Politecnico di Torino

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METROLOGY

Analysis and classification of vocal signals

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Context of the research activity	The research deals with acquisition and analysis of vocal signals collected by subjects that suffer from physiological and neurological diseases and subjects that have undergone laryngectomy. The features extracted from the vocal signals are used to train classification algorithms. The main goal of the research consists in developing devices based on artificial intelligence that help physicians in diagnosing the different pathologies. The same devices can also allow physicians to remotely monitoring the patients at home, thus reducing the access to the medical structures.
	The research is framed in the field of analysis of vocal features for diagnosis purposes and for the evaluation of different rehabilitation paths. The analysis of vocal signals is a technique that has been increasing in the last decades, thanks to its poor invasiveness with respect to clinical tests and to an increasing reliability, which also depends on the application of suitable classification algorithms. However, the training and the performance evaluation of classification algorithms often do not take into account the uncertainty of the input features. To fill this gap, the research will include the uncertainty evaluation of the features extracted from vocal signals and this information will be used during the different steps of the development of machine learning models, which include feature selection, algorithm training and evaluation of the classification performance.

Objectives	This research will be performed in collaboration with the San Giovanni Bosco Hospital (Otolaryngology Head and Neck Surgery Unit, Turin, Italy) and with the IRCCS Fondazione Don Carlo Gnocchi (Milan, Italy). Vocal signals will be collected by healthy subjects, subjects that suffer from physiological (dysphonia) and neurological diseases (multiple sclerosis and Parkinson), and subjects that have undergone different types of laryngectomy. The first step consists in extracting vocal features that are representative of the subjects' status and identifying and evaluating the main uncertainty contributions that affect the vocal parameters. The uncertainty analysis has to take all the components of the measuring chain into account, thus including the acoustic domain (microphone and environment), the electrical domain (conditioning circuitry and analog-to-digital converter) and the software domain (algorithms for the extraction of vocal features). Another important source of uncertainty will be considered, which is related to the reproducibility of human subjects. An uncertainty-based feature selection will be then performed in order to identify the best candidates for classifying the involved subjects and the training of classification algorithms will be weighted by the evaluated uncertainty. According to the type of classification algorithm, the uncertainty will be also propagated to the algorithm output and new metrics of classification performance will be defined. The main goal of the research consists in developing low-cost devices that are based on artificial intelligence that help physicians in diagnosing the different pathologies. The same devices can also allow physicians to remotely monitoring the patients at home, thus reducing the access to the medical structures. In addition, the use of a similar approach can easily enable physicians in maintaining digital medical records of their patients, thus driving the public health system towards the digital transition.

Skills and competencies for the development of the activity	signal theory, signal processing, uncertainty evaluation, classification algorithms