# A tentative toolbox for classification of frost damages on brick walls

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## Summary

We describe two plugins (AMT and GLCM) for texture analysis in ImageJ.

We demonstrate two cases:

1. A tool to monitor the frost damage of brick walls.
2. A benchmark on the Brodatz dataset

## Materials and Methods

### Images of bricks and Brodatz

The brick samples are from an apartment building in Oslo. The Brodatz dataset is a well known image database for texture characterisation [Brodatz 1966].

### Algorithms

AMT (Angle Measure Technique) was used as a preprocessing algorithm to model the degree of frost damage from complex textured images of brick walls. AMT transforms an image from 2-D domain into a 1-D texture complexity domain, suitable for further multivariate data analysis [Kvaal et al. 2008, Anderle 1994].

AMT as a texture characterizing method produces feature vectors (AMT-spectra) that contain information of the hidden features in images.

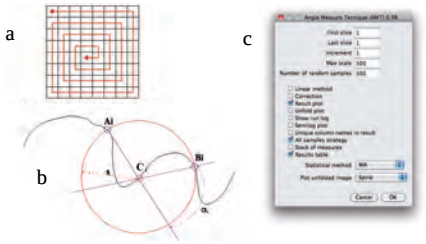
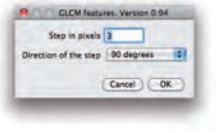



**Fig 1 a:** Shows the spiral unfolding of an image. **b:** The principle for angle measurement in the AMT algorithm. **C:** The AMT plugin.

*GLCM* or Gray-level co-occurrence matrix is a well established method for feature extraction from images [Haralick 1979].




### Brick wall

Each brick in an wall was extracted as a separate image and added to a ImageJ stack. The AMT and GLCM plugins were applied on the stack.

The resulting spectra were exported to Matlab and processed further using multivariate statistics in the PLS toolbox.

### Brodatz

The images were stacked, labelled and processed using the AMT and GLCM plugins.

### Multivariate Image Analysis

Principal Component Analysis (PCA) was used to look for similarities and differences between frost damaged and intact bricks. PLS-DA was used to identify and classify bricks into two groups (1) damaged and (2) intact bricks.

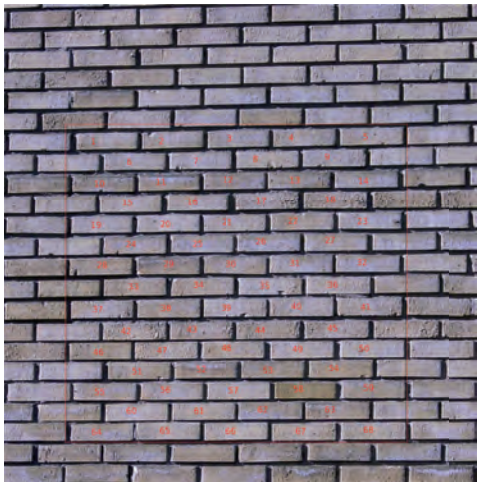


**Fig 3:** The original wall.

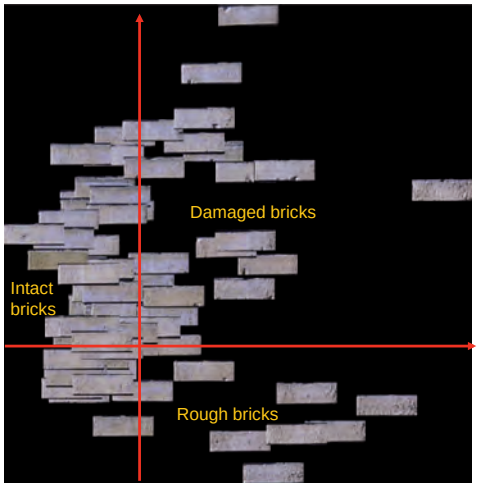



**Fig 4:** Individual bricks mounted in a PCA plot of the AMT spectra.

## Results and conclusions

### Bricks

Figure 4 shows that damaged bricks are located in the first quadrant. Bricks with a homogenous surface are located to the left, whereas bricks with a rough surface are located to the right. Plots like this are of great value as a tool to monitor single bricks and see how they compare to each other.

The example shows that texture analysis combined with multivariate statistics, is a possible method to classify frost damage. The method should be automated in a more elaborate study and research.

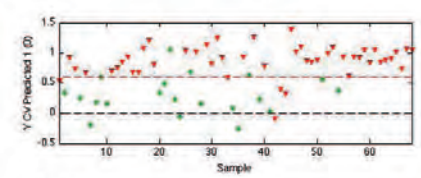



**Fig 5:** Predictions of the brick classes as a function of sample number. Frost damaged bricks are labeled green (*) and intact are labeled red (▽).

The PLS-DA model can predict whether a brick is damaged or not with a precision of 90%.

### Brodatz dataset

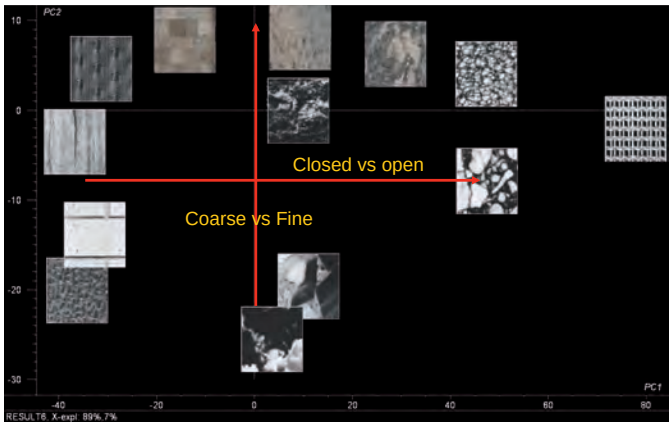



**Fig 6:** Brodatz images mounted in a PCA plot of the AMT spectra.

Using the AMT and GLCM plugins, PCA can separate the Brodatz images into different categories depending on the texture and structure.

### References

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