

Road Friction Monitoring Paper No 49

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PROBLEM



- Slippery roads cause thousands of accidents each year
- Slipperiness: reduction of friction between road and tire
- Reason: ice, snow or water
- Easy to observe: snow, water and icy road
 - Exception: “black ice”
- BUT
- The evaluation of friction is difficult





MEASUREMENT EQUIPMENT



- Xenics XS-1265 NIR (0.9 - 1.7 μm)
- Road side unit
- Stereo camera system with the polarization filters
 - horizontal and vertical polarization





ANALYSIS METHODS



- Intensity I: average grayscale value

- Graininess S:
 1. low-pass filtering (Wiener filtering)
 2. contrast (difference of the adjacent pixels aligned horizontally or vertically)
 3. graininess from contrasts $S = \frac{C_{original} - C_{filtered}}{C_{original}}$

- Polarization difference: $I_{diff} = I_{horizontal} - I_{vertical}$
- Approximated polarization $I_{diff} = I - I_{zeroimage}$



DATA COLLECTED

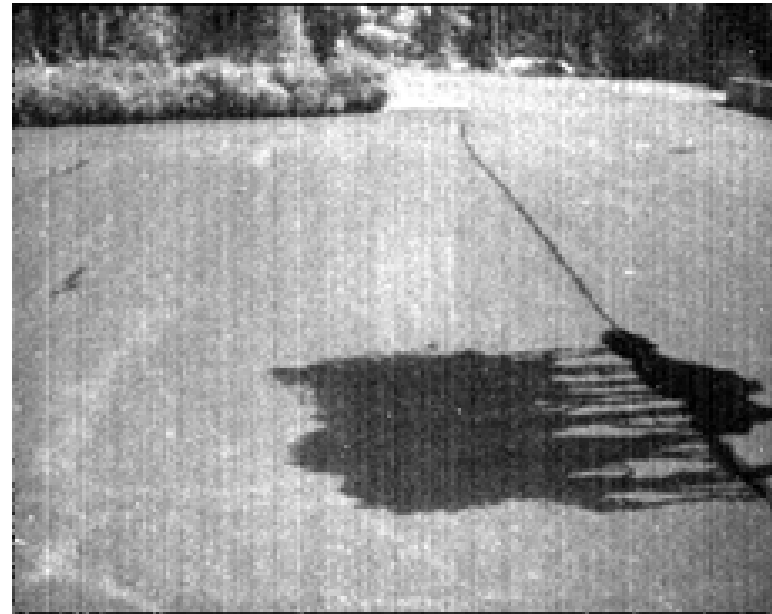


- Images from NIR camera

ice & snow

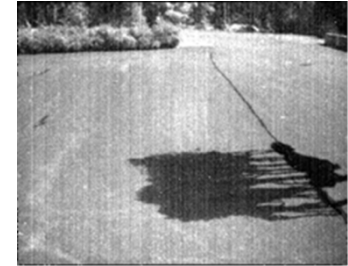


water & dry road

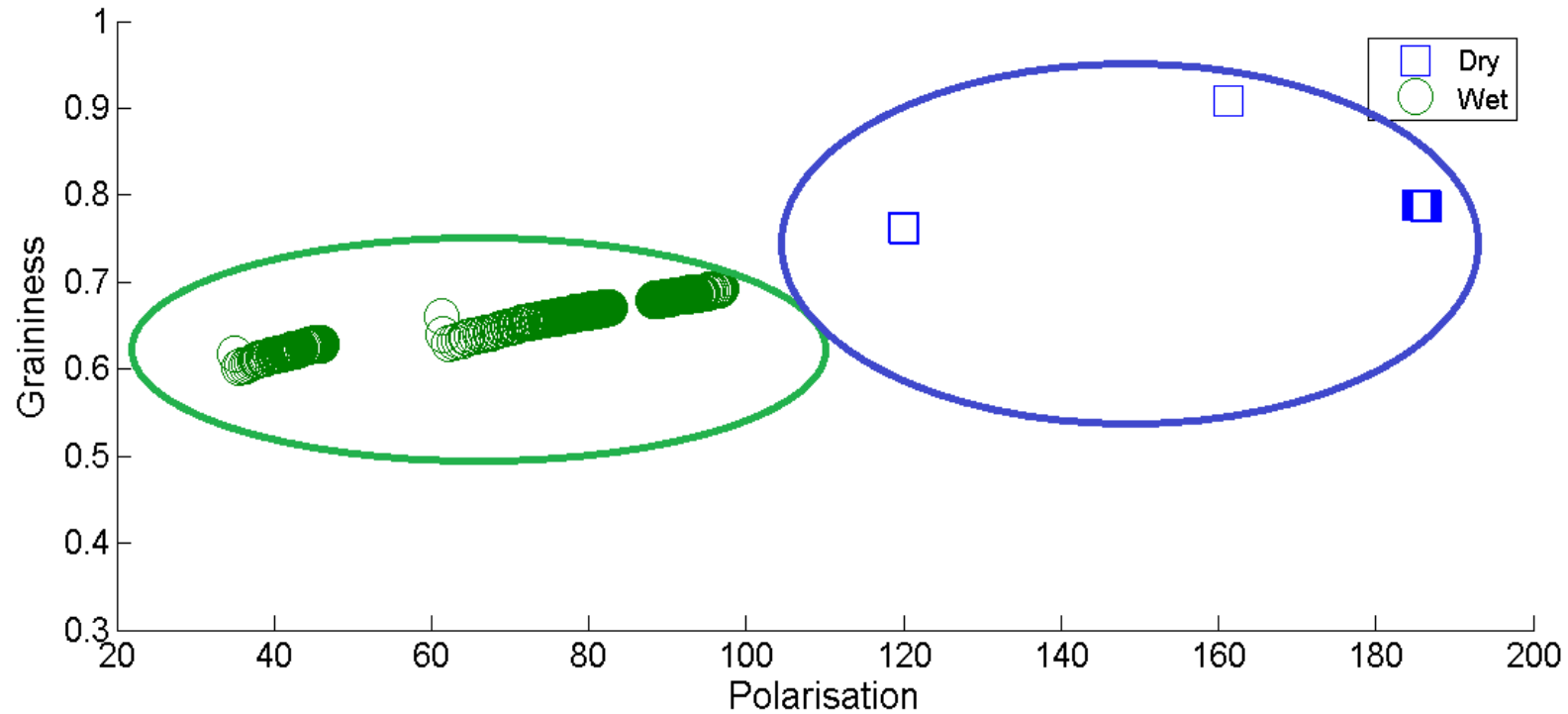




RESULTS: SUMMER

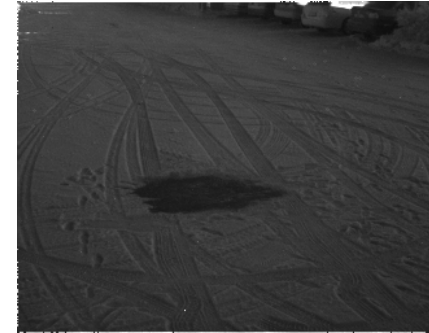


- Dry asphalt road with a wet surface patch

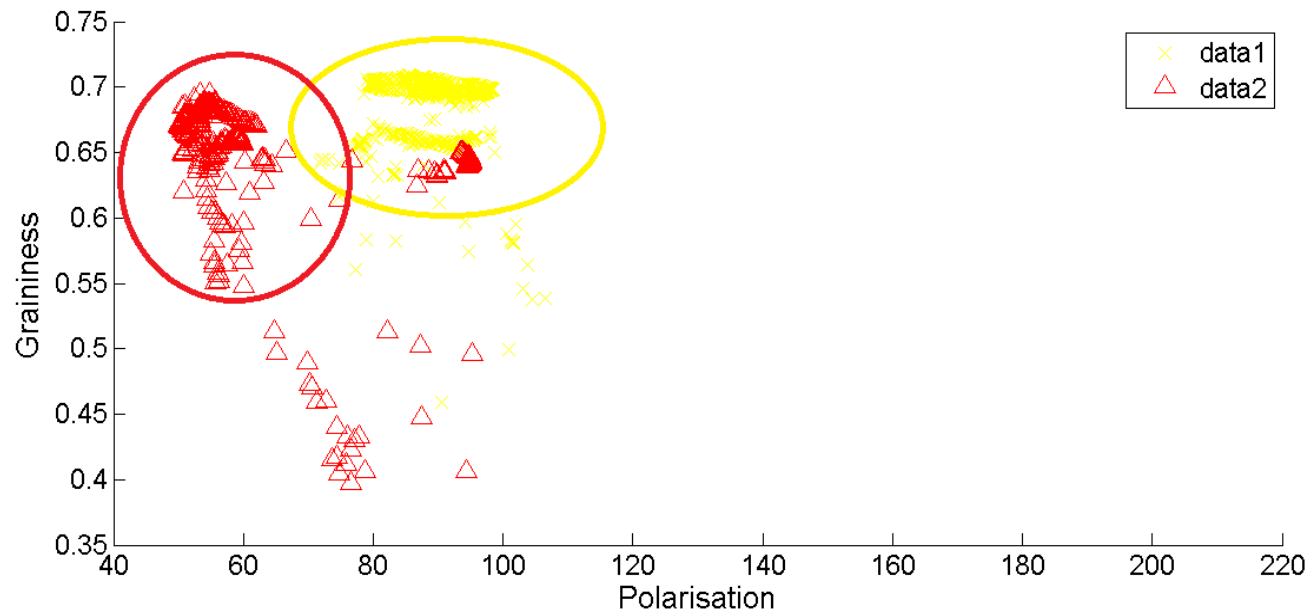




RESULTS: WINTER

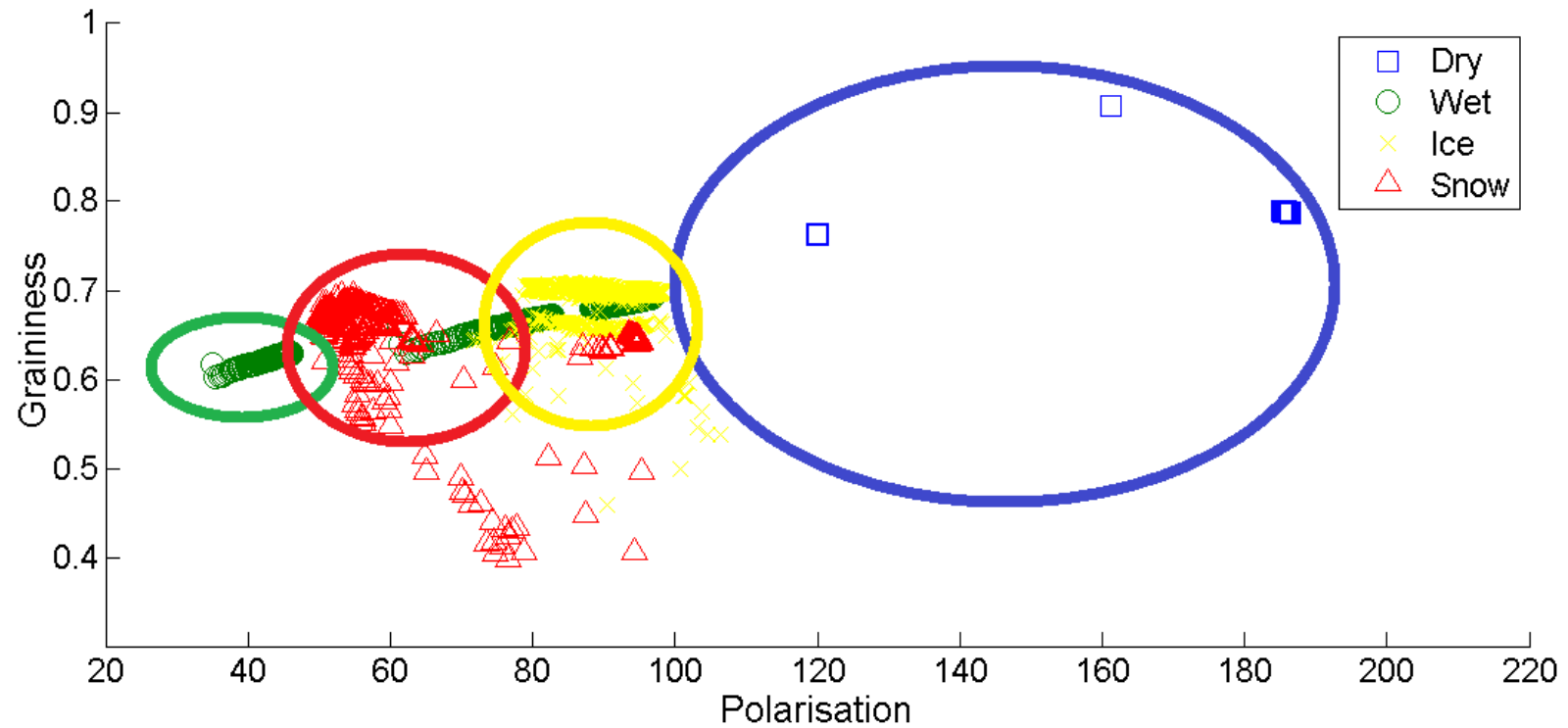


- Snowy road with icy patch





ALL RESULTS

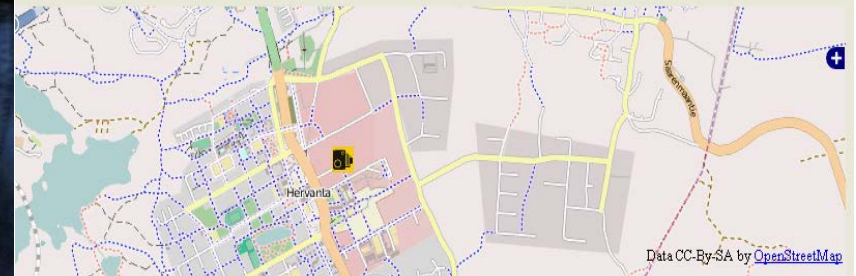
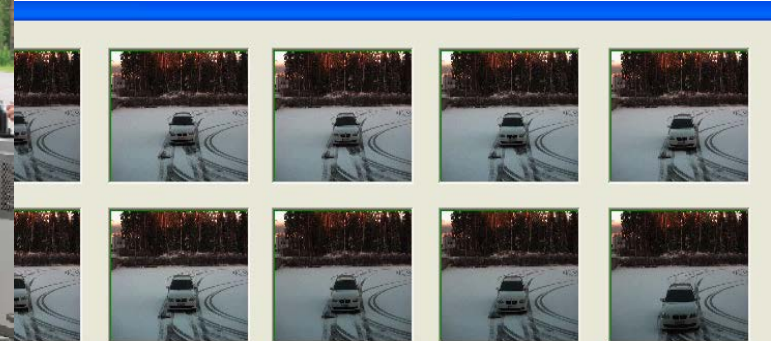
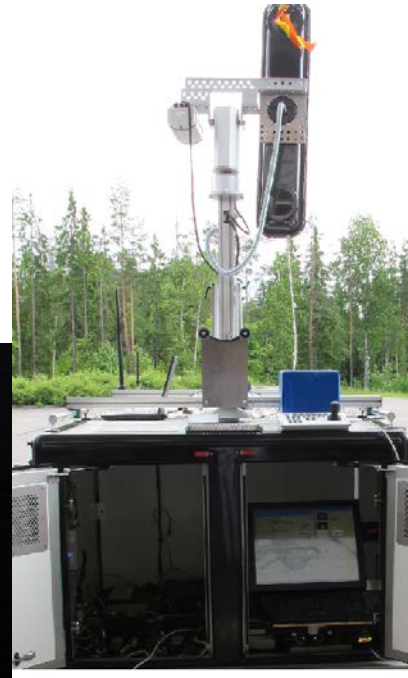


 **Examples** 





Examples





CONCLUSIONS



- NIR camera is a potential image sensor for road friction monitoring
- “Polarization” and graininess provided
- Further work:
 - NIR camera is sensitive to varying lighting (automatic brightness adjustment)
 - Wavelength range selection
 - Image intensity changes affect “polarization” values
 - Exclusions of passing cars





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