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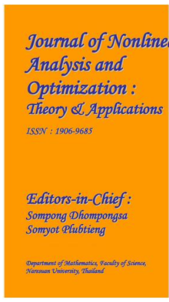

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OBJECT TRACKING IN SATELLITE VIDEOS USING YOLOV8 AND DEEPSORT METHOD

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ABSTRACT: This paper addresses the hard task of tracking quickly moving objects and dealing with occlusion in satellite imagery by integrating YOLOv8's accurate object detection capabilities with the DeepSORT algorithm's sophisticated tracking capabilities. The anticipated outcome is a fundamental shift in satellite technology, with the potential to not only improve the precision of surveillance over ever-changing terrains, but also to reveal previously unknown territories in applications ranging from terrestrial observation to fortified security and rapid disaster response. By using cutting-edge technology, this integration intends to improve the capability and efficiency of satellite systems, ushering in a new era in which comprehensive, real-time situational awareness is achieved from above.

Keywords: *Yolov8, Deep SORT, Object Detection, Object Tracking, Object Occlusion.*

I. INTRODUCTION

Satellite technology has transformed the science of Earth observation by providing unprecedented capabilities for celestial monitoring of our globe. Despite these advances, the task of monitoring rapidly moving objects on satellite recordings and ensuring precise identification and subsequent tracking remains a tough challenge. This project is specifically designed to handle the challenges of fast object tracking, where traditional algorithms struggle due to the quick motion of automobiles, aircraft, and other dynamic entities acquired by satellites. It is vital to prioritize the development of a specialized tracking algorithm designed specifically for satellite video data. This method should effectively track the trajectories of fast-moving objects, taking into account their unique characteristics such as frequent changes in direction and rapid movement. Furthermore, the project focuses on the resolution of object occlusion concerns in satellite photography caused by natural causes such as topography or clouds. This emphasizes the importance of keeping continual observation and exact monitoring, especially when dealing with partially or completely occluded situations.

Fig 1: Airport satellite image [1]

The second step of the project involves conducting a thorough evaluation of the proposed tracking system using actual satellite data. This evaluation will analyze the system's capacity to follow fast-moving objects with precision, durability, and velocity, as well as its usefulness in managing object occlusion. Comparisons with known approaches, particularly in the field of tracking concealed objects, might help assess the performance of the innovation. Furthermore, the research studies pragmatic applications in defense surveillance, traffic management, and disaster monitoring, assessing the potential impact on data precision and decision-making capacity. Further investigation into the tracking algorithm's adaptability and scalability ensures a broader range of potential applications on a variety of satellite types and sensors. As a result of the effort, complete documentation, including user guides and technical reports, is created to aid the monitoring system's smooth integration with current satellite-based surveillance infrastructures.

2. Existing System

Author: Chao Xiao et al. (2) To improve the tracking of many objects in satellite films, we propose introducing local motion priors into the network. Tracking discrepancies between frames are obtained by constructing local cost volumes, which aid in the transmission of characteristics across frames, resulting in improved spatiotemporal information. Our technique works well, as evidenced by experimental validation on Jilin-1 satellite footage.

Yidan Nie and colleagues presentedSiam-TMC is a novel remote sensing device that utilizes temporal motion compensation and a Dim-Aware module. By combining high-frequency and foreground information, we improve small item recognition in congested environments. Validation on benchmark datasets demonstrates superior performance, notably in resolving the issue of occlusion-induced trajectory drift.

Author Guo-Cheng Xu et al. Tracking moving objects in satellite imagery is a popular topic in remote sensing. The object's motion appears insignificant in compared to the rest of the frame. Satellite motion disrupts the momentum of a moving item due to the constant mobility of satellite photos. This paper provides an improved algorithm for target tracking in satellite pictures that uses the DBSCAN framework to monitor targets and detect moving objects.

Jie Wei et al. developed a new strategy to object tracking in remote-sensing videos by combining 3-D total variation (3DTV) regularization and resilient principal component analysis (RPCA). Our technique successfully distinguishes in-motion objects from dynamic backgrounds and camera noise, with excellent performance on authentic datasets.

Qibin He et al. proposed TGraM, an end-to-end system for multi-object tracking in satellite movies that combines multiplex gradient adversarial learning and graph-based spatiotemporal reasoning. TGraM outperforms established trackers by a factor of 1.2 when using the recently generated AIR-MOT dataset.

Author Yuzeng Chen et al. A correlation filter-based dual-flow (DF) tracker is proposed as a method for monitoring a single object in satellite movies. This tracker makes use of motion modeling and spatial-spectral feature fusion. By adaptively integrating information and sensing motion confidence, DF quickly reaches optimal performance on genuine SVs. Promoting advancements in the realm of remote sensing ground surveillance

3. Proposed System

Given the complicated complexity of object tracking in satellite films, the proposed resolution employs a hybrid technique that combines the advanced tracking algorithm, Deep SORT, with the resilient object recognition functionalities of the YOLOv8 model. The goal is to successfully use the advantages of both models to increase the precision and productivity of object tracking over ever-changing landscapes captured by satellite sensors.

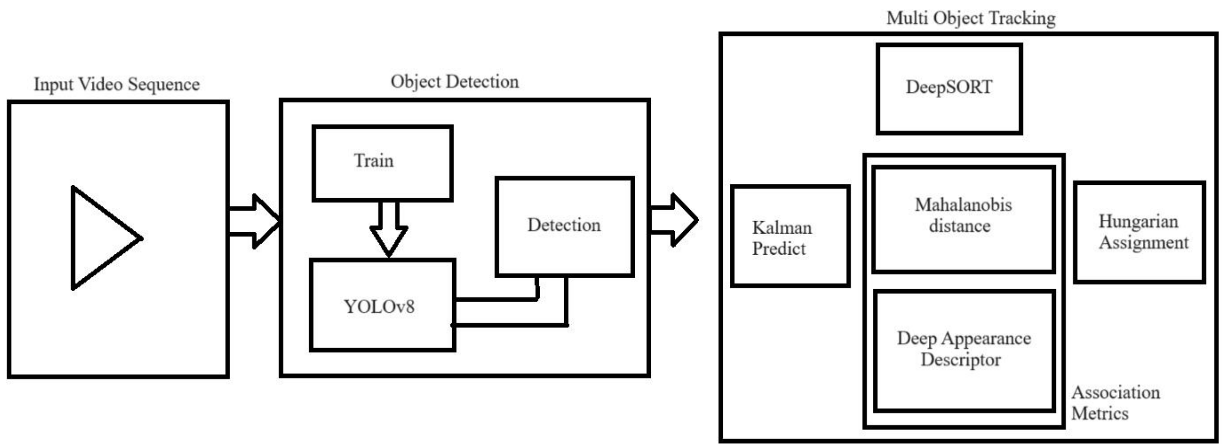

Fig 2: Proposed system block diagram

Object Detection with YOLOv8:

The preliminary stage comprises using the YOLOv8 model to identify objects in satellite image data. YOLOv8, a highly respected real-time object identification model, was trained on satellite imagery data to accurately recognize and position objects of interest in a wide range of circumstances. The system's unique ability to reliably detect and track several objects in a single pass provides a solid foundation for subsequent tracking phases, successfully addressing the complexities inherent in satellite movies.

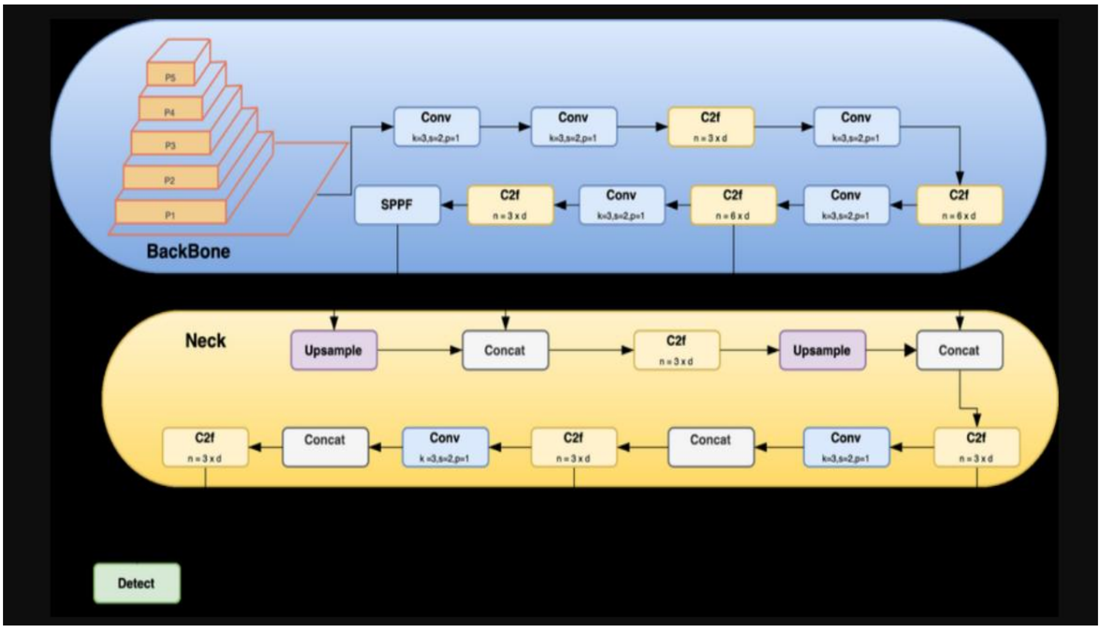

Fig 3: Yolov8 Architecture [8]

Object Tracking with Deep SORT:

The discovered items are followed throughout time using the Deep SORT algorithm, which is invoked upon successful object detection. Deep SORT makes it easier to monitor and associate items across several frames by combining deep learning techniques with the Simple Online and Realtime Monitoring (SORT) algorithm. This technology significantly enhances object tracking precision by establishing and maintaining separate object identities even in challenging conditions like as occlusion, rapid motion transitions, and cluttered settings. As a result, the dependability of object tracking systems that use satellite technology is guaranteed.

1. Mahalanobis distance incorporating motion information:

$$d^{(1)}(i, j) = (d_j - y_i)^T S_i^{-1} (d_j - y_i) \longrightarrow (1)[9]$$

Where:

- d_j is the j-th bounding box detection.
- y_i, S_i denote the projection of the i-th track distribution into measurement space.
- S_i represents the covariance matrix of the i-th track.
- The Mahalanobis distance takes state estimation uncertainty into account.

2. Indicator for admissible association based on Mahalanobis distance:

$$b^{(1)}_{i,j} = \begin{cases} 1 & \text{if } d^{(1)}(i, j) \leq t^{(1)} \\ 0 & \text{otherwise} \end{cases} \longrightarrow (2)[9]$$

Where:

- $t^{(1)} = 9.4877$ is the threshold computed from the inverse chi-square distribution.

3. Cosine distance measuring appearance similarity:

$$d^{(2)}(i, j) = \min \{ 1 - r_j^T r_k^{(i)} | r_k^{(i)} \in R_i \} \longrightarrow (3)[9]$$

Where:

- r_j is the appearance descriptor of the j-th detection.
- R_i is the gallery of appearance descriptors for track i.

4. Indicator for admissible association based on cosine distance:

$$b^{(2)}_{i,j} = \begin{cases} 1 & \text{if } d^{(2)}(i, j) \leq t^{(2)} \\ 0 & \text{otherwise} \end{cases} \longrightarrow (4)[9]$$

5. Combined metric using a weighted sum of both distances:

$$c_{i,j} = \lambda d^{(1)}(i, j) + (1 - \lambda)d^{(2)}(i, j) \qquad \longrightarrow \qquad (5)[9]$$

Where:

- $0 \leq \lambda \leq 1$ controls the trade-off between motion and appearance information.

6. Indicator for overall admissible association within the gating region of both metrics:

$$b_{i,j} = \prod_{m=1}^{2} b^{(m)}_{i,j} \qquad \longrightarrow \qquad (6)[9]$$

Tools

YOLOv8 Model:
Framework: PyTorch or TensorFlow (Dependent on YOLOv8 implementation)
Roboflow: Used for creating Datasets.
YOLOv8 Implementation: YOLOv8 model pre-trained on satellite imagery data or custom-trained with relevant datasets.
To Implement Deep SORT we are applying following libraries:
Programming Language: Python
Libraries: NumPy, OpenCV, TensorFlow or PyTorch (for deep learning operations)
Deep SORT Implementation: Deep SORT library integrated with the chosen deep learning framework.

4. Result Analysis

The suggested hybrid technique to object tracking in satellite movies combines YOLOv8's robust object detection features with the Deep SORT algorithm's sophisticated tracking capabilities. YOLOv8 performs exceptionally well in the domain of real-time object detection utilizing satellite photography data. It correctly recognizes several objects in a variety of circumstances. The basic step creates a solid foundation for subsequent tracking phases, effectively addressing the complexities inherent in satellite footage. Using both the Simple Online and Realtime Tracking (SORT) algorithm and deep learning techniques, the Deep SORT algorithm is then used to monitor objects. Deep SORT enhances object tracking precision by constantly associating and keeping discrete item identities, even in challenging settings including occlusion, rapid motion changes, and densely populated areas. By using the complimentary functions of YOLOv8 and Deep SORT, the hybrid technique improves the precision, effectiveness, and dependability of object tracking in dynamic landscapes acquired by satellites. Using performance indicators such as precision, recall, and F1 score, one may quantitatively assess the system's efficacy in overcoming the various challenges connected with satellite-based surveillance.

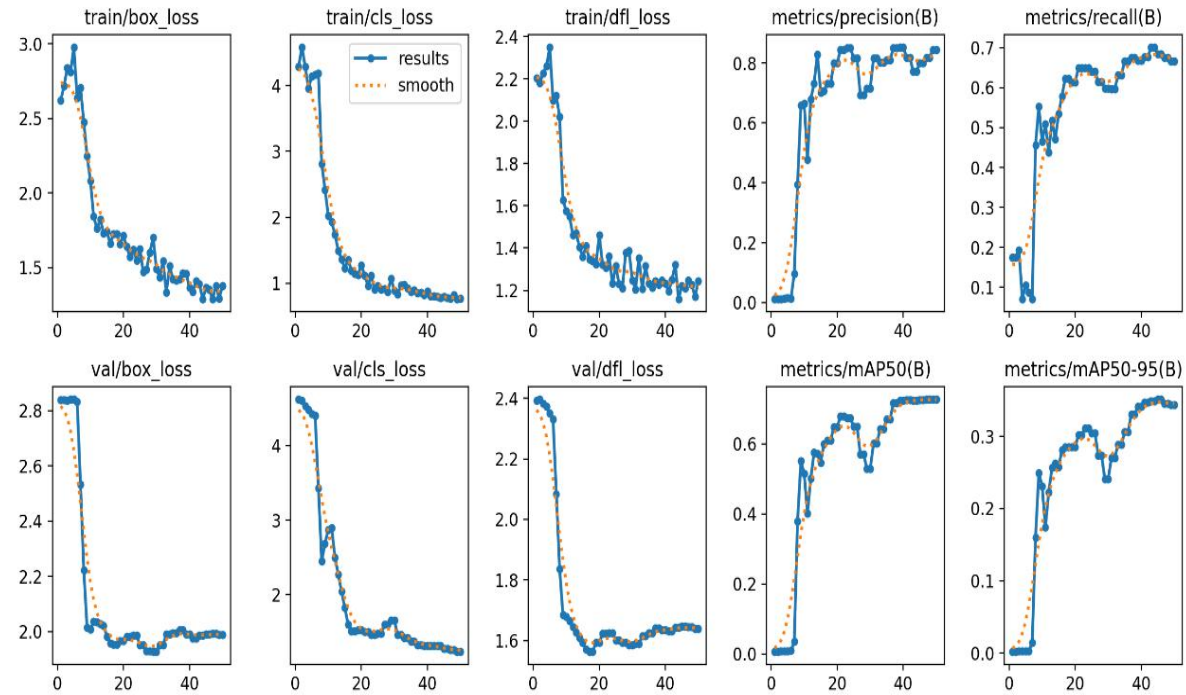

Fig-4: Results and Graphs

The graph comprises of results of train and value data along with metrics.

Fig-5: Predictions of the model

5. CONCLUSION

The YOLOv8 object detection model and the Deep SORT tracking algorithm are combined to provide a unique approach for tracking things in satellite recordings. This approach demonstrates a great ability to overcome problems faced in the disciplines of Earth observation and remote sensing. YOLOv8, an instrument widely recognized for its capacity to detect objects in real time, is a critical component for precise identification in satellite photography data. The accuracy of these results is increased by Deep SORT's robust tracking capabilities, which establish and maintain separate identities for objects across frames, even in complex situations like as occlusion and rapid motion transitions.

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