Foggy-road pictures

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DMI







How to automatically identify the pictures with fog?



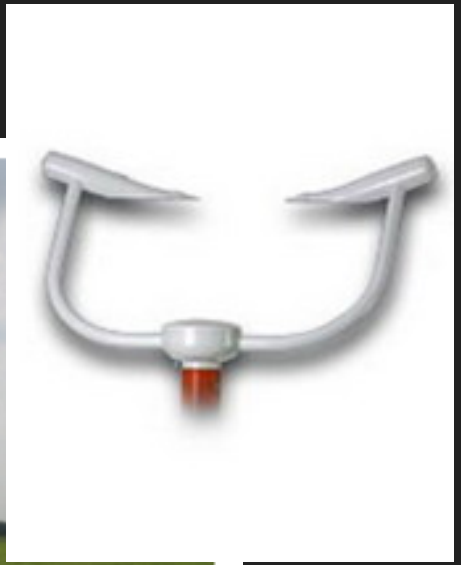

Automatic fog detection from images - why?

- Road safety - warnings can be issued
- Validation of forecasts - model improvement
- Dedicated ‘sigtbarhedsmålere’ are expensive and only a few are used; there are plenty of cameras
  - Some ‘sigtbarhedsmålere’ measure locally only
  - Some ‘sigtbarhedsmålere’ measure along sightlines only
- Cameras (can) give wide-field information

Local, and line-of-sight meters

Figure 1: Transmissometer setup, consisting of a transmitter (Xenon flash lamp) and two receivers.

Figure 2: Forward scatter sensor (present weather sensor), which emits an infrared beam of light that is scattered into the receiver.



What is ‘visibility’, quantitatively?

Often, visibility is the distance to which an object can be seen.

This requires

- Ability to detect objects in a scene, and
- Knowing their distance in a scene.

The problem of detecting features in images automatically, is hard enough - focus on detectability, rather than distances.

Examples

Examples from Google

Objects at distance are not seen

Contrast between objects and background is less in fog

Lamps on buildings or vehicles look fuzzy in fog

Colours disappear in fog

Fog tends to be in the top rows of the image

DMI examples

Notice:

1. Wet road & reflections
2. Darkness
3. Moving traffic
4. Variable text
5. Non-data regions

More DMI examples

Tolerance to rapid changes in illumination
Camera ghosts

Issues - snow - focus - loss of colour

1. Need to handle focus problems, snow/rain/dirt on lens, occasional snow on ground.
2. Blank images.
3. RGB → grey-scale at dawn/dusk on some cameras

Methods

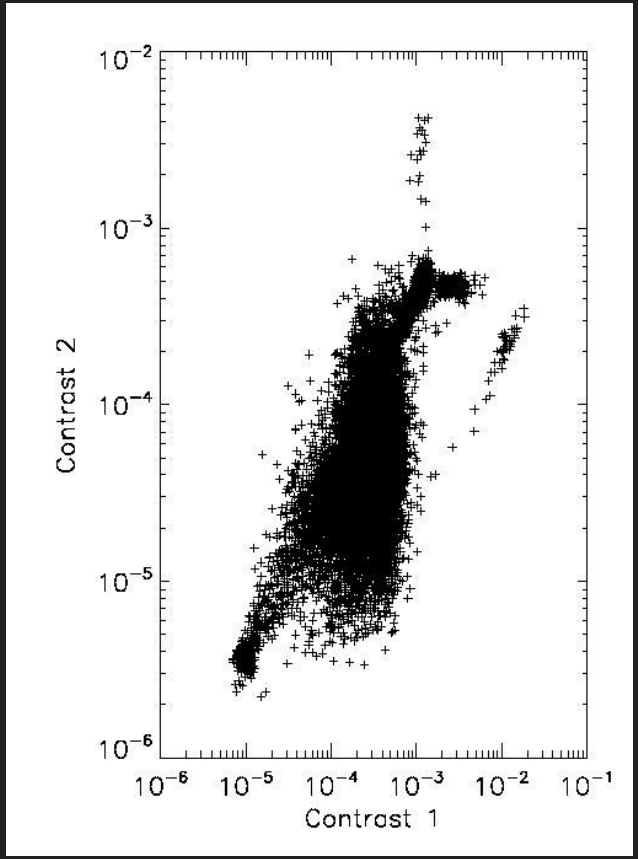
Typical image-based fog-detection methods

- Indicators
  - Changes relative to reference image
  - Contrast changes in regions relative to reference
  - Spatial structure - lamp contour slope
  - Colour changes
- Methods
  - Hand-built single-site methods
  - General multi-indicator methods trained on prepared datasets
    - Neural networks
    - Regression trees (‘random forest’)

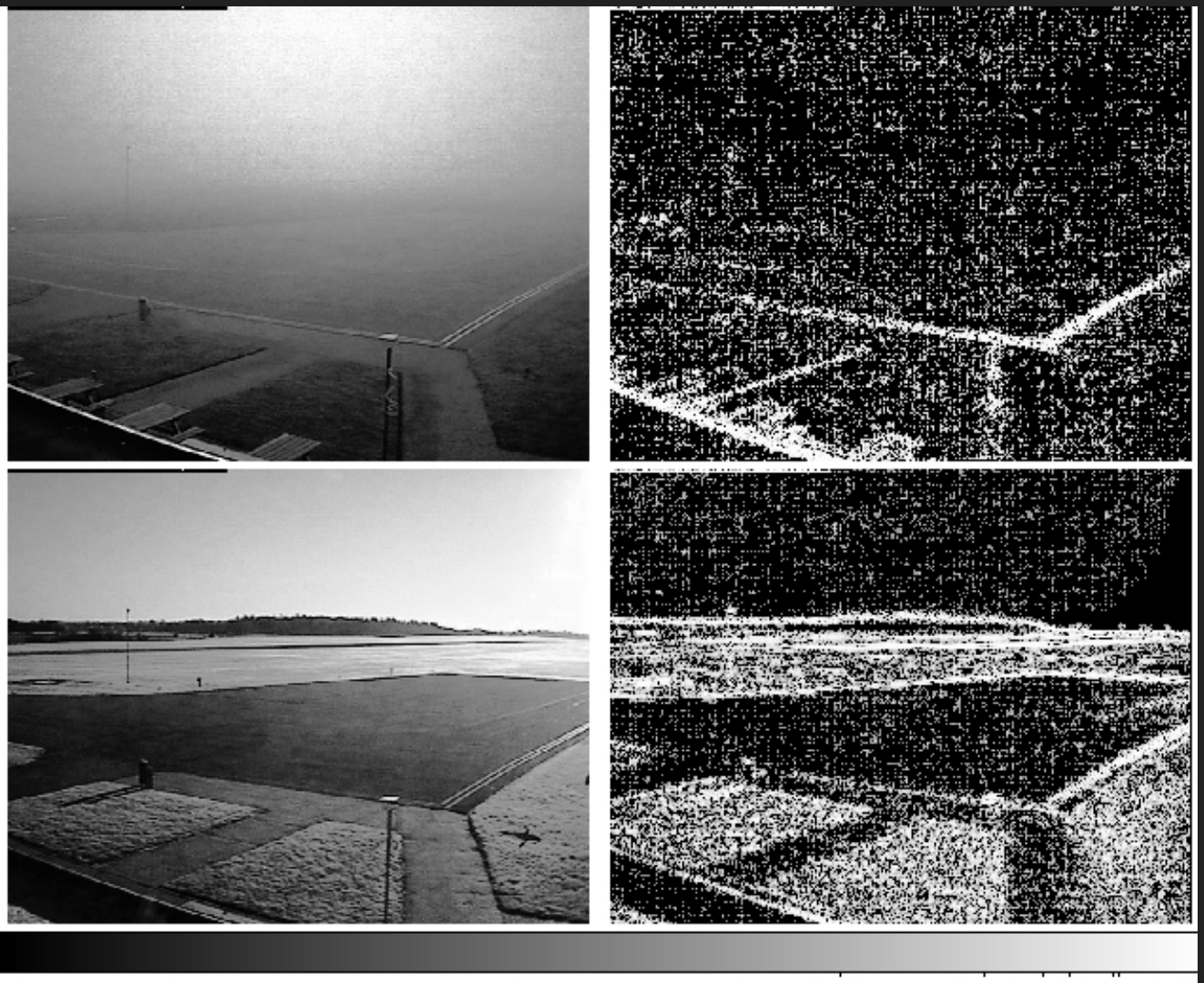
Typical image-based fog-detection methods

- Thresholding - in grey-level image make a binary cut; see if objects are detected still.
- Edge detection - count pixels in edge-image where edges should be
- High-pass filtering finds detailed objects - if missing, scene is foggy
- Image ratio - divide foggy picture by clear picture - fog is brighter (in daytime!)
- Uniformity segmentation - fog is uniform, so in foggy pictures there should be large uniform areas, not present in clear reference scenes

Image-specific method



Normalized images - else ...



Edge detection

At left: foggy and clear images

At right: Laplacian² of normalized image

Advice

Demonstrating “skill” - statistically

- Skill must be demonstrated above the level attainable by randomness
  - If fog is rare, always guessing “no fog” will succeed very often … need to do better than this!
- Separate Training and Validation datasets very important

A suggested way forward:

1. Hand-prepare large training & testing dataset
2. Gain experience with hand-built specific methods
3. Write a general method based on many image indicators

If good enough, rejoice, publish and implement!

Also ...

4. Use a preliminary method to improve on training sets
5. … iterate …

And perhaps try

6. Add fog to clear pictures and use as artificial training data

Learn more

100.000+ hits in Google Scholar on “image based fog detection” - may get you into ‘self driving cars’ though

65.000+ hits on “haze removal in images”

20.000+ hits on “visibility estimation image based fog detection”

100+ hits on “dehazenet”

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Contact

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Dark Channel Prior example

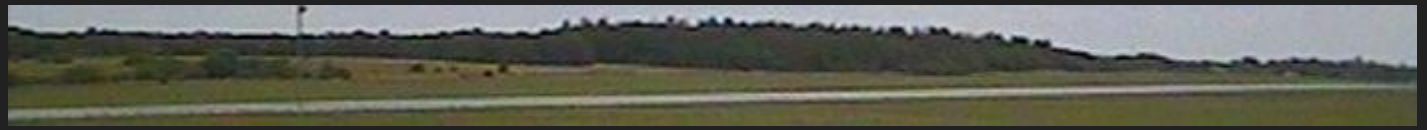
Also “single-image” fog detection methods exist - i.e. not dependent on having many images of the same scene. “Single Image Haze Removal Using Dark Channel Prior”, by He, Sun & Tang. link

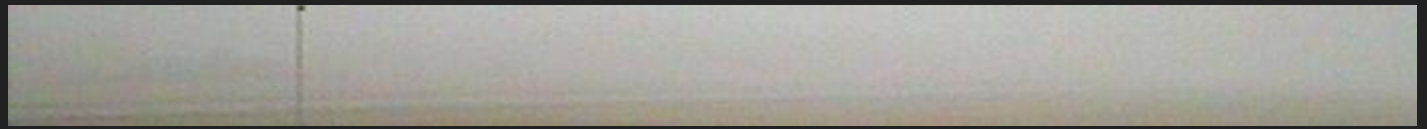
If the cleared image is very different from the original, there was fog!

Figure 1. Haze removal using a single image. (a) input haze image. (b) image after haze removal by our approach. (c) our recovered depth map.

Contrast variations in subregions
Looping over images

“Normalized contrast”, else …





Data overview

1. From Vejdirektoratets road-side cameras we have collected 2.7 million jpeg images from Denmark, at 10m - 15m - hourly cadence. link
2. Issues:
    a. Seasons - foliage, snow on ground, frost
    b. City vs Country - many vs few cars
    c. Day/Night: Lamps vs no-lamps on roads/houses
    d. Colour vs B&W
    e. Different sizes

Examples of problems

1. Images collected despite camera not working
    a. Need algorithm to check for identical images
2. Time-stamps on file may be different from time-stamp in image … which to trust?