Non-Destructive Rapid Method for Blend Grade Verification using VNIR Hyperspectral Imaging and Advanced Data Processing Algorithms

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What is Hyperspectral Imaging?

- Combination of spectroscopy and imaging
- Measures spectra for each sample point represented by a pixel
- Identifies materials
Project Impact and Benefits

- Maintains consistency of leaf grades in a cost effective manner
- Reduces human subjectivity
- Supplements SME’s time and skill
- User-friendly and real time with minimal training
- Streamlines blend grade verification process
- Supports tobacco purchases
  - Grade verification
  - Appropriate purchase price
Stemmery AutoGrader Apparatus

Cost per unit of ~$60k
AutoGrader Program Workflow Example
Preprocessing
Classification

- Use Mahalanobis Distance to measure differences between control and test

- If sample is within 3 standard deviations of the labeled class centroid then it is **acceptable**

- If sample is outside of 3 standard deviations of the labeled class centroid then calculate the class distance ratio:
  - If the class distance ratio is less than 70% then **inspect** the sample
  - If the class distance ratio is greater than 70% then it is **acceptable**
Proving Success in Tobacco

Major Groups

US Burley
US Flue Cured
Oriental

Burley Tobacco

Tobacco plant

Tips
Red Leaves
Leaves
Cutters
Lugs
Hyperspectral Imaging Accuracy Success*

Flue-Cured Tobacco

**East Carolina Belt**

<table>
<thead>
<tr>
<th>Machine Classification</th>
<th>Labeled Grade</th>
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<td>Cutters</td>
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**Old Belt**

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Relative Classification Accuracy = 95%
Relative Classification Accuracy = 100%

**Classification Accuracy = 100%**
Hyperspectral Imaging Accuracy Success*

Burley Tobacco

Machine Classification

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<th>Labeled Grade</th>
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<th>Leaves</th>
<th>Red Leaves</th>
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Relative Classification Accuracy = 90%

Classification Accuracy = 100%

* Hyperspectral System Grading vs. ALCS Grader
Burley Annual Variation

- 2011 Sample
- 2012 Sample

- Lugs
- Cutters
- Leaves
- Red Leaves
- Tips
2015 Flue Cured Variation

Grade: F

Discriminant Score 1

Discriminant Score 2
Implementation Challenges

- Factory personnel
  - Blown light bulbs
  - Lens out of focus
  - Required a more user friendly, robust system and protocol

- Flexibility for new grades
  - New grades can be added to database

- Calibration features
  - Master-sample feature
Conclusion

- A VNIR hyperspectral imaging system can be used for tobacco grading

- The system can successfully differentiate between the three major groups of tobacco – Burley, Flue-Cured and Oriental

- The system can differentiate between tobacco plant stalk positions

- The relative classification accuracy ~ 93%
Reducing risk. Expanding choice.

Altria.

Website at www.altria.com/alcs-science