Intelligent Urban Asset Analysis: A Scalable Deep Learning Based Inspection System

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1. Introduction

- The rapidly growing city of Guwahati faces issues like traffic congestion, waste management, and potentially deforestation.
- A real-time smart system using deep learning is proposed to automatically monitor key urban assets like traffic signs, garbage bins, and trees.
- This system aims to be cost-effective and fast, using location data to track assets and analyze their presence. This data can help authorities manage Guwahati's assets more effectively.

2. Problem Statement

- Rapid increase in urbanization calls for efficient ways for monitoring assets in cities since different roadway assets degrade over time and need timely replacement and are crucial for safety [1]
- Paperwork and manual inspections slow road assessments - machine learning offers faster, data-driven insights for better asset maintenance.

3. Contributions

1. Version 1 of a new custom multi-class **urban assets dataset** comprising images and annotations of urban assets (trees, traffic signs and garbage bins) of major routes of Guwahati city.
2. An end-to-end real-time urban asset inspection system equipped with state-of-the-art detection model for real-time asset detection and geolocation..
3. A detailed analytical and visualized outcomes for two major routes, offering insights and comprising essential inferences for future urban development.

6. Conclusions

- Rapid urbanisation rate comes with the cost of high maintenance of various urban assets.
- We present a prototype implementation of an automated urban asset inspection system for efficient detection and geolocation of assets in 2 major city routes. Our ongoing framework analyzes traffic data – scaling to cover a dozen routes soon. Dataset v2 expands to include diverse daytime scenes.

7. References

[1] Sudhir Yarram, Girish Varma, and C.V. Jawahar. City-Scale Road Audit System using Deep Learning. In *2018 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, pages 635–640, October 2018.

[2] Debashis Das, Anil Kr. Ojha, Harlin Kramsapi, Partha P. Baruah, and Mrinal Kr. Dutta. Road network analysis of Guwahati city using GIS. *SN Applied Sciences*, 1(8):906, July 2019.

[3] Chaoquan Zhang, Hongchao Fan, and Wanzhi Li. Automated detecting and placing road objects from street-level images. *Computational Urban Science*, 1(1):18, August 2021.

4. System Overview
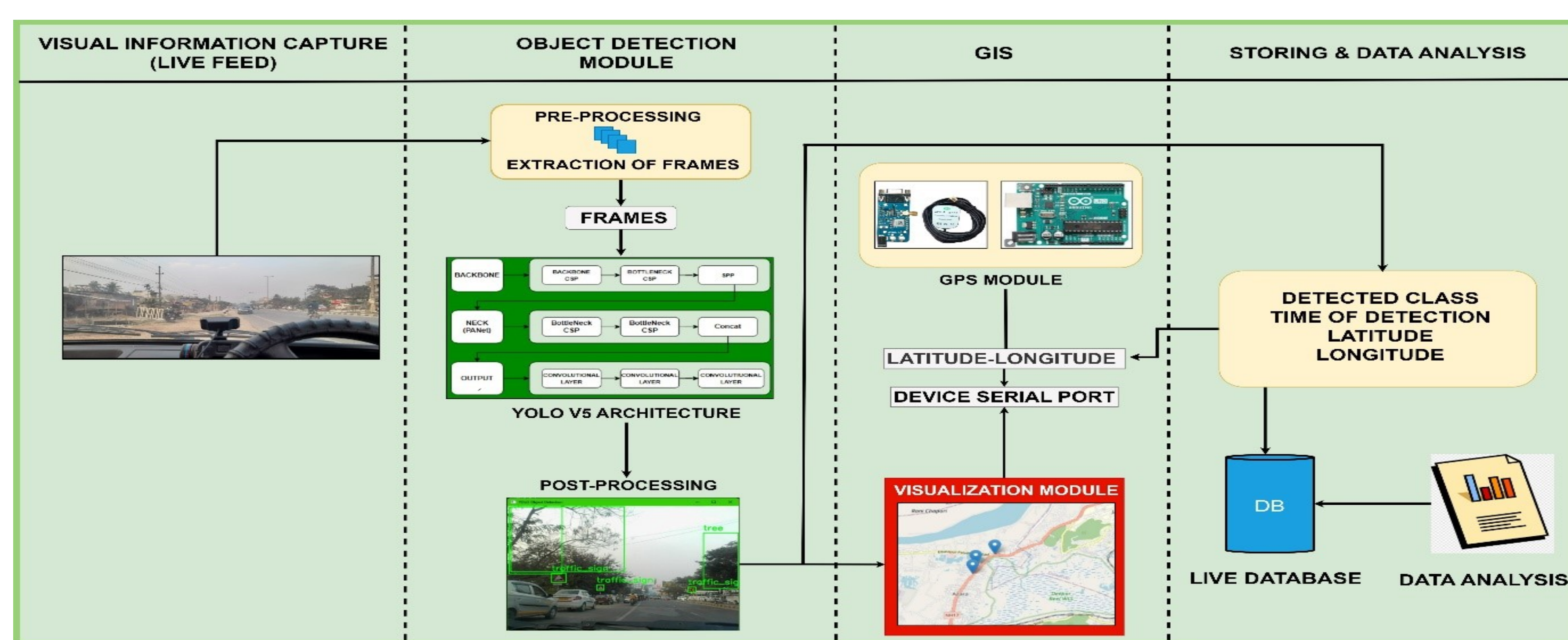
The system uses Computer Vision to detect and classify urban assets traffic signs, garbage bins and trees. A map is then generated of the tested route [2] where the detected objects are geotagged. The system can accurately and efficiently track the number and location of roadway assets.[3]

## 5. Results and Evaluation

1. Dataset -
   - Real-time data of the city of Guwahati was captured.
   - Data is captured using a mobile camera in video format for three choosen classes i.e trees, traffic signs and garbage bins.
   - Frame extraction followed by data-augmentation is performed to increase the amount and efficiency of the dataset.

2. Object detection model (Yolov5m)-
   - Classification loss: Rapid improvement stalls near 0.01 loss, indicating proficiency after a certain point.
   - Validation loss: Drops initially (0.015 to 0.005), suggesting better early bounding box classification, then plateaus for stable performance.
   - mAP@0.5: Sharp rise (0-0.08) signifies enhanced object detection and classification (50% overlap with ground truth), followed by a plateau for stabilized performance.
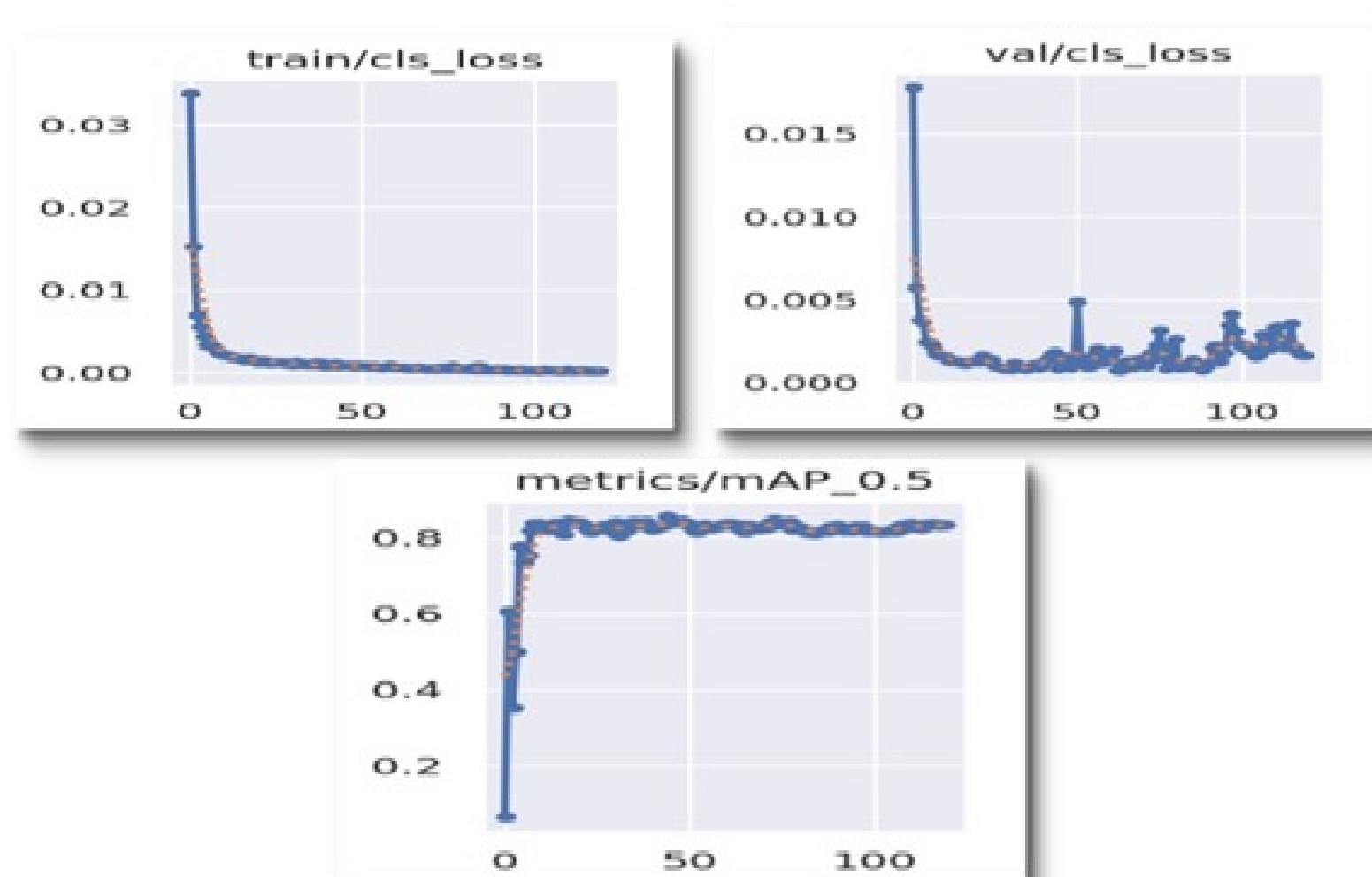
3. Inspection System (Route-1)
   - From NH-17, Ganakpara, Guwahati 781017 to Ganakpara, Guwahati 781017,Assam
   - Total distance covered- 2km, while NH-17's beauty and clear directions are attractive, it lacks proper garbage bins, which may lead to littering, potentially breeding health concerns.
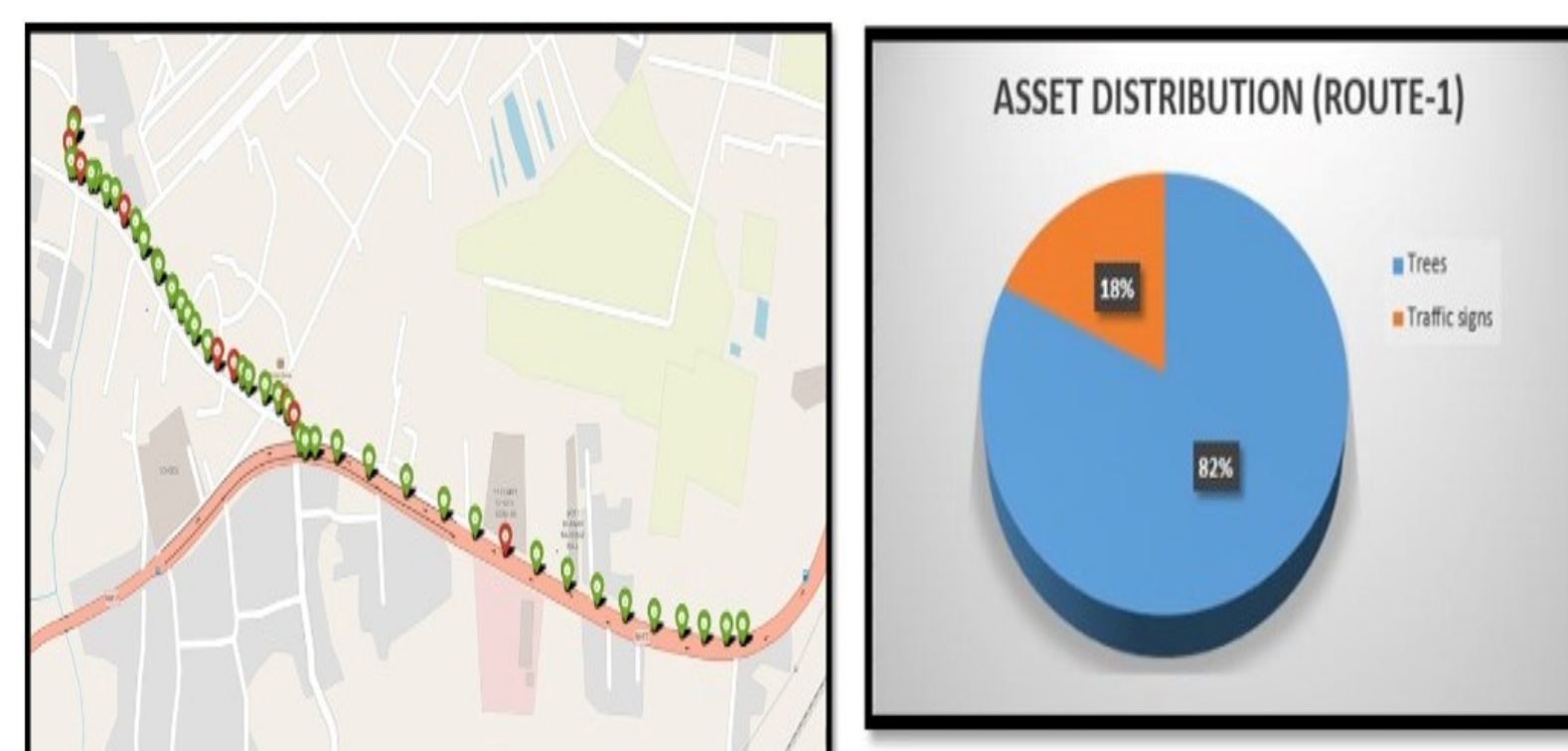
4. Inspection System (Route-2)
   - From Dharapur, Guwahati 781013, Assam to Gauhati University Byepass Road, Jalukbari, Guwahati 781014, Assam)
   - Route 2 on NH-17 offers scenic beauty, but lacks essential garbage bins. Installing bins will prevent littering and fosters responsible waste management for all.