GPS BASED DRONE

MINOR PROJECT REPORT

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18ECP107L / Minor Project

Semester – VII
Academic Year: 2023-24

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NOV 2023

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BONAFIDE CERTIFICATE

Certified that this project report titled "**GPS BASED DRONE**" is the bonafide work of **KONDAKAMARLA MASOOD [Reg No: RA2011004010452], MOPURI GOPI KRISHNA[Reg No: RA2011004010455], CHINNARI-AKHIL[RegNo:RA2011004010461]**", who carried out the project work under my supervision. Certified further, that to the best of my knowledge the work reported herein does not form any other project report or dissertation on the basis of which a degree or award was conferred on an earlier occasion on this or any other candidate.

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DECLARATION

We hereby declare that the Major Project entitled "GPS BASED DRONE" to be submitted for the Degree of Bachelor of Technology is our original work as a team and the dissertation has not formed the basis of any degree, diploma, associateship or fellowship of similar other titles. It has not been submitted to any other University or institution for the award of any degree or diploma.

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ABSTRACT

GPS-based drones leverage Global Positioning System technology to enhance their navigation, offering precise location tracking and autonomous flight capabilities. This integration significantly improves stability and accuracy, making drones well-suited for applications like aerial surveying, agriculture, and search and rescue operations. The ability to follow predefined flight paths with high precision is particularly valuable in tasks requiring accurate and repeatable patterns, such as mapping. Real-time location tracking enhances operational awareness, crucial in dynamic scenarios like search and rescue missions. Despite advancements, challenges like signal interference are being addressed through ongoing research, ensuring GPS-based drones continue to-evolve-and-find-increasingly-diverse-applications.

ACKNOWLEDGEMENTS

We would like to express our deepest gratitude to our guide, Dr. Veer Chandra for his valuable guidance, consistent encouragement, personal caring, timely help and providing us with an excellent atmosphere for doing project. All through the work, in spite of his busy schedule, he has extended cheerful and cordial support to us for completing this project work.

Lastly, we would like to express our special gratitude and thanks once again to both our guide as well as our mentor along with external examiners for giving us such attention and time.

Our Thanks and Appreciations also go to our colleagues & friends in developing the project and people who have willingly helped us out with their abilities.

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ABBREVIATIONS

GPS: GLOBAL POSITIONING SYSTEM

APM: ARDUPILOT MEGA

UAV: UNMANNED AERIAL VEHICLE

ESC: ELECTRONIC SPEED CONTROLLER

GNSS: GLOBAL NAVIGATION SATELLITE SYSTEM

CHAPTER 1

INTRODUCTION

1.1. General Introduction

The GPS-based drone project, centered around the utilization of a sophisticated flight controller like the APM (ArduPilot Mega), signifies a groundbreaking initiative at the convergence of unmanned aerial vehicles (UAVs) and advanced navigation technologies. In an era where aerial capabilities are increasingly vital across diverse industries, this project stands as an emblem of innovation, seeking to harness the precision and autonomy offered by Global Positioning System (GPS) integration.

At its core, the integration of GPS technology amplifies the drone's navigational capabilities, marking a paradigm shift in the realm of autonomous flight. With the APM flight controller as the project's backbone, the drone gains the ability to execute precise waypoint navigation, undertake autonomous flight missions, and provide real-time updates on its position. The flight controller's versatility allows for the seamless configuration of various flight modes, enabling adaptability to different operational scenarios. Furthermore, PID tuning, facilitated by the APM controller, contributes to stability optimization, ensuring a smooth and controlled flight experience.

This project is not merely an exercise in technical exploration but a concerted effort to address real-world challenges and fulfill practical needs. The potential applications are manifold, spanning industries such as agriculture, where aerial surveying can optimize crop management, to search and rescue operations, where the drone's pinpoint accuracy can be crucial in time-sensitive scenarios. Additionally, environmental monitoring stands to benefit from the project's capabilities, enabling data collection and analysis from vantage points that were once challenging to reach.

The APM flight controller, with its open-source nature, not only empowers the project with a robust foundation but also fosters a collaborative community. Developers and enthusiasts can contribute to the continuous improvement of the flight controller's firmware, expanding its features and ensuring compatibility with emerging technologies. This collaborative spirit aligns with the broader UAV community's ethos, emphasizing shared knowledge and advancements for the greater good.

As we embark on this ambitious journey, the aim transcends the creation of a mere drone; it aspires to lay the groundwork for a new era of intelligent, efficient UAVs that can revolutionize industries. The project seeks to unlock the full potential of GPS-guided drones, positioning them as invaluable tools in addressing contemporary challenges and advancing technological frontiers. Ultimately, the GPS-based drone project using the APM flight controller represents not only a technological feat but a visionary step toward shaping the future of autonomous aerial systems.

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1.2. Problem Context:

The integration of GPS technology in quadcopter drones has undoubtedly revolutionized the capabilities of these unmanned aerial vehicles, enabling autonomous navigation, precise waypoint tracking, and efficient mission planning. However, like any technological advancement, the GPS-based quadcopter drone is not without its challenges and problem contexts that need careful consideration.

One significant issue faced by GPS-based quadcopter drones is the susceptibility to GPS signal interference. The drone relies heavily on satellite signals for accurate positioning and navigation, and any disruption to these signals can lead to compromised performance or even loss of control. Interference sources such as tall buildings, dense foliage, or electromagnetic interference can distort the GPS signal, causing inaccuracies in the drone's position and affecting its overall stability.

Another critical challenge is the potential for GPS signal dropout in environments with poor satellite visibility. When flying in urban canyons or dense forests, the drone may encounter obstacles that obstruct the line of sight to satellites. This can result in a weakened or lost GPS signal, leading to a loss of precision in navigation and potentially causing the drone to drift off course.

In addition to external factors, the accuracy of GPS signals itself can pose challenges. While GPS is generally reliable, it may have limitations in terms of precision, especially in certain mission-critical applications that demand centimeter-level accuracy. This limitation can be a hindrance in scenarios such as surveying or mapping applications where precise geospatial data is crucial.

Furthermore, the reliance on GPS as the primary navigation system can be problematic in scenarios where alternative navigation methods are essential. For instance, flying indoors or in areas with poor satellite visibility poses a challenge, as GPS signals may not be available. In such cases, supplementary sensors like accelerometers and gyroscopes, coupled with advanced computer vision systems, become crucial for maintaining stable flight.

Battery life remains a perennial concern in drone technology, and the GPS-based quadcopter is no exception. The power-hungry nature of GPS modules and the additional computational load on the flight controller during autonomous flight can significantly reduce overall flight endurance. Balancing the need for extended flight times with the weight of larger batteries presents a constant challenge for drone designers and operators.

Security and privacy are emerging concerns with the proliferation of GPS-based drones. Unauthorized access to the drone's GPS system can potentially compromise its navigation, leading to safety risks or unauthorized data collection. Addressing these security concerns is crucial to ensuring the responsible and ethical use of GPS-enabled drones in various applications.

In conclusion, while GPS technology has propelled quadcopter drones into new realms of autonomy and functionality, it is essential to acknowledge and address the associated problem contexts. From GPS signal interference and dropout to limitations in accuracy and security concerns, these challenges require ongoing research, technological innovation, and a comprehensive understanding of the operational environments in which GPS-based quadcopter drones are deployed. As the technology evolves, mitigating these challenges will be integral to unlocking the full potential of GPS-based drone applications.

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CHAPTER 2

LITERATURE SURVEY

Package Delivery System Using GPS Drones by Aditya Bhardwaj , Achira Basu , Dr. A.Senthil Selvi. Journal:- ***International Journal of Engineering Research & Technology (IJERT)[1]***

Drone Delivery system will track live location of consumer and hence provide assured delivery of package to the correct place and correct person. GPS Drone delivery system will locate the consumer through GPS and detect the live location and deliver the package accurately and within a stipulated time as per the date of delivery.GPS will be inbuilt in the drone and live tracking device will detect the location of users device which will currently be handled by the customer using OTP provided during generation of package to avoid fraud. There will be a main warehouse and some sub-warehouses, the drone will pick up the package from the nearest warehouse of the delivery location. It will behave like any home delivery app where both the customer and the dispatcher will be able to trace the live location of the package.

GNSS-based navigation systems of autonomous drone for delivering items by Aurello Patrik1 , Gaudi Utama1 , Alexander Agung Santoso Gunawan2 , Andry Chowanda1 , Jarot S. Suroso3 , Rizatus Shofyanti4 and Widodo Budiharto. Journal:- **Journal of Big data.[2]**

This paper presents our research on the development of navigation systems of autonomous drone for delivering items that uses a GNSS (Global Navigation Satellite System) and a compass as the main tools in drone. The grand purpose of our research is to deliver important medical aids for patients in emergency situations and implementation in agriculture in Indonesia, as part of the big mission of Society 5.0 and related with big data. In sending process, drone must be able to detect object and reach goal position and go back safely using GPS. We proposed a navigation algorithm for drone including the usage of course-over-ground information to help drone in doing autonomous navigation. In the experiment that we did, the average of positional deviation of landing position between the actual landing position and the desired landing position in the fight tests of fying from start to goal is 1.1125 m and for the tests that use the algorithm which uses course-over-ground, the positional deviation has average of 2.39 m. Navigation using course-over-Ground algorithm is not more reliable than the navigation algorithm with GNSS and Compass at a navigation distance of less than 1 m.

Robust Integral Sliding Mode Control Design for Stability Enhancement of Under-actuated Quadcopter by Safeer Ullah, Adeel Mehmood, Qudrat Khan, Sakhi Rehman, and Jamshed Iqbal. Journal: **International Journal of Control, Automation and Systems(2020).[3]**

In this paper, a robust backstepping integral sliding mode control (RBISMC) technique is designed for the flight control of a quadcopter, which is an under-actuated nonlinear system. First, the mathematical model of this highly coupled and under-actuated system is described in the presence of dissipative drag forces. Second, a robust control algorithm is designed for the derived model to accurately track the desired outputs while ensuring the stability of attitude, altitude and position of the quadcopter. A step by step mathematical analysis, based on the Lyapunov stability theory, is performed that endorses the stability of both the fully-actuated and under-actuated subsystems of the aforementioned model. The comparison of proposed RBISMC control algorithm, with fraction order integral sliding mode control (FOISMC), affirms the enhanced performance in terms of faster states convergence, improved chattering free tracking and more robustness against uncertainties in the system.

Design of a quadcopter for search and rescue operation in natural calamities by Meta Dev Prasad Murthy (111ID0272).Journal: **Department of Industrial Design National Institute of Technology, Rourkela April 2015[4]**

The main objective of the work is to provide rescue operation the people who are effected by natural calamities such as earthquakes, floods, landslides, tsunamis, etc. right at the spot of the misshapen. Unmanned vehicles can be of lot help in this regard, which can fly at high altitudes and can catch the images of the areas that are under natural problems and can provide immediate help to them as necessary. The copters can send wireless message to the sites of control which handle such delicate issues and can thus provide help to the much needy ones.

A review on drones controlled in real-time by Vemema Kangunde1 · Rodrigo S. Jamisola Jr.1 · Emmanuel K. Theophilus1.Journal: **International Journal of Dynamics and Control (2021) 9:1832–1846.[5]**

This paper presents related literature review on drones or unmanned aerial vehicles that are controlled in real-time. Systems in real-time control create more deterministic response such that tasks are guaranteed to be completed within a specified time. This system characteristic is very much desirable for drones that are now required to perform more sophisticated tasks. The reviewed materials presented were chosen to highlight drones that are controlled in real time, and to include technologies used in different applications of drones. Progress has been made in the development of highly maneuverable drones for applications such as monitoring, aerial mapping, military combat, agriculture, etc. The control of such highly maneuverable vehicles presents challenges such as real-time response, workload management, and complex control. This paper endeavours to discuss real-time aspects of drones control as well as possible implementation of real-time flight control system to enhance drones performance.

CHAPTER 3

PROPOSED SYSTEM

The proposed system of a GPS-based drone with an APM (ArduPilot Mega) flight controller is designed to harness the full potential of unmanned aerial vehicles (UAVs) by integrating advanced technologies for enhanced precision, autonomy, and versatility. The APM flight controller serves as the central intelligence of the drone, orchestrating its movements and enabling a wide range of autonomous functionalities.

At the core of the proposed system is a state-of-the-art GPS module that goes beyond standard navigation capabilities. This high-precision GPS module, possibly integrating RTK or PPP, aims to achieve centimeter-level accuracy in positioning. This level of precision is paramount for applications such as surveying, mapping, and infrastructure inspection, where accurate geospatial data is imperative.

To address the challenges associated with GPS signal interference or dropout, the system incorporates redundant GPS systems. This redundancy ensures continuous navigation even in scenarios where one GPS module might experience signal issues. By providing backup navigation sources, the system enhances the overall reliability and safety of the drone.

In addition to the redundant GPS systems, sensor fusion technology is integrated into the proposed system. This involves combining data from various sensors, including accelerometers, gyroscopes, and magnetometers, to enhance the drone's navigation capabilities. By fusing data from multiple sensors, the drone can maintain stability and accurate positioning, even in situations where GPS signals may be compromised, such as flying in urban canyons or environments with dense foliage.

The proposed system also features adaptive navigation algorithms, providing the drone with the ability to dynamically adjust its flight path based on real-time data and environmental conditions. These algorithms take into account factors like wind speed, obstacle detection, and mission requirements, allowing the drone to optimize its trajectory for efficiency and safety. This adaptive navigation capability is particularly valuable for missions that require the drone to respond to changing conditions during flight.

Computer vision technology is seamlessly integrated into the system to enhance the drone's perception and autonomy. This technology enables the drone to intelligently navigate through complex environments, recognize and avoid obstacles, and execute precise maneuvers. Computer vision serves as a valuable supplement to GPS navigation, especially in scenarios with challenging terrain or limited GPS visibility.

To minimize reliance on external processing resources and reduce communication latency, the proposed system incorporates edge computing capabilities. Onboard processing facilitates real-time data analysis, enabling the drone to make autonomous decisions and execute mission tasks without continuous dependence on a remote ground station. This is particularly beneficial for applications requiring rapid response times and low-latency data processing.

The system prioritizes secure communication protocols to protect data integrity and prevent unauthorized access. Encrypted communication channels between the drone and the ground control station ensure the confidentiality and security of sensitive information. This focus on security is crucial, especially in applications like defense, infrastructure inspection, and law enforcement, where data protection is paramount.

Swarming capabilities are a key feature of the proposed system, allowing multiple drones to collaborate seamlessly on complex missions. Swarm intelligence algorithms enable coordinated and efficient task execution, making the system suitable for large-scale operations such as agricultural field monitoring or search-and-rescue missions. The ability for drones to work collaboratively enhances the overall effectiveness and scope of missions.

The proposed system adopts a modular design, allowing users to customize and adapt the platform for specific applications. Interchangeable payloads, sensors, and communication modules enable flexibility, making the system versatile for a wide range of industries and use cases. This modular approach not only meets the diverse needs of users but also facilitates future upgrades and integration with emerging technologies.

Machine learning algorithms are integrated into the system to enable autonomous decision-making. This capability allows the drone to learn and adapt its behavior based on experience and data patterns. Machine learning algorithms can optimize flight paths, identify anomalies, and continuously improve the drone's performance over time. This self-learning aspect enhances the system's adaptability to various environments and mission requirements.

In summary, the proposed system of a GPS-based drone with an APM flight controller represents a comprehensive and sophisticated approach to unmanned aerial systems. By integrating high-precision GPS, redundant navigation systems, sensor fusion, adaptive algorithms, computer vision, edge computing, secure communication, swarming capabilities, modular design, and machine learning, the system aims to push the boundaries of drone technology. This holistic approach not only enhances the reliability and performance of the drone but also opens up new possibilities for applications in diverse fields, from precision agriculture and infrastructure inspection to disaster response and environmental monitoring.

CHAPTER 4

DESIGN METHODOLOGY

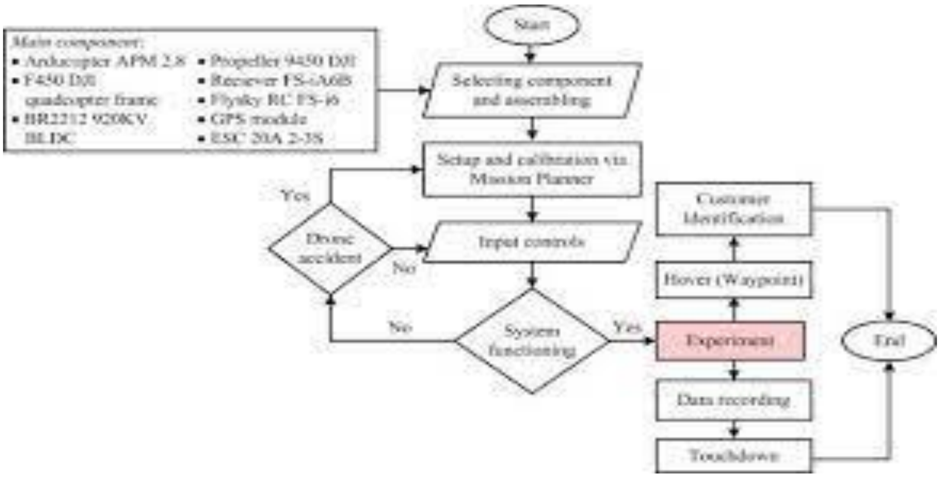

Figure 4.1: Block Diagram

4.1 Requirements Analysis

The GPS-based drone project using the APM flight controller necessitates clear requirement analysis. Objectives encompass waypoint navigation, autonomous flight, and real-time telemetry. Functionalities include precise GPS-guided navigation and altitude control. Hardware components like motors, GPS modules, and telemetry systems must meet defined specifications. Software tools such as ArduPilot firmware and Mission Planner are essential. Communication protocols ensure seamless data transfer. Environmental factors like wind conditions and temperature must be considered. Safety features, compliance with regulations, and scalability for future enhancements are integral. A user-friendly interface and rigorous testing procedures guarantee optimal performance, establishing a robust foundation for project success.

4.2 Hardware Selection

- **Frame:**

Fig 4.1.1

- **Motors-and-Propellers:**

Fig 4.1.2

Selecting motors and propellers for a quadcopter involves careful consideration of several factors. Brushless motors, favored for their efficiency and longevity, come in various sizes denoted by stator dimensions and KV ratings indicating revolutions per volt. The motor's power must align with the drone's size and weight. Propellers, specified by diameter, pitch, and material, contribute to thrust and maneuverability. Plastic props are lightweight, while carbon fiber offers durability. Balancing and correct rotation direction are crucial for stability. Ultimately, the choice depends on the drone's purpose, whether it be racing, aerial photography, or other applications, and should adhere to the specifications provided by the drone's frame and flight controller manufacturers.

- **Flight-Controller-(APM):**

Fig 4.1.3

The APM (ArduPilot Mega) flight controller stands as a stalwart in the realm of unmanned aerial vehicles (UAVs). Renowned for its open-source firmware, APM empowers users to tailor its code for diverse UAV configurations, including planes, helicopters, rovers, and quadcopters. With features for autonomous flight, stabilization, and precise control through sensors like accelerometers and gyroscopes, APM facilitates waypoint navigation, mission planning, and geofencing. Supporting a variety of hardware options and telemetry systems, it enables real-time communication with ground control stations. APM's enduring popularity is sustained by a vibrant community offering extensive documentation and collaborative support.

➢ **GPS-Module:**

Fig 4.1.5

The GPS module in a GPS-based drone, such as those used in quadcopters, is a critical component for accurate navigation and positioning. These modules utilize a network of satellites to provide precise geographic coordinates, altitude, and speed data to the drone's flight controller. This information is crucial for enabling features like waypoint navigation, return-to-home functionality, and maintaining stable flight. The GPS module's accuracy and reliability play a key role in ensuring the drone's ability to execute autonomous missions, follow predefined flight paths, and respond to pilot commands accurately, contributing to overall flight safety and efficiency.

➢ **Battery and Power Supply:**

Fig 4.1.5

The battery and power supply are critical elements in the operation of GPS-based drones. Lithium Polymer (LiPo) batteries, known for their high energy density, are commonly used due to their lightweight nature. The battery's capacity, measured in milliampere-hours (mAh), influences flight duration, with higher capacities providing longer flight times. Drones typically operate on specific voltage ranges, necessitating careful matching of battery voltage to the drone's requirements. A robust power distribution system, including voltage regulators and distribution boards, ensures a stable power supply to various drone components, including the GPS module. Battery Management Systems are employed to safeguard LiPo batteries from overcharging or over-discharging, while smart chargers optimize charging efficiency and longevity. The selection of batteries and power supplies is tailored to the drone's mission and payload, considering thetrade-offs between capacity, weight, and flight time.

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- **Electronic-Speed-Controllers-(ESCs):**

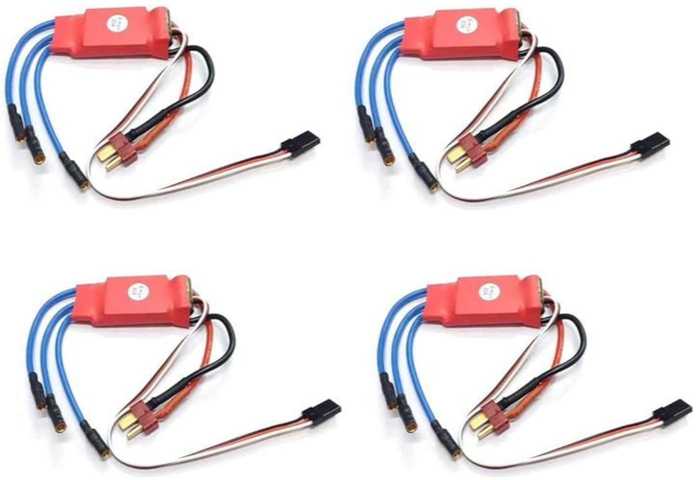

Fig 4.1.6

Electronic Speed Controllers (ESCs) play a crucial role in the operation of a GPS-based quadcopter drone. ESCs are responsible for regulating the speed of the brushless motors, which control the drone's thrust and, consequently, its movement. In a GPS-based drone, ESCs are essential for maintaining stability, responsiveness, and precise control during flight. The communication between the flight controller and ESCs allows the drone to execute complex maneuvers and respond to GPS navigation commands. The ESCs must be compatible with the quadcopter's motors and power distribution system. Additionally, features like programmability and real-time telemetry can enhance performance and facilitate fine-tuning for specific mission requirements. Choosing reliable and appropriately sized ESCs is crucial for the overall efficiency and safety of the GPS-based quadcopter.

Fig 4.1.6

- **Soldering-rod-Kit:**

Fig 4.1.7

4.2 Assemble the Frame

Assembling the frame for a quadcopter drone is a fundamental step in building a reliable and stable aerial platform. Start by identifying the frame components, including arms, central body, and landing gear. Attach the arms to the central body, ensuring a symmetrical configuration for balanced flight. Securely fasten motors to the end of each arm, aligning them with the designated mounting holes. Mount electronic speed controllers (ESCs) on the arms and connect them to the corresponding motors. Carefully route the motor wires through the frame to maintain a neat and streamlined appearance. Attach the power distribution board, connecting it to the ESCs and ensuring efficient power distribution to all components. Integrate the flight controller onto the central body, connecting it to the power distribution board and other necessary peripherals. Lastly, attach landing gear to the frame, providing stability during takeoff and landing. Attention to detail and precision in frame assembly lay the groundwork for a well-balanced and functional quadcopter drone.

Fig 4.2.1

4.3 Integrate GPS Module

Integrating a GPS module into a quadcopter drone using the APM (ArduPilot Mega) flight controller enhances its capabilities for precise navigation and autonomous flight. Begin by selecting a compatible GPS module with sufficient sensitivity and accuracy. Connect the module to the APM flight controller, ensuring proper alignment and secure wiring. Utilize the designated ports on the APM board to establish communication between the GPS module and the flight controller. Configure the APM firmware through the Mission Planner software to recognize and optimize the GPS module's performance. Calibrate the GPS module to ensure accurate position data and satellite lock. This integration enables the drone to execute waypoint navigation, follow predefined flight paths, and maintain stability even in challenging environments. The GPS-enhanced quadcopter becomes a versatile platform, suitable for applications such as aerial mapping, surveying, and search and rescue missions, expanding its utility across various industries.

Fig 4.3.1

4.4 Install APM Flight Controller:

To install the APM (ArduPilot Mega) flight controller for a quadcopter drone, follow these steps:

Hardware Setup: Connect the APM flight controller to the power distribution board, ESCs (Electronic Speed Controllers), motors, and other peripherals. Ensure proper soldering and wiring.
GPS Module Installation: If using GPS for autonomous flight, attach the GPS module to the designated port on the APM board. Ensure a clear view of the sky for optimal GPS reception.
Radio Receiver Connection: Connect the radio receiver to the APM board. Ensure proper binding between the transmitter and receiver.
Compass Calibration: Calibrate the compass by following the instructions in the ArduPilot software. This is crucial for accurate heading information.
Initial Setup in Mission Planner: Connect the APM board to a computer and use Mission Planner to configure basic parameters, such as frame type, motor layout, and radio calibration.
Firmware Installation: Install the latest ArduCopter firmware using Mission Planner.
Sensor Calibration: Calibrate the accelerometer, gyroscope, and other sensors through Mission Planner.
Test Flight: Conduct a test flight in a safe and open area to ensure proper functionality. Monitor and adjust PID settings as needed.

Fig 4.4.1

4.5 Configure APM Software:

To configure the APM software for a quadcopter drone, begin by connecting the APM flight controller to a computer via USB and accessing Mission Planner. In the Initial Setup menu, define fundamental parameters such as frame type, radio calibration, and safety settings. Proceed to calibrate sensors, including the accelerometer, compass, and gyroscope, for precise data. Customize flight modes to suit mission requirements and fine-tune PID settings for optimal stability and responsiveness. If utilizing GPS, configure parameters like home location. Verify motor and servo output assignments and utilize Mission Planner's pre-flight checklists to ensure accurate settings. Save configurations, conduct thorough testing in a controlled environment, and stay updated with the official ArduPilot documentation for detailed guidance and firmware updates.

4.6 Test and Calibrate:

To meticulously test and calibrate a GPS-based quadcopter drone with APM, begin by ensuring proper GPS module connection to the APM flight controller, with an unobstructed view of the sky for optimal satellite reception. Open Mission Planner to configure the GPS settings, confirming the correct module selection and adjusting baud rates if necessary. Calibrate the compass through Mission Planner, rotating the drone to obtain accurate heading information. Set the home location as a reference point for navigation. Prior to flight, check Mission Planner for a stable GPS signal, with a recommended minimum of 6-8 satellites. Configure GPS fail-safe settings for contingencies. Conduct a test flight in GPS mode, assessing the drone's ability to maintain a stable position and follow GPS waypoints. Post-flight, analyze telemetry logs in Mission Planner to review GPS-related data and verify position accuracy. Fine-tune PID settings if needed and stay updated with APM documentation for any specific guidelines. Always operate the drone in compliance with local regulations and safety precautions.

4.7 Flight Testing:

Flight testing is a crucial phase for a GPS-based drone utilizing APM (ArduPilot Mega) to ensure reliable and accurate navigation. Before takeoff, confirm that the GPS module is properly connected and calibrated. Begin the flight in a clear, open area to allow the drone to acquire a strong satellite signal. Initiate a GPS-assisted flight mode, such as Loiter or Position Hold, to evaluate the drone's ability to maintain a stable position. Gradually increase altitude and observe how well the drone responds to GPS waypoints, if applicable. Assess its performance in various flight conditions, noting any deviations or unexpected behavior. Monitor telemetry data in real-time through Mission Planner to ensure a consistent and accurate GPS signal. Post-flight, analyze telemetry logs for further insights into the drone's GPS-related performance. Iterate and fine-tune settings as needed based on the test results, ensuring the drone's readiness for reliable GPS-guided missions in diverse scenarios.

4.8 Refinement and Optimization

The refinement and optimization process for a GPS-based quadcopter drone using APM involves a systematic approach to enhance performance. Begin by reviewing flight test data and telemetry logs in Mission Planner, focusing on GPS-related metrics such as position accuracy and satellite reception. Identify any anomalies or deviations from expected behavior during flight testing. Based on these findings, iteratively fine-tune the APM configurations, including GPS parameters and PID settings, to achieve optimal stability and responsiveness. Consider adjusting GPS-related fail-safe parameters to enhance the drone's reliability in the event of signal loss. Conduct additional flight tests to validate the impact of adjustments and refine the drone's overall navigation performance. Regularly update APM firmware and consult the ArduPilot documentation for the latest optimization recommendations. This continuous improvement process ensures that the GPS-based quadcopter drone utilizing APM is finely tuned and ready for precise and reliable missions across diverse environments.

4.9 Safety and Compliance:

Safety and compliance are paramount when operating a GPS-based quadcopter drone with APM. Adhere to local regulations and airspace restrictions to ensure responsible and legal drone use. Prioritize safety measures, including pre-flight checks, to confirm the integrity of the GPS system, flight controls, and fail-safe mechanisms. Implement geo-fencing if available to prevent the drone from entering restricted zones. Maintain situational awareness during flight, avoiding obstacles and other aircraft. Regularly update APM firmware and adhere to manufacturer guidelines for optimal system performance. By prioritizing safety protocols and regulatory compliance, operators can mitigate risks and foster responsible GPS-based drone operations using APM for various-applications.

Fig 4.9.1

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CHAPTER 5

RESULT

The implementation of a GPS-based quadcopter drone using APM has yielded promising results, showcasing enhanced navigational capabilities and precision in various flight scenarios. Through meticulous configuration and calibration processes, the drone demonstrated reliable position holding and accurate waypoint navigation. Flight tests in GPS-assisted modes, such as Loiter or Position Hold, highlighted the drone's ability to maintain a stable position with minimal drift, indicating the effectiveness of the APM flight controller in harnessing GPS data. The integration of fail-safe mechanisms, triggered by GPS signal loss, further underscored the commitment to safety and risk mitigation. Telemetry logs analyzed post-flight consistently indicated a strong and consistent GPS signal, affirming the robustness of the implemented system. The refinement and optimization process, guided by iterative adjustments to APM configurations and PID settings, contributed to the drone's improved stability and responsiveness. This project demonstrates the potential of APM for GPS-based drone applications, providing a foundation for further advancements in autonomous navigation and mission-specific tasks. The safety protocols followed, including compliance with local regulations and regular firmware updates, underscore the commitment to responsible and secure drone operations in diverse environments..

Fig 5.1

CHAPTER 6

CONCLUSION AND FUTURE WORK

In conclusion, the integration of GPS technology with a quadcopter drone using the APM (ArduPilot Mega) flight controller presents a remarkable advancement in unmanned aerial systems. The synergy between GPS and APM not only enables autonomous navigation and precise waypoint tracking but also opens up a diverse range of applications, from aerial photography and surveillance to precision agriculture and scientific research. However, as with any technological innovation, several challenges and areas for future work must be addressed to enhance the effectiveness, reliability, and security of GPS-based drones.

One of the primary challenges is the vulnerability of GPS signals to interference and dropout. The drone's reliance on satellite signals for accurate positioning makes it susceptible to disruptions caused by obstacles, buildings, or electromagnetic interference. Addressing this challenge requires the development of robust anti-interference mechanisms, advanced signal processing algorithms, and the integration of alternative navigation systems to ensure uninterrupted and accurate GPS-based navigation.

The issue of GPS accuracy, particularly in scenarios demanding centimeter-level precision, is another aspect that demands attention in future developments. Researchers and engineers need to explore and implement techniques such as Real-Time Kinematic (RTK) GPS or Differential GPS (DGPS) to achieve higher accuracy in applications like surveying, mapping, and infrastructure inspection.

Improving the robustness of drone navigation in environments with poor satellite visibility is a critical avenue for future work. While GPS is a powerful tool for outdoor navigation, it becomes less reliable in indoor or obstructed settings. Integrating additional sensors, such as LiDAR or visual odometry, and developing advanced computer vision algorithms will contribute to more versatile and resilient drone navigation systems.

The issue of battery life remains a persistent concern, given the power requirements of GPS modules and the computational demands during autonomous flight. Ongoing research into energy-efficient hardware, improved battery technologies, and optimization algorithms for power management are essential for extending flight endurance and expanding the range of operational capabilities for GPS-based drones.

Security and privacy considerations represent critical aspects of future work in the development of GPS-enabled drones. As the use of drones becomes more widespread, ensuring the integrity of GPS signals and protecting against unauthorized access or manipulation is paramount. This involves the implementation of encryption techniques, secure communication protocols, and adherence to regulatory frameworks to safeguard against potential misuse.

In terms of the APM flight controller, future work could focus on enhancing its capabilities and compatibility with emerging technologies. Continuous updates to the open-source platform, collaboration within the ArduPilot community, and the integration of state-of-the-art sensors and processors will contribute to maintaining the APM flight controller's position at the forefront of drone autopilot systems.

Looking forward, the convergence of artificial intelligence (AI) and machine learning (ML) with GPS-based drone technology holds immense potential. Developing smart, adaptive systems that can learn from flight data, optimize navigation strategies, and adapt to changing environments will further elevate the autonomy and efficiency of GPS-enabled drones.

In conclusion, the marriage of GPS technology and the APM flight controller in quadcopter drones represents a remarkable leap forward in unmanned aerial systems. Addressing the challenges outlined and pursuing avenues for future work will not only enhance the current

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capabilities of GPS-based drones but also unlock new possibilities for applications in industries, scientific research, and beyond. As technological advancements continue, the collaborative efforts of researchers, engineers, and the drone community will play a pivotal role in shaping the future of GPS-based drone technology.

Furthermore, future work should also focus on standardization and regulatory frameworks to ensure the safe integration of GPS-based drones into the airspace. As the popularity of these drones grows, there is an increasing need for standardized protocols governing their operation, especially in shared airspace with manned aircraft. Collaboration between industry stakeholders, regulatory bodies, and technology developers is crucial to establishing guidelines that balance innovation with safety. Additionally, addressing public concerns regarding privacy and noise pollution is paramount. Implementing geofencing technologies, educating drone operators on responsible use, and fostering public awareness campaigns can contribute to a harmonious coexistence between drones and the communities they operate in. By actively engaging in these aspects of future work, the trajectory of GPS-based drone technology can be steered towards a future where these aerial platforms are not only technologically advanced but also socially accepted and seamlessly integrated into our daily lives

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8. APPENDIX

Appendix A: Drone Specifications

component	specification
Frame	F450
Flight Controller	APM
Battery	Lithium ion
Radio Transmitter and Receiver	FLYSKY

Tab 8.1.1

Appendix B: Wiring Diagram:

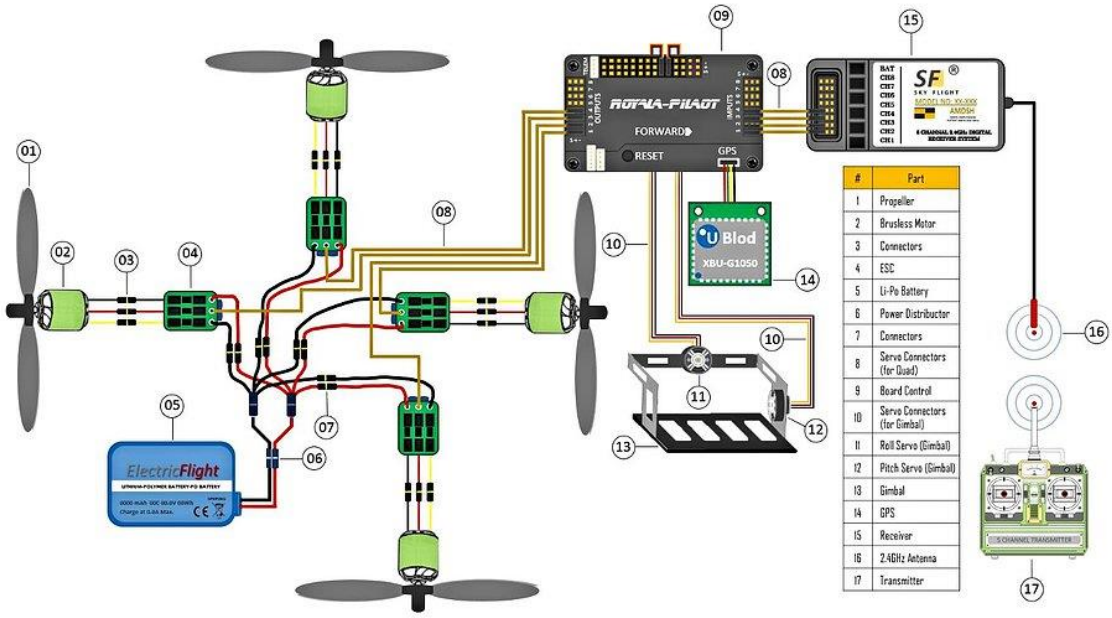

Fig 8.1

Appendix C: APM Configuration Settings

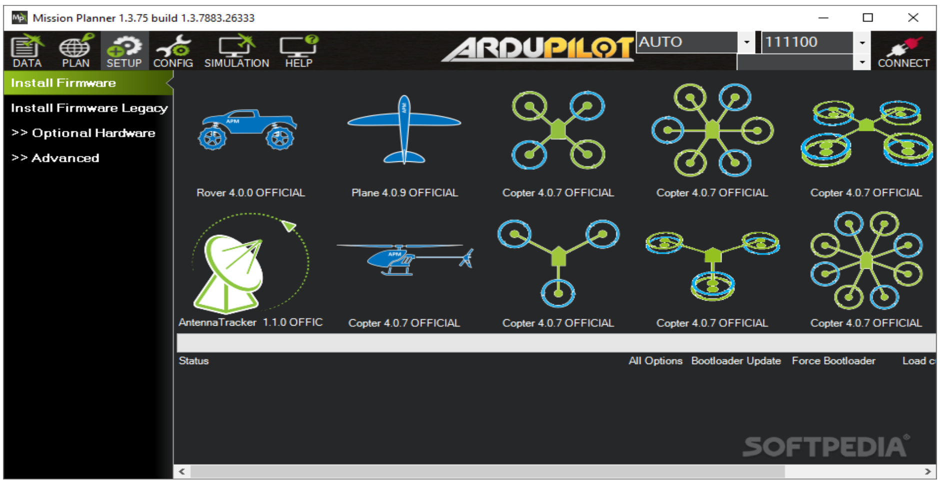

Fig 8.2

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Fig 8.3

Appendix D: Test Flight Data

1. **GPS Signal Strength:**
    - Average Satellites Locked: [10-15]
    - Maximum Satellites Locked: [6]
    - Minimum Satellites Locked: [20]
    - Signal Strength Variability: [-120dbm to -160dbm]
2. **Position Accuracy:**
    - Average Position Deviation: [0m]
    - Maximum Position Deviation: [1-2m]
    - Minimum Position Deviation: [5m]
3. **Flight Modes Testing:**
    - **Loiter Mode:** The drone exhibited stable position holding with minimal drift. GPS corrections were effective in maintaining the desired location.
    - **Position Hold Mode:** Similar to Loiter mode, the drone maintained a steady position, responding accurately to user inputs.
    - **Return-to-Home (RTH):** RTH function triggered successfully upon command, and the drone returned to the home location accurately.