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# Extraction of Heart Rate Parameters Using Speech Analysis

**Jaswinder Kaur[1], Rupinder Kaur[2]**

[1, 2]IET, Kharar, Punjab, India

**Abstract:** ***The heart rate variation has been observed when analyzing the speech analysis of a person sitting at remote place. In the presented approach, 20 –30 years age group person's speech is recorded using the common recording utility for testing purposes. The time duration for speech production is approximately 1 - 2 minutes. Further, the entropy, energy, power, mean, frequency, standard deviation and variance are computed by statistical analysis of the speech signal. The equations for the same are illustrated in algorithm section of the paper. A correlation is established between the heart rate and features of the speech signal. The validation of the algorithm for correlation between the features and heart rate is the important activity of the work. More and more no. of speech signal samples may be tried out for exact correlation of heart rate and feature vectors.***

**Keywords:** HR, Speech Synthesis, Zero Crossing

## 1. Introduction

Speech sounds are sensations of air pressure vibrations produced by air exhaled from the lungs and modulated and shaped by the vibrations of the glottal cords and the resonance of the vocal tract as the air is pushed out through the lips and nose. Speech is an immensely information-rich signal exploiting frequency-modulated, amplitude-modulated and time-modulated carriers (e.g. resonance movements, harmonics and noise, pitch intonation, power, duration) to convey information about words, speaker identity, accent, expression, style of speech, emotion and the state of health of the speaker. All this information is conveyed primarily within the traditional telephone bandwidth of 4 kHz. The speech energy above 4 kHz mostly conveys audio quality and sensation.

## 2. Related Work

Bjorn Schuller, Felix Friedmann, Florian Eyben; (2013) "Automatic Recognition of Physiological Parameters in the Human Voice : Heart Rate and Skin Conductance," We show that high pulse/low pulse, heart rate and skin conductance recognition can reach good accuracies using classification on a large group of 4k audio features extracted from sustained vowels and breathing periods. A database containing audio, heart rate and skin conductance recordings from 19 subjects is established for evaluation of audio-based bio-signal recognition. [2]

Saloni, R.K. Sharma and Anil K. Gupta; (2013) "Classification of High Blood Pressure Persons Vs Normal Blood Pressure Persons Using Voice Analysis," The human voice is remarkable, complex and delicate. All parts of the body play some role in voice production and may be responsible for voice dysfunction. The larynx contains muscles that are surrounded by blood vessels connected to circulatory system. [9]

Jurák P, Zvoníček V, Leinveber P, Halámek J, Vondra V; (2012) "Respiratory Induced Heart Rate and Blood Pressure Variability during Mechanical Ventilation in Critically ill and Brain Death Patients," We analyze respiratory induced heart rate and blood pressure variability in mechanically ventilated patients with different levels of sedation and central nervous system activity. Our aim was to determine whether it is possible to distinguish different levels of sedation or human brain activity from heart rate and blood pressure. We measure 19 critically ill and 15 brain death patients ventilated at various respiratory frequencies - 15, 12, 8 and 6 breaths per minute. [4]

Abdelwadood Mesleh1, Dmitriy Skopin1, Sergey Baglikov2, and Anas Quteishat1; (2012) "Heart Rate Extraction from Vowel Speech Signals," In this we presents a novel non-contact heart rate extraction method from vowel speech signals. [1]

Zhe Chen, Patrick L.Purdon, Eric T. Pierce, Grace Harrell, Emery N. Brown, and Riccardo Barbieri; (2009) "Assessment of Baroreflex Control of Heart Rate During General Anesthesia Using a Point Process Method,"[10] Evaluation of baroreflex control of heart rate (HR) has important implications in clinical practice of anesthesia and postoperative care. [10]

D. H. Phan, S. Bonnet, R. Guillemaud, E. Castelli, N. Y. PHAM THI; (2008) "Estimation of Respiratory Waveform and Heart Rate using an Accelerometer," The use of an accelerometer to measure cardio-respiratory activity is presented in this theory. Movement of the chest was recorded by an accelerometer attached to a belt around the chest. The acquisition is realized in different status: normal, apnea, deep breathing or after exhaustion and also in different postures: vertical (sitting, standing) or horizontal (lying down). [3]

Michiaki Ariga, Yoshikazu Yano, Shinji Doki, and Shigeru Okuma; (2007) "Mental Tension Detection in the Speech based on Physiological Monitoring," The focus of this theory is mental tension detection in speech to assist control the tension in day-to-day business such as conferences and operations in a call center. It is difficult to use classical techniques for mental tension detection in day to- day business because those techniques require invasion body by electrodes or squirts and tied up by cables. [7]

RR Galigekere, JK Shoemaker; (2004) "On Utilizing the Strengths of AR and MVDR Methods to Circumvent their Weaknesses in Application to HRV Analysis," We discuss a procedure that exploits the strengths of autoregressive (AR) and minimum variance distortionless response (MVDR) methods to circumvent their respective weaknesses, in the context of estimating the power spectral measures from cardiovascular signals. [8]

L.J.M. Rothkrantz, FLJ. Van Vark, D. Datcu; (2004) "Multi-medial Stress Assessment," The aims of the theory is to develop an instrument: for automated stress assessment. The underlying system is based on the analysis of facial expressions, voice ana!ysis and the analysis of physiological signals such as heart rate and blood pressure. Analysis of these multi-medial data takes place in parallel and are based on Artificial Intelligerice technology. [6]

Kumari L. Fernando, V. John Mathews, Michael W. Varner and Edward B. clark; (2003) "Robust estimation of fetal heart rate variability using Doppler ultrasound," Heart rate variability (HRV) provides important information about the development of the cardiovascular system in fetuses. We presents a new measure of fetal HRV that can be estimated using Doppler ultrasound techniques. [5]

## 3. Algorithm

The presented work is implemented on the audio signals as recorded using the Samsung Mobile phone recording utility. The sound clips are made of time duration of 1 minutes each. The audio format kept is mp3. The same matter of speech was given to each reader under testing. The characteristics of the recorded speech is given as below:
Time Duration: 60 secs.
Recording Utility: Samsung Mobile – Galaxy
No. of Words: 200
Language: English
Speech: Abstract of the paper

The people under test are in the age group 20 – 30 years. The experiment may be repeated for the children in different age groups for research purposes. However, the algorithm performance will deviate if the people under test suffer from the problem of stammering.

The audio clip is read in matlab environment using mp3 reader. The test is performed in different segment of the same audio clip so as to confirm the same heart rate for the same person. Further, the different audio clips of different person are tested for the same segment and duration. The results are given in next section for review.

**Entropy (Ent)**
The entropy of a signal is a measure of the randomness of the signal. In other words, it can be viewed as a measure of uncertainty. Entropy has been shown to be effective in dealing with complex biological signals. The entropy Ent is given by:

$$Entropy\ (Ent) = -\sum_{i=1}^{n} p(xi).\log_{10} p(xi)$$

where, x = (x1, x2. . .xn) is a set of random phenomena of speech samples, and p is a probability of random phenomenon of speech samples.

**Power (P)**
Power is given by average square sum of speech samples and given by the following equation:

$$Power\ (P) = \frac{1}{n}\sum_{i=1}^{n} x_i^2$$

Where xi is the speech samples and n is the total no of samples no.

**Energy (E)**
Power is given by square sum of speech samples and given by the following equation:

$$Energy\ (E) = \sum_{i=1}^{n} x_i^2$$

Where xi is the speech samples and n is the total no of samples no.

**Mean (μ)**
Mean is given by avaerage sum of speech samples and given by the following equation:

$$Mean\ (\mu) = \frac{1}{n}\sum_{i=1}^{n} x_i$$

Where xi is the wavelet coefficient and n is the total no of wavelet coefficients

**Standard Deviation (SD)**
Standard Deviation is given by:

$$SD = \frac{1}{n}\sum_{i=1}^{n} (x_i - \mu)^2$$

Where xi and μ are the speech samples and n is the total no of samples no. and Mean respectively.

The entropy, mean, energy, power, variance, standard deviation and freq. are computed using the following equations:

The HR is related to different properties given by:

HR = f(Entropy, Energy, Mean, Power, Freq., Var., SD)

When inserting the coefficients, the equation beomes as:

$$HR = K_1.Energy + K_2.Entropy + K_3.Mean + K_4.Power + K_5.Var + K_6.SD$$

## 4. Results and Conclusion

The presented work is based on extraction of body physiological parameters work is based on extraction of body skin conductance and heart rate. The accuracy primarily depends upon the authentic recording of speech signal and uniformity of the text material. The different text material may give rise to large variations in the results as the work is considerably new and the data for the same is not available for validation or comparison. The data or the same has to be generated and text material has to be more specific and not the general one. A heart surgeon may suggest in this case when deciding on text material that may give enough information about the heart variation.

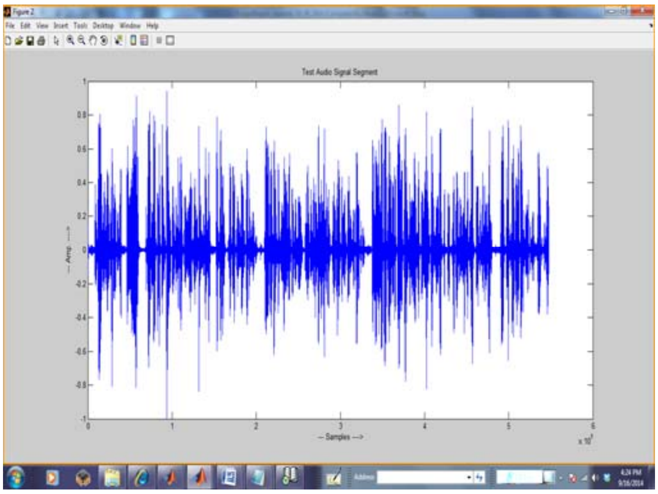


**Figure 1:** Test Audio Signal Segment

## Flow Chart

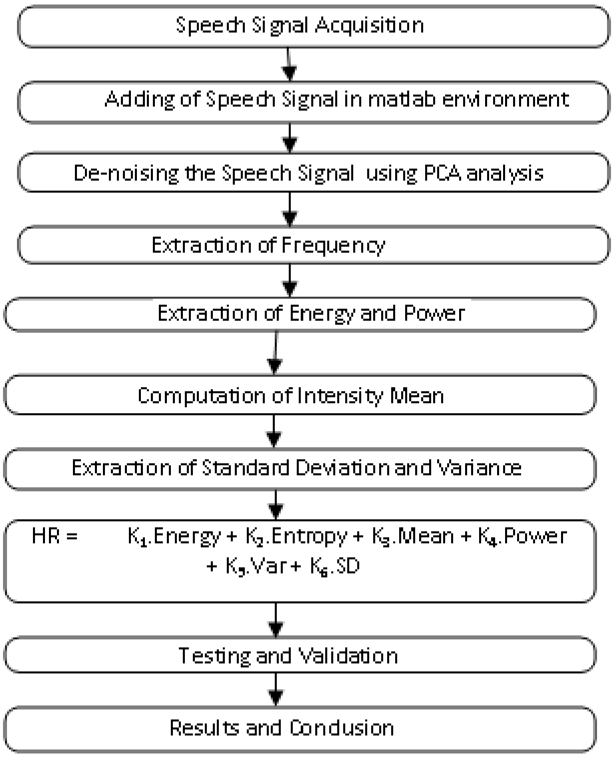


**Table 1:** Speech Signal Features of different persons for the same speech abstract

| *S. No.* | *Mean* | *Entropy* | *Power* | *Energy* | *Freq.* | *Variance* | *SD* | *HR* |
|---|---|---|---|---|---|---|---|---|
| 1. | 0.07 | 3.48 | 3.80 | 2.53 | 17.50 | 0.01 | 0.13 | 86 |
| 2. | 0.17 | 3.42 | 3.56 | 1.53 | 15.51 | 0.11 | 0.12 | 76 |
| 3. | 0.24 | 2.46 | 2.80 | 2.23 | 12.90 | 0.21 | 0.22 | 78 |
| 4. | 0.33 | 1.58 | 3.84 | 2.03 | 14.52 | 0.05 | 0.34 | 77 |
| 5. | 0.12 | 2.40 | 1.23 | 1.13 | 12.51 | 0.01 | 0.15 | 81 |

Age Group: 20-30 Years

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## Author Profile

**Jaswinder Kaur** is pursuing her M.Tech in ECE from DIET, Kharar, Punjab. Her field of interest is in digital signal processing based system applications