Highway Automated Inspection System (HAIS)

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Abstract

We present a smart monitoring system for automated real-time road condition inspection. The proposed solution includes hardware and software applications for data processing: road condition inspection using hybrid algorithms based on digital signal processing and artificial intelligence technologies. The proposed system has an interactive web interface for real-time data sharing and the monitoring, visualization, and management.

Introduction

In public transportation, the highway will become digitalized, allowing real-time data collection and sharing, surveillance of the infrastructure condition such as bridges and tunnels, and traffic monitoring and management [1]. Digitalization will prepare the needed digital capabilities to integrate and assist the transition to fully connected and automated vehicles (CAV) [2].

Objective:

- Automate road conditions inspection and monitoring,
- Reduce road pretreatment and treatment applications,
- Reduce the overall material usage such as salt,
- Manage road maintenance and inspection missions,
- Enhance drivers and pedestrians safety,
- Send road safety alerts/notifications to all road users,
- Facilitate the integration of the CAVs new technologies

Challenges:

- ***Manual inspection***: usually, regular road inspection missions/visits are performed to check the road visually or using some measurement tools which is costly due to the need for human resources and long duration.
- ***Small-size and Low-quality data***: the manually collected data takes few samples and focuses on some selected areas which might have inconsistency due to human mistakes.
- ***Harsh weather conditions***: limit the camera-based inspection performance due to ambient light variation and visibility reduction (e.g., dust or snow).

The Proposed Framework

The proposed framework is described as follows [3]:

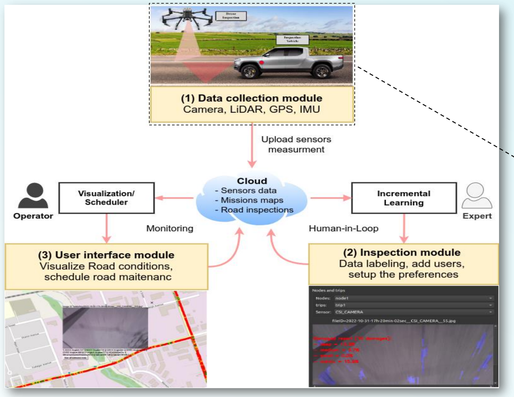

Figure 1: *The proposed road inspection and monitoring system.*

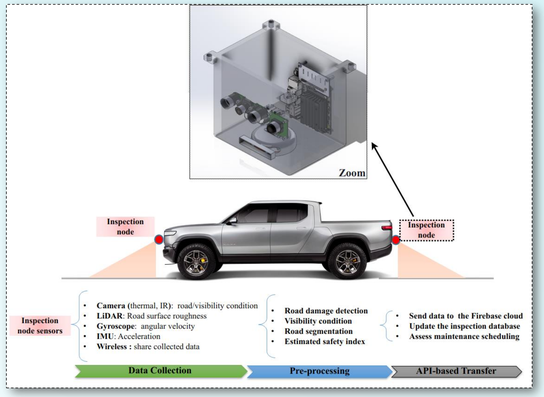

Figure 2: *The Illustration of the inspection node*

Road Conditions Inspection and Monitoring

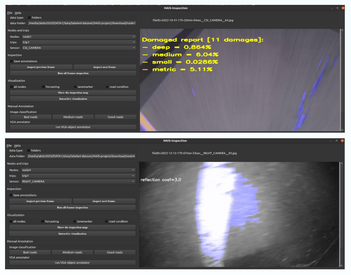

Figure 3: *(a) road damages [4], (b) road lane markings reflectivity [5]*

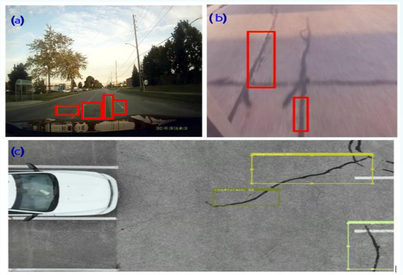

Figure 4: *Damage detection using: (a) Dashcam, (b) node camera, and (c) drone camera [6]*

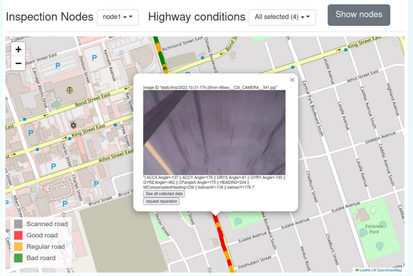

Figure 5: *Road condition visualization data exploration using the inspection node [7]*

Conclusions

- ✓ Develop an automated highway inspection system enabling real-time hybrid inspection and monitoring,
- ✓ enable data-sharing of the collected data using the Firebase cloud platform,
- ✓ Design an interactive web interface for monitoring, and management of inspection reports.

Future work

- Extend the proposed solution to other infrastructure inspections, such as bridges and tunnels,
- Using autonomous drones and implementing an optimization-based algorithm for trajectory planning,
- Consider the minimization of the overall cost and resources: number of used drones, battery charging, …

Acknowledgment

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References

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[2] Saeed, T.U.; Alabi, B.N.T.; Labi, S. Preparing Road Infrastructure to Accommodate Connected and Automated Vehicles: System Level Perspective. J. Infrastruct. Syst. 2021, 27, 6020003
[3] H. A. Gabbar, A. Chahid et al., "HAIS: Highways Automated-Inspection System," Technologies, vol. 11, no. 2, 2023.
[4] https://youtu.be/SY8MXkMBv3A
[5] https://youtu.be/uSXqjpOBzsY
[6] https://youtu.be/Eq5joyWuiKU
[7] https://youtu.be/5k4igwUg2ao