Intelligent Winter Road Condition Sensors (Phase I)

tech transfer summary

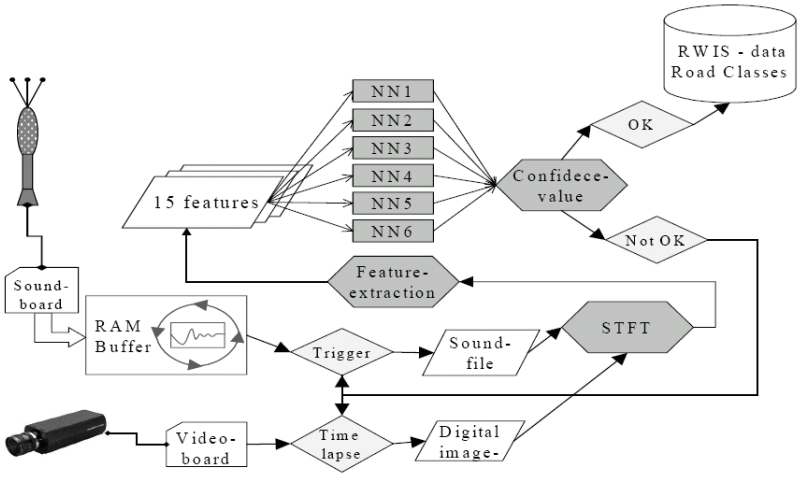
Objectives

The primary objective of this study is to determine the ability of audio/visual (AV) sensor systems to accurately determine winter road conditions. This involved separate analyses of two intelligent sensor systems: Acoustic Road Condition ANAlysis (ARCANA) and MAchine Recognition of road Condition using Optical Neural Informatics (MARCONI).

Technology/Technique Description

MARCONI determines road condition based on a road image, while ARCANA classifies road condition by analyzing sound signals from passing cars. Both systems detect conditions by comparing a captured data with a database of defined road conditions.

Both networks were initially trained to identify four road condition classes: wet, dry, snow, and ice. The MARCONI system was additionally designed to identify snow tracks. However, due to light winter weather conditions during data collection—and thus a limited database of defined conditions—the field study focused on the three most frequently occurring conditions: wet, dry, and snow.



The system design for integrating ARCANA and MARCONI networks with RWIS.

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working to advance road weather information systems technology

RESEARCH PROJECT TITLE
Signal and Image Processing for Road Condition Classification

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PROJECT CHAMPION
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KEY WORDS
audio/visual (AV) sensors—intelligent sensors—road condition classification—winter road conditions

ABOUT AURORA
Aurora is an international partnership of public agencies performing joint research, evaluation, and deployment initiatives related to road weather information systems (RWIS).

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Key Findings

This study demonstrates that intelligent AV sensors potentially offer 90% accuracy in classification of road conditions, even under real-world and real-time conditions. As a result of the project, this technology is in a phase where suitable technical components should be offered for use in Road Weather Information Systems (RWIS).

Of most interest is that combining MARCONI and ARCANA into a hybrid system results in achieving over 90% successful identification of all road condition classes except dry. To compensate, dry performance can be boosted by relying on additional RWIS data such as humidity and precipitation.

Implementation Benefits

- Intelligent sensors can provide important road condition information to operations and traffic safety personnel.
- AV sensors are capable of automatically feeding captured data to the RWIS for ease of use.
- Intelligent AV sensors can potentially provide more descriptive information than traditional binary sensors because of their ability to detect simultaneous road conditions (such as ice and snow).

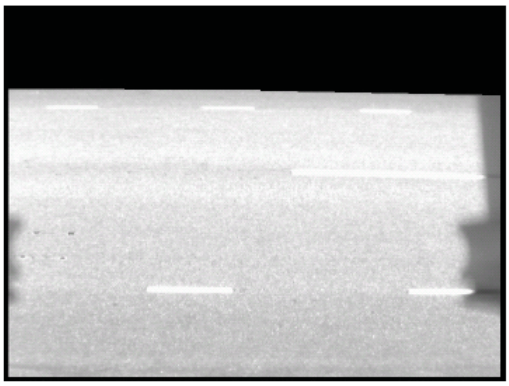
Implementation Readiness

Since the prototype analyzed a highly trafficked highway, few cases of snow-tracked road or snow-covered conditions were observable. Although adequate data was retrieved for this analysis, a usable intelligent sensor system should be trained with approximately 200 examples per road condition to help ensure successful classification.

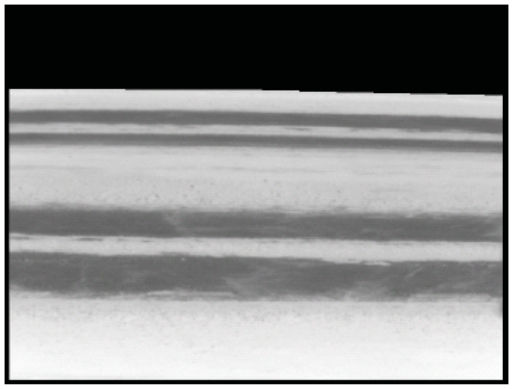
Focused product development and marketing is necessary to develop and implement AV sensor systems to their full potential. Future research and development should address the following:

- Eliminate problems and limitations, especially the current inability of MARCONI to classify nighttime road conditions
- Further enhance the classification, particularly for hard-to-identify dry conditions
- Facilitate installation of new sensor systems

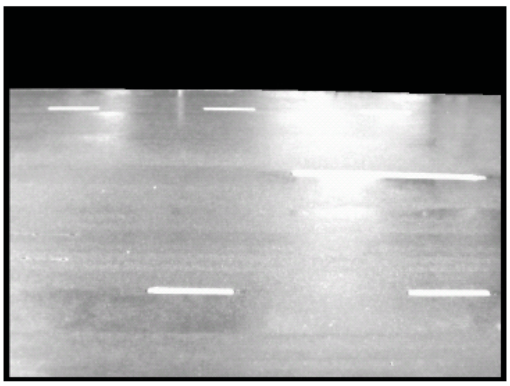
It is also noteworthy that a lack of expertise in AV components used in the ARCANA and MARCONI systems was a hindrance in this study. To facilitate future product development, an AV professional should conduct an independent study of the quality, function, and price of the AV components used in these two systems.



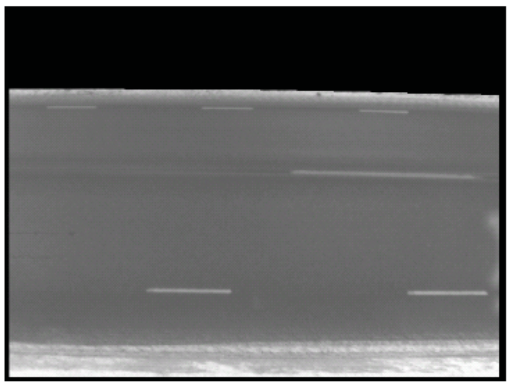
MARCONI image of a typical dry road



MARCONI image of a typical snowy road



MARCONI image of a typical wet road



MARCONI image of a typical icy road