Re-Identification of Identical Objects – Assignment Submission

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1. Initial Detection

When two identical iPhones first appear in the camera frame, an object detection model like YOLO, Faster R-CNN, or SSD is used to identify them.
These models detect the presence of objects by analysing edges, contours, textures, and colour features in each frame.

However, in this scenario, since both iPhones are *visually identical*, the model will only recognize them as the same object class (“iPhone” or “mobile phone”) — it cannot assign unique identities to each phone.
This is because traditional object detection focuses on classifying objects, not differentiating between instances that look the same.

Limitations:

- The detector can locate both phones but cannot say which is which.
- Without distinctive visual features, it’s impossible to assign a consistent ID.

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2. Tracking After Exiting the Frame

Once the iPhones move or go out of the camera’s view, tracking algorithms like SORT, Deep SORT, or ByteTrack come into play.
These algorithms use motion models such as Kalman Filters to predict the next position of the object based on its previous trajectory.

If the phones are briefly occluded or move out of frame, the tracker predicts their likely positions and re-identifies them when they reappear.
However, if both phones leave and re-enter in swapped positions, the tracker may lose the original identity because it relies mainly on motion continuity, not visual uniqueness.

Key Concepts:

- SORT uses bounding box coordinates and motion patterns.

- Deep SORT adds deep visual embeddings for stronger identification.
- Prediction alone is not sufficient when two objects are *identical*.

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3. Handling Object Swap

If the iPhones are swapped off-camera and then come back into view, the system faces a serious challenge.
Most trackers assume that each detected object is unique and maintain IDs based on appearance and position consistency.
When objects look *exactly alike*, the tracker may accidentally switch their identities, treating Phone A as B and vice versa.

Conventional trackers cannot reliably detect this type of identity switch because their models are not aware of semantic context or ownership.
Thus, visually identical objects often cause ID confusion or mismatched tracking.

Common Issues:

- Identity switches when motion paths intersect.
- Loss of reliable tracking after occlusion.
- Inability to recover the correct ID after swap.

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4. Potential Solutions

To handle such complex scenarios, several strategies can improve re-identification accuracy:

1. Re-ID (Re-Identification) Models:
   Deep learning models trained for person or object re-identification can generate unique embeddings for each object.
   Even small texture variations or reflection patterns might be used for identification.
2. Motion & Trajectory Analysis:
   By analyzing movement patterns over time, the system can guess which phone is which based on its historical path.

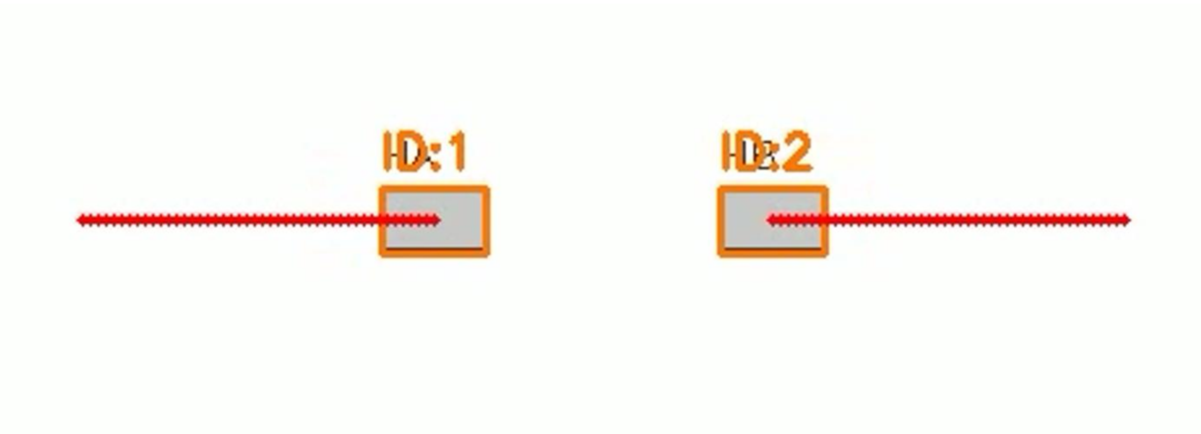
3. Context-Aware Tracking:
   Using contextual clues (like surrounding objects or surfaces) helps maintain continuity when appearance is identical.

4. Multi-Camera or 3D Sensors:
   Multiple angles or depth sensors can provide additional visual information, making it easier to differentiate between similar-looking objects.

Conclusion

Re-identifying visually identical objects remains a major challenge in computer vision.
While detection and tracking models like YOLO and SORT perform well on distinct objects, they struggle when visual cues are identical.
Combining deep re-identification models, motion analysis, and multi-camera setups can help overcome these limitations in real-world systems.

Output Section:



References

- YOLOv8: Real-Time Object Detection (Ultralytics)
- Deep SORT: Simple Online and Realtime Tracking with a Deep Association Metric
- Kalman Filter Motion Prediction (OpenCV Implementation)