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Discrimination of Stressed Person with Normal Person Using Voice Analysis

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Abstract- Voice medium is the most primitive and natural form of communication known to human civilization. Vocal communication is an essential skill required in man's professional as well as personal life for expressing feelings, earning livelihood, and in other day to day social interactions. There are certain medical conditions which affect the voice patterns of patients affected by those disorders. People suffering from pathologic voices have to face many difficulties in their daily lives. The Voice Pathological disorders are associated with respiratory, nasal, Asthma, Depression, Stress etc. A voice disorder can be defined as a problem involving abnormal pitch, loudness or quality of the sound produced by the larynx. A person may lose his/her voice even when no physical damage is apparent or present. Stress or psychological issues can cause a person to become hoarse or even lose the voice temporarily.Acoustic voice analysis can be used to characterize the pathological voices. This dissertation report presents the classification of stressed persons and normal persons with the aid of voice signal recorded from the patients. Simulation results show differences in the parameter values of healthy and pathological persons. Then an Optimum feature vector is prepared and K-means classification algorithm was implemented using MATLAB for data classification. The 98.2143% accuracy and 80.3571% precesion was obtained. Voice analysis basically deals with the decomposition of voice signal into voice parameters for processing the resulted features in desirable application.

Key Words – Voice analysis, Stress, acoustic parameters, K mean algorithm.

I. INTRODUCTION

Vocal communication skills are among the fundamental characteristic necessary for the healthy survival of human body in society [1]. The voice media being the earliest way of communication known to humans since their evolution has always been a subject of interest for scientific studies. Emotions have been recognized to be an important aspect of human beings [2]. Spoken language comes from our inside. There are some factors such as mood, emotion, physical disturbances, and further practical information contained in speech signals. With increasing demand for speech technology systems, there is an increasing need for rectification of emotion and other typical effects. In some cases, it becomes very important to detect the emotional state of person (stress, fatigue) from his/her voice. The apperception of human stress remains a major challenge in computational field. Stress [3] is generally defined as a strain upon a bodily organ or mental power. Stress is a normal physical response to events that makes you feel endangered or upset your balance in some way. Depending upon its duration and intensity, stress can have short term or long-lasting effects. Stress results in emotional instability, loss of performance, depression and anxiety, voice disorders, blood pressure (hypertension), premature death [4].

II. STRESS AND HYPERTENSION

Stress is a normal part of life. But too much stress can lead to emotional, psychological and even physical problems including heart disease, high blood pressure, and chest pains. Stress can cause hypertension [5] through repeated blood pressure elevations as well as by stimulation of the nervous system to produce large amounts of vasoconstrictions hormones that increase blood pressure. Factors affecting blood pressure through stress include white coat hypertension, job strain, race, social environment, and emotional distress. Furthermore, when one risk factor is coupled with other stress producing factors, the effect on blood pressure is multiplied. Overall, studies show that stress does not directly cause hypertension, but can have an effect on its development. A variety of non-pharmacologic treatments to manage stress have been found effective in reducing blood pressure and development of hypertension, examples of which are meditation, acupressure, biofeedback and music therapy. Recent results from the National Health and Nutrition Examination Survey indicate that 50 million American adults have hypertension (defined to be a systolic blood pressure of greater than 139 mm Hg or a diastolic blood pressure of greater than 89 mm Hg). In 95% of these cases, the cause of hypertension is unknown and they are categorized as "essential" hypertension. Although a single cause may not be identified, the general consensus is that various factors contribute to blood pressure elevation in essential hypertension. In these days of 70 hour work weeks, pagers, fax machines, and endless committee meetings, stress has become a prevalent part of people's lives; therefore the effect of stress on blood pressure is of increasing relevance and importance. Although stress may not directly cause hypertension, it can lead to repeated blood pressure elevations, which eventually may lead to hypertension.

III. FEATURES AND CLASSIFICATION METHODS

In this research, the recorded voice database is used. The voice database includes 42 voice recording from 7 normal females, 7 normal males, 7 stressed females, 7 stressed males, 7 hypertensive females, 7 hypertensive males. Speech record database consists of following words ("hum sab ek hein") [6]. Acoustic analysis was performed using PRAAT Software programme. The following parameters were analyzed: Pitch (Hz), DVB (%), and Jitter (frequency perturbation – local, %), Shimmer (amplitude perturbation – local, %), Harmonic to noise ratio (HNR - db).

IV. IMPLEMENTATION AND PROPOSED WORK

In this research, the recorded voice database is used. The voice database includes 42 voice recording from 7 normal females, 7 normal males, 7 stressed females, 7 stressed males, 7 hypertensive females, 7 hypertensive males. Speech record database consists of following words ("hum sab ek hein"). Acoustic analysis was performed using PRAAT Software program. The following parameters were analyzed: Pitch (Hz), DVB (%), and Jitter (frequency perturbation – local, %), Shimmer (amplitude perturbation – local, %), Harmonic to noise ratio (HNR – db).

V. FEATURE EXTRACTION TABLE OF NORMAL FEMALES

The recorded voice of 7 normal females is given as input to the PRAAT software various features of voice are extracted from PRAAT [8]. The values of different extracted parameters like maximum Pitch, minimum Pitch, Mean Pitch, S.D, Jitter, Shimmer, Degree of Voice Breaks, Harmonic to Noise Ratio are clubbed and shown in table 1.

Table-1 Feature extraction table of 7 normal females.

Normal Females	Max. Pitch (Hz)	Min. Pitch (Hz)	Mean Pitch (Hz)	S.D (Hz)	Jitter (%)	Shimmer (%)	DVB (%)	HNR (db)
Female 1	474.081	85.766	210.316	44.63	1.841	8.194	46.578	13.999
Female 2	467.092	154.45	213.309	50.159	1.564	7.113	56.875	13.824
Female 3	457.464	75.923	266.693	36.075	1.741	7.168	49.365	14.817
Female 4	428.971	175.747	234.93	48.448	1.729	7.925	47.954	13.705
Female 5	435.574	213.533	282.823	40.637	1	8.148	29.975	12.32
Female 6	474.71	196.766	275.359	69.655	1.169	8.532	36.098	12.197
Female 7	483.693	183.531	248.827	44.889	1.742	8.749	19.031	12.12

VI. FEATURE EXTRACTION TABLE OF NORMAL MALES

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Table -2 Feature extraction table of 7 normal males.

Normal Males	MAX. Pitch (Hz)	MIN. Pitch (Hz)	MEAN Pitch (Hz)	S.D (Hz)	Jitter (%)	Shimmer (%)	DVB (%)	HNR (%)
Male 1	175.929	93.968	128.583	14.142	2.746	10.652	55.794	11.482
Male 2	147.223	83.181	122.114	13.704	2.713	10.436	47.345	10.222
Male 3	157.279	93.47	128.918	12.217	2.587	10.813	51.14	8.77
Male 4	163.701	93.389	134.77	17.694	2.576	10.676	43.058	10.493
Male 5	154.355	75.007	123.44	18.438	2.12	10.51	48.29	7.454
Male 6	226.44	134.074	184.635	22.255	1.932	9.915	48.771	12.273
Male 7	237.717	72.043	151.38	32.212	2.12	10.357	40.443	7.354

VII. FEATURE EXTRACTION TABLE OF STRESSED FEMALES

The recorded voice of 7 normal females is given as input to the PRAAT software various features of voice are extracted from PRAAT. The values of different extracted parameters like maximum Pitch, minimum Pitch, Mean Pitch, S.D, Jitter, Shimmer, Degree of Voice Breaks, Harmonic to Noise Ratio are clubbed and shown in table-2.

Table-3 Feature extraction table of 7 Stressed females.

Stressed Females	MAX. Pitch (Hz)	MIN. Pitch (Hz)	MEAN Pitch (Hz)	S.D (Hz)	Jitter (%)	Shimmer (%)	DVB (%)	HNR (%)
Female 1	262.933	178.642	230.955	22.573	3.276	16.002	49.986	6.217
Female 2	251.51	189.061	237.48	8.673	4.999	18.714	39.05	6.559
Female 3	270.962	200.945	234.793	12.029	3.523	15.223	37.279	8.787
Female 4	274.883	119.638	229.558	18.085	3.737	16.406	19.391	9.289
Female 5	257.549	177.546	212.535	12.731	3.567	14.998	36.17	9.542
Female 6	267.243	94.743	204.369	28.907	3.416	12.351	31.983	9.599
Female 7	251.62	93.72	194.23	44.937	3.96	14.08	43.284	8.062

VIII. FEATURE EXTRACTION TABLE OF STRESSED MALES

The recorded voice of 7 normal females is given as input to the PRAAT software various features of voice are extracted from PRAAT. The values of different extracted parameters like maximum Pitch, minimum Pitch, Mean Pitch, S.D, Jitter, Shimmer, Degree of Voice Breaks, Harmonic to Noise Ratio are clubbed and shown in table -4.

Table-5 Feature extraction table of 7 Stressed males.

Stressed Males	MAX. Pitch (Hz)	MIN. Pitch (Hz)	MEAN Pitch (Hz)	S.D (Hz)	Jitter (%)	Shimmer (%)	DVB (%)	HNR (%)
Male 1	261.183	70.764	129.091	39.657	4.39	14.292	65.776	5.922
Male 2	163.951	67.742	120.624	19.189	2.671	10.791	44.857	9.603
Male 3	258.838	66.729	111.979	42.232	3.699	15.699	32.816	6.98
Male 4	203.627	75.094	203.627	24.327	3.011	18.878	9.197	6.27
Male 5	175.394	67.803	133.472	19.84	5.046	16.854	23.999	4.954
Male 6	210.423	70.79	157.798	26.319	6.572	19.942	37.21	4.537
Male 7	210.151	279.17	141.981	37.217	2.094	12.47	53.183	9.298

IX. PROPOSED MODEL

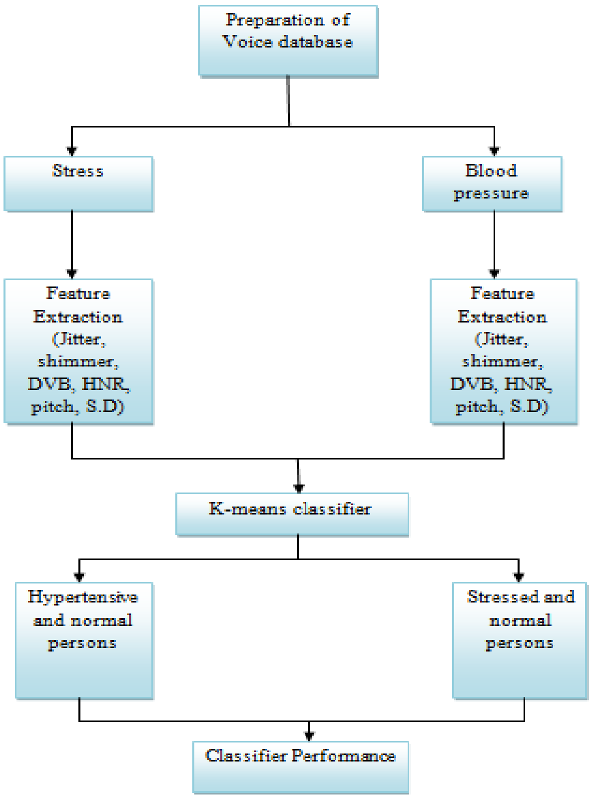

Fig 1: Layout of the dissertation work.

X. RESULTS

Stressed vs. Normal female samples

Table-6 shows training dataset of 7 normal females and table-7 shows the prediction data vector of Stressed females.

a) Actual

Table-6 Training Dataset

```
>> ACTUAL

ACTUAL =

  474.0810   85.7660  210.3160   44.6300    1.8410    8.1940   46.5780   13.9990
  467.0920  154.4500  213.3090   50.1590    1.5640    7.1130   56.8750   13.8240
  457.4640   75.9230  266.6930   36.0750    1.7410    7.1680   49.3650   14.8170
  328.9710  175.7470  234.9300   48.4480    1.7920    7.9250   47.9540   13.7050
  435.5740  213.5330  282.8230   40.6370    1.0000    8.1480   29.9750   12.3200
  474.7100  196.7660  275.3590   69.6550    1.1690    8.5320   36.0980   12.1970
  483.6930  183.5310  248.8270   44.8890    1.7420    8.7490   19.0310   12.1200
```


b) Predicted

Table-7 Prediction Dataset

```
>> PREDICTED

PREDICTED =
```

262.9330	178.6420	230.9550	22.5730	3.2760	16.0020	49.9860	6.2170
251.5100	189.0610	237.4800	8.6730	4.9990	18.7140	39.0500	6.5590
270.9620	200.9450	234.7930	12.0290	3.5230	15.2230	37.2790	8.7870
274.8830	119.6380	229.5580	18.0850	3.7370	16.4060	19.3910	9.2890
257.5490	177.5460	212.5350	12.7310	1.0000	14.9980	36.1700	9.5420
267.2430	94.7430	204.3690	28.9070	3.4160	12.3510	31.9830	9.5990
435.5740	213.5330	282.8230	40.6370	1.0000	8.1480	29.9750	12.3200

K-means Classification

K-means classification of training dataset and predicted dataset is done with the help of MATLAB.

Table-8 K-means Classification of Training and

c) Prediction dataset

```
>> kmeans(Dataset,7)
Displaying Data
```

474.0810	85.7660	210.3160	44.6300	1.8410	8.1940	46.5780	13.9990	1.0000
467.0920	154.4500	213.3090	50.1590	1.5640	7.1130	56.8750	13.8240	2.0000
457.4640	75.9230	266.6930	36.0750	1.7410	7.1680	49.3650	14.8170	3.0000
328.9710	175.7470	234.9300	48.4480	1.7920	7.9250	47.9540	13.7050	4.0000
435.5740	213.5330	282.8230	40.6370	1.0000	8.1480	29.9750	12.3200	5.0000
474.7100	196.7660	275.3590	69.6550	1.1690	8.5320	36.0980	12.1970	6.0000
483.6930	183.5310	248.8270	44.8890	1.7420	8.7490	19.0310	12.1200	7.0000
262.9330	178.6420	230.9550	22.5730	3.2760	16.0020	49.9860	6.2170	4.0000
251.5100	189.0610	237.4800	8.6730	4.9990	18.7140	39.0500	6.5590	4.0000
270.9620	200.9450	234.7930	12.0290	3.5230	15.2230	37.2790	8.7870	4.0000
274.8830	119.6380	229.5580	18.0850	3.7370	16.4060	19.3910	9.2890	4.0000
257.5490	177.5460	212.5350	12.7310	3.5670	14.9980	36.1700	9.5420	4.0000
267.2430	94.7430	204.3690	28.9070	3.4160	12.3510	31.9830	9.5990	4.0000
435.5740	213.5330	282.8230	40.6370	1.0000	8.1480	29.9750	12.3200	5.0000

d) Clustering

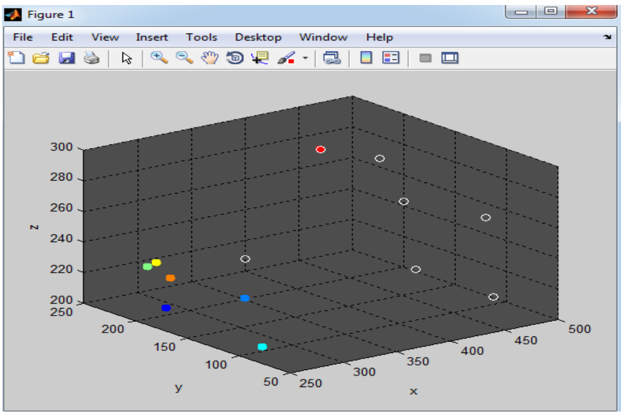

Fig 2 Clusters of training and predicted dataset

From figure 2 it is clear that white circles shows the training data vectors and colored circles indicate predicted data vectors. From table-8 it is clear that the first 7 samples are of actual dataset. And the next 7 samples are of predicted dataset. After applying K-means algorithm to these samples clusters are formed for eg. The first patient of predicted dataset lies near to the 4th patient of actual dataset as shown in clustering Figure 2.

XI. CLASSIFIER PERFORMANCE

In order to test the classifier performance, several measures namely**,** accuracy, sensitivity, specificity, precision, are considered. These measures are calculated from the measures true positive, true negative, false positive, false negative. The percentage of positive predictions that are correct.

Table -9 Defining Classifier Performance Measures

Measure	Formula	Meaning
Accuracy	(TP + TN) / (TP + TN + FP + FN)	The percentage of predictions that is correct.
Precision	TP / (TP + FP)	The percentage of positive predictions that is correct.

```
Accurcy Precision
ans =

    98.2143   80.3571
```

Fig 3 Classifier Performance results

XII. CONCLUSION

Characterizing pathological voice using efficient acoustic analysis have been the focus of a number of research studies in past. The research work presented in this paper successfully demonstrated the usefulness of some basic features in classifying normal and highly stressed persons. After applying K-means algorithm using MATLAB accuracy of 98.2143 and precision of 80.3571 are obtained. Highly stressed persons have different values of acoustic parameters than healthy one. These observations can be used further in various medical applications. Also, further research can be done to develop algorithm to diagnose Stress using voice.

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