Effectiveness of a Biometric Patient Identification System

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MSc in Business Information Systems Management with Middlesex University

Scientific Areas of Interest:

- e-Health
- Internet of Things
- Knowledge management for people with disabilities
- Web and Mobile Development
1. Introduction

Around 2.6 million deaths¹ per year, due to medical errors

684 patient misidentification events in the US led to patient harm, and in some cases, death (32 months span)

Missing patient wristbands or incorrect information on them

$42 billion¹ & $1.2 million² in costs each year

¹ In low to middle-income countries (WHO)
² for the average healthcare organization in the US ("2016 National Patient Misidentification Report" independently conducted by Ponemon Institute LLC Sponsored by Imprivata)
Objective - Effectiveness of using biometric technology for identifying patients

**Research**
- Patient Identification Process
- Existing problems
- Identification methods and solutions
- Security and privacy issues

**System Requirements**
- Developing a list of system requirements
- By means of a questionnaire to healthcare professionals

**System Proposal**
- Propose a system based on biometric technology
Objective - Effectiveness of using biometric technology for identifying patients

- **Evaluation**: System versus a dataset
- **Analysis**: The results
- **Recommendations**: How to improve the system
2. Research

Identification methods

i. Wristbands

ii. Palm Vein Pattern Recognition

iii. Ocular Based Identification

iv. Face Recognition
i. Wristbands

**Written wristbands**
- Leading cause for misidentification
- Missing and wrong information
- Damages and Tort cases

**Barcoded Wristbands**
- Reduce medical errors by 57%
- Damage control and money saver
- Cheap, portable and easy to use and maintain

ii. Palm Vein Pattern Recognition

- **Uniqueness of palm vein pattern**
- **Impossible to reproduce with fake palms**
- **More accurate** – More costly and Intrusive
- **Less Hygienic**

iii. Ocular Based Identification

**Iris**
- Does not require proximity to camera
- Iris recognition – UCSD’s Moore Cancer Center¹

**Retina**
- Requires proximity to camera
- Unique for each person due to complex structure of capillaries
- Diseases may affect scan accuracy


Image source: https://www.irisid.com/iris-recognition-and-retinal-scans-are-not-the-same/
iv. Face Recognition

<table>
<thead>
<tr>
<th>Identification of person by facial features</th>
<th>Challenges for faces with occlusions</th>
<th>Cheap to use</th>
<th>Hygienic</th>
<th>May be Intrusive</th>
<th>Less accurate than palm vein and ocular based scanning</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3. Methodology

Questionnaire

- Stakeholder information
- Their awareness of the problem, if any
- Their process of patient identification
- Their preferences of solutions

Participants

- Nurses
- Doctors
- Physiotherapists
- Surgeon
- Speech language pathologist

Results

- 67% think that their current system works moderately well, with low-cost being the main reason behind this
- Security was the biggest concern
House of Quality (HoQ) Matrix for System Requirements

**Correlation matrix**

| + +   | Strong positive |
| +     | Positive        |
| -     | Negative        |
| - -   | Strong negative |
| Not correlated |

**Relationship matrix**

<table>
<thead>
<tr>
<th></th>
<th>Strong</th>
<th>Medium</th>
<th>Weak</th>
<th>No assignment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>9</td>
<td>3</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

**Customer importance rating**

<table>
<thead>
<tr>
<th>Importance rating</th>
<th>Percent of customer importance rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.38</td>
<td>12%</td>
</tr>
<tr>
<td>4.59</td>
<td>13%</td>
</tr>
<tr>
<td>3.30</td>
<td>9%</td>
</tr>
<tr>
<td>3.96</td>
<td>11%</td>
</tr>
<tr>
<td>2.07</td>
<td>6%</td>
</tr>
<tr>
<td>1.40</td>
<td>4%</td>
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<tr>
<td>5.43</td>
<td>15%</td>
</tr>
<tr>
<td>2.15</td>
<td>6%</td>
</tr>
<tr>
<td>2.04</td>
<td>6%</td>
</tr>
<tr>
<td>2.05</td>
<td>2%</td>
</tr>
<tr>
<td>0.66</td>
<td>3%</td>
</tr>
<tr>
<td>1.08</td>
<td>10%</td>
</tr>
<tr>
<td>3.86</td>
<td>10%</td>
</tr>
</tbody>
</table>

**Importance**

- Accuracy: 5 (26%)
- Efficiency: 4 (21%)
- Security: 4 (21%)
- Ease of Use: 3 (16%)
- Cost: 2 (11%)
- Patient's Comfort: 1 (5%)
4. Design

• **Mobile app** with user authentication and authorisation.

• User can identify an already registered patient by:
  • **Scanning** the patient’s barcode
  • Taking a **photo** of the patient’s face
  • **Confirming** the patient details

• Patient crucial information is then displayed on the phone, which can be adjusted to the organization’s needs.
4. Design

Proposed app system designs. Authentication, Barcode/QR code scanning, Identification confirmation
5. Evaluation

Implementation using Microsoft Cognitive Services and their Face API

- Seamless, secure and easy to integrate and operate
- Face images are not stored on their servers
- Configurable confidence thresholds
- Relatively cheap

Accuracy Evaluation

- Dataset of faces\(^1\) to be evaluate against
- All faces were registered with the API
- Identification was tested

Performance Evaluation

- A proof-of-concept mobile application was developed
- Scanning of a barcode and a person’s face
- Biometric information sent to Microsoft Face API for identification.
- Database call to fetch patient’s fake records.

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6. Results

- Accuracy
  1. Different **angles**:  
     - 88%-93% with 0.97 confidence  
     - 100% with 0.94 confidence  
  2. Different **lighting**:  
     - 40%-44% with 0.97 confidence  
     - 93%-97% with 0.94 confidence  
  3. After **training** the dataset:  
     - 65% with 0.97 confidence  
     - 97% with 0.94 confidence  

- Performance  
  - **5 to 7 seconds** with full-bar Wi-Fi connection to detect and identify the patient and get their records from a database.

### TABLE I. CASE 1 Results

<table>
<thead>
<tr>
<th>Thr. Sc.</th>
<th>0.87</th>
<th>0.96</th>
<th>0.95</th>
<th>0.94</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>b</strong></td>
<td>88.04</td>
<td>98.56</td>
<td>99.28</td>
<td>100.00</td>
</tr>
<tr>
<td><strong>c</strong></td>
<td>88.04</td>
<td>98.56</td>
<td>99.28</td>
<td>100.00</td>
</tr>
<tr>
<td><strong>d</strong></td>
<td>99.28</td>
<td>100.00</td>
<td>100.00</td>
<td>100.00</td>
</tr>
<tr>
<td><strong>e</strong></td>
<td>93.48</td>
<td>97.83</td>
<td>98.91</td>
<td>100.00</td>
</tr>
</tbody>
</table>

n = 276

### TABLE II. CASE 2 Results

<table>
<thead>
<tr>
<th>Thr. Sc.</th>
<th>0.87</th>
<th>0.96</th>
<th>0.95</th>
<th>0.94</th>
<th>0.93</th>
<th>0.92</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>rb</strong></td>
<td>43.96</td>
<td>72.63</td>
<td>90.11</td>
<td>96.70</td>
<td>100.00</td>
<td>100.00</td>
</tr>
<tr>
<td><strong>sb</strong></td>
<td>20.56</td>
<td>64.04</td>
<td>82.42</td>
<td>93.41</td>
<td>98.54</td>
<td>100.00</td>
</tr>
</tbody>
</table>

n = 91 (photos 000 - 090)

### TABLE III. CASE 3 Results

<table>
<thead>
<tr>
<th>Thr. Sc.</th>
<th>0.57</th>
<th>0.96</th>
<th>0.95</th>
<th>0.94</th>
<th>0.93</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>sb</strong></td>
<td>64.94</td>
<td>82.42</td>
<td>52.31</td>
<td>96.70</td>
<td>100.00</td>
</tr>
</tbody>
</table>

n = 91 (photos 010 - 090)
Conclusion and Future Works

**Patient Misidentification**

- Known global problem in the Health Sector
- Complications - Patient and Organisation

**Face Recognition**

- This was the main focal point of study for identification of patients
- Most biometric preferred method chosen by questionnaire participants
- Over 80% accuracy
Conclusion and Future Works

Future Works
- System needs to be evaluated against a larger dataset
- More face occlusions and real-case scenarios

Security Aspects
- Minimise risks of malicious attacks
- Gain more confidence from end users.
Thank you for your attention!

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