P10541: Micro-gloss Measurement System

Week 3 Progress Report
12/18/2009

Tim Salter (ME)
Jason Smith (ME)
Ahmed Alfadhel (EE)
Mike Neurohr (CE)
**Week 3 Summary**

- Meet with customer
  - Finalize complete list of needs
  - Finalize engineering specs (as-known)
  - Finalize house of quality
  - Define reflectance and gloss
  - Data interpretation
- Planning (gannt chart, WBS, etc.)
- Device layout schematic
- Device operation flowchart
- Risk mitigation
- Begin design concept discussion
Function Flow Diagram

Turn On:
- Computer
- Camera
- Light source

Load The sample

- Adjust exposure time and gain
- Capture the bright image

- Upload the captured images to a JAVA code for analysis.
- Analyze images
- Data Results

- Rotate the polarizing lens 90 degrees
- Adjust exposure time and gain
- Capture dark image

Data Results
Current Hardware Layout

- Sample
- Fiber Optics light beam
- Light Source (red, blue, green)
- Illumination Angle
- Camera
- Computer
## Preliminary Risk Mitigation

<table>
<thead>
<tr>
<th>Risk Item</th>
<th>Effect</th>
<th>Cause</th>
<th>Likelihood</th>
<th>Severity</th>
<th>Importance</th>
<th>Action to Minimize Risk</th>
<th>Owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device cannot be packaged to meet size requirements using current hardware</td>
<td>Unable to meet customer needs</td>
<td>Current hardware is not sized appropriately</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>Proper analysis and design of hardware layout. Plan ahead and determine any needed hardware changes.</td>
<td>Jason/Tim/Ahmed</td>
</tr>
<tr>
<td>Enclosure becomes too hot during operation</td>
<td>Reduced Performance, Camera will be damaged</td>
<td>Inadequate cooling</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>Reduce: introduce a small cooling fan into the enclosure. Having enough space between the camera and power supply and having a good cooling fan.</td>
<td>Jason/Tim/Ahmed</td>
</tr>
<tr>
<td>Damaging the paper gloss while loading the sample</td>
<td>Wrong measurements, destroying the sample</td>
<td>Design error</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>Choosing good materials and delicate mechanism to load the samples</td>
<td>Jason/Tim/Ahmed</td>
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<tr>
<td>There is no way to automate rotating the polarizing lens and sync it with the program operation</td>
<td>The program will try to capture light/dark pictures when the apparatus isn't ready</td>
<td>No way to send a signal to or from apparatus (Java limitations), program does not sync with device</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>Prevent: Write a separate program to handle signals and synchronization (may not be possible) Reduce: Add another step in the process for the user to signal to the program that the lens is ready</td>
<td>Mike</td>
</tr>
<tr>
<td>The two programming step (image capture, image analysis) cannot be linked into one program</td>
<td>The user would not be able to click one button to analyze a sample</td>
<td>A new camera requires new image capture software to be used which doesn't sync well with Java</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>Accept: The user would have to use two programs</td>
<td>Mike</td>
</tr>
<tr>
<td>Customer Weights</td>
<td>Size</td>
<td>Weight</td>
<td>Durability</td>
<td>Cost</td>
<td>Light Intensity</td>
<td>Power</td>
<td>Operating Temperature</td>
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<tr>
<td>Desktop size (fits in overhead compartment)</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>3</td>
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<tr>
<td>To be operated by one person</td>
<td>9</td>
<td>3</td>
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<tr>
<td>Affordable</td>
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<td>Is accurate, precise and consistent</td>
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<td>Gives graphical results to user</td>
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<tr>
<td>Minimized power consumption</td>
<td>3</td>
<td>3</td>
<td>9</td>
<td>3</td>
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<tr>
<td>Easy to use (high school level operator)</td>
<td>9</td>
<td>3</td>
<td>1</td>
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<td>Simple user interface</td>
<td>9</td>
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<tr>
<td>Upgradable</td>
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<td>3</td>
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<tr>
<td>Easily serviceable</td>
<td>6</td>
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<tr>
<td>Easy to load sample sheet</td>
<td>6</td>
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<tr>
<td>8.5&quot;x11&quot; standard paper size (sample sheet)</td>
<td>9</td>
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<tr>
<td>Read anywhere on the sample sheet</td>
<td>6</td>
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<tr>
<td>Measures in red, green, blue bands (narrow) of light</td>
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<td>Robust/durable</td>
<td>9</td>
<td>9</td>
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</tbody>
</table>

**Technical Targets**

100-1000 lux (superbright LED)
Room Temperature, ~60-80°F
-90 to 90 degrees
Visible, 400 to 700 nm
8.5"x11" paper
**WBS Weeks 3 through 5**

<table>
<thead>
<tr>
<th>Team</th>
<th>Week 3</th>
<th>Week 4</th>
<th>Week 5</th>
</tr>
</thead>
</table>
|                    | - Begin concept generation  
- Begin system level design  
- Risk mitigation  
- Finalize customer needs and specs  
- Revise WBS  
- Risk mitigation | - System level design  
- Concept selection  
- Customer meeting  
- Risk mitigation | - System design customer review  
- Final system level design  
- Risk mitigation |
| Tim Salter (ME)    | - Update EDGE website  
- Scheduling and planning  
- Hardware considerations | - Update EDGE  
- Scheduling and planning  
- Concept development  
- Hardware layout | - Update EDGE website  
- Scheduling and planning  
- Finalize system level hardware layout |
| Jason Smith (ME)   | - Hardware concept generation  
- Benchmark existing device | - Start system analysis  
- Revise and narrow concepts  
- Start CAD drawings | - CAD drawings  
- Finalize system level hardware layout |
| Ahmed Alfadhel (EE) | - Understand the existing device functionality and investigate ways to minimize the work needed from the user  
- Search for an alternative camera (smaller, easier to use and cheaper than the existing research camera) | - Design of needed electrical system and components  
- Design of the system hardware integration and automation | - Finalize the design of the system hardware integration and automation  
- Finalize electrical components wiring schematics  
- Finalize camera selection process |
| Mike Neurohr (CE)  | - Start measurement procedure write-up  
- Plan data storage for control charts  
- Gather more details on what inputs to the programs can be standardized through construction or physical mechanisms | - Finish measurement procedure write-up on EDGE  
- Plan UI design with concepts (possible prototypes)  
- Investigate ways to link image capture and image analysis aspects of program | - Choose UI design (likely with John) and at least prototype it  
- Investigate ways to communicate with apparatus (for lens rotation, image capture, etc.) |
Reflectance and Gloss

Reflectance

- Light shines on surface, scatters around, and comes out somewhere else
- 2 types of reflectance
  - Diffuse reflectance (scattered)
    - If polarized, becomes scrambled when reflected
  - Specular reflectance (more direct)
    - Comes off at equal and opposite angle of incident material
    - Difficult to measure up until introduction of device
    - Remains the same reflection even if polarized
Reflectance and Gloss

Gloss
- An experience the human observer has that we call “gloss”
- Associated with specular reflectance
- Device image analysis
  - “Vector” of features from specular reflectance
    - [area, width, half width, 1/10 width, diffuse level]
  - Vector used to construct mathematical function
    - Direct relation to human perception (physics to psyche)
    - Or… $F(x,y,z) = \text{visual perception} = \text{gloss}$
Sample Image Capture

Low gloss

High gloss
Data Analysis Results

Low Gloss
- Flattens out ~10-15 degrees (+/-)
- Peaks at a value of ~50

High Gloss
- Flattens out ~2-3 degrees (+/-)
- Peaks at a value of ~500
Summary of Data Results

- Device is used to generate data
  - Measure of gloss (different than reflectance)
- Intensity of light onto and coming off of sample:
  - Reflectance factor
    - Electrical tape = 0.045 (standard or calibration sample)
    - Mirror = ~0.99
- Light intensity and spread
  - Tall, thin plots = higher gloss
  - Short, wide plots = lower gloss
No Questions
(Thanks!)