VKFD: Computerized Analysis of Videokymographic Data *(no. 193)*

A. Novozámský, J. Sedlář, A. Zita, C. Herbst, J.G. Švec, B. Zitova, J. Flusser

- **Form:** Oral Presentation
- **Category:** Basic Science
- **Topic:** Imaging

Videokymography (VKG) is a recently developed imaging method, which is used in laryngology and phoniatrics for observation and diagnosis of vocal fold vibrations. The method was designed in 1994 as a low-cost, clinic-friendly alternative to the classic digital high-speed imaging systems. It is based on a specially adapted video camera that captures images only from a single selected line of the vocal folds at a high-speed rate (7200 lines/s). The new generation of VKG cameras can simultaneously deliver both the classic laryngeal images and the spatiotemporal videokymographic images. Even though the amount of the captured VKG data is not as excessive as in the case of high-speed imaging techniques, their visual evaluation can be tedious and time consuming. Hence, the development of computer-assisted diagnostics is of great interest.

Our paper proposes a software solution for the enhancement of videokymographic data and the extraction of typical characteristics of vocal folds vibrations, such as, e.g., the time-varying extent of rima glottidis and the progression of mucosal waves, and corresponding vibration parameters (e.g. frequency, symmetries, amplitude). The proposed methodology is based on well-established digital image processing methods; namely image denoising, edge detection, image segmentation, and object identification. The set of evaluated features was designed by experts, drawing on their longtime expertise with videokymography. These features are mostly based on the estimated shape of the glottal contour, i.e. the boundary between the vocal folds and the rima glottidis, but also on mucosal waves. We trace a set of base features - opening and closing points and ventral and medial peaks. They determine the duration of the vibration cycle and the symmetries. They are used for deriving the shape, the amplitudes, and the extent of mucosal waves, too. Accurate detection and measurement of these base features is critical for proper computation of further vocal fold vibration parameters. In addition to the automated detection of analysis parameters, the proposed software offers clinicians an option to manually intervene in any algorithm step.

A representative set of videokymographic data with a wide range of vibration patterns was used for testing the developed system (50 videokymograms evaluated by 18 expert and non-expert raters). The performance of the new software was assessed by comparing the outcome of the automated parameter detection to the manual/visual ratings.

The proposed software tool, VKFD – the Videokymography Feature Detection Software, was developed for computerized analysis of videokymographic data, but also enabling direct inputs from clinicians. Such computer-assisted feature extraction and parameter estimation will facilitate the diagnostic process. Moreover, it will produce parameter sets, which can be numerically compared to previous analyses.

Author no. 1
- **Name:** Adam Novozámský
- **Name of institution:** Institute of Information Theory and Automation, Academy of Sciences of the Czech Republic
- **City:** Prague
- **Country:** Czech Republic
- **E-mail:** novozamsky@utia.cas.cz

Author no. 2
- **Name:** Jiří Sedlář
- **Name of institution:** Institute of Information Theory and Automation, Academy of Sciences of the Czech Republic
- **City:** Prague
- **Country:** Czech Republic
- **E-mail:** sedlar@utia.cas.cz

Author no. 3
- **Name:** Aleš Zita
- **Name of institution:** Institute of Information Theory and Automation, Academy of Sciences of the Czech Republic
- **City:** Prague
- **Country:** Czech Republic
- **E-mail:** zita@utia.cas.cz

Author no. 4
- **Name:** Christian Herbst
- **Name of institution:** Dept. Biophysics, Faculty of Science, Palacký University Olomouc
- **City:** Olomouc
- **Country:** Czech Republic
- **E-mail:** herbst@ccrma.stanford.edu

Author no. 5
- **Name:** Jan G. Švec
- **Name of institution:** Dept. Biophysics, Faculty of Science, Palacký University Olomouc
- **City:** Olomouc
- **Country:** Czech Republic
- **E-mail:** jan.svec@upol.cz

Author no. 6
- **Name:** Barbara Zitova
- **Name of institution:** Institute of Information Theory and Automation, Academy of Sciences of the Czech Republic
- **City:** Prague
- **Country:** Czech Republic
- **E-mail:** zitova@utia.cas.cz

Author no. 7
- **Name:** Jan Flusser
- **Name of institution:** Institute of Information Theory and Automation, Academy of Sciences of the Czech Republic
- **City:** Prague
- **Country:** Czech Republic
- **E-mail:** flusser@utia.cas.cz