JBMT 2021, 2:3

Journal of Bioengineering and Medical Technology

Short communication

A SCITECHNOL JOURNAL

Speech Signal Analysis as an Alternative to Spirometry in Asthma Diagnosis

Kutor John

Department of Biomedical Engineering, University of Ghana, Ghana

Abstract

Speech production involves the vibration of the vocal cords. Voice changes will however occur in asthma due to the inflamed lung airways. Spirometry is a well-known technique employed in diagnosis of asthma to give information on patient pulmonary function. The purpose of this research was to investigate the correlation between FEV1 /FVC (Forced Expiratory Volume to Forced Vital Capacity) ratio obtained from spirometry and Harmonics-to-Noise Ratio (HNR) obtained from human speech, in order to determine whether speech analysis could be an alternative to spirometry in diagnosing asthma. Spirometry data was obtained from 150 subjects, who were asthmatic patients attending the Korle-Bu Teaching Hospital, Ghana. Speech data consisting of the vowel sounds /a:/, /e:/, /ɛ:/, /i:/, /o:/, /ɔ/ ,/:u:/, consonant /s:/ and phrase "She sells", was also recorded from the subjects. 33 samples were selected and analyzed to generate speech parameters with Praat software. Correlation was established between HNR from the speech signals and spirometry data FEV1 /FVC. The highest correlation coefficient was observed between HNR and vowel sound /ɛ:/ (42.08%). In conclusion, among the other speech vowels and phonemes, Harmonics-to-Noise ratio (HNR) of /ɛ:/ sound showed the most promise to being a suitable alternative to spirometry in asthma diagnosis

Introduction

Sound production in humans involves airflow from the lungs through the larynx, the vibration of the vocal cords and resonance within the oral and nasal cavities. Infections that cause physical changes in any of the parts of the pathway of sound production therefore have the tendency to affect the natural sounds a private produces during speech. There has been research into human voice analysis in diagnosis medical conditions that affects voice parameters like depression, schizophrenia and autism spectrum disorders. This paper investigates the effect of asthma on an individual's speech and therefore the possibility of diagnosing asthma via speech. Asthma may be a chronic immune inflammatory disorder influenced by many factors. In 2007, it had been stipulated that about 300 million people suffer from asthma. Another report in 2014 also stated that about 334 million people from all ages suffer from asthma, with the foremost prevalence of symptoms among 18-45 years old. Asthma is an obstructive lung disease. A recognizable effect of asthma is that the inflammation of the expiratory organs like the trachea, bronchi, bronchioles and alveoli with wheezing being a key symptom during asthmatic . Other symptoms of asthma include coughing, shortness of breath and chest tightness. The airways of asthmatic patient are hypersensitive to stimulus and allergies causing a chronic inflammation of the airways when exposed to such triggers.

Methods

Spirometry and speech data of 150 asthmatic patients at the Korle-Bu Teaching Hospital (Ghana) were taken, along side other information like age, mass, height and sex. The age range was 18 to 45 years. Consent was obtained from subjects before including them within the research. Data from 33 of those patients was then taken for analysis, since the opposite data had speech errors or had incomplete information. Acoustic data extraction The speech signals to be analyzed were continuous and sustained pronunciation of vowels sounds: /a:/, /e:/, /ɛ:/, /i:/, /o:/, /ɔ/ ,/:u:/, consonant /s:/ and phrase 'She sells'. The vowel notation used is predicated on the IPA (International Phonetic Alphabet) symbols. Patients were made to pronounce each of those sounds and therefore the phrase three consecutive times while being recorded at a frequency of 44.1 kHz. The recorder used was Sony ICD px333 Voice Recorder. Speech parameters were then extracted using Praat acoustic analysis software version 6.0.08. The speech data were filtered at a gain of 40 dB (where necessary) using Adobe Audition CS6 so as to attenuate ground noise .A sample audio file opened within the Praat interface and the view of a specific vowel segment

Conclusion

In this study, acoustic analysis was wont to investigate the correlation between FEV1 /FVC ratio obtained from spirometry and Harmonics-toNoise Ratio (HNR) of the vowels sounds /a:/, /e:/, /ɛ:/, /i:/, /o:/, /ɔ/ ,/:u:/ and phrase "she sells". it had been found that the various sounds yielded different R2 values. The results obtained have generally low R2 values, the very best being 42.08% for the vowel /ɛ:/ with cubic polynomial regression. Challenges in speech and spirometry data collection could have greatly affected the results and thus it's recommended that any future work should address the challenges.