

Telemonitoring of Three Characteristic Parameters of Acoustics Vocal Signal in Patients with Tumor or Inflammatory Chronic Dysphonia

S Abdelouahed^{1*}, M Benabdellah¹ and S Aounallah²

¹Laboratory of Biomedical Engineering, Tlemcen University, Tlemcen, Algeria

²Specialist in Oto-Rhino-Laryngology (ORL), Assistant at Tlemcen University, Tlemcen, Algeria

Abstract

The evaluation of voice quality and the perception of its degradation through various acoustic clues are major concerns for voice professionals involved in the process of vocal rehabilitation. In this context, it is necessary to pay particular attention to the set of indices capable of delivering relevant information to help diagnose and assess the effects of vocal re-education proposed. Therefore, the contribution of experimental phonetics in clinical practice is a proven fact. If the study we propose is part of the evaluation of voice quality, our problem is to develop a system dedicated to the objective characterization of chronic dysphonia of tumor or inflammatory origin. The aim of the telemedicine device that we develop is threefold: diagnosis, treatment and monitoring of disease. For this we proceed initially to the remote recording and archiving of an acoustic speech signal voiced in this case "a" sustained for three seconds. We then apply at the ENT department of the University Hospital of Tlemcen, different algorithms of objective assessment of three parameters in this case the fundamental frequency, jitter and DFT-RD that allow experts to assess the development of chronic dysphonia of tumor or inflammatory origin (larynx cancer, inflammatory polyp of the vocal cords, chronic laryngitis).

Keywords: Télé medicine; DFT-RD; Chronic dysphonia; Voiced sound; Jitter; Fundamental frequency; Winsock

Introduction

The voice is a spectacular indicator of physical and mental health of a person. The technology of voice pathology has been a marked increase over the past two decades, the voice processing is now a fundamental component of engineering [1-4].

The special importance of voice processing in the more general framework is due to the privileged position of the speech as a vehicle of information in our human society [5]. The voice is indeed produced by the vocal tract, continuously monitored by the motor cortex [6,7].

Among the voice treatment applications we distinguish [8,9];

- 1) Temporal spatio-spectro analysis of the vocal signal observing the objective characterization of dysphonia of laryngeal origins [6,10].
- 2) Quantitative estimation of characteristics parameters of the vocal signal during its acoustical representation Including the Fundamental Frequency and the jitter of voiced sounds [11].

Material and Methods

The slide that we have implemented is composed of an interface for acquiring the acoustic speech signal consists of a classic microphone to reproduce sound in analog form and sound card for digitization and the environment "Audacity" as software to archive the signal in Wave format in order to perform the calculation of different indices and we had to implement an algorithm for converting Wave format to decimal format in Visual Basic environment. The experimental protocol includes the following steps:

- Pronunciation of a voiced sound in this case 'a' sustained for three seconds.
- The division of the signal into 6 frames each 0.5 seconds
- The calculation of the three indices (spectral content, fundamental frequency and jitter) averaged over six frames.

- The correlation between the indices themselves and the balance sheet and para-clinic of patients.

- The implementation of an interactive database of physiological and pathological acoustic voice signals for a clinical and epidemiological study and better therapeutic management.

Global algorithm of the application

Recording the vocal signal via Audacity software

Data conversion from the WAVE format to hexadecimal one

The signal windowing

The signal layout

The Calculation and the layout of the DFT

Calculation of jitter

Calculates the average fundamental frequency (Table 1)

The fundamental frequency is established by gliding average method [12,13] is given by following equation

Distant Sustained of the Patient

The patient treated by the radiotherapy (persons suffering from

***Corresponding author:** S Abdelouahed, Laboratory of Biomedical Engineering, and Tlemcen University, Tlemcen, Algeria, Tel: 00 21343 28 5689; E-mail: sara.abdelouahed@hotmail.com

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Healthy subjects										
Fundamental frequencies Fs (HZ)	1 st subject	2 nd subject	3 rd subject	4 th subject	5 th subject	6 th subject	7 th subject	8 th subject	9 th subject	10 th subject
	Male sex					Female sex				
1 st selection	227.05	200.65	190.09	184.81	216.49	205.93	184.81	211.21	200.65	190.09
2 nd selection	184.81	211.2	184.8	211.21	184.81	179.53	205.93	190.09	211.2	184.8
3 rd selection	184.81	184.8	184.8	179.53	200.65	221.77	227.05	195.37	184.8	184.8
4 th selection	227.05	184.8	216.49	184.81	221.77	205.93	211.21	216.49	184.8	216.49
5 th selection	195.12	211.4	184.81	211.21	200.65	184.81	195.37	179.53	184.81	184.81
6 th selection	184.8	195.37	211.21	184.8	184.81	205.93	195.37	195.37	195.37	211.21
The average fundamental frequencies (HZ)	200.6	198.03	196.68	192.72	201.53	200.65	203.29	198.01	193.59	195.36
Jitter (sec)	0.69	0.67	0.68	0.67	0.77	0.68	0.61	0.79	0.7	0.68

Table 1: The jitter and the average fundamental frequency in healthy subjects of corpus.

Sick subjects										
Fundamental frequencies Fs (HZ)	1 st subject	2 nd subject	3 rd subject	4 th subject	5 th subject	6 th subject	7 th subject	8 th subject	9 th subject	10 th subject
	Pathologietumorale					Pathologieinflammatoire				
1 st selection	73.92	58.08	68.64	47.52	47.52	50.52	105.6	121.44	105.6	174.25
2 nd selection	73.92	47.52	47.52	52.8	63.36	67.36	147.85	105.6	137.29	163.69
3 rd selection	52.8	47.5	47.52	52.8	47.52	50.52	126.73	110.88	126.73	142.57
4 th selection	73.92	42.24	68.64	47.58	58.08	58.08	142.57	100.32	110.88	174.81
5 th selection	63.36	42.24	68.64	58.08	63.36	68.64	105.6	137.29	121.44	163.69
6 th selection	73.92	47.52	73.92	58.08	68.64	47.52	110.88	137.29	105.6	142.57
The average fundamental frequencies (HZ)	68.64	47.51	62.48	52.81	58.08	57.10	123.20	118.8	117.92	160.17
Jitter (sec)	2.64	2.22	2.62	2.4	2.69	2.65	1.5	1.59	1.55	1.03

Table 2: The jitter and the average fundamental frequency in sick subjects of corpus.

cancer) or by medical treatment (a patient presents a clinical inflamed syndrome) and whose living in isolated area especially the north polar could be distant sustained thank to platform implantation at near the health centers and thanks to the periodical recording of the acoustical signal vocal according to the precedent described protocol and its O.R.L department of University Hospital accordance with the architecture client-server hold up by the component Winsock compatible with the protocol TCP/IP which permitted the transmission of the data toward intranet or internet thus the patient avoiding the inutile movement a condition that he responds favorably to the instituted treatment.

Summary of Results

In healthy subjects the fundamental frequency is situated around 200 Hz corresponding to the physiological frequency of the vowel 'a'. Jitter extend to 0.7 sec (Table 2).

In patients with cancer of the vocal cords the fundamental frequency is significantly reduced by around 60 HZ against jitter is greatly increased set to 2.5 sec.

- In patients with inflammatory disease: chronic laryngitis: fundamental frequency is reduced to 120 HZ. Jitter is increased slightly to 1.5 sec.

- Inflammatory polyp of the vocal cords: fundamental frequency decreased slightly to 160 HZ. Jitter is increased slightly to 1.03 sec.

The spectral range is also significantly diminished in cancer patients due to the large reduction see the total absence of vibration of the vocal cords. This limitation of the frequency content is also present but truncated in the case of chronic inflammatory diseases of the larynx.

Conclusion

Characterization and objective assessment of chronic dysphonia using three parameters study seems to be in perfect harmony in effect in the case of inflammatory diseases the fundamental frequency is around 120 HZ and jitter around 1.2 sec; While in tumor pathologies fundamental frequency is much lower (goshawks 60 HZ) while the jitter increases to three times compared to healthy subjects (2.5 sec).

The clinical and para-clinical examination and notably the pathological examination are in perfect agreement with the evolution of its indices.

Clinical validation of the results is still subject to a much larger sample supported by a rigorous statistical support.

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