비디오 에스노그래피를 이용한 서비스 로봇의 대기상태 행동패턴 연구

The Behavioral Patterns of Neutral Affective State for Service Robot Using Video Ethnography

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Abstract : In recent years, a large number of robots have been developed in several countries, and these robots have been built for the purpose to appeal to users by well designed human-robot interaction. In case of the robots developed so far, they show proper reactions only when there is a certain input. On the other hands, they cannot perform in a standby mode which means there is no input. In other words, if a robot does not make any motion in standby mode, users may feel that the robot is being turned-off or even out of work. Especially, the social service robots maintain the standby status after finishing a certain task. In this period of time, if the robots can make human-like behavioral patterns such like a person in help desk, then they are expected to make people feels that they are alive and is more likely to interact with them. It is said that even if there is no interaction with others or the environment, people normally reacts to internal or external stimuli which are created by themselves such as moving their eyes or bodies. In order to create robotic behavioral patterns for standby mode, we analyze the actual facial expression and behavior from people who are in neutral affective emotion based on ethnographic methodology and apply extracted characteristics to our robots. Moreover, by using the robots which can show those series of expression and action, our research needs to find that people can feel like they are alive.

Keywords : behavioral pattern, neutral affective state, service robot, standby mode

요약 : 현재 진행되고 있는 대부분의 로봇 연구는 특정한 목적을 수행함에 있어서 기능적으로 안정적이고 원활한 움직임을 보이는 것과 더불어 사용자가 원하는 정보를 적절하게 전달하는 것에 초점을 맞춰 진행하고 있다. 본 논문에서는 로봇의 작업수행 상태가 아닌 외부로부터 입력 값이 없는 대기상태의 행동패턴을 제시하여 보다 자연스러운 인간-로봇 상호작용을 제시하고자 하였다. 로봇의 대기상태 행동패턴을 디자인함에 있어서 비디오 관독 방법을 선택하였고, 실제 서비스업에 종사하는 10명의 사람들을 비디오로 녹화하여 사람들과 상호작용이 없는 대기상태의 반복적인 행동패턴을 관찰하였다. 각각의 비디오 데이터로부터 총 21개의 반복적 행동을 기록하였고, 비슷한 항목들을 통합하여 최종적으로 11개의 행동패턴을 추출하였다. 추출된 패턴들 가운데 6개의 대표적인 행동들을 EEEX라는 로봇에 적합하도록 인코딩 작업을 하였고, 이것들이 사람들에게 올바르게 인식되는지를 확인하기 위하여 검증실험을 수행하였다. 사람들은 대부분의 로봇 행동패턴을 실험에서 의도한 바와 같이 인식하였으나 로봇의 하드웨어 특성상 몸과 팔의 움직임에서 약간의 혼동 요소가 있었다. 추후 실험을 통해 EEEX를 대형 마트의 입구에 실제로 배치하여 대기 중에 중립행동을 보일 때와 보이지 않을 때의 손님의 관심도 차이를 조사해보고자 한다.

주제어 : 행동패턴, 무감정상태, 서비스 로봇, 대기상태

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1. Introduction

Human-Robot Interaction has been regarded as an emerging issue for a few years in the robot industry and research area. Especially, intelligent service and entertainment robots need to be played an attentive role among a large group of people such as in exhibitions or shows. Therefore, robots of those purposes have a tendency of being designed as similar as how human behave.

For the most part, recent critical researches about humanoid robotic actions have tended to center around its active behaviors such as how stable it walks and how fast it runs. On the other hand, research on neutral affective state of robot is still in its early stage.

Neutral affective state indicates around center area of Russell's Circumplex Model[12] (Figure 1) which is representative diagram in human emotion studies.

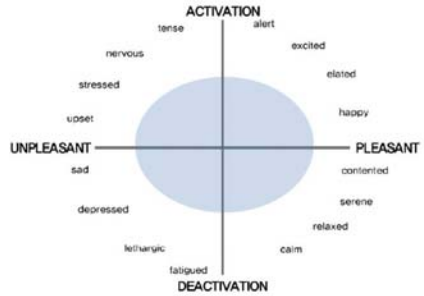

Figure 1. Russell's Circumplex Model(1980)[12]

We defined the term as a certain emotional

state between high and low arousal, also between pleasure and displeasure. As we apply this concept to service robot, the defined state implies standby situation that the robot interacts with nobody while it is working. However, in these moments, it needs to be shown as its activation to people so that they can ask information anytime[6].

Before looking more closely at our experiments, it might be useful to briefly consider what video ethnography generally is and why this method is reasonably suited to our purpose for building robot's neutral behavioral patterns.

2. Video Ethnography

Ethnographic user research is a representative methodology in cultural anthropology and it has been widely used in various fields for human centered approach in these days, such as psychology, economics, sociology and industrial design. Ethnography helps researchers to observe people more carefully so that they can make cultural inferences or new solutions purely focusing on human behavior[14].

Based on this basic concept, this methodology can be differently applied depending on the research background and purpose. For example, cultural anthropologists usually use fieldwork based ethnography, which needs observer to live in another society for more than a year in order to understand local behavior and thought. However, ethnographic researches in industrial design field generally concern about how people use products and services for new product development, so observing period is relatively short and video recording is commonly used. Design ethnography normally consist of two parts - user interview and video recording - because the researchers need to find out unstated desire from consumer's behaviors comparing with what they are already aware of. Therefore, video ethnography is one of the most suitable methodologies for observing unconscious behavioral pattern of human in neutral affective state[1, 8, 9, 10, 16].

3. Experiment

3.1 Participants

In order to decide eligible occupation group for video ethnography, we considered that the primary role of service robot is offering proper information to public. Accordingly, we selected people, such as clerks at information desk, as the participants of this experiment. Ten subjects took part in video ethnography, 5 of them were male, and 5 were female. The observed place is E-Mart, Galleria department store, Samsung service center in Daejeon.

3.2 Condition of Video Recording

We used digital camcorder as a video recording device and actual recording time was about 10 minutes per each participant. To avoiding Hawthorn effect, we tried to record their behaviors without notice if it is possible. After video recording is done, we asked for their permission. A few public places were not admitted to record without permission, we had to let them know before starting to videotape.

4. Data Analysis

4.1 Extract the Behavioral Patterns

From video ethnography data, we made an effort to extract the behavioral patterns of clerks at the service area. We found clerks' unconscious behaviors as much as possible, and listed their behavioral patterns. Figure 2 shows some examples of the behavioral patterns at the neutral affective state in video recordings.

Figure 2. Some examples of the behavioral patterns at the neutral affective state in video recordings

Consequently, 21 behavioral patterns of neutral affective state were extracted from recording video data according to a moving part of the body. Table 1 lists the 21 behavioral patterns extracted from video. These patterns are almost movements of the upper half of the body.

Table 1. The 21 behavioral patterns extracted from video

fast blinking eyes	touching nose
making tension to lip	touching eyes
stick out lip	touching lip
smiling	touching hair
lip stretching	roll up sleeves
cough	hold of one's hands
looking around	grasp one's arm
eye-contact	lean on something
neck stretching	fingering
nod the head slantwise	arm stretching
	body stretching

But some behaviors were confusing to classify each other. Eye-contact, for example, is very confused with looking around. Therefore, we reduced the number of patterns by grouping among similar behaviors. 11 behavior patterns were selected by coding standard finally. Table 2 shows the refined 11 behavioral patterns extracted from video data.

Table 2. The refined 11 behavioral patterns extracted form video data

eye stretching	touching face
mouth movement	touching hair
cough	arm movement
looking around	hand movement
neck movement	lean on something
	body stretching

4.2 Data Coding

We coded 10 video data according to the 11 behavioral patterns from table 2. Table 3 shows the result of the behavioral patterns at neutral affective state by video ethnography.

This result tells what clerks in the service area do at the time they don't offer service to customers. The term frequency in table 3 is the data how many times clerks act each behavior. It is defined by the total number of behaviors divided by the total service idling time. The term rate in table 3 shows how much portion each behavior has.

In addition, there is little disparity in the distinction of sex. The overall frequency of the behavioral patterns is similar between male and female subjects even though there are some differences among patterns. The data of more subjects would be necessary to find whether there is disparity or not.

Table 3. The result of data coding by video ethnography

Behavioral Pattern	Freq. (no./min)	Rate (%)
eye stretching	0.11	1.09
mouth movement	2.41	3.68
cough	0.09	0.91
touching face	0.52	5.10
touching hair	0.26	2.55
looking around	4.05	39.71
neck movement	0.22	2.19
arm movement	1.39	13.66
hand movement	0.58	5.65
lean on something	0.04	0.36
body stretching	0.52	5.10
Total	10.19	100.00

5 patterns have very small parts in the 11 behavioral patterns of neutral affective state. These behaviors hold tiny portion each smaller than 5 %. We thus choose 6 behaviors, mouth movement, touching face, looking around, arm movement, hand movement, and body stretching, to apply to the robot.

Frequency of behavior is very important factor. This data would be a standard how many times robot acts these behaviors actually. Table 4 shows the 6 selected behavioral patterns among 11 patterns of neutral affective state.

Table 4. The 6 selected behavioral patterns among 11 patterns of neutral affective state

Behavioral Pattern	Freq. (no./min)	Rate (%)
mouth movement	2.41	23.68
touching face	0.52	5.10
looking around	4.05	39.71
arm movement	1.39	13.66
hand movement	0.58	5.65
body stretching	0.52	5.10
Total	9.47	92.90

5. Application

We applied the behavioral patterns to specific robot, and modified these behaviors to the robot moderately.

5.1 Robot Platform

Figure 3 is the robot platform to apply the behavioral patterns of neutral affective state. The robot's name is EEEX(Exaggerating Emotion EXpresser)[13].

EEEX consists of 4 parts from a wide point of view. First is a pair of arm-type antennae. This antenna has 3-DOFs each side. It can move pan-tilt-tilt motion by direct driven motors and wire mechanism. These arm-type antennae can make motions like human's arms and hands[2, 4, 7, 15]. Second part is big emoticon-eyes made up of 100 LEDs array. These eyes show LED pattern according to its emotion[3]. EEEX has 3-DOFs neck[5] also. The robot head needs a neck for eye-contact and looking around for the human-robot interaction. Last part is a mouth. EEEX has 1-DOF mouth for lip-sink.

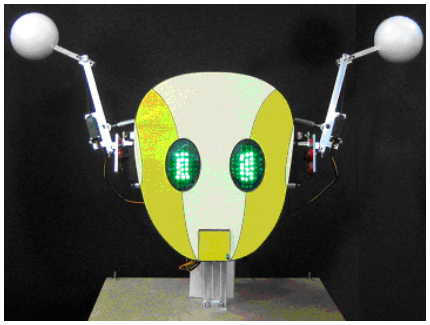

Figure 3. The robot platform for applying the behavioral patterns of neutral affective state: EEEX14

5.2 Application to the Robot

EEEX is not a humanoid robot. Consequently, it is necessary to simplify the behavioral patterns for non-human typed robot[11]. EEEX has a pair of antennae moving like human's arms and hands. These antennae are useful for human's arm motions. And this robot can perform a neck movement and a simple mouth movement.

We selected 6 behaviors at chapter 4.2 according to the coding by video ethnography. These behavioral patterns are mouth movement, touching face, looking around, bowing, arm movement, hand movement, and body stretching. Figure 4 shows the continuous key-frames of the behavioral patterns at the neutral affective state.

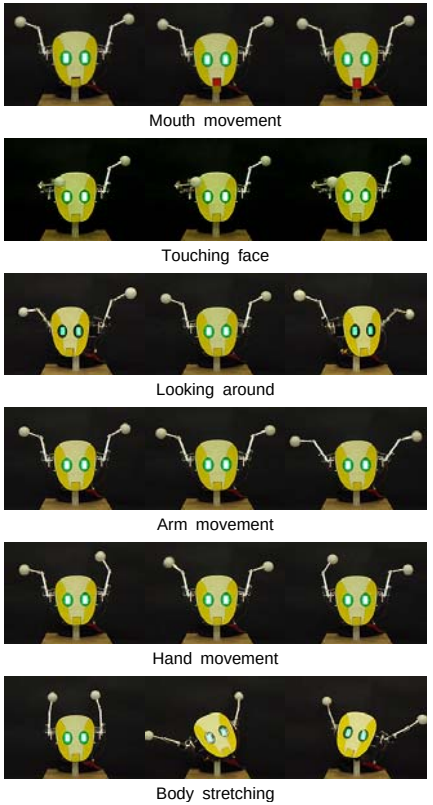

Figure 4. The continuous key-frames of the behavioral patterns at the neutral affective state

EEEX acts the above motions periodically according to the frequency data from table 4. By video ethnography, human does unconscious actions listed in table 2 every 6 seconds approximately. (10.19 actions/min.) This robot thus performs above 6 behaviors every 6 seconds roughly, but randomly.

5.3 Limitation of the Robot Platform about Applied Patterns

The motions applied to the robot have to be evaluated in order to check that human can recognize these behaviors or not. Therefore, we evaluated these 6 behavioral patterns by survey. The survey method is as follows.

1) Watches one behavior among the 6 selected behavioral patterns.
2) Chooses 1 answer well fitted among the 6 behavioral patterns.

Table 5 shows the suitability of each behavior pattern. Rows of table are the patterns shown to the subjects, and Columns of table are the answers understood as. For example, we showed 'looking around' to the subjects, 80% subjects understood that motion as 'looking around', and 20% people recognized that as 'body stretching'.

Table 5. The behavioral patterns cognitive rate

		understood as					
		m.	t.	l.	a.	h.	b.
shown to the subjects	mouth movement	**100**	0	0	0	0	0
	touching face	0	**70**	0	20	10	0
	looking around	0	0	**80**	0	0	20
	arm movement	0	0	0	**60**	30	10
	hand movement	0	0	0	20	**70**	10
	body stretching	0	0	50	10	0	**40**

This chart can be recognized more clearly about the matching of each behavior. Most patterns were matched with major answers, but because of robot appearance, some of them are a little confused. Subjects confused some actions using arms and hands, because EEEX has no arms and hands, and has just a pair of arm-type antennae. However, according to the table 5, most subjects comprehended a motion of arm-type antennae as human's arm motion. If we use humanoid robot platform which has arms, hands, neck, and upper body like human, people don't confuse those behavioral motions each other.

Additionally speaking, we had a preceding experiment, a free description about the each behavior, before behavioral patterns cognitive test. Because the test is a 'free' description without restriction, it is difficult to find consistent answers. However, subjects respond similar explanation about some behaviors such as touching face, looking around and touching face.

6. Conclusion & Further Works

Many robots have already worked in various service fields such as an airport, a restaurant, or a market. These robots are able to offer information and service to customers quite well, but most people avoid getting information from robots. There are various reasons; one of reason may be awkwardness between human and robot.

Current robots show no action when they don't offer service to a customer. Human feels that robot is turned off at no action time. This problem would be solved if robot acts some motions at no service time.

We extracted 6 behavioral patterns of neutral affective state from recording data by video ethnography, and then these behaviors were applied to the test bed robot, EEEX. EEEX has the 6 behavioral patterns of neutral affective state from table 4. These motions are extracted by video ethnography, and modified for a non human typed robot EEEX. These 6 behavioral patterns are expected to increase efficiency of interaction between human and robot.

For further works, an experiment is necessary to verify that these behavioral patterns of neutral affective state increase efficiency of interaction between human and robot or not. The scenario of applied experiment is as follows.

1) Robot acts nothing when they don't offer service to a customer.
2) Robot acts the 6 behavioral patterns from video data when they don't offer service to a customer.
3) Robot acts random motions that have no meaning when they don't offer service to a customer.

We would have this applied experiment in the common service area such as an airport, a library, or a market. And we would check the number of person who accesses the robot acts above motions during idle intervals. This number of person would show the effect of the behavioral patterns of neutral affective state indirectly for smooth interaction between human and robot.

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