

Analysis of Stress Level from Voice Sample and Psychological Factors

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ABSTRACT

The main goal of this research is to look at the effects of psychological stress (both positive and negative stress) on human articulation. The estimation of several voice parameters is used in both of these analyses. The results of the psychological stress studies show that the influence of stress on humans affects all of the voice parameters. The research technique included the use of a speech database containing recorded items, as well as systematically varying deception and stress levels. In this research paper will also analyses the threat pattern which will be on conceptual basis of the subject to understand the psychological behavior and emotional behavior of the subject. The frequency, pitch and intensity of the voice sample are analyzed by various software; comparing the taken sample with the standard sample. According to the psychological studies, the basic standard pattern of voice frequency is +70-80Hz and the wave pattern above that are taken as suspicious pattern. The psychology study of emotional diamond is also been used in this paper which is been on the theoretical concept where mood of the subjects is also been observed; the stress level, anger, emotional stress etc. The voice readings in this research are taken as minimum and maximum volume which are compared with the standard wavelength. The stress level of male and female are been differentiated from this experiment. The level of stress because of different psychological mood changes and particular note patterns have been observed.

Keywords: *Stress level, psychological effect, voice sample, voice stress, speech, emotional diamond concept.*

In the fields of psychology and law, there has been a growing interest in deceit and its detection since the 1980s. A large body of research has historically looked at physiological, nonverbal, and verbal behavior cues to see if they may be used to distinguish between liars and truth tellers. Despite this, study on the subject has proven difficult, with disappointing results: to yet, no single cue (physiological, behavioral, or verbal) has been discovered to be uniquely linked to deceit. In any case, compared to nonverbal and physiological signs, linguistic behavior under duress has received less attention in the past. In fact, because

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nonverbal behavior is thought to be less prone to be controlled under duress, it has gotten increasing attention.

With the advancement of technology, the volume of data continues to grow, making it challenging to evaluate such a large amount of data in order to extract useful information. Organizations have created a variety of analytical approaches and tools to examine and extract business insights from data. Voice analysis is a part of analytics which aids various firms in this endeavor by analyzing speech or words interviewed between two individuals in the session. It is the fastest-enduring technologies because it allows you to analyses people's feelings during a call, which can help you figure out how they feel about a product or service.

The goal of this study was to see if there was a link between acoustic speech metrics, listener assessments of pitch, volume, and rate of speech, and telephone interviewer success rates. There is a lot of evidence that speech and voice features are important indications of a speaker's personality, emotional state, affect, and attitudes. Since informal surveys done at the University of Michigan Survey Research Center show that refusals most often occur in the first minute or two of the call, when standardized introduction material is given, the evidence speaks to the importance of speech features. There is a lot of evidence that speech and voice features are good predictors of a speaker's personality, emotional state, affect, and attitudes.

There is a lotless evidence out there. Nine physicians working in an alcoholic treatment program were rated on the following factors: anger-irritation, sympathy-kindness, anxiety-nervousness, and matter- effeteness-professionalism, as well as the effect that such characteristics have on the actions of listeners, based on recorded interviews. These ratings were correlated with the number of alcoholics who sought additional treatment from the total number seen initially.

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Emotions are powerful natural components. They influence an individual's psycho-physiological condition through physiological-arousal, motor-expression, and subjective feelings. Physiological arousal* and motor expression could be noticed through facial-expressions, body-language, and speech*, whereas subjective sensations refer to an individual's interior state when they are stressed. Previous research has been seen that physiological arousal combined with fear alters speaker's breathing*, phonation*, and articulation* in such a way that stress-related auditory patterns emerge. Previous study has demonstrated that physiological arousal paired with fear causes stress-related auditory patterns to appearing the speaker's breathing, phonation, and articulation. The main purpose of this study is to find such stress-related patterns in the spectral and vocal aspects of a speaker attempting to deceive a cop during an interrogation.

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Deception can take many forms, including exaggeration, equivocation, concealment, and outright lying. "A deliberate attempt, whether successful or not, to conceal, fabricate, and/or manipulate factual and/or emotional information in any other way, by verbal and/or nonverbal means, in order to create or maintain in another or others a belief that the communicator is telling the truth, "according to the definition."

Many commercial by measuring changes in micro tremors in the laryngeal muscles induced by stress, devices like as voice stress analyzers, CVSAs, Lantern instruments, and others claim to be able to detect dishonesty. The polygraph examination is the most well-known and commonly utilised method for detecting deceit today. It's a medical device that records cardiovascular activity, breathing rate, and skin conductance using electrodes, blood pressure cuffs, and pneumatic gauges. The physiological reactions of liars are expected to differ from those of truth-tellers. Despite the fact that the polygraph is widely acknowledged as a deception detection technique, there is much debate about its usefulness, as demonstrated in National Academies research.

While most previous psychological studies on deception have focused on standard biometric indicators commonly measured in polygraphs (cardiovascular, electrodermal, and respiratory) as well as non-verbal hints such as gestures, body movement, facial expressions, brain imaging, bad smells, and vocal behaviour, it appears that literature on the acoustic correlates of deception by real criminals is limited.

As a result, more research in this area is necessary. In order to develop a reliable, non-invasive, and non-contact system that can tell the difference, it's critical to determine if there's a consistent and reliable link between stress (while deceptive) and basic voice parameters such as fundamental frequency, formant character traits, and voice perturbation metrics like jitter and shimmer. between truth and deception.

Previous research has shown that the listener derives various impressions of the speaker from the speech signal, including pitch, loudness, and rate; physical characteristics such as size and sex; and social and psychological characteristics such as personality type, emotional state, and social class. The relationship between these impressions has been studied extensively, particularly the relationship between speech features and the other types of impressions, as well as the relationship between speech acoustics and listener impressions. The basic research topic is how much a speaker's speech qualities influence a listener's actions. The basic research topic is how much a speaker's speech qualities influence a listener's actions.

If there is a link between a speaker's speech qualities and a listener's behavior, it should be visible in the speech signal's acoustic parameters, their perceptual equivalents, and the listener's impressions. As a result, there may be a benefit to explicitly analyzing the relationship between listener action and acoustic parameters. Although each acoustic characteristic has its own set of measurements, they are undoubtedly fewer and easier to obtain than listener judgments of speaker personality, emotions, and attitudes. It's best to start with measurements that have been examined in past paralinguistic investigations. Speech is a complicated auditory event that contains not just linguistic content, but also information about the speaker's identity and personal characteristics such as age and sex. Anatomical differences in the vocal structures, as well as learning differences in the use of the vocal mechanism, accounting for the distinctive, speaker-specific elements of the voice signal, but the nature of the relationship between acoustic output and a listener's perception is uncertain. Correlational analysis was used to determine variables relevant to the

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perception of interspeaker variations depending on the outcomes of evaluative tasks. Semantic differential rating systems and rating scales of specific vocal qualities have been used to identify speakers and distinguish between voices.

HISTORY OF VSA TECHNOLOGY

Three military officials departed from the United States Army in 1970, just before Lippold's article was published in 1971, and created a company called Dektor Counterintelligence and Security (CIS). Alan Bell, Bill Ford, and Charles McQuiston were the three officers. Bell was an expert in polygraphy, Ford was an expert in electronics, and McQuiston was an expert in counterintelligence. Ford had constructed an electrical device based on Lippold, Halliday, and Redfearn's idea, in which he tape-recorded the human voice, slowed it down three to four times its normal rate, and processed it through various lowpass filters before feeding it into an EKG strip chart recorder. The strip chart recorder drew tracings of the chart on heat sensitive paper after that. The device's name was the Psychological Stress Evaluator (PSE). Despite the fact that Dektor CIS began as a security firm, the PSE quickly became a success, and the company's focus turned to this system. A polygraph examiner from a local police force that had begun using the PSE was one of Dektor's first hires. Based on their polygraph experience and the usage of polygraph formats, this person developed a three-day training course with McQuiston. Allan Bell Enterprises [1] claims that all lie-detection tests as well as assessments are based on the assumption that speaking a begun truth will result in some level of psychological discomfort. As a result of psychological stress, a variety of physiological changes occur." Polygraph uses these physiological changes to determine a person's level of psychological stress. Polygraphs are often used to measure blood pressure, hormone levels, stomach and chest breathing patterns, galvanic skin response (perspiration), and pulse wave and amplitude. The US Army Land Warfare Laboratory sponsored the first VSA project, entitled application of Voice Analysis Method, which has been carried out by Bethesda, Maryland-based Decision Control, Incorporated. The goal of this research was to investigate if a speech analysis tool could detect tension in the spoken no. The investigations measured the stress levels of participants who were undergoing polygraph testing by recording their voice responses. The results were then compared to the polygraph interpretations. In this stress response comparison, the waveform results were similar. A prototype of a voice analyzer was designed, built, and tested. The device analysed audio files and provided three voice metrics as a consequence of its analysis. As per the report's introduction, a previous study showed that analysing the response no might tell whether the response was honest or dishonest. Six semi-orthogonal measurements and a broad range of band-pass frequencies were used in the research.

Types of VSA system

- Psychological stress evaluator
- Lantern
- Vericator
- Computerized voiced stress analyzer
- VSA mark1000
- VSA-15
- Xandi-electronics
- TVSA

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Psychological Stress Evaluator

(PSE): In March of 1971, this was the first VSA unit to hit the market. It was created to be used in the same way as a polygraph is used: one-on-one testing to identify deceit. It was a black box that produced a waveform using thermograph readout as an output. The PSE detects the variance and plots the change in in audible FM features of the voice. When analysed by a professional examiner, the graphic shows the person being questioned's major stress areas.

LANTERN:

The Lantern is a system created by the Diogenes Group Inc., which was founded in 1995. The Lantern system consisted of an analog-type magnetic tape recorder with integrated microphone, a Pentium laptop computer serving as a high-speed processor, and a big package of copyrighted, proprietary processing software specifically designed for ease of use. The format and presentation of the wave forms that represent the microtremor's activity, as well as the printing of tangible copies of the waveforms. The tape recorder is used to produce the primary record during an interview, which includes both questions and responses in their original context. The digital processor receives real-time input from the recorder's monitor output. With a single finger, the examiner may control high-sample rate digital collection of the data and the wave pattern of each answer which was said by the subject.

VERICATOR:

T*stech Ltd. was created in 1997 and makes the Vericator system, which was previously known as the T*rusterPro. This system allows the user to use their own computer if they meet the following criteria: WIN95™, WIN95™/NT 4.0™, Pentium™ I1 or 32mb RAM to 128mb RAM, a microphone, CD-ROM Drive double speed, and a 16 Bit Soundcard full duplex. A Vericator* CD, a Stereo TConnector for connecting the PC and the telephone, and a Vericator* The user manual is included with the package. It enables automated calibration, real-time deception analysis, and analysis of pre-recorded online conversations, interviews, and TV or radio parts. You can view, save, and print both the technical and study programs. There are graph displays for proper diagnosis, four built-in psychological lie detection patterns, a foreground reduction filtering system, and a background noise filtering system.

Computerized Voice stress analyzer (CVSA):

In 1986, NITV introduced the Computerized Voice Stress Analyzer (CVSA), which is today's most popular VSA system. Adverts for NITV claim that the system is used by over 500 security agencies nationwide, providing letters of endorsement as proof. To prevent criminals from accessing NITV to track down undercover cops, the network has pledged to only market to law enforcement agencies.

VSAMark-1000:

This technology is described as a stealthy electronic lie detection technique featuring quick analysis, results, and responses. The built-in tape recorder on the VSA Mark 1000 allows you to study audio data subsequently. A clear, precise digital read out is given in both LED and printed format, with fast returns.

VSA-15:

This concept is similar to the VSA Mark 1000, however it is only accessible as a handheld device. This device is for quasi only.

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Xandi Electronics:

It contains a total of ten LEDs. A 9-volt battery or a power adaptor are used to power the system. The LEDs in the normal position on the left should light up when you talk into the analyser. More LEDs on the right-hand side will light up in the stress position, and fewer will light up in the usual position, under stress.

TVSA-3:

The TVSA3 is a computer program that takes digital audio files and converts them into new audio files with a shifting tone in the background. The fluctuating tension levels of the person speaking are indicated by these background tones. A higher tone denotes a higher amount of stress. The lone control is a threshold that regulates how high the vocal stress frequency must be in order to activate the background tone. The stress range in a specific recording is regarded as a percentage of the threshold setting.

In this study, just the Diogenes-Lantern and Vericator were evaluated, and they will be discussed in this paper. The most popular VSA units on the commercial market now are these.

VOICE UNDERSTRESS

In today's frenetic and fast-paced environment, stress is prevalent in virtually all occupations. A strain on a physiological organ or mental capacity is what stress is defined as. Stress can have short- or long-term consequences, depending on its duration and intensity. It is commonly understood that stress has a negative impact on one's health, professional performance, and interpersonal communication. The Encyclopedia of Stress, for example, provides a comprehensive reference source on stressors, the effects of activating stress response pathways, and the illnesses that can result from acute or chronic stress.

Theory Behind Stress Detection

The audiocorpus worked under 6000 sentences are read by a professional female speaker in the audio corpus used in this study. Research assistants label all of the utterances segmentally based on the audio data. Three assistants were taught numerous times using a subset corpus before beginning the stress labelling. Due to the frequent apparent conflict between tone, intonation, and stress, modest percentage of disagreement is tolerable. The goal of training is to maintain as much consistency as possible between annotators during the entire annotating process. According to their significance degrees inside a prosodic word, three levels of stress are used, namely stressed, regular, and unstressed syllables. We split the utterance into prosodic words and stored them independently according to their tone patterns to decrease the impact of adjacent syllables on the perception of the present syllable.

REVIEW OF RESEARCH

A Review Paper on Voice analysis

[1] The publication includes an overview of the literature on speech analytics as well as brief descriptions of the various U.S. patented inventions and technologies that are used to do voice analytics. Apart from that, it discusses the use of speech analytics in a variety of disciplines and provides an overview of the main companies in the voice analytics industry and how it has evolved over time. This demonstrates that voice analytics has a lot of promise, and more work needs to be done to develop new technologies and link them with other industries. With the advancement of technology, the amount of data continues to grow, making it challenging to evaluate such a large amount of data in order to provide useful

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information. Organizations have created a variety of analytical methodologies and tools for analysing and extracting business insights from data. Voice analytics is one branch of analytics that aids various companies by analysing spoken words or speech between two or more persons. It is one of the fastest-growing technologies because it aids in the analysis of people's attitudes during phone calls, which can be valuable in determining their preference for a product or service. It can also aid in the detection of fraud in specific circumstances. Voice analytics is a discipline of data science that deals with the computerised extraction of information from a (digitised) voice audio source. The retrieved data has a wide range of commercial applications and can be utilised to make key business choices. Voice analytics is most commonly utilised in contact centres to extract usable information from both organised and unstructured calls between a caller and an agent. Aside from call centres, it has applications in domains such as bioacoustics, speech disorder diagnosis, financial markets, and so on. Because of its importance, a lot of research has been done in this subject for more than a decade, and numerous technologies and methodologies for performing voice analytics have been devised.

[2] Voice Stress Detection

Stress or emotion might cause distortion in speech recognition, according to studies. Techniques for identifying or analysing the presence of stress could aid in the neutralisation of stressed speech and increase the reliability of speech recognition systems. When a speaker is stressed or emotional, a speaker recognition system's performance suffers. We investigate and identify a system that allows for the utilisation of natural stress-in-speech or speaking style information in a person's speech as additional cues for speaker recognition in this dissertation. Voice Stress Analysis uses a variety of ways to identify stress in human speech (VSA). Stress detection in speech is a wonderful approach to get noninvasive information about a probable lie from a person's assertion. This article presents the finding so far primary study that demonstrate show Mel Frequency's stress levels alter over time.

When a person is under psychological stress, Cepstral Coefficient features can be recognised with FFT signal processing. The main goal is to develop a tool that would allow innocent persons to demonstrate their innocence in cases when they have been accused of committing a crime. Many studies have been published on stress and how it manifests in the auditory signal. Researchers have sought to identify accurate stress indicators by studying speech variables such as fundamental frequency (pitch), amplitude, spectral energy concentration, duration, and a variety of others. In the literature, stress analysis is done by analysing some stress parameters in recorded emotional speech, such as fundamental frequency (F0), pitch, vowel duration, and formants, i.e., analysing a speaker's speech when they are under stress, fatigue, heavy workload, environmental noise, sleep loss, or expressing an emotion like happiness, anger, or sorrow.

Emotion Detection and Classification of Using Speech

The study discusses "emotion recognition through vocal audios." The speech that is determined by the signals makes up the majority of the vocals. Emotion recognition from speech is a long-standing and difficult challenge in artificial intelligence. The latest breakthroughs in sentiment analysis utilising speech, as well as many difficulties associated to it, are discussed in this paper. The classification of various emotions using the emotion detection model is the main problem of the speech detection model. As a result, picking the right classification model is critical. This paper, together with a prior work review, describes many sorts of aspects of emotional speech data and the extraction algorithms that deal with them. The usefulness of several categorization algorithms has also been looked into. Many

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firms would benefit from automating robots that identify emotions from speech. This will allow them to better understand their customers and make more informed decisions. This review study shows far speech emotion recognition has progressed to date. This field has progressed significantly over time, but much work has to be done to make machines more human-friendly and to better comprehend them by evaluating their emotions.

Emotional Speech Recognition

We look at emotional speech detection in this study with three purposes in mind. The first purpose is to keep a current record of all available emotional speech data collections. The amount of emotional states, language, speaker count, and type of speech are briefly discussed. The second purpose is to show the most common acoustic parameters utilised for emotional speech identification and examine how they are affected by emotion. Pitch, formants, vocal-tract cross-section areas, mel-frequency cepstral coefficients, Teager energy operator-based features, speech signal intensity, and speech rate are examples of common features. The final purpose is to go over proper procedures for categorising speech into emotional states. We look at classification techniques that use temporal information against those that don't. Emotional speech recognition seeks to detect a person's emotional or physical status from his or her voice automatically. Emotional elements of speech refer to a speaker's emotional and physical conditions, and they are part of the so-called paralinguistic features. Despite the fact that the emotional state has no effect on the linguistic content, it is a significant aspect in human communication since it gives feedback information for a variety of uses, as detailed below. It is not a novel concept to develop a machine that can discern emotions from speech. The first studies, which used statistical qualities of certain auditory variables, were carried out around the mid-1980s. The advancement of computer architectures ten years later made it possible to implement more complex emotion recognition.

METHODOLOGY

To conduct this practical I have used software like Gold-wave, Audacity and Praat to take out the Frequency and pitch of the voice sample and analyze the samples with the given standard sample. The analyze is on the basis of psychological distress of the person and also to look for the stress pattern of the person by repeating the speech (words) regarding the criminal behavior. 80 samples are been collected that included both male and female class. Each voice samples are been runed in gold wave to check-out the wave pattern of the sample and converting the sample into .WAV. The voice sample are been converted into mono form in audacity. The second is the audacity, where the samples are been treated to look for the frequency of the wave pattern. The samples are been divided into 10 sec of time duration to be runed in praat software. Each samples are classified focusing into the words like anger, stress, depression etc. the words and the expressions are been noted in the mean time and the samples are been separated to be later analysis. In the praat, each samples are been carried of 10 sec duration. In the praat pitch report, spectrum of the vocal, voice report can be analyzed individually.

Material Required

Sound recorder, software to get voice sample analyzed.

Sampling

The study was conducted Total on 80 subjects that includes both male and female subjects on Indian race between the age group of 20-23. Sampling was done by interview mode keeping the recorder on and the voice samples was taken.

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Inclusion And Exclusion *Criteria

- Only Participants from India were included. Individualization of male and female subject were classified. Age group between 20-23.
- Individual whose age was below 20 and more than 20 were not added in this research study.

Method

Before analyzing the subjects, the aim and objectives of the study was explained to all the subjects and written consent forms were taken. The subjects were shown the questions and allowed to read the questions on that any kind of prohibition to answer could be said before. The subjects were made comfortable so that they speak truth under confidence and to think of stating anything either to any friend or councilor. The subjects were made assure that all their speech would be highly confidential and would not be shared to any third person.

Study Designs

Observational study was done under emotional diamond concept. This was a theoretical approach towards the subject. It could not be seminar practically because of lack of software available.

Procedure

I made participants it comfortably, I explained the aims and objective of the study. I have explained all the procedure and questions that were going to be asked to the subjects. I made assure that the subjects for the interview must be comfortable with answering all the questions and needed to present truth to get the accurate results. Before taking into direct questions a small conversation with the subjects was done so that they feel comfortable and relaxed before facing the questions.

The voicerecorderwaskeptinfrontofthesubjectwithrecordingonsothatthevoicesamplescould be taken. The questions were presented to the subjects one by one and the subjects started giving answers to all the questions. It was made sure that no background capture in the recorder as tampering of the voice sample might happened. The subjects were assuring that the no conversation was to be delivered to the third person, all the conversation was completely private and are kept confidential. While the interview session was been conducted, the emotional pattern of the subjects was observed keenly. The movement of the eyes, the leg shaking, the voicer education and increment was observed. It was observed that the subjects who got emotional on few words, sentences. The words were quoted like “anger”, “stress”, harassment”, “irritations” etc.

The psychological factories, emotional diamond concept was observed properly under the interview process. Unfortunately, the emotional diamond concept could only be observed theoretically as there is lack of software like LVA (layered voice analysis). Hence, the stress pattern was performed and practically explained.

The voice samples then were taken in the system in raw format for the analysis. The raw voice sample was firstly runed in software GOLDWAVE, where the samples were converted into .wav file format so that no glitches come in later. The converted files were runed in the AUDACITY, where the samples were converted into mono format from solo form. The audacity software also helped in expanding audio file and break the voice samples into seconds. Each audio samples were parted into 10 sec durations so that it would help to analyze well.

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The sample the pruned in PRAAT software. The PRAAT helps to determine the pitch level, intensity level, spectrum level of the voice sample. The limitation of the software is only 10sec per sample can be analyzed. But, to overcome the problem only specific word with more emotional level of the subjects were analyzed in the software. The emotional level was observed manually and patterns were noted down. The voice samples were marked for the voice report analysis were the variation in “pitch patterns”, “intensity level”, “voice break”, “mean value”, “median value”, “maximum value”, “minimum value” was followed as marked. The marked value was then differentiated and then later they were graphical scale.

The outcome of the project was, the stress level of different gender (male and female) both were different level at different circumstance. The positive point of this experiment was, even if the expensive software like LVA, VSA is not available, even then, different variation in the software do brings out the result of what it needed to be presented in the court room. The drawback of this project is, emotional patterns under psychological factors, like emotional diamond concept could not be justified in practical conduct; but the observation for the subjects can be clearly classified and hence can be noted manually.

RESULT AND DISCUSSION

The above-mentioned figures represent the graphical analysis of the voice sample. From the result, the stress level of the subjects could be identified. The stress patterns can be clearly seen in the g bar graph. The line graph represents the pitch deviation pattern. From the analysis, it can be said that the stress level of each individual varies differently that also include psychological behavior and patterns of the person. The emotional diamond concept could not be presented as lack of software, but it has been noted down manually. Even if expensive software like LVA* and VSA* are not available, by using various other software the results can be taken out and can be presented in the court of law for the trial. The results were approximate and can be acceptable. There was a difference between stress pattern in male and female subjects which can be seen in the graph. Another positive section of this result is clear visible of the stress pattern in both male and female subjects can be differentiated.

The pitch value represents the different variation factors in the voice sample. We can see the pitch level starting from above the level of 100HZ and decreasing below 50HZ and so on. This variation comes when there is a matter to hide or excited to tell something. From the result of hidden points or pitch and intensity variation we can also check for the deception and detection of the subject. In the voice report, the voice break, unfractured patterns are also observed and checked. The emotional diamond concept, hence been observed while the interview was been conducted. The anger, eye movement, leg shake and other body movement wa sobserved.



Fig 1: Spectrum representation of stress factor in voice sample (a) and intensity representation of voice.

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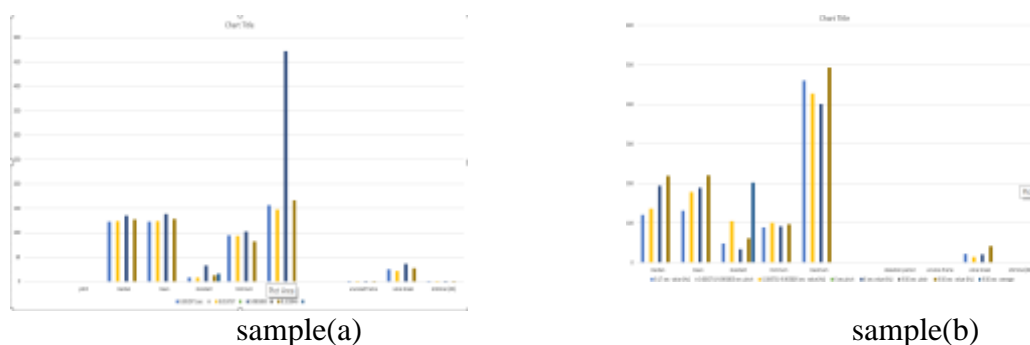


Sample (a)

Sample (b)

Sample (c)

Fig 2: pitch representation of voice sample (a) and pulse rate representation of voice sample (b) and pulse listing representation (c)



sample(a)

sample(b)

Fig: 3 Male voice representation of voice sample(a) and female voice representation of voice sample (b)

CONCLUSION

From the above result, we can conclude that the stress level of the subjects depends on the psychological state of mind. The different psychological state depends on the past history, bad incident etc. we can also see here that the stress level does vary among the subjects of different genders (male and female).

The stress pattern is usually analyzed by software like LVA and the VSA. But, by these methods using different software, in shorter amount of time and in cost effective manner, it can be used in different places where costly software cannot be purchased.

The drawback of this experiment is emotional diamond concept of psychology cannot be explained in practical way as lack of software but stress eye land detection and deception test can be concluded from this.

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Conflict of Interest

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