2011-01-11

Augmented Control of a Hands-Free Electrolarynx

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Recommended Citation

Madden, B., Condron, J., Coyle, E. (2011). Augmented Control of a Hands-Free Electrolarynx. *Bioengineering in Ireland*, January 28-29, 2011, Galway, Ireland. doi:10.21427/D7T89T

AUGMENTED CONTROL OF A HANDS-FREE ELECTROLARYNX

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INTRODUCTION

During voiced speech, the larynx acts as the sound source, providing a quasi-periodic excitation of the vocal tract. Following a total laryngectomy, some people speak using an electrolarynx which employs an electromechanical actuator to perform the excitatory function of the absent larynx. Drawbacks of conventional electrolarynx designs include the monotonic sound emitted, the need for a free-hand to operate the device, and the difficulty experienced by many laryngectomees in adapting to its use. One improvement to the electrolarynx, which clinicians and users frequently suggest, is the provision of a convenient hands-free control facility. This would allow more natural use of body language, as well as enabling the user to perform other manual tasks whilst speaking. An additional enhancement is the redevelopment of the devices' actuator to remove the self-radiated *buzzing* sound which is emitted during operation. The overall goal of this research is to investigate the implementation of a more natural sounding, hands-free electrolarynx, as seen in figure 1, with an activation method which uses accelerometers that are placed on the chest and abdomen to detect torso based breathing prior to the initiation of speech.

MATERIALS AND METHODS

A method for providing a hands-free solution was implemented previously in 2004 by Goldstein et al. who created a hands-free electrolarynx which was activated and deactivated using the electromyogram (EMG) [1]. Within human vocalizations, a number of bio-mechanical signals are generated. These emanate from the torso during breathing and speech, particularly from the thoracic and abdominal regions. This study has explored a method of capturing these subconscious bio-mechanical signals and classifying them as a method of distinguishing between normal breathing and the natural onset of speech. These signals could then be harnessed as the on/off control signal for the electrolarynx device. Our system uses three tri-axial accelerometers to measure relative expansion and contraction of the chest and abdomen.

Some significant contributions have been made that focused on removing the buzzing sound created by the transducer (Houston et al. [2]). Our alternative actuator design consists of a simple pager motor (which is typically found in a mobile phone) attached to a thin piece of high-density polyethylene (HDPE) by an aluminum support. When a current is sent through the motor, it causes the off-centred cam to rotate causing an unbalanced centrifugal force. The motor in this design has a minute amount of play within the support and the HDPE section, thus causing a vibration that is resonated through the plastic. The thinner the plastic material is, the better the resonance becomes and resulting in a more efficient transfer of vibrations into the user's neck.

Figure 1 Final design of hands free electrolarynx device.

RESULTS

Results illustrate from intelligibility tests carried out that the speech produced using our novel actuator is substantially more intelligible to all the listeners than that produced using the conventional electrolarynx. Also, the abrupt change in breathing pattern which occurs at the onset of speech is clearly observable in signals recorded by the accelerometers, facilitating a possible automatic activation of an electro-larynx which will be investigated further in future tests.

DISCUSSION

Since 1949, the same fundamental shortcomings have remained in the design and the output of the electrolarynx. In particular its monotonous sounding output and its cumbersome design. With the aid of Speech and Language therapists in Ireland, this study is attempting to overcome these deficiencies through various empirical techniques.

REFERENCES

[1] Goldstein E..A, et al. (2004) "*Design and implementation of a hands-free electrolarynx device controlled by neck strap muscle electromyographic activity*" IEEE Trans. On Biomed. Eng. Vol. 51, No. 2
[2] Houston K.M. et al. (1999) "*Development of sound source components for new electrolarynx speech prosthesis*". IEEE Proc. International Conference on Acoustics, Speech, and Signal Processing Vol. 4, Issue, 15-19 Page(s):2347 - 2350 vol.4.