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

3rd Workshop - ”Process and Service life modelling”
Ghent/Belgium 17 - 19 April 2013

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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)
Background

Visual assessment of mould growth is dependent on:

• evaluator

• type of rating scale

⇒ limited comparability of visually evaluated samples

⇒ more objective assessment is desirable

⇒ digital image analysis

Treteknisk
Demands on digital analysis

• Accurate results
• Better reproducibility of results than by visual evaluation
• Easy to use
• Easy to adjust
• Freeware
Objective of the study

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

• Public domain software
  => no ownership (copyright, trademark og patent)

• Open architecture
  => provides extensibility 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
Material and methods

• Material of Gobakken (2009)
• 19 x 145 x 800 mm³
• Test fields in Birkenes and Sørkedalen/Norway
• Evaluation acc. to 927-3 (2000)
• Images:
  • constant virtual distance
  • varying light conditions
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
Calibration (examples)
## Calibration

<table>
<thead>
<tr>
<th>Average of mould coverage [%]</th>
<th>0-3</th>
<th>4-8</th>
<th>9-15</th>
<th>16-29</th>
<th>30-64</th>
<th>65-100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rating class (EN 927-3)</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
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" algorithm 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
   run("Analyze Particles...", "size=0-8100 pixel circularity=0.17-1.00 show=Masks include display summarize");

7. Definition of circularity
   => third criterion for mould
Results (Example 1)
Results (Example 1)
## Results
(difference between visual and digital evaluation)

<table>
<thead>
<tr>
<th>Difference [grading classes]</th>
<th>No. of samples [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>29</td>
</tr>
<tr>
<td>1</td>
<td>43</td>
</tr>
<tr>
<td>2</td>
<td>21</td>
</tr>
<tr>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
</tr>
</tbody>
</table>
Conclusions

• Good overall agreement between visual 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
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
Thank you for your attention