Manual process vs Automatic System

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<th>Manual Process</th>
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<td>Precision</td>
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References


Hearing loss exists when there is diminished sensitivity to the sounds normally heard. It is one of the most common disorders and it can affect anyone regardless of age. According to the World Health Organization (WHO), 360 million people suffer some degree of hearing loss. Among them, those people over the age of 65 are the most affected sector, affecting one elder in every three (a total of 165 million). Hearing loss and communication disorders may have a negative impact on the state of emotional, physical and social well-being.

In the practice, Liminar Tonal Audiometry (LTA) is the gold standard for the clinical evaluation of hearing loss. In this sense, we have developed automatic solutions to provide an objective screening system for the automatic measurement of the patient’s response times, and also for supporting the audiologists when evaluating patients with cognitive decline.

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**Liminar Tonal Audiometry (LTA)**

Standard test for the clinical evaluation of the hearing capacity.

- Audiologists are interested in patient’s response times.
- Abnormally slow response times may be a symptom of cognitive problems or other pathologies.
- This measurement by the audiologist is imprecise and subjective.

The LTA test involves some operational constraints, especially among people with cognitive decline.

- No possible question-answer interaction.
- Reactions to the auditory stimuli can be shown by facial reactions.

**Solution**

- Automatic detection of the auditory stimuli (for analogical audiometers).
- Automatic detection of patient’s positive responses (hand raising).
- Automatic measurement of response times.
- Automatic detection of eye region (for facial reactions).
- Movement characterization for facial reactions.

**Response time measurement**

Detecting the auditory stimuli and the patient’s positive responses, response times are computed as:

- Difference between the moment when the auditory stimulus starts and the moment when the reaction starts.

The average of the $n$ response times of the patient, allow the system to distinguish between normal patients and slow patients.

**Facial gestural reaction**

For patients with cognitive decline the positive response to the auditory stimuli is shown by facial reactions, which occur mainly within the eye region.

The system estimates and characterizes the movements occurring within this region (that are particular to each patient). By the correlation of this information with the auditory stimuli, the system provides information to the audiologist of which one are the movements that correspond to possible positive responses to the stimuli, so that the audiologist can corroborate them or discard them.

**Web application**

To complement this system, we have developed a distributed web application for the management of patients and their examinations and also for the automatic processing of the video sequences, allowing this way the monitoring of patients.

**Devices and videos**

Our solutions deal with Full HD video sequences (1920x1080 px, 25 FPS, MTS format) recorded during the audiometric evaluation. Auditory stimuli signal acquisition was adapted to the analogical devices Audiometer Beltone Electronics 109 and Audiometer Madsen by Otometrics.

**Results**

- **Response time measurement**
  - Precise quantification of the speed of response and objectively identification of patients abnormally slow

- **Facial gestural reaction**
  - 90.65% of accuracy when classifying region eye movements