iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 14 **Issue:** VI **Month of publication:** June 2026

DOI: https://doi.org/10.22214/ijraset.2026.83555

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 14 Issue VI June 2026- Available at www.ijraset.com

Design and Development of an IoT-Enabled Long-Range Surveillance Hexacopter UAV with GPS Tracking and Real-Time Video Transmission

Pandyaraj V[1], Janardhanan R[2], Nadimuthu Gokul D[3], Thirivikraman[4], Nagaraju Balan Bhargavan[5], Balaji K[6]
[1, 2]Department of Mechanical and Automation Engineering, [3,4,5,6]Department of Mechanical Engineering Sri Sairam Engineering College, West Tambaram, Chennai, India

Abstract: Unmanned Aerial Vehicles (UAVs) have gained significant importance in surveillance and monitoring applications due to their flexibility, mobility, and ability to access remote or hazardous locations. This paper presents the design and development of a long-range surveillance hexacopter drone integrated with GPS tracking, telemetry communication, and real-time video transmission capabilities. The proposed system employs a six-rotor configuration powered by brushless DC motors and controlled through a flight controller to ensure stable flight performance and enhanced payload carrying capability. A GPS module is incorporated to provide accurate location tracking, while a wireless telemetry system enables continuous communication between the drone and the ground control station. An onboard camera captures and transmits live video streams for real-time surveillance and monitoring purposes. The developed UAV platform was evaluated for flight stability, communication range, tracking performance, and surveillance effectiveness. Experimental observations indicate reliable operation, stable flight characteristics, and effective real-time monitoring over extended distances. The proposed surveillance drone offers a cost-effective and efficient solution for applications such as border security, disaster management, traffic monitoring, environmental observation, infrastructure inspection, and search-and-rescue operations. The results demonstrate that the developed hexacopter UAV can successfully perform aerial surveillance tasks while maintaining operational reliability and communication efficiency.
Keywords: Hexacopter UAV, Surveillance Drone, GPS Tracking, Telemetry System, Real-Time Video Transmission, Unmanned Aerial Vehicle, Remote Monitoring, Aerial Surveillance.

I. INTRODUCTION

Unmanned Aerial Vehicles (UAVs), commonly known as drones, have emerged as an important technology for surveillance, monitoring, inspection, and data acquisition applications. The rapid advancement of flight control systems, wireless communication technologies, and lightweight materials has significantly improved the operational capabilities of UAVs. Among the various UAV configurations, the hexacopter has gained considerable attention due to its enhanced stability, higher payload carrying capacity, and improved reliability compared to conventional quadcopters.

Surveillance operations often require continuous monitoring of large geographical areas that may be difficult, dangerous, or expensive to access using traditional methods. Applications such as border security, disaster management, traffic monitoring, environmental observation, coastal surveillance, and search-and-rescue missions demand real-time aerial information for effective decision-making. Conventional surveillance systems, including fixed cameras and manned aerial vehicles, are often limited by restricted coverage, high operational costs, and reduced mobility.

Fig.1. Developed Long-Range Surveillance Hexacopter Drone

To overcome these challenges, long-range surveillance drones provide a flexible and cost-effective alternative. The integration of GPS-based positioning systems, wireless telemetry, and real-time video transmission enables UAVs to perform monitoring tasks efficiently while maintaining communication with a ground control station. Additionally, advances in battery technology and flight control algorithms have enhanced the endurance and operational range of modern surveillance drones.

In this work, a long-range surveillance hexacopter drone is designed and developed to provide real-time monitoring and location tracking capabilities. The proposed system incorporates brushless DC motors, electronic speed controllers, a flight controller, GPS tracking, and wireless communication modules to achieve stable flight and reliable surveillance performance. An onboard camera is integrated for live video transmission, enabling remote observation of target locations. The developed platform aims to provide an economical and efficient solution for surveillance applications requiring mobility, situational awareness, and real-time information gathering.

The primary objectives of this study are to design a stable hexacopter platform, implement a GPS-based tracking system, establish reliable telemetry communication, and evaluate the surveillance performance of the developed UAV system. proposed drone can be effectively utilized in security operations, disaster response activities, infrastructure inspection, and remote monitoring applications.

II. LITERATURE REVIEW

Unmanned Aerial Vehicles (UAVs) have become increasingly important in surveillance, monitoring, and reconnaissance applications due to their mobility, flexibility, and ability to access remote locations. Researchers have developed various drone-based systems to improve real-time monitoring, communication range, and operational efficiency.

Boon (2014) discussed the use of UAVs for surveillance and reconnaissance applications, highlighting their capability to provide aerial observation without requiring human presence in hazardous environments. The study emphasized the growing importance of drones in security and monitoring operations.

Parker (2012) investigated the design and control of quadcopter systems and demonstrated the effectiveness of flight stabilization techniques in improving UAV maneuverability and operational performance. The work provided a foundation for modern multirotor control systems.

Several researchers have developed GPS-enabled drone platforms for location tracking and remote monitoring. Their studies demonstrated that integrating GPS technology with UAVs improves navigation accuracy and enhances mission reliability during surveillance operations.

Recent developments in telemetry systems have enabled drones to transmit flight parameters and real-time status information to ground stations. These communication systems improve operational awareness and allow operators to monitor UAV performance over long distances.

Researchers have also explored the integration of wireless video transmission systems with UAV platforms for surveillance applications. Live video streaming enables continuous monitoring of target areas and supports decision-making in security, disaster management, and search-and-rescue operations.

Although previous studies have demonstrated the effectiveness of drone-based surveillance systems, many existing platforms are limited by communication range, payload capacity, and operational flexibility. Therefore, the present work focuses on the design and development of a long-range surveillance hexacopter integrated with GPS tracking, telemetry communication, and real-time video transmission to enhance monitoring capabilities and operational efficiency.

TABLE I
SPECIFICATION OF THE DRONE

Weight	1.7 kg
Motor max tilt angle	35ºasfw
Length	0.91 m
Max roll angle	50º
Max pitch angle	30
Max thrust	3 kg
Max extra payload	1 kg

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 14 Issue VI June 2026- Available at www.ijraset.com

III. METHODOLOGY AND SYSTEM DESIGN

A. System Overview

The proposed surveillance system consists of a long-range hexacopter UAV integrated with a flight control unit, GPS tracking module, telemetry communication system, onboard camera, brushless DC motors, electronic speed controllers (ESCs), and a lithium-polymer battery. The drone is designed to perform real-time aerial monitoring while maintaining stable flight characteristics and reliable communication with the ground station.

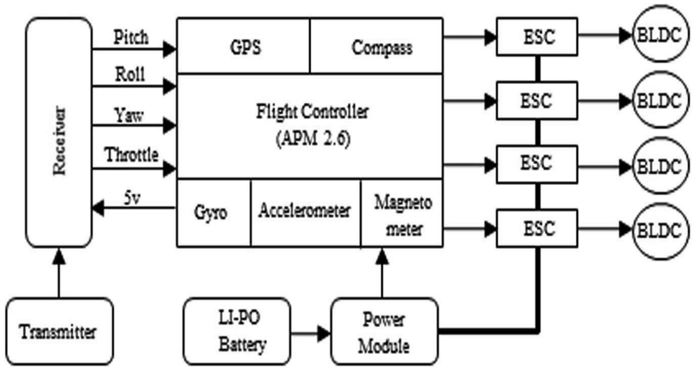


Fig.2. Overall System Block Diagram

The overall system architecture is divided into four major subsystems: the propulsion system, flight control system, communication system, and surveillance system. These subsystems work together to ensure stable operation, accurate navigation, and effective surveillance performance.

B. Hexacopter Frame Design

A six-rotor configuration was selected due to its superior stability, higher payload carrying capacity, and improved reliability compared to lower rotor configurations. The frame serves as the structural backbone of the drone and supports all electronic components, including motors, battery, flight controller, telemetry module, GPS module, and camera system.

The frame was designed to provide balanced weight distribution and minimize vibration during flight. Lightweight materials were considered to reduce the overall mass while maintaining structural strength and durability.

C. Propulsion System

The propulsion system consists of six brushless DC motors coupled with propellers and controlled using electronic speed controllers. The motors generate the required thrust to achieve lift, maneuverability, and directional control.

Fig.3. Brushless DC Motor

Electronic Speed Controllers (ESCs) regulate the speed of each motor based on commands received from the flight controller. By varying the rotational speed of individual motors, the drone achieves roll, pitch, yaw, and altitude control.

The propulsion system was designed to generate sufficient thrust to lift the drone along with the surveillance payload while ensuring stable operation under different flight conditions.

D. Flight Control System

The flight control system is the core component responsible for stabilizing and controlling the UAV. A KK2.1.5 flight controller was utilized to process sensor inputs and generate control signals for the motors.

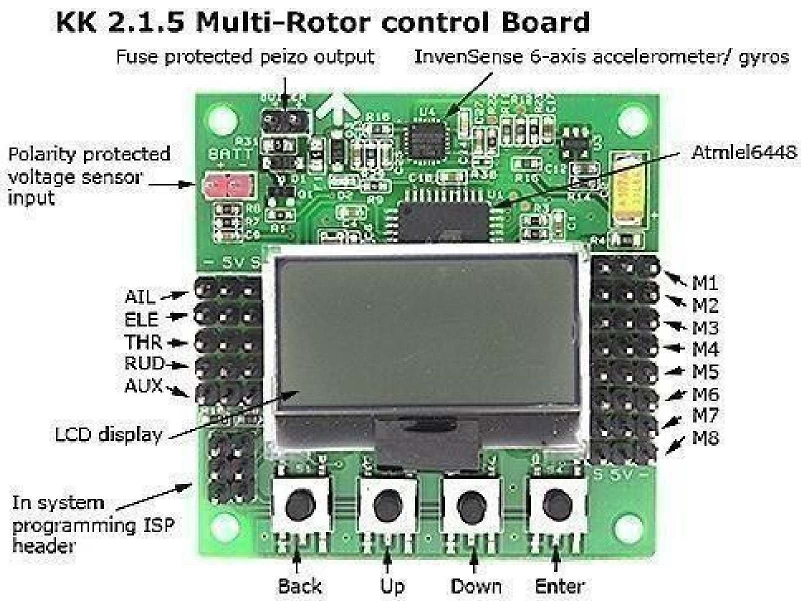


Fig.4. KK2.1.5 Flight Controller

The controller continuously monitors the drone's orientation through onboard sensors and performs corrective actions whenever disturbances occur. The flight controller manages:

- Roll Control – Movement along the longitudinal axis.
- Pitch Control – Movement along the lateral axis.
- Yaw Control – Rotational movement about the vertical axis.
- Altitude Control – Vertical movement of the drone.

The control algorithm maintains stable flight by adjusting motor speeds in real time based on sensor feedback.

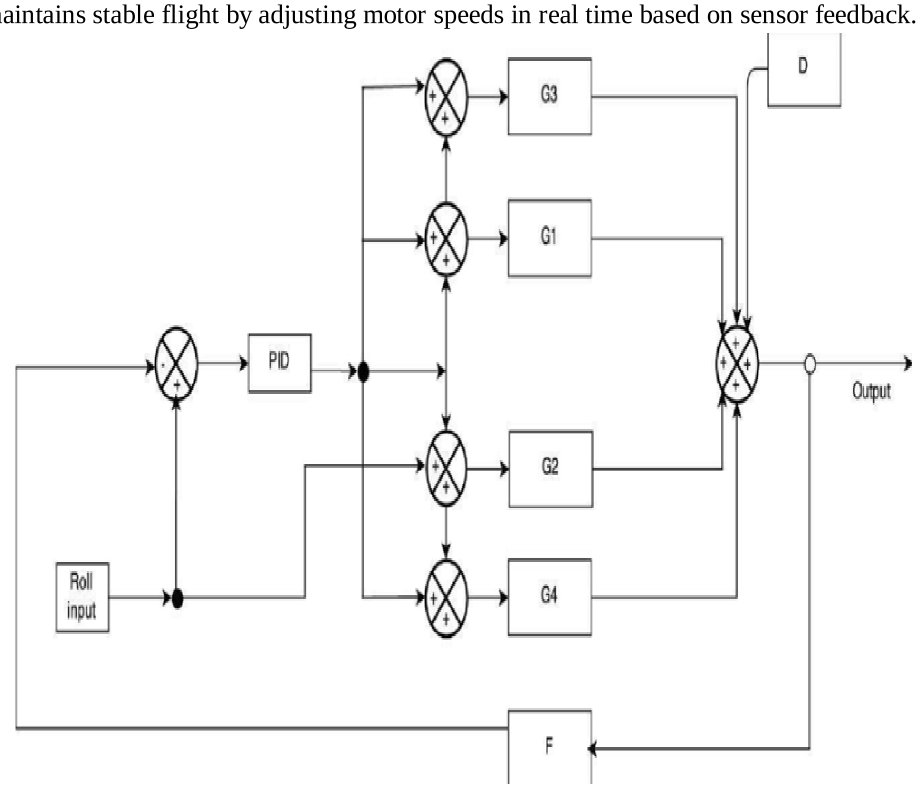


Fig. 5. Roll Control System

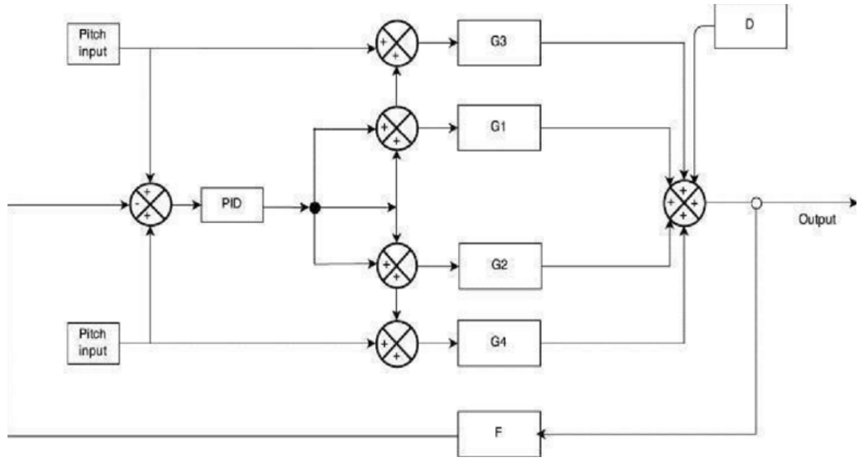


Fig. 6. Pitch Control System

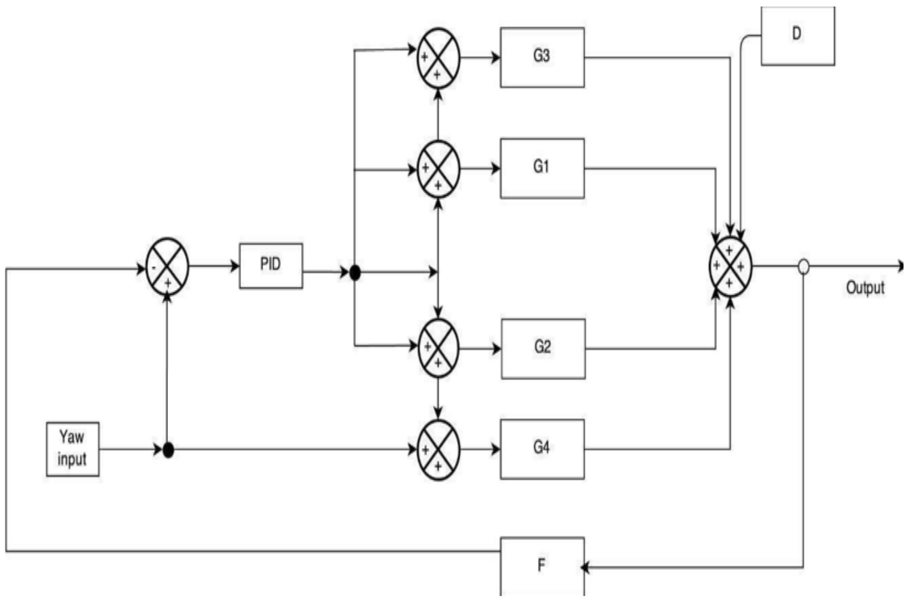


Fig. 7. Yaw Control System

The control system consists of a feedback loop that processes orientation data and generates appropriate control signals for the electronic speed controllers. This enables stable hovering and maneuvering during surveillance missions.

E. GPS Tracking System

A GPS module was integrated into the drone to provide real-time location information. The GPS receiver continuously acquires satellite signals and determines the geographical coordinates of the UAV.

The acquired location data can be transmitted to the ground station, enabling operators to monitor the drone's position during surveillance missions. GPS integration improves navigation accuracy and enhances operational safety.

F. Telemetry and Communication System

A wireless telemetry system was implemented to establish communication between the drone and the ground control station. The telemetry module enables the transmission of critical flight information, including position, altitude, battery status, and system health parameters.

Fig. 8. RF Transmitter and Reeciver Module

Radio frequency communication operating at 2.4 GHz was utilized for remote control of the drone. The communication system provides sufficient range for long-distance surveillance operations while maintaining stable connectivity.

G. Surveillance System

An onboard camera was mounted on the UAV to capture real-time video footage during flight. The camera transmits live video streams to the monitoring station through a wireless communication network.

The surveillance system enables operators to observe target locations remotely and collect visual information for security monitoring, disaster assessment, search-and-rescue operations, and environmental observation.

H. Working Principle

The operation of the surveillance drone begins with the activation of the flight controller and communication systems. Once powered, the GPS module establishes satellite connectivity and determines the drone's location. The flight controller receives pilot commands through the radio transmitter and adjusts motor speeds accordingly.

During flight, the onboard camera continuously captures video footage and transmits it to the ground station. Simultaneously, telemetry data and GPS coordinates are communicated to the operator for real-time monitoring. The integrated operation of these subsystems enables efficient aerial surveillance and remote observation over extended distances.

IV. RESULTS AND DISCUSSION

A. Flight Performance Evaluation

The developed hexacopter drone was tested under various operating conditions to evaluate its flight stability and surveillance capabilities. The flight controller successfully maintained stable operation during take-off, hovering, maneuvering, and landing. The six-rotor configuration provided enhanced stability and improved control response compared to conventional multirotor platforms. The drone demonstrated smooth roll, pitch, and yaw movements with minimal oscillations during flight operations.

Fig. 9. Experimental Flight Testing of the Developed Hexacopter

B. Communication Range Analysis

The communication performance of the UAV was evaluated using a 2.4 GHz radio frequency transmitter and receiver system. Experimental observations indicated that the communication link remained stable for distances approaching 1 km under normal environmental conditions. Beyond this range, signal strength gradually decreased, resulting in reduced communication reliability. The obtained range is adequate for short- to medium-range surveillance missions and remote monitoring applications.

TABLE III
COMMUNICATION PERFORMANCE

Parameter	Observed Value
Operating Frequency	2.4 GHz
Reliable Communication Range	~1 km
Signal Stability	High
Data Transmission	Continuous

C. GPS Tracking Performance

The integrated GPS module successfully provided real-time location information throughout the flight mission. The acquired latitude and longitude coordinates were transmitted to the monitoring station, enabling continuous tracking of the UAV position. The GPS system enhanced operational safety by allowing operators to monitor the drone’s movement and retrieve positional information during surveillance activities.

D. Real-Time Surveillance Capability

The onboard camera system successfully transmitted live video footage to the ground station. Real-time monitoring enabled observation of remote locations without direct human intervention. The surveillance system provided continuous visual feedback, making the platform suitable for security monitoring, traffic observation, disaster assessment, and search-and-rescue applications.

The video transmission system maintained acceptable image quality throughout the communication range and provided effective situational awareness for remote operators.

E. Payload and Structural Performance

The hexacopter configuration offered improved payload carrying capability due to the presence of six brushless DC motors. The structural arrangement ensured balanced load distribution and enhanced flight reliability. The frame successfully accommodated the flight controller, battery, GPS module, telemetry unit, and surveillance camera without affecting flight stability.

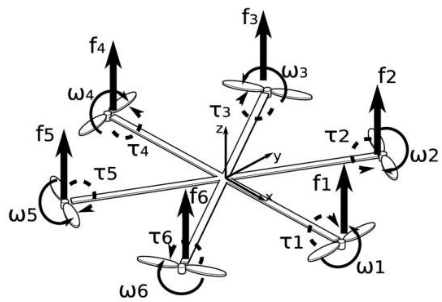


Fig. 10. Schematic Representation of Hexacopter Dynamics and Rotor Forces

TABLE III
SYSTEM PERFORMANCE SUMMARY

Parameter	Result
UAV Configuration	Hexacopter
Maximum Thrust	3 kg

Payload Capability	1 kg
Communication Range	~1 km
GPS Tracking	Successful
Live Video Streaming	Successful
Flight Stability	Stable
Surveillance Capability	Effective

F. Discussion

The experimental results demonstrate that the developed surveillance hexacopter successfully integrates flight control, GPS navigation, telemetry communication, and real-time video transmission within a single aerial platform. The six-rotor configuration contributed significantly to flight stability and payload handling capability. The implemented communication and tracking systems provided reliable monitoring performance, making the UAV suitable for various surveillance applications.

Compared to conventional monitoring methods, the proposed system offers improved mobility, wider coverage, reduced operational cost, and enhanced accessibility to remote locations. The obtained results confirm that the developed UAV platform can serve as an effective solution for security surveillance, disaster monitoring, infrastructure inspection, and environmental observation.

V. CONCLUSIONS

A long-range surveillance hexacopter UAV was successfully designed and developed for real-time monitoring and tracking applications. The proposed system integrates a hexacopter platform with a flight controller, GPS tracking module, telemetry communication system, and onboard camera to provide reliable surveillance capabilities. The six-rotor configuration offered enhanced flight stability, improved payload carrying capacity, and better operational reliability compared to conventional multirotor platforms.

The implemented GPS module enabled accurate location tracking, while the telemetry system ensured continuous communication between the UAV and the ground station. Real-time video transmission provided effective monitoring of remote locations, making the system suitable for surveillance and reconnaissance operations. Experimental observations demonstrated stable flight performance, reliable communication over a range of approximately 1 km, and successful real-time monitoring capabilities.

The developed surveillance drone provides a cost-effective and flexible solution for applications such as border security, disaster management, traffic monitoring, environmental observation, infrastructure inspection, and search-and-rescue missions. The results indicate that the proposed hexacopter platform can effectively perform aerial surveillance tasks while maintaining operational efficiency and system reliability.

Future enhancements may include autonomous navigation, artificial intelligence-based object detection, obstacle avoidance systems, thermal imaging cameras, and extended communication capabilities to further improve the performance and versatility of the surveillance platform.

REFERENCES

[1] R. Austin, *Unmanned Aircraft Systems: UAV Design, Development and Deployment*, 1st ed. Chichester, U.K.: John Wiley & Sons, 2010.
[2] J. G. Valavanis and G. J. Vachtsevanos, *Handbook of Unmanned Aerial Vehicles*. Dordrecht, Netherlands: Springer, 2015.
[3] M. Hassanalian and A. Abdelkefi, "Classifications, applications, and design challenges of drones: A review," *Progress in Aerospace Sciences*, vol. 91, pp. 99–131, May 2017.
[4] S. Waharte and N. Trigoni, "Supporting search and rescue operations with UAVs," in *Proc. International Conference on Emerging Security Technologies*, Canterbury, U.K., 2010, pp. 142–147.
[5] A. Ollero and I. Maza, "Multiple UAV cooperative systems for disaster management," *Journal of Intelligent and Robotic Systems*, vol. 65, no. 1–4, pp. 563–585, Jan. 2012.
[6] M. Erdelj and E. Natalizio, "UAV-assisted disaster management: Applications and open issues," in *Proc. International Conference on Computing, Networking and Communications*, Kauai, HI, USA, 2016, pp. 1–5.
[7] P. Pounds, R. Mahony, and P. Corke, "Modelling and control of a quad-rotor robot," in *Proc. Australasian Conference on Robotics and Automation*, Auckland, New Zealand, 2006, pp. 1–6.
[8] T. Samad and A. M. Annaswamy, "Control challenges in autonomous UAV systems," *IEEE Control Systems Magazine*, vol. 33, no. 4, pp. 32–50, Aug. 2013.
[9] K. P. Valavanis, *Advances in Unmanned Aerial Vehicles: State of the Art and the Road to Autonomy*. Dordrecht, Netherlands: Springer, 2007.
[10] D. Molloy, "A review of UAV navigation and GPS-based positioning systems," *International Journal of Aerospace Engineering*, vol. 2019, pp. 1–12, 2019.
[11] Y. Zeng, R. Zhang, and T. J. Lim, "Wireless communications with unmanned aerial vehicles: Opportunities and challenges," *IEEE Communications Magazine*, vol. 54, no. 5, pp. 36–42, May 2016.

[12] M. Mozaffari, W. Saad, M. Bennis, and M. Debbah, “A tutorial on UAVs for wireless networks: Applications, challenges, and open problems,” *IEEE Communications Surveys & Tutorials*, vol. 21, no. 3, pp. 2334–2360, 2019.

[13] H. Menouar, I. Guvenc, K. Akkaya, A. S. Uluagac, A. Kadri, and A. Tuncer, “UAV-enabled intelligent transportation systems for the smart city,” *IEEE Communications Magazine*, vol. 55, no. 3, pp. 22–28, Mar. 2017.

[14] M. A. Hossain, M. A. Rahman, and M. F. Rabbi, “Design and implementation of a surveillance drone for monitoring applications,” *International Journal of Engineering Research and Technology*, vol. 9, no. 7, pp. 112–118, 2020.

[15] S. Saha, A. Mukherjee, and P. Das, “GPS-based autonomous navigation system for unmanned aerial vehicles,” *International Journal of Advanced Computer Science and Applications*, vol. 11, no. 4, pp. 230–236, 2020.

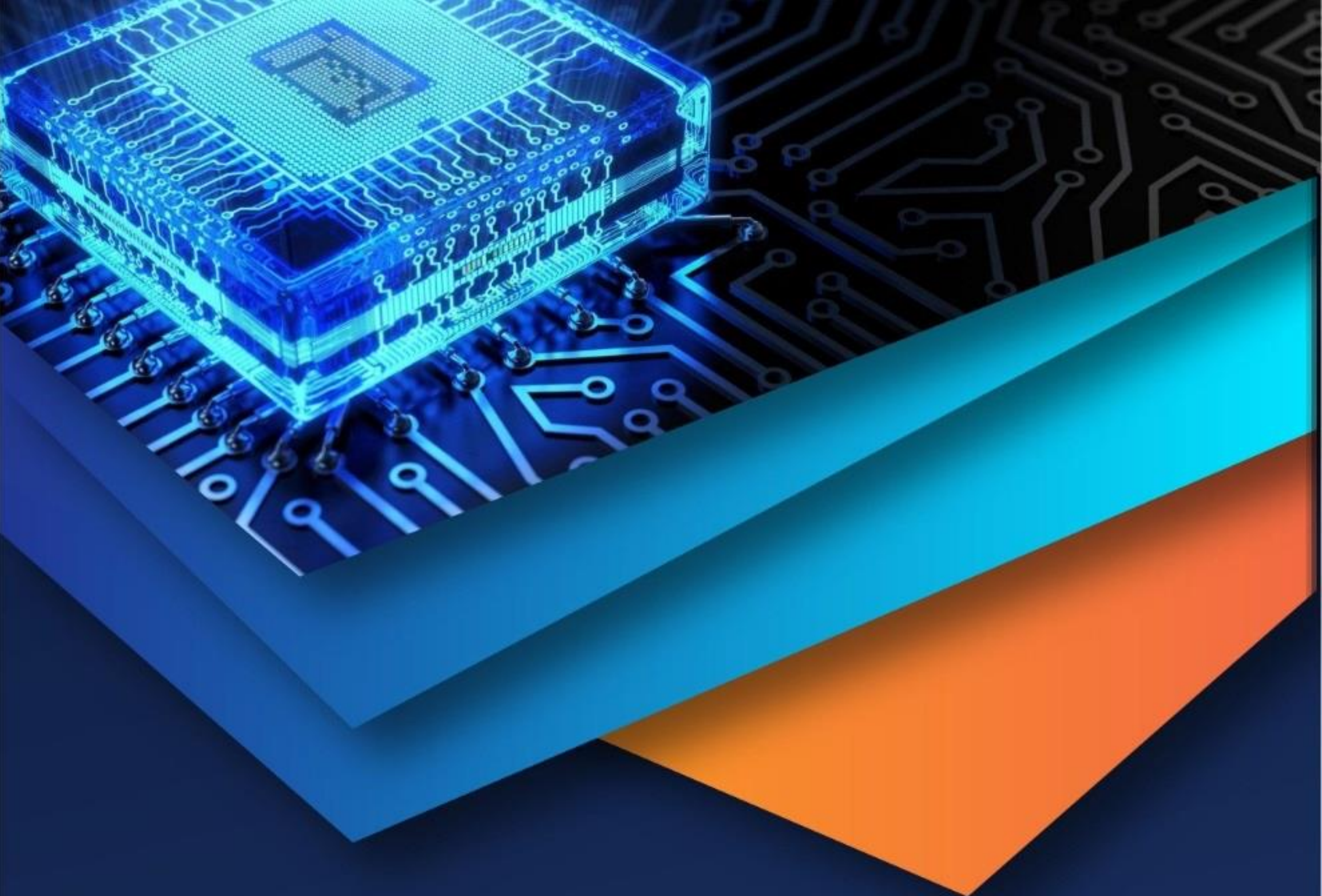
[16] A. Al-Kaff, F. García, D. Martín, A. Escalera, and J. Armingol, “Obstacle avoidance system for UAVs using computer vision techniques,” *Sensors*, vol. 17, no. 5, pp. 1061–1078, 2017.

[17] B. Siciliano and O. Khatib, *Springer Handbook of Robotics*, 2nd ed. Cham, Switzerland: Springer, 2016.

[18] S. Hrabar, “3D path planning and navigation for autonomous UAVs,” *Journal of Field Robotics*, vol. 28, no. 1, pp. 87–105, Jan. 2011.

[19] C. Goerzen, Z. Kong, and B. Mettler, “A survey of motion planning algorithms from the perspective of autonomous UAV guidance,” *Journal of Intelligent and Robotic Systems*, vol. 57, no. 1–4, pp. 65–100, Jan. 2010.

[20] M. R. Brust, G. Danoy, P. Bouvry, D. Gashi, H. Pathak, and M. P. Gonçalves, “Communicating drones for large-scale surveillance applications,” in *Proc. IEEE* International Conference on Wireless and Mobile Computing, Networking and Communications, *2011, pp. 58–65.*



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY