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Design And Analysis of Hexacopter Drone to Increase the Pay Load Capacity

Tanvi Dandhare[1], Dr. S. D. Shelare[2]

[1]*Tanvi Dandhare, Mechanical Engineering Department & Priyadarshini College of Engineering*
[2]*Dr. S. D. Shelare, Mechanical Engineering Department & Priyadarshini College of Engineering*

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Abstract - Over the past decade, drone technology has advanced rapidly, with applications expanding across sectors like agriculture and healthcare in India and worldwide. A promising future application involves collecting chemical, physical, and genetic information from aquatic environments by gathering water samples. This study aimed to develop a drone-based water sampling system. A key challenge was optimizing the drone's payload capacity. To address this, we designed a 3D-printed "bottle hanger" for carrying sampling bottles. Computational tools and Finite Element Analysis (FEA) simulations were used to estimate stresses on the drone frame and bottle hanger, helping determine payload limits. Theoretical calculations were also performed to estimate the required thrust.

Key Words: Hexacopter Drone, CAD Modelling, Payload Optimization, Finite Element Analysis, Structural Analysis, Computational Fluid Dynamics

1.INTRODUCTION:

In an era where technology seems to advance daily, drones have emerged as one of the most transformative innovations of the 21st century. These unmanned aerial vehicles (UAVs) are revolutionizing industries, from agriculture and real estate to filmmaking and disaster management. Equipped with high-resolution cameras, advanced sensors, and sophisticated navigation systems, drones offer unparalleled capabilities in capturing data, surveying landscapes, and executing complex tasks from above.

In agriculture, drones are revolutionizing crop monitoring and precision farming by providing real-time aerial data, which enables farmers to optimize resources and improve yields. In real estate and construction, they offer stunning aerial views and detailed site inspections, facilitating better decision-making and project management. Meanwhile, in emergency services and disaster response, drones provide crucial support by delivering supplies, assessing damage, and locating individuals in hard-to-reach areas.

Specialized drones are designed to address the challenges of water quality testing by providing efficient, accurate, and real-time data from otherwise inaccessible or hazardous locations. Traditional water testing often involves labor-intensive processes, requiring personnel to collect samples manually and transport them to laboratories for analysis. This can be both time-consuming and limited in scope, particularly in remote or dangerous areas. Water testing drones, however, streamline this process by deploying advanced sensors and sampling equipment directly into the water. They can collect high-resolution data on parameters such as temperature, pH levels, dissolved oxygen, turbidity, and contaminants without the need for physical access.

Equipped with cutting-edge technology, these drones are capable of flying over lakes, rivers, and coastal areas, performing systematic surveys that provide comprehensive snapshots of water quality. They can be programmed to follow specific flight paths, collect samples at predetermined intervals, and transmit real-time data back to researchers and environmental agencies. This capability not only accelerates the data collection process but also enhances the accuracy and consistency of water quality assessments.

In addition to their technical advantages, water testing drones are invaluable in disaster response scenarios. They can quickly assess the impact of floods, oil spills, or other environmental hazards on water bodies, offering critical insights that guide remediation efforts and safeguard public health. Their ability to operate in hazardous or hard-to-reach areas reduces the risk to human operators and speeds up the response time in emergencies. As the technology behind water testing drones continues to advance, their potential applications expand. Future developments may include more sophisticated sensors, longer flight times, and enhanced data analytics capabilities, further improving our ability to monitor and protect our vital water resources.

2. LITERATURE REVIEW:

Omkar Tatale, "Design and development of heavy-lift hexacopter for heavy payload"

Unmanned Airborne Vehicles (UAVs) like rambles and quadcopters have upset flight. They offer assistance people to take to the discuss in unused, significant ways. The military utilize of bigger measure UAVs has developed since of their capacity to work in dangerous areas whereas keeping their human administrators at a secure separate. Here quadcopter as a little UAV is discussed . It is the unmanned discuss vehicles and playing a overwhelming part in diverse ranges like observation, military operations, fire detecting, activity control and commercial and mechanical applications. The primary objective of the paper is to learn the design, development and testing strategy of quadcopter. In the proposed framework, plan is based on the approximate payload carry by quadcopter and weight of person components which gives comparing electronic components selection. The choice of materials for the structure is based on weight, strengths acting on them, mechanical properties and fetched.

This article show mechanical structure and describe all parts of quadcopter which gives great arrangement for a quadrotor plan when its measurement and taken a toll are the main imperatives. The quadcopter setup has a greater solidness as compared to the other configurations and it is able to float near to its target, unlike its other counter parts. This sort of project plays a major part in civilized nations for surveillance of the earthly zones, film industries, managing traffics and city arranging. The center intention of this work is to think about total planning and manufacturing handle of quadcopter from the engineering imminent and progressing their balance and steadiness framework. As per future perspectives, there is advancement in innovation of quadcopters dramatically. In later days, a companies like Boeing, Airbus, DJ Advancements, Parrot, Walkera, Edge and Heli-Max are working on a few ventures like Bell Boeing Quad TiltRotor, AeroQuad and ArduCopter, Parrot AR. Ramble, Nixie, Zano (ramble), Lily Camera drone, etc.[1]

M. Hassanalian, "Design, Construction and Finite Element Analysis of a Hexacopter for Precision Agriculture Applications"

There is an increasing demand for drones with diverse functionalities, serving both civilian and military purposes. Additionally, significant efforts are being made to create advanced drones capable of autonomous flight in various environments. These drones are designed to carry out a wide range of tasks and missions with minimal human intervention, enhancing their versatility and efficiency.

Recent researches and studies in the field of flying drones including fixed and flapping wing vehicles were consolidated and deeply discussed. A new classification of these drones was first proposed. This classification includes various classes of drones, such as unmanned air vehicles, micro air vehicles, nano air vehicles, pico air vehicles, and smart dust. These flying drones can be used to carry out various civil and military missions.[2]

Chien Wei Jan, "Determining Quasi-Static Load Carrying Capacity of Composite Sandwich Rotor Blades for Copter-Type Drones"

The design of lightweight composite rotor blades with sufficient load-carrying capacity is a critical challenge in the development of larger copter-type drones. This paper presents a method for determining the quasi-static blade load-carrying capacity, which is crucial for ensuring drone reliability. The proposed method involves a systematic procedure comprising three main components: (1) a process to calculate the distributed quasi-static aerodynamic load on the blade using the Blade Element Momentum (BEM) theory, (2) a finite element-based failure analysis technique to identify the blade's failure mode, and (3) an optimization method to calculate the actual load-carrying capacity of the blade. Experimental failure characteristics, including failure mode, failure thrust, and failure location, were assessed for two types of composite sandwich rotor blades with different skin lamination configurations. These experimental results were used to validate the theoretical findings derived from the proposed load-carrying capacity determination method. The study also identifies the optimal skin lamination arrangement for achieving the highest blade-specific load-carrying capacity, as well as the incipient rotational speed necessary for safe drone operation.

The failure characteristics and load-bearing capabilities of composite sandwich rotor blades for copter-type drones have been analysed through both theoretical models and experimental investigations. In the experimental phase, two different composite sandwich blade designs, each with varying lengths of Region 2, were manufactured for measuring blade thrust and testing failure loads. The relationship between rotational speed and blade thrust, as well as the failure characteristics, were obtained to validate the theoretical model. The theoretical approach involved a comprehensive method for evaluating the blade's load-carrying capacity. This method includes three main components: (1) an iterative procedure for calculating the distributed quasi-static aerodynamic load using the Blade Element Momentum (BEM) theory, (2) a finite element analysis to identify the actual failure mode of the blade, and (3) an optimization procedure for estimating the blade's load-carrying capacity . Based on experimental findings, it was established that the primary failure mode for the composite sandwich blades is first-ply failure. Of the three failure criteria considered, the Tsai-Wu criterion was found to predict failure locations and loads more accurately than the others. The proposed method was then used to derive useful relationships, allowing for the determination of load-carrying capacities and incipient failure rotational speeds for blades with varying lengths of Region 2. For the composite sandwich blades tested, the optimal length of Region 2 for achieving the highest specific load-carrying capacity was identified as 20 cm. This information, which links load-carrying capacity to rotational speed, can be valuable when selecting the appropriate drone payload and motor specifications.[3]

Bhakti Yudho Suprapto, "Design, Control and Application of Quadcopter"

Inquire about on multicopter these days is rapidly growing in numerous areas of application. One of the issues in the multicopter application is the capacity to lift a overwhelming stack that requires the cautious plan and choice of the legitimate sort of multicopter for its capacity in carrying out the missions involving the overwhelming stack lifting. One sort of multicopters that is regularly used is hexacopter. This paper depicts the plan of hexacopter that lift a overwhelming stack. The plan is done by calculating and analyzing the imperatives and the criteria by the help of program. The first flight explore demonstrated the capability of the outlined heavy-lift hexacopter to fly in steady state of mind whereas carrying a overwhelming stack.

This ask around has been suitable to arrange, examination and constructs heavy- lift hexacopter that's competent of flying and lifting the cargo. In testing the heavy- lift hexacopter is also able of moving move to a elevation of 26 measures and flight time is 15 twinkles. Heavy- lift Hexacopter is as well suitable to fly by lifting the cargo. unborn explore that's done in the future is to control the heavy- lift hexacopter is free.[4]

Sagar Shelare, "A payload based detail study on design and simulation of hexacopter drone"

Unmanned ethereal vehicles, further routinely known as " drones, " are a trending advancement that will probably have wide practical uses and significance in the near future, especially for the acknowledgments of conventional mapping and arrive cover modify in secluded and blocked off ranges. The most delicate point of view of exercising drifts is lifting more prominent loads, which requires the selection of reasonable multi - rotor meanders as well as exact arrange optimization. unborn propels like drifts have unconceivable promise for tending to societal issues, but they've not in any case been considered to their fullest eventuality. In development to different multi-rotor drones , hexacopter and octocopter have a further conspicuous capacity to lift colossal loads. Computer- backed arrange and Finite- element- analysis (FEA) is a critical approach for assaying unyielding quality, and it makes a discrepancy to choose the specifications of the motor and propeller for specified cargo. This paper portrays the arrange and FEA diversion of the hexacopter drift layout and3D- published bottle holder. The Factor- of- safety may characterize by comparing the yield- strength of the accoutrements with the developed von- mises- stresses in both factors. The number of stylish- fit loads for each is tone-apparent in organize to maximize payload carrying capacity. FEA reenactment envisions that the 7500 g and1500 g are the most prominent loads for the hexacopter drift layout and bottle holder, singly with the needed academic pushed of kg. Comparing the FEA results with the needed academic pushed to lift the cargo will render the arrange of a hexacopter meander for an optimized payload. In conclusion, the comes roughly of this consider figure that maunder advancement can be employed for collecting water samples from lakes in a speedier, strong, and further cost-effective way than out-dated assaying by suggests of water creates.[5]

Abdul Hakim, "Design and development of hexacopter for heavy payload"

This work presents a strategy of plan for heavy lifting hexacopter rambles. The issue of such a ramble is to overcome the soundness of the structure and the edge plan for the ramble. The main objective for this work is to plan and analyze a heavy-lifting hexacopter ramble structure and to degree pushed created by the newly designed edge. Plan and investigation were conducted utilizing SOLIDWORKS, in mimicking the stress and relocation of a proposed structure of the hexacopter ramble. The stack connected on the structure is 350N which incorporates the 20kg of the payload and 10kg of the add up to weight of the drone. The most extreme stresses (Von Mises) are obtained for 1mm and 2mm aluminum outline thickness which are 17.63MPa and 13.77MPa respectively. The relocation esteem for 1mm and 2mm thickness which are 0.73mm and 0.40mm respectively on the arm joined to the hexagonal hub. As for the recently planned edge, the thrust test demonstrated the capacity to accomplish a most extreme of 3.4kg at 1500RPM utilizing 105KV engine.

A plan and advancement of the hexacopter ramble for overwhelming lifting payload with specifically outlined edges was displayed. The pushed pick up from a single rotor is 3.4 kg of pushed. The hexacopter ramble with6 rotors in add up to will provide the maximum lifting capability at 1500 rpm is 20.4 kg counting the weight of the ramble. The lifting capability can be expanded as the control source given at 29 V to achieve the outlined speed 3000 rpm and pushed 10 kg for each rotor which allow the total of 60 kg of pushed.[6]

Osman ÖZTÜRK, "parametric optimization of structural frame design for high payload hexacopter"

For rambles, the utilize of which has been expanding as of late for stack carrying, lightweight ramble outline plan is noteworthy for increased flight time and payload capacity. Rambles are created in distinctive setups with three, four, or six rotors, and in different sizes depending on the reason of utilize. Whereas dexterity is more imperative in three and four rotor ramble applications, six-rotor and generally large-bodied rambles are favored in cases such as stack carrying. When the body structure has to be huge, helping the design gets to be exceptionally basic. Lightweight plans can be accomplished by two

commonly utilized strategies for basic optimization: topology optimization and parametric optimization. Topology optimization is an progressed strategy that can essentially diminish weight but is costly and time-consuming. Parametric optimization is a more commonsense approach to customary fabricating methods
and was utilized in this consider. This ponder points to to begin with disentangle the hexacopter outline show and characterize key geometric parameters for mass-decreasing optimization. Limited component investigation reenactments were utilized to assess the quality and miss happening of the frame under different plan scenarios. The comes about appeared that parametric optimization effectively decreased the weight of the hexacopter frame whereas keeping up auxiliary keenness. The most extreme Von Mises push was found as around one quarter of the yield strength of the outline fabric. The greatest add up to miss happening was accomplished underneath 0.3 mm, and distortion beneath 1 mm is considered secure in the writing. As a result, the optimized plan offers a lighter ramble structure in line with conventional manufacturing strategies, giving way better flight time and payload capacity whereas keeping up taken a toll viability. In future studies, comparisons can be made based on this consider by performing weight optimizations reasonable for current strategies such as topology optimization or generative plan. The taken a toll calculate and the accessibility of existing generation lines ought to be taken into consideration when comparing the specified strategies with parametric optimization.[7]

Miguel Ernesto Gutierrez-Rivera, "Design, Construction and Finite Element Analysis of a Hexacopter for Precision Agriculture Applications."

Agribusiness rambles confront critical challenges with respect to independence and development, as flying time underneath the 9-minute stamp is the standard, and their make requires a few tests and investigate some time recently coming to appropriate flight flow. Subsequently, redress plan, investigation, and make of the structure are basic to address the previously mentioned issues and guarantee a strong construct that withstands the extreme situations of this application. In this work, the examination and execution of a Nylamid engine bracket, aluminum sandwich-type skeleton, and carbon fiber tube arm in a 30 kg agribusiness ramble is displayed. The mechanical reaction of these components is assessed utilizing the limited component strategy in ANSYS Workbench, and the fabric behavior presumptions are surveyed utilizing a all inclusive testing machine some time recently their executions. The common portrayal of these models and the numerical comes about are displayed. This early expectation of the behavior of the structure permits for mass optimization and fetched decreases. The quick flow of ramble applications set vital confinements in pliable materials such as this, requiring broad auxiliary investigation some time recently make. Test and numerical comes about appeared a greatest variety of 8.7% for the carbon fiber composite and 13% for the Nylamid fabric. The mechanical properties of polyamide nylon permitted for a 51% mass diminishment compared to a 6061 aluminum combination structure optimized for the same stack case in the engine brackets plan. The moo mechanical complexity of sandwich-type skeletons interpreted into quick execution. At last, the by and large execution of the farming ramble is assessed through the information accumulated amid the flight test, appearing the satisfactory plan handle.

Exactness farming frameworks have procured pertinence since of the undeniable arrangements they bring to the agribusiness challenges of this time: extraordinary climate conditions, wastefulness in the utilize of assets, and an heightening request for items. The progressions in information preparing, control methods, and inserted frameworks must be complemented by optimized and vigorous mechanical ramble structures to guarantee viable missions and dependable frameworks. This investigate proposed the utilize of an aluminum sandwich-type skeleton and polyamide nylon (Nylamid) as an elective fabric for engine brackets, in expansion to an epoxy carbon fiber tube optimized for this application. Their execution was analyzed in a 30 kg agribusiness drone.
The discoveries illustrate that the utilize of elective materials, such as Nylamid, can quicken the fabricating handle of ramble parts by up to 69%, in light-duty CNC machines. The modern Nylamid engine bracket plan diminished weight by 51%, compared to an aluminum bracket optimized for the same application. On the other hand, sandwich-type skeletons were found to be especially successful in the early improvement stages of huge rambles; their mechanical straightforwardness permits for quick usage and testing. In any case, broad mass optimization must be conducted to compete with conventional light UAV skeletons. In spite of the tall flexibility of plastics, the limited component strategy demonstrated to be a capable instrument to accurately estimate the structures to comply with the plan necessities of ramble farming applications. The comes about of this work can be utilized to plan lighter, faster-to-implement farming drones. In future work, the Nylamid structure will be subjected to more tests and a greater stack. A 6061 aluminum combination engine back will be outlined, optimized, and fabricated to assess the execution of both materials beneath the flow of a UAV.[8]

Mihai-Alin stamate, "study regarding flight autonomy estimation for hexacopter drones in various equipment configurations"

There is a noticeable increase in the development of unmanned aerial vehicles (UAVs), particularly in the area of multirotor drones. Unlike fixed-wing aircraft, multirotors offer the advantage of being able to hover, making them ideal for a variety of remote surveillance tasks, including those in industrial, strategic, governmental, public, and homeland security sectors. Additionally, as the market for components in this field continues to expand, new concepts are emerging to improve the stability and reliability of multicopters . However, there is still a demand for more cost-effective solutions. This study focuses on testing hexacopter UAVs on a custom-built platform, both in a laboratory setting and in open, unrestricted areas. The tests were designed to evaluate the operational parameters, stability, reliability, and aerodynamics during start-stop maneuvers, hover flight, and flight under different wind conditions. Flight data gathered from sensor systems, including accelerometers, gyroscopes, magnetometers, barometers, GPS, and EO/IR cameras, were analyzed, with adjustments made as necessary. Additionally, a Finite Element Method (FEM) simulation approach was used to complement the physical tests, providing a virtual environment for further analysis. Finally, practical insights were drawn to improve the hexacopter's stability, reliability, and overall maneuverability.[9]

D. Pranay Sai, "Study regarding flight autonomy estimation for hexacopter drones in various equipment configurations"

A drone is an advanced, flexible aircraft with a simple design and structure. It is known for its high payload capacity and various other features. Drones, which fall under the category of Unmanned Aerial Vehicles (UAVs), are commonly used for tasks such as lifting, transporting, surveillance, rescue operations, and data collection. These tasks are completed efficiently, quickly, and cost-effectively, without taking up much space. Drones are initially classified based on their design, functionality, size, and weight. They can also be further categorized according to factors like the number of rotors, their placement and orientation, and the overall frame design. By adjusting the design, aerodynamics, and structural weight of different drones (e.g., Monocopters, Tricopters, Quadcopters, and Hexacopters), the payload capacity can be modified. In cases where the drone's size and type are not predefined, increasing the number of rotors is an option to improve payload capacity. As the number of rotors grows, so does the payload, but this comes with an increase in size and structural weight. To mitigate this, lightweight materials can be selected, and the design or size of the drone can be altered. Carbon fiber is a preferred material due to its lighter weight compared to aluminium . In addition, carbon fiber offers exceptional strength and rigidity, with a tensile strength approximately 3.8 times that of aluminium and a specific stiffness that is 1.71 times greater than aluminium .This study will focus on the design of different drone frames, including Monocopters , Tricopters, Quadcopters, and Hexacopters. We will first design the structure with specific dimensions and then analyse the frame to choose the appropriate materials and structure that meet the weight, strength, and stiffness requirements. We will also use various software tools to analyse and simulate the performance of these drone frames.

This research aims to design, analyze, and develop multi-rotor drones, such as Monocopters, Tricopters, Quadcopters, and Hexacopters, that are capable of flight and payload lifting. By reducing the overall weight and optimizing the design and size, these multi-rotors are able to carry heavier payloads efficiently. The results of the study are presented through the ANSYS Workbench, where the calculated outcomes are processed for further analysis. Various flow parameters will be extracted and analyzed to understand the behavior of the flow. Tools such as vectors and streamlines will be used to study the direction and other characteristics of the flow.[10]

Beena Stanislaus Arputharaj, "Comprehensive and Validated Computational Investigations of Structural Integrity, Aerodynamic Behavior, and Its Turbulence Characteristics on Agricultural Drone with and without Payload Devices"

In recent years, multirotor unmanned aerial vehicles (MRUAVs) have attracted significant attention and investment due to their versatile applications in areas such as intruder surveillance, agricultural farming, and crack detection in challenging environments. This study aims to expand the use of MRUAVs in agriculture, focusing on enhancing their performance for agricultural tasks. The research utilizes an agricultural drone (AD) equipped with a coaxial propeller. This design improves stability compared to conventional agricultural drones by replacing one of the traditional rotors with a coaxial rotor setup. The proposed AD is highly customizable to meet various design specifications. For this study, a payload weight of 2.5 kg is used. Key components of the drone, such as the coaxial propeller arrangement, the "Y" frame, and the fertilizer tank, are efficiently designed using advanced software tools like CATIA. Simulations of airflow around the drone and its associated effects are conducted to validate the design. Eddy formation and pressure drag effects on the drone are simulated using Ansys Fluent. The velocity profiles of fluid flow over the drone are studied under different conditions, including vertical take off, vertical landing, and forward speed with various payloads. The drone's minor influence on airflow allows for the formation of eddy structures around it. Lastly, the drone's structural displacements and failure risks under aerodynamic stresses are evaluated using a fluid-structure interaction approach. The findings suggest that this agricultural drone is both durable and well-suited for complex, computationally-intensive agricultural applications.

A novel configuration of multirotor UAVs is proposed, based on the design of an agricultural drone. However, due to the instability of the agricultural drone, the study incorporates a coaxial propeller-based propulsion system at one end to enhance stability. The basic design parameters of this stable agricultural drone are derived using conventional methods and historical correlations. Critical estimated design factors include the 6-inch propeller, arm length, and landing stick length. These parameters are strongly supported by computational research studies, which examine various phases of the anticipated mission profile. In computational assessments of motor dynamics, thrust and drag constants play a crucial role. Additionally, when determining the propeller design parameters, the maximum lift coefficient is considered. After completing the conceptual design, the agricultural drone is modeled in CATIA. This includes a detailed representation of the drone and all its components, such as the fertilizer tank, to enable the calculation of key aerodynamic coefficients, including lift, drag, and moment of inertia. Next, the operational conditions of the agricultural drone, such as rotational velocity and forward speed, are computed using established, validated formulas. The primary components of the agricultural drone are selected based on the estimated design, and the total weight of the drone is calculated. Additionally, the fluid dynamics around and within the agricultural drone are studied, as they significantly influence its performance. To predict flow behavior, conventional computational methods are applied. The results from CFD analysis indicate that the proposed agricultural drone generates minimal pressure drag. Consequently, the drone design is validated for various agricultural scenarios, incorporating multiple optimization perspectives. Finally, two key strategies for utilizing agricultural drones in farming applications are presented, with the main conclusions summarized in Table 7.[11]

Dirman Hanafi, "Comprehensive and Validated Computational Investigations of Structural Integrity, Aerodynamic Behavior, and Its Turbulence Characteristics on Agricultural Drone with and without Payload Devices"

This paper discusses the development of a remotely operated quadcopter system. The quadcopter is controlled via a graphical user interface (GUI), with communication between the GUI and the quadcopter established through a wireless system. The quadcopter's balance is monitored using the FY90 controller and an IMU 5DOF sensor. For smooth landings, the system is equipped with an ultrasonic sensor. All sensor data is processed by an Arduino Uno microcontroller, which controls the quadcopter's propellers based on the processed outputs. The GUI is developed using Visual Basic 2008 Express, facilitating communication between the PID (Proportional, Integral, Derivative) controller and the quadcopter system. The experiment demonstrates that the quadcopter is capable of hovering and maintaining its balance with stable performance. Additionally, the system can handle load disturbances up to 250 grams while maintaining its hover position. The quadcopter operates for a maximum of six minutes using a 2200 mAh LiPo battery, and the flight time can be extended by using a larger battery capacity.

The quadcopter and its GUI controller have been successfully designed and developed. Based on the test results, the GUI controller is capable of sending control signals to the quadcopter's controller, which then translates these commands to maintain stability and balance. The developed quadcopter is able to handle load disturbances of up to 250 grams while maintaining a stable hover.[12]

Marcel Veismann, "Study of Rotor-Jetpack-Wind Aerodynamic Interaction for Mid-Air Helicopter Delivery on Mars"

Mid-Air Helicopter Delivery (MAHD) is a novel Entry, Descent, and Landing (EDL) architecture designed for future Mars helicopter-only missions, such as the Mars Science Helicopter (MSH). This approach offers significantly greater in-situ mobility compared to traditional rover missions, at a reduced cost. The MAHD concept employs a delivery jetpack to slow the rotorcraft's free fall after it separates from the parachute's back shell, preventing undesirable rotorcraft descent aerodynamics and creating favourable conditions for helicopter take off in mid-air. While the Ingenuity system has demonstrated the feasibility of Martian rotorcraft operation, mid-air helicopter take off from a self-propelled jetpack platform remains a critical challenge in this EDL strategy. This paper describes the development of a sub-scale experimental test-bench designed to evaluate the aerodynamic interactions between the MSH, a jetpack simulation system, and the surrounding wind, to assess the technical feasibility of MAHD. Aerodynamic

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measurements and various flow visualizations, both qualitative and quantitative, were conducted in a (1 atm / 1 g) environment and compared with computational fluid dynamics (CFD) simulations for validation. Additionally, we demonstrate the in-flight capabilities of wind sensing and active trimming of the rotorcraft under crosswind conditions, using an integrated force-torque sensor placed between the rotorcraft and the jetpack.

A static test-bench was successfully constructed to investigate the aerodynamic interactions between a Martian helicopter and jetpack system, designed for the mid-air deployment of the rotorcraft during Entry, Descent, and Landing (EDL) in future Mars missions. This setup enabled the comprehensive quantification of rotor-jet-wind flow interactions and the assessment of how the rotor's performance is influenced by jetpack operation and relative crosswinds, using rotorcraft force/torque measurements and detailed flow field analysis. Specifically, we demonstrate:
(i) Minimal impact on the mean rotor performance of the Mars Science Helicopter (MSH) during continuous thruster firing, with average thrust losses around 3.5% at maximum jetpack thrust, exceeding scaled Martian conditions.
(ii) Rotorcraft-based wind sensing by analysing force/torque sensor data, with thrust, drag, and pitching moments showing strong correlation to wind speeds.
(iii) Wind trimming capabilities using rotorcraft force/torque data for achieving zero-moment take-off conditions relative to the jetpack, preventing rapid attitude changes and avoiding jetpack re-contact after separation.
(iv) A good agreement between the results generated by STAR CCM+ and the experimental data, both for jetpack-only and jetpack-wind conditions, confirming the suitability of the CFD tool for MAHD scenarios. It is important to note that the MAHD project is an ongoing research effort and not limited to the results presented here. Additional data analysis and static tests are planned, along with more extensive experimental and computational flow studies, especially regarding helicopter-jetpack interactions. Future hardware improvements for the experimental setup include the integration of a directly driven main inlet valve to reduce pulse time, which will allow for higher pulsing frequency and more accurate replication of the jetpack's flow characteristics .While the static tests have confirmed that the rotor's mean performance is only marginally affected by the jet-induced flow field, and that pre-take off wind sensing and trimming are feasible, dynamic take off tests of the rotorcraft from a (semi-)static jetpack platform are still needed.[13]

Gordana Ostojić, “Design, Control and Application of Quadcopter”

Quadcopter is an unmanned ethereal vehicle, which can be executed in distinctive applications. In paper it will be spoken to a improvement of a quadcopter framework and potential application in which it can be actualized. Quadcopter structure show, essential components with square chart, hovering stability, measurements, and portrayal of fundamental developments will be spoken to and examined. Control algorithms with steps in experimental technique will moreover be displayed. Current respectful and military application will be inspected, and future applications will be recommended.

Quadcopter is a extraordinary kind of vehicle, which can be implemented in distinctive applications. In this paper basic standards of quadcopter plan as well as current applications are spoken to. In the future applications, quadcopter may be utilized for a assortment of unused policing functions. Quadcopter might be utilized for safety inspections, edge watches around detainment facilities and thermal imaging to check for cannabis being developed in roof lofts and other not simple to get to areas. The police may utilize them to capture number plates of speeding drivers, for recognizing robbery from cash machines, railroad checking, combat fly-posting, fly tipping, deserted vehicles, squander management. Future investigate will be in field of look and protect. In future an exertion will be coordinated to advancement of a system for characterizing evacuation/safe way in case of natural calamities and mischances. The framework will consists of quadcopter which is prepared with a camera to capture diverse territory (arrive or water) and a processing unit for preparing the recorded condition which is set on the vehicle/vessel or in frame of handheld gadget. In expansion to the circumstances of natural disasters and mischances it is conceivable to utilize this systemin cases of climatic changes that influence the security and health of the populace, or in cases where it is endangering the usefulness of distinctive economic systems.[14]

S. Bhandari, “Design and Development of Hexa-copter for Environmental Research”

A UAV (Unmanned Aerial Vehicle) is a type of flying robot that operates without the need for a pilot onboard. It can be controlled either manually or through autonomous systems. In countries like Nepal, UAV technology presents a promising opportunity for various applications, especially in environmental research. These applications include aerial surveillance, photogrammetry, medical supply delivery, conservation monitoring, and more. In many cases, UAVs could serve as a more affordable and accessible alternative to traditional manned aerial vehicles like helicopters. This shift could greatly benefit the economy and reduce the risks associated with operating larger aerial vehicles. For critical tasks such as disaster assessment, delivering medical supplies, and carrying out rescue operations, UAVs could prove to be both more cost-effective and safer than their manned counter parts. While there are numerous types and designs of UAVs globally, such as multi rotors and fixed-wing aircraft, these technologies are not as easily accessible in Nepal. However, Kathmandu University has developed its own UAV, the KU-COPTER, a hexacopter with six propellers. This multirotor UAV is designed for vertical take off and landing and is primarily used for aerial surveillance and medical aid delivery. The wide-ranging potential of UAVs in Nepal opens up numerous possibilities for further research and development in the field. The indigenous design and development of the KU-COPTER set a foundation for future modifications and feature additions based on specific needs and applications in Nepal's context.

The application of multirotor UAVs is rapidly expanding worldwide, with increasing opportunities in the Asia-Pacific region to foster socio-economic growth. In developing nations, using large aircraft like helicopters for tasks such as surveillance and rescue operations can be economically challenging and pose significant risks to human safety. In contrast, the KU-Copter offers an effective solution. Developed at Kathmandu University, this UAV features a locally constructed frame made from Aluminium Composite Panel (ACP) and utilizes readily available electronic components. The design of the KU-Copter makes it stable, durable, and easy to operate and maintain. Following several successful test flights and public demonstrations, the UAV is now fully operational and prepared to carry payloads for various applications, including surveillance and rescue missions.[15]

3. CONCLUSIONS:

The static analysis confirms that carbon fiber is an optimal material for the drone chassis due to its lightweight and high strength-to-weight ratio, excellent structural performance under heavy loads, and minimal deformation with safe stress distribution. These characteristics ensure that the frame is well-suited for real-world drone operations, with the potential for scaling to accommodate heavier payloads. The CFD analysis further demonstrated efficient thrust generation and aerodynamic flow behavior, along with stable and realistic airflow around the propeller. Additionally, the high accuracy and reliability of the simulation model validate the drone's aerodynamic design, confirming its effectiveness in real-world flight conditions.

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