What Creates a Pleasant Mood?
－ Development of an Information Model to Create a Good Mood －

Masahide YUASA † Hidefumi OHMURA † †,‡ and Daisuke KATAGAMI ‡

† Shonan Institute of Technology, 1-1-25 Tsujido-Nishikaigan, Fujisawa, Kanagawa, 251-8511, Japan

† † Department of Adult Mental Health, National Institute of Mental Health,
National Center of Neurology and Psychiatry, 4-1-1 Ogawa-Higashi, Kodaira, Tokyo 187-8553, Japan

‡ Tokyo Polytechnic University, 1583 Iiyama, Atsugi, Kanagawa, 243-0297, Japan

E-mail: † yuasa@sc.shonan-it.ac.jp

Abstract Several previous studies have investigated verbal and nonverbal information that may induce a good or bad mood by observing human behaviors; however, to the best of our knowledge, a model that can influence the mood of a robot/agent has not been developed thus far. In this study, we develop an information model for creating an environment that is conducive to pleasant interactions between humans and robots/agents. We propose an information model for mood estimation based on the innate tendency of curiosity. By using the proposed information model, we can estimate the verbal and nonverbal behaviors of robots/agents that are suitable for inducing positive or negative moods according to a given situation.

Keywords Animated agent, robot, mood, mood engineering, information model, human agent interaction

1. Introduction

In our everyday conversation, we comprehend others' emotions by observing nonverbal cues, to understand what they are thinking and ensure smooth communication. We do not just comprehend individuals' emotions but also share in conversational moods created by multiple people (i.e., an enjoyable or excited mood at a party, bored mood during a repetitive speech, or grief at a funeral).

Sharing moods is crucial because it contributes to maintaining and improving everyday life activities; once we understand the thoughts and feelings of a group, we tend to unify and share them, in order to sustain the mood of the group. The mood of a group can also be changed to improve a situation, based on the actions of one person. Understanding and improving mood can benefit group activities and every life (by enabling cooperative work, the creation of new ideas, and good decision-making, etc.) Therefore, investigations regarding mood may contribute to improvement of human communication, and may produce new communication methods for humans.

Furthermore, we believe that the study of mood can inform the study of interactive robots/agents that are capable of communicating with people. Much research has been aimed at developing interactive conversational robots/agents, which can smoothly communicate with people. If robots/agents are developed that can also create a particular mood in a situation, this will enable major advances in relationships between people and robots/agents.

However, a robot/agent model that can estimate the next mood has not been developed thus far, even though several previous studies have investigated verbal and nonverbal information. An information model that can estimate the next mood across multiple situations is desired to develop robots/agents that can create a pleasant mood. Moreover, the model should have simplified principles to enable wide applicability across multiple situations [1]

Therefore, we propose an information model for mood, based on the innate curious tendency of humans. Research on curiosity illustrates the principle that people like complex information, and that it influences human emotions [2]. We hypothesize that this principle is applicable to various kind of human behaviors; thus, the complexity of mood information is also related to people's emotions. Using the proposed model that expresses the relationship between the complexity of information and emotions, we can estimate the behaviors of robots/agents that are suitable for inducing moods according to a given situation.

In the following section, we explain Berlyne's model [2], which expresses the relationship between information and emotion. Based on Berlyne's model, we propose an information model that expresses the relationship between emotions and suitable behaviors of robots/agents. Additionally, we demonstrate examples of applications using our model.

Furthermore, we propose a new area of study in terms

of the creation of mood by multiple robots/agents, which we refer to as “mood engineering” and investigate the comprehension and creation of moods in conversations between robots/agents and humans.

2. Related Research

According to the model of multiple party communication and emotion, Barsade et al. investigated group emotion [3], and Bartel et al. categorized emotions observed in conversations, and proposed a circumflex model, in which moods are represented in two-dimensional space, in terms of valence and arousal [4]. However, these researchers have not proposed a mood generation model that can estimate the next mood.

Several researchers have developed multiple party interactive robots/agents. Padilha et al. [5] developed a simulation system, which mimics small group discussion. Yuasa et al. [6] proposed a turn-taking agent system based on a social scientific approach. The aim of these studies was to develop a conversational agent who could start speaking when the first speaker agent finished speaking; they did not focus on mood generation or the informative model. A model that expresses the relationship between conversation information and emotions (pleasant) is desired for effective conversational robots/agents that can create a pleasant mood.

Researchers in the areas of psychology and brain sciences have investigated the study of human curiosity, and the relationship between complexity of information and emotion. Hatano et al. argued that there are several types of curiosity, one being the need to obtain more knowledge and information [7] and being pleased with receiving novel information. This type of curiosity is considered to be caused by a “hunger for information,” which is an innate need in humans that induces exploratory behavior. In other words, people seek daily news and love to gossip. Curiosity may play an important role in activating human activities.

Berlyne proposed the optimal-complexity model [2], which indicates the relationship between pleasure and complexity of information expressed by entropy value; for example, when complexity increases and entropy values rise, people feel good. However, when complexity is too high and entropy values rise too much, people do not feel good. For example, in daily life; once a rumor is repeated, people become tired of it and eventually are not interested at all and feel disgust. Thus, the Berlyne study is excellent at formalizing the relationship between information and emotion.

We hypothesized that this principle could be applied to other areas. In music research, there has been a focus on expectations of information with consideration of Berlyne’s model. Meyer described that deviations of expectations increase emotions when we listen to music [8], and Narmour also focused on the relationship between expectation and deviation [9]. Ohmura et al. proposed a new model that could generate a melodic rhythm based on entropy [10]. Ohmura also insisted that the model might be related to creating mood [11]. Based on their study, we propose an information model for creating mood.

3. Information Model for Creating Mood

We focus on a model of complexity in order to develop a model of robot/agent behaviors. As described, we propose an information model to create mood based on Berlyne’s proposal. We hypothesize that good/bad moods are related to information indicated by various factors in verbal and nonverbal communication. In particular, we expect that entropy values may relate to various factors such as turn-taking patterns, complexity of opinions in discussion, and variety of facial expressions of participants in group work. Moreover, our model follows Berlyne’s model; when the complexity/entropy of information in conversation increases, good mood is generated. However, when complexity/entropy is too high, mood becomes negative. This relationship is illustrated by an inverted U-shaped graph, which is the same as Berlyne’s model. The proposed model shows the relationship between complexity/entropy of information and good/bad mood, and the verbal and nonverbal behaviors of robots/agents that are suitable for inducing positive or negative moods.

In the next section, we show two examples of applications of our concept: a conversation system using multiple agents that presents different opinions, and a comment support system for a video hosting service using multiple characters.

4. Method and Results

4.1 Proposal of a conversation system using multiple agents that presents different opinions

When someone agrees with our opinions, it pleases us. The more people follow our opinion, the more we are pleased. On the other hand, in addition to increases in those who agree with us, increases in those who do not

agree with us may activate an excited mood in situations in which various opinions are desired, such as discussion and brainstorming. Thus, too many of the same opinions (too many people agreeing with just one opinion) creates a bored mood, and different opinions may create a better mood. We believe that whether the same or different opinions are expressed affects complexity/entropy, and that the relationship between complexity/entropy and excited/bored mood can be explained in this way.

Based on this concept, we developed a test system using two animated agents that discuss different opinions (Fig. 1). In this system, both agents agree with a user's opinion, or one agent agrees while the other does not agree. In our preliminary test using the system, users felt better when both agents agreed, contrary to our expectations. Based on these results, the estimation method using the information model can be improved, and the number of agents should be adjusted. There is significant value in defining the kinds of opinions related to complexity/entropy and mood. In the future, we aim to conduct additional tests to investigate the relationship between opinions of complexity/entropy and mood in conversations.

Fig. 1 Multiple agents that discuss different opinions

4.2 Proposal of a comment support system for a video hosting service using multiple characters

Video hosting sites, for which users can input comments for each video, have been developed and are enjoyed by many users. However, there are many inappropriate and hurtful comments shared, because anyone can comment anonymously. It is desirable that users do not share hurtful and mean comments; however, there is not yet an effective method.

Therefore, we propose a new method using multiple characters; each character has facial expressions that express the mood for the comment that a user wants to input. When a user is inputting a comment, the next mood is predicted by the comment, and facial expressions of characters change (Fig. 2). The extent of changing facial expressions reflect the appropriateness of comments. For instance, if the comment is very inappropriate, all characters' faces change to sad ones. It is expected that these sad faces may deter the user from inputting their comment. If the comment is not overly hurtful but also not positive, some faces (not all faces) change. Moreover, which characters' faces change is decided by the system, using entropy values. We hypothesize that random faces are more effective for inducing users' hesitation than arranged faces (Fig. 3). Complexity/entropy may be useful to estimate which pattern of faces is effective to elicit user hesitation.

Fig. 2 Comment support system for a video hosting service. When a user inputs a comment, the expressions of displayed faces change.

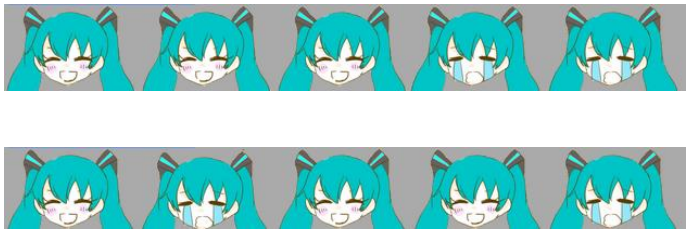

Fig. 3 Arranged faces (upper) and random faces (lower)

5. Discussion and Conclusions

We proposed an information model for creating an environment that was conducive to pleasant interactions between humans and robots/agents. This model could be crucial to the development of an environment in which humans can enjoy their interactions with conversational robots/agents. We focused on the study of curiosity as an innate tendency of humans, to make an information model

for mood estimation. Using the proposed information model, we can estimate the verbal and nonverbal behaviors of robots/agents. We demonstrated two examples of applications that applied to our concept.

As we described, the model is applicable to many areas, and we expect that the model can explain the mechanism of turn-taking patterns and generation of mood. Yuasa et al. proposed a turn-taking simulation system based on observations of human conversation (Fig. 4) [12-14], and investigated the relationship between turn-taking patterns and emotion; for example, moods can be represented in two-dimensional space, in terms of valence and arousal. However, there is no suitable model to explain the mechanism of these moods. Complexity/entropy may be a significant factor in the explanation of this mechanism. In the future, we will define complexity/entropy and test mood estimation for the turn-taking system.

We believe that the relationship between complexity/entropy and mood can be applied to other factors in communication. Using our concept, we can develop a pleasant environment in which humans can enjoy their interactions with the robots/agents.

Fig. 4 Turn-taking agent simulation system

References

[1] Yuasa, M. A Design Method using Cooperative Principle for Conversational Agent, HAI2014, (2014).

[2] Berlyne, D.E. A theory of human curiosity, British Journal of Psychology, Vol. 45, No. 3, pp. 180–191, (1954).

[3] Barsade, S.G. and Gibson, D.E. Group emotion: A view from top and bottom. In Neale M.A., Mannix E.A. (eds.) Research on Managing Groups and Teams 1, pp. 81–102, (1998).

[4] Bartel, C.A., and Saavedra, R. The Collective Construction of Work Group Moods. Administrative Science Quarterly, Vol. 45, No. 2, pp. 197–231, (2000).

[5] Padilha, E.G. and Carletta, J. A simulation of small group discussion. In Proc. EDILOG 2002, 117–124, (2002).

[6] Yuasa, M., Tokunaga, H., and Mukawa, N. Autonomous Turn-Taking Agent System based on Behavior Model. In: Proc. HCI International 2009, pp. 368–373 (2009).

[7] Hatano, G., and Inagaki, K. Intellectual curiosity. Chuko-Shinsho, (1973). (in Japanese)

[8] Meyer, L.B. Emotion and meaning in music. Chicago: University of Chicago Press, (1956).

[9] Narmour, E. The analysis and cognition of basic melodic structures. Chicago: University of Chicago Press, (1990).

[10] Ohmura, H., Shibayama, T., Shibuya, T., Takahashi, T., Okanoya, K., and Furukawa, K. Modeling of Melodic Rhythm Based on Entropy toward Creating Expectation and Emotion. In: Proc. SMC 2013, pp. 69–73 (2013).

[11] Ohmura, H., Shibayama, T., Takahashi T., Shibuya S., Nito H., and Furukawa K. Development of a Generative Musical Structure System Based on Entropy. The 28th Annual Conference of the Japanese Society for Artificial Intelligence, (2014). (in Japanese)

[12] Yuasa M., Mukawa N., Kimura K., Tokunaga H., and Terai H. An Utterance Attitude Model in Human-Agent Communication: From Good Turn-taking to Better Human-Agent Understanding, CHI Extended Abstracts 2010, pp. 3919–3924, (2010).

[13] Yuasa M. and Mukawa N. Building of Turn-Taking Avatars that Express Utterance Attitudes: A Social Scientific Approach to Behavioral Design of Conversational Agents, HCI 2011, pp. 101–107, (2011).

[14] Yuasa M. Can Animated Agents Help us Create Better Conversational Moods? An Experiment on the Nature of Optimal Conversations, HCI 2014, (2014).