International Journal of Tropical Engineering and Computing
Vol. 1, No 1. July 2025, pp. 1-8
https://doi.org/10.60787/ijtec.vol1no1.30

Available online at https://ijtec.org.ng

Part Design and Implementation of an Arduino-Based Quadcopter Drone for Surveillance Applications

[1] Miracle Anucha, [2]Victor Eziakolamnwa and [3]Precious Abuo

[1]Department of Mechanical Engineering, Delta State University, Delta, Nigeria
(E-mail: anuchamirale348@gmail.com; ORCID: https://orcid.org/0009-0004-4695-6590)
[2]Department of Production Engineering, University of Benin, Edo, Nigeria
(E-mail: victor.eziakolamnwa@eng.uniben.edu; ORCID: https://orcid.org/0009-0003-3062-544X)
[3]Department of Mechanical Engineering, Cross River University of Technology, Cross River, Nigeria
(E-mail: abuopearl@gmail.com; ORCID: https://orcid.org/0009-0005-7835-1630)

***Correspondent Author**: anuchamiracle348@gmail.com; **Tel**: +234-806-002-8075

Article Information

Article history: Received June 2025
Revised June 2025
Accepted June 2025
Published online July 2025

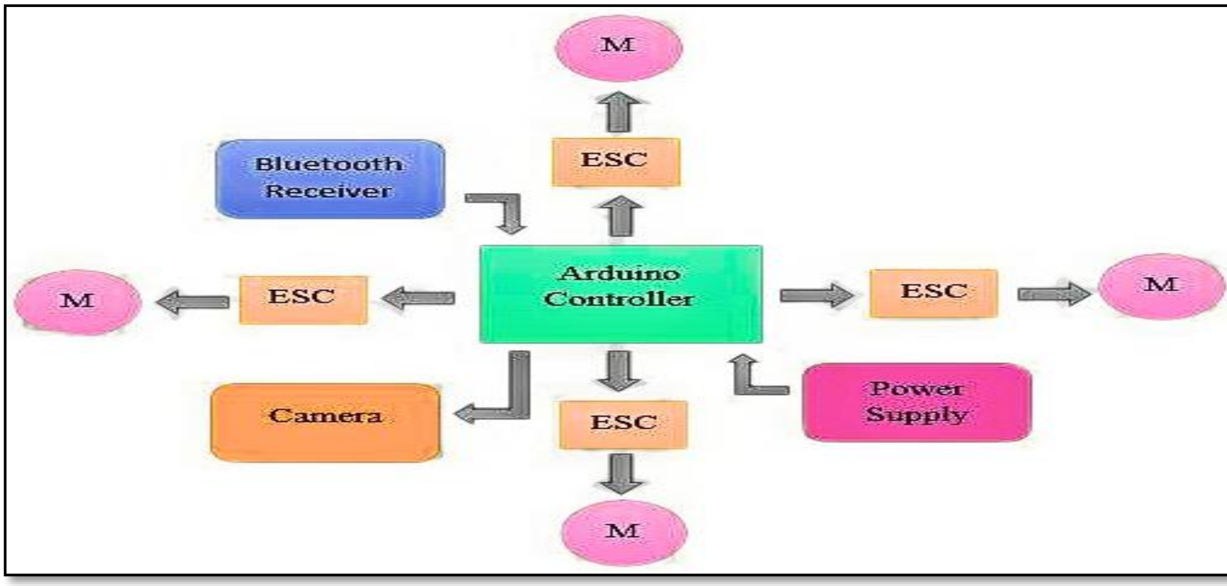
Citation: Anucha, M., Eziakolamnwa, V., & Abuo, P. (2025). Part design and implementation of an Arduino-based quadcopter drone for surveillance applications. International Journal of Tropical Engineering and Computing, 1(1), 1–9. https://doi.org/10.60787/ijtec.vol1no1.30

Official Journal of Tropical Engineering and Computing Research Network (TREN Research Group) at the faculty of Engineering of Benson Idahosa University, Nigeria.

Abstract

Insufficient surveillance camera in the study area (Delta State University) has led to security risks which includes high number of examination malpractice and theft within the school premises. Students or people can be very deceptive by finding blind spots if CCTV are used in certain locations in the school. Thus, the implementation of a quadcopter is proposed to fly into every area of the University for Surveillance both on a normal day and during examinations. It has the capability for both remote control and autonomous operation. The paper presents the design, application, and future scope of quadcopters. The study aimed to assemble and construct a functional quadcopter drone using Arduino based controller. Arduino IDE functions was used for hardware programming. The assembled quadcopter has four brushless DC motors with 800g weight available for DC Motor to lift with a total current of 1.8A and lasting capacity of 1.94h. The quadcopter reached a maximum altitude of 500cm. The lithium battery capacity was 3500mAh based on weight consideration of the drone. The flight time was estimated to be approximately 45minutes due to the extra power consumption of the controller and camera. The camera resolution was 720p. The quadcopter is deployable as it captures events in real time as images or video recordings.

***Keywords**: Unmanned Aerial Vehicle, Electronic Speed Controller, Lithium Polymer Battery, Slave Controller.*



1.0 INTRODUCTION

A quadcopter drone or unmanned aerial vehicle (UAV) is a four-winged autonomous aircraft. Industries and surveillance operations are increasingly relying on quadcopters due to their effectiveness as assistive tools [1]. Drones are a part of a larger unmanned aircraft system (UAS), which includes UAV, a ground controller, and communication system. To minimize sound and absorb vibrations, the quadcopter drone is built using highly intricate composite engineering materials. The materials used for drone construction have to be of a very light weight due to the fact that the drone has to suspend in the air.

Quadcopters typically come equipped with two sets of identical fixed-pitch propellers: a pair that spins clockwise and another pair that spins counter clockwise. To control the quadcopter, the speed of each individual rotor is adjusted independently [2]. Adjusting individual rotor speeds allows a quadcopter to precisely control total thrust, thrust center (lateral and longitudinal positioning), and total torque (turning force). Typically operated by wireless remote control, these drones can hover, take off, and land.

An arduino Uno microcontroller board provides the means to control a drone's various components, such as its motors, sensors, and communication devices [3]. The flight controller acts as the drones's brain, a circuit board equipped with sensors that detects its orientation and receive user commands. It then controls the motors to keep the quadcopter airborne. Most flight controllers include basic gyroscopes and accelerometers, while some advanced models may add barometric pressure sensors and magnetometer compasses. The flight controller also serves as a central hub for peripherals like GPS, LED, and sonar sensors [4].

Aerial surveillance drones can also be used to gather real-time intelligence, providing law enforcement agencies and security personnel with up-to-date information about potential threats or security breaches [5]. This design features of this drone designed represent a departure from existing solution like the use of CCTV. An Arduino quadcopter is essentially a drone you build yourself. It uses an Arduino microcontroller (like a Uno or Nano) as its main control unit. This "brain" manages the drone's movements by controlling the motors, interpreting data from sensors such as accelerometers and gyroscopes, and carrying out pre-set flight instructions [6]. The combination of electronics and mechanical components is essential for the quadcopter's operation, primarily relying on the principles of aviation. Its main intention is to manage the forces acting on the aircraft during flight. These four fundamental forces that govern the motion of an aircraft are lift, drag, thrust, and weight [7]. The Quadcopter requires a components that can be used to control the movement and position of the quadcopter while flying in the air. The component used to control movement, stability, and balance while flying is called a flight controller (FC) [8]. The Unmanned aerial vehicles (UAVs), particularly quadcopters, are gaining ground in autonomous surveillance, infrastructure inspection, and reconnaissance tasks where human intervention is constrained [9]. Custom-built quadcopters are usually used for research or leisure. They are equipped with flight controllers and flight computers that determine the attitude of the flying machine. Many commercial flight controllers are available for custom drones, while flight computers are usually made of Raspberry Pi boards programmed to give commands to the flight controller [10]. Drones were initially developed for military applications, but are now accessible to

https://doi.org/10.60787/ijtec.vol1no1.30

civilians with a growing number of applications. Although these UAVs have not yet gained widespread use, they are gradually being used in the production of video contents, recording of events, etc.

Drones have the potential to increase tourism which contribute to socio-cultural development of countries. In addition to recreational applications, drones have a significant development potential in sectors such as agriculture, supervision of power lines, supervision of borders, cartography, security, etc.[11]. The development of the Surveillance Quadcopter Drone involves a systematic approach that integrates hardware assembly, software programming, and testing phases to ensure a functional and efficient drone for surveillance applications. The main components chosen for this project include: Arduino Uno, serving as the main microcontroller responsible for managing inputs and outputs, controlling the motors, processing sensor data, and executing flight control algorithms [12]. There are different technical characteristics of drones. The most notable characteristic defines a drone's classification, such as fixed-wing systems, multirotor systems, and other specialized systems like hybrid models (combining multirotor and fixed-wing features), ornithopters, and drones that utilize turbo fans [13]. As drones become more accessible, there are opportunities for development in other fields. However, challenges like data ownership and surveillance need to be addressed. Drones monitor environment: air, water, soil, and waste. Sensors are often used for forest and biodiversity monitoring. Drones explore inaccessible areas, and the future promises IoT drones for real-time examination of habitats. Smartphone apps can control drone systems for site evaluation and solutions. Drones enhance agency efforts to manage resources, benefiting civil society and small landholders. More education and training opportunities are needed, as well as outreach initiatives for conservation efforts. Ethical issues surrounding data ownership and privacy violations arise. The future of drone reign is a high-stakes gamble with potential environmental benefits or unforeseen consequences [14]. UAVs can acquire high-resolution multispectral images, which in turn can produce 3D models of hazard zones without putting human lives at risk. Meteorologists, hydrologists, and spatial modelers can use such data to provide better detail and reliable results at a local scale[15]. In recent years, technology has completely transformed our lives. New technological advancements like satellite data, machine learning, remote sensing tools have provided good forest surveillance and monitoring opportunities. Many research and academic institutions, service providers, space agencies, and government agencies have been involved in developing unique approaches and techniques that can be used to support forest surveillance. Nowadays, drones are used in various sectors due to their low maintenance cost. Since there is an exponential increase in trespassing, animal poaching, illegal cutting down of forest trees, and therefore leading to degradation of forest covers, a combination of drone and forest surveillance modules is a very efficient methodology [16]. This makes UAVs essential Technology to be used in every aspect of life like Environmental Monitoring & Conservation, Disaster Management & Emergency Response, Agriculture and Precision Farming, Infrastructure Inspection and Maintenance and also in Logistics and Delivery etc. Unlike arduino quadcopter, AI drones use artificial intelligence and machine learning with powerful processors and advanced sensors for high-level autonomy, perception, and decision-making. This work is basically the design of a low-cost UAV surveillance system and testing of its effectiveness in a campus environment as it’s easier to build, low cost. The biggest hurdle of arduino in UAV is limited processing power compared to the likes of Raspberry Pi or Pixhawks in UAV. In crowded areas, navigation and avoidance of obstacle might become a challenge. Noise pollution can also become a challenge.

Section II of this paper outlines the proposed methodology which involves the calculation of required parameters and arduino programming language. Section III presents the experimental setup, operation mode and performance tests. Section IV concludes the study.

2.0 MATERIALS AND METHODS

2.1 Weight and Battery Capacity Design

The drone employed the use of four brushless DC motors with the following specification;

Rated speed: 1000rpm, Operating voltage: 3.7v, Maximum consumed current: 7.5A (Load), Current consumption at No Load = 0.1A, Weight: 50g, Max thrust: 250g

Total Thrust=Sum of Motor Thrust (1)

Total Thrust=250+250+250+250=1000g

Total Weight of DC Motors=50+50+50+50=200g

Weight Available for DC Motor To Li=Total thrust-Total Weight of DC Motors (2)

Weight Available for DC Motor To Lift=1000-200=800g

Hence, the maximum weight of drone including the DC motors should not exceed 1000g.

At maximum load, the expected current consumption for each DC motor is 0.45A.

Hence, the maximum weight of drone including the DC motors should not exceed 1000g.

https://doi.org/10.60787/ijtec.vol1no1.30

At maximum load, the expected current consumption for each DC motor is 0.45A.
Hence, total consumed current,
Total Current=0.45+0.45+0.45+0.45=1.8A
Since the DC motors are powered using at voltage of 3.7V, a Lipo battery of same rating was considered.
However, the weight of the battery was considered during the design and as such affected the rated capacity choice of the battery.
Hence, a Lipo battery of 3500mAh capacity was selected.
By computation, the expected lasting capacity of the drone is
Lasting Capacity= (Battery Capacity (mAh))/(Consumed Current)= 3500/1800=1.94h (3)

2.2. Assembly of Drone

Mount the four brushless DC motors on the frame and connect their terminal wires to the controller through the ESC as seen below. The Bluetooth module (receiver) is connected to the controller as well as the power supply (Li-Po battery). On the master controller, the Bluetooth module (transmitter) is connected to the controller and the various joysticks and buttons as seen below. The controller was then inserted in container to house the controller. The battery system of the master controller was designed and assembled. The camera was mounted on a swivel joint, connected to a power source and configured to display on a mobile phone through using an application.

2.3. Configuration of Camera
1. A camera app known as HF UFO was downloaded and installed on mobile phone from either Playstore for Android users or Appstore for IOS users.
2. The mobile phone was switched on and the WiFi turned on.
3. The drone was powered on of which automatically turns On the Camera.
4. The mobile phone is connected to the WiFi of the camera by searching for the WiFi name (HF_2b88c150) and click on connect. In doing so, the data and hotspot of the mobile phone is turned off. Hence, the mobile phone connects to the camera without internet.
5. Once successfully connected, the mobile app is opened.
6. Click on settings on the mobile app and ensure that it has identified the WiFi name of the Camera.
7. Return back to app main screen and click on Start.
8. The app will connect to the Camera and display a success message on the screen. Otherwise repeat procedures 4 to 7.
9. The start interface shows on the mobile phone displays any image the Camera sees on its screen using the mobile app.
10. User can now take pictures or make video recording which are stored in a dedicated folder on the mobile phone.

2.4. Arduino Programming
The versioning is 1.8.11
Check here for the complete working code and card files on GitHub: GitHub link

3.0 RESULTS AND DISCUSSION
Presented are the Figures and Tables of results in this study.

Figure 1: Constructed Quadcopter Drone with Camera

Figure 2: Flight Controller

Figure 3: Installed Drone Camera

https://doi.org/10.60787/ijtec.vol1no1.30

Table 1: Performance Test

S/N	Performance	Value
1	**Height**	500cm
2	**Resolution**	720p
3	**Time of Flight (minutes)**	45 mins
4	**Frame Rate**	25fps
5	**WiFi Range**	30-50m
6	**Storage Capacity**	Depends on phone connected
7	**Field of view**	60-90 degrees
8	**Latency**	100-200 millisecond
9	**Signal Loss**	Beyond connecting radius

3.1 Operation Modes of Drone

Start Mode: Press the Up button on the joystick once to start the drone motors spinning at minimal speed.
Rise Mode: To enable flight (lift) of drone, press and hold he up button till the drone rises to the height desired by the operator.
Fall Mode: This feature is used to land the drone, press thee Down button gradually and intermittently until the drone is successfully landed.
Left Turn and Right Turn Mode: While the drone is in the air, the front orientation can be changed to face another direction by clicking on either the Left Arrow to make the drone turn to the left on a particular spot or Right Arrow to make the drone turn to the right on a particular spot.
Forward and Backward Mode: While the drone is in the air, to make the drone advance in the forward direction, the forward button on the joystick is click either intermittently or press down. Similarly, to make the drone advance in the backward direction, the backward button on the joystick is click either intermittently or press down.
Left Side and Right Side Mode: While the drone is in the air, the drone can be made to move to either the left side or right side without change in orientation. To this end, the left side button on the joystick is click either intermittently or press down to make the drone move sideways to the left. Similarly, to make the drone advance in the right side direction, the right side button on the joystick is click either intermittently or press down.
Emergency Stop Mode: There is an emergency stop button on the controller that enables the operator force land the drone if the down button fails to activate.
Fine Tuning Mode: If the drone keeps drifting in a certain direction while in the air, first press the fine tuning button on the hand controller and simultaneously press the opposite direction to where the drone drifts to till it becomes stable.
Max Rise and Fall Mode: By clicking the max rise button, the drone rises to the maximum height and remains there after it must have been turned on and started. Similarly, while the drone is at Max height, it fall button can be click to land the drone successfully.
Calibration Mode: Every other time and especially when the drone drifts in particular direction, place the drone on horizontal surface and press the calibration button for two seconds and release. This helps to calibrate the ESC that supplies current to the DC motor.

3.2. Performance Test
3.2.1. Movement Functions

The drone was tested for various movements such as rise, fall, forward, backward, sideways, left turn and right turn and the drone was able to perform those functions effectively. The maximum rise height attained for the drone was approximately 500cm

3.2.2. Camera Surveillance

Figure 4: Installed Drone Camera

While the camera was turned on and connect to a mobile phone, pictures of events were taken as well as video recordings made. These data were saved in a folder on the phone and was viewed it. The camera has a resolution of 720p. The image storage capacity depends on the phone been connected to the Wi-Fi. The frame rate is determined by the camera module. The camera module connected through the HF UFO app. The frame rate is 25fps. In an outdoor space it has the capacity 30-50 meters Wi-Fi range. Due to mobile device performance been connected the MP is approximately 1 and the field of view is 60 degrees to 90 degrees. The latency is 100-200millisecond. One limitation is that video lag gets noticed when obstacle interference or the drone turns quickly or when it's competing with other nearby Wi-Fi devices
3.2.3. Battery Lasting

The lithium battery capacity selected to power the device was 3500mAh based on weight consideration of the

https://doi.org/10.60787/ijtec.vol1no1.30

drone. The battery was fully charged and subject to various operation function with the drone until it was totally drained. This was carried out three times and on the average, the battery lasting capacity was estimated to be approximately 45minutes as compared to 116.4 minutes in a similar work due to the extra power consumption of the controller and camera.

3.3. Discussion

The constructed Arduino-based quadcopter drone demonstrated a number of operational capabilities and constraints that align with findings reported in similar low-cost drone development studies. The drone successfully executed all primary movement functions, including ascent, descent, directional turns, and lateral shifts. The maximum rise height attained was approximately 500 cm, which is within the range observed for comparable brushless motor-driven quadcopters intended for lightweight surveillance applications [1, 3]. This performance level, although modest compared to higher-end commercial drones, is consistent with the design objective of achieving basic surveillance functionality within limited budget and power constraints [1].

The camera module integrated into the drone provided a resolution of 720p and a frame rate of 25 frames per second, supporting real-time image capture and video streaming to a connected mobile device via Wi-Fi. However, latency ranged from 100 to 200 milliseconds, and video lag was observed particularly during rapid orientation changes and in environments with competing wireless signals. These limitations are widely acknowledged in literature where similar Wi-Fi-based streaming solutions are employed, as signal congestion and low-power transmitters are common causes of lag and occasional connection loss [2, 5]. Indeed, Al-Turjman and Al-Rahmi [5] emphasized that interference from urban wireless infrastructure remains a significant challenge for drone-based surveillance systems operating in the 2.4 GHz frequency band.

The effective Wi-Fi transmission range of 30 to 50 meters also reflects constraints inherent in low-cost modules and small onboard antennas [6]. In this implementation, the relatively modest field of view (60–90 degrees) further limited situational awareness, reinforcing the need for more advanced gimbaled camera systems if comprehensive surveillance coverage is required [1, 4].

Battery life emerged as the most prominent constraint in the system's performance. Although the theoretical calculation based on a 3500 mAh lithium polymer battery and the estimated current draw predicted a potential flight time of approximately 1.94 hours, real-world testing showed an average operational duration of only 45 minutes per full charge. This discrepancy can be attributed to cumulative power consumption from the camera module, the Bluetooth communication between the drone and the hand controller, as well as efficiency losses in the electronic speed controllers and voltage regulators [3]. The result aligns with findings by Rahman et al. [3] and Gunes and Düzkaya [6], who also reported that actual flight durations of Arduino-based drones are significantly lower than nominal calculations due to the simultaneous load of navigation and data transmission components.

The modular design of the hand controller proved effective for managing basic maneuvers, and the inclusion of multiple operational modes (fine tuning, calibration, emergency stop) contributed to safer and more predictable handling. The calibration mode, in particular, allowed for ESC synchronization and improved hovering stability, as highlighted in related quadcopter development research [4, 6]. Nevertheless, the lack of an integrated inertial measurement unit (IMU) with sophisticated sensor fusion limited the stability and responsiveness when compared to systems employing PID control algorithms and accelerometer–gyroscope combinations [2, 4].

While the drone achieved its core objective of providing a cost-effective surveillance platform, its limitations in endurance, altitude ceiling, and video transmission reliability suggest several avenues for future improvement. Incorporating higher-capacity batteries balanced against weight penalties, optimizing power distribution to reduce consumption, and employing higher-resolution camera modules with dedicated transmitters could significantly enhance overall performance [1, 5]. Additionally, moving beyond Arduino Uno to more capable flight control systems, such as those utilizing custom PID algorithms for dynamic stability, may allow the drone to achieve smoother flight profiles and more reliable operation under varying loads [2, 4].

Overall, the project illustrates the practical feasibility of deploying a modular, Arduino-based quadcopter for basic surveillance missions, while reinforcing findings from previous research that emphasize the trade-offs between cost, payload capacity, and operational robustness [1, 3, 5, 6]. Continued refinement of component selection and system integration will be necessary to approach the performance benchmarks established by more advanced unmanned aerial vehicle platforms [4, 5].

4.0. CONCLUSION

In conclusion, the design and implementation of the Arduino-based quadcopter drone for surveillance demonstrated that low-cost, modular platforms can achieve reliable basic flight and video monitoring capabilities within specific operational limits. While the drone successfully performed essential maneuvers and provided live camera feeds, limitations such as restricted battery life, video latency, and a modest altitude ceiling highlight the need for further optimization. Incorporating higher-capacity power systems, improved sensor integration, and advanced control algorithms would substantially enhance performance and stability. This

https://doi.org/10.60787/ijtec.vol1no1.30

project underscores the potential of accessible technologies like Arduino to support practical surveillance applications in educational, research, and low-resource contexts. However, to match the capabilities of commercial drones, future work must focus on overcoming the trade-offs between cost, weight, and functionality. Overall, the project validates the feasibility of an affordable, open-source approach while pointing clearly to pathways for refinement and technological advancement.

Conflict of Interest

The authors declare that there is no conflict of interest.

Authors' Contribution

M.A. conceptualized the study, designed the methodology and supervised the project. V.E. conducted testing and performance evaluation and provided critical feedback on the manuscript. P.A assisted in programming and manuscript editing.

Authors' Declaration

The authors affirm that the content of this manuscript is original, has not been published elsewhere, and is not under consideration for publication in any other journal. The authors accept full responsibility for the integrity and accuracy of all data and interpretations presented herein.

Acknowledgments

We acknowledge the Almighty God for knowledge and resources to embark and complete this project. We also thank Engr. J. Amagre for his invaluable support, time, guidance in reviewing this research work. Also gratitude goes to the head of mechanical engineering department, Dr. M. Ekpu for his support. The authors also wish to disclose the use of ChatGPT (OpenAI, 2024) and Grammarly for grammar refinement and language polishing, which contributed to improving the manuscript's clarity and readability (if applicable to your project). These tools were used exclusively for editorial and illustrative purposes and did not influence the research methodology, analysis, or interpretation of results. The authors affirm that all components used for the assembly of the drone were procured, and no human or animal subjects were involved; hence, no formal ethics board approval was required. All arduino programming are described to allow replication via the GitHub link GitHub link

References

[1] Aina, E. M., Baiyeroju, D. A., Fadare, D. A., Fadare, D. E., Falana, A., Kazeem, R. A., Ikumapayi, O. M., Ogedengbe, T. S., Akinlabi, E. T., & Tien-Chien. (2024). UIQuad I: A Low-Cost and Modular Surveillance Quadcopter. *International Journal of Mechanical Engineering and Robotics Research.* https://doi.org/10.18178/ijmerr.13.1.11

[2] Kose, O., & Okay, T. (2020). Investigation of the Effect of Differential Morphing on Lateral Flight by Using PID Algorithm in Quadrotors. *Avrupa Bilim ve Teknoloji Dergisi*, (18), 636-644. https://doi.org/10.31590/ejosat.702727

[3] Rahman, A. S., Faruqui, J., & Hasan, T. (2023). Quadcopter Drone Using Arduino Uno. *International Journal of Research and Technology Innovation*, 8(4), 282–286. https://doi.org/10.6084/m9.doione.IJRTI2304045

[4] Rahmat, M. K., Suhardi, H., & Ramdan, A. H. (2024). Design and Development of Flight Controller for Quadcopter Drone Control. *Telecommunications Computers and Electricals Engineering Journal, 1(3), 279*. https://doi.org/10.26418/telectrical.v1i3.73681

[5] Al-Turjman, F., & Al-Rahmi, W. M. (2020). Towards a smart security and surveillance system for smart cities using IoT-based drones. *Future Generation Computer Systems*, 106, 843–856. https://doi.org/10.1016/j.future.2019.12.016

[6] Gunes, E., & Düzkaya, H. (2024). Arduino Based Flight Control Card Design and Quadcopter Integration. Gazi University Journal of Science Part A: Engineering and Innovation, 11(2), 392–406. https://doi.org/10.54287/gujsa.1480315

[7] Nagesh, K. N., Altaf, S., Kiran mayee, M., Jagadi, S., & Vaishnavi, D. (2020). Design and Implementation of Quadcopter for Surveillance Application. *International Journal of Innovative Science and Research Technology*, 5(4), 836.

[8] Muhamad, A., Panjaitan, S. D., & Yacoub, R. R. (2024). Design and Development of Flight Controller For Quadcopter Drone Control. *Telecommunications, Computers, and Electricals Engineering Journal (TELECTRICAL)*, 1(3), 279-291. https://doi.org/10.26418/telectrical.v1i3.73681

[9] Tyagi, A., & Gaur, C. (2025, April 18). SLAM-Based Navigation and Fault Resilience in a Surveillance Quadcopter with Embedded Vision Systems. https://doi.org/10.48550/arXiv.2504.15305

[10] Caliston, N. P., Aliac, C. J. G., & Nogra, J. A. E. (2024). Quadcopter Position Hold Function using Optical Flow in a Smartphone-based Flight Computer. *International Journal of Computing Sciences Research*, 8, 2809-2821. https://doi.org/10.25147/ijcsr.2017.001.1.189

[11] Acakpovi, A., Doku, P., Owusu, M. A., & Amoabeng, K. O. (2020). Design and Implementation of a Quadcopter Based on a Linear Quadratic Regulator (LQR). *Journal of Digital Food, Energy & Water Systems*, 1(1), 1-7. https://doi.org/10.36615/digitalfoodenergywatersystems.v1i1.409

[12] Barbadekar, A., Raynade, T., Pawar, S., Muli, R., & Deshpande, A. (2024). Surveillance Quadcopter Drone: Design and Implementation. *International Research Journal of Modernization in Engineering Technology and Science, 6(5), 1198–1202.* https://doi.org/10.56726/IRJMETS1716367397

https://doi.org/10.60787/ijtec.vol1no1.30

[13] Adepoju, T. M., Akanni, A. A., Orimogunje, O. K., Olalude, A. O., & Osalusi, A. G. (2021). Design and Implementation of Quadcopter Multirotor Uncrewed Aerial Vehicle. *International Conference of Sciences, Engineering & Environmental Technology (ICONSEET)*, 6(6), 45–49.

[14] Mwaura, F. M. (2024). The Use of Drones in Environmental Monitoring and Conservation. *Research Invention Journal of Biological and Applied Sciences*, 3(3), 69–72.

[15] Madhavan, R., Silva, T., Farina, F., Wiebbelling, R., Renner, L., & Prestes, E. (2020). Unmanned Aerial Vehicles for Environmental Monitoring, Ecological Conservation, and Disaster Management. In Proceedings of the 37th International Symposium on Automation and Robotics in Construction (ISARC 2020) (pp. 1–8). *International Association for Automation and Robotics in Construction (IAARC)*. https://doi.org/10.1007/978-3-319-91068-0_3

[16] Roy, S., Singh, S., Jaiswal, V., & Samal, P. (2022). IoT controlled UAV for forest surveillance. *In Proceedings of the 3rd International Conference on ICT for Digital, Smart, and Sustainable Development* (ICIDSSD 2022) (Vol. 24, No. 3). EAI Digital Library. https://doi.org/10.4108/eai.24-3-2022.2318928

https://doi.org/10.60787/ijtec.vol1no1.30