Dissertation Title:
Road Quality Assessment System Using Computer Vision and GPS-Based Mapping

Course No. : SEZG628T

Course Title: Dissertation

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Degree Program: M.Tech in Software Engineering

Research Area: Machine Learning

Dissertation carried out at:

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February 2026

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1. Broad Area of Work

Computer vision and deep learning have emerged as powerful tools for automated infrastructure monitoring and assessment. The broad range of this project includes artificial intelligence, machine learning, computer vision, and geospatial information systems. The research project focuses on the following application areas:

- **Computer Vision**: To detect and localize potholes from dashcam imagery
- **Deep Learning**: To train models that can identify potholes.
- **Transfer Learning**: To adapt pre-trained models like YOLO to Indian road conditions.
- **Geospatial Mapping**: To integrate detection results with GPS coordinates for road quality visualization in a map.

2. Background

Road infrastructure quality directly impacts commuter safety, vehicle maintenance costs, and municipal planning decisions. Navigation systems today optimize routes based on distance and travel time but fail to account for road surface quality, particularly pothole density and severity. This limitation forces commuters to either accept poor road conditions or rely on informal knowledge about road quality.

In Indian road conditions, this problem is particularly acute due to diverse surface types, varying maintenance standards, monsoon impacts, and rapid urban development. Potholes and road damage cause accidents, vehicle damage, and increased travel discomfort. However, systematic data collection for road quality assessment remains manual, expensive, and infrequent.

Recent advances in deep learning, particularly object detection architectures like YOLO (You Only Look Once), have shown promise in automated defect detection. However, existing pothole detection models are predominantly trained on Western road datasets and perform poorly when applied to Indian roads. This is due to differences in road surface materials, damage patterns, environmental conditions, and visual complexity.

The proliferation of affordable dashcams with GPS capabilities provides an opportunity to collect road condition data easily. By combining computer vision techniques with GPS-based mapping, it becomes feasible to create road quality assessment systems that

can inform both individual routing decisions and municipal maintenance prioritization.

This dissertation proposes to develop such a system specifically adapted for Indian road conditions through transfer learning techniques, addressing the gap between existing models and the unique characteristics of local infrastructure.

3. Objectives

The objectives of this project are as follows:

- Understand the current scenario with respect to pothole detection and limitations of existing approaches for Indian roads.
- Create an annotated dataset of road defects collected from Kerala roads using dashcam footage, suitable for training and evaluation.
- Implement transfer learning to adapt the YOLOv8 object detection architecture for pothole detection on Indian road conditions.
- Design a road quality grading algorithm that aggregates pothole detections into segment-level quality scores based on density and severity.
- Create a visualization interface to display quality-graded road segments on an interactive map for practical demonstration.

4. Scope of Work

The scope of this dissertation is to design and implement an automated road quality assessment system that:

- Detects potholes and road defects from dashcam video footage using deep learning-based computer vision.
- Generates quality scores for road segments based on detected defect characteristics.
- Provides visual representation of road quality through a web-based mapping interface.

5. Plan of Work

Phases	Start Date-End Date	Work to be done
Dissertation Outline	31 Jan 2026 – 7 Feb 2026	Literature Review and prepare Dissertation Outline
Data Collection & Preparation	8 Feb 2026 – 21 Feb 2026	Extract frames from dashcam videos, annotation using LLMs and review (500 images), dataset organization and quality checks
Model Development	21 Feb 2026 – 20 Mar 2026	Transfer learning implementation, model training, hyperparameter optimization, initial evaluation
Mid-Semester Report	15 Mar 2026 – 28 Mar	Progress documentation, prepare mid-sem report, present preliminary results in viva.
GPS Integration & Road Grading	22 Apr 2026 – 5 May 2026	OCR-based GPS extraction, quality scoring algorithm design and implementation
Visualization Development	29 Apr 2026 – 10 May	Web-based mapping interface.
Comprehensive Evaluation	6 May 2026 – 12 May	Testing on diverse road segments, baseline comparisons, performance analysis, results.
Final Report Writing	22 Apr 2026 – 12 May 2026	Dissertation writing, methodology documentation, results analysis, presentation preparation.

6. Literature References

Maeda et al. [1] proposed a deep learning based road damage detection system using smartphone captured images using a mobile application on Japanese roads, with real-time processing and selective transmission of pothole data to reduce bandwidth and server load. Arya et al. [2] extended this work using transfer learning to a multi-country setting, including India, demonstrating improved generalization across diverse road conditions. Redmon et al. [3] paper is about the YOLO object detection architecture, a real-time, single-stage detection framework which can be used in infrastructure and road damage monitoring.

[1] H. Maeda et al., "Road damage detection using deep neural networks with images captured through a smartphone," arXiv:1801.09454, 2018.

[2] D. Arya et al., "Transfer learning-based road damage detection for multiple countries," arXiv:2008.13101, 2021.

[3] J. Redmon et al., "You only look once: Unified, real-time object detection," arXiv:1506.02640, 2016.

Additional references will be incorporated as the project progresses, targeting recent advancements in object detection, infrastructure monitoring, and geospatial analysis.

7. Particulars of the Supervisor and Examiner

	Supervisor	**Additional Examiner**
Name	Dr. Kavya Manohar	Mr. Ashik Salahudeen
Qualification	PhD Electronics and Communication Engineering	Bachelor of Technology in Electrical Engineering
Designation	ML Researcher	Senior software Engineer
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8. Remarks of the Supervisor

The area chosen for the dissertation project is very relevant. The student has done the basic literature survey to cover the related works in the field. The proposal involves proper plan for data collection, annotation, deep learning model training, evaluation and integration of the results into a usable format through a web based mapping interface.The project also has a prospect of publication in future. The student is motivated enough to conduct the project and has sufficient skills to implement this. I approved the project as the supervisor.

Information about the Supervisor:

Dr. Kavya Manohar holds PhD in Electronics and Communication Engineering from APJ Abdul Kalam Technological University, Kerala. She has publication track records in peer-reviewed journals and conferences. Kavya currently leads the Speech and Language Research at Adalat AI as the founding ML Researcher.

BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI
WORK INTEGRATED LEARNING PROGRAMMES (WILP) DIVISION
SECOND SEMESTER OF ACADEMIC YEAR 2021-2022

SEZG628T : Dissertation OUTLINE

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DISSERTATION / PROJECT / PROJECT WORK TITLE	Road Quality Assessment System Using Computer Vision and GPS-Based Mapping

		
Signature of Student	**Signature of Supervisor**	**Signature of Additional Examiner**
Name: Anish A.	**Name: Dr. Kavya Manohar**	**Name: Ashik Salahudeen**