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Active Surveillance for COVID-19 Through Artificial Intelligence Using Real-Time Speech-Recognition Mobile Application

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Abstract-- **We propose a novel model of active surveillance for COVID-19 through artificial intelligence. Both past and recent events of viral disease outbreaks have shown us that we do not have effective methods to screen the whole population, and efforts are failing to stop the pandemics. Moreover, at this stage, social distancing and home quarantine are only measures to prevent the spread of COVID-19 infection. The purpose of our project is to introduce a robust method of using speech-recognition techniques through a mobile application in analyzing cough sounds of suspected people who previously were healthy, suffering from a respiratory ailment, and actively monitor the progress of their symptoms in real-time.**

I. Introduction

COVID-19 is a highly contagious respiratory disease caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). The disease was first reported in Wuhan, China, on 31 December 2019. Since then, the disease has taken the shape of the global outbreak and hence, declared a global pandemic. Common symptoms include fever, cough, and shortness of breath. Other symptoms may include myalgia, expectoration, diarrhea, and abdominal pain. The majority of cases develop only mild symptoms, but some may progress to severe pneumonia and multi-organ failure. The mortality rate to date is 4.6% ranging from 0.5% to 15% according to the age group. The virus spreads through respiratory droplets released when a person cough or sneeze. People may also contract the infection (COVID-19) by touching the contaminated surface and then their face. Recommended measures to prevent infection include frequent hand washing, social distancing (maintaining physical distance from others, especially from those with symptoms). The use of masks is recommended for those who suspect they have the virus and their caregivers. Still, now in some reported studies, it has considered mandatory for both suspected and unsuspected people to wear face masks. The incubation period, which is the time from exposure to onset of symptoms is generally between two and fourteen days, with an average of five days. The infection can also be diagnosed from a combination of symptoms, risk factors, and a chest radiological features of pneumonia. At present, real-time reverse transcription-polymerase chain reaction (rRT-PCR) is the standard method of diagnosing COVID-19 from nasopharyngeal swabs. The test usually takes a few hours to 2 days to produce the result. The management includes supportive care; the severe cases may require mechanical ventilation support. Right now, the real challenge faced by a majority of the country is to provide mechanical ventilators and diagnostic test kits in large numbers as these are being manufactured in limited quantities and not enough to address total world population of 7.8 billion for COVID-19 infection. Besides stopping the transmission of the virus, our proposed project is also designed to find suitable candidates for the COVID-19 test and make wise use of existing resources.

II. Related Work

The cough detection method proposed here is based on similar speech-recognition algorithms reported in previous works done in this field. For instance, in a paper published in the journal of Respiratory Research, researchers from Curtin University and The University of Queensland developed an automatic cough detector to identify and extract cough sounds in a continuous audio stream [1]. The model was done using a Time Delay Neural Network operating and identifying Mel Frequency Cepstral Coefficients (MFCC), a common technique used in the speech-recognition system. Another notable work we have found to use a similar method is in the Automated Cough Assessment on Mobile Platform (ADAM) developed by researchers from the University of Rochester. In their work, they have introduced an MFCC/HMM (Hidden Markov Model) recognition framework to analyze the cough sounds in adolescents with the asthmatic diagnosis [2]. There are so many other works reported in the literature which have shown the great benefit of using speech recognition and machine learning principles in diagnosing respiratory diseases [3][4].

III. System Model

The model uses symptom detection algorithms based upon standard speech-recognition and machine learning, as shown in Fig.1. The custom application runs on a consumer electronics mobile platform. The application will use the device inbuilt microphone to record audio signals and processed to determine the presence or absence of the cough sounds in real-time. If the sound features correspond with the features seen in a diseased person, the app will notify the user and advise to take necessary health precautions.

To differentiate a native cough sound from a non-native one, we are going to integrate the same motion- recognition feature runs in existing smartphones where it is used to record the step-counts in popular fitness apps like Nike+, Samsung Fitness, Apple Health app, RunGo, Aaptiv. The features record the state of a user while coughing.

The biggest challenge we may face in developing this ANN is collecting a potential dataset of cough sounds. Looking at the diversity of human races and the languages we speak, it is difficult to obtain such datasets on a large scale using a single platform. To solve this issue, we propose a unique solution that would require the biggest telecom service providers around the world to come together and show efforts in constructing a phone monologue in different languages spoken across the continents. The short monologue will comprise a set of questions, and the receiver's answers will be recorded. At the end of the monologue, they will be asked to cough, and its sound will be recorded. The purpose of such a monologue is to obtain a cough sound from a native device, which will help the ANN cough detection module to work with higher specificity and sensitivity.

The app will give feedback to the App-Centre in real-time after recording and processing the user cough sounds on the first day and advise to take necessary precautions. On the third day, it will notify the sick user (suspecting of having COVID-19 infection) if the symptoms are deteriorating (as we know the incubation period of COVID-19 is 2-14 days). A set of the questionnaire will be generated by the app asking for more associated symptoms related to COVID-19 (like fever, body ache, diarrhea), recent travel history to any virus prevalent regions, and score the severity accordingly. The App-Centre will also notify the local health authority about this suspected user and advice to seek medical care if necessary. Besides, it will also inform the healthy users living in the risk regions (where the number of suspected users is more) to stay alert and take necessary precautions not to contract the infection.

IV. CONCLUSION

The proposed mobile application is simply a tool to notify the users whether his/her cough sound is alarming or not and may be used to diagnose the disease based on the sensitivity and specificity of a disease. The advanced techniques of neural networks are used to analyze cough sounds in various respiratory diseases, especially COVID-19, which is crucial to make this application more efficient. The app is designed to trace the number of suspected cases found in different regions of the country, understand the pattern of spread of infection, successfully notify the local health authorities to take necessary measures, and hence, break the transmission to prevent disease outbreak. This model can be applied in similar future outbreaks and help create awareness amongst the people. The proposed concept has great potential to shape future works in developing more advanced active health surveillance.

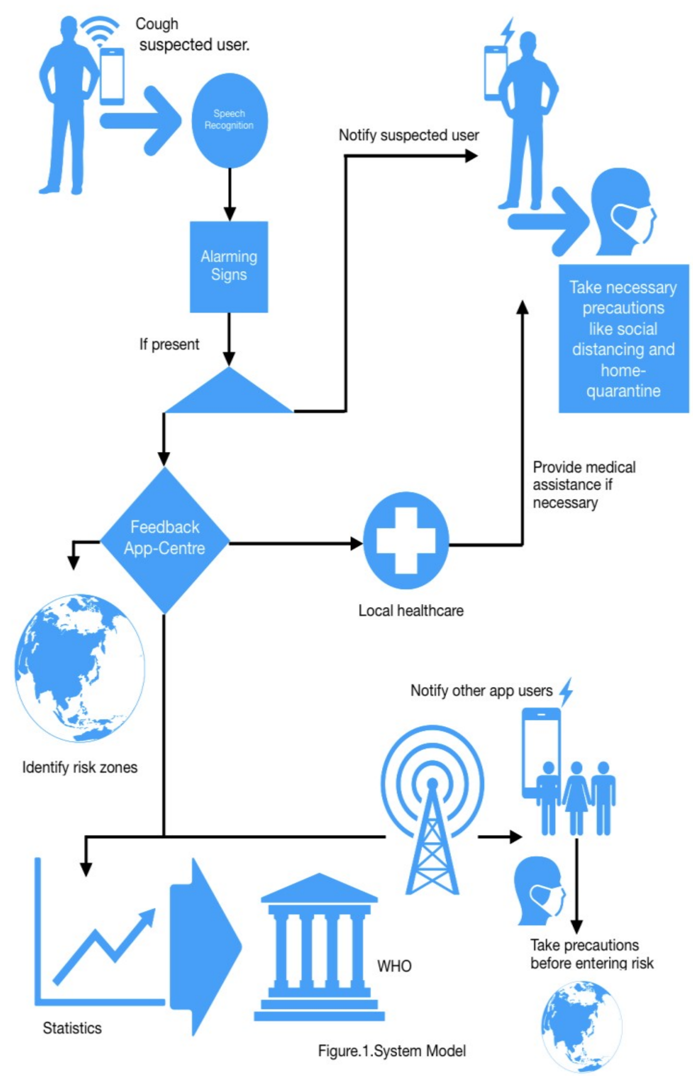

Figure.1.System Model

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