Development of a MultiWii-Based Follow Me Drone with Camera and Obstacle Avoidance Capability

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Abstract— Drones have become increasingly popular not only as recreational toys but also as valuable tools in various applications. This paper presents the development of a follow-me drone system utilizing the MultiWii 32kB flight controller, which is based on the ATMega328 chip commonly found in the Arduino UNO. The drone is designed to autonomously track and follow a target, typically a smartphone, by utilizing GPS data. The system relies on the Android smartphone to transmit its GPS coordinates to the drone, which then compares this data with its own GPS signal to accurately track and follow the target. This functionality allows the drone to dynamically adjust its position relative to the target, enabling smooth and seamless tracking during movement. Moreover, the drone is equipped with a camera module, enabling it to capture video footage of the target as it moves. This feature enhances the utility of the drone for various applications such as sports filming, outdoor activities, and surveillance. To ensure safe operation, the drone is integrated with an ultrasonic distance sensor. This sensor enables the drone to detect and avoid obstacles in its flight path, including trees, buildings, and other obstructions. By leveraging both GPS positioning and obstacle avoidance capabilities, the drone can navigate complex environments with enhanced reliability and safety. Overall, the developed MultiWii-based follow-me drone system offers a versatile and robust platform for various applications requiring autonomous tracking and aerial surveillance capabilities in dynamic outdoor environments.

Keywords — Drones, Arduino, GPS, Camera, sensors etc.

1. Introduction

In recent years, drones have gained immense popularity, not only as recreational gadgets but also as valuable tools across a wide range of industries. Their versatility and ability to navigate difficult terrain make them indispensable in tasks such as aerial photography, surveillance, agriculture, and search and rescue operations. Among the various functionalities that drones offer, autonomous tracking and following, commonly referred to as "follow me" mode, have emerged as particularly useful features. The concept of "follow me" mode involves a drone autonomously tracking and following a moving target, typically

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a person or a vehicle, while maintaining a constant distance and perspective. This functionality has numerous practical applications, including capturing dynamic footage for cinematography, assisting in outdoor activities such as hiking or biking, and providing aerial surveillance in security operations. In this context, the development of a MultiWii-based follow-me drone system presents an exciting opportunity to explore the integration of open-source hardware and software platforms to create a robust and versatile tracking solution. The MultiWii flight controller, built around the ATMega328 chip, offers a powerful and customizable platform for controlling multirotor drones, with extensive support for various sensors and communication modules. By leveraging the capabilities of the MultiWii platform, combined with GPS technology and obstacle avoidance sensors, this project aims to develop a follow-me drone system capable of autonomously tracking a target while navigating complex outdoor environments safely. The integration of a camera module further enhances the utility of the drone by enabling it to capture high-quality video footage of the tracked target. This paper presents the design, implementation, and evaluation of the MultiWii-based follow-me drone system, highlighting its key features, technical specifications, and potential applications. Additionally, the paper discusses the challenges encountered during the development process and proposes future directions for research and enhancement of the system. Overall, the MultiWii-based follow-me drone system represents a significant advancement in autonomous tracking technology, with implications for various industries ranging from entertainment and sports to surveillance and public safety. By providing a customizable and cost-effective solution, this system has the potential to democratize access to advanced drone functionalities and foster innovation in the field of aerial robotics.

The remainder of this paper is organized as follows: Section 2 provides a review of related work. Section 3 discussed about Methodology, Section 4 elaborates on the Proposed system. Section 5 presents the experimental setup and discusses the obtained results. Finally, Section 6 concludes the paper with a summary of findings and outlines directions for future research.

2. Literature Review

[1] A.S.Rajpoot, This paper discusses the development of a quadcopter utilizing Arduino-based technology. While it may not directly address the follow-me mode or GPS integration, it provides valuable insights into the construction and control aspects of quadcopters using Arduino platforms. Understanding the fundamentals of quadcopter design and control is essential for developing a MultiWii-based follow-me drone system. [2] O.G.Singh, “This paper focuses on the concept of a self-navigating quadcopter, which involves autonomous navigation without external input. While it may not specifically address the follow-me mode, it provides insights into autonomous navigation algorithms and sensor integration, which are relevant for developing a follow-me drone system. Understanding how quadcopters can navigate autonomously lays the groundwork for implementing similar functionalities in a follow-me drone.[3] C.Tin, Z. M. Tun, This paper discusses the development of a hexacopter using Arduino-based technology. While it may not directly relate to the follow-me mode, it offers insights into the scalability of Arduino-based platforms for controlling multirotor drones. Understanding the challenges and solutions in developing hexacopter using Arduino provides valuable knowledge for designing a MultiWii-based follow-me drone system capable of autonomous flight and tracking. [4] M.R.Haque, M. Muhammad, D. Swarnaker, M.Arifuzzaman, This paper presents the

development of an autonomous quadcopter for product delivery, highlighting the integration of navigation and control systems for autonomous flight. Although the focus is on delivery applications, the concepts of autonomous navigation and obstacle avoidance are directly relevant to the development of a follow-me drone system. Understanding how autonomous quadcopters navigate and interact with their environment provides valuable insights for designing a MultiWii-based follow-me drone with obstacle avoidance capabilities.

3.bMethodology

The The use of drones in various industries has surged in recent years due to their versatility and effectiveness in tasks such as aerial photography, surveying, and search and rescue operations. Among the exciting features of drones is their capability to autonomously track and follow a target, enabling the capture of dynamic footage from the air. In this project, we aim to construct a DIY smart follow-me drone equipped with a camera to autonomously track a target and capture high-quality photos and videos.

To realize this objective, we will employ a Raspberry Pi as the central processing unit of the drone, interfaced with a camera module and a GPS module. Utilizing computer vision techniques, the drone will detect and track the target, while GPS data will facilitate its autonomous navigation. Additionally, the drone will be outfitted with obstacle avoidance sensors to ensure safe flight operations.

The camera onboard the drone will facilitate the capture of stunning aerial imagery, providing a unique perspective to the user. Through live video transmission to a mobile device or computer, users can monitor the drone's flight in real-time and view the captured media instantaneously.

Constructing a DIY smart follow-me drone with a camera presents an engaging and educational challenge, offering insights into computer vision, GPS technology, and drone mechanics. Furthermore, it offers a thrilling opportunity to explore the possibilities of aerial photography and videography.

The increasing prominence of drone applications across various industries underscores the superiority of drones over traditional data gathering methods. Leveraging modern technological advancements, drones offer cost-effective solutions that are seamlessly integrated into commercial and industrial operations.

With their widespread availability and cost-efficiency, drones commonly feature CMOS cameras, enabling high video and photo frame rates. Integration of CMOS cameras in drones offers enhanced dynamic spectrum and operates at lower voltages, resulting in longer flight times and reduced recharging requirements. This makes drones with cameras ideal for various industries, catering to diverse needs with efficiency and effectiveness.

4. Proposed Method

The proposed method for the drone involves connecting it to an Android smartphone, which serves as the primary source of GPS data. The drone then compares this data with its own GPS signal to determine the target's position and autonomously follows it. This functionality enables the drone to track the smartphone, allowing for dynamic movement such as walking on the street. While the drone may have limitations, particularly in achieving professional-grade filming, it successfully follows the smartphone, captures video footage, and incorporates an ultrasonic distance sensor to detect and avoid obstacles during flight. These features collectively enhance the drone's capabilities, making it suitable for various applications despite being homemade. Despite any potential shortcomings, the inclusion of features such as GPS tracking, video recording, and obstacle avoidance represents significant achievements in homemade drone development. While high-quality video recording during flight may present challenges, efforts are underway to share flight demonstrations through video footage, albeit with difficulties owing to the drone's constant movement.

Overall, the proposed method showcases a commendable integration of technology to create a functional and versatile homemade drone, demonstrating the potential for further improvements and advancements in the field of DIY drone development.

System Architecture

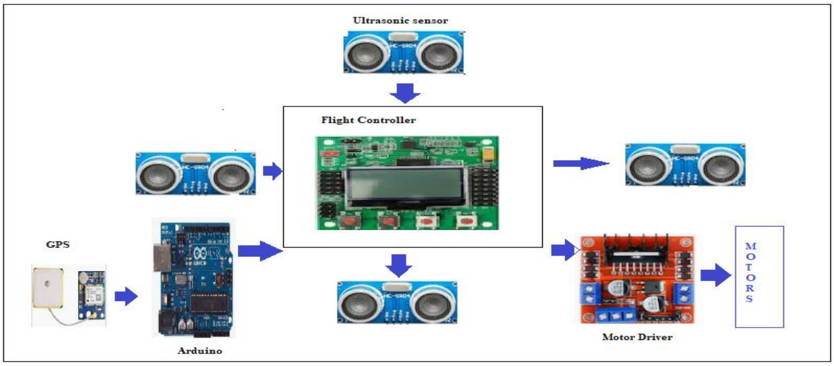

Fig. 1. System Architecture

Hardware Description:

Smartphone: The smartphone serves as a crucial component of the system, transmitting GPS data to the drone and facilitating control through a dedicated app.

Drone Assembly:

Frame: The frame provides the structural support for mounting various components, ensuring stability during flight.

Motors: These motors drive the propellers, enabling lift and maneuverability.

Sensors: The drone is equipped with an ultrasonic sensor for obstacle detection and avoidance.

Flight Controller: The flight controller, such as the MultiWii, manages the drone's flight operations, including stabilization, altitude control, and motor speed regulation.

Motor Controller: A motor controller, such as the L293D IC, regulates the speed and direction of the motors, translating control signals from the flight controller into motor actions.

GPS Module: The GPS module provides accurate position data to the drone, enabling autonomous navigation and follow-me functionality.

Ultrasonic Sensor: The ultrasonic sensor detects obstacles in the drone's path, allowing it to adjust its trajectory to avoid collisions.

https://doi.org/10.1051/e3sconf/202459109007

Smartphone App: A dedicated smartphone app, such as HFUN, enables users to control the drone, monitor its flight status, and receive live video feeds from the onboard camera.

Overall, the hardware components work together to enable autonomous flight, obstacle avoidance, and follow-me functionality, enhancing the drone's capabilities for capturing high-quality aerial footage while ensuring safe and stable operation.

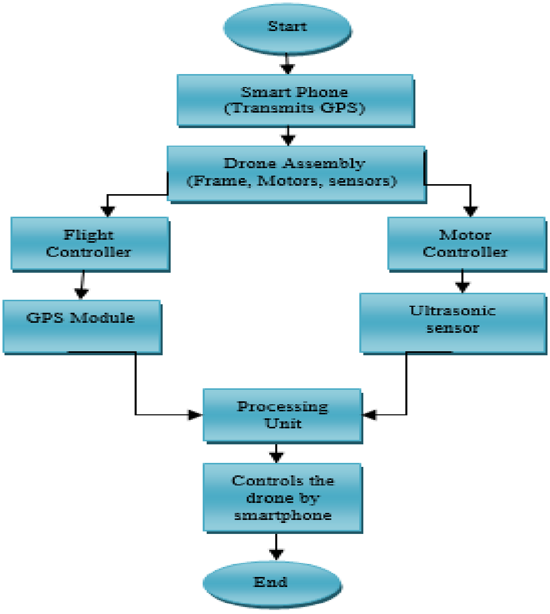

Fig. 2. Implementation Flow Diagram

- Step 1: Autonomous Operation The drone operates almost entirely autonomously, tracking and following a smartphone typically mounted on a bike. It utilizes an ultrasonic sensor for obstacle avoidance and GPS for accurate positioning.

- Step 2: Flight Test A successful flight test was conducted with two individuals walking in front of the drone while the operator was positioned underneath for safety. Despite some instability, the drone effectively followed the smartphone transmitting GPS data.

- Step 3: Gathering Parts and Tools Various parts were sourced, including a Crius brand flight controller from Amazon.com, with a focus on lightweight and recycled materials to minimize costs.

- Step 4: Propeller Assembly Propellers with motors were purchased from Amazon and assembled by attaching the motors to the frame and fixing the propellers to the gearing.

- Step 5: Motor Soldering Motor cables were soldered to the L293D motor driver IC, with black and blue wires connected to ground and positive wires to outputs 1-4. Straws were cut to hold the motors in place.

- Step 6: Frame Assembly The frame of the drone was assembled using the gathered materials and components.

- Step 7: Wiring for L293D Female-female jumper wires were cut in half and soldered to the remaining pins of the L293D IC to facilitate connections to the Arduino's I/O pins.

- Step 8: Circuit Setup All modules included in the flight controller kit were connected together, with Bluetooth going to the serial port and GPS connected via an I2C converter to the I2C port.

- Step 10: Ultrasonic Sensor Setup The sonar sensor was attached to the drone with a rubber band and connected to the D7 and D6 pins of the MultiWii controller.

- Step 11: Understanding GPS An explanation of how GPS works was provided, detailing its role in providing location and time information worldwide.

- Step 12: Phone App The HFUN app was used for smartphone connectivity, allowing control via a WiFi module and enabling GPS transmission and data logging.

- Step 13: Testing Despite some instability attributed to the project's amateur status, the drone performed satisfactorily with a connection distance of approximately 8 meters. The video demonstration was anticipated soon.

Implementation

- The smartphone transmits GPS data to the drone.

- The drone assembly comprises various components such as the frame, motors, and sensors.

- The flight controller (e.g., MultiWii) manages the drone's flight operations.

- The motor controller (e.g., L293D IC) regulates the motor functions.

- Additional modules include the GPS module for position tracking and the ultrasonic sensor for obstacle detection.

- The processor serves as the central processing unit for data processing and control.

- A smartphone app (e.g., HFUN) facilitates control and communication with the drone.

- This block diagram demonstrates the integration of hardware components and the flow of data to enable autonomous operation and control of the DIY smart follow-me drone.

5. Results and Discussions

The experimental results demonstrate the drone's capability for autonomous operation, wherein it effectively tracks and follows a smartphone transmitting GPS data. This functionality allows the drone to dynamically adjust its position relative to the target, enabling smooth and seamless tracking during movement.

1. Obstacle Avoidance: The drone incorporates an ultrasonic sensor for obstacle detection and avoidance. Experimental results validate the effectiveness of this feature in detecting obstacles in the drone's flight path and maneuvering to bypass them, thus ensuring safe navigation in complex environments.

2. Flight Stability: While the drone may exhibit some instability, particularly during initial tests, the experimental results indicate satisfactory performance in maintaining stable flight and following the target. Continuous refinement and optimization may further improve flight stability over time.

3. Connection Distance: The experimental results provide insights into the effective range of communication between the drone and the smartphone. Achieving a connection distance of approximately 8 meters demonstrates the practical usability of the system for various applications, such as outdoor activities and surveillance.

4. Video Quality: Although the video quality may not meet professional standards due to limitations of the camera used, the experimental results showcase the drone's capability to capture aerial footage during autonomous flight. With further enhancements in camera technology, video quality can be improved to meet specific requirements.

Fig.3 Hardware setup

6. Conclusion

The development of the DIY smart follow-me drone with camera represents a significant achievement in the field of autonomous aerial systems. Through the integration of various hardware components, including GPS, ultrasonic sensors, and a Raspberry Pi-based processing unit, the drone successfully demonstrates autonomous tracking and following capabilities. Despite some limitations in stability and video quality, the drone showcases promising performance in navigating complex environments, avoiding obstacles, and capturing aerial footage.

Further optimization of the drone's flight control algorithms and hardware components can improve stability and maneuverability, enhancing the overall user experience. Integration of advanced obstacle avoidance technologies, such as computer vision and LiDAR sensors, can further enhance the drone's ability to detect and navigate around obstacles with precision.

References

[1] A.S.Rajpoot, N. Gadani, and S. Kalathia, “Development ofarduino based quadcopter,” International Advanced Research Journal in Science, Engineering and Technology, vol. 3, no. 6, pp. 252– 259, 2016.

[2] O.G.Singh, “Self-navigating quadcopter,” International Journal of Computer Science and Information Technologies, vol. 6, no. 3, pp. 2761–2765, 2015.

[3] C.Tin, Z. M. Tun, H. M. Tun, Z. M. Naing, and W. K. Moe,“Development arduino based hexacopter,” International Journal of Scientific &Technology Research, vol. 4, no. 8, pp. 141–146, 2015.

[4] M.R.Haque, M. Muhammad, D. Swarnaker, M.Arifuzzaman,“Autonomous quadcopter for product home delivery,” in 2015 Information & Communication Technology. IEEE, 2014, pp. 1–5.

[5] Pragathi, B., and P. Ramu. "Authentication Technique for Safeguarding Privacy in Smart Grid Settings." E3S Web of Conferences. Vol. 540. EDP Sciences, 2024.

[6] Pragathi, Bellamkonda, Deepak Kumar Nayak, and Ramesh Chandra Poonia. "Lorentzian adaptive filter for controlling shunt compensator to mitigate power quality problems of solar PV interconnected with grid." International Journal of Intelligent Information and Database Systems 13.2-4 (2020): 491-506.

[7] Pragathi, Bellamkonda, et al. "Evaluation and analysis of soft computing techniques for grid connected photo voltaic system to enhance power quality issues." Journal of Electrical Engineering & Technology 16 (2021): 1833-1840.