Laugh Enhancer using Laugh Track Synchronized with the User's Laugh Motion

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Abstract
In television shows, we are familiar with the sound of artificial laughter, the so called "canned laughter" or "laugh track". It generally has an enhancing effect on the viewer's desire to laugh. However, if the sound is played when the user dislikes the content, it works negatively. To cope with this problem, we propose a system that produces the laugh track synchronized with the user's desire to laugh. We use a use a myoelectric signal from the diaphragmatic muscle to detect an initial laugh, and dolls around the user to produce the laugh sound. We speculated that although the initial laugh trigger from the user is necessary, the system can still effectively enhance the laugh activity, and even affect the subjective quality of the contents.

Keywords
Laughter, Laugh Enhancement, Laugh track, Diaphragmatic muscle

ACM Classification Keywords
H5.1. Information interfaces and presentation, Multimedia Information Systems, Artificial, augmented, and virtual realities

General Terms
Human Factors

Introduction
In general, human laughter has a contagious effect on laughter from person to person [1][2]. To utilize this effect, a laugh sound called the "laugh track" is inserted into television comedy show [3][4]. However, if the sound is played when the user dislikes the content, it works negatively.

We propose a system that produces a laugh track synchronized to the user's laughter. In this system, named "Flatters", customized dolls are placed around the user. Each is embedded with an actuator and a speaker, so laughter and a laugh track can be played by the dolls. We believe that we can enhance the sympathetic reaction of the users by embodying the laughter of the audience with the actuation and laugh sound of these dolls.

To detect the initial laughter of the user, we use a myoelectric signal from the diaphragmatic muscle. Using this method, we can quickly detect the user's initial laughter, so we can play a laugh track synchronized to the user's laughter.

Currently, in typical TV program, the laugh track is inserted manually. In contrast, our system automatically initiates a laugh track triggered by the user's laugh motion, so that it can be applied to various TV programs. While we are starting our investigations with these TV programs, there are many other applications, such as comic shows and interpersonal communications.

In this paper, after describing our system, we investigated the laugh enhancement effect of our system. Subjects watched cartoon animations, and their level of laughter was measured quantitatively by the myoelectric signal. The subjects were divided into two groups, one of which was subject to our system and the other not. We compared the amount of laughter from each group.

Figure 1 System overview. The dolls play laughter sounds and shake their heads in synchronism with the user's laughter.

System overview
Figure 1 provides an overview of our system and Figure 2 shows the system structure. Ten customized dolls are placed around the user. Each is fitted with an electromagnet for actuation and a speaker for playing the laugh track.

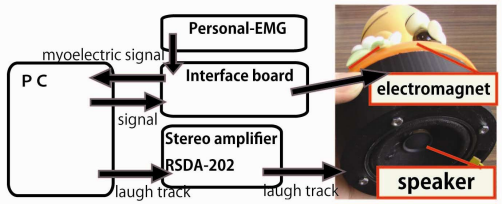

Figure 2 System structure

An electrode seal is attached to the right flank (between sixth and seventh rib) of a user, and it senses the surface myoelectric signals. This signal is sent to the PC via an AD interface board and the PC calculates the amount of laughter in real-time (The algorithm is presented in the following section). Depending on the signal processing outputs, laugh track and actuation signals are sent to the doll.

Algorism for detecting user's laugh

We use the surface myoelectric signal on right flank of the user to recognize laughter quantitatively. We use an electromyograph (Personal-EMG: Oisaka Electronic Device Ltd) and set its gain to 10,000. In general, the flank area is used for detecting diaphragmatic activity. As the laugh is generally considered to be related to breath, this is the correct place for detecting initial laughter activity. Furthermore, since the left area is close to the heart and the EMG signal is contaminated by the heart activity, we chose the right flank area.

Figure 3 shows the raw data of the surface myoelectric signal from the right flank. In this case, the user started to laugh at 698.2s. We analyzed the frequency characteristics of the resting and laughing conditions (Figure 4 and Figure 5). The frequency characteristic in the resting condition was almost entirely the low frequency component, while in the laughing condition, the signal include high frequency components. The low frequency component was due to the heart beat.

Therefore, to extract the laughter component from the raw data, we used the following method. First, the raw data were passed through a high-pass filter, and the heart beat component was removed. Second, the data were passed through an absolute filter and an averaging filter (Figure 6). In Figure 6, we can see the heart beat component being decayed and the laughter element being enhanced. We defined a threshold level of laughter as the red dotted line in Figure 6. If the filtered data crossed this threshold for over 0.3s, the system judged that the user was laughing, and actuated the dolls.

To evaluate a user's laughter quantitatively, we defined the amount of laughter by the area surrounded by the filtered data and the threshold of the laughter.

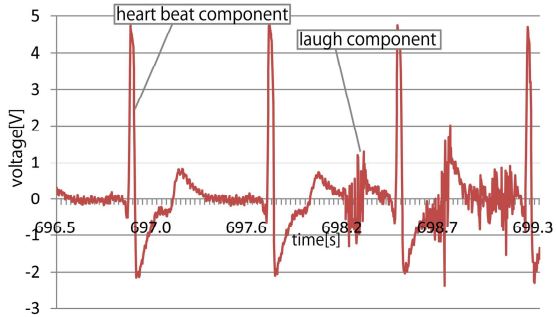

Figure 3 Raw data of surface myoelectric signal on right flank.

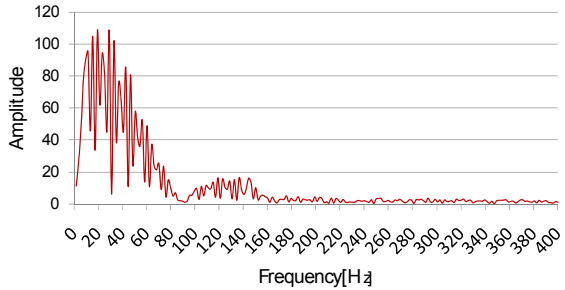

Figure 4 Frequency characteristic at resting condition.

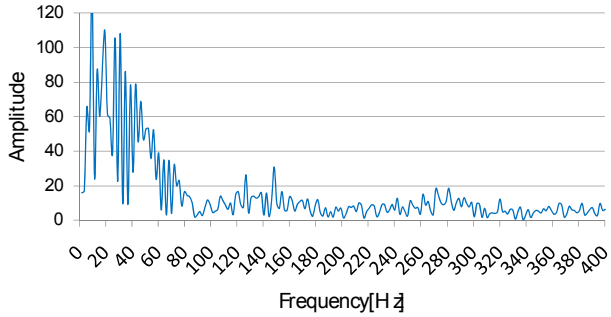

Figure 5 Frequency characteristic in the laughing condition.

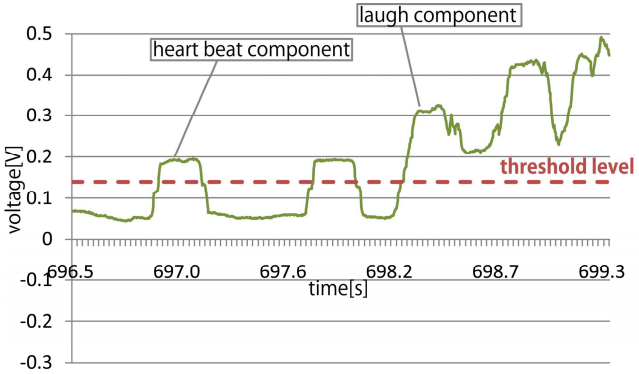

Figure 6 Filtered data of surface myoelectric signal. Red dot line is the threshold level of laughter

Laughter dolls' details

The laugh track is played throgh the customized dolls. We adapted a commercially available doll (nohohon zoku: TAKARA TOMY COMPANY.LTD) that has an electromagnet for shaking its head left and light. We added a speaker to the base of the doll.

To investigate the dolls' effectiveness, we compared two experimental tests, one that did not use the dolls in which the laugh track was played from general audio speakers, and another that used these dolls in which the laugh track was through them. This preliminary experiment was done with two participants, and both of them commented that the version using the dolls version produced a better atmosphere for laughing.

Experiment

We tested this system with ten participants (male: 9, female: 1). Two of them never smiled or laughed during the experiment, so we excluded them from the results. We used a Japanese animation comedy ("GYAGU MANGA BIYORI"). The duration of one story was 5 min and we selected 6 stories (total time was 30 min). The subjects (8) were divided into two groups, one group of four used the laughter enhancement system and the other group of four did not use the system. In the former group, the laughter enhancement system was used at 4th, 5th and 6th stories. and it was not used for the 1st, 2nd and 3rd stories. This was to enable us to compare the effect of laughter enhancement system within the same group. For the duration of the whole experiment, the participants placed the electrode seals on the right flank, which was used to detect the laughter for the laugh enhancer and to measure the volume and duration of the laughter.

After experiencing the system, the subjects responded to questionnaires which had a 5 point scale f evaluation of the funniness each of contents.

Result

Table 1, Table 2 and Table 3 show the results of the experiment. The first row shows the subject's name (A - H), the first column shows the stories (1st - 6th stoies). Table 1 shows the amount of laughter. Table 2 and

Table 3 show the total laugh duration and number of laughter occurrences. The total duration of the animation is 1800s(300s×6stories). Participants A, B, C and D were in the group that used the laugh enhancement system and subjects E, F, G and H were in the group that did not use it. In the former group, the laugh enhancer was used only during the latter three stories (4^{th} - 6^{th} stories).

From Table 1 the amount of laughter varies greatly between the individuals and the stories. Therefore, these data did not reach the significance level of t-test. It was clear that we should use more participants.

From Table 2 and Table 3, we calculated the duration of laughter per single laugh for each story (Table 4). Then we calculated averages for the 1^{st} - 3^{rd} stories and for the 4^{th} - 6^{th} stories (Table 5). In Table 5, subjects A, B and E laughed only a few times, this has been identified by the changed cell color.

From Table 5, subjects who used the laugh enhancement system (subjects C, D) tend to increase the average duration of laughter per single laugh for the $4^{th} \sim 6^{th}$ stories. On the other hand, subjects who did not use the laugh enhancement system (subjects F, G, H) showed the opposite trend. Thus, we infer that our system did extend the duration of laughter per single laugh.

Table 6 shows the result of questionnaires. Each cell is the average score at every story and the former and latter stories. All the stories' averaged score were over 3, which implies that the animations we used were an appropriate stimulus for inducing user's laughter. From Table 1 and Table 6, we observe no correlation between the amount of laughter and its funniness. Which agrees with Cupchik's[3] report that the laugh track can enhance laugh activity, but does not change the subjective value of funniness.

Many of the participants reported positive impression of the experience. For example, "Because of the laugh enhancement system, I felt like laughing", "the dolls laughter synchronized with the subject's laughter, so it was enjoyable".

Discussion and Conclusion

We proposed a system that produces a laugh track synchronized with the user's laughter. The system extends the duration of laughter per single laugh, but the current results are not from a large enough samples to validate the enhancement effect.

We plan to conduct additional experiments with this system, and explore more efficient methods for laughter enhancement.

Table 1 Amount of laughter

	A	B	C	D	E	F	G	H
1st	0.00	0.02	0.51	2.66	0.00	0.25	1.04	4.14
2nd	0.00	0.00	2.73	0.90	0.00	0.04	0.06	1.85
3rd	0.00	0.54	0.84	2.35	0.04	0.30	2.03	2.96
4th	0.07	0.00	0.55	1.49	0.05	0.11	0.03	0.39
5th	0.12	0.00	1.69	3.31	0.17	3.84	0.46	4.18
6th	0.31	0.12	1.11	1.90	0.18	0.87	1.10	2.84
SUM	0.50	0.68	7.44	12.61	0.44	5.41	4.73	16.37

Table 2 Laugh duration and number of laugh activities for A, B, C and D group.

	A		B		C		D	
	time [s]	number	time	number	time	number	time	number
1st	0.00	0	0.37	1	2.17	4	9.97	18
2nd	0.00	0	0.00	0	8.05	11	4.82	8
3rd	0.00	0	3.06	4	3.12	5	6.64	10
4th	0.40	1	0.00	0	2.50	5	4.14	4
5th	1.09	3	0.00	0	5.46	9	13.21	18
6th	2.25	5	1.06	2	3.47	4	8.48	13
SUM	3.74	9	4.50	7	24.77	38	47.26	71

Table 3 Laugh duration and number of laugh activities for E, F, G and H group.

	E		F		G		H	
	time [s]	number	time	number	time	number	time	number
1st	0.00	0	1.34	3	5.67	9	14.47	27
2nd	0.00	0	0.37	1	0.77	2	9.05	19
3rd	0.63	2	1.51	2	13.66	17	12.35	27
4th	0.52	1	0.92	2	0.33	1	2.35	6
5th	1.56	3	11.91	21	1.49	3	14.08	24
6th	1.55	1	4.23	8	5.97	8	13.63	29
SUM	4.26	7	20.28	37	27.89	40	65.94	132

T**able 4** Duration of laughter per single laugh

	A	B	C	D	E	F	G	H
1st	0.00	0.37	0.54	0.55	0.00	0.45	0.63	0.54
2nd	0.00	0.00	0.73	0.60	0.00	0.37	0.38	0.48
3rd	0.00	0.76	0.62	0.66	0.32	0.76	0.80	0.46
4th	0.40	0.00	0.50	1.03	0.52	0.46	0.33	0.39
5th	0.36	0.00	0.61	0.73	0.52	0.57	0.50	0.59
6th	0.45	0.53	0.87	0.65	1.55	0.53	0.75	0.47

Table 5 Average duration of laughter per single laugh

	A	B	C	D	E	F	G	H
Fomer	0	0.38	0.633	0.607	0.105	0.523	0.606	0.49
Latter	0.405	0.177	0.658	0.807	0.865	0.519	0.525	0.483

Table 6 Results of questionnaires

	The Group of A, B, C, D		The Group of E, F, G, H	
1st	3.50	3.67	0.3	0.7
2nd	3.50		1.4	
3rd	4.00		0.4	
4th	3.00	3.75	0.3	0.6
5th	4.00		0.9	
6th	4.25		0.7	

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