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, noncontact, 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)

Iterative Edge Detection

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>9603</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>13.94</td>
<td>13.71</td>
</tr>
<tr>
<td>10</td>
<td>13.22</td>
<td>13.85</td>
</tr>
<tr>
<td>20</td>
<td>13.96</td>
<td>14.43</td>
</tr>
<tr>
<td>30</td>
<td>14.08</td>
<td>14.82</td>
</tr>
<tr>
<td>35</td>
<td>13.31</td>
<td>14.51</td>
</tr>
</tbody>
</table>

mean       13.55 14.14
avg error  6.2%  5.1%
Cov Variation 2.6% 2.6%

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 & Kudin gage
• Repeatability
  • Coefficient of variation
    • <7% for well-defined ulcer
    • < 10% for poorly-defined ulcer
• Clinical testing underway
• Ready for Technology transfer