

# Effects Analysis of Stress Relaxation Stimulation using Voice Analysis

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## Abstract

Establishment and focus: In modern society, the maximum of health is said to be the stress of the body and mind. Unnecessary tension and stress that arise in busy life are the source of all kinds of diseases. Stress is a source of panacea and affects both physical and mental health, causing stress-related disorders as well as various diseases and disorders. Stress is so diverse that interest is growing as a fundamental cause for a wide range of diseases. In addition, the cost of treating stress-related diseases is increasing every year. Therefore, it is important to prevent stress-related illness before it occurs. In recent years, various methods for alleviating stress have been known, and a method of stimulating the hand is widely used.

System: Therefore, stressful diseases in the modern society are of interest, and various research and development are actively conducted to measure, manage, and prevent stress in advance. Therefore, in this paper, we performed comparison and analysis according to the degree of stress using the web service using the voice signal analysis technology. The voice analysis web service applied in this study utilized vocal vibration, degree of voice break, and 2 formant frequency bandwidth. This study was conducted to analyze the effect of hand pressure point stimulation that relieves stress in everyday life.

**Keywords:** Stress Relaxation, Hand Massage, Voice Analysis, Web Service, Pitch, Degree of Voice Break, 2 Formant Frequency.

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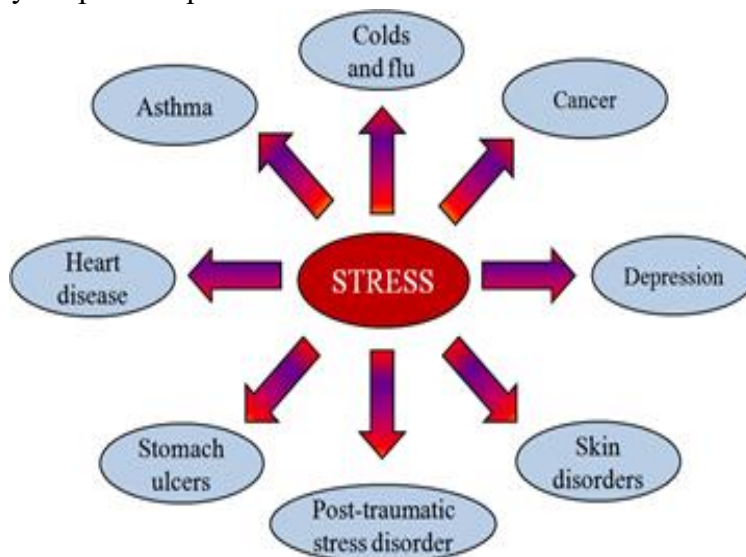
## 1. Introduction

In order to succeed and develop in the modern society, we demand constant development and competition for the members of the organization. These social phenomena cause chronic stress and harm physical and mental health. Excessive stress is a cause of chronic illness. It may also manifest physical symptoms such as headache, fatigue, heart disease, back pain, ulcer, and mental symptoms such as temporary memory loss, nervousness, irritability and anxiety[1].

In the United States, economic losses from stress are more than 10% of the GNP. In addition, an average of 1 million workers are absent from stress-related disabilities every day. This is also the case in Japan. In 1985, the Ministry of Health and Welfare in Japan reported 1.6 times increase in overtime and a 15.4 percent death in Kyoto compared to 10 years ago. In Korea, 75.3% of the 503 workers who died of various diseases in 1994 were found to have died from overwork due to occupational stress. Thus, the stress that can be directly linked to economic loss and national competitiveness has a very important social

significance. Figure 1 shown the threat of stress throughout society is causing a great deal of stress on contemporary society. Stress has become a source of chronic diseases in modern society and is pointed out as a very important problem in

society. Stress is so diverse that interest is growing as a fundamental cause for a wide range of diseases. Therefore, the cost of treating diseases caused by stress is increasing every year[2,3].



**Figure 1. Examples of stressful diseases**

Many people know that they are aware of the dangers of stress, but many of them live with such excessive tension to adjust to the environment of modern society. Especially, in the case of Korea, the problems such as the examination and employment of the younger generation are serious, and the degree of stress is increased in the case of the examinees preparing for it and the preparers for employment. A survey of 1,272 jobseekers and job seekers who had participated in an interview on a job portal site found that 52.8 percent of respondents said they were "nervous" ahead of their interviews and 20.4 percent of respondents were "very nervous". Thus, stress is an inseparable entity in the process of living in modern society, and it causes mistakes and diseases[4,5]. In order to reduce unnecessary mistakes and prevent diseases, relieving tension and relieving stress is a necessary task in modern society.

Therefore, in this paper, we have conducted a research to manage the stress by providing the analysis technology of voice signal in the form of web service. For this purpose, the system analysis is

performed based on vocal cords vibration, degree of voice break, and 2 formant frequency bandwidth of the voice signal analysis parameter, and a system design that can provide it as a web service type has been performed. In order to manage the stress, the degree of stress was evaluated through hand massage which can be conveniently used in daily life. And the effect of hand massage was measured and analyzed.

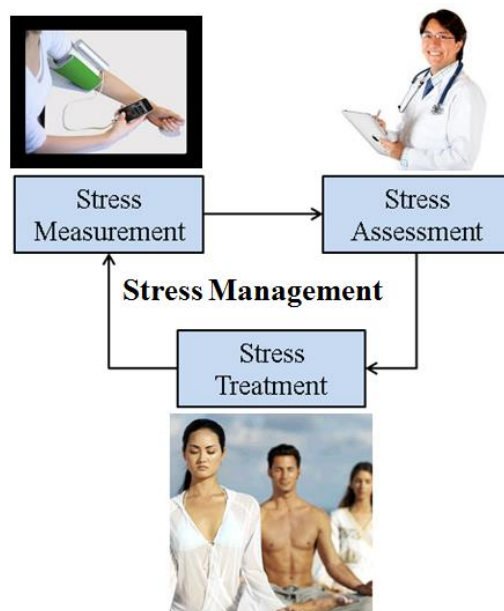
## 2. Related Works

Stress prediction and management techniques exist in a variety of ways. Figure 2 shown existing stress management is proceeding as self-report or medical device. The evaluation of stress is done through self-awareness or clinical education. In addition, treatment for stress is applied to medication, psychiatric treatment, meditation therapy, exercise therapy, and art therapy.

There are two main trends and levels of domestic technology related to stress diagnosis. The first is self-diagnosis by questionnaire, and the second is diagnosis by medical device. Although self-

diagnosis by questionnaire is a simple way to measure stress, it is based on subjective evaluation and is of very low accuracy. In addition, the diagnostic method using a medical device is very accurate because it is a method of diagnosing a

stress state through various measurement of bio-signals such as blood pressure, blood glucose, electrocardiogram and EEG[6,7]. However, it is often difficult to diagnose because of the high cost and time required for diagnosis.



**Figure 2. Stress management, evaluation and treatment**

Currently, the domestic stress diagnosis technology includes a method of measuring stress by analyzing changes in the brain image, a method of measuring stress by analyzing EEG changes, a method of measuring stress by analyzing changes in blood pressure and blood glucose, And the method of measuring stress, and the evaluation of emotion using various physiological measurements and the application of technology development, products for stress diagnosis are being developed. In the case of advanced foreign countries, not only the interest in stress but also the rapid growth of technology in policy support. In the United States, research on brain function has been conducted in various fields such as sensory engineering, medicine, biology, physics, electronics, computer science, and cognitive psychology under the banner of brain for 10 years since 1991. In addition, development of measuring instruments capable of detecting brain functions and development of techniques for signal processing thereof are actively under way[8,9].

However, it is possible to measure only the intensity of subjective distinction in relation to the level of physical awakening and excitement. Therefore, the physiological measurement factors such as anger, fear, and human emotions can't be clearly distinguished. In addition, since most of the measurement methods using precision instruments such as brain waves and electrocardiogram are used, there is a disadvantage that much time and cost are invested.

### 3. Results and Discussion

It is an era of well-being, in which lifestyle medicine is more prevalent than modern social therapy. In other words, even if your body is weak, you do not take medicine and make your body healthy by alternative medicine. In oriental medicine, certain parts of the palms and soles are connected to organs of the human body. Especially, it is said that it is connected to not only all the organs of the human body, but also the mental part. In modern society, I get a lot of stress from living in

company life and human relationship. If the stress is not solved, the mental stress will have a bad influence on the human health. So it is very important to relieve stress during your life.

There are many ways to relieve stress, but the easiest way to use it is by hand massage. In this paper, we performed the following 10 steps in order to relieve the stress applied to the acupressure point stimulation hand massage.

Step 1. Release the wrist: gently hold the wrist and shake to relieve pressure. When you release your hand, it keeps you in a state of weakness enough to tug.

Step 2. Finger tapping: Apply finger pressure while moving little by little from the bottom to the tip of the finger. This operation is repeated three times.

Step 3. Opening your palm: Press your thumb against the palm of your hand and press it slightly outward.

Step 4. Pull back palm: Straighten your palm and turn it outward for about 5 seconds. This operation is repeated three times.

Step 5. Palpation: Divide the palm into nine equal parts and rotate it clockwise from the center.

Step 6. Unfolding your back: Moving from the center of your hand to the outside.

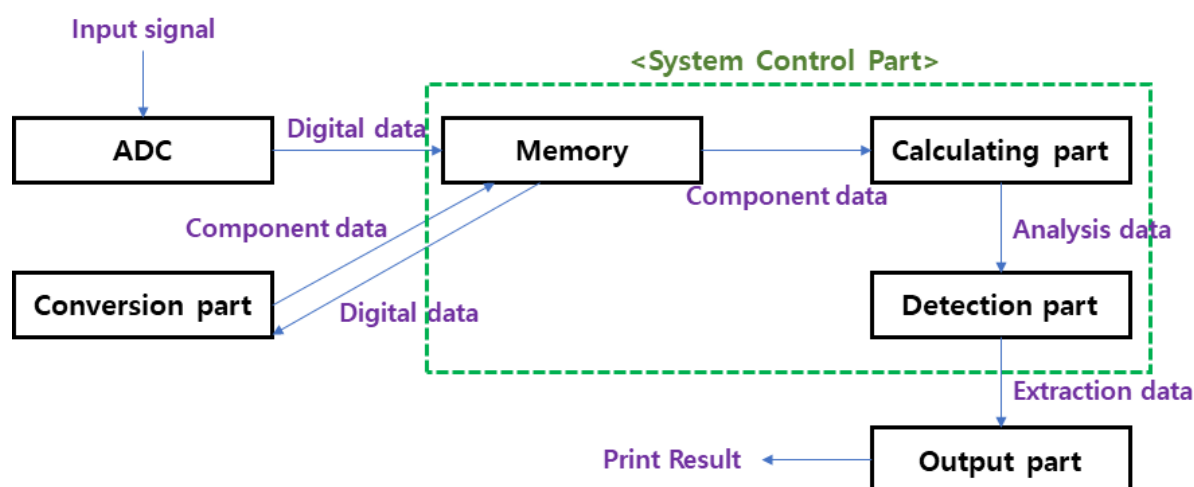
Step 7. Hand back pressure: Shiatsu while moving between the bones of the back of the hand and fingertips.

Step 8. Press and stretch: While moving from the wrist to the fingertip, press and release the palm of your hand.

Step 9. Hand pressure: Press the entire hand for 5 seconds as if shaking hands and loosen it loosely for 3 seconds. This operation is repeated five times.

Step 10. Wrapping: Wrap the entire hand and rub it down overall.

When you are stressed or resting due to stress, you will be affected by sympathetic and parasympathetic nerves in your body. As a result, your heart rate will be affected by your body and mind as it accelerates or slows down. Therefore, in this paper, a phonetic sentence containing the cardinal vowel is used for voice signal analysis. The test sentence was "Noran Nabiga Nalaganda."



**Figure 3. Voice analysis web service design**

In the experimental procedure, the experimenter is recorded in a normal voice so that the noise can't be

heard as much as possible. Hand pressure is applied while performing the steps of 10 steps in a relaxed

sitting position while releasing the strength of the subject. Record the same test sentence to the person who performed the hand massage to relieve the stress in the same place. Voice signal analysis program analysis voice frequency, degree of voice break and 2 formant frequency bandwidth. Finally, based on the results of the voice analysis, we analyze the stress relieving effect of hand massage [10-12].

As shown in Figure 3, the voice analysis web service environment is classified into an input unit, a conversion unit, a detection unit, and an output unit. The input part was recorded according to the voice signal input system and the environment and the analysis program was applied. As a result, when a vital voice signal is transmitted, data is converted and outputted through an analog / digital converter (ADC). The converting unit performs Fourier transform on each of the plurality of digital data and outputs it as component data. The converting unit sequentially receives a plurality of digital data from the memory and performs Fourier transform. Then, the plurality of component data converted and outputted is temporarily stored in the memory.

The detection unit averages a plurality of component data and outputs the average component data. That is, a plurality of component data temporarily stored in the memory are received and averaged by one component data. Further, a meaningful result value is detected from average component data outputted according to each voice signal analysis parameter. Finally, each measurement result is displayed through a result output unit [13-15].

#### 4. Voice Analysis Service

In this paper, we have conducted a study to measure the effects of engineering techniques for relieving stress through hand massage. For this purpose, we applied a voice signal analysis technique to demonstrate a stress relieving method for hand massage. We also studied system design methodology to implement web service

environment. In this paper, vocal vibration, degree of voice break and 2 formants are used for analysis of voice signals. The information of the voice waveform represents a form in which similar shapes are repeatedly repeated in a certain section. This repetition period provides the most important information for characterizing the speech waveform and is called pitch, which is the basic period of the speech information. The repetition period was extracted to use the voice analysis element. That is, when the discrete sample signal  $x(k)$  is a static signal, the similarity between samples is shown in Equation (1). At this time, if the repetitive period is found, the pitch result value based on the statistical characteristics is extracted.

$$R(k) = \sum_{n=-\infty}^{n=\infty} x(n)x(n+k) \quad (1)$$

This is the total duration of the breaks between the voiced parts of the signal, divided by the total duration of the analysed part of the signal calls it DVB. Since silences at the beginning and the end of the signal are not considered breaks, you will probably not want to select these silences when measuring this parameter.

The formant analysis element is used to perform analysis on the areas where energy is concentrated among the parameters for speech analysis. The formant frequency can be extracted using the linear predictive coefficient (LPC) of the speech signal. The LPC can predict the current output speech signal by linear combination of the past input signal and the past output signal. In Equations (2) and (3),  $s(n)$  is a speech signal,  $a(i)$  is a prediction coefficient,  $M$  is a prediction order, and  $e(n)$  is a prediction error. In this paper, the root of the inverse filter  $A(z)$  is calculated using the LPC value to extract all candidates of formant frequency and bandwidth. In addition, the bandwidth  $\hat{B}$  and frequency  $\hat{F}$  for a certain complex root  $z$  are obtained by the conversion from the s-plane to the z-plane.

$$s(n) = \sum_{i=1}^M a_i s(n-i) + e(n) \quad M = 1 \leq n \leq N \quad (2)$$



$$e(n) = \sum_{i=0}^M a_i s(n-i) = s(n) + \sum_{i=1}^M a_i s(n-i) \quad (3)$$

The information of the voice waveform shows a form in which a similar shape is continuously repeated in a certain section. These repetition cycles provide the most important information to characterize the voice waveform. This is called vocal cord vibration, and is referred to as a pitch, which is a fundamental period of voice information. In order to use such a voice analysis parameter, a repetition cycle is extracted. At this time, if the repetition period is found, the pitch result based on the statistical characteristic is extracted. However, it is ideal to make the voice analysis section infinite. Actually, the result should be obtained within a finite range[12,14]. Therefore, the autocorrelation coefficient is normalized and the pitch result value

necessary for the analysis is extracted in order to evaluate the same method for all the voice signals. As the blood pressure rises due to stress, it tensions the body and affects the vocal cords. Particularly, as the sympathetic nerves become active, the body is kept in tension, the heart rate is increased, the blood flow is increased, and the blood pressure is raised.

Based on this theory, we analyzed the vocal fold vibration. As shown in Table 1, 90% of the female experimenter had a hand massage, and the Pitch value decreased. These results are the result of the hand massage and the stable heart and mind of the female experimenter, resulting in a lower heart rate than usual. This means that sympathetic nervous system is reduced and stress is relaxed.

**Table 1. Female subject pitch analysis result**

Massage	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10
Before	234.11	230.84	232.22	221.92	242.94	198.54	207.68	176.43	212.75	225.07
After	216.82	214.17	209.62	238.96	222.88	190.46	166.47	170.83	210.97	200.09
<b>Change</b>	<b>-17.29</b>	<b>-16.67</b>	<b>-22.60</b>	<b>17.04</b>	<b>-20.06</b>	<b>-8.08</b>	<b>-41.21</b>	<b>-5.60</b>	<b>-1.78</b>	<b>-24.98</b>

The Number of Voice Breaks is like the rest of the voice that occurs during the reading of the entire test sentence. It is the numerical value of the interval of the pulse waveform which is not expressed when the voice waveform is converted into the pulse waveform. That is, the minimum value of the pitch range is set to 75 Hz and divided by 75 Hz to analyze all pulse intervals. At this time, when the distance between pulses of 16.6667 milliseconds or more occurs, it is regarded as Voice Breaks and the corresponding number of voice breaks is extracted[13].

Degree of voice break an analytic parameter that measures the stability of vocalization, refers to a period of time between vocal components. Voice analysis tools can be measured by degree of voice breaks or by spectrograms. The lower the degree of voice break (DOVB), the better the pronunciation. As shown in Table 2, 80% of male subjects had decreased DOVB values. These results show that after the hand massage, the stress is reduced and the pronunciation is improved.

**Table 2. Male subject DOVB(degree of voice break) analysis result**

Massage	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10
Before	13.83	24.41	8.40	5.30	1.21	16.56	1.29	9.06	2.97	1.01
After	1.52	8.48	6.45	4.44	2.23	6.86	8.63	1.69	1.02	0
<b>Change</b>	<b>-12.31</b>	<b>-15.93</b>	<b>-1.95</b>	<b>-0.86</b>	<b>1.02</b>	<b>-9.7</b>	<b>7.34</b>	<b>-7.37</b>	<b>-1.97</b>	<b>-1.01</b>

Inside the human body is a tube shaped like a tube that can vibrate sound. Sound is produced when air passes through this part, and the final sound is produced by the end (vocal cords, tongue, teeth, lips). The resonance of such a soul is called a formant, and the waveform generated here is called a formant frequency. In addition, formants are also used in the word form, which means that energy is concentrated in certain frequency bands. In other words, each vowel has its own formant distribution.

The formant measurement parameter sets the time step to the time corresponding to 25% of the analysis window length. The Max number of formants specifies the maximum number of possible formants, up to the fourth formant. In addition, the maximum formant uses an average of 1,000 Hz per figure. Therefore, the maximum

number of formants is set to 4,000 Hz, which is the same as 4. The Window length is a Gaussian method for specifying the voice interval to be analyzed. Finally, the pre-emphasis means a high-frequency emphasis filter for extracting a sharp formant value by emphasizing the fact that the amplitude of the actual voice is lower as the frequency increases. With 50Hz, the formant value for the basic voice can be extracted most clearly without forcible amplification[14, 15].

As shown in Table 3, in the case of male subjects, all of the values decreased after the 2 formant frequency bandwidth was subjected to hand massaging. This result can be interpreted as the change of voice as the stress relaxation decreases the tensions of the heart.

**Table 3. Male subject 2 formant frequency bandwidth analysis result**

Massage	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10
Before	501.71	536.11	856.24	672.58	361.02	228.56	645.28	378.94	245.09	310.77
After	425.62	327.53	510.05	624.28	202.11	178.94	529.65	328.48	189.20	169.69
Change	-76.09	-208.58	-346.19	-48.30	-158.91	-49.62	-115.63	-50.46	-55.89	-141.08

## 5. Conclusion

Stress has become a source of chronic diseases in modern society and is pointed out as a very important issue in society. In addition, stress is very diverse and provides a fundamental cause for a wide range of diseases. As a result, the cost of treating stress-related diseases is increasing every year. Therefore, research for solving or mitigating stress in real time is indispensable.

Therefore, in this paper, we designed a stress measurement service environment using voice signal analysis technology. Especially, we analyzed the effect of hand massage method using palm stimulation and acupressure on stress relief and designed an implementation methodology to apply it to web service environment. Finally, in the experiment, we applied voice analysis factors of

vocal cord vibration, degree of voice break, 2 formant frequency bandwidth, and proved the effect of relieving stress by applying hand massage.

There is little research on stress prediction and management technology using voice signal system analysis, and IT based technology and related source technology are lacking. In this paper, we can extend the implementation and application of web and mobile systems through the study of stress prediction service technology combined with the voice engineering technology studied in this paper.

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