Modeling Group Emotion Based on Emotional Contagion

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Abstract. Using computer to generate crowd animation to understand the behavior choice and making decision of individuals in crowd has become a trend in several fields. And group emotions have a great impact on group behaviors and group outcomes. Based on the researches of group emotions described by Hatifield, we propose a quantitative method to building the group emotion model which is focus on a group or a crowd, not on an individual. Our aim is to reflect more believable emotion experiences of individuals in social situation; the individuals' emotion is coming not only from the external stimulus, but from others group members through the conscious and unconscious induction of emotion states as well. For the emotional contagion plays a significant role in the development of group emotion, we select personality, emotional expressivity and susceptibility as mainly factors which influence the intensity of group emotions. Simulation is done by using Netlogo software, and the results show that the model is available and embody the fundamental characteristics of group emotion, and virtual individuals in crowd can generate credible emotional experience and response.

Keywords: Group Emotion, Emotional Contagion, Emotion Model, Personality

1 Introduction

Emotion is an essential part of human life; it not only influences how we think, adapt, learn, behave and how communicate with others, but impacts other people in same situation through emotional contagion as well. Psychologists pointed out that emotional influence on others is completed by emotional contagion. In social interaction, an individual will unconsciously imitate other people's emotional expressions, experience those emotions and then affect his emotions. The process is called as emotional contagion [1]. The essence of emotional contagion is exchange and transfer of emotion which influences others' emotion and further impact their cognition and affective attitude toward the environment which they are facing.

In order to better embody the emotional experience of individuals in social situation, the paper adopts the emotional contagion as the main mechanism of individuals'

emotion interaction, and proposes a new method to model the group emotion based on the 'bottom-up' approach which is discussed by Barsade and Gibson [5].

2 Relative Works

Group emotion can be dated back to the study of mass movements in 19th century. Gustave Le Bon[2] pointed out that crowd emotion was induced by collective mind in his book 'The Crowd: A Study of the Popular Mind', and he explained further that collective mind would emerge in a crowd of people and influence group behavior which would not predicted by simply studying an individual. Modern views proposed that crowd emotion is the functional reaction to situations or events related to individuals. Sociological researches showed the relative deprivation is the most important root causing the negative emotion of the individuals in mass events; it believed that the individuals in crowd will felt discontent when they compare their positions to others and realize that they are lower than others. Smith et al[3] described that members of the group assessed the sense of unfairness as a group events rather than an individual event, and the group emotion would be formed in the evaluation process of individuals who should responsible for the unfair and unequal situation. Yingxin[4] viewed the crowd emotion as 'gas field' in study of mass event; he pointed out that the 'gas field' is a kind of special emotional atmosphere formed by mass who vented their discontents. Although the concept of 'gas field' has its limitations, from the perspective of Chinese traditional culture, it interpreted the procession of forming and development of group emotion. Sigal G. Barsade and Donald E.Gibson [5] offered a brief summary of prominent of research on group emotion and suggested that, from a top-down perspective, group emotion has been characterized as powerful forces which dramatically shape individual emotional response, as social norms prescribing feeling and expression, as the interpersonal glue that keeps groups together and as a window to viewing a group's maturity and development. However, from a bottom-up perspective, they proposed that group emotion can be viewed as the sum of its part of individuals' emotion. There are many computational emotion models recently. However, most of these models focus on the individual, no on the group. Rob Duell et al [6] provided firstly the computational group emotion based on the emotional contagion and the work of Barsade and Gibson. In their model [6,7], the emotion level of a special group was defined as the sum of the product of the emotion intensity of group members and an relevance factor respectively, but the relevance factor did not give any explanation on how to calculate it. In the research on the virtual spectators in game, Xiejun[8] provided the level of neighboring emotion of a special individual as the mean emotion of all of his neighbors. Zhangxue and cheng'an[9] provided a way to calculate the group angry based on network review of news. In the way, many factors: index of angry, group correlation and the level of event influence, have been involved, but in fact the group emotion is defined as the weight sum of individual s' emotion.

Based on above theories and technologies, we provided a new way to calculate the group emotion level using emotional contagion. In our method, we define individual's personality, emotional expressivity and susceptibility as main factors to influence the intensity of group emotion.

3 Main Factors of Group Emotion

3.1 Personality

Emotional contagion, proposed by Hatfield et al [1], is defined as the tendency to automatically mimic and synchronize facial expressions, vocalizations, postures, and movements with those of another person and, consequently, to converge emotionally. In social situation, individuals are easier to be infected by others' emotion. However, there are obviously different in the degree of which individuals transmit their emotions or catch others' emotions [10]. From emotional contagion perspective, Verbeke [11] developed a classification method of personality. Based on the ability to infect and the capability to be infected, individuals are divided into four different classifications: charismatic, empathetic, expansive and bland. In general, most descriptions of personality emphasize the distinctive quality of individual. Most widely accepted models of personality have three-dimensional personality model (PEN) and Five Factor model (FFM). In the paper, the definition of personality is based on the work of Verbeke and described as two-dimensional vector, where each dimension is represented by a personality factor. The distribution of the personality factors is modeled by a normal distribution function N with mean μ_i and standard σ_i :

$$personality =< \lambda_{Ex}, \lambda_{Es} > \tag{1}$$

$$\lambda_i = N(\mu_i, \sigma_i^2), \quad \mu_i \in [0,1] \qquad for \quad i \in \{Ex, Es\} \tag{2}$$

Where *Ex* (Emotional expressivity) represents the ability to infect others' emotion through emotional expression, and *Es* (Emotional susceptibility) denotes the capability to be infected by others through catching others' emotion clue and understanding others' inner feeling. As an example, an expansive individual that has the high ability to infect and low capability to be infected is represented as *personality=<0.8, 0.3>*. However, an empathetic individual that has the low ability to infect and high capability to be infected is represented as *personality=<0.1, 0.9>*, an charismatic individual as *personality=<0.7,0.9>*, a bland individual as *personality=<0.1, 0.2>*.

4 Group Emotion Model

4.1 Emotion Intensity of Individual in Crowd

In psychology, emotion is often defined as a complex state of feeling that results in physical and psychological changes that influence thoughts and behaviors. However, there is a clear difference in the extent. When an individual is alone, his emotion is elicited by external stimulus. The emotional experience of the individual is only response to his cognition and the attitude toward what happened to him, and the emotional expression is the nature revelation of his inner feelings. So in most of computational emotion model, emotion is defines as a function of the individual's personality and external stimulus. However, sociological researches showed that the emotion of an individual in crowd will be influenced by other people. From the emotional conta-

gion perspective, the process of emotional contagion, in which a group member influences the emotion of anther group member and vice versa, through the conscious and unconscious induction of emotion states [12], is primary mechanism through which individual emotions create a group emotion. And the social comparison theory also gave the interpretations about the difference. Individuals tend to compare their behavior and attitude with others that are most like them. In the process of comparison, individuals coordinate his behaviors, attitudes and emotions with those of others people.

Based on these analyses and our previous work [13], we defined the emotion of individual in crowd as a time variation function in which the effect of emotional contagion is considered. For a given individual A, at time step t+1, the intensity of his/her emotion is $I_a(t+1)$, which is

$$I_a(t+1) = I_a(t) + \beta * IC_a(t) + IS_a(t) \tag{3}$$

Where $I_a(t)$ is the emotion intensity of the individual *A* in the last time step. β is an adaptable factor and is set in line with emotional types and environments. $IS_a(t)$ is the level of individual emotion elicited by external stimulus at the time *t*. if there is no external stimulus at the time *t*, $IS_a(t)$ is zero. $IC_a(t)$ denotes the intensity emotion caused by others' emotional contagion. It is defined as follow.

$$IC_a(t+1) = \lambda_{Es}(a) * [\omega * I_{special}(t) + (1-\omega) * I_{goupimpact}(t)] \tag{4}$$

$$I_{special}(t) = \max\{abs[\lambda_{Ex}(s) * (I_a - I_s(t))] * \tau \mid s \in G \setminus \{a\}\} \tag{5}$$

Where $\lambda_{Ex}(a)$ represents the emotional susceptibility of individual A, ω the degree of attainment for special individual. Ispecial (t) is the emotional influence of special individual on the individual A, and it is defined based on the absorption model described by Bosse et al [7]. $\lambda_{Es}(s)$ represents the emotional expressivity of individual S. I_a and I_s are the level of emotion of individual A and S. τ is a moderation factor representing the strength of the channel from individual A to S. $I_{groupimpact}(t)$ is the emotion intensity of individual caused by group emotion at the time t, it will be described in detail in next section.

Emotion does not immediately disappear with external stimulus' end, but it is bound to undergo decay, which is a natural depression or a gradually decline because of mental satisfaction or emotional catharsis. The differences of the decay degree of emotion are showed on individuals' personality. In general, the emotional decay of individual with the high ability to express his emotions is faster than that of whom with low ability. And an individual tends to forget the positive emotions more quickly than the negative emotions. In social situation, the emotional decay is influenced by group size. Researcher pointed out that the emotional delay of individuals in the group with large size is lower than one with smaller size. Based on the researching in psychology, we propose a decay function as follow:

$$I_a(t+1) = I_a(t) * [1 - \exp(\frac{-\mu * groupSize}{\lambda_{Ex}(a) * timeStep})] \tag{6}$$

Where μ is a moderation factor representing different decay speeds for different emotions. For example, its value is smaller when individual experience positive emotion than negative emotion. $\lambda_{Ex}(a)$ is the emotional expressivity of individual *A*. *timeStep* represents the number of emotional contagion times. *groupSize* is the number of individual in a group.

4.2 Group Emotion

Emotion is an inherent part of mass events. Individuals bring their unique emotional tendencies to the group. The group emotion has been viewed as moving upward from the compositional effects of individual group member emotions. The dynamic of group emotion will be in line with the individuals' emotion. That is, the intensity of group emotion should be related with the 'expected value' of individuals. In the paper, we defined group emotion as follow.

$$I_{group}(t) = \sum_{a \in G} \frac{\lambda_{Ex}(a)}{\sum_{s \in G} \lambda_{Ex}(s)} * I_a(t) \tag{7}$$

Where λ_{Ex} is the emotional expressivity of individuals. $I_{group}(t)$ is represent the emotion intensity of group at time step *t*. The emotion intensity of individual caused by group emotion is defined as follow:

$$I_{groupimpact}(t) = \frac{\sum_{a \in G} \lambda_{Ex}(a)}{groupSize} * I_{group}(t) - \rho * I_a(t) \tag{8}$$

Where ρ is the weight coefficient representing different influence on individual from different group characteristics, for example group size and group type.

5 Experiences and Result Analysis

A group emotion model based on emotional contagion is proposed in the paper. Our aim is to reflect more believable behavior and emotion of individual in social situation. A large number of simulations have been performed to test the model, using simulation software. In the section, some of simulation results are discussed.

Firstly, we have fixed the emotion levels and personalities of individuals in crowd to explore the effect of group size. The value of group size is from 3 to 100. The emotion intensities are random numbers following a normal distribution with mean 0.3 and standard deviation 0.1, and group members are charismatic with *personality*=<0.9,0.9>. As expected, group size plays a significant role in emotional contagion, and it influences the level of group emotion. The group emotion is easier to outburst in large group than in small group. Although the decaying speed of positive emotion is faster than that of negative emotion, emotional explosion of group is likely to occur if the group is large enough (Fig.1). And in small group, it is difficult to increase the emotion intensity of individuals, especially when the individuals have positive emotions (Fig 2). The results show that the emotion dynamic of group based on the model provided by the paper is in line with the emotional response of human crowd.

Secondly, we have fixed group size at value 20, and studied the effect of the personalities of individuals in group. We set four groups representing four group types: charismatic, empathetic, expansive and bland respectively. The emotion intensities of individuals in these groups were generated randomly following a normal distribute (μ=0.5, θ=0.1). From the result (Fig.3), we can see the Charismatic group is easier to form emotion climate than others group, especially for negative emotion. And the bland group has low emotion expressivity and susceptibility, so the void of emotional communication and understanding make the bland group difficult to form collective mind.

At last, this model was implemented in the NetLogo[14] environment to simulate the panic crowd. We show an example of the fleeing behavior triggered when a danger is encountered. A fire is treated as a danger to individuals' health. When individuals saw the fire, they would sense the danger and fear/panic is elicited. In our model, the emotion intensity of these individuals is generated random following the normal distribution. The fear/panic will be propagated in the crowd very quickly. All infected individuals (in blue) take the group mind of escaping from the source of danger and performing the flee behavior. There are many individuals who did not saw the danger, their flee behaviors were made based on the information from others emotional expression, for example facial expressions, vocalizations, postures and behavior (Fig.4, Fig.5).

6 Conclusions

In the paper, we proposed a computational model of group emotion, based on the emotional contagion provided by Hatfield. A large number of experiences have been done. And the simulation results show that the group emotion model is reasonable and it can make the virtual individuals in crowd more believable. For the crowd simulation, the model has some referential value. In a future work, we are interesting to investigate the relationship between emotion and behavior choice of individuals in crowd.

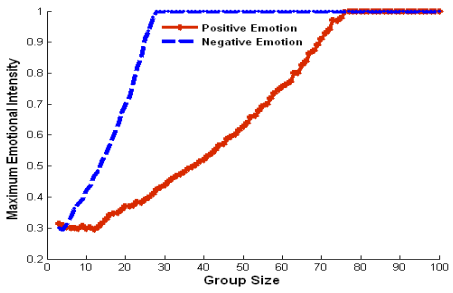

Fig. 1. The maximum emotional intensity of different group sizes. The maximum emotional intensity is the maximum value of group emotion intensity in the whole variable process.

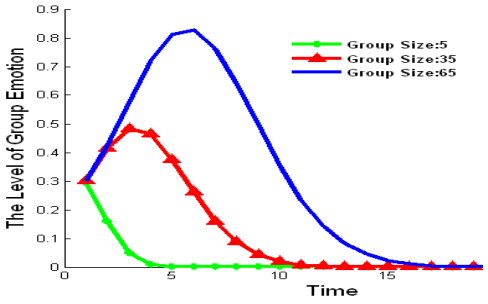

Fig. 2. The change of emotion intensity of groups with different participants

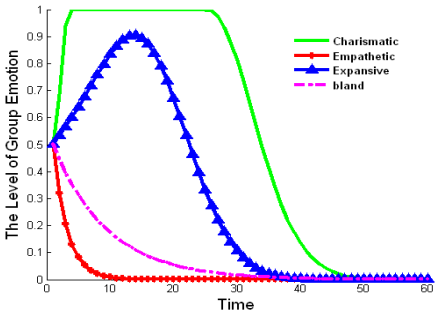

Fig. 3. The change of emotional intensity of groups which have different emotional expressivity and emotional susceptibility

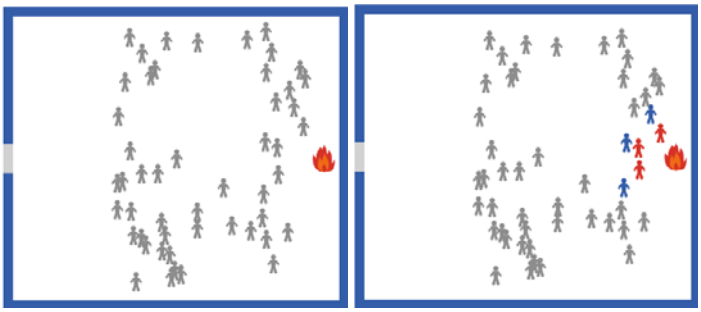

Fig. 4. Snapshots of a crowd performing the fleeing behavior when they feel the existence of a danger. In the left subfigure, these individual (in grey) did not find any danger. In the right subfigure, some individuals (in red) saw the danger and panic/fear emotion was elicited, and they infected others (in blue) emotion through emotional contagion.

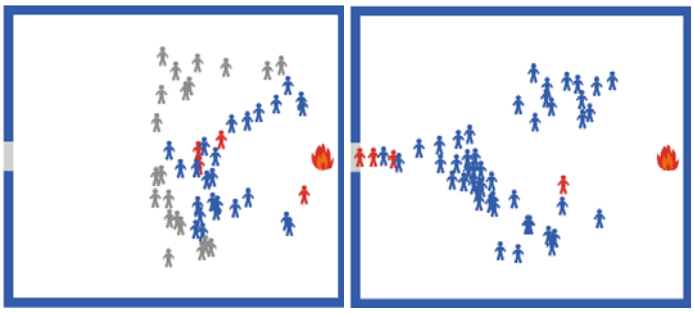

Fig. 5. Snapshots of a crowd performing the fleeing behavior

References

1. Hatfield, E., Cacioppo, J.T., & Rapson, R.L. Emotional contagion. Current Directions in Psychological Science(1993).Vol. 2:96-99.
2. G. L. Bon.: The Crowd: A Study of the Popular Mind. Goungxi Normal University Press. 2007. In Chinese.
3. E. R. Smith. Social identity and social emotions: toward new conceptualizations of prejudice. Affect，Cognition and Stereotyping (1993).297-315.
4. XinYing. 'Gas Field' and the Occurring Mechanism of Mass Events—the comparison of two cases. Sociological Research (2009). Vol. 6:01-09
5. Barsade S.G. and Gibson D.E. Group Emotion: A View from Top and Bottom. Research on Managing Groups and Teams (1998). Vol. 1:81-102.
6. Duell, R.; Memon, Z.A.; Treur, J.; van der Wal, C.N. An ambient agent model for group emotion support. Affective Computing and Intelligent Interaction and Workshops (2009). ACII 2009:1-8.
7. Bosse, T., Duell, R., Memon, Z.A., Treur, J., and Wal, C.N. van der. A Multi-Agent Model for Emotion Contagion Spirals Integrated within a Supporting Ambient Agent Model. Proc. of the 12th International Conference on Principles of Practice in Multi-Agent Systems, PRIMA'09. Lecture Notes in Artificial Intelligence(2009).vol. 5925: 48–67.
8. XieJun. Research of Effect Model of Spectators in Virtual Game. Nanjing University of Science and Technology.Master dissertation 2011. In Chinese
9. Zhang Xue , Chen An. The Monitoring and Measurement of Mood of Anger Based on Network Review of News. SCIENCE&TECHNOLOGY FOR DEVELOPMENT (2010). Vol. 09:44-49. In Chinese.
10. Barsade S.G. The Ripple Effect: Emotional Contagion and Its Influence on Group Behaior . Administrative Science Quarterly (2002).Vol.47: 644-675.
11. Verbeke, W. Individual differences in emotional contagion of salespersons: Its effect on performance and burnout. Psychology and Marketing (1997). Vol.14(6): 617-636.
12. Schoenewolf, G. Emotional Contagion: Behavioral induction in individuals and groups. Modern Psycho-analysis (1990). Vol.15:49-61
13. Yaniun Yin, Weiqing Li, Weiqing Tang, Spectator's Emotion Modeling Based on Emotional Contagion, The International Conference on Automatic Control and Artificial Intelligence (ACAI 2012). Vol.3:2256-2260
14. NetLogo homepage. http://ccl.northwestern.edu/netlogo/.Center for Connected Learning and Computer-Based Modeling, Northwestern University.