

VTT Technical Research Centre of Finland

Ice detection via advanced infrared image analysis

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Published: 10/02/2016

Document Version
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Please cite the original version:

Tiihonen, M., Lehtomäki, V., & Suopajarvi, P. (2016). *Ice detection via advanced infrared image analysis*. Poster session presented at Winterwind International Wind Energy Conference, Åre, Sweden.



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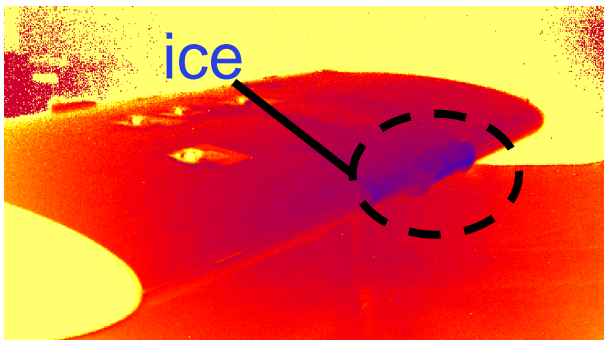
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Ice detection via advanced image analysis



WinterWind 2016 / Åre Sweden / 09.02.2016

Mikko Tiihonen / VTT Wind Power

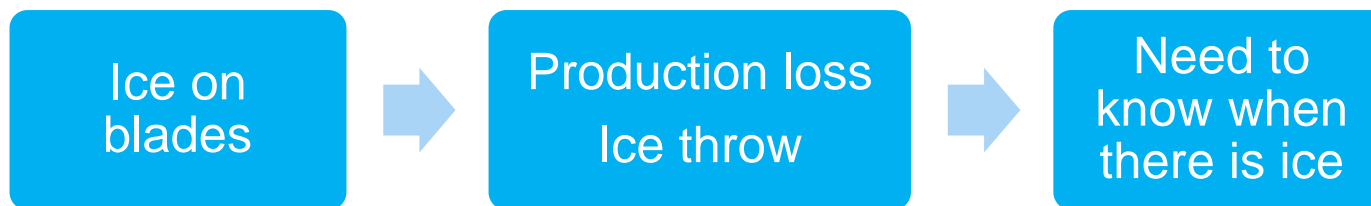
Ville Lehtomäki / VTT Wind Power

Pekka Suopajarvi / VTT Optical Instruments

VTT Technical Research Centre of Finland Ltd.

Market need

10 GW/a wind power projects in cold climates*



- **Blade ice detectors** to replace **stationary detectors?**
 - **Blade is where it all happens!**
- **Large need for a 1) reliable and 2) cost efficient ice detector!**
Considered as the Holy Grail!



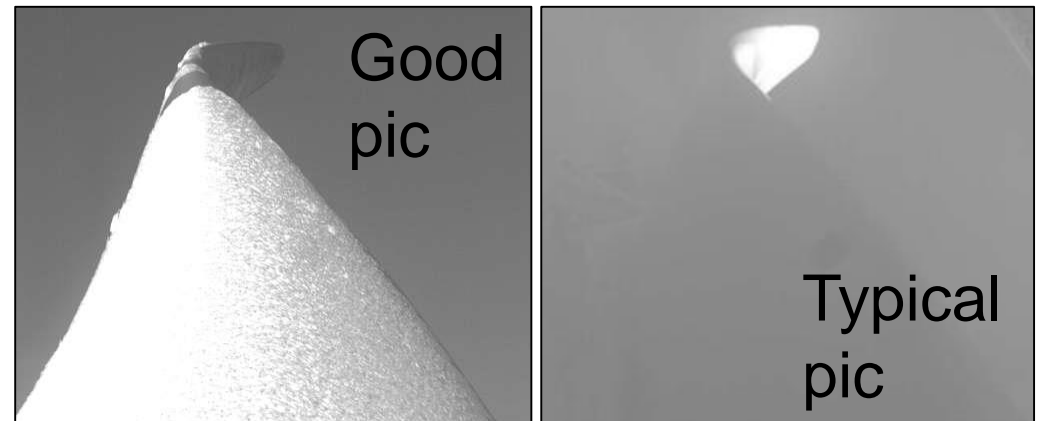
* Navigant Research: BTM WMU 2012

Market need

- Webcam is the most reliable ice detector* but
 1. Picture quality is not good enough for reliable detection
 2. Detection is not real-time
 3. Costly, manual work of interpretation

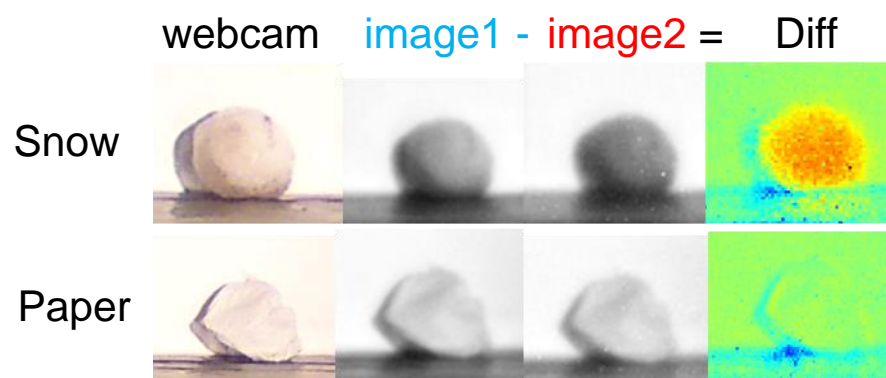
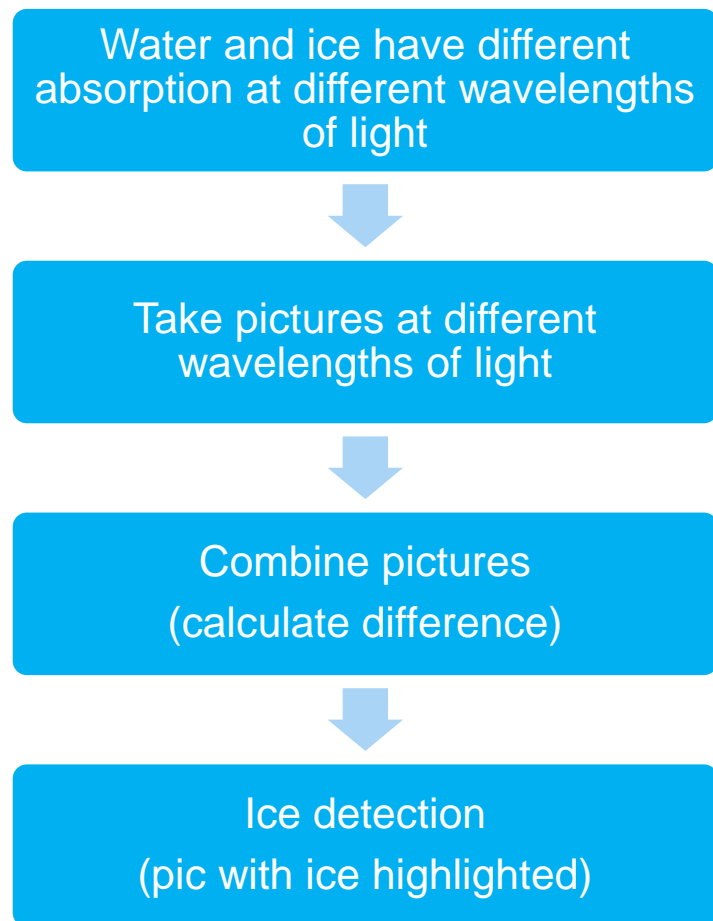
Webcam might still be the way to go, but it has to be made better to fill the need!

Wind turbine blade cam



* IEA Task19 Recommended Practices report

Measurement principle



Method validation in VTT icing wind tunnel



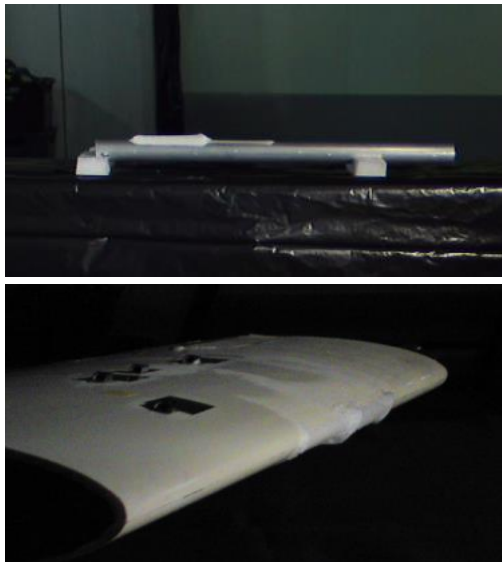
3 Cameras

Narrow bandwidth filters

Daylight (halogen) + special light (LED)

2 test specimens:

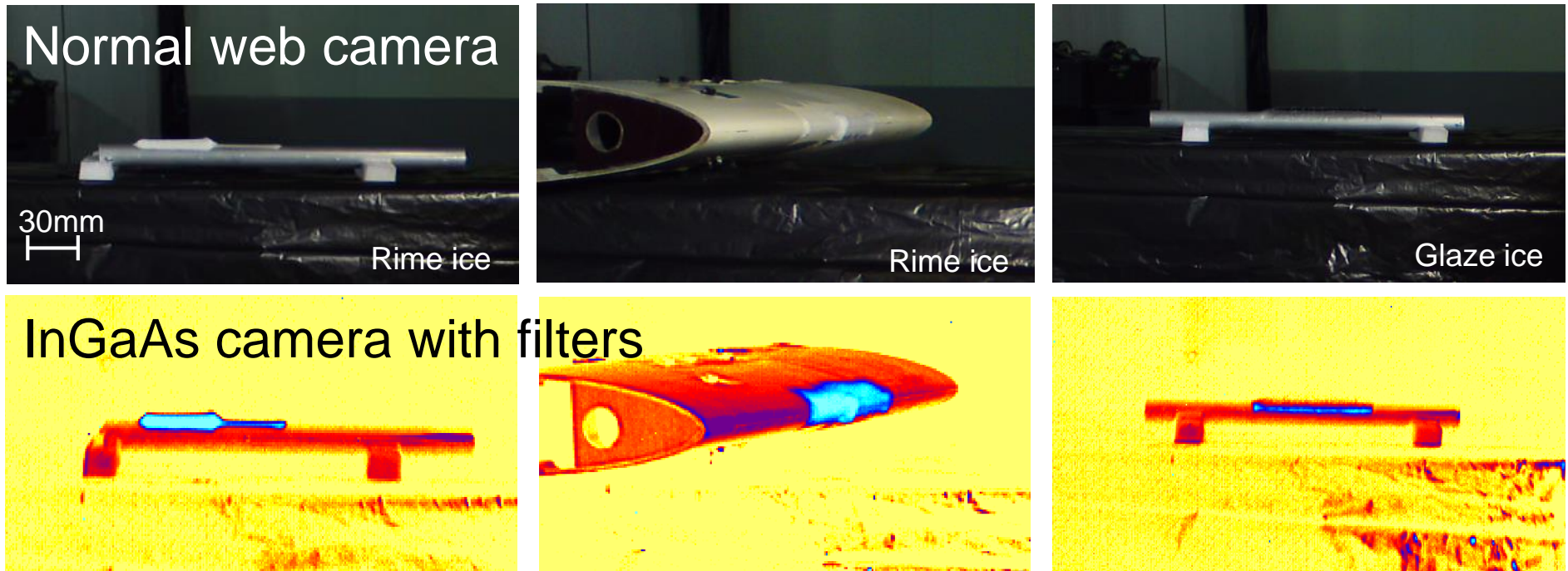
- Ø3cm tube
- airfoil section



Method validation in VTT icing wind tunnel



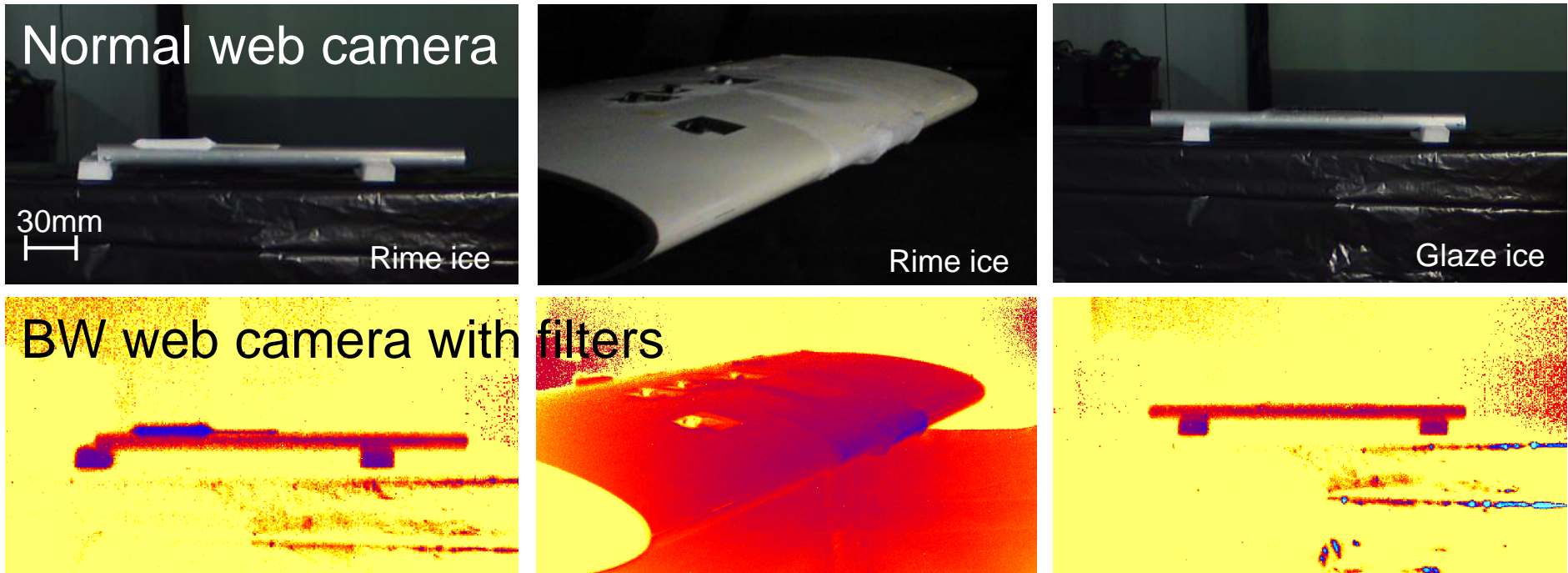
Results with **InGaAs** camera (10,000€): Reliable ice detection



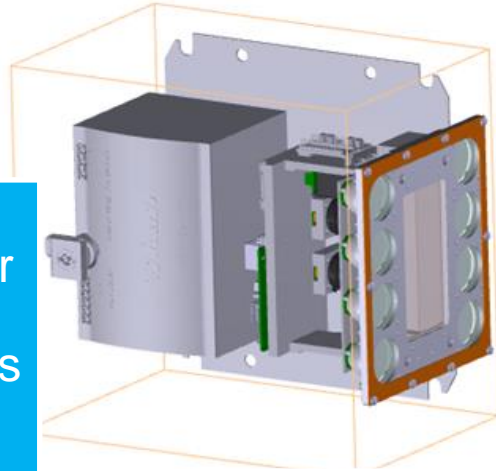
Method validation in VTT icing wind tunnel



Results with **normal web camera (100€):**
Still reliable ice detection, with minimal cost!



Prototype



Designed for demanding environments (MIL spec)



Raspberry Pi™

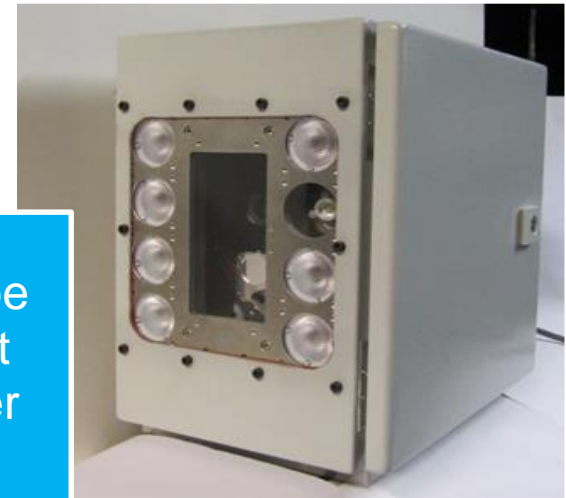


Off-the-shelf hardware and software

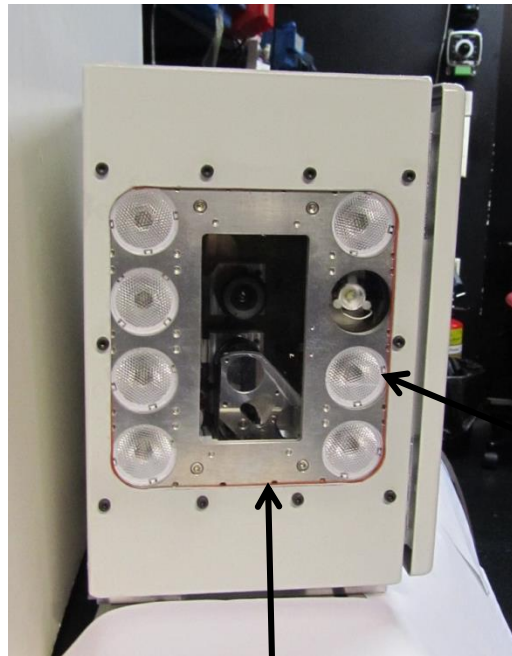
Super Cheap

Camera retail price ~ 5k€

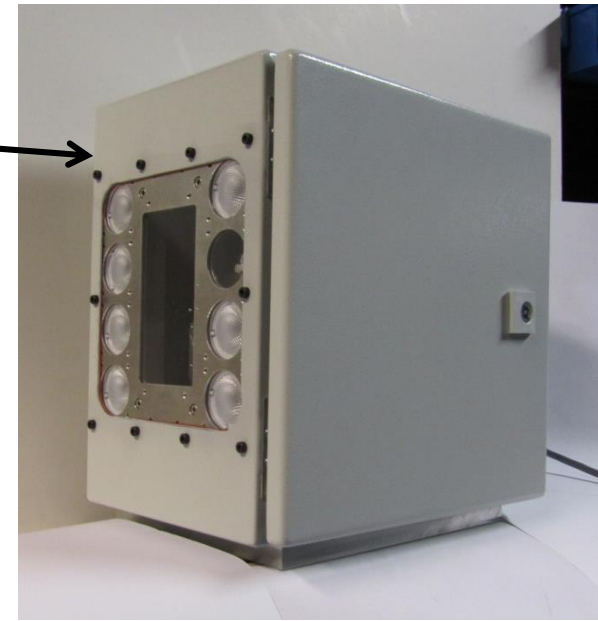
2 prototype units built December 2015



Prototype



Standard weatherproof cabinet



Special illumination of subject

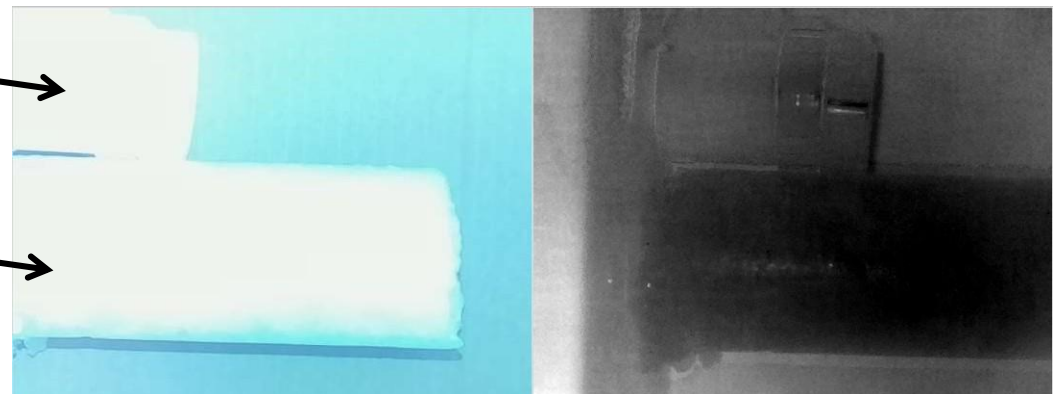
Normal webcam

Icelmage prototype

Heated faceplate stays ice free

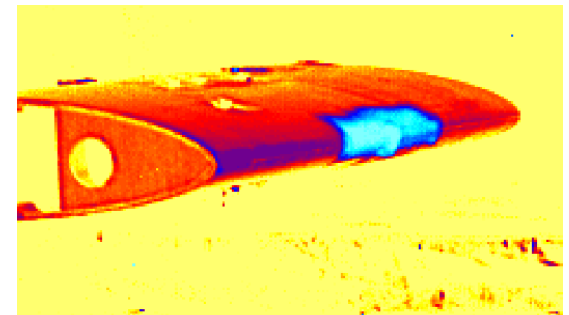
Plastic

Ice



Prototype benefits

- Unique ice detector:
 - Advanced image analysis method (no competitor)
 - Using off-the-shelf HW & SW = affordable unit & easy maintenance
 - Built with tough military specs “only a meteorite can harm it”
 - Easy installation eg. on wind turbine hub
 - Markets also outside wind power
- Possibility to enable real-time ice detection with a machine vision algorithm



Benefit

- **Safety!** Know when you have ice on a structure - Avoid property & personnel damages!
- **Efficiency!** Know when to activate de- or anti-icing devices, eg save 20k€/turbine/year by minimizing standstill!
- **Low cost!** The VTT ice camera uses standard SW & HW, easy & low-cost maintenance
- **Applicability!** VTT ice camera used for wind energy, railway, high structures, road applications etc



Roadmap for next steps

Gathering results from initial tests at office roof, Oulu, Finland (ongoing)

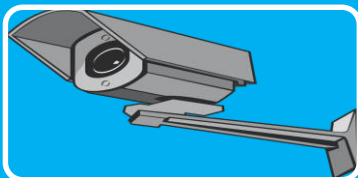
Installation of second prototype in extreme conditions in Norway (Q1/2016)

Development of machine vision algorithm to enable real time detection

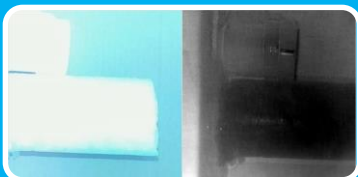
Finetuning of hardware and software

Licensing of technology?

Summary



We took the world's most reliable ice detector (camera) and made it even better!



Working prototype sends pictures with ice highlighted right now!



Roadmap to commercial product seems free of obstacles



Affordable detector made from cheap off-the-self parts



Generic use outside wind power widens the customer base making the detector even more affordable



TECHNOLOGY FOR BUSINESS

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