Usage of Emotion Recognition in Military Health Care

Detecting Emotional Change under Stress

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Abstract— Post Traumatic Stress Disorder (PTSD), depression and suicide are major psychiatric problem in both military and civilian situation. These mental diseases combine with emotion change. Recently, the technology of emotion recognition has been developed rapidly and highly. Therefore, we investigate if the emotion recognition by natural speaking voice could detect the emotion change which would occur when exposing mental stress. We used "Sensibility technology ST Emotion" (AGI Japan Inc.) for emotion voice analysis system. This system determines emotional elements as including anger, joy, sorrow, and calmness. It also measures feeling of excitement. Voice data were collected from the personnel of military medical corps participating in a special stressful mission. The voice data were divided into two groups depending on participating period. Some subject's feelings during experimental period were changed. There is a tendency that "joy" of long stay group (Group L) is lower than short stay group (Group S) and "sorrow" of Group L is higher than Group S. The result suggested that the techniques of emotion recognition may be used for screening of mental status in military situation. However, further development is necessary for practical use.

Keywords; Emotion Recognition; Screening System; Mental Health; Mental Stress; Depression

I. INTRODUCTION

Post Traumatic Stress Disorder (PTSD) and Depression after stressful mission are becoming major psychiatric problem in military health care. Depression and suicide during routine work are also big problem in military health care same as civilian life. Earlier treatment leads more effective for these disorders. However, the screenings for these diseases are mainly performed by psychological examination and interview. That is why the present technique has a part lacking objectivity. Thus, technology for earlier detecting psychiatric change in patients is expected. Some medical research reported that some bio-markers of psychiatric diseases are found [1]. But these markers are not suitable for military situation because they need a big, complicated machine or the medical facilities such as the drawing blood. We need easy and simple method like a home thermometer for detecting or screening of these disorders in military situation, especially in battle field.

On the other hand, in engineering research area, the development of technologies in voice, speech and emotion recognition is surprisingly fast. Many of these technologies are already used in real life, but still developing continuously. These technologies are mainly developed for man-machine interface. Some research showed the strength of stress and fatigue can be measured by voice of natural speaking [2]. These researches are grateful and useful in civilian life or some

of special situation, but not in military, because soldier is exposed to extreme strong stress. If using existing technology on a soldier, we will arrive at a wrong result. Therefore, tunings of the machine is necessary to adapt it military situation. Additionally, the strength of stress and fatigue is not lead mental disorder directly. The most important thing is to know the individual reaction against stress. Some of mental diseases combine with emotion change. Most of doctors understand mental condition of his patients from her/his face and voice which shows her/his emotion in his clinic. This fact means that the machine of emotion recognition could be detecting some mental disorders.

Therefore, we investigate if the emotion recognition by natural speaking voice could detect the emotion change which would occur when exposing mental stress. In this paper, we show the possibility of usage of emotion recognition in military mental health care, through our trial experiment. We focused on emotion recognition technique using natural speaking voice, because we need to develop the easy and simple method with small machine. After showing our data we discuss about future machine for screening of mental disorder in military.

II. Emotion Recognition

For recognition of emotion, expression of the face and natural speaking voice are mainly used. We choose to use natural speaking voice for our experiments due to mainly two reasons. First is that the voice of natural speaking contains non-verbal elements [3]. That means that it is difficult for subjects to hind their feelings and emotions. Second is that we can perform our experiments with small and simple equipment. Indeed, small electronic voice recorder is only equipment for data collection in this study.

A. Emotion and Feelings

Many researchers have studied on recognizing emotion or feeling by analyzing speech waveforms [4]-[6]. The study on recognizing stress and fatigue has also been reported [2]. Defining “emotion” is problem in conducting research on voice emotion recognition. Many studies classified and analyzed by using various concepts. They are divided in tow representative classifications of emotion;

1. Using pleasure-displeasure and degree-of –arousal dimensions [7].
2. Classifying emotion into several feelings such as sadness, anger, surprise, fear, disgust, contempt, and enjoyment [8].

Mitsuyoshi suggested a possible connection between the pleasure-displeasure emotions and various feelings. He adopted feelings into four emotional elements: “anger”, “joy”, “sorrow”, “calmness”, and investigate the relation between the pleasure-displeasure emotions and feelings. From his a series of studies, he concludes his emotion recognition system can detect more than 70% of human emotion. That is high rate detection because the emotion has variability itself.

B. Emotion Parameters

In voice recognition analysis, power, fundamental frequency (F0), and their transition are usually used for parameters as well as information of speed and intonation of speech. His system uses mainly power and F0, an involuntary or non-verbal element in voice, to isolate the emotional elements from human voice. F0 and power mean the vibration of vocal codes and may be an expression of natural human emotion. The autonomic neural system may be related to the function of vocal cords, which independent of high-level language processing that occurs in the cortex [9]. Therefore, his system possible detects change of the feelings or emotion that the person himself does not notice. In other words, the person cannot role character which he wants like an actor against his system.

From the reason of all above, we use the Mitsuyoshi’s emotion model and his analyze system.

C. Emotion Voice Analysis Systems

We used AGI Japan Inc. “Sensibility technology ST Emotion”, software of emotion estimation, for determining the emotion parameters in speech recognition. This system determines emotional elements as including anger, joy, sorrow, and calmness. The feeling of excitement was also determined by independent measure because it is classified as low level emotion.

III. Collection of Voice Data

Voice data were collected from the personnel of military medical corps participating in a special stressful mission. The data collected for 5days, twice per day; morning and evening except for 1day morning and last day evening. The voice data were divided into two groups depending on participating period. Long stay group (Group L; n = 4) participated more than one month in the mission, and short stay group (Group S; n = 5) participated for one week in the mission. Group L took mental care during voice recording period by the person in Group S.

Voice recorded by small IC voice recorder (ICR-PS502RM, SANYO). To record voice, Subject oneself operated the recorder. The voice was recorded on PCM format as low voice data. The voice was recorded reading the short phrases written in Japanese, the mother tongue of all subjects. The phrases are below;

1. I-ro-ha-ni-ho-he-to

   (no means like “a-b-c”)
2. I-ro-ha-ni-ho-he-to

   (no means like “a-b-c”, repeat)
3. Watashi ha jieikan de, nihon kara kiteimasu.

   (I belong to the Self-Defense Force and come from Japan)
4. Tsukarete guttari shiteimasu.

   (I am tired and am dead tired.)
5. Totemo genki desu.

(I am very cheerful.)

6. Kinou ha yoku nemuremashita.

   (I was able to sleep well yesterday.)

7. Syokuyoku ga arimasu.

   (I have an appetite.)

8. Okorippoi desu.

   (I am irritable.)

9. Huan de ippaidesu.

   (I am in great anxiety.)

10. Kokoro odayaka desu.

    (My heart is calm.)

11. Kyono kibun wo iro de arawasuto { color } desu.

    (I am { color } when I express today's feeling with a color.)

IV. Data Analysis

All data was analyzed in the laboratory after Group S finished their mission and returned. The algorithm of ST Emotion consists of two steps: calculating parameters and conducting decision tree analysis.

We calculated some sets of voice parameters from each voice data. We conducted voice waveform analysis and obtained voice parameters related to F0 and power. The total number of parameters was about 50. Then, 50 times decision tree analyses were conducted by using 50 pre-constructed decision trees. Voice parameters obtained by voice waveform analysis were used as input variables and four emotions (anger, joy, sorrow, calmness). By summing the results of 50 times analysis for each emotion, scores of four emotions were obtained. Then the scores were adjusted as the total scores of four emotions were 10. In addition, excitement score was similarly calculated by using 50 pre-constructed decision trees.

V. Result

Figure 1 shows the example of individual data from total speach. As shown example, some subject's feelings and emotional excitement during experimental period were changed. However, there are subjects whose feelings did not change significantly also.

Figure 2 shows the comparison of four feelings and emotional excitement between Group L and Group S which analyzed by all phrases. There is a tendency that "Joy" of Group L is lower than Group S and "sorrow" of Group L is higher than Group S.

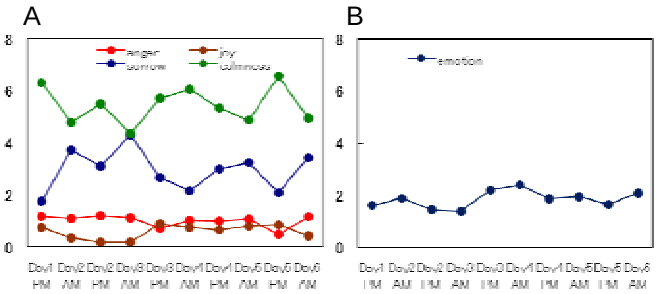

Figure 1. Example individual data of total speech analysis

Graphs show score of four feelings (A) and emotional excitement (B) on each data corecting point. Red, brown, blue, green lines show scores of "anger", "joy", "sorrow", "calmness" each.

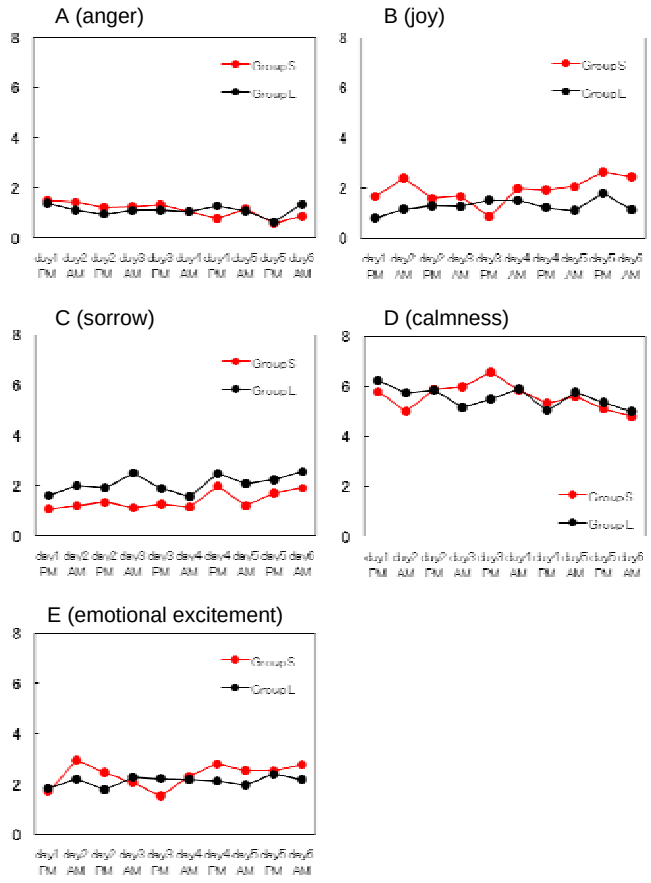

Figure 2. Scores of each feelings from total speech analysis

Graphs show scores of anger (A), joy (B), sorrow (C), calmness (D) and emotinal excitement (E). Blue line shows the average score of long stay group (Group L) Red line shows the average score of short stay group (Group S). The socores of joy on Group L lower than on Group S, and the scores of sorrow on Group L are higher than Group S. During the experimental period, the percentage of joy and sorrow were increased.

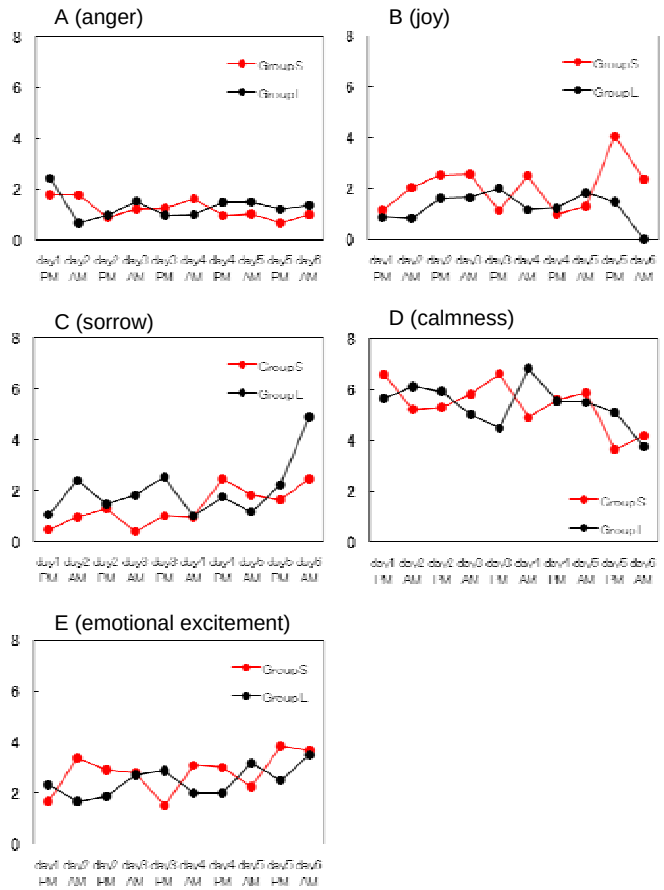

Figure 3. Scores of each feelings from phrase 1&2 speech analysis

Graphs show scores of anger (A), joy (B), sorrow (C), calmness (D) and emotinal excitement (E). Blue line shows the average score of long stay group (Group L) Red line shows the average score of short stay group (Group S) The detas on first 3days shows same tendency as total speech analysis (Figure 2), but there is not significant defference between both groups .

Figure 3 shows the changes of four feelings and emotional excitement between Group L and Group S which analyzed by phrase 1 and phrase 2. These phrases have no meaning and no requiring reading paper. There is a tendency that "joy" of Group L is lower than Group S and "sorrow" of Group L is higher than Group S. But data tend to vary compared with Figure 2.

Table 1 shows four feelings and emotional excitement of each phrase. There are tendencies that There is a tendency that "joy" of Group L is lower than Group S and "sorrow" of Group L is higher than Group S at all phrases. But, differences of "sorrow" are bigger at phrase 3, 5 and 7 than others, and differences of "joy" are bigger at phrase 4 and 9 than others.

VI. DISCUSSION

We showed that our system could detect the changes of emotion due to strength of stress in our results. Strong stress increased the feeling of "sorrow", and decreased the feeling of "joy". These changes of feelings are similar to dejection state or depression, but are not impossible to decide if the changes mean mental disorder or normal mental reaction. Some subject's feelings and emotional excitement during experimental period were changed. In most of Group L, their feelings of "joy" are increasing after the mental care by Group S. That result suggests that the mental state by stress could influence the emotions such as feelings and emotional excitement, and that there is possibility to understand the effect of mental care by using our system. Additionally, feelings react sensitively when subjects talked about a specific phrase. From this results, there is possibility to understand what he takes stress by.

The limitation of our experiments is that there is no data which can compare with voice data because our experiment performed in the real mission and therefore we had no chance to do any additional investigation except for voice data collection. For understanding of influences to emotion by stress, we need other stress index such as psychological test or stress bio-marker and so on. However, there is no universal marker

TABLE I. ANALYSIS OF EACH PHRASE

Phrase	Feelings and Emotion									
	Anger		*Joy*		*Sorrow*		*Calmness*		*Emotionl Excitement*	
	Group L	Group S	Group L	Group S	Group L	Group S	Group L	Group S	Group L	Group S
1 & 2	1.28±0.62	1.24±0.85	1.35±1.31	2.13±1.65	1.90±1.25	1.25±1.01	5.47±1.38	5.37±1.64	2.43±1.27	2.85±1.62
3	1.44±0.88	1.28±0.94	0.95±1.16	1.54±1.39	1.90±1.72	0.96±0.97	5.71±1.75	6.22±1.76	2.03±1.40	2.20±1.32
4	0.84±0.62	1.32±0.90	0.77±0.91	2.01±1.75	1.79±1.21	1.00±1.18	6.60±1.82	5.67±1.81	1.86±1.16	2.35±1.74
5	1.41±0.88	1.19±0.68	1.38±1.73	2.49±2.09	1.83±1.67	0.86±0.81	5.39±1.99	5.46±1.80	2.23±1.65	3.00±1.87
6	0.82±0.65	0.94±0.93	1.55±1.95	1.77±2.01	2.56±1.96	1.61±1.52	5.07±1.84	5.68±2.16	2.06±1.29	2.12±1.33
7	1.22±0.92	1.20±1.09	1.15±1.68	2.10±2.18	2.03±1.69	0.96±0.93	5.60±1.83	5.74±1.74	1.87±1.31	2.11±1.09
8	0.90±0.92	0.84±0.57	1.57±2.09	2.19±2.05	2.05±1.22	1.50±1.05	5.48±1.51	5.47±1.75	1.90±1.19	2.51±1.43
9	1.03±0.80	1.05±1.09	1.20±1.65	2.40±1.98	2.51±1.24	1.71±1.17	5.26±1.42	4.84±1.76	1.95±1.37	2.35±1.21
10	0.96±0.72	1.22±0.87	1.69±2.33	1.97±2.15	2.33±2.00	1.41±1.08	5.03±2.04	5.40±1.89	2.23±1.06	2.51±1.66
11	0.98±0.82	1.04±0.80	1.49±1.73	1.19±1.06	1.66±1.45	1.18±1.03	5.86±1.74	6.60±1.61	2.20±1.40	2.01±1.23
ALL	1.10±0.27	1.14±0.52	1.28±1.13	1.94±1.06	2.03±0.94	1.34±0.67	5.59±0.89	5.57±1.16	2.10±0.70	2.39±0.78

Data shows as "mean ± SD"

for stress yet. Thus, we have to compare our voice data with some different stress markers. After these processes, we need advices from specialists like psychologists or clinical psychologists. It is expected that to understand the reason of changes of feeling or emotion which causes by not only normal mental reaction but also mental disorder. However, to combine the analyzing voice data by machine and knowledge of specialist may make clear the reasons and mental backgrounds of feelings and emotional changes.

Our system showed not only the changes of feelings and emotion during the period but also the differences of emotion or feeling at one analyzing point. That is the advantage of our system comparing with existing study methods. Many methods which are used on clinical scene need to compare with old data or historical data. We used the non-verbal element in voice for analysis emotion. Thus we could measure the emotion status of point. Our goal is development of simple and easy screening system for mental disorder especially depression, acute stress disorder, and post traumatic stress disorder. For achieve to the goal, we may have to reconstruct and tuning our system up. However, the fact that our system could detect the changes of emotion under stress and measure status of emotion lights up the way to our goal.

VII. CONCLUSION

We investigate if the emotion recognition by natural speaking voice could detect the emotion change which would occur when exposing mental stress. “Sensibility technology ST Emotion” (AGI Japan Inc.) could detect the change of emotion depend on the stress by analyzing the voice data which collected from the personnel of military medical corps participating in a special stressful mission. The result suggested that the techniques of emotion recognition may be used for screening of mental status in military situation. However, further development is necessary for practical use.

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