LitterNET:

Litter Detection Within Heart & Soul Park

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Background

Current literature on litter detection focuses on (1):

- ➔ Neural network models
- ➔ PlastOPol Dataset
- ➔ Static images

Literature on vandalism detection focuses on (2):

- ➔ Static changes
- ➔ Pre-defined areas
- ➔ Object segmentation

Annotated images of plastic bottles from the PlastOPol Dataset

Project Goals

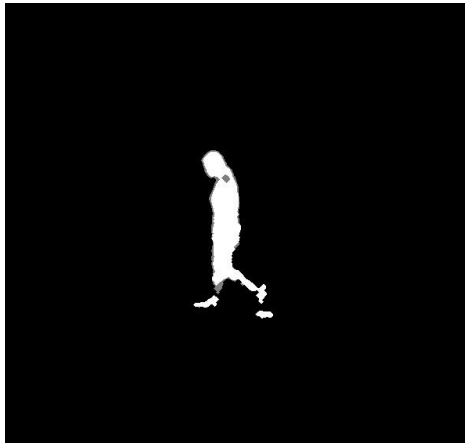
Optimizing real-time detection

Smaller and more targeted ROIs have greater confidence when inputted into the model

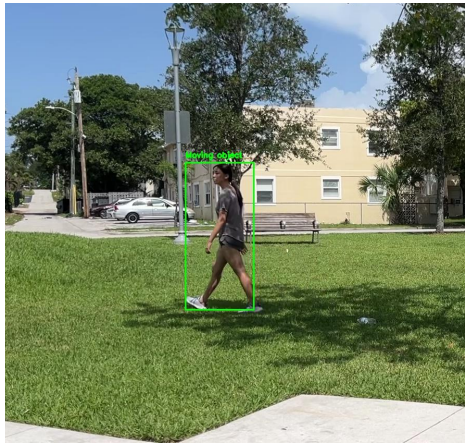
Homography mapping

Top-down map of Heart and Soul Park, marked with simulated red dots for litter

Methods



Binary image of moving object in frame



Left contour defined as moving object

Input Video
Real-time video footage of a person littering

Background Subtraction
Extract foreground objects from background model

Object Presence
Track contours that enter and leave the scene

Methods

Background Update
Compare scene change to initial background model

Static Change Detection
Detect ROIs from static background changes

CNN Model
Detect whether the ROI actually contains litter

Mapping with OpenCV Homography

Four Features / Landmarks
Pick 4 features from map & camera perspective

↓

Pixel Coordinates
Save the pixel coordinates of the 4 features

↓

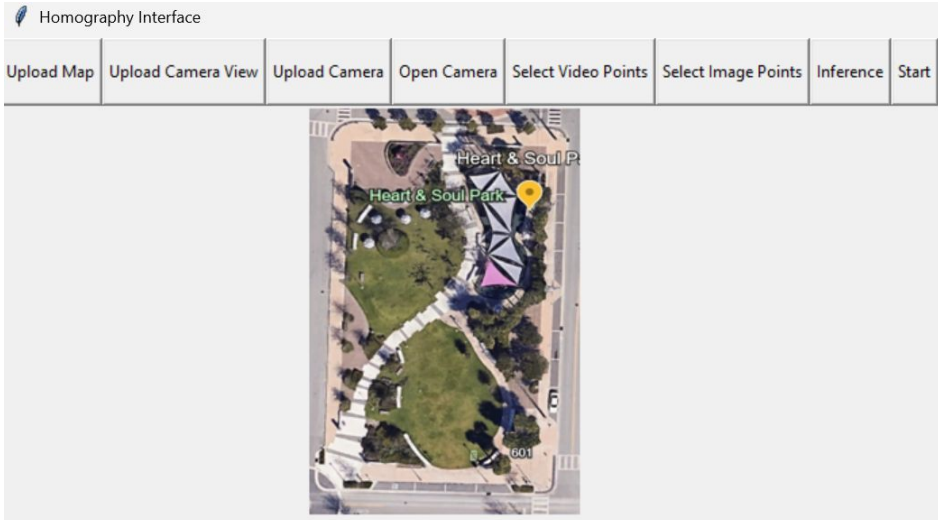
Homography Matrix
Using pixel coordinates, calculate the homography matrix


```
Homography matrix computed:
[[-1.57789336e-02 -9.70606616e-01  2.25005379e+02]
 [ 3.35622167e-02 -1.40541354e+00  2.77422312e+02]
 [ 1.58374654e-05 -5.01985036e-03  1.00000000e+00]]
```

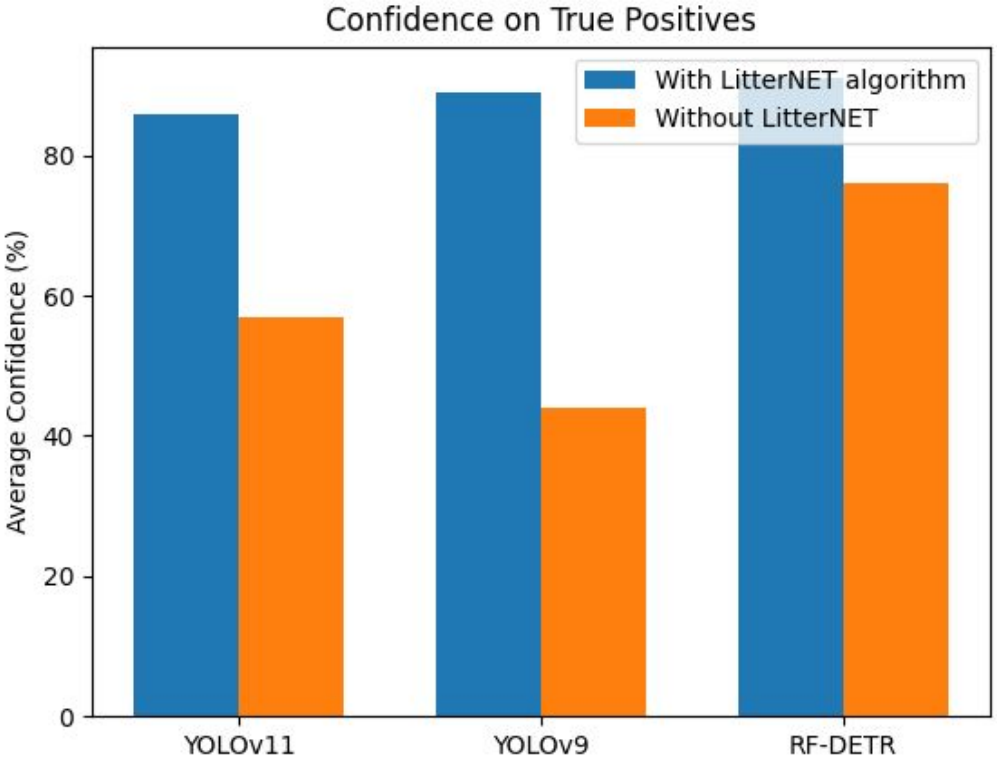
Mapping

Our GUI

- ➔ Built with Tkinter
- ➔ Supports easy access to a system of cameras
  - ◆ Add cameras
  - ◆ Open cameras
- ➔ User-adjustable homography mapping system from OpenCV
  - ◆ Easy addition of new cameras with different scopes



Results


Confidence on True Positives
With LitterNET algorithm
Without LitterNET
Average Confidence (%)
0
20
40
60
80
YOLOv11
YOLOv9
RF-DETR

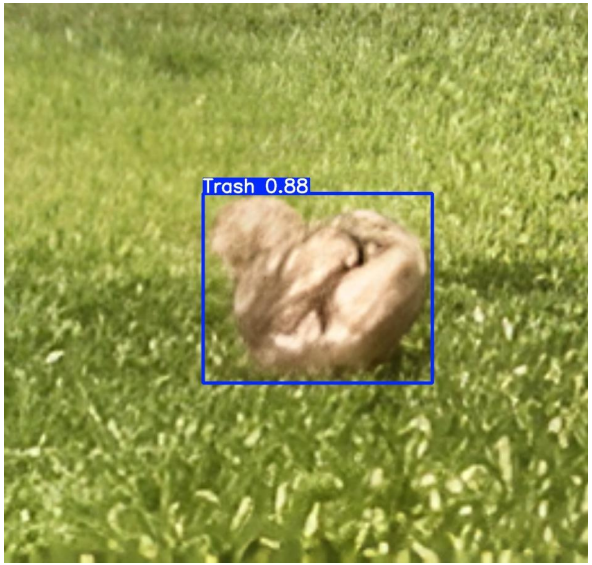
Conclusion

Advantages:

- ➔ Increased confidence in true litter
- ➔ Less false positives

Future Work:

- ➔ More model training and differentiation of trash types
- ➔ Brightness normalization and occlusion
- ➔ Physical system
- ➔ Improved resistance to shadows



RF-DETR confidence on identifying the plastic bag as trash

References

1. Córdova, M., Pinto, A., Hellevik, C. C., Alaliyat, S. A.-A., Hameed, I. A., Pedrini, H., & Torres, R. d. S. (2022). *Litter Detection with Deep Learning: A Comparative Study.* Sensors, 22(2), 548. https://doi.org/10.3390/s22020548
2. Mohammed Ghazal, Carlos Vázquez, and Aishy Amer. 2012. *Real-time vandalism detection by monitoring object activities.* Multimedia Tools Appl. 58, 3 (June 2012), 585–611. https://doi.org/10.1007/s11042-011-0751-z

Thank you!