Sir,

Development of non-invasive methods in diagnosing different diseases can lead to improvement of prevention and care programs. The speech is an easily accessible signal, which clearly represents the characteristics of larynx and vocal folds. Therefore, application of some proper machine learning algorithms (e.g., feature extraction and classification methods) on a small part of a recorded speech signal may help in diagnosing vocal fold diseases such as paralysis, edema, nodules, and polyp.\(^1\)\(^{-3}\) Generally, transforming the input signal into the set of features is called feature extraction. If these features are accurately extracted, it is expected that the feature set will capture the relevant pathological information of speech signal to predict the diagnosis.

Conventionally, some acoustic features of speech signal like pitch frequency, shimmer (amplitude perturbation), and jitter (pitch perturbation) are used to distinguish between normal and pathological cases.\(^4\),\(^5\) On the other hand, there are some experimental evidences that proof the existence of chaotic behavior in speech production system (e.g., turbulence airflow) not considered in the conventional and mentioned feature extraction methods.\(^6\),\(^7\) For example, some of recent researches have considered chaotic characteristics of speech signal such as correlation dimension, the largest Lyapunov exponent, approximate entropy, fractal dimension, and Ziv–Lempel complexity.\(^8\),\(^9\)

One of the best domains to represent chaotic properties of different biological signals is the phase space domain.\(^7\),\(^10\) Take has introduced delay coordinate embedding theorem to reconstruct a signal in the phase space domain. This theorem shows that a one-dimensional signal (e.g., a recorded speech signal) can be embedded and reconstructed as a set of points in a high dimensional space so-called reconstructed phase space (RPS) topologically equivalent to its original system.\(^10\),\(^12\) Often, these points show a trajectory in the RPS, which is called an “attractor.” The true dynamic of signals generated by different systems can be exhibited in the RPS. So, the proposed method is based upon modeling the trajectory of pathological signal as it is captured in the RPS.

Based on above mentioned points, we hypothesize that not only modeling of pathological voice as a speech trajectory or speech attractor in the RPS is suitable for detection of vocal fold pathologies, but also their obtained results will be comparable to conventional classification methods. Hence, for each normal or pathological voice such as paralysis, edema, nodules, and polyp, a specific speech attractor model will be constructed using a parametric and probabilistic model e.g., Gaussian Mixture model (GMM) in the RPS.\(^11\),\(^12\) It learns the probability distribution of the attractor in the RPS. One of the powerful characteristics of the GMM is its ability to form smooth approximations of attractors. Utilizing the GMM-based attractor models learned for each class of pathological signals, a set of probability scores such as likelihood can be computed for each unknown test signal. Finally, behavior of vocal fold for unknown test signal will be predicted in a non-invasive procedure by comparing the computed probability scores using a naive Bayesian maximum likelihood classifier. Surely, experimental researches are needed to validate our hypothesis.

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