2021 43rd Annual International Conference of the
IEEE Engineering in Medicine & Biology Society (EMBC)
Oct 31 - Nov 4, 2021. Virtual Conference

Covid-19 diagnosis using cough signal processing

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***Abstract* - In this study, a support vector machine (SVM) system for the detection of COVID-19, based on patients' coughing signals extracted from remote audio recordings is presented. The system includes cough detection and segmentation, followed by separation between the different cough phases. Acoustic features from each individual phase were extracted and used for the classification of Corona patients. Audio recordings were collected from crowdsourced VOCA dataset and include recordings from 2,954 subjects, of whom 26 are diagnosed as positive for COVID-19. The predicted results from the SVM classifier yield sensitivity of 0.796 and F1 score of 0.656.**

***Clinical Relevance* - This work offers a complete system that can identify cough segments from subjects' audio recordings and provide covid-19 diagnosis.**

I. INTRODUCTION

In March 2020 the World Health Organization declared on COVID-19 a global epidemic, which has so far caused the deaths of over 4 million people [1]. Common symptom of COVID-19 is a dry cough. It's also a symptom of many other respiratory diseases, each affecting the respiratory system differently and therefore may carry important information related with each disease [2]. Recent research has shown a capability in differentiating between healthy subjects and those diagnosed with respiratory diseases, using audio signals [3], [4]. As far as we were able to discover, only a few studies have tried to develop COVID-19 diagnosis algorithms utilizing pre-processing and segmentation methods for acquiring more specific acoustic features from cough audio signals.

II. METHODS

In this work, we analyzed audio recordings of 52 subjects (26 positives and 26 negatives diagnosed with COVID-19), ages 19-58 years (34.7±11.1). All recordings have been obtained from Voca dataset of voca.ai [5] which were acquired via web/mobile platforms. From each subject, additional information was collected regarding their age, sex, COVID-19 status, health conditions, etc.

The proposed system (Figure 1) included pre-processing step for identification and removal of recordings without cough events using anomaly detection algorithm based on multivariate Gaussian distribution. Next, segmentation step for cough event detection and segmentation followed by separation between the different cough phases to acquire more specific acoustic features from each phase individually. Finally, extraction of time/frequency domain features from each phase, such as mel frequency cepstral coefficients (MFCC), formant frequencies, sound intensity, event duration, followed by an SVM classifier for COVID-19 positive/negative prediction.

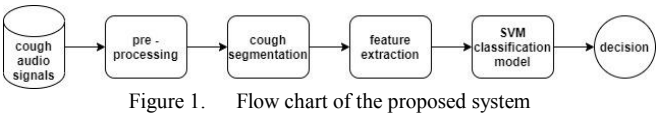

Figure 1. Flow chart of the proposed system

III. RESULTS

The proposed segmentation system identified coughs' 1st and 2nd phases with PPV of 0.983 and 0.962, and F1-score 0.876 and 0.906 respectively, from the whole database. For the SVM classifier we conducted 10 classification iterations. At each iteration we divided our dataset into 64% train, 16% validation and 20% test, with 5-fold cross validation for hyper-parameter tuning. The mean classification performances of the SVM are presented as confusion matrix in Table 1. Mean result for F1 score is 0.656.

TABLE I. CONFUSION MATRIX OF SVM CLASSIFIER*: MEAN ± STD.*

	Predicted as positive [%]	***Predicted as negative [%]***
True positive	79.6 ± 26.5	20.4 ± 26.5
True negative	48.1 ± 25.8	51.9 ± 25.8

IV. DISCUSSION & CONCLUSION

The current study demonstrates the capability of an automated system for the diagnosis of COVID-19 using only cough audio recording. Unlike previous studies, we put emphasis on segmentation step to acquire more specific acoustic features.

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*Research supported in part by the data science center, Ben-Gurion University of the Negev.

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