Eye Contact Detection on Constrained Devices
A platform for rapid prototyping attention-aware systems

Bachelor Thesis

November 10, 2017

Description

Eye contact occurs when two people look at each other's eyes at the same time. This form of nonverbal communication is part of our interaction with other people, and also has the potential to be applied in our interaction with smart objects. As shown in existing research [1], people look at the object of interest before issuing any verbal commands. However, in current works about human-object interaction, our input modalities are usually limited to touch interfaces, voice commands, or gesture control. This motivates us to create systems which incorporate the user’s visual attention to achieve more natural interaction. Attentive user interfaces or assistive systems are only a few examples which leverage eye contact as a building block.

One way to detect eye contact is through embedded sensors consisting of a camera and several infrared LEDs [2]. While this method works well for people, the eye contact and non-eye contact boundaries are dependent on the shape of the target object. Zhang et al. [3] address this issue with a machine learning approach which combines an appearance-based gaze estimator with unsupervised gaze target detection. This approach works well, but requires significant computational power.

In this thesis, we intend to build a software and hardware platform which facilitates rapid prototyping of attention-aware systems. Our vision is to develop a camera-based device which requires few resources, can be attached to any object, and can recognize eye contact in real-time. Additionally, our platform will expose an API for other researchers and developers to effortlessly prototype systems on basis of visual attention.

Work packages

WP 1
Setting-up the environment and exploring eye contact detection
Expected time effort: 60 hours
In this work package, the student is expected to set-up the working environment based on a Raspberry Pi, get familiar with the tools, and read existing literature about eye contact detection.

Deliverable: a report explaining the state of the art for detecting visual attention.

WP 2
Baseline implementation
Expected time effort: 60 hours
The student has to identify at least one closely related approach, understand it, and implement it. This will help better understand existing systems and, at the same time, create the baseline for evaluation.

**Deliverable:** Implement and evaluate at least one closely related project for eye contact detection.

### WP 3

**Eye contact detection on constrained devices**

*Expected time effort: 90 hours*

In this work package, the student is expected to develop a novel eye contact detection algorithm for constrained devices (in our case, the Raspberry Pi).

**Deliverable:** Design and implementation.

### WP 4

**Testing and evaluation**

*Expected time effort: 60 hours*

The algorithm proposed in WP3 must be evaluated and compared to the baseline implementation from WP2.

**Deliverable:** a report containing the performance evaluation.

### WP 5

**Demo Application**

*Expected time effort: 30 hours*

The student must implement a demo application on top of the eye contact detection platform.

(Optional) **WP 6**

**Open-source platform and API**

Our vision for this project is to create an open-source platform which others can easily use. This goal can be achieved by releasing a well designed and documented API.

**Deliverable:** The project and the API are uploaded online and available for the community to use.

### Report and Presentation

The student must present the project in a talk (15 minutes + 5 minutes if the talk includes a demonstration). Additionally, a written report has to be submitted and it should cover the finished work, theoretical aspects of the thesis, encountered difficulties, and other relevant topics (e.g., code documentation).
Required Skills

- Good programming skills (C++ programming is a plus)
- Ability to work independently
- Good problem solving skills
- Computer vision skills are a plus

Grading

Grading will be based on the following criteria:

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Weight (± 0.5)</th>
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</thead>
<tbody>
<tr>
<td>Implementation (functionality, extensibility, documentation)</td>
<td>3</td>
</tr>
<tr>
<td>Report (content, illustration, writing)</td>
<td>2</td>
</tr>
<tr>
<td>Presentation (content, illustration, quality of talk)</td>
<td>1</td>
</tr>
<tr>
<td>Approach (organization, approaching problems, independence, involvement)</td>
<td>1</td>
</tr>
<tr>
<td>Contribution to the state of the art research</td>
<td>1</td>
</tr>
<tr>
<td>Completion of all tasks</td>
<td>3</td>
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Supervision

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References

