Algorithms and Analysis of Sweet-Pepper Color Estimation
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Background
Maturity evaluation is an important feature for selective robotic harvesting.
Fruit visibility for sweet peppers is limited to 65%, multiple viewpoints are necessary to detect more than 90% of the fruit.
Color is an important maturity feature that is also the main factor in consumer selection.

Objective
Develop algorithms to determine the best viewpoint to derive the sweet pepper color level using machine vision.

Databases
54 yellow peppers and 30 red peppers
Proefstation Groenteteelt Belgium. Uniform illumination, Panasonic DMC-LX7 CMOS camera.

Algorithms

- K means
- Connected components
- Peduncle removal
- Skin color detection

Results
Comparison to “whole” pepper
Paired two samples for mean t-test; certainty level of 5%

<table>
<thead>
<tr>
<th></th>
<th>V1</th>
<th>V2</th>
<th>V3</th>
<th>V4</th>
<th>Bottom</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correlation</td>
<td>0.707</td>
<td>0.78</td>
<td>0.526</td>
<td>0.618</td>
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<td>Observations</td>
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<td>54</td>
<td>34</td>
<td>54</td>
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<tr>
<td>P-value</td>
<td>0.029</td>
<td>0.141</td>
<td>0.019</td>
<td>0.183</td>
<td>0.161</td>
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<table>
<thead>
<tr>
<th></th>
<th>V1</th>
<th>V2</th>
<th>V3</th>
<th>V4</th>
<th>Bottom</th>
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<tbody>
<tr>
<td>Correlation</td>
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</table>

68% correlation  Correlation between side to bottom  69% correlation

Conclusions
- The bottom view has high correlation to the other views
- The bottom view has high correlation to the “whole” pepper

Ongoing R&D
- Different angles
- Extensive field tests