Towards the Scalable Cloud Platform for Non-Invasive Skin Cancer Diagnostics

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Outlines

- Background
- Skin cancer
- Existing devices and approaches
- Proposed architecture
- Challenges and future plans
Background

- PhD in Engineering, thesis “Applying Sensor Networks Technologies in Time Critical Applications”
- Research interests in wireless networks, embedded systems and industrial automation
- Cooperation with Biophotonics laboratory (Latvian University) from 2013 in the field of skin cancer diagnostics
- Ongoing project with Biophotonics laboratory “Portable Device for Noncontact Early Stage Skin Cancer Diagnostics”

NOTES: ICD is the International Classification of Diseases. Circled numbers indicate ranking of conditions as leading causes of death in 2014.
Changes in the risk of dying from cancer, 2010 relative to 2000

Source: CBS
Melanoma mortality rate

## Background

### Skin cancer

### Existing

### Proposal

### Challenges

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**10 year survival rate**

<table>
<thead>
<tr>
<th>Clark's Levels</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 year survival rate</td>
<td>93%</td>
<td>71%</td>
<td>59%</td>
<td>36%</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Breslow Depth (mm)</th>
<th>0 &gt;</th>
<th>1 &gt;</th>
<th>2 &gt;</th>
<th>3 &gt;</th>
<th>4 &gt;</th>
<th>5 &gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 year survival rate</td>
<td>94%</td>
<td>82%</td>
<td>63%</td>
<td>61%</td>
<td>40%</td>
<td></td>
</tr>
</tbody>
</table>

“Almost 100% will survive their cancer for 5 years or more after they are diagnosed at Stage #1”

vs

“Almost 10% men and 25% women will survive their cancer for 5 years or more after they are diagnosed at Stage #4”

*Statistical Information Team at Cancer Research UK*
How to detect melanoma?

Biopsy – 100%

Easy?
No!
Dermatologist or self screening

- Asymmetry
- Borders (the outer edges are uneven)
- Color (dark black or have multiple colors)
- Diameter (greater than 6 mm)
- Evolving (change in size, shape and color)
Availability of diagnostics

- Regular full body analysis

- According to SCREEN project in the German state of Schleswig-Holstein, state achieved reduction for 48% in deaths due to skin cancer

- Same results were not achieved on the national level

- Possible reason — lack of dermatologists
Wavelengths’ penetration depth
Optical Density spectra of skin lesions

Example of analysis

- Natural (RGB) images are visually similar

- Multispectral analysis allows noticeable differentiation in healthy and skin with pathology
What kind of equipment is available for diagnostics?
Imaging equipment

- High price,
- Not portable,
- Proprietary hardware and software
Low cost portable equipment

Portable, affordable  Hard to update and support

Further steps

PC as visualization and processing unit
Further steps

- Smartphone as image source
- Images analyzed by dermatologists
- Image quality and illumination features are limited by smartphone
Supercomputer power

- **Background**

- **Skin cancer**

- **Existing**

- **Proposal**

- **Challenges**
Further steps

Smartphone with additional module for illumination
SkImager

- Illumination
- Imaging
- Processing
- Displaying

Proposal

- Illumination
- Imaging
- Processing
- Displaying
- Transmission

«+»

All in one
No extras

«-»

- Limited CPU power
- Special processing techniques
- Hard to change hardware

«+»

- Quick module changing
- Flexible displaying

«-»

- Need for some displaying device
Proposals

- Portable
- Easy to use
- Quick prototype transition from lab to user
- Easy exchange of modules
- Fast implementation of processing algorithms
- No limitation on processing power
Proposed system

D. Bļizņuks, D. Jakovels, I. Saknite, J. Spigulis “Mobile platform for online processing of multimodal skin optical images”
Proposed system

*Dr.phys. I.Kuzmina*
Proposed system

Battery (>8 hours of service)

WiFi module (Access Point)

IDS camera
1 – 5 MPix

3 LEDs diffuse reflection
535 / 640 / 950 nm

1 LED fluorescence – 405nm

IDS camera driver forms video stream

WEB server forms real time video stream

Control unit (Raspberry Pi)

Remote Matlab servers

D.Bļizņuks, D.Jakovels, I.Saknite, J.Spigulis “Mobile platform for online processing of multimodal skin optical images”
Cloud processing

1. Local test server
2. Amazon S3 cloud
3. Private cloud (eg. RTU HPC)

*Dr.sc.ing. P. Osipovs
Image examples

405 nm

535 nm

660 nm

RGB

940 nm
Photobleaching (405nm)

I.Ferulova, A.Rieba, J.Lesins, A.Berzina, A.Lihachev, J.Spigulis Portable device for skin autofluorescence photobleaching measurements
Nonuniform illumination

*Dr.phys. I.Kuzmina*
Intensity drift due to temperature

*Dr.phys. I.Kuzmina*
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Projekts Nr: 1.1.1.1/16/A/197
„Portatīva ierīce ādas vēža agrīnai bezkontakta diagnostikai”