Development of a Machine Learning-Based Quality Control Approach for Automated Pavement Condition Data

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Introduction

- *Extensive advancements in computer technology → Machine learning and artificial intelligence*
- *Using machine learning algorithms to identify road surface distresses from pavement downward images has been gaining momentum in the pavement management industry in recent years.*
- *There are numerous advantages in using automotive technologies to collect pavement condition data including safety, speed, and comprehensiveness*

Advantages of Automated Pavement Data Collection Technology

Safety	Traffic control and lane closures are not required.
	Pavement inspectors are not exposed to traffic hazards.
	Pavement distress surveys are performed by inspectors in the office.
Speed	**Highways and Roadways** – Data collection rates of over 150 lane miles per day on highways and 30-40 miles per day on city streets.
	Highways and Roadways – Data collection is performed at posted traffic speeds, up to 60 mph.
	Airfields – 10,000 ft. x 150 ft. runway survey can be completed in approximately 5 hours.
	Airfiel … on airside operations.
Comprehensive, Geocentric Pavement Data	Sub-m … ation for each pavement data elemen …
	Accura …
	High … forward- facing ROW images provid …
	ASTM … surements along with accurate, contin …
	Pavem … and longitudinal grade.

RELIABILITY OF THE DATA?!

Challenges with Automated Pavement Condition Data

- *Identification of micro/macro texture-based distresses such as weathering, raveling, and bleeding;*
- *Confusion with the existence of stationary objects on the pavement road and consequently in downward photos such as security cones, foliage and debris such as plastic bottles;*
- *Challenges with pavement condition rating of asphalt concrete roads with concrete gutters;*
- *Issues with rutting measurements when the data is collected on a road with a steep slope, sharp turn, or sudden change in direction or lane;*
- *Incorrectly including the road shoulder in rating of narrow roads;*

Challenges with Automated Pavement Condition Data (continue)

- *Identification of paint cracking as a pavement distress;*
- *Identification of cobblestone cross-walks and speed bumps as surface distresses;*
- *Incorrect detection of manhole leads and catch basin covers as pavement distresses;*
- *Difficulty in identifying patches;*
- *Difficulty in identifying and classifying block cracking separately from other cracking; and*
- *Challenges with machine learning algorithms to distinguish between raveling and potholes.*

Problem Statement

- *There are still serious limitations with machine learning algorithms in identifying and classifying pavement distress data.*

- *Accuracy and consistency in machine learning algorithm outputs are not certain and should be constantly verified.*

- *Currently, the most common QC program for APCD includes random sample audits*

Goal

- *The main goal of this study is to develop a systematic approach for quality control of automated pavement condition data.*

- *This study includes a systematic approach to flag the pavement sections (or sample units) for further checks based on known challenges and deficiencies of APCD in addition to random quality checks.*

Data Patterns

- *It is unlikely that medium and high severity potholes occur in sections with no weathering distress;*
- *Usually potholes cannot be the only distress type present on the sample unit;*
- *Potholes are load related distress and generally exist with other load related distresses such as alligator cracking;*
- *In asphalt roads which are older than five years, weathering at either low, medium, or high severity is usually present;*

Data Patterns (continue)

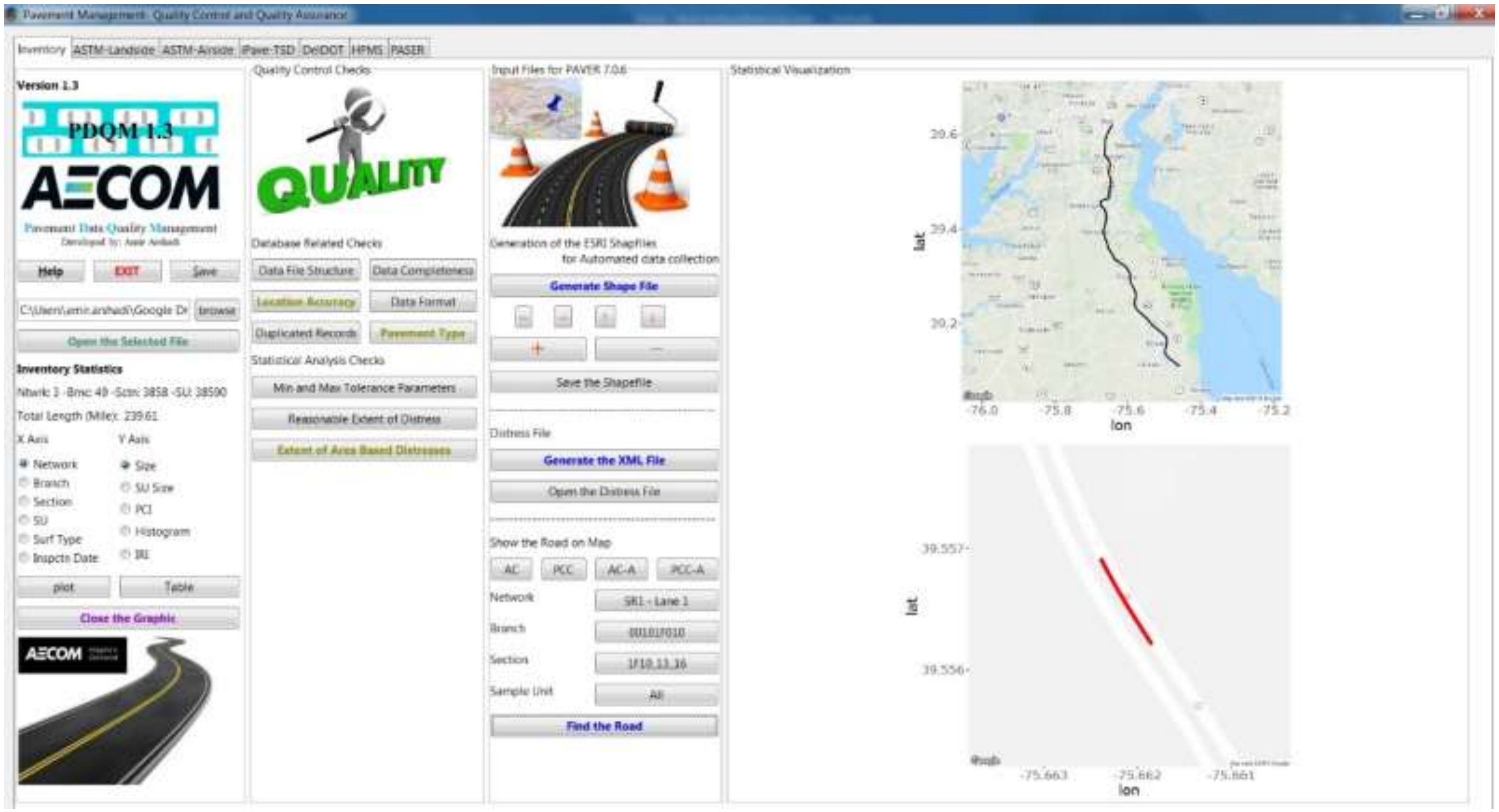
- *Sections (or samples) exhibiting medium or high severity weathering generally have other distresses present;*
- *Alligator cracking evolves from longitudinal and transverse (L&T) cracking. Therefore, other quantities of L&T cracking will likely be present if alligator cracking is present;*
- *High severity distresses such as alligator cracks, potholes, and raveling are not generally observed on pavement sections with age less than 5 years;*

Data Patterns (continue)

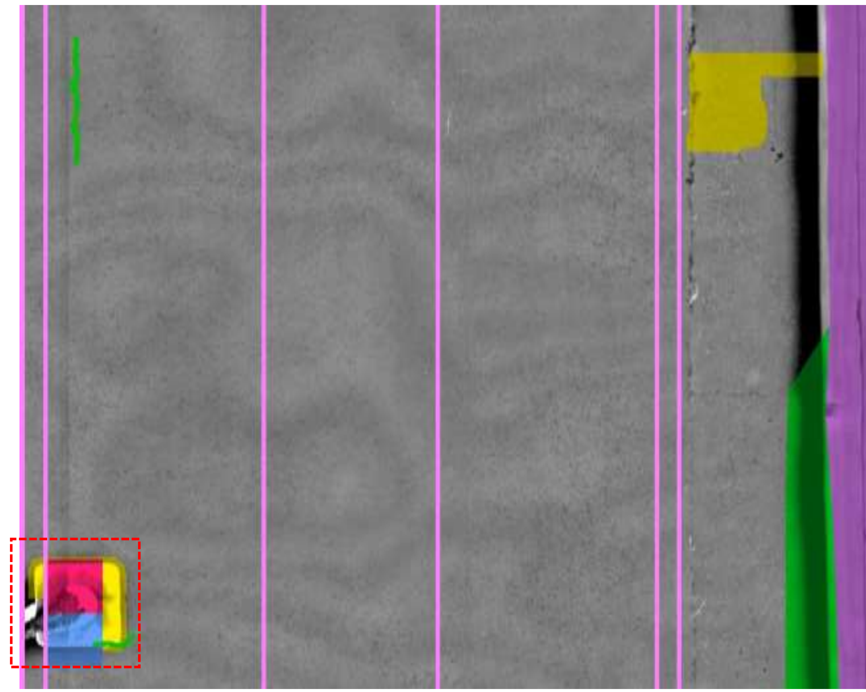
- *In a specific road section, it is uncommon to see significant instances of rutting distress in only one sample unit while not in other sample units (with the exception of intersections); and*

- *In a specific road section, it is uncommon to see significant quantities of alligator cracking distress in only one sample unit and not in other sample units.*

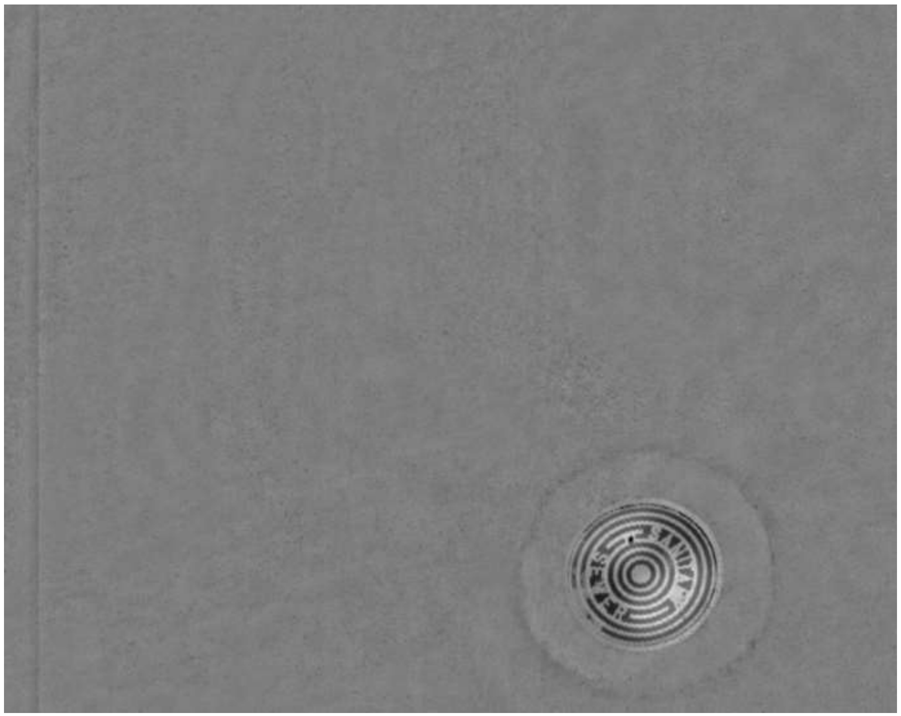
Pavement Data Quality Management (PDQM) Software

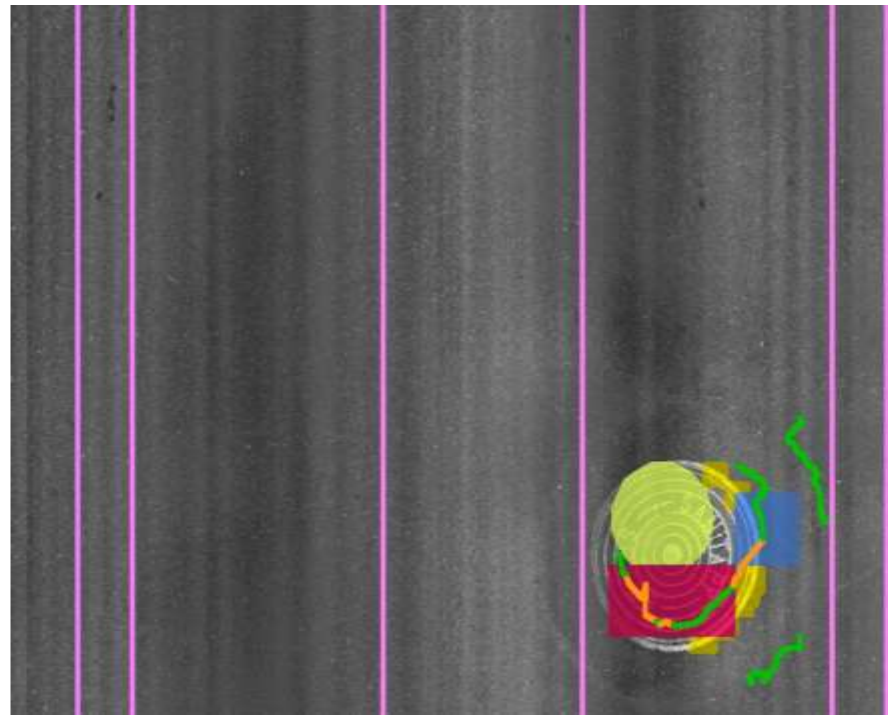


Incorrect Distress Identification

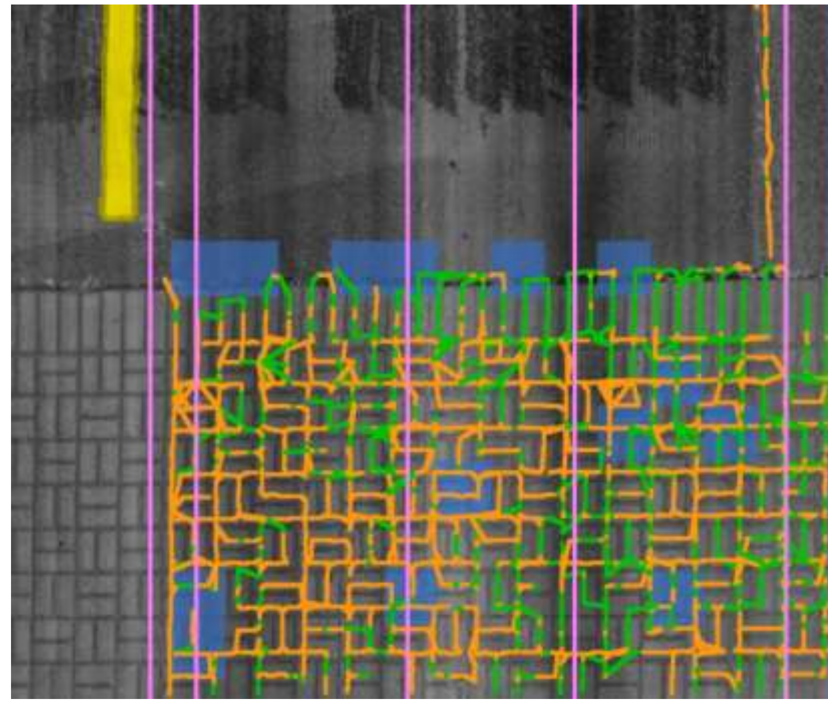


Incorrect Identification of Raveling within Manhole Cover

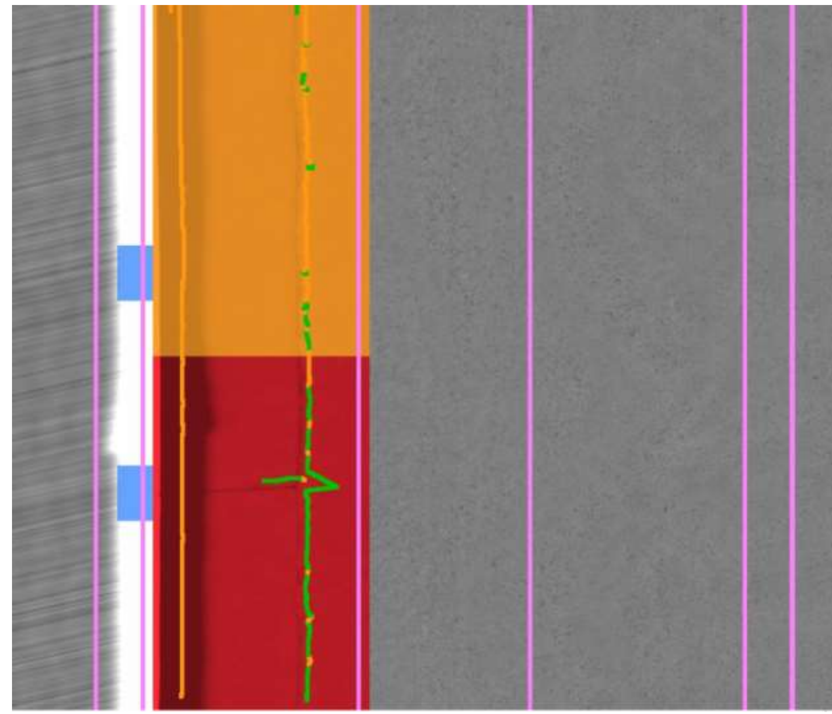




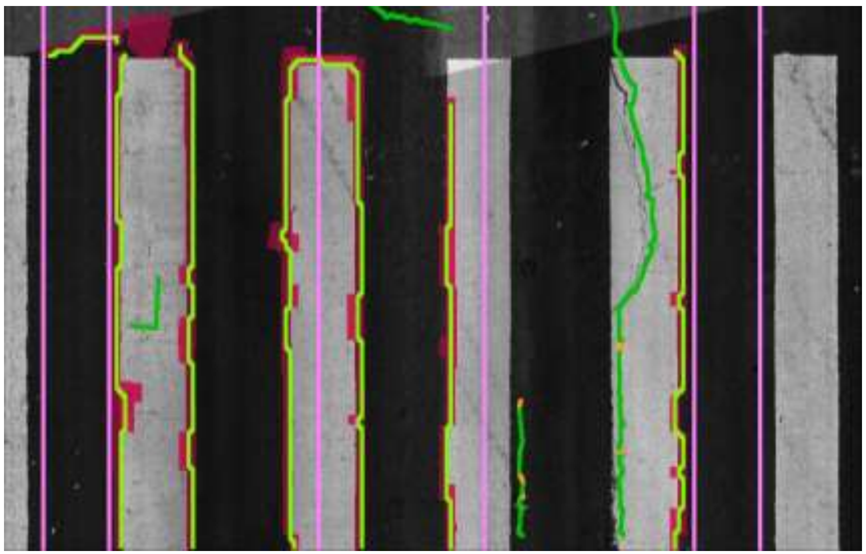
Identification of Cobblestone Cross-walk as Surface Distress

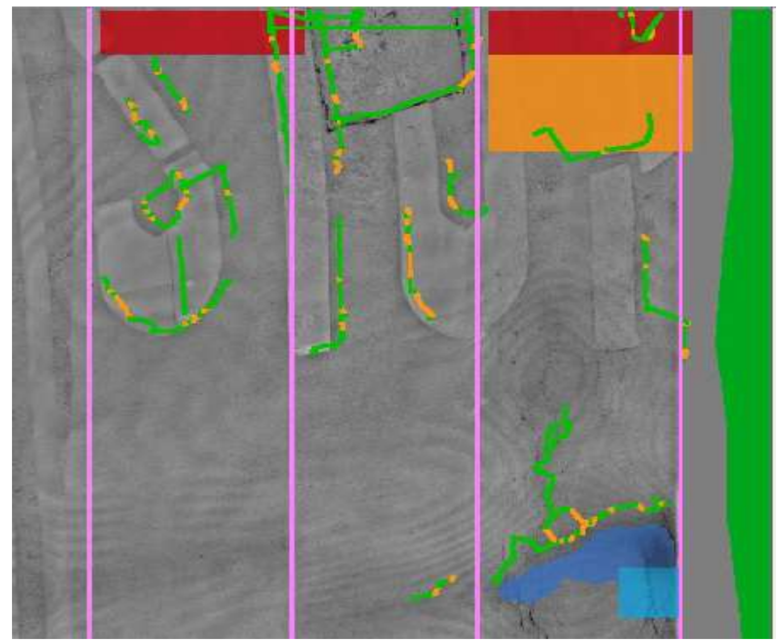


Incorrect Pavement Condition Rating in Narrow Streets

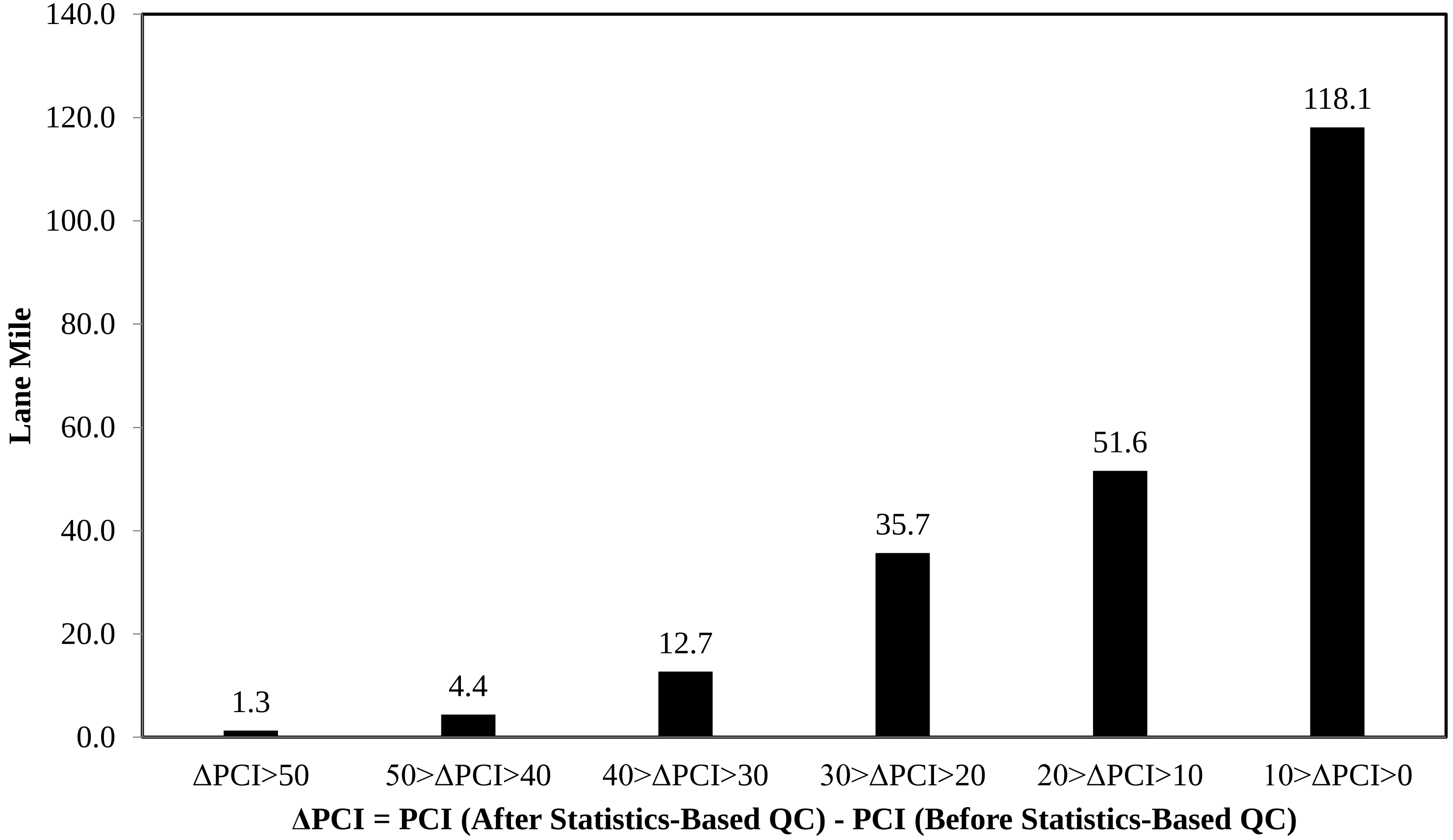


Identification of Road Markings as Pavement Distresses





Effect of Statistics-Based QC on PCI Values



Conclusions

- A statistics-based quality control approach was presented as an effective method to improve the automated pavement condition data.
- This approach was successfully tested on one thousand miles of automated pavement condition data collected on urban and suburban asphalt roads.
- The results indicate that typical quality control approaches that are based on random spot checks of the data are not sufficient due to the nature of the automated pavement condition data processing.

Thank You

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