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Advanced UAS Border Monitoring

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Introduction

Effective border security is essential for maintaining national safety and managing immigration. This helps prevent illegal activities such as smuggling, trafficking, and unauthorized entry. Traditional methods of border monitoring are heavily reliant on human patrols which can be inadequate given the cost and labor-intensity given the challenging terrain involved. This report presents an advanced unmanned solution designed to significantly enhance border security through currently used drone technology using integrated autonomy by the adoption of ORNL's sophisticated software platform known as Mapster-Nomad.

The Need for Advanced Border Monitoring

Efficient border monitoring presents considerable challenges, in part due to the rugged nature of border terrains. Conventional surveillance approaches depend primarily on human patrols and stationary posts, which often lead to significant coverage gaps and delayed responses. Additionally, reliance on human personnel increases operational costs and exposure to risk. Thus, a modernized surveillance system incorporating advanced technology is essential to achieve real-time threat detection, rapid response, and comprehensive area coverage while reducing resource demands and personnel risk.

Currently, U.S. Customs and Border Protection (CBP) employs small Unmanned Aerial Systems (sUAS) as part of their border security strategy. These drones provide critical support in reconnaissance, real-time surveillance, and response to illicit border crossings, particularly in inaccessible and hazardous terrains. Equipped with high-resolution and thermal imaging capabilities, these systems have proven effective in enhancing operational safety, expanding coverage, and significantly reducing response times. The demonstrated success of drone integration by CBP underscores the viability and effectiveness of advanced UAS technologies in border security.

Proposed Solution

Our proposed solution utilizes Skydio Unmanned Aerial Systems (UAS), specifically the Skydio X10, combined with autonomous docking stations (Dock for the X10) for continuous and comprehensive surveillance. Skydio's autonomous drones offer advanced artificial intelligence-driven flight capabilities, including obstacle avoidance, allowing seamless navigation through complex border environments with minimal human supervision. U.S. Border Patrol has already demonstrated that these drones can significantly reduce incident response times from hours to mere minutes, providing detailed real-time intelligence such as target count, movement patterns, and carried equipment.

Figure 1: Skydio X10

To achieve continuous operation, Skydio docking stations facilitate automatic drone deployment, recharging, and redeployment cycles, eliminating manual intervention and enabling uninterrupted surveillance even in remote or challenging locations. Additionally, Skydio's drones meet federal security requirements through NDAA compliance and U.S.-based supply chains, ensuring safe and trusted hardware. Comprehensive regulatory support from Skydio assists agencies in swiftly securing Beyond-Visual-Line-Of-Sight (BVLOS) approvals, essential for extensive border monitoring operations.

Figure 2: X10 Docking Station

Integration with the Mapster-Nomad software elevates the drone-based system into a full-spectrum Intelligence, Surveillance, and Reconnaissance (ISR) solution. Mapster-Nomad is an all-in-one geospatial intelligence platform designed for anomaly detection, real-time data streaming, and rapid situational awareness. Its architecture is highly modular, allowing seamless customization to meet mission-specific needs. One of its core strengths lies in its ability to run any user-defined detection model, enabling agencies to incorporate their preferred AI or machine learning algorithms for object detection and classification. These detections are rendered as geospatial artifacts on it's interactive map interface, ensuring clear and actionable visualization. The system also supports intuitive dashboards, configurable alerting (via SMS, email, or other channels), and streamlined integration with applications like ATAK. Combined with Skydio's high-resolution visual and thermal imaging feeds, Mapster-Nomad enables immediate data analysis and operational response—all from a centralized, user-friendly interface.

Figure 3: Mapster-Nomad UI features

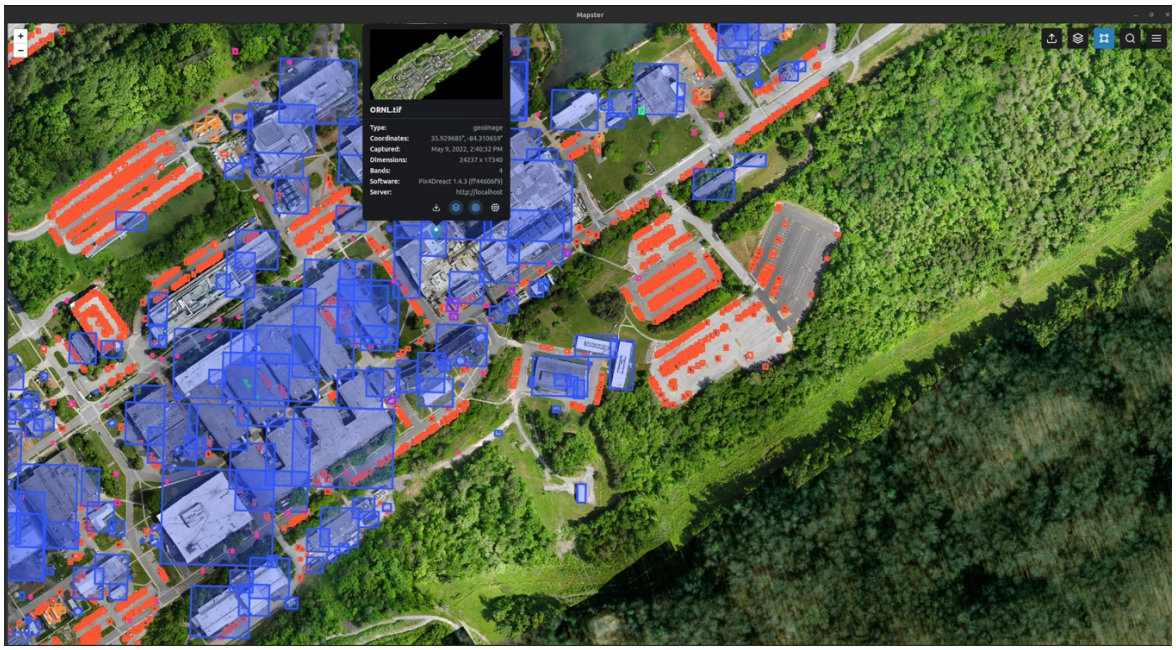

Figure 4: Mapster-Nomad with WALDO model showing detections.

Operational Workflow

Operationally, border agents define patrol routes through Skydio software, after which drones autonomously launch from their docking stations to execute the designated surveillance missions. Skydio's drones continuously scan predefined routes, using onboard sensors and thermal imaging to detect anomalies or unauthorized border crossings. Upon the completion of a patrol, at the docking station, the drone will upload its latest data to the Mapster-Nomad.

Border personnel (from the Mapster-Nomad instance) will receive instantaneous notifications upon an anomaly detection and access to stream the recorded video feeds via secure communication channels, enhancing situational awareness and decision-making capabilities. After completing missions or reaching battery thresholds, drones autonomously return to docking stations for recharging and preparation for subsequent patrol cycles, without the need for human involvement.

This automated process significantly enhances operational efficiency, extends surveillance coverage, reduces manpower needs, and ensures consistent and reliable data collection.

Conclusion

By implementing an advanced unmanned border monitoring solution leveraging Skydio's UAS capabilities and the comprehensive data management provided by Mapster-Nomad software, border agencies can substantially improve surveillance effectiveness. This automated approach ensures continuous, extensive, and reliable border monitoring, enhancing national security, reducing operational costs, and minimizing risks to border personnel.

References

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