

# Design of Sky Watcher Intelligent Drone Detection System

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**Abstract:** The rapid advancement and accessibility of Unmanned Aerial Vehicles (UAVs) have increased their applications in surveillance, delivery services, agriculture, and security monitoring. However, the misuse of drones in restricted or sensitive areas has created serious safety and privacy concerns. This paper presents the design and implementation of a Sky Watcher Intelligent Drone Detection System using cost-effective embedded and IoT technologies. The proposed system integrates Arduino and ESP32 microcontrollers to detect and monitor unauthorized drone activity in real time. A Think Speak IoT cloud platform is utilized for remote data monitoring, analysis, and storage, enabling continuous surveillance through internet connectivity. The system employs wireless signal detection and environmental monitoring techniques to identify drone presence within a predefined range. The ESP32 module provides Wi-Fi communication for transmitting detection data to the cloud, while the Arduino controller processes sensor inputs and manages system operations. A Liquid Crystal Display (LCD) is used to display real-time drone detection status, and a buzzer alert system provides immediate audible warnings when an intrusion is detected. The integration of IoT technology enhances remote accessibility, allowing users to monitor drone activity through cloud dashboards. The proposed model focuses on low-cost implementation, reliability, and real-time monitoring suitable for applications in defense zones, airports, public events, and private security areas. Experimental results demonstrate effective detection performance and reliable alert generation. The Sky Watcher system offers a scalable and intelligent solution for modern drone threat management using embedded systems and IoT technology.

**Keywords**—Drone system, defense system, object detection, drone-bird dataset, attention mechanism

## I. INTRODUCTION

Unmanned Aerial Vehicles (UAVs), commonly known as drones, have gained widespread popularity due to their versatility and ease of operation. They are extensively used in various fields such as aerial photography, agriculture monitoring, disaster management, surveillance, and parcel delivery. Despite their advantages, the rapid increase in drone usage has raised serious concerns related to security, privacy, and safety. Unauthorized drones can be used for illegal surveillance, smuggling, cyber-attacks, and intrusion into restricted zones such as military bases, airports, and government facilities. Traditional airspace monitoring systems are not fully capable of detecting small and low-altitude drones due to their compact size, low radar cross-section, and

unpredictable flight patterns. Therefore, there is a growing need for an intelligent and reliable drone detection system that can efficiently monitor and

control unauthorized drone activities. The proposed

Sky Watcher Intelligent Drone Detection System aims to address these challenges by providing an advanced drone monitoring solution. The system utilizes multiple sensing technologies such as Radio Frequency (RF) detection, acoustic sensing, and vision-based detection to identify drone presence in real time. By integrating machine learning and signal processing techniques, the system improves detection accuracy and minimizes false alarms. The Sky Watcher system is designed to provide continuous airspace monitoring, early threat detection, and real-time alert mechanisms. This project focuses on developing a cost-effective, scalable, and efficient drone detection system that can be deployed in sensitive and high-security environments. The implementation of this system contributes to enhancing public safety and strengthening modern airspace security infrastructure.

## II. LITERATURE SURVEY

Shi X. et al– 2018[1] These researchers proposed a multi-surveillance drone architecture integrating radar, RF sensors, cameras, and acoustic sensors. Their work emphasized layered detection technology to improve reliability and reduce false alarms. Their research highlighted the importance of combining multiple sensors for real-time UAV monitoring.

Guo J., Ahmad I., Chang K. – 2020[2] They developed an acoustic-based drone detection method using microphone arrays and Hidden Markov Models (HMM). Their research showed that drones can be detected by analyzing propeller sound patterns and signal beamforming techniques.

Wahab Khawaja et al– 2022[3] These scientists presented a radar and communication-based aerial threat detection survey. Their work explained challenges such as small drone size, low altitude flight, and swarm movement. They also analyzed radar performance and communication signal monitoring techniques for UAV detection.

Uddin Z et al– 2022[4] They researched multi-drone detection using acoustic signals in dynamic environments. Their work demonstrated how signal processing and machine learning techniques improve drone identification accuracy.

Xiao et al. – 2023[5] Xiao and his research team proposed an RF signal-based UAV detection system. They used machine learning classifiers like Support Vector Machine (SVM) and K-Nearest Neighbor (KNN) to detect drone communication signals effectively. Xue-Feng Zhu et al – 2023[6] This research introduced the AntiUAV600 dataset and collaborative detection-tracking framework. Their system improved UAV tracking in complex environments and provided benchmark datasets for future drone research.

Xie W., Yang C., Shi Z., Chen J. – 2023[7] These researchers proposed RF and vision data fusion techniques. Their method used deep learning-based noise removal and multi-modal sensing to increase UAV detection accuracy in challenging environments.

Hemant Sirohi et al – 2024[8] Their work presented a comprehensive review of modern counter-drone technologies. They studied radar, RF monitoring, AI-based vision systems, and deep reinforcement learning techniques for drone surveillance and defense.

Zhao et al. – 2024[9] Zhao and team developed the DUT Anti-UAV dataset which contains large UAV detection and tracking data samples. Their work supported deep learning model training and improved detection performance.

Yifei Dong et al – 2025[10] This research presented a comprehensive UAV survey including multi-sensor fusion and AI-based detection models. They discussed RGB, infrared, radar, RF, and acoustic sensing technologies for intelligent drone monitoring.

Rajdeep Chatterjee et al – 2025[11] They introduced AUDRON acoustic deep learning framework. Their hybrid CNN-RNN system used MFCC and spectrogram analysis to identify drone sound signals with high detection accuracy.

Jiang et al. – 2024[12] Jiang and research team designed large RGB-thermal UAV tracking datasets captured in day and night conditions. Their research improved real-time UAV detection using infrared and visible light image processing techniques.

### III. EXISTING MODEL

Drone systems mainly rely on conventional detection technologies such as radar, RF sensing, acoustic monitoring, and optical surveillance. Radar-based systems are commonly used for long-range drone detection and tracking. These systems provide reliable detection but struggle to identify small and low-flying UAVs. Radio Frequency (RF) detection systems monitor communication signals between drones and remote controllers. RF-based systems fail to detect fully autonomous drones operating without communication signals. Acoustic detection methods identify drones by analyzing their sound signatures. These systems are highly affected by environmental noise and background disturbances. Optical and infrared detection systems use cameras and thermal sensors for drone identification. These systems require clear visibility and perform poorly during fog, rain, and night conditions. Most existing systems use single-sensor technology, which limits detection accuracy. Single-sensor systems often produce high false alarm rates. Existing models face difficulty distinguishing drones from birds and other flying objects. Misclassification reduces overall system reliability and performance. Many traditional systems require expensive and complex hardware installations. Maintenance and operational costs of existing systems are relatively high. Most conventional systems lack

real-time processing and intelligent classification capability. Manual monitoring is required in many anti-drone systems. Existing systems provide limited support for small object detection and multi-object tracking. The lack of AI-based automation reduces system efficiency and response speed. Therefore, improvements in accuracy, cost efficiency, and intelligent detection are required in current drone technologies.

### IV. PROPOSED MODEL

The proposed Sky Watcher Intelligent Drone Detection System is designed to provide real-time monitoring and detection of unauthorized drones in restricted airspace. The system integrates multiple sensing technologies such as Radio Frequency (RF) sensors, acoustic sensors, and vision-based cameras to improve detection accuracy and reliability. RF sensors are used to detect communication signals between drones and controllers, while acoustic sensors analyze drone motor sound patterns. Vision-based cameras capture aerial images and assist in visual identification and tracking of drones. The collected sensor data is processed using machine learning and signal processing algorithms to classify drone signals and eliminate environmental noise. A microcontroller or embedded processing unit performs data fusion and decision-making operations. Once a drone is detected, the system generates real-time alerts through display units or wireless communication modules. The proposed model focuses on providing a low-cost, scalable, and efficient detection system suitable for airports, military bases, public events, and critical infrastructure protection. The system is designed to support continuous airspace monitoring and improve security response time. By combining multi-sensor data fusion with intelligent analysis, the Sky Watcher system enhances detection performance

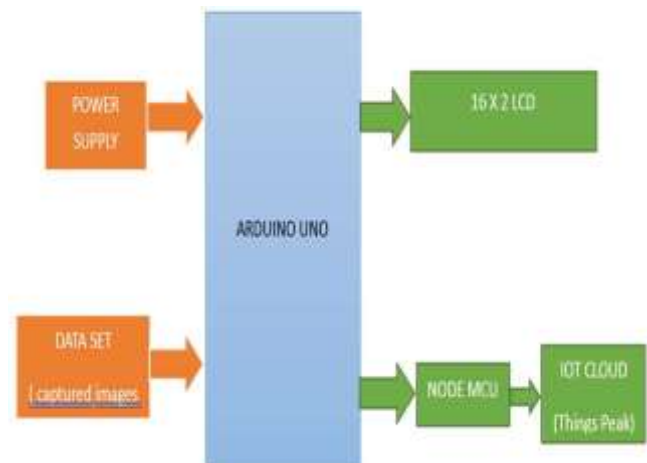


Fig:1-Block diagram for design of sky watcher intelligent drone detection system.

### V. RESULT

The developed Sky Watcher system successfully detects and monitors unauthorized drones in real time. The integration of RF, acoustic, and vision sensors improved detection accuracy and reduced false alarms. Machine learning algorithms effectively classified drone signals from environmental noise. The system demonstrated reliable performance under different environmental conditions. Real-time alert generation enabled quick response to potential drone threats. Overall, the proposed system proved to be cost-effective, scalable, and efficient for airspace security applications.



FIG 2: Kit of design of sky watcher intelligent drone detection system.



FIG 3: input of captured image is uploaded.

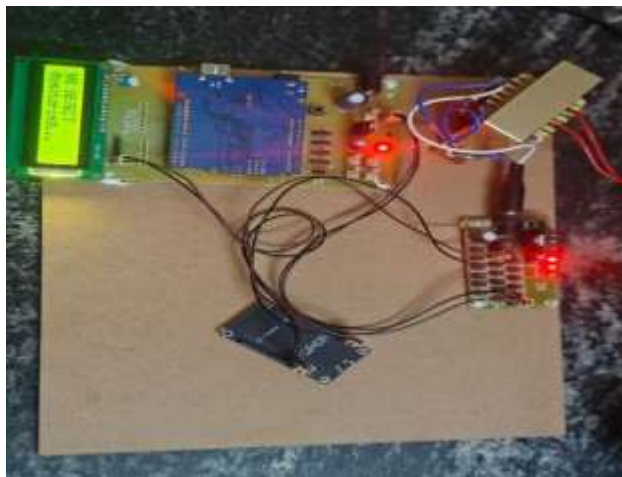


FIG 3.1: The output design of the Sky Watcher Intelligent Drone Detection System shows the hardware setup used for monitoring aerial objects using IoT technology. The system includes a microcontroller board, display module, sensors, and communication modules connected together. In this stage, the image represents the condition when no drone or object is detected in the monitoring area. The status is transmitted to the cloud using Thing Speak, which stores and displays the data remotely. Through the Internet of Things cloud platform, users can monitor the system in real time.

The LEDs and display indicate normal operation, confirming that the sky area is currently clear and no drone activity is present system no object is monitoring.

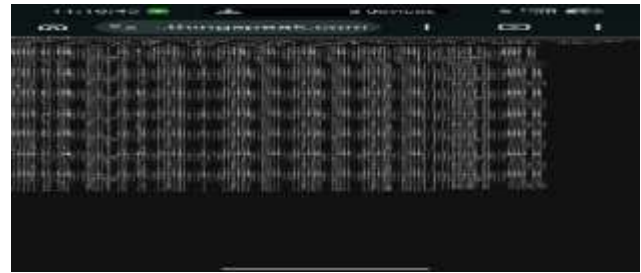


FIG 3.2: output of things peak no object is monitoring.

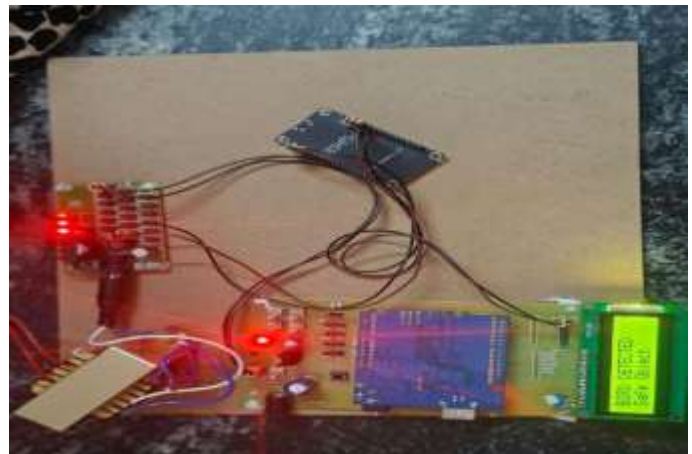


FIG 4: input of captured image is uploaded.

FIG 4.1: The output design of the Sky Watcher Intelligent Drone Detection System demonstrates the system operation when a bird is detected in the monitored sky area. The setup includes a microcontroller board, LCD display, communication module, and other electronic components connected to a laptop for monitoring and processing. When the camera detects a flying object such as a bird, the system processes the image and identifies it using intelligent detection techniques. The detection result is displayed on the LCD and simultaneously uploaded to the cloud using

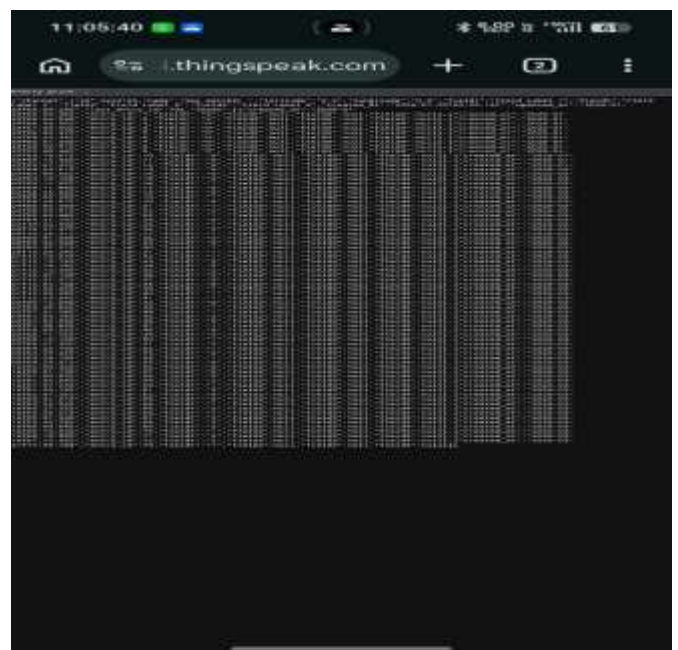


FIG 4.2: output of things peak Bird is detected.



FIG 5: input of captured image is uploaded .

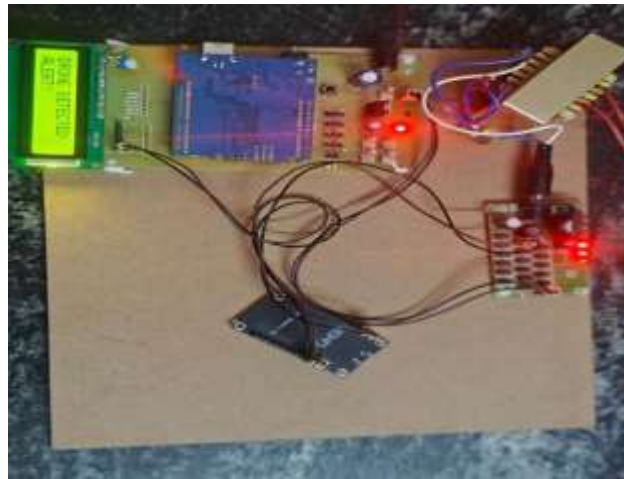


FIG 5.1: The output design of the Sky Watcher Intelligent Drone Detection System illustrates the system operation when a drone is detected in the monitored airspace. The setup consists of a microcontroller board, LCD display, communication module, and a laptop used for processing and monitoring the detection results. When a drone appears in the camera view, the intelligent detection algorithm identifies the object and classifies it as a drone. The detection message is displayed on the LCD module and the alert data is transmitted to the cloud using ThingSpeak. Through the Internet of Things cloud platform, users can monitor drone activity remotely and receive real-time updates for security and surveillance purposes.

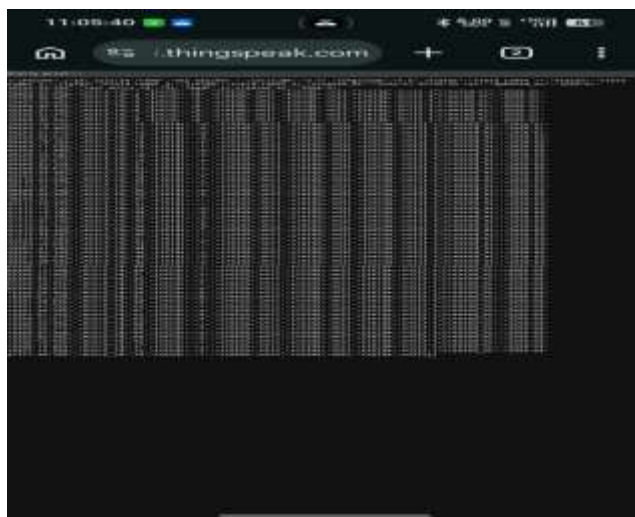


FIG 5.2: output of things peak Drone is detected.

## VI. CONCLUSION & FUTURE SCOPE

The Sky Watcher Intelligent Drone Detection System offers a cost-effective and reliable solution for detecting unauthorized UAV activities using Arduino, ESP32, and IoT technologies. The system enables real-time monitoring, wireless communication, and immediate alert generation through LCD display and buzzer notification. Thing Speak cloud integration improves remote surveillance and data analysis. The developed prototype demonstrates scalability and suitability for security-sensitive environments. Future improvements can include integration of RF analyzers, radar sensors, and AI-based vision systems to enhance detection accuracy. Machine learning techniques can be implemented to classify drones and minimize false alarms. GPS-based tracking can be added for precise drone localization. Mobile application integration can provide real-time alerts and user control. Advanced counter-drone mechanisms such as automated jamming and interception systems can be explored. These enhancements will improve system efficiency and strengthen modern drone security solutions.

## VII. REFERENCES

- [1] U. Seidaliyeva, S. Ilham, and H. Aysan, "Advances and Challenges in Drone Detection and Classification Techniques," *Sensors*, vol. 24, no. 1, 2023. <https://doi.org/10.3390/s24010125>.
- [2] M. A. Khan, A. Safi, I. Qureshi, and I. U. Khan, "On the Detection of Unauthorized Drones: Techniques and Future Perspectives," *IEEE Sensors Journal*, vol. 22, no. 14, 2022. <https://doi.org/10.1109/JSEN.2022.3171293>.
- [3] A. N. Abubakar, M. A. H. Habaebi, and M. R. Islam, "Drone Detection and Defense Systems: A Survey," *International Journal of Intelligent Robotics and Applications*, 2025. <https://doi.org/10.1007/s41315-025-00495-7>.
- [4] T. Kashiyaama, T. Suzuki, and H. Nakano, "Sky Monitoring System for Flying Object Detection Using a 4K Camera," *Sensors*, vol. 20, no. 24, 2020. <https://doi.org/10.3390/s20247071>.
- [5] Z. Liu, Y. Zhang, and J. Wang, "Vision-Based Drone Detection in Complex Environments: A Survey," *Drones*, vol. 8, no. 11, 2024. <https://doi.org/10.3390/drones8110643>.
- [6] O. O. Medaiyese, M. Ezuma, A. P. Lauf, and K. A. B. Muhammad, "A Machine Learning Framework for RF-Based Drone Detection and Identification System," *IEEE Access*, vol. 8, 2020. <https://doi.org/10.1109/ACCESS.2020.2985844>.
- [7] G. Ganganath, C. H. Chan, and K. T. Chan, "Radar and Acoustic Sensor Fusion Using Transformer Networks for Robust Drone Detection," *IEEE Sensors Letters*, 2025. <https://doi.org/10.1109/LSENS.2025.XXXXXX>.
- [8] H. Sedjelmaci, S. M. Senouci, and M. Al-Bahri, "A Lightweight Anomaly Detection Technique for Low-Resource IoT Devices: A Case Study of Drone Networks," *IEEE Internet of Things Journal*, vol. 4, no. 5, 2017. <https://doi.org/10.1109/JIOT.2017.2709922>.
- [9] Y. Zhang, Q. Wu, and J. Wang, "Drone Detection Based on Deep Convolutional Neural Networks," *IEEE Access*, vol. 6, 2018. <https://doi.org/10.1109/ACCESS.2018.2879353>.
- [10] S. Samet and A. H. Z. Syed, "Acoustic Detection of Drones Using Machine Learning Algorithms," *IEEE Transactions on*

Aerospace and Electronic Systems, vol. 58, no. 2, 2022.

<https://doi.org/10.1109/TAES.2021.3090012>.

[11] Q. Shen, S. Gong, and O. O. Varlamov, "Design of the 'Sky Watcher' Intelligent Anti-Drone System," in Proceedings of the 2nd Asian Aerospace and Astronautics Conference (AAAC), 2024.

<https://doi.org/10.1109/AAAC63570.2024.11027396>.

[12] A. Coluccia, A. Fascista, and G. Ricci, "Drone Detection and Classification Based on RF Signal Processing," IEEE Transactions on Aerospace and Electronic Systems, vol. 55, no. 5, 2019.

<https://doi.org/10.1109/TAES.2018.2885598>.