Assessment of plant leaf area measurement by using stereo-vision

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Problem

- Leaf Area Index and Average Leaf Angle are important agronomic parameters for crop grow monitoring.
- Their measurement is tedious and require a high work load.
- An alternative method should be quicker and present a similar precision.
- 2D solution present a saturation problem.
Solution

- Histogram equalization
- Images rectification
- Computation of xyz coordinate of each pixel ("modified H. Hirschmuller algorithm")
- Image segmentation (Leaves/Soil)
- Computation of the areas
  - Leaves
  - Total: based on the mean leave z plane
- LAI = Leave Area / Total Area
- ALA: mean of α

\[
CP = \overrightarrow{AB} \times \overrightarrow{AC} \\
\alpha = \cos \left( \frac{CP_z}{|CP|} \right)
\]
**Results**

- Good estimation of the mean distance
- Over-estimation of the measured area
- Both for the laboratory and for the filed tests

<table>
<thead>
<tr>
<th>Image sizes</th>
<th>1024*768</th>
<th>1280*960</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>relative (%)</td>
<td>m²</td>
</tr>
<tr>
<td>Accuracy</td>
<td>34</td>
<td>0.0053</td>
</tr>
<tr>
<td>Precision</td>
<td>10.9</td>
<td>0.0017</td>
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</tbody>
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Results

• Analysis of the error: $\sigma_z \approx 3.4 \times 10^{-4}$

• $\Rightarrow$ estimation of LAI via regression 
  $r = 0.93$, $\sigma_{\text{LAI}} = 0.39$, similar to manual measurements