EVALUATION OF MOULD GROWTH ON COATED WOOD USING DIGITAL IMAGE ANALYSIS (IMAGEJ)

3rd Workshop - ”Process and Service life modelling”

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Background

Visual assessment of discoloring fungi:

- **ASTMD 5590-00**
- **ASTMD 3274-95**
- **EN 927-3 (2006)**
- **EN 152 (2011)**
- **EN 15457 (2007)**

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Background

Visual assessment of mould growth is dependent on:

- **evaluator**
- **type of rating scale**

⇒ limited comparability of visually evaluted samples

⇒ more objective assessment is desirable

⇒ digital image analysis

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Demands on digital analysis

- Accurate results
- Better reproducibility of results than by visual evaluation
- Easy to use
- Easy to adjust
- Freeware

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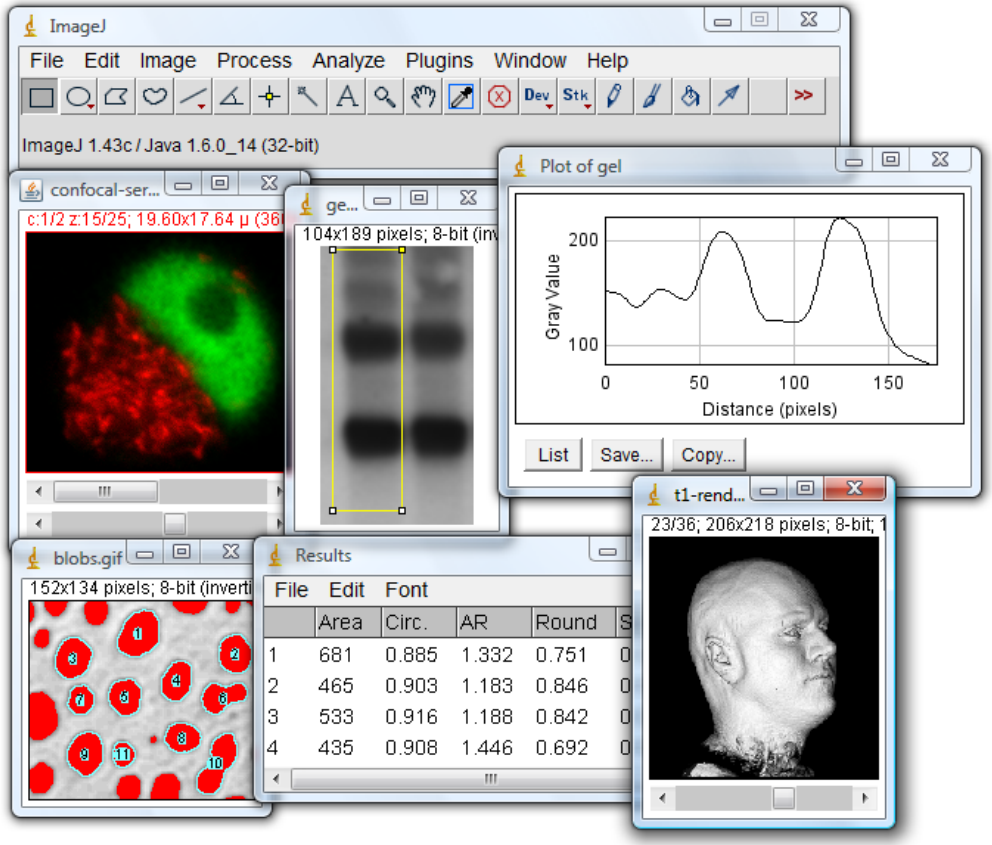
Objective of the study

Development of a user-friendly and rapid image processing procedure using the software ImageJ



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Why ImageJ?

- **Public domain software**
  => no ownership (copyright, trademark og patent)
- **Open architecture**
  => provides exensibility via Java plugins and recordable macros
- **Runs on many systems**
  => Windows, Mac OS, Mac OS X and Linux
- **It supports "stacks", a series of images**
  => time saving

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Material and methods

- Material of Gobakken (2009)
- 19 x 145 x 800 mm^3
- Test fields in Birkenes and Sørkedalen/Norway
- Aug. 2005 – Jun. 2008 (4 evaluations pr. year)
- Evalution acc. to 927-3 (2000)
- Images:
  - constant virtual distance
  - varying light conditions

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Material and methods

- 40 white coated-samples where rated again acc. to 927-3 (2000)
- Calibration: 15 images
  => of samples after 36 months outdoor exposure
- Verification: 105 images
  => 40 images of samples after 12 months exposure
  => 40 images of samples after 28 months exposure
  => 25 images of samples after 36 months exposure

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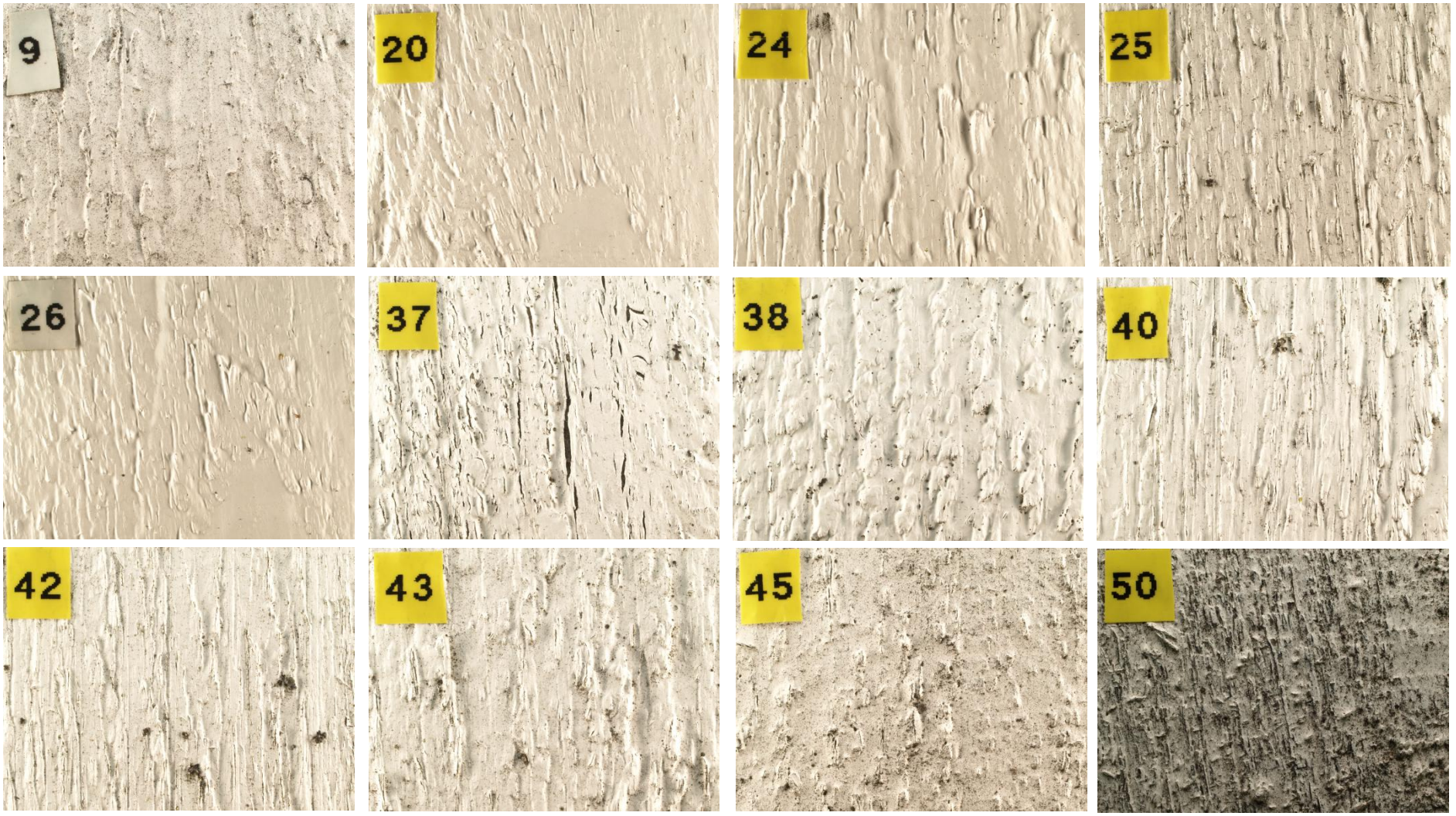
Calibration (examples)



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Calibration

Average of mould coverage [%]	0-3	4-8	9-15	16-29	30-64	65-100
Rating class (EN 927-3)	0	1	2	3	4	5

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Results (Macro)

1. **Scaling**
   => pixel to mm

```
run("Set Scale...", "distance=1290 known=10 pixel=1
unit=mm");
```

2. **Conversion to 8-bit grey scale**
   => 256 possible grey values per bit

```
run("8-bit");
```

3. **Adjustment of illumination**
   => using a ”rolling ball” algorythm due to varying light conditions

```
run("Subtract Background...", "rolling=2000 light
sliding");
```

4. **Sharpening**
   => clearer distinction between mould and background

```
run("Sharpen");
```

5. **Definition of grey threshold**
   => first criterion for mould

```
run("Green");
setThreshold(0, 137);
```

6. **Definition of maximum size**
   => second criterion for mould

7. **Definition of circularity**
   => third criterion for mould

```
run("Analyze Particles...", "size=0-8100 pixel
circularity=0.17-1.00 show=Masks include display
summarize");
```

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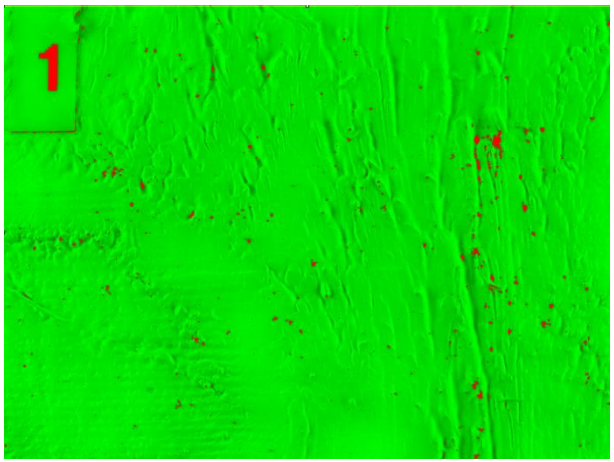
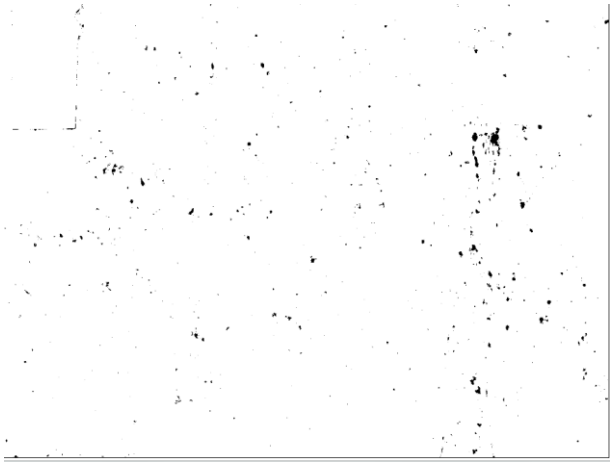
Results (Example 1)





Summary

File Edit Font

Slice	Count	Total Area	Average Size	%Area	Mean
S 1.JPG	1173	3.195	0.003	0.533	122.876

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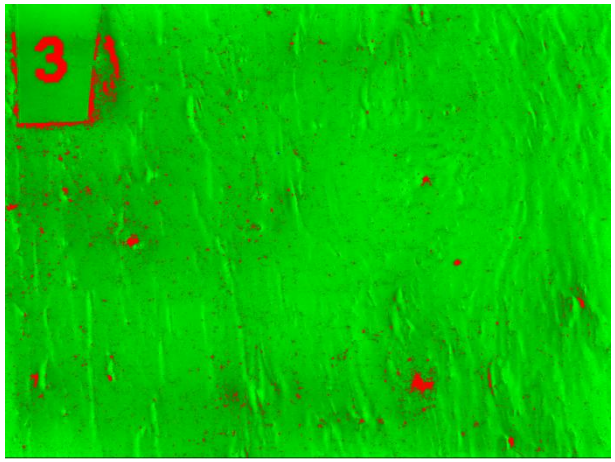
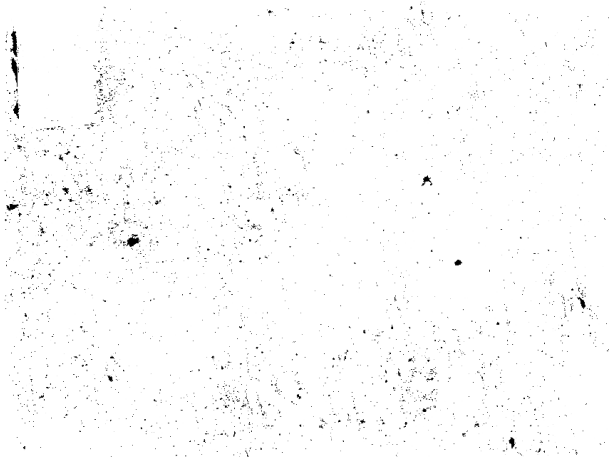
Results (Example 1)





Summary

File Edit Font

Slice	Count	Total Area	Average Size	%Area	Mean
S 3.JPG	6131	3.468	5.657E-4	1.174	128.779

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Results (difference between visual and digital evaluation)

Differemce [grading classes]	No. of samples [%]
0	29
1	43
2	21
3	5
4	2

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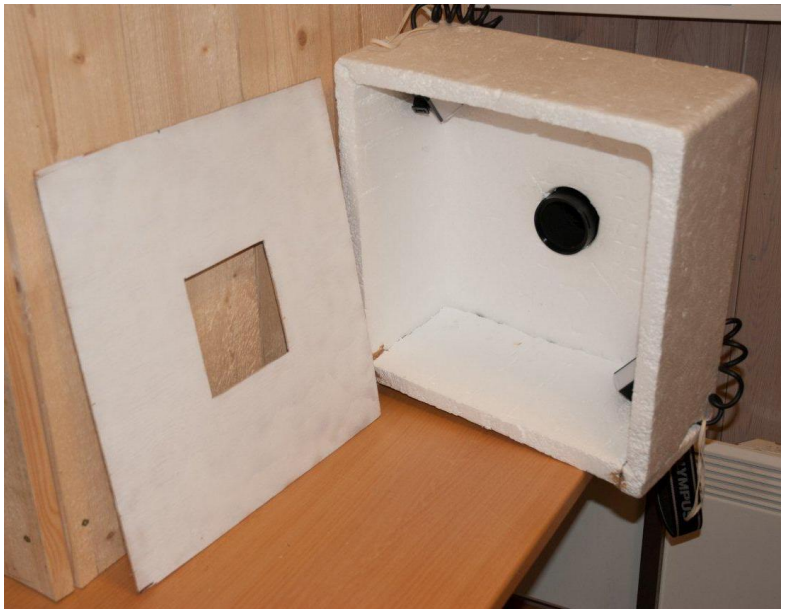
Conclusions

- **Good overall agreement between vsiual and digital assessment**
- **Strongly varying values of brightness and contrasts of the images**
  => can be improved, e.g., by using a camera box with flashlights



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Conclusions

- **Each user has certainly to adjust the macro**
  => minimum particle size, grey threshold
- **Easy to adjust, very intuitive software**
- **Procedure must be verified using different evaluators, study material, and picture quality**

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Thank you
for your attention