# Design and Fabrication of Hoverbike

[1]C Dilli Babu
Department of Aeronautical Engineering,
Bharath Institute of Higher Education and Research,
Selaiyur,Chennai-600073

[2]S Vinay Kumar Reddy
Department of Aeronautical Engineering,
Bharath Institute of Higher Education and Research,
Selaiyur, Chennai-600073

[3]D Ravi Kiran
Department of Aeronautical Engineering,
Bharath Institute of Higher Education and
Research,Selaiyur,Chennai-600073

[4]N Kalaimani
Assistant Professor, School of Aeronautical Engineering,
Bharath Institute of Higher Education and Research,
Selaiyur, Chennai-600073

**Abstract:- This research paper presents the design and fabrication process of a hoverbike utilizing an overlapped configuration. The aim of this study is to explore the feasibility and performance potential of a hoverbike concept that incorporates overlapping rotors for enhanced stability, maneuverability, and safety with 2.5 kg payload. The design considerations, structural analysis, aerodynamic optimization, and fabrication techniques employed in the development of the hoverbike are discussed in detail. Experimental tests and evaluations are conducted to validate the performance characteristics and assess the feasibility of the proposed design. The findings demonstrate the potential of the overlapped configuration in hoverbike design, highlighting its ability to achieve improved stability and control, paving the way for advancements in future hoverbike technologies.**

***Keywords:-*** *BLDC Motors, Drones, Unmanned Aerial Vehicles, Efficiency, Power-To-Weight Ratio, High RPM Capability, Control, Stability, Noise Reduction, Maintenance, Future Advancements.*

## I. INTRODUCTION

Hoverbikes have long captured the imagination of science fiction enthusiasts, embodying the seamless fusion of aviation and ground-based transportation. As technology continues to advance, bringing us closer to the realization of futuristic modes of transportation, the development of practical hoverbikes has gained traction. One promising approach involves the utilization of an overlapped configuration, where rotors are strategically positioned in an overlapping arrangement to achieve enhanced stability, maneuverability, and safety. The overlapped configuration offers a unique solution to the inherent challenges faced in hoverbike design, addressing issues such as control, stability, and aerodynamic efficiency. The primary motivation behind exploring the overlapped configuration for hoverbikes lies in its potential to revolutionize the field of personal aerial transportation. By incorporating overlapping rotors, the design aims to overcome the limitations associated with traditional hoverbike configurations, which often suffer from inherent instability and restricted maneuverability. The overlapping arrangement of rotors introduces a novel mechanism that promises improved control and stability, allowing users to navigate through urban environments with greater ease and confidence.

The objectives of this research endeavour encompass several key aspects. First and foremost, the study aims to investigate the feasibility and practicality of the overlapped configuration in hoverbike design. By delving into the intricacies of the design process, encompassing considerations such as rotor placement, aerodynamic optimization, weight distribution, and control mechanisms, we seek to unlock the potential of this configuration for realizing a functional and efficient hoverbike.

Additionally, the research places great emphasis on the structural analysis of the hoverbike, employing advanced techniques such as finite element analysis (FEA) to ensure the integrity and durability of the frame and components.

Furthermore, aerodynamic optimization through computational fluid dynamics (CFD) simulations is undertaken to enhance the overall performance of the hoverbike, reducing drag and improving efficiency.

Fabrication techniques play a crucial role in the realization of the proposed hoverbike design. Careful selection of materials, utilization of lightweight construction methodologies, and effective integration of various components are critical factors that contribute to the successful fabrication of a functional prototype. Through detailed exploration of these fabrication techniques, this research aims to provide insights into the practical implementation of the overlapped configuration.

To validate the performance characteristics and assess the feasibility of the proposed design, comprehensive experimental testing is conducted. Hover tests, stability assessments, maneuverability trials, and safety evaluations are carried out to gather empirical data, allowing for quantitative analysis and comparison with predefined criteria. The results obtained from these experiments provide crucial insights into the capabilities and limitations of the hoverbike using the overlapped configuration.

ISSN No:-2456-2165

Ultimately, this research seeks to contribute to the advancement of hoverbike technologies by shedding light on the potential of the overlapped configuration. By identifying areas for improvement and outlining potential future directions, this study aims to drive innovation in the field, paving the way for the development of practical, efficient, and safe hoverbikes that could revolutionize personal transportation in urban environments.

## II. LITERATURE SURVEY

The original Hoverbike was built by Chris Malloy of New Zealand, after work and studies in his garage in suburban Sydney, Australia. His project started out as a hobby, but quickly grew into a commercial enterprise, with interest from people and group such as universities, farmers, military, with notable visits from US Army G-3/5/7 and Lockheed Martin's 'Skunk Works'. Most of the frame of original Hoverbike was handcrafted from carbon fiber and aluminum with a foam core.

Swaraj Lewis in his paper discussed the scaled prototype of hoverbike in bi-copter configuration and propellers are protected with ducts. Propellers that are driven electrically incorporating tilt motor mechanism, wherein servo motors are used to maneuver the model. Hence concluded that remote-controlled aircraft had a flying range of approximately 800 meters and could stay airborne for a maximum of 5-10 minutes. When equipped with a two-blade propeller, it could carry a payload of 0.3 kilograms, while with a three-blade propeller, the payload capacity increased to 0.5 kilograms

Ankit et al (2020) explains. The hoverbike, unlike a bi-copter, is a model that can fly in the air and accommodate a person. It offers easy operation and eliminates the need for a runway, as it can take off and land vertically from the ground. The utilization of a ducted fan configuration in the design serves to protect the rotor from damage. This innovative design enables the hoverbike to serve various purposes such as rescuing people, aiding law enforcement, and efficiently traveling long distances without being hindered by traffic. Additionally, it finds applications across multiple industries, military operations, and emergency situations.

Zhang et al. (2019) concludes that this paper is based on the numerical analysis of ducted propellers. As mentioned, ducted propellers are numerically inquieted at Re of $1.765 \times 10^5$. And at last, the experimental data is compared with the obtained results. Many numerical calculations had been performed to overcome of open propeller model. And many studies were spotted on the development of the ducted propeller model.

- *Objective*

The main aim of the project is to design the prototype of Hoverbike which can be able to lift 2.5 kg of payload, and to obtain high endurance.

## III. COMPONENTS

### *A. BLDC Motors*

Brushless DC motor is that which contain both stator and rotor this are widely used in multi-copters and drones. They have good efficiency and are easy to control. It specifies that in drones the feature of motor uses brushless direct current. At the tip of BLDC motor, the propeller is placed this application id done with each motor. And also, some of the avionics systems were used to control the motor. And some mechanical gadgets like wires which supplies power to the motor from the batteries. In this paper it is concluded of various approach of BLDC motors characterization in UAVs consisting of describes the concept to control speed in BLDC motor in quadcopter. The first and most important thing is that in drones the speed should be controlled according while flying. There is an optical sensor that measure the speed rotation and control the speed. Drone uses limited power to fly for ling time. This type of drones doesn't contain any brushes and commutator. Although their aim of this paper is to conduct an experiment on control of rotation speed during ground test.

Fig 1 BLDC Motor

### *B. Electronic Speed Controller (ESC)*

The ESC (Electronic Speed Controller) is used to control the speed and torque of the BLDC motor. This is chosen based on the discharge rate of the motor. This plays a major role in between the hoverbike and ground transmitter, which helps in changing directions by increasing and decreasing the motor speed. This also has the 6 degrees of freedom in hoverbike. In the survey it is observed that the design of esc for BLDC motors. Electronic speed controller has some of the components of different modules such as microcontroller to control the speed of the motor, power sensing, and power stage. And there must pe a specific voltage of the battery based on the requirement of drone.


Fig 2 Electronic Speed Controller (ESC)

### *C. Flight Control Board*

The flight control board is that which plays a major role between the ground transmitter and receiver. All the commands given by the transmitter will be received by the receiver and send the signals to the flight control board and this plays a specific role in stability control in hoverbikes. And also, sends the signal to esc to rotate the motor at a certain rpm to do operations. Such as take-off, landing, pitching, rolling, and yawing. This was directly connected to the Power distribution board and takes the power and distribute the required power for all the control systems such as GPS module and ESC's and this is used to give the commands to the motor to rotate at specific RPM. These stability controls are given by using "mission planner" software. There are many types of Flight control boards the selection of flight controller board was done by investigation on various types of Flight controllers. The Pixhawk 2.4.8 flight control board was selected based on our requirement.


Fig 3 Flight Control Board

### *D. Power Distribution Board*

Power distribution board is that which supplies the power to all the avionics systems such as Flight controller board, ESC's equally to all the parts of Hoverbike it is directly connected to the battery and flight control board. And distribute the enough current that the system wants. The Power distribution board works basically by taking the power from the battery and supply to the ESE's and flight control system.

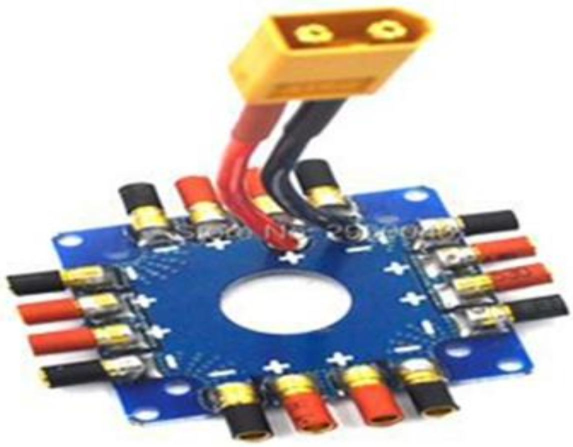

Fig 4 Power Distribution Board

### *E. LiPo battery*

Battery plays an important role in any of the electric vehicles and drones because it is the energy source that supplies electricity to all the electronic parts in the model. There is various type of battery's available now a days in market such as fuel cell, lithium-ion, nickel cadmium and lithium polymer. In this project the Lithium-ion Polymer battery was used because these types of battery's are safe when compared to other types because the Lithium-ion polymer batteries are rechargeable and lithium-ion technology using a polymer electrolyte instead of a liquid electrolyte. This battery provides higher specific energy then the other lithium battery types and also used in many applications where weigh is a critical feature such as mini drones, agriculture drones and also in mobiles and also in electric vehicles. The discharge rate in the battery plays a key role because it decides the system how can much current it can draw during the flight. As LIPO batteries can damage if fully discharged so the power that can be used in the LIPO battery are 80% of its full battery power.


Fig 5 LiPo Battery

### *F. Propellers*

Propellers plays a major role in lift generation in Hoverbike. Based on the battery capacity and motor kV the propellers are selected and also by considering all other impacts such as the power consumption of the BLDC motor is also based on the propeller size. As our requirement to get the required thrust the propeller APC 15*10E propeller was selected.

Fig 6 Propeller

*G. RC- Transmitter and Receiver*

Rc-transimitter and receiver plays a major role to communicate between the person who control and the drone. This is used to communicate the drone from the ground the RC transmitter is in the ground and the receiver is connected to the drone flight controller this receiver will receive the commands given by the person using transmitter and the receiver will give the command to the Flight control board which gives the signals to the motor ESC so that the motor RPM will be controlled and also all the 6 degree of freedom motion were controlled such as pitching, rolling, yawing.


Fig 7 RC- Transmitter and Receiver

*H. GPS (Global Positioning System)*

This is used to allow us to trace the location which is relative to the network. The GPS is described as "global positioning system" which places an important role mainly for the military and defense sectors. As mentioned above they can trace the location of any place and can initiate to ground control through satellite.

Fig 8 GPS

## IV. DESIGN CONSIDERATIONS

*A. Rotor Placement:*

The design considerations for the hoverbike using the overlapped configuration revolve around the strategic placement of rotors. The arrangement of overlapping rotors is meticulously planned to optimize stability, control, and lift distribution. Factors such as the distance between rotors, their angle of inclination, and the positioning along the hoverbike frame are taken into account. By carefully analyzing the aerodynamic interactions between the rotors and their impact on airflow patterns, an optimal rotor placement scheme is determined to achieve balanced lift and improved stability during hoverbike operation.

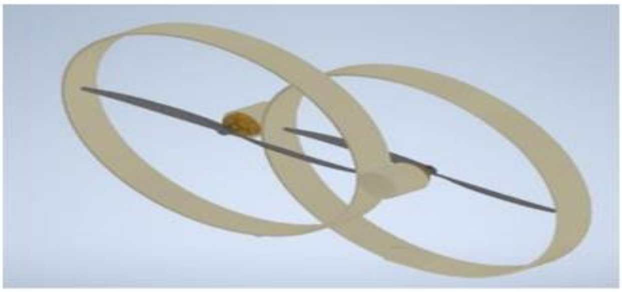

Fig 9 Rotor Placement

*B. Aerodynamic Considerations:*

Aerodynamic considerations play a vital role in the design of the hoverbike. The configuration of overlapping rotors introduces unique aerodynamic challenges that must be addressed. Computational Fluid Dynamics (CFD) simulations are employed to analyze the airflow patterns, pressure differentials, and drag forces experienced by the hoverbike during operation. By refining the design based on CFD analysis, aerodynamic efficiency can be improved, resulting in reduced drag, enhanced lift generation, and overall improved performance.

*C. Weight Distribution:*

Effective weight distribution is critical to ensure stability and maneuverability. The placement of components, including the power source, control systems, and passenger seating, is carefully considered to achieve an optimal center of gravity. By distributing the weight evenly along the hoverbike frame, it becomes easier to maintain balance and control during various flight maneuvers. The use of lightweight materials and efficient structural design techniques further aids in achieving an optimal weight distribution, enhancing overall stability and responsiveness.

*D. Control Mechanisms:*

The design of control mechanisms plays a pivotal role in enabling precise maneuverability and responsiveness. Advanced control systems, such as fly-by-wire technology, are incorporated to facilitate smooth and intuitive piloting. The control mechanisms are designed to provide accurate and immediate response to pilot inputs, ensuring precise control over the hoverbike's movements. Additionally, safety features like stability augmentation systems and redundant control mechanisms may be integrated to enhance stability and mitigate potential risks during flight.

ISSN No:-2456-2165

*E. Safety Considerations:*

Safety is of paramount importance in the design of the hoverbike. Redundancy and fault tolerance mechanisms are implemented to minimize the impact of component failures. Emergency landing systems, such as parachutes or airbags, may be incorporated to ensure the safety of the occupants in the event of an unforeseen emergency. Structural integrity and crashworthiness are also key considerations, with robust construction methods and impact-absorbing features implemented to protect occupants and minimize damage in case of accidents.

Fig 10 Final Design Model

## V. STRUCTURAL ANALYSIS

*A. Load Distribution:*

Structural analysis plays a crucial role in ensuring the integrity and durability of the hoverbike's frame and components. Load distribution analysis involves assessing the forces exerted on various structural elements during different flight manoeuvres and operating conditions. By employing analytical methods and computer simulations, the distribution of loads can be determined, enabling the identification of areas prone to stress concentrations or excessive deformation. This analysis allows for the optimization of structural design, ensuring that the hoverbike can withstand the anticipated loads while maintaining structural integrity.

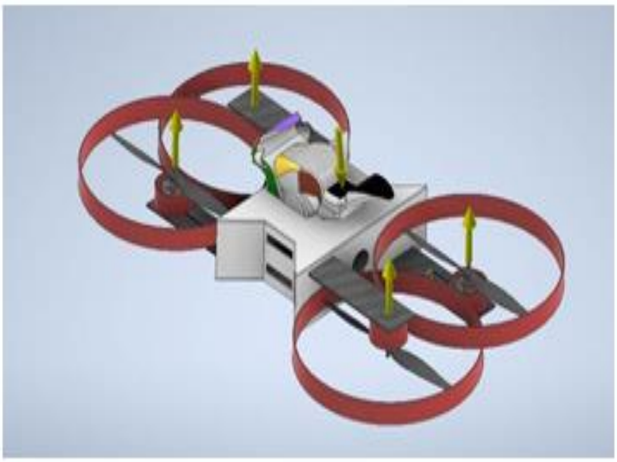

Fig 11 Load Distribution

*B. Stress Analysis:*

Stress analysis involves evaluating the stresses and strains experienced by the hoverbike's components under different loading scenarios. Finite Element Analysis (FEA) techniques are commonly employed to simulate and analyze these stresses. By dividing the hoverbike's structure into finite elements, the FEA software calculates the stresses and strains at each element based on the applied loads and material properties. This analysis provides insights into potential areas of high stress concentration, deformation, or failure, allowing for design modifications or reinforcements to ensure structural stability and safety.

*C. Material Selection:*

Choosing appropriate materials is a critical aspect of structural design. Material selection is based on a variety of factors, including strength, weight, durability, and cost. The structural analysis helps in determining the material requirements for different components of the hoverbike. High-strength materials, such as carbon fibre composites or aerospace-grade aluminium alloys, are often preferred to achieve the desired strength-to-weight ratio. Material properties, including tensile strength, elasticity, and fatigue resistance, are considered to ensure that the chosen materials can withstand the anticipated loads and stresses during hoverbike operation.

*D. Structural Optimization:*

Structural optimization aims to achieve a balance between strength, weight, and performance. By employing optimization algorithms and techniques, the structural design can be refined to reduce weight while maintaining the required strength and rigidity. This process involves iteratively adjusting parameters such as the thickness of structural members, the arrangement of support structures, or the distribution of material within the components. Finite element analysis and computational tools assist in identifying the optimal configuration that minimizes weight without compromising structural integrity, enhancing the overall performance and efficiency of the hoverbike.

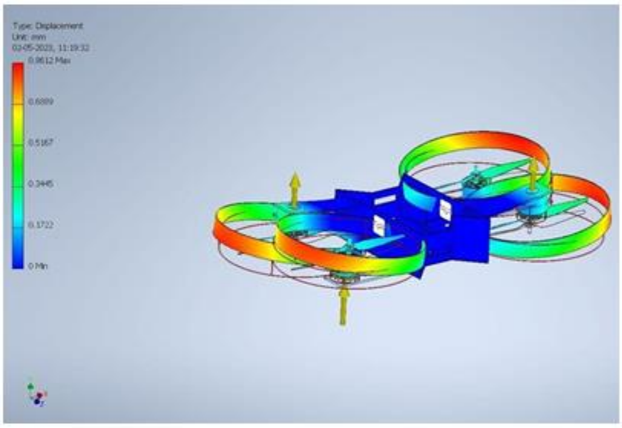


Fig 12 Structural Analysis

Through comprehensive structural analysis, including load distribution, stress analysis, material selection, optimization, vibration analysis, and fatigue analysis, the hoverbike's structural design can be optimized for strength, durability, and performance. This rigorous analysis ensures that the hoverbike can withstand the anticipated loads, vibrations, and cyclic stresses experienced during operation, resulting in a safe and robust structure for successful hoverbike implementation.

## VI. EXPERIMENTAL TESTING

Experimental testing is a crucial phase in the development of a hoverbike prototype, aiming to validate its performance, functionality, and safety under real-world conditions. Through a series of rigorous tests and measurements, the hoverbike's capabilities are evaluated, and any design modifications or refinements can be identified.

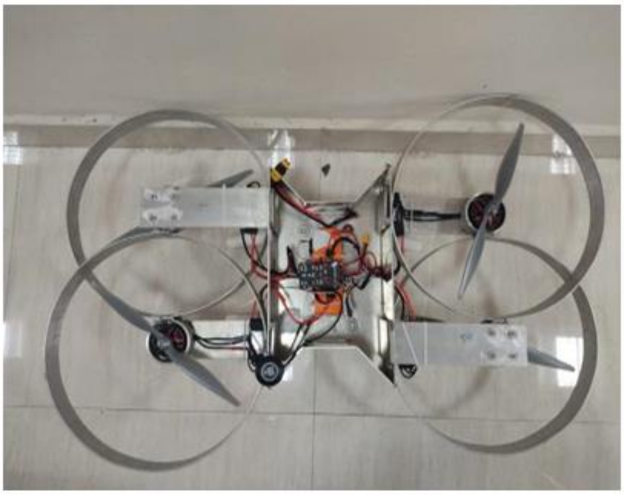

Fig 13 Testing Model

### *A. Flight testing:*

Flight testing is the primary method used to assess the hoverbike's performance and flight characteristics. It involves conducting controlled flights in various conditions, such as different altitudes, speeds, and manoeuvring scenarios. Flight testing allows for the evaluation of parameters such as stability, control responsiveness, lift-to-drag ratio, payload capacity, and endurance. Instrumentation, including sensors, data acquisition systems, and flight control systems, is employed to capture and analyses critical flight data during these tests.

### *B. Stability and Control Evaluation:*

Stability and control tests aim to assess the hoverbike's ability to maintain equilibrium and respond to pilot inputs effectively. These tests involve performing controlled manoeuvre, including pitch, roll, and yaw movements, to evaluate stability, controllability, and response characteristics. Parameters such as roll rate, pitch stability, yaw stability, and control authority are measured and analysed to ensure the hoverbike's stability and maneuverability meet design specifications.

### *C. Payload and Endurance Testing:*

Payload and endurance testing assess the hoverbike's capability to carry specified loads over extended periods. The hoverbike is loaded with predetermined weights or simulated payloads to evaluate its performance under different weight conditions. This testing also helps assess the hoverbike's endurance, evaluating factors such as battery life, fuel consumption (if applicable), and the hoverbike's ability to sustain flight for the desired duration. These tests provide valuable insights into the hoverbike's practical usability and operational limitations.

### *D. Safety Testing:*

Safety testing focuses on assessing the hoverbike's safety features and response in emergency situations. This includes conducting tests to evaluate emergency landing systems, such as parachutes or airbags, to ensure their functionality and effectiveness. Crash tests may also be conducted to assess the hoverbike's crashworthiness and the protection it provides to occupants in the event of an accident. These tests help identify any potential safety issues and guide design improvements to enhance occupant protection.

### *E. Data Analysis and Performance Validation:*

Throughout the experimental testing phase, extensive data is collected, including flight data, sensor readings, and performance metrics. This data is analysed and compared against design specifications and performance targets. Statistical analysis techniques, data visualization tools, and performance modelling are utilized to validate the hoverbike's performance, identify areas of improvement, and inform design modifications or optimizations.

By conducting comprehensive experimental testing, including flight testing, stability and control evaluation, payload and endurance testing, safety testing, and data analysis, the hoverbike's performance, functionality, and safety can be thoroughly assessed. The insights gained from these tests drive further refinements in the design, ensuring the hoverbike meets the desired performance benchmarks and operational requirements.

## VII. SOFTWARE

In the design and fabrication of a hoverbike project, the Pixhawk autopilot system is a commonly used platform for controlling and managing the vehicle's flight operations. The Pixhawk system relies on mission planner software, a powerful and versatile tool that enables the configuration, programming, and mission planning for the hoverbike.

Mission planner software acts as a user-friendly interface between the operator and the Pixhawk autopilot system, allowing for seamless communication and control. It provides a comprehensive set of features and functionalities to optimize the hoverbike's flight behavior, navigation, and overall mission execution. Here, we delve into the various aspects and capabilities of mission planner software used to code Pixhawk.

Fig 14 Mission Planner Interface

*A. Configuration and Setup:*

Mission planner software facilitates the initial configuration and setup of the Pixhawk autopilot system. This includes defining the vehicle type, sensor calibration, and specifying hardware connections. The software guides the user through a step-by-step process, ensuring proper setup and compatibility between the autopilot system and the hoverbike's components.

Fig 15 Configuration Setup

*B. Flight Modes and Behaviour:*

Mission planner software enables the customization of flight modes and behavior for the hoverbike. It allows the operator to define different flight modes, such as manual mode, stabilize mode, altitude hold mode, loiter mode, or waypoint navigation mode. These flight modes determine how the hoverbike responds to user input and autopilot commands, ensuring precise control and stability during various flight operations.

*C. Waypoint Planning and Mission Execution:*

One of the key features of mission planner software is the ability to plan and execute complex missions for the hoverbike. Using a graphical interface, the operator can define waypoints, specify flight paths, and set mission parameters. The software supports both simple waypoint navigation and more advanced mission planning with commands like loiter, takeoff, land, or trigger events. This functionality allows for autonomous and precise mission execution.

*D. Telemetry and Real-Time Monitoring:*

Mission planner software provides real-time telemetry and monitoring capabilities, allowing the operator to view critical flight data and monitor the hoverbike's status during mission execution. This includes live information on altitude, speed, GPS position, battery voltage, motor performance, and sensor readings. The software presents the data in a user-friendly graphical interface, aiding in decision-making and ensuring safe and efficient hoverbike operation.

*E. Data Logging and Analysis:*

Mission planner software allows for data logging and analysis, capturing detailed flight data for post-flight analysis and evaluation. The software records essential flight parameters and sensor readings, which can be later analyzed to assess performance, diagnose issues, and optimize flight operations. This data-driven approach enables iterative improvements and refinement of the hoverbike design.

ISSN No:-2456-2165

*F. Firmware Updates and Integration:*

Mission planner software supports firmware updates for the Pixhawk autopilot system, ensuring compatibility with the latest features, bug fixes, and system enhancements. The software provides an intuitive interface to manage firmware updates, ensuring the hoverbike remains up-to-date with the latest software developments. It also supports integration with other systems or peripherals, allowing for additional functionalities and customization.

*G. Simulation and Testing:*

Mission planner software often includes simulation capabilities, enabling the operator to test and validate hoverbike missions in a virtual environment before actual flight. This feature allows for safe and cost-effective testing, fine-tuning mission parameters, and verifying the performance of the hoverbike under various scenarios. Simulation helps reduce risks and refine mission plans before deploying the hoverbike in real-world situations.

Overall, mission planner software plays a crucial role in the design and fabrication of a hoverbike project using the Pixhawk autopilot system. It empowers the operator with a comprehensive set of tools for configuring, programming, planning, and executing missions, ensuring precise control, safety, and optimization of the hoverbike's flight operations.

## VIII. FUTURE DIRECTIONS AND ADVANCEMENTS

As hoverbike technology continues to evolve, there are several promising future directions and potential advancements that can further enhance the performance, capabilities, and safety of hoverbikes. These advancements involve advancements in propulsion systems, materials, control systems, and operational integration.

*A. Electric Propulsion Advancements:*

Electric propulsion systems are expected to see significant advancements in the future. Improved battery technologies, such as higher energy density and faster charging capabilities, will enable longer flight durations and reduced downtime for recharging. Advancements in electric motor designs, including higher power-to-weight ratios and improved efficiency, will enhance the hoverbike's thrust generation capabilities. Additionally, the integration of regenerative braking systems can help improve energy efficiency and extend battery life.

*B. Autonomous Control Systems:*

The development of advanced autonomous control systems will enable hoverbikes to operate with increased autonomy and reliability. Incorporating artificial intelligence (AI) algorithms and machine learning techniques will enhance the hoverbike's ability to perceive its environment, make intelligent decisions, and adapt to changing conditions. Autonomous control systems can enhance operational safety, enable precise navigation, and facilitate coordinated flight in complex airspace.

*C. Materials Advancements:*

Advancements in materials science will contribute to the development of lighter, stronger, and more durable hoverbike components. Lightweight composite materials with improved mechanical properties, such as carbon fiber composites or advanced polymers, can reduce the weight of the hoverbike without compromising structural integrity. These advancements will enhance maneuverability, payload capacity, and overall performance.

*D. Safety Systems:*

Safety remains a critical focus for hoverbike advancements. Integration of advanced safety systems, such as collision avoidance technology, redundant flight control systems, and emergency landing systems, can enhance operational safety and mitigate potential risks. Sensor technologies, including radar, lidar, and advanced vision systems, can provide enhanced situational awareness and help prevent accidents.

*E. Integration with Urban Air Mobility:*

Hoverbikes have the potential to play a role in the emerging field of urban air mobility (UAM). Advancements in UAM infrastructure, including dedicated landing pads, air traffic management systems, and communication networks, will enable the safe and efficient integration of hoverbikes into urban airspace. Seamless integration with existing transportation systems, such as integrating with ride-sharing platforms or connecting with public transportation networks, will enhance the overall usability and accessibility of hoverbikes.

*F. Sustainability and Green Technologies:*

The development of sustainable and environmentally friendly hoverbike technologies is gaining attention. Advancements in electric propulsion and the utilization of renewable energy sources, such as solar or hydrogen fuel cells, can significantly reduce the carbon footprint associated with hoverbike operations. Integration of eco-friendly materials and manufacturing processes will contribute to more sustainable hoverbike production.

*G. Advanced Human-Machine Interface:*

Improvements in human-machine interface technologies will enhance the user experience and operator control. Advancements in haptic feedback systems, augmented reality displays, and intuitive control interfaces will provide pilots with enhanced situational awareness and improved control capabilities. These advancements will make hoverbikes more user-friendly and increase their acceptance among a broader range of users.

By focusing on these future directions and advancements, the hoverbike industry can unlock new possibilities, improve performance, enhance safety, and contribute to the development of innovative transportation solutions.

ISSN No:-2456-2165

## IX. RESULTS AND DISCUSSION

In the testing phase of our Hoverbike prototype model, which incorporated an overlapped configuration and was loaded with a 2.5 kg payload, we observed that the stability of the hoverbike did not meet our initial expectations. However, despite the stability concerns, the model demonstrated successful flight performance and exhibited commendable endurance. These results indicate the potential of the hoverbike design but highlight the need for further investigation and modifications to improve stability.

The successful flight performance of the hoverbike with the 2.5 kg payload showcases the effectiveness of the propulsion system and power management. The hoverbike demonstrated the capability to lift the payload and maintain controlled flight, indicating the adequacy of the selected motors and power source. The endurance exhibited by the prototype indicates that the hoverbike can sustain flight for a satisfactory duration, which is encouraging for its practical applications.

However, the observed instability necessitates a closer examination of the structural design. The identified stability issues prompt us to investigate potential areas of improvement and modification in the hoverbike's structure. These modifications may include adjustments to the frame, landing gear, or overall weight distribution. By addressing the stability concerns through structural changes, we aim to enhance the hoverbike's maneuverability, control, and overall flight stability.

Furthermore, additional analysis and simulations will be conducted to identify the specific causes of the stability issues. Computational fluid dynamics (CFD) simulations can provide insights into the aerodynamic characteristics of the hoverbike, such as airflow patterns, drag, and lift distribution. These simulations can help us pinpoint areas where improvements are needed and guide us in making informed design modifications.

The results also highlight the iterative nature of hoverbike development. It is important to recognize that the initial prototype serves as a foundation for further improvements and refinement. By identifying the shortcomings in stability, we can gather valuable insights that will inform the design iterations required to achieve the desired stability performance.

Future testing and validation will focus on evaluating the impact of the proposed structural changes on the hoverbike's stability. Rigorous flight testing, including controlled maneuvers and stability assessments, will be conducted to validate the effectiveness of the modifications. Continuous monitoring of flight data and real-time feedback from onboard sensors will provide valuable information for further adjustments and optimizations.

It is worth noting that achieving stability in hoverbike design is a complex task influenced by multiple factors, including aerodynamics, weight distribution, control systems, and pilot input. Therefore, a holistic approach that considers all these elements is crucial in addressing the stability challenges.

## X. CONCLUSION

In conclusion, the testing of the prototype hoverbike with an overlapped propeller configuration has revealed significant challenges regarding stability, which prevent the successful fabrication of a viable model. Despite initial enthusiasm and optimism surrounding the concept, the experimental results have highlighted critical design flaws that hinder the hoverbike's stability and performance.

The overlapping propeller configuration was expected to enhance the hoverbike's maneuverability, speed, and overall efficiency. However, it became evident during testing that this design choice introduced inherent instability issues. The overlapping propellers created turbulent airflows and uneven thrust distribution, leading to erratic movements and unpredictable behavior during flight.

The lack of required stability poses significant safety concerns and prevents the prototype from being suitable for practical use or commercial production. The risks associated with an unstable hoverbike could lead to accidents, injuries, and potential fatalities. Therefore, it is crucial to address these stability issues and reevaluate the design concept thoroughly before proceeding with further development.

The findings from the testing phase serve as valuable feedback for future iterations and improvements. The development team should now focus on reassessing the hoverbike's overall design, exploring alternative propulsion systems, and implementing advanced control algorithms to ensure stability and maneuverability.

Additionally, it is essential to conduct further research and testing to identify the specific factors contributing to the instability and devise appropriate solutions. Collaborations with experts in aerodynamics, control systems, and vehicle stability would greatly aid in resolving the challenges associated with the overlapped propeller configuration.

While the current testing results may be disappointing, they are an integral part of the iterative design process. Recognizing and addressing the limitations and failures of the prototype will guide future developments and bring us closer to a functional, stable, and safe hoverbike model.

In conclusion, the testing of the prototype hoverbike with an overlapped propeller configuration has revealed substantial stability issues that prevent the fabrication of a viable model. However, by learning from these challenges and taking them into account during the redesign process, we can pave the way for significant improvements and eventually achieve a stable and successful hoverbike design.

ISSN No:-2456-2165

**REFERENCES**


[1]. Ankit Zade R, Rishikesh Ugale R, Shubham S 2020, 'Fabrication and Testing the Prototype of Hoverbike', International Journal of Advance Research and Innovative Ideas in Education, vol. 6, no. 3, pp. 1044-1047.

[2]. Arshad Q, Nishad S, Labeed P, Umair S 2021, 'Hoverbike Design Analysis and Prototype', Journal of Emerging Technologies and Innovative Research (JETIR), vol. 8, no. 10, pp. 93-100.

[3]. Aditya Intwala M 2015, 'Design and Analysis of Vertical Takeoff and Landing Vehicle (VTOL)', International Journal of Applied Engineering Research, vol 10, no. 11, pp. 28955-28962.

[4]. Ali Rohan, Rabah M, Talha M 2019, 'Advanced Drone Battery charging system', Journal of electrical engineering and technology, vol. 8, no. 3, pp. 42-68.

[5]. Apurv S, Akash kumar, Aishwary kumar S 2018, 'Face Recognition Drone', Institute of Electrical and Electronics Engineers (IEEE) vol. 2, no. 1, pp. 1-5.

[6]. Abhay N 2018, 'Study of Construction and Working of Hoverbike', International Research Journal of Engineering and Technology (IRJET), vol. 5, no. 5, pp. 4287-4293.

[7]. Berk K, Arabul A 2021,'Sizing, Design and Analysis of Fixed Wing Unmanned Aerial Vehicle's Wing', University of Waterloo, London, vol. 25, no. 27, pp. 74-81.

[8]. Brescianini D, Raffaello Andrea D 2016, 'Design Modeling, and Control of an Omni-directional Aerial vehicle', IEEE, International Conference on Robotics and Automation (ICRA), pp. 3261–3266.

[9]. Dinesh S 2015, 'A Review of Security Threats of Unmanned Aerial Vehicles and Mitigation Steps', Science and Technology Research Institute for Defence, pp. 23-31.

[10]. Eleftheria M, Spiridon G 2017, 'Classification of Drones', Aericam Journal of Engineering Research (AJER), vol. 6, no. 7, pp. 36-41.

[11]. Emad E, Martin Skriver, Jin J 2017, 'A survey on open-source flight control platforms of unmanned aerial vehicle', Institute of Electrical and Electronics Engineers (IEEE), pp. 396-402.

[12]. Gong, Ding J, Wang L, 'Propeller–Duct Interaction on The Wake Dynamics of a Ducted Propeller', Physics of Fluids, vol. 33, no. 7, pp. 1-13.

[13]. Farina P, Rossi G, Casagli N 2017, 'The Use of Multi-copter Drones for Land Slide Investigations', Association of Environmental and Engineering Geologists, vol. 4, no. 8, pp. 978-984.

[14]. Hoffmann, Gabriel, Huang, Haomiao, Waslander, Steven, Tomlin, Claire 2007, 'Navigation, and Control Conference and Exhibit - Quadrotor Helicopter Flight Dynamics and Control: Theory and Experiment', American Institute of Aeronautics and Astronautics (AIAA), pp. 1-20.

[15]. Indriyano T, Ibrahim Jennie Y 2010, 'Modeling and Simulation of a Ducted Fan Unmanned Aerial Vehicle (UAV) Using X-Plane Simulation Software', Regional Conference on Mechanical and Aerospace Technology.

[16]. Junyan Hu, Lanzon, Alexander 2018, 'An innovative tri-rotor drone and associated distributed aerial drone swarm control', Robotics and Autonomous Systems, pp. 162–174.

[17]. Jeroen A, Ligthart J, Poksawat P, Wang L, Henk N 2017, 'Experimentally Validated Model Predictive Controller for a Hexacopter', IFAC, pp. 4076-4081.

[18]. Jalu Prakosa A, Samokhvalov V, Gabino R 2019, 'Speed control of brushless DC motor for quad copter drone ground test' Institute of Electrical and Electronics Engineers (IEEE), pp. 644-648.

[19]. Kyung-Jae N, Joung J, Dongsoo H 2020, 'Tri-Copter UAV With Individually Tilted Main Wings for Flight Maneuvers', IEEE Access, vol. 8, pp. 46753–46772.

[20]. Lin, Chin E,Supsukbaworn, Thanakorn 2017, Development of Dual Power Multirotor System. International Journal of Aerospace Engineering, pp. 1–19.

[21]. Medeiros V, Ramos G, Nascimento J, Lima Filho C 2018, 'A Novel Approach for Brushless DC Motors Characterization in Drones Based on Chaos' American Institute of Aeronautics and Astronautics (AIAA), vol. 2, no.18, pp. 1-11.

[22]. Ozdemir U, Aktas Y, Vuruskan, Aslihan, Dereli 2014, 'Design of a Commercial Hybrid VTOL UAV System' Journal of Intelligent & Robotic Systems, pp. 371–393.

[23]. Ong W, Srigrarom S, Hesse H 2019, 'Design Methodology for Heavy-Lift Unmanned Aerial Vehicles with Coaxial Rotors', American Institute of Aeronautics and Astronautics (AIAA), pp. 1-13.

[24]. Paranjape, Aditya A, Chung, Soon-Jo 2013, 'Dihedral-Based Control of Flapping-Wing Aircraft with Application to Perching' IEEE Transactions on Robotics, vol. 29, no. 5, pp. 1071–1084.

[25]. Robin K, Tobias B, Fischer L 2019, 'Drones for parcel and passenger transportation', Transportation Research Interdisciplinary Perspectives, pp. 1-13.

[26]. Swaraj Lewis D, Noel Shiri D, Vikesh K, Sonali C 2016, 'Fabrication and Testing of Scaled Prototype of Hoverbike' Journal of Mechanical Engineering and Automation, vol. 6, no. 5A, pp. 71-74.

[27]. Sababha, Belal H, Hamzeh M, Rawashdeh, Osamah A 2015, 'A rotor-tilt-free tricopter UAV: design, modeling, and stability control' International Journal of Mechatronics and Automation, vol. 5, pp. 107-113.

[28]. Sarghini F, De Vivo A 2017, 'Analysis of preliminary design requirements of a heavy lift multirotor drone for agriculture use' Italian Association of Chemical engineering, pp. 625-630.

[29]. Sadath Hussain, Arjun P, Mannat K, Raju B.S 2014, 'Optimization of a Quad Rotor Aircraft for a Stable Flight', Journal on Science Engineering and Technology, vol. 1, no. 2, pp. 471- 480.

[30]. Tshar K, Kamarudin S 2016, 'UAV Onboard GPS In Positioning Determination', The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, pp. 1037-1042.

[31]. Umamaheswara Rao M, Deepak 2018, 'Review on Application of Drone Systems in Precision

Agriculture', International Conference on Robotics and Smart Manufacturing, vol. 113, pp. 502-509.

[32]. Wei He, Xinxing Mu, Liang Zhang 2021, 'Modeling and Trajectory Tracking Control for Flapping-Wing Micro Aerial Vehicles', IEEE/CAA Journal of Automatica Sinica, vol. 8, pp. 148-156.

[33]. Yazid Y, Zazi I, Guerrero-Gonzalez A, Oualkadi A, Arioua M 2021, 'UAV-Enabled Moblie Edge-Comuting for IoT Based on AI Comprehensive Review. Drones', International Journal of Aerospace Engineering, pp. 1-30.

[34]. Yilmaz S, Erdem D, Kavsaoglu M 2013, 'Effects of Ducts shape on a Ducted Propeller Performance', American Institute of Aeronautics and Astronautics (AIAA), pp. 1-11.

[35]. Zhang Q, Rajeev Jaiman K 2019, 'Numerical Analysis on the Wake Dynamics of a Ducted Propeller', Ocean Engineering, pp. 202-224.