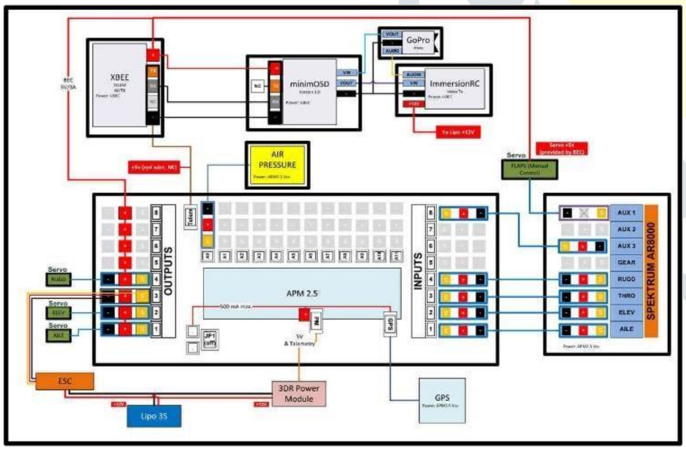


Fig -8: circuitry and process flow

Fluid flow analysis of Propellers [1]

The velocity contours which create low velocity region at lower side of the fuselage and higher velocity, acceleration region at the upper side of the fuselage and according to principle of Bernoulli's upper surface will gain low pressure and lower surface will gain higher pressure. Hence value ofcoefficient of lift will increase and coefficient of drag will alsoincrease but the increasing in drag is low compare to increasing in lift force.

Fig -9: Total Deformation of Octocopter drone frame

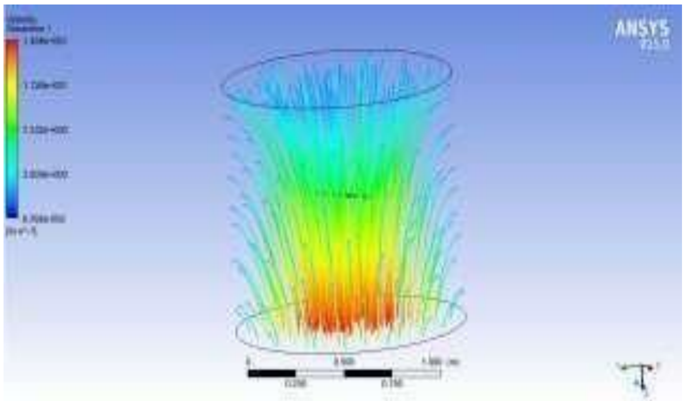


Fig -10: Velocity Stream line of Octocopter dronePropeller

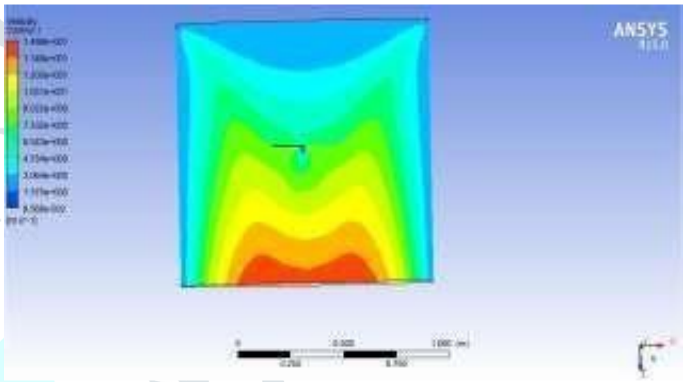
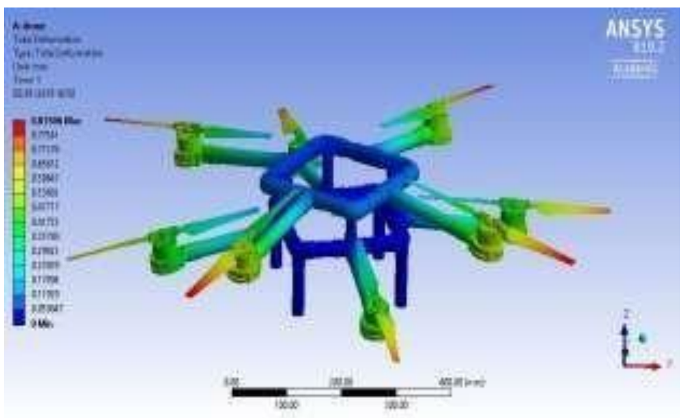


Fig -11: Velocity Contour of Octocopter drone Propeller

• Conclusion [7]

Finally, the integration of computer vision (CV) and artificial intelligence (AI) models into the ASTRA X8 UAV constitutes a huge step forward in unmanned aerial vehicle technology. The ASTRA X8 UAV's capabilities in object identification, recognition, and decision-making are strengthened by leveraging the power of CV and AI, making it a versatile and intelligent platform for a variety of applications.

The ASTRA X8 UAV's CV capabilities let it to evaluate its surroundings, locate items of interest, and extract useful information from collected photos in real time. This allows the UAV to carry out duties like surveillance, reconnaissance, and environmental monitoring with remarkable precision and efficiency.



Furthermore, the AI models included into the ASTRA X8 UAV enable improved picture processing, semantic segmentation, and anomaly identification, resulting in a more comprehensive and nuanced knowledge of the surroundings. Overall, the ASTRA X8 UAV with CV and AI is a cutting-edge solution for a variety of applications, such as surveillance, search and rescue, and environmental monitoring. Its intelligence, agility, and versatility make it a vital tool in both civilian and military environments, helping to progress airborne technology and improve operational capabilities across several domains.

Future development

Advanced AI Algorithms: Future work will concentrate on using deep learning approaches to increase object identification, recognition, and decision-making skills.

Autonomous Navigation: New features will allow the drone to explore complicated terrain, avoid obstacles in real time, and optimize flight paths for efficiency and safety. Multi-sensor fusion combines data from cameras, LiDAR, radar, and thermal imaging to create a more precise knowledge of the surroundings.

Edge Computing: Onboard processing reduces latency and enables quicker decision-making, increasing responsiveness and autonomy.

Swarm Intelligence: Development will allow several drones to work together as a swarm, improving efficiency, scalability, and robustness.

Extended Payload Options: The integration of specialized sensors and payloads will enable a broader variety of applications, including environmental monitoring and catastrophe response. Enhanced

Improved User Interfaces: Ground control software updates will make mission planning, monitoring, and data analysis more straightforward and efficient.

Regulatory Compliance: The focus will be on ensuring compliance with airspace rules, adopting strong security measures, and resolving safety and privacy concerns related with UAV operations.

These developments will take the ASTRA X8 AI Drone to new heights, broadening its capabilities and applications across sectors.

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