National Highway Visibility Conference

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Utah Camera Imagery (150+)
Video Camera Goals

- Automatically measure visibility and detect fog utilizing standard visible camera imagery

Visibility: 1 km : No Fog
Roadway Conditions: Partially Snow Covered
Precipitation: Moderate Snow

Visibility: 0.2 km : Heavy Fog : Thickening

Fog Description
- Heavy
- Moderate
- Light

Roadway Conditions: Clear
Precipitation: None

Visibility (km)
- >10
- >5
- 1-5
- 0.0-1.0
Guidelines & Assumptions

• Keep sensor requirements simple
  – Digital camera at known location
  – View must capture multiple ranges

• Require only limited image range survey

• Initially only daylight imagery

• Focus on key ranges of visibility
  – Visibility < 10km (and in particular < 1km)

• Use multiple determination techniques
  – Determine optimal answer using fuzzy logic techniques
Edge Extraction

- Taconic Ridge Line: 6.7km
- E-Hangar: 0.4km
- Hangar: 0.2km
- Road: 0.030km
- Near Ridge: 2.1km
- Gas Tanks: 0.042km
Algorithm Flow Chart*

Image Capture → Lighting Correction → Edge Detection → Image Registration

- Composite Image Generator
- GPS
- Satellite

Edges of interest → Normalized Edge Extraction
- Unexpected Edges

Visibility Algorithm → Fog Algorithm → Trend Algorithm
- Sensor Problems
- Weather Detection

Users

(30 day average)
Out-year development

*Patent pending
Data Quality Issues

Edge Detection

Composite Image

Threshold & Normalize Image w/ Composite Image

Image Database

Feb 28, 2000 (14Z)

Feb 21, 2000 (14Z)
Threshold & Normalize

Composite Edges

Current Edges

Normalize

Threshold
Multiple Determination Techniques

Edge Detection Image

Mean R=0.68
Stddev R=0.63
Power R=0.61
Visibility Algorithm - Initial Assessment

Visibility: Value, Direction, Confidence
Camera: Status

Normalized Edge Extraction

Edges of interest

Unexpected Edges

Status

Consensus

Estimators
- Edge Mean
- Edge Median
- Image Power
- Edge Power
- Max Edge Power

Video Estimated Visibility (km)

Video Estimated Visibility (km)

<1  1-5  5-10  ≥ 10

<1  28  2  0  0

1-5  1  24  11  6

5-10  0  10  64  32

≥ 10  0  46  174  663

Mt. Greylock, MA hourly daylight images 7/1-10/31/00 (estimators trained on same data set)
Video Visibility - Next Steps

- Develop driver code for end-to-end system
- Refine current visibility estimators
- Apply normalized model to untrained images
  - From the same trained camera
  - Other locations
- Expand to other algorithms (fog, snow, data quality, etc)