Advanced Pothole Detection and Mitigation

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Problem Statement

Design an innovative and advanced pothole detection system to identify potential road hazards and avoid them.

Objectives

- Develop a pipelined framework for real-time pothole detection using multi-modal data.
- A reliable assistance system for executing safe driving maneuvers in real time.
- Provide visual and audio feedback to the user upon pothole detection, ensuring immediate awareness and safety.

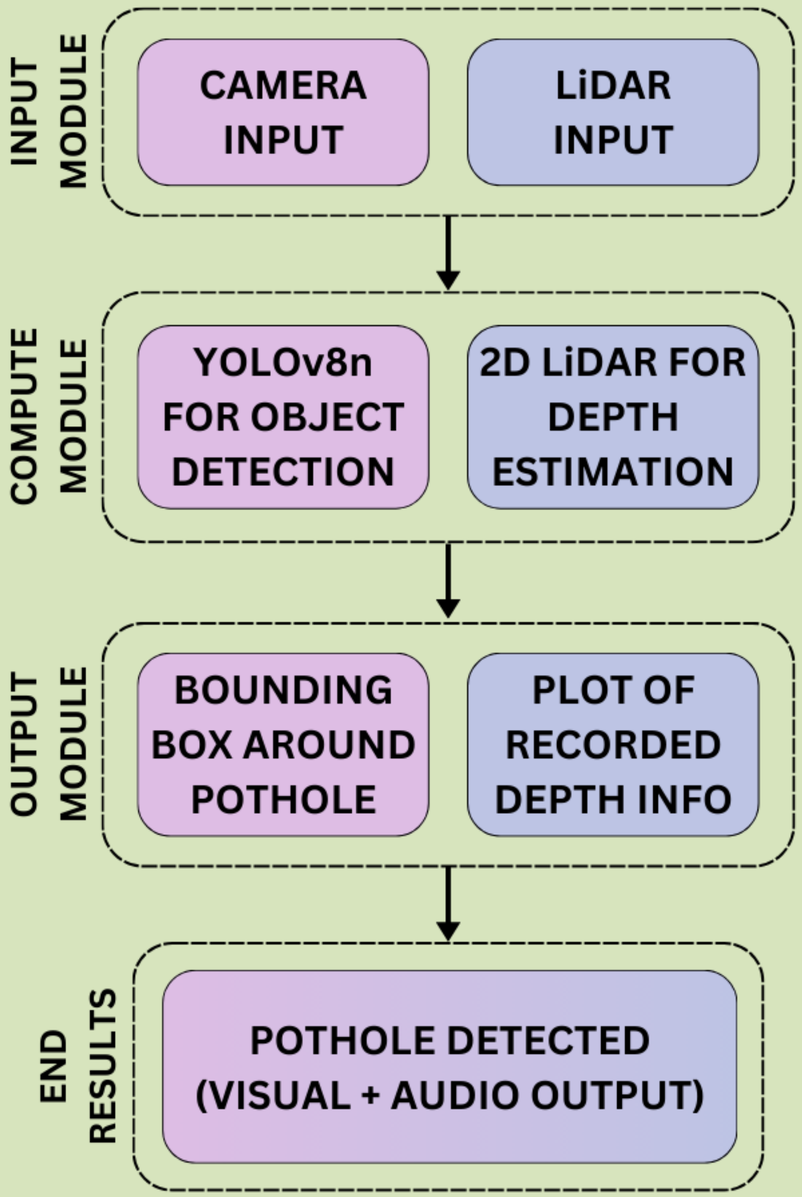
Contributions

- Enhanced Safety: Alerts drivers to potholes, reducing accidents and vehicle damage.
- Cost Savings: Optimizes road repair and maintenance, saving resources.
- Environmental Impact: Reduces fuel consumption and pollution from smoother traffic flow.
- Technological Innovation: Employs advanced sensors and algorithms for precise detection.
- Data-Driven Insights: Provides actionable data for infrastructure planning.
- Scalability: Can extend to detect other road anomalies and integrate with smart city systems.

Literature Survey

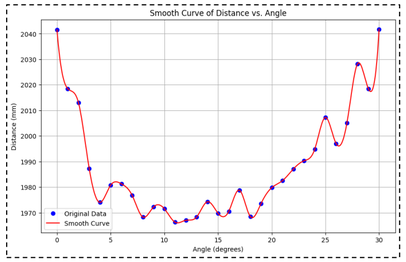
- Conducted an exhaustive literature survey, reviewing state-of-the-art advancements and approaches towards pothole detection using computer vision (camera) and LiDAR.
- Talha, S. A., Manasreh, D., & Nazzal, M. D. (2024). The Use of Lidar and Artificial Intelligence Algorithms for Detection and Size Estimation of Potholes. *Buildings*, *14*(4), 1078.
- Yik, Y. K., Alias, N. E., Yusof, Y., & Isaak, S. (2021, February). A real-time pothole detection based on deep learning approach. In *Journal of physics: Conference series* (Vol. 1828, No. 1, p. 012001). IOP Publishing.

Methodology



Results

Pothole at Left
Keep Right



Angle (deg)	Distance (mm)
0	2041.5
1	2018.5
2	2013
3	1987.25
4	1974
5	1980.75
6	1981.25
7	1976.75
8	1968.25
9	1972.25
10	1971.5
11	1966.25
12	1967
13	1968.25
14	1974.25
15	1969.75
16	1970.5
17	1978.75
18	1968.5
19	1973.5
20	1979.75
21	1982.5
22	1987
23	1990.25
24	1994.75
25	2007.25
26	1997
27	2005
28	2028.25
29	2018.5
30	2041.75

Optimization Details

- Implemented the lightweight YOLOv8n model to balance accuracy and computational efficiency.
- Fine-tuned LiDAR distance thresholds to effectively filter out minor surface irregularities, enhancing the system's precision in identifying significant potholes.
- Optimized the LiDAR and camera synchronization to ensure seamless data acquisition and processing for accurate pothole detection.

Conclusions

Our pothole detection and mitigation system combines YOLOv8-based real-time detection with LiDAR-based depth analysis to accurately identify and differentiate potholes, ensuring improved road safety and actionable insights for infrastructure management.