Handheld, Non-Contact Wound Measurement Device

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Background
Repeatable and accurate wound measurement forms an important part in the assessment and treatment of chronic wounds and pressure ulcers.
Current wound measurement methods span a continuum:
• from the ruler method which is easy to perform but lacks accuracy
• to devices using stereophotogrammetry which are accurate and repeatable but are expensive

Design Goal
To design, fabricate and test a handheld, non-contact, affordable wound measurement device.

Design Features
• Simple digital camera (current device uses a cell phone)
• Laser pointers and computer vision techniques permit distance measurement and skew correction
• Wound margin detected using canny edge detection

Device Photo
Top side with touch screen
Bottom side with lasers & LEDs for illumination

User Interface
Touch screen interface permits the user to:
• accept the area (if the wound boundary detection is correct)
• modify the wound boundary by dragging the outline using a stylus on the touch screen
• reject the wound boundary and re-trace the wound manually using the stylus

Skew Correction
left to right: diagram, skewed, corrected

Manual Tracing Repeatability
Two wounds
• One wound selected because of its poorly defined margin
Ten repeated measurement trials
• Results blinded to subject

Tracing Repeatability Results

<table>
<thead>
<tr>
<th>Subject</th>
<th>Wound 1</th>
<th>Wound 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pixel mean</td>
<td>C.V</td>
</tr>
<tr>
<td>1</td>
<td>903</td>
<td>2.13%</td>
</tr>
<tr>
<td>2</td>
<td>10380</td>
<td>4.53%</td>
</tr>
<tr>
<td>3</td>
<td>10458</td>
<td>6.84%</td>
</tr>
</tbody>
</table>

Distance & Skew Accuracy
• 3.8 x 3.8 cm ‘wound’ (14.44 sq cm)
• Image taken at different heights and degrees of skew

Distance & Skew Test Results

<table>
<thead>
<tr>
<th>skew angle</th>
<th>Distance= 19.5 cm</th>
<th>Distance= 17.7 cm</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>13.84</td>
<td>13.71</td>
</tr>
<tr>
<td>10</td>
<td>13.17</td>
<td>13.85</td>
</tr>
<tr>
<td>15</td>
<td>13.22</td>
<td>13.81</td>
</tr>
<tr>
<td>20</td>
<td>13.36</td>
<td>14.33</td>
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<td>30</td>
<td>14.05</td>
<td>14.62</td>
</tr>
<tr>
<td>35</td>
<td>13.31</td>
<td>14.51</td>
</tr>
</tbody>
</table>

mean 13.55 14.14
diff error 0.2% 8.1%
Cov Variation 2.8% 2.8%

Conclusion
• A simple wound measurement device has been developed and tested
  • Novel distance and skew determination permits non-contact measurement
  • Low cost components (<$100) will lead to affordable device
• Accuracy at different distances & skew:
  - 6%
  - exceed those of photography, tracing & Kundin gage
• Repeatability
  • Coefficient of variation
    • ≈7% for well-defined ulcer
    • < 10% for poorly-defined ulcer
• Clinical testing underway
• Ready for Technology transfer

Iterative Edge Detection