

# Robust Unsupervised Anomaly Detection Approach for CCTV Surveillance of Public Spaces

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## Machine Vision for Protecting Public Spaces

Law enforcement agencies are tasked with maintaining safety in public areas, but traditional CCTV systems require intensive human monitoring across multiple feeds. Although computer vision has been introduced to help detect anomalies, these systems often need large, scene-specific training datasets, limiting their adaptability. To overcome these challenges, we propose an unsupervised method that automatically adjusts to each camera view without the need for retraining.

## Unsupervised Anomaly Detection

The workflow of our approach is outlined in the flowchart of Fig. 1. Using this approach, we first generate trajectories for each person passing by the camera scene. Key features of these trajectories are calculated, resulting in fixed-length feature vectors. Finally, these vectors are fed to the unsupervised anomaly detection algorithm.

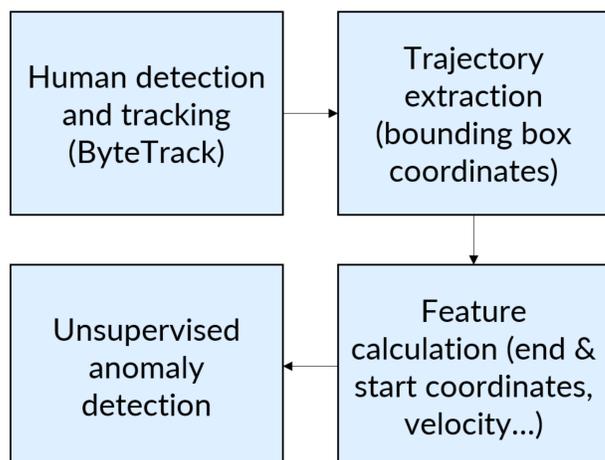


Fig. 1: Workflow of our approach.

## Validation of Our Approach

We tested two methods for anomaly detection, Isolation Forest (IF) and Local Outlier Factor (LOF). For testing, we utilized the Trclust dataset [1], which contains 1000 scenes with only x- and y-coordinate information segmented in 1–10 clusters of featuring varying number of anomalies outside these clusters. Our feature extraction and LOF clearly outperformed the baseline approach: we achieved 97.1% and 0.96% true and false positive rates, whilst the SVM results by the authors were 95.2% and 1.61%, respectively.

1. Piciarelli, C., Micheloni, C., & Foresti, G.L. (2008). Trajectory-Based Anomalous Event Detection. IEEE Transactions on Circuits and Systems for Video Technology, 18, 1544-1554. <https://doi.org/10.1109/TCSVT.2008.2005599>

## Software Implementation

To facilitate real-world deployment, we developed a graphical user interface (GUI) and integrated an MQTT data exchange service. This service ingests RTSP video feeds, and applies our workflow while visualizing resulting outputs (see Fig. 2). Users can adjust the contamination rate in the IF algorithm to fine-tune the anomaly score threshold, capturing relevant anomalies while minimizing false positives. Multiple models can be trained, frozen and saved for consistent inference. The entire tool is packaged in Docker containers for streamlined deployment and portability. Ongoing trials are underway to further validate the tool's effectiveness in operational environments. We anticipate that our approach will significantly enhance the efficiency and adaptability of CCTV-based anomaly detection for public spaces.

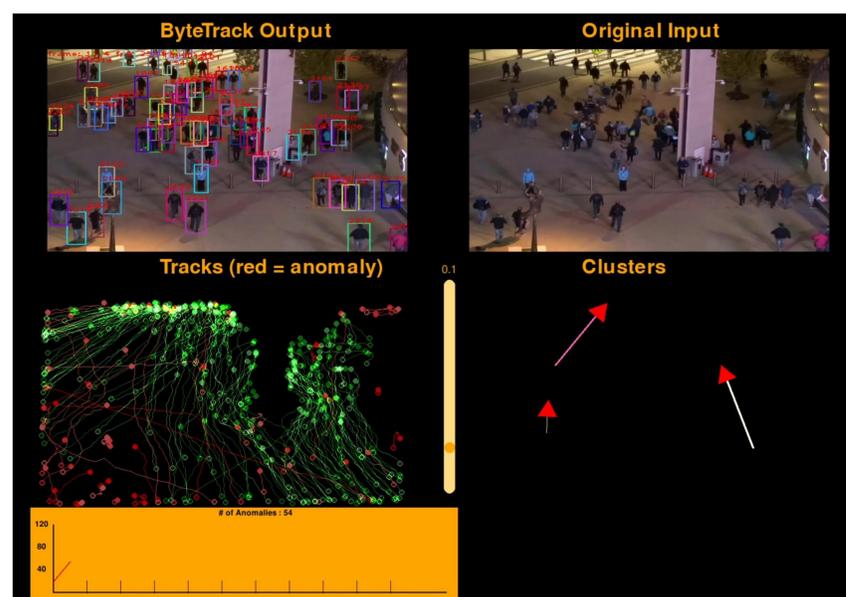


Fig. 2: Screen capture of the GUI of our anomaly detection tool.

## Conclusion

- Our unsupervised anomaly detection approach adapts automatically to each camera view without needing retraining
- We validated our approach using a large dataset, clearly outperforming the baseline
- We built a user-friendly GUI for real-time video feed processing in a Docker container, which is currently tested in real environment

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