An Inductive Tongue Computer Interface for Control of Computers and Assistive Devices (ITCI)

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ELE 482 Biomedical Engineering Seminar III, March 5, 2007
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Introduction

With the increased computerization of everyday equipment, several everyday tasks can be automated and controlled through environmental control systems. Effective control methods to access these things can significantly improve the quality of life for millions of disabled all over the world. Current control methods includes eye control devices, head control devices, voice recognition, and tongue control devices. Still there are problems related to the efficiency of the use of these methods. The tongue control methods are favorable since they are practically invisible and manageable for people with even severe disabilities.

There have been different attempts to interface the tongue, including **electrical contacts, hall element techniques and pressure sensors**. However, the use of electrical contacts may not function during eating and talking. The technique with the Hall element has similar limitations. Further, the use of pressure sensitive sensors does not seem optimal, since normal speech and swallowing generates tongue-palatal pressures in the range of 20-60% of maximal achievable pressure which poses demands on the detection threshold and therefore may increase the risk of fatigue. Therefore, this letter introduces a new **inductive tongue computer interface (ITCI)** to facilitate tongue activated commands.

II. Methods

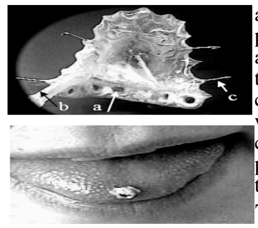
Theory:

The detection method used in this letter is based on Faraday's law of induction for a coil, and uses variable inductance techniques. The idea is to change the inductance of an air-cored induction coil, by moving a ferro magnetic material, attached to the tongue, into the core of the coils. From Faraday's law the voltage drop across an inductance can be found as:

$\varepsilon = -L\, di/dt = -\mu_0 \cdot \mu_r \cdot N^2 \cdot A/l \cdot di/dt$, where L = inductance, μ_0 = vacuum permeability, μ_r = relative magnetic permeability of the core material, N= number of turns , l = is the average length of the magnetic flux path. When only air is present as the core of the inductance, $\mu_r=1$. As a ferromagnetic material is placed in the coil, the core becomes a combination of air and ferromagnetic material, and μ_r changes according to the magnetic permeability of the ferromagnetic material. Applying a sine wave current, i, of constant peak-peak amplitude, a constant amplitude voltage drop, ε, is obtained across the coil L. Introduction of the ferromagnetic material into the air gap of the coil, results in an increase of ε, which stays increased, until the material is removed.

Design of the Inductive Sensor:

The Sensor consists of two parts: a) A coil, or inductor to be placed in the oral cavity using a palatal plate.
b) An activation unit made of magnetic material, to be placed on the tongue b1) Five Inductors were produced having a different number of turns N = 50, 60, 70, 100, and 110, to be able to induce changes of in of different sizes. This made it possible to determine, which coil that was activated using thresholding, when the coils were connected in series.



a: The activation unit, b: the palatal plate, c: the inductors. The tongue activates the sensors by placing the tongue-mounted activation unit at or inside a coil. Right, top: the palatal plate with 5 sensors. a: the lead wires, b: the coils, c: the clamps keeping the plate in place. Right, bottom: the activation unit glued to the tongue.

The function of the ITCI was demonstrated in one 37 year old, healthy female volunteer. The activation unit was glued to the tongue using n-butyl-2-cyanoacrylate tissue glue (Histoacryl). The inductors were connected in series, and a 50-kHz sine wave current with an amplitude of 30 was applied to the inductors from a battery driven current source.
The measured signal was amplified and rectified using a custom made battery driven rectifier to obtain and envelope of the signal and further amplified and low-pass filtered at 1 kHz. The resulting signal was used for thresholding, to detect which coil that was activated. When the same coil was activated for an interval of at least 0.3s, a coil was regarded as selected by the subject and a character assigned to the coil appeared in a text box on the visual display. Each trial lasted 20 s, and the string "ABCDE" was to be typed by the subject using the ITCI.

Results:

The subject succeeded in typing the desired text string, with this rather simple sensor configuration. Although, there are activations of the coils outside the defined threshold areas for the different characters, prior to the real activation.

IV. DISCUSSION

This study introduced a new tongue-computer interface, the ITCI, and demonstrated the function of the system in one healthy subject. No prior training was performed by the subject and the subject did not aim towards fast selection rates. Only one combination of 5 characters was typed. Future work will include a more detailed study of selection rates of randomly ordered characters in several subjects.

Sources:

An Inductive Tongue Computer Interface for Control of Computers and Assistive Devices
By: Andreasen Struijk, L. N. S.
This paper appears in: Biomedical Engineering, IEEE Transactions on
Publication Date: Dec. 2006
On page(s): 2594-2597, Volume: 53, Issue: 12

http://www.smi.hst.aau.dk/~naja/absICFVRAT06fiproceed.pdf