Detecting and classifying bus stop trash cans

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I. Introduction

- Solid waste management is expensive and relies on humans
- Monitoring trash cans around an area by hand is tedious and does not scale well
- Re-use safety cameras on public transport bus

- Weak computer on bus (no GPU), strong server in the background
- Use a pipeline of multiple Computer Vision models
- Human operator is then notified about full cans
- **Goal**: Single out promising images, then **detect** trash cans and **classify** them according to their fill level

II. Methodology

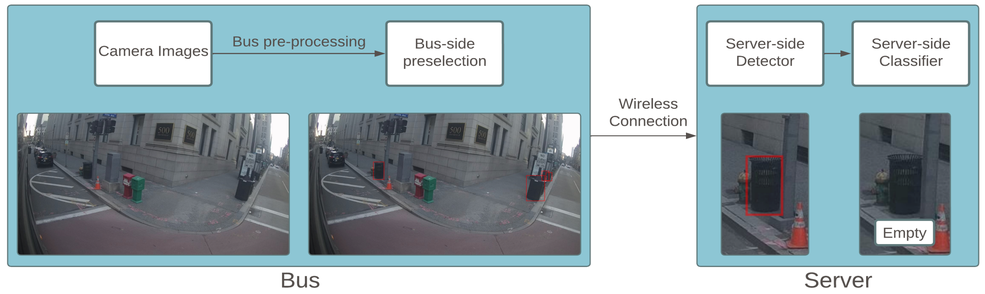
Training and deployment

- Run a simple detection model (ResNet18) emphasizing speed for **fast filtering on the bus**
- Use a more complex model (ResNet101) for highly **accurate detections on the server**, both trained on the same dataset
- Cut out results and **classify** them with a third model (also Resnet101) to distinguish between "Full", "Empty" and "Garbage bag nearby"
- Deploy using *BusEdge*[1] platform

Assumptions and limitations

- Dataset also contains domestic trash cans, which are unimportant to this application
- On average we expect **multiple images per trash can** (from different perspectives)
- Special emphasis on large (≥ 1024 pixel) trash can instances, as we expect to get a close-up image of every bus stop trash can, when we drive past it
- **Localization** within images is **not as important**, as we can **rely on GPS** data and our domain knowledge (bus stop trash cans are permanent installations), therefore we can fix IoU at 0.5 for further considerations

III. Implemented Pipeline



IV. Results

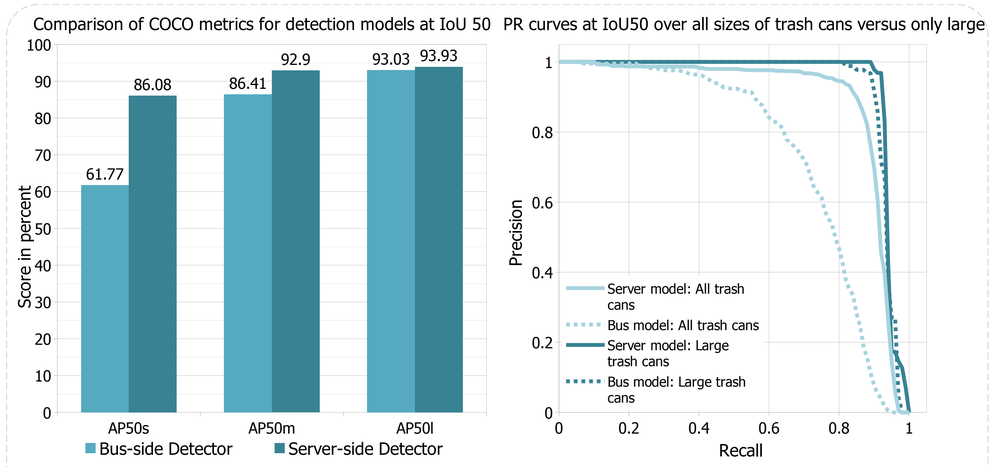


Figure 1. High precision at IoU 50, especially when considering medium to large trash cans

Figure 2. Bus-side detector's recall can keep up with the server-side model with slightly lower precision

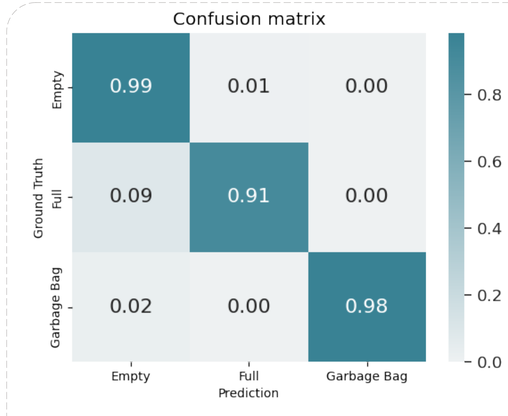


Figure 3. Classification works well enough for a human operator to barely have to double check

Figure 4. Examples of desirable outputs: "Garbage Bag", "Full" and "Empty" (left-to-right)

V. Conclusions

- Improvement of previous work [2]
- Both our detection models achieve very good results, especially for medium to large trash cans (cf. Figure 1)
- Pipeline accounts for hardware constraints of the bus system (cf. Figure 2)
- Classification is reliable enough to help a human operator (cf. Figure 3)

VI. Future Work

- We will have to deploy and test our system on the bus
- We want to build an application to visualize the collected data

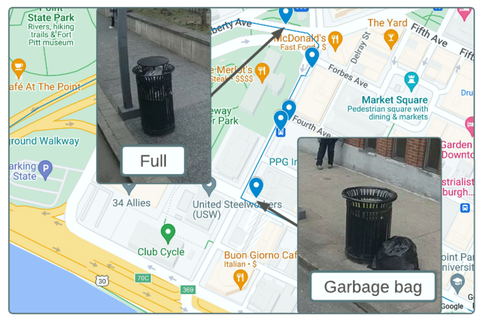


Figure 5. Possible future end-user application

VII. Acknowledgments

- Tim thanks Anurag Ghosh for his many helpful suggestions and Christoph for his mentorship
- Tim thanks Rachel, John and the DAAD for making the participation in the RISS program possible
- Data and background software were provided by projects sponsored in part by NSF under Award No 2038612 and Carnegie Mellon University's Mobility21 National University Transportation Center, sponsored by the US Department of Transportation.

VIII. References

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