Evaluating the quality of the glottis closure

Introduction

The aim of this work is to present new knowledge, which would be useful for evaluation of the quality of the glottis closure. The source of knowledge is the analysis of one period of the laryngeal tone recording, which is obtained by measuring the changes of the sound pressure through the microphone placed in front of the patient’s mouth.

Common examination methods with new knowledge expressed by SCORE value can be used to evaluate the vocal cord function and determine the diagnosis of voice disorder.

Approach and Methods

The principle of the method is the Fourier analysis of one period of the laryngeal tone recording to detect the transition process as a response to pressure pulse. This process is caused by closure of the glottis. The regression SCORE model is used to evaluate the quality of the glottis closure. The variables in the model are standardized amplitudes, which are calculated from the coefficients of Fourier series. The parameters of SCORE model are the coefficients, which are derived by comparison with the expert rating of individual records. The expert rating consists of the results of medical examination of voice quality as well as experience of the evaluating expert.

Following signal description is devised:

\[ x[k] = \sum_{\alpha} a_\alpha \cos \left( \frac{2\pi \alpha}{L} k \right) + \sum_{\beta} b_\beta \sin \left( \frac{2\pi \beta}{L} k \right) \]

where \( x[k] \) is the sample of the periodic curve of interval \( \alpha \), \( L \); \( k \) is the position of sample on periodic curve \( k \); \( L \) is length of the phonation recording in samples; \( \beta \) is the number of harmonic in Fourier series.

Coefficients of Fourier series are then:

\[ a_\alpha = \frac{2}{L} \sum_{k} x[k] \cos \left( \frac{2\pi \alpha}{L} k \right) \]
\[ b_\beta = \frac{2}{L} \sum_{k} x[k] \sin \left( \frac{2\pi \beta}{L} k \right) \]

For these coefficients of Fourier series we can create invariants which describe the shape of the curve independently on its position and relative to its shift. For amplitude spectrum after normalization applies:

\[ \text{SCORE} = c_3 \sum k |a_i| \]

Regression model of weight function is used to evaluate quality of the glottis closure:

\[ \text{SCORE} = c_3 + \sum_{k} b_i |a_i| \]

Parameters of weight function \( c_3 \), are chosen after expert classification \( \text{CLASS}_{\text{OK}}(1-5) \):

\[ \text{SCORE} = 10789 \times |a_1| - 0.0971 \times |a_2| - 0.1905 \times |a_3| - 0.7629 \]

Conclusion

The method is based on expansion of one period of the laryngeal tone recording using trigonometric series for defined finite number of its members.