PROTECDOME: PROTECtion DOME for Public Spaces against Rogue Drones

Demonstration Track

Nicolas Souli
Department of Electrical and Computer Engineering & the KIOS Research and Innovation Center of Excellence, University of Cyprus
Nicosia, Cyprus
nsouli02@ucy.ac.cy

Giorgos Pettemeridis
Department of Computer Science & the KIOS Research and Innovation Center of Excellence, University of Cyprus
Nicosia, Cyprus
gpette01@ucy.ac.cy

Panayiotis Kolios
Department of Computer Science & the KIOS Research and Innovation Center of Excellence, University of Cyprus
Nicosia, Cyprus
pkolios@ucy.ac.cy

Georgios Ellinas
Department of Electrical and Computer Engineering & the KIOS Research and Innovation Center of Excellence, University of Cyprus
Nicosia, Cyprus
gellinas@ucy.ac.cy

ABSTRACT

The exponential proliferation and ease of use of unmanned aerial vehicles require the design and development of counter-unmanned aircraft systems (CUASs) to safeguard critical infrastructures and public spaces from malicious attacks. The PROTECDOME project is focused on developing a novel CUAS while also enhancing the capabilities and expertise of law enforcement agencies (LEAs) in utilizing CUAS technology. PROTECDOME's main objectives include (i) the detection, tracking, and classification of rogue drones at an early stage and in real-time, (ii) risk quantification and vulnerability analysis for any public space through an evidence-based assessment toolkit, (iii) the development of an integrated CUAS system that combines detection, tracking, alerting, and situational awareness by employing various sensor modalities in a sensor fusion AI-aided framework to achieve single- and multi-target tracking and (iv) the improvement of the long-term capacity of LEAs' services on CUAS systems. The PROTECDOME system is implemented in both software and hardware, and is extensively evaluated in real-world outdoor experiments to validate its performance.

KEYWORDS

Counter-UAS; AI-aided detection and tracking; Sensor fusion.

ACM Reference Format:

Nicolas Souli, Giorgos Pettemeridis, Panayiotis Kolios, and Georgios Ellinas. 2026. PROTECDOME: PROTECtion DOME for Public Spaces against Rogue Drones: Demonstration Track. In *Proc. of the 25th International Conference on Autonomous Agents and Multiagent Systems (AAMAS 2026), Paphos, Cyprus, May 25 – 29, 2026*, IFAAMAS, 3 pages. https://doi.org/10.65109/RXLH8860

Proc. of the 25th International Conference on Autonomous Agents and Multiagent Systems (AAMAS 2026), C. Amato, L. Dennis, V. Mascardi, J. Thangarajah (eds.), May 25 – 29, 2026, Paphos, Cyprus. © 2026 International Foundation for Autonomous Agents and Multiagent Systems (www.ifaamas.org). https://doi.org/10.65109/RXLH8860

1 INTRODUCTION

The increased usage of drone technology for illegal operations, that can disrupt the normal operations of critical infrastructures and public spaces, has led to a new set of security concerns [2, 5, 15]. Therefore, numerous efforts have been conducted to design various anti-drone systems, focusing on detecting, tracking, and mitigating security risks arising from non-cooperative drones (classified as criminal, illegal, or careless), employing different sensor modalities (e.g., sound, image, and radio frequency (RF) signals) [3]. Although various anti-drone systems have been developed, military-grade hardware equipment is required to mitigate unauthorized drone operations, which limits their usage in critical infrastructures and public spaces due to their high cost and potential impact on nearby equipment and infrastructure, leading to the exploration of alternative solutions [4].

To counter UAS threats in public areas, rapid detection and continuous tracking are becoming a necessity [9]. This can be accomplished through standalone sensor systems (such as RF, radar, acoustic, or visual sensors) or through multimodal sensor fusion approaches to improve robustness and situational awareness. For example, vision-based approaches have been investigated, employing vision-based architectures for detection and tracking of UASs [18, 19]. Also, recent advancements in software-defined radios (SDRs) enable the collection of signals of opportunity (SOPs) that can be passively detected from the environment. These signals, characterized by their high power, are utilized for drone localization [13, 14, 17] and detection [6, 8, 20]. By implementing advanced signal processing techniques, these readily available signals (such as DVB-T, UMTS, 4G/5G) can be used to design detection and tracking systems for targets with a low radar cross-section [10–12, 16]. In addition, active RF radar systems have been investigated to analyze the target reflections directly, offering robust detection performance at the cost of increased system complexity and operating expenses [7]. Further, acoustic sensing offers a low-cost and passive approach for detecting UASs in public spaces by employing the characteristic harmonic patterns and broadband signatures produced by multi-rotor propeller noise [1]. Even though RF-, acoustic-, and vision-based approaches can provide UAS detection and tracking, their evaluation is conducted under controlled/ideal conditions rather than real-world operational scenarios. In addition, multimodal sensor-fusion CUAS solutions are specifically developed for military applications and remain restricted for public deployment.

In accordance, this work proposes an integrated and novel CUAS system that delivers real-time situational awareness for public space protection by combining advanced AI-aided detection, tracking, alerting, and decision-support capabilities within a sensor fusion operational architecture. Building on validated components from prior research efforts and extending them with additional functionalities, the proposed approach supports evidence-based threat modeling through the development of threat scenarios and specific risk and vulnerability assessment methods.

2 SYSTEM ARCHITECTURE

Figure 1 provides an overview of the PROTECDOME system. The configuration is comprised of three main components: the camera, the acoustic array, and the RF-based sensors (active and passive radars). Each component operates as a unimodal system, supplying detection data and, when feasible, information regarding the drone's location to the dedicated processing units.

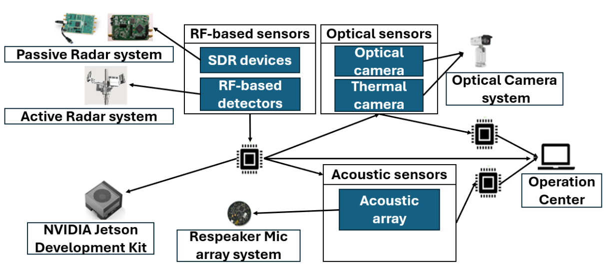

Figure 1: PROTECDOME System Architecture.

The information computed by all sensors is subsequently integrated into the multimodal PROTECDOME system (Fig. 2). As illustrated in Fig. 3, the outputs from both the unimodal sensors and the combined multimodal system are subsequently displayed on the dedicated web-based platform.

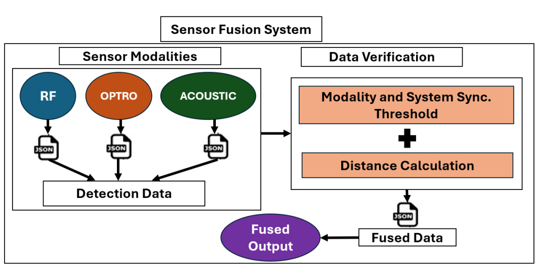

Figure 2: PROTECDOME Sensor Fusion Architecture.

The architecture of the PROTECDOME system is designed as a multi-layer (Layer 1-7) framework that integrates heterogeneous

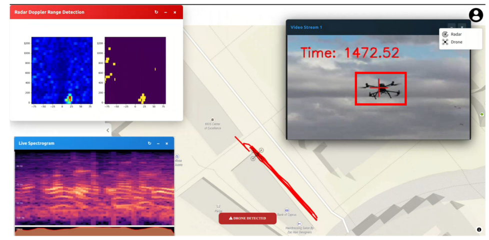

Figure 3: PROTECDOME Web-based Platform.

components to provide robust protection against unauthorized drone activities. Each layer enhances functionality, reliability, and security, resulting in a resilient end-to-end defense mechanism.

- **Layer 1 (Physical Topology):** Defines the hardware components and network structure of the web-based platform, enabling efficient connectivity and deployment across diverse operational environments.
- **Layer 2 (Information Collection, Transfer Protocols, and Methods):** Specifies protocols and methodologies for collecting data from the detection sub-systems (e.g., acoustic, passive radar, and cameras) and securely transferring the data to the ground control center for processing and analysis.
- **Layer 3 (Unimodal Functionality):** Captures the capabilities and outputs of each individual sensing modality.
- **Layer 4 (Multimodal PROTECDOME System):** Integrates multiple sensor streams using fusion techniques to improve detection accuracy, reduce false positives, and increase overall reliability.
- **Layer 5 (PROTECDOME Platform):** Provides the software infrastructure and user interface for system management, visualization, and interpretation of CUAS data products.
- **Layer 6 (Storage and Data Management):** Ensures efficient data storage, indexing, and retrieval, while applying security measures to protect sensitive information.
- **Layer 7 (Security):** Implements end-to-end protection mechanisms, including secure communication channels, encryption, authentication, and access control to preserve system integrity and confidentiality.

3 CONCLUSION

PROTECDOME is an innovative CUAS for protecting public spaces through real-time detection, tracking, alerting, and situational awareness. The proposed system combines unimodal sensing modalities and a multi-layer software/hardware architecture to support both unimodal operation and multimodal sensor fusion, improving robustness and reliability under real-world operational conditions. The proposed CUAS (PROTECDOME) is demonstrated for the detection, tracking, and localization of a rogue drone inside a designated area with the employment of RF-, acoustic-, and vision-based data (a short video of the demonstration is available at https://www.youtube.com/watch?v=uSw1n0784d8). Current work focuses on scaling the CUAS framework through the incorporation of the active radar component in order to further enhance rogue drone detection and tracking performance.

ACKNOWLEDGMENTS

This work was supported by the PROTECDOME project, implemented under the Internal Security Fund and co-financed by the European Union and the Republic of Cyprus. This work was also supported by the European Union's Horizon 2020 research and innovation programme under grant agreement No 739551 (KIOS CoE - TEAMING) and from the Republic of Cyprus through the Deputy Ministry of Research, Innovation and Digital Policy.

REFERENCES

[1] Chaudhry Awais Ahmed, Faryal Batool, Wajeeha Haider, Muhammad Asad, and Syed Hossein Raza Hamdani. 2022. Acoustic Based Drone Detection Via Machine Learning. In *Proc. International Conference on IT and Industrial Technologies (ICIT)*. 1–6.

[2] Dharmendra Chauhan, Harshil Kagathara, Hiren Mewada, Sagar Patel, Sagar Kavaiya, and Gordana Barb. 2025. Nation's Defense: A Comprehensive Review of Anti-Drone Systems and Strategies. *IEEE Access* 13 (2025), 53476–53505.

[3] Sumin Han, Uichan Kim, and Byung-Jun Jang. 2024. Low-Cost Real Time Anti-Drone RF Scanner using Switched Array Beamformer. In *Proc. International Symposium on Antennas and Propagation (ISAP)*. 1–2.

[4] Honggu Kang, Jingon Joung, Jinyoung Kim, Joonhyuk Kang, and Yong Soo Cho. 2020. Protect Your Sky: A Survey of Counter Unmanned Aerial Vehicle Systems. *IEEE Access* 8 (2020), 168671–168710.

[5] Hyeong Tae Kim, Sangmin Lee, Hyeontae Joo, and Hwangnam Kim. 2021. Survey on Anti-Drone Systems: Components, Designs, and Challenges. *IEEE Access* 9 (2021), 42635–42659.

[6] James E. Palmer, H. Andrew Harms, Stephen J. Searle, and Linda M. Davis. 2013. DVB-T Passive Radar Signal Processing. *IEEE Trans. Signal Process.* 61, 8 (2013), 2116–2126.

[7] P. Janpangngern, P. Changnam, W. Charoensiri, S. Samroeng, J. Pakprom, C. Thongsopa, A. Intarapanich, T. Thosdeekoraphat, N. Santalunai, and S. Santalunai. 2025. High-Resolution FMCW Radar for Small UAV Detection Using GNU Software-Defined Radio. *IEEE Access* 13 (2025), 86396–86412.

[8] Rahul Krishnan, R. Ganesh Babu, S. Kaviya, N. Pragadeesh Kumar, C. Rahul, and S. Santhana Raman. 2017. Software defined radio (SDR) foundations, technology tradeoffs: A survey. In *Proc. IEEE International Conference on Power, Control, Signals and Instrumentation Engineering (ICPCSI)*. 2677–2682.

[9] Stylianos Lagaras, Danilo Amendola, and David Anderson. 2024. Design of a counter-drone visualisation platform incorporating sensor-data fusion. In *Proc. 15th IFIP Wireless and Mobile Networking Conference (WMNC)*. 9–16.

[10] Tatiana Martelli, Fabiola Colone, and Roberta Cardinali. 2020. DVB-T based Passive Radar for Simultaneous Counter-drone Operations and Civil Air Traffic Surveillance. *IET Radar, Sonar & Navigation* 14, 4 (2020), 505–515.

[11] Nicolas Souli, Ilias Theodorou, Panayiotis Kolios, and Georgios Ellinas. 2022. Detection and Tracking of Rogue UASs Using a Novel Real-time Passive Radar System. In *Proc. IEEE International Conference on Unmanned Aircraft Systems (ICUAS)*. 576–582.

[12] Nicolas Souli, Panagiotis Kardaras, Panayiotis Kolios, and Georgios Ellinas. 2023. Onboard Passive Radar for Detection and Tracking of Rogue UAVs. In *Proc. IEEE International Conference on Unmanned Aircraft Systems (ICUAS)*. 820–826.

[13] Nicolas Souli, Panayiotis Kolios, and Georgios Ellinas. 2022. Online Relative Positioning of Autonomous Vehicles using Signals of Opportunity. *IEEE Trans. Intell. Veh.* 7, 4 (2022), 873–885.

[14] Nicolas Souli, Rafael Makrigiorgis, Panayiotis Kolios, and Georgios Ellinas. 2021. Real-Time Relative Positioning System Implementation, employing Signals of Opportunity, Inertial, and Optical Flow Modalities. In *Proc. IEEE International Conference on Unmanned Aircraft Systems (ICUAS)*. 229–236.

[15] David Schneider. 2019. Regulators Seek Ways to Down Rogue Drones: Growing Anti-drone Industry offers Radar, Remote ID, and Other Tools. *IEEE Spectrum* 56, 4 (2019), 10–11.

[16] Nicolas Souli, Panagiotis Kardaras, Panayiotis Kolios, and Georgios Ellinas. 2024. A Joint Rogue Drone Detection and Tracking Fusing DOA and Passive Radar Measurements. In *Proc. IEEE International Conference on Unmanned Aircraft Systems (ICUAS)*. 1200–1207.

[17] Nicolas Souli, Panayiotis Kolios, and Georgios Ellinas. 2020. Relative Positioning of Automated Systems using Signals of Opportunity. In *Proc. IEEE 91st Vehicular Technology Conference (VTC2020-Spring)*. 1–6.

[18] Halil Utku Unlu, Phillip Stefan Niehaus, Daniel Chirita, Nikolaos Evangeliou, and Anthony Tzes. 2019. Deep Learning-based Visual Tracking of UAVs using a PTZ Camera System. In *Proc. 45th Annual Conference of the IEEE Industrial Electronics Society (IECON)*, Vol. 1. 638–644.

[19] Amy R. Wagoner, Daniel K. Schrader, and Eric T. Matson. 2017. Survey on Detection and Tracking of UAVs Using Computer Vision. In *Proc. 1st IEEE International Conference on Robotic Computing (IRC)*. 320–325.

[20] Xiaoqi Yang, Kai Huo, Weidong Jiang, Jingjing Zhao, and Zhaokun Qiu. 2016. A passive radar system for detecting UAV based on the OFDM communication signal. In *Proc. Progress in Electromagnetic Research Symposium (PIERS)*. 2757–2762.