On the Stimulation Frequency for SSVEP-Based Image Quality Assessment

Sebastian Bosse
Video Coding & Analytics

March 19, 2018
Introduction
Stimulus Presentation for SSVEP-Based Image Quality Assessment

![Graph showing impairment over time](image)

**Time [s]**

<table>
<thead>
<tr>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
<th>15</th>
<th>16</th>
<th>17</th>
<th>18</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Introduction

Stimulus Presentation for SSVEP-Based Image Quality Assessment
Introduction
Predicting MOS from the SSVEP of Individual Participants

⇒ Behavioral and neural accuracy of assessment is statistically equivalent!
Introduction
Questions Left Open (not exhaustive!)

Is there an optimal stimulation frequency?

▶ An optimal stimulation frequency exists e.g. for face detection
▶ Previously: \( f_{\text{stim}} = 1.5\text{Hz} \)

What quality-related information in encoded different harmonics?

▶ Odd harmonics: Asymmetric responses
▶ Even harmonics: Symmetric responses
Experimental Setup

Parameters

- Distortion type
- Source content
- Stimulation frequencies
Experimental Setup

Parameters

- Distortion type
  - Restriction to distortion by block-based hybrid compression at 2 impairment levels
- Source content
- Stimulation frequencies
Experimental Setup

Parameters

- Distortion type
  - Restriction to distortion by block-based hybrid compression at 2 impairment levels
- Source content
  - Restriction to 3 SRCs
- Stimulation frequencies
Experimental Setup

Parameters

- **Distortion type**
  - Restriction to distortion by block-based hybrid compression at 2 impairment levels

- **Source content**
  - Restriction to 3 SRCs

- **Stimulation frequencies**
  - Restriction to 6 stimulation frequencies: [2, 3, 5, 6, 7.5, 10] Hz
Experimental Setup

Parameters

- **Distortion type**
  - Restriction to distortion by block-based hybrid compression at 2 impairment levels

- **Source content**
  - Restriction to 3 SRCs

- **Stimulation frequencies**
  - Restriction to 6 stimulation frequencies: [2, 3, 5, 6, 7, 10] Hz

**Evaluation based on SNR:**

\[
\text{SNR} = \frac{P(f_{\text{stim}})}{0.5 \cdot (P(f_{\text{stim}} - \Delta f) + P(f_{\text{stim}} + \Delta f))}
\]
Experimental Setup

Stimulus Material

CrowdRun  SunFlower  Woods
Experimental Setup

Stimulus Presentation

\[ f_{\text{stim}} = 2\text{Hz} \]

\[ f_{\text{stim}} = 10\text{Hz} \]
Results

Self-Reported Responses
Results
Neural Responses - Scalp Topographies

First Harmonics
- 2.0Hz
- 3.0Hz
- 5.0Hz
- 6.0Hz
- 7.5Hz
- 10.0Hz

Second Harmonics
Results
Neural Responses - Signal at Oz

2.0Hz

3.0Hz

5.0Hz

6.0Hz

7.5Hz

10.0Hz
Results
Neural Responses - SNR at Oz
Results

SNR vs. Stimulation Frequency
Spectrum of Background Activity
Conclusion

- Impact of stimulation frequency on SSVEP-based image quality assessment was studied
- Stimulation frequency has an influence of SNR
- Findings explain high correlations of $4f_{stim}$ with $f_{stim} = 1.5\text{Hz}$
- Influence might be related to the background activity of the EEG
Conclusion

- Impact of stimulation frequency on SSVEP-based image quality assessment was studied
- Stimulation frequency has an influence of SNR
- Findings explain high correlations of $4f_{stim}$ with $f_{stim} = 1.5$Hz
- Influence might be related to the background activity of the EEG
- Is the SNR a valid proxy of correlation to MOS?
- Optimal stimulation frequency predicted by subjectwise background activity?
- We still don’t know what the different harmonics encode
Thank you!

Any Questions?