TRACKING MOVING OBJECTS IN VIDEOS

USING OPENCV, KALMAN FILTERING, AND MACHINE LEARNING

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MOTIVATION

01 Traffic monitoring

02 Robotics

03 Sports analytics

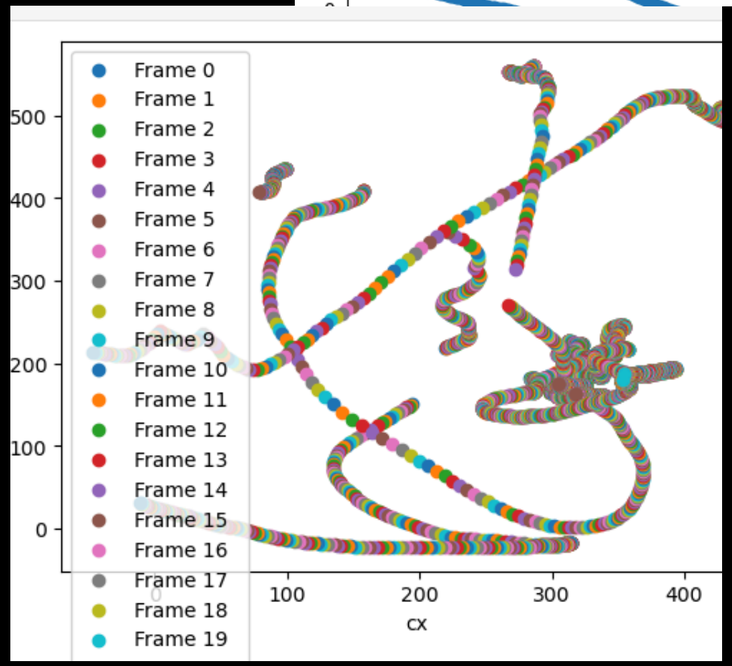
04 Surveillance

CHALLENGES:

Need for motion prediction

Tracker drift or loss

Noisy detection



SYSTEM WORKFLOW

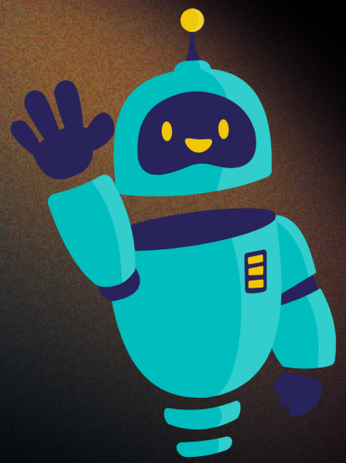
Input: Multiple videos →

ROI selection (manual / auto)
OpenCV Tracker
(CSRT/KCF/MOSSE)
Kalman Filter (smooth trajectory)

Save outputs:

Annotated video
CSV (frame, time, bbox, centroid)
Next step: Train ML model to predict future centroids from CSVs

TRACKERS USED



CSRT

(accurate, slower)

KFC

(faster)

MOSSE

(very fast, less accurate)

Auto -init via Motion Detection

(first 60 frames)

Outputs: Bounding box, trajectory, centroid

PREDICTION MODULE

1) Build dataset from CSVs

2) Features : Last W =15 frames of centroids

3) Labels : next (cx , cy) position

4) Model : Ridge Regression(baseline)

5) Metric : Mean Absolute Error(MAE)

RESULTS

1. MAE (validation) : cx: 49.25 px II cy: 28.86 px
2. Interpretation : Predictions within ~ 2-3% of video resolution
3. Better vertical accuracy than horizontal

Limitations

1. Linear Model : Struggles with nonlinear motion
2. Horizontal error higher due to frequent side movement
3. Accuracy depends on tracker quality

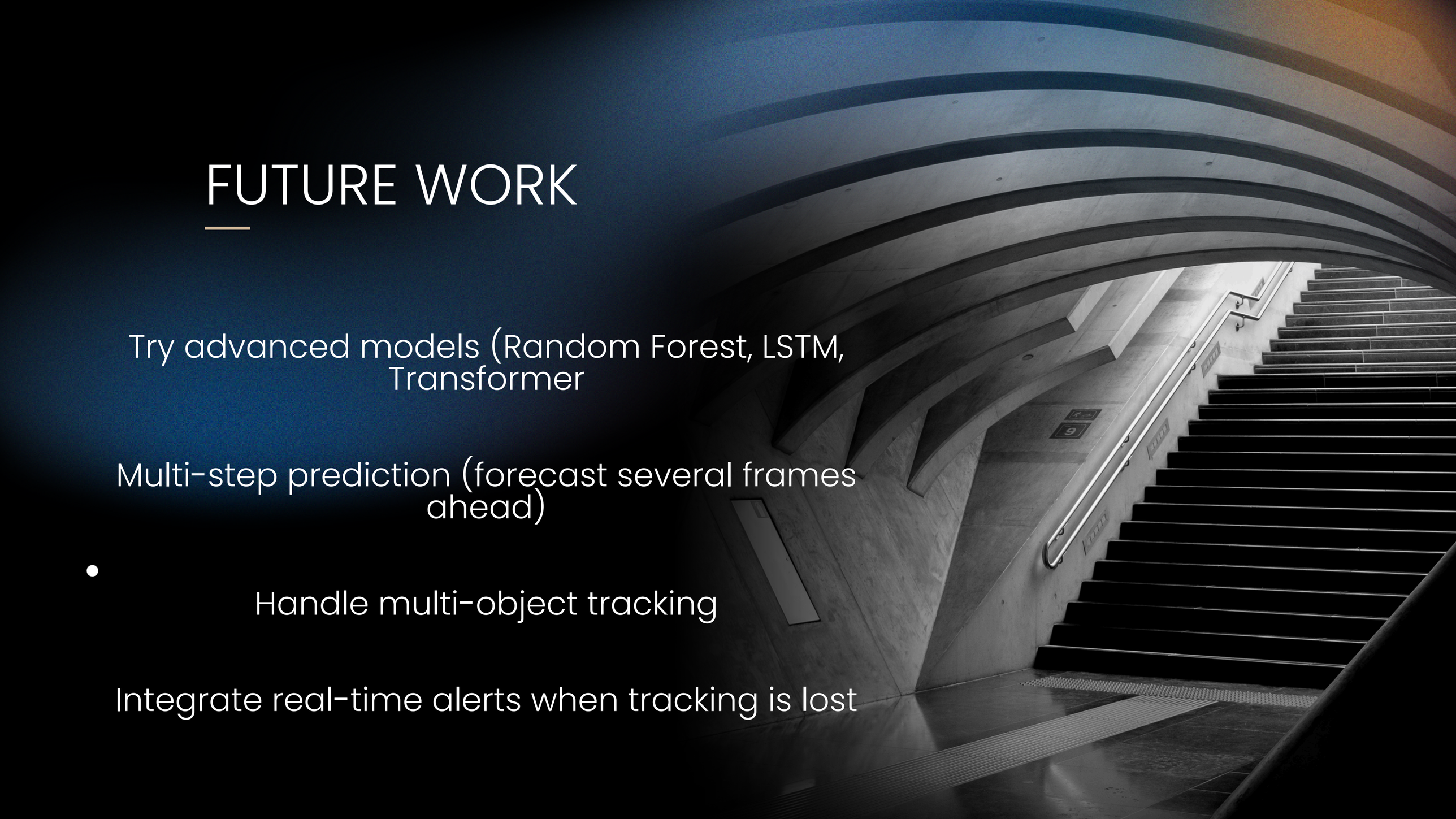
FUTURE WORK

Try advanced models (Random Forest, LSTM, Transformer

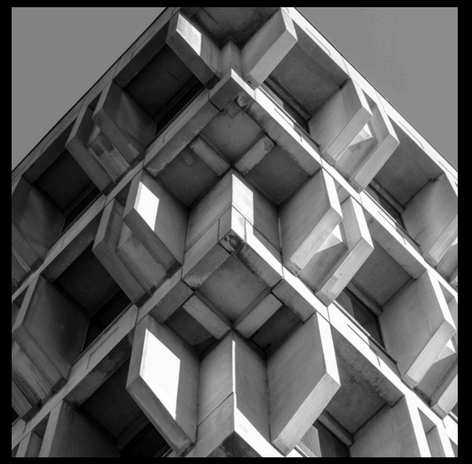
Multi-step prediction (forecast several frames ahead)

- Handle multi-object tracking

Integrate real-time alerts when tracking is lost



CONCLUSION



BUILT A
FULL
PIPELINE:

1) Video tracking with OpenCV
2)Trajectory smoothing with Kalman filter
3) Motion prediction using ML