Title: Remote Covid 19 detection from coughing sound analysis and breathing rate extraction using a smartphone.

Abstract:

Background: The widespread COVID-19 has disrupted the everyday life of people all around the world. Due to the numerous deaths and distress of the patients, this viral disease has created the necessity of a discrete, convenient, and easy-to-use remote device as a diagnosis platform. The development of smartphone technology has made it possible to be used as a primary diagnosis device as these are equipped with powerful processors and an array of multidimensional sensors. In this paper, we offer a viable solution to first classify vocal events as speaking, breathing, and coughing events, and simultaneously extract the type and frequency of the coughing events as well as respiration rate from the breathing events from a subject's audio signal with the help of a smartphone. The audio signals are evaluated based on their unique features extracted using our novel algorithms. The system is developed from data obtained from a public database and evaluated on the data of COVID-19 patients. The model resulted in a 78.81% training accuracy and 68.96% testing accuracy using a Support vector machine (SVM). Our proposed method is implemented as a smartphone application. We strongly believe that our proposed method can provide a primary diagnosis of COVID-19 utilizing the symptoms and significantly help the medical procedure.

Materials and Methods: Covid-19 causes distressed respiratory illness, resulting in dry coughing, breathing difficulty, and shortness of breath. Conventional audio signal-based respiration or cough detection methods depend on the external microphone, attachable patch, and inconvenient mobile phone-based methods. External microphones and patches are inconvenient and costly as they need set-up with or without wiring to the device. Our proposed method is ubiquitous as it is implementable in the most convenient smartphones for the users. According to our study, a smartphone's inbuilt microphone can solve the issue with convenience. Due to the advanced sensor technology of smartphones, it picks up tiny to loud audio sounds. The method uses audio and video sensors to record vocal events, and classify them into breathing, coughing, and speaking events based on their unique characteristics. Furthermore, the proposed algorithm extracts the features of coughing events (frequency, type of coughing) and breathing events (respiration signal). From the recorded audio signals, breathing can be identified easily from the periodic and regular pulse shapes in the time domain. In contrast, the speaking and coughing segments have aperiodic and irregular pulse shapes. Each segment here is defined as 5 secs. The feature extraction procedure (both in time and frequency domain) then finds the parameters from the breathing frequency and severity of coughing. Afterward, it discriminates coughing from speaking and breathing using SVM. Significantly, the algorithm can separate regular speaking events from coughing events and calculate the frequency of occurrence of coughing. Hence evaluates the severity of coughing of a subject. By combining the symptoms, our proposed algorithm determines if a subject has COVID-19 symptoms or not.

Results: According to the performance metrics, the training accuracy of our SVM classifier is 78.9%. The specificity and sensitivity of the coughing segment with an of average 96.4% accuracy and the breathing segment with 94.8% accuracy. The data is labeled with 2 person voting system. Taking 196 seconds of data for testing which are divided into 12 breathing segments, 16 coughing segments, and 19 speaking segments, each of 4 seconds. The model resulted in a testing accuracy of 82.76%, 51.06%, and 52.17, the sensitivity of 64.29%, 75.00%, and 15.79%, and specificity of 100%, 37.81%, and 77.78%, for breathing, coughing and speaking, respectively. Testing the model on the test data required 0.0370 sec. Therefore, the proposed model can classify test data instantly if trained properly. This observation is consistent with the gold standard, and the result matches the findings.

Conclusion: In this paper, we propose a smartphone-based COVID-19 diagnosis algorithm solely based on vocal events which can effectively and efficiently deliver a primary diagnosis of COVID-19 in a remote, fast, and convenient way without a visit to the hospital or clinic. This method is especially beneficial for suspected COVID-19 patients. Our proposed method can not only help the doctors manage the patients and emergency room more efficiently, delivering better disease management, but also provide better care for the diagnosed patients for their symptom monitoring.

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Learning Objectives:

- Demonstrate research skills and continuing projects
- Analyze the current trend in technology for improvement in research and development
- Discuss the possibility of collaboration in diverse fields