Area-Based Macrotexture Measurements using Stereo Vision

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Objective

- To present a new system that is being developed to measure the texture of a pavement surface using a stereo vision camera
  - Uses relatively low cost off-the-shelf components
  - Captures images of pavements
  - Reconstructs a three dimensional surface map of the pavement surfaces.
Background

- All pavement surface characteristics relate in some way to the pavement texture.
- Adequate, effective, and rapid assessment of pavement texture can be used to support
  - Support wet-accident reduction programs
  - Help reduce splash and spray conditions, promote lower tire-pavement noise production
  - Monitor the quality of the finished traveled surfaces
Background (cont.)

- Current approaches have some limitations
- “Static” methods such as the sand patch measurements (ASTM E965) and the Circular Track Meter (ASTM E2157) require traffic control and only providing a limited sample of the road texture
- High speed laser profilers only measure very thin longitudinal lines and may miss important features adjacent to these lines
Components

- Calibrated stereo vision system
- Enclosure box
- Lighting System
- Laptop Computer
- Developed Software
Operation

Stereo Vision System
Algorithm

1. Set appropriate camera properties
2. Capture pair of stereo images
3. Remove lens distortions + rectification to align the epipolar lines
4. Edge detection (using pre-selected filter masks and coefficients)
5. Matching using constraints for texture validation, surface size validation and disparity range
6. Disparity values converted to a grid $x$, $y$, and $z$ coordinates = 3-dimensional map
7. Calculate statistics, such as average depth
Overview

Objective

Background

Equipment Development

Results

Conclusions

Center for Sustainable Transportation Infrastructure
Preliminary Smart Road Comparisons
Proof-of-Concept Surfaces Tested

- Railroad Bridge
- CRCP
- JRCP
- Cargill
- EP5
- Section D
- Section C
- Section B
- Section A
- Tined CRCP
- Cargill SafeLane™
- OGFC
- VDOT EP5LV
- SMA 9.5 D
- SM 9.5 D
- SUPERPAVE
- VDOT 4.5 D
- GDOT 5.5 D
- Ground JRCP
- JRCP
2008 Rodeo Comparisons

- 2 Circular Track Meter (ASTM E2157)
  - Mean profile depth (MPD)
  - Mean texture depth (MTD)
- Hydrotimer (ASTM 2380),
- Digital Surface Roughness Meter (DSRM)
Comparisons

\[ y = 1.7736x + 0.3795 \]
\[ R^2 = 0.9211 \]

\[ y = 0.9061x + 0.065 \]
\[ R^2 = 0.9934 \]
Why do we need area-based approaches?
Additional Validation Tests (Wallops)
Visualizations

POINTS

MESH
PCC 3D Surface
HMA Surface

Rectified Surface

3-D Map
Overview

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Conclusions

- The development of a relatively low-cost pavement surface texture measurement system that can conduct wide-area measurements instead of thin longitudinal lines can provide an accurate characterization of pavement surfaces.
Conclusions (cont.)

- The stereo-vision-based macrotexture measurement system provides a more accurate (and relevant) methodology for evaluating pavement surface texture than currently available technologies.
  - Allows the determination of area surface measurements.
Conclusions (cont.)

- The results suggest that the development and implementation of area-based macrotexture indicators and measurement techniques will allow a better understanding of the pavement surface properties and more accurate simulations of tire-surface interactions.
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