

Development of Tidy-up Promotion System by Anthropomorphication of Shared Space

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Abstract. Although it is important for our daily lives and works to keep things tidy and in order, it is difficult to always keep it especially in the shared space because it is unclear who has the responsibility. In this study, therefore, a method to persuade them to change their daily behaviors has been proposed from the concept of Ambient Intelligence. In order to realize the method, a system has been developed to encourage them to keep things tidy and in order by personifying the shared space. The personified system expresses its emotions in response to the degree of the disorder. The system consists of (1) a disorder estimation function from the captured image of the shared space by a camera, (2) an emotion creation function of the personified space by the transition of the disorder, and (3) an emotion expression function in appropriate timing. In addition, a case study had been conducted for 31 days to evaluate the system in a student room of a laboratory. As the result, the longer they stayed in the room, the more they watched the messages of the personified room, and improved their consciousness and habituation of keeping the room in order. However, the users who rarely stayed in the room did not improve the habituation.

Keywords: Ambient Intelligence · Persuasion · Nurturance · Anthropomorphism

1 Introduction

There are shared work spaces where we usually use for our daily work such as meeting rooms and work tables. However they are sometimes left disorderly because the responsibility to manage the shared work space is unclear. In this study, therefore, a tidy-up promotion system has been proposed as shown in Fig. 1 where a personified shared space joins the micro-blog community in which the users of the space join. And it submits the tweets which are corresponding to the emotions generated by the degree of disorder of the space. It aims that the tweets arouse the users' emotions to help the room (nursing desire [1]) and promotes their tidy-up behaviors. In addition in this study, the system was developed and evaluated through a month case study.

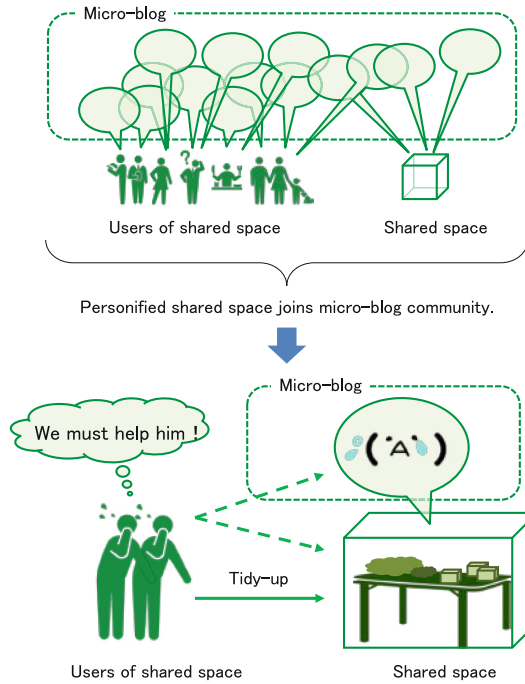


Fig. 1. Outline of tidy-up promotion system

2 Related Works

There are lots of research studies which utilize interaction with computers in order to persuade someone to do something. B.J Fogg summarizes them systematically by using a coined word ‘captology’ which means ‘Computer as persuasive technologies’ [2]. On the other hand, Ambient Intelligence (AmI) has been proposed which are intelligent agents embedded in the environment [3]. The captology based on the AmI has been also discussed. Here, Kaptein et al. indicate the following persuasion factors in order to promote their behavioral changes [4];

- They feel that the provided information is reflected to the actual state.
- They feel that the object which persuades is similar to humans.
- They feel that the persuasion is directly given to them.

In case of the shared space, however, it is difficult to realize the last factor because attribution of the responsibility is sometimes unclear.

The personified agents in micro-blog are called ‘bot’ and they are often used [5]. They have various mechanisms in order to be seen like human, but there is no work which promotes tidy-up behaviors based on arousal of nursing desire.

3 System Design

3.1 Objective of the System

The objective of the system is to promote the users' own tidy-up behaviors by personifying the shared space where the responsibility to be cleaned and well-arranged is unclear.

3.2 System Requirements

The system requirements based on the concept to arouse their nursing desire and persuading factors mentioned in chapter 2 are described as follows;

1. The users feel that the provided information is reflected to the actual state.
2. The users feel that the personified shared space is similar to humans.
3. It arouses the users' nursing desire to the shared space.
4. It improves the users' tidy-up behaviors.

As the precondition to introduce the system, all the users are participating to a micro-blog community where the personified shared space submits its tweets.

3.3 Outline of System

Figure 2 shows the process flow of the system. When detecting a user comes to the shared space, the degree of disorder is measured. Then the emotion of the shared space is generated by the current degree of disorder and its change from the time of the last submission to the micro-blog is calculated. If the time interval from the last submission is longer than a certain period, one of the prepared sentences corresponding to generated emotion is submitted.

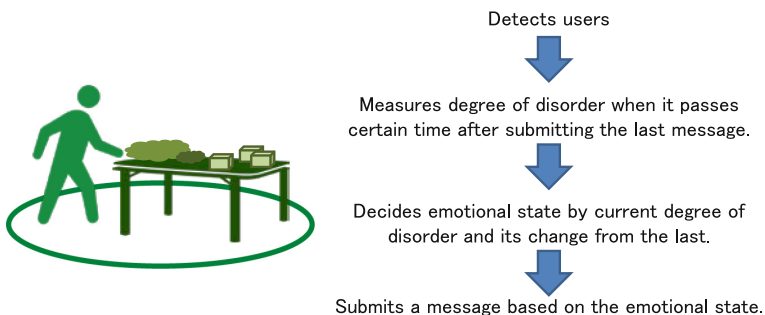


Fig. 2. Process flow of system

3.4 System Implementation

The system has been implemented as follows;

User Detection. In this study, the system employs an image processing method to detect the user because it is convenient to introduce the system into the practical work space using only ordinary camera. The human body detection method by HOG (Histograms of Oriented Gradients) feature values [6] of OpenCV [7] has been employed in the system.

Estimation of Degree of Disorder. Another image processing method has been employed to estimate the degree of disorder of the shared space. Actually a probabilistic Hough conversion has been employed which was proposed by Ishii [8]. This method extracts line segments from the captured image by probabilistic Hough conversion and the number of the extracted line segments is considered as the index of disorder. Most of artificial objects have rectilinear contours such as books and stationaries so that it becomes higher when there are lots of artificial objects in the shared space.

Generation of Emotional Messages. Table 1 shows examples of the emotional states and corresponding messages submitted to the micro-blog by the shared space. In this study, the degree of disorder is first measured by the number of the line segments ($N_{seg}(t)$) and is classified into four categories which are ‘Very ordered’, ‘Ordered’, ‘Disordered’ and ‘Very disordered’. Then the change of disorder degree from the last submission ($\Delta N_{seg} = N_{seg}(t) - N_{seg}(t-1)$) is calculated and classified into six categories. In other words, there are totally 24 states and they are corresponding to the emotions of the shared space as shown in Fig. 3.

As shown in Table 1 and Fig. 3 the emotional messages based on the left side of Fig. 3 express happiness and gratitude, while those on the right side express anger and sadness. The messages on the middle which have less change express moderate emotions. At u3 and t4 in Fig. 3, event information or question to the users are submitted in order not to bore them.

Message Submission to Micro-Blog. The typical micro-blogging service, Twitter [9], is employed in this study. The reason is because lots of people enjoy it so that it is easier to introduce this system into practical use. A PHP script, EasyBotter [5], is used to realize the mechanism to submit the messages into the timetable of Twitter. Plural messages which correspond to 24 emotional states were prepared in advance and they are submitted according to the degree of disorder of the shared space.

3.5 Information Presentation

The timeline of Twitter can be easily accessed by such as web browsers of PC and smartphones. In addition, a mini display which has 8-inch LCD is set around the shared space in order to make the users to easily notice the new message from the shared space

Table 1. 24 emotional states and examples to be submitted to micro-blog

State code	Emotion	Example message
T1	Delight	Oops! Cleared!! Surprized!! \(\textcircled{o}\textcircled{o})/\
T2	Satisfied	Satisfied thanks to you. Thank you ♪ (*'ω`)
T3	Easy, trust	This easy feeling... (▽`)
T4	Optimistic	Welcome. I am pretty fine and calm. (^ω^)
T5	Anxious	It's clean, not too bad, but I feel uneasy... (><)
T6	Uneasy	It's still OK... But I am expecting your tidy-up. *ω*
t1	Refreshing	∩(`ω*)∩ Wow! So beautiful! I feel refreshed!
t2	Gratitude	Thank you, thank you. (^~)
t3	Fine	OK! (*▽*) I'm fine.
t4	Interest in others	Today is meat day, isn't it? \(\textcircled{o})/\
t5	Confused	What? You remain it? I'm confused. (*'ω*)
t6	Depressed	Well, how am I going to be? I'm worrying. (*'ω*)
u1	Recoverd	Oh! I can recover now.
u2	Calm down	Well, it's getting better. ε-(`▽`*)
u3	Interest in others	Are you goint to your hometown in New Year vacation? (**)
u4	Impatient	Oops. Please help me! I can't stop to be impatient (; -□-) oops!
u5	Request	Please. m(____)m Please clean up the table, please..
u6	Disappointed	Oh, I believed you... It's a pity. (*'ω*)
U1	Reticent	(_ _ `)
U2	Lonely	It's untidy, isn't it? My mind is deserted. (>Δ<_)
U3	Sad	It was no use asking here. I want to cry. (': ω: `) umm.
U4	Dissatisfied	I'm dissatisfied now. Because anyone does nothing. (>Δ<_)
U5	Angry	I'm sick! Help me right now! \(`ε`)/
U6	Despair	("□")Wowwwwwww. Oh, No!

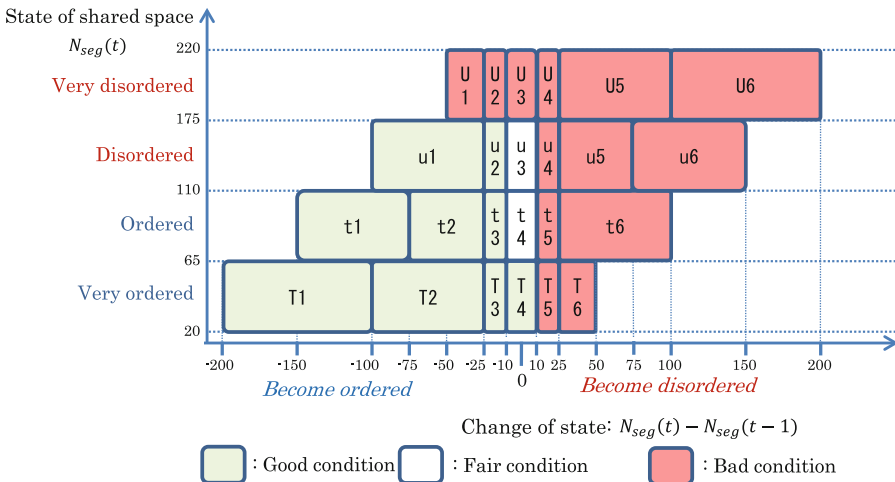


Fig. 3. Classification of generated emotional states

without active access to the timeline. Figure 4 shows a snapshot of the mini display. The timeline including the emotional messages by the shared space is displayed on the right, while the result of the image processing for the user detection and the measurement of disorder is on the left in order to realize one of the system requirements, ‘the users feel that the provided information is reflected to the actual state.’

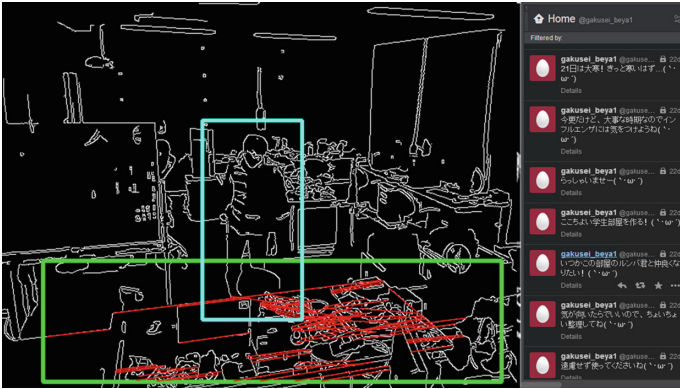


Fig. 4. A snapshot of mini display

4 Evaluation by Case Study

A case study was conducted in order to evaluate the proposed system. It confirmed whether the system requirements described in 3.2 are realized or not.

4.1 Place and Term

The case study was conducted in a student room of a laboratory of other university. The term was 31 days from December 22nd, 2013 to January 21st, 2014. It is because at least two weeks are necessary for the users to become accustomed to the new environment [10].

4.2 Participants

The participants are seven people who are P1 to P7 as shown in Table 2. P1 did not belong to the laboratory so that he didn't have his own desk in the room. However, he often comes there because of joint seminar. The frequencies of the space use and twitter

Table 2. Attributes of participants

Participant	Sex	Position	Frequency of shared table use (/day)	Frequency of accessing Twitter (/day)
P1	Male	1st year of master course	0	5
P2	Male	2nd year of master course	4	1
P3	Male	1st year of master course	10	Not registered
P4	Female	4th year of under graduate	4	Not registered
P5	Female	4th year of under graduate	2	11
P6	Male	Assistant professor	1	15
P7	Female	4th year of under graduate	5	15

submission in Table 2 express those before the case study. Although P3 and P4 didn't have the accounts of Twitter, they registered and got their own accounts before starting the case study.

4.3 Room Environment

Figure 5 shows the top view the student room. P2–P7 shows the desks which the participants P2–P7 occupies for their study, while table A, table B and a kitchen sink are their shared spaces. The table A was chosen to be the shared space in this case study because it has been frequently used for such as lunch and informal discussions.

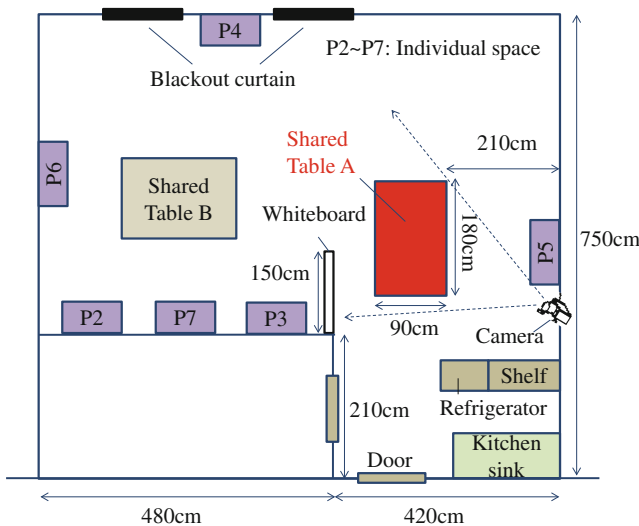


Fig. 5. Top view of student room

4.4 Procedure of Case Study

Figure 6 shows the schedule of the case study. As shown in the figure, the system had stopped from 12th day to 17th day because it was a New Year vacation so that few participants stayed at the room. Questionnaires and an interview were conducted along with the schedule in order to examine their subjective impressions to the system.

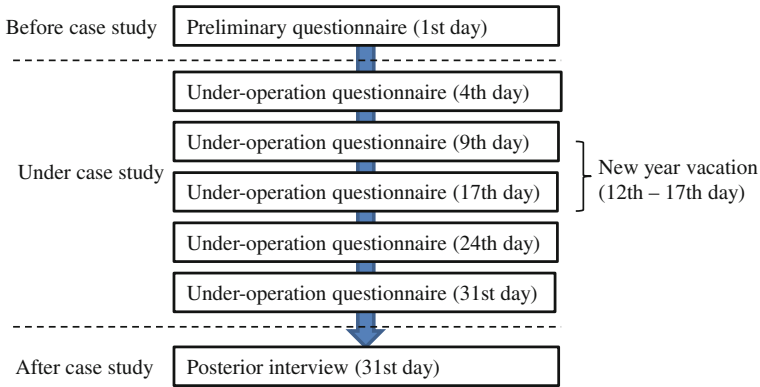


Fig. 6. Schedule of case study

4.5 Results

As shown in Fig. 7, there were long sojourn participants P2, P4, P5 and P7, and short sojourn participants P1, P3 and P6. The effectiveness of the system can be considered to be depending on the sojourn time at the room. They are, therefore, divided into two groups in the later analysis.

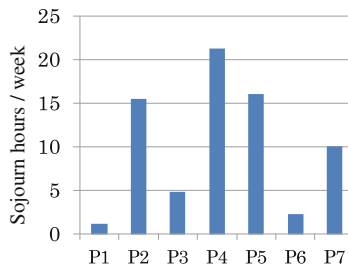


Fig. 7. Sojourn time of each participant

Evaluation by Short Sojourn Group. As shown in Table 3, P1 and P3 answered that their tidy-up behaviors were not promoted. Since they have not spent much time in the student room, they didn't have much chance to see the messages of the shared table. The reason why P3 answered 'No' for all the questions is that he rarely spent time

Table 3. Result of questionnaire and interview

Question	Short sojourn group			Long sojourn group			
	P1	P3	P6	P2	P4	P5	P7
The message fit the state of the shared table.	Fair	No	Fair	Yes	Fair	No	Fair
I felt the table is human like by the messages.	Fair	No	Fair	Yes	No	Yes	Yes
I felt familiarity to the table by the messages.	Yes	No	Yes	Yes	Yes	Yes	Fair
I felt desire to help the table by the messages.	Yes	No	Δ	Yes	Yes	Yes	Fair
My tidy-up behavior was promoted.	No	No	Yes	Yes	Yes	Yes	Fair
Opinion	C1	C3	C6	C2	C4	C5	C7

C1: It was difficult to see the relationship between the states of the table and the messages.

It is better that he tweets even when no one is in the room.

When using emoticons and net slang, I felt it like human.

C3: It may be possible that they don't tidy up when they are accustomed to the system.

I felt uneasy because the camera always observed me.

C6: I felt familiarity to the table by the emoticons submitted to Twitter.

Further operation may bore us. It needs some more things to cheer up.

C2: The consciousness of the table by introducing the system may depend on the individuals.

In order to operate it further, it needs a method to hide the standard of disorder.

C4: I felt familiarity to the table but I couldn't see it like human.

It is better to emphasize to be seen by someone in order to improve the tidy-up behaviors.

C5: I didn't understand whether the system worked well or not.

C7: The change of the emotion based on the change of disorder was too large.

because of his job hunting activity. He also mentioned that he sometimes felt uneasy for the camera installed in the room. Since P6 also belongs to other laboratory, his sojourn time was short. However he actively joined the events such as a year-end party and he was interested in the change of the messages depending on the change of the shared table state. He mentioned this promoted his tidy-up behaviors.

Evaluation by Long Sojourn Group. All of the participants in this group have been writing their theses during the case study term so that they have stayed long in the room. As shown in Table 3, they answered their tidy-up behaviors were promoted. P2 answered positive in all the questions. The main reason is that he felt the tweets of the shared table were like humans did, especially emoticons such as “(^ ^)” were effective. P4 felt familiarity to the table and wanted to help it when it suffered, however, she could not feel it like humans. She also pointed out that the messages of the shared table did not always reflect the actual situations. P5 answered positive in almost all of the questions, however, she sometimes felt the system didn't work well. P7 answered that he felt the space was like humans, however, he also mentioned that the change of the emotion based on the change of disorder was too large.

4.6 Discussion

As the results of the case study, the tidy-up behaviors of the participants who stayed longer were improved because they saw lots of messages by the shared space. However, only one participant answered positive in the question of “Did the tweets well fit the situation of the shared space?” so that one of the requirements, “1. The users feel that the provided information is reflected to the actual state” was not satisfied. As the message interactions between the participants and the shared table, some of them felt familiarity to the table and they indicated that the emoticons were effective for the familiarity. Further consideration is necessary to reveal how to create human-like messages which give human-like impressions. P3 mentioned that he felt uneasy to be observed by the camera. It is necessary to explain the system in advance and to obtain the consent of all the users when introducing it for practical use.

5 Conclusion

The authors have proposed a system which personifies a shared space and submits emotional messages into the timeline of micro-blog in order to improve the tidy-up behaviors of the users by arousing their nursing desire to help it. In addition, a case study had been conducted for 31 days to evaluate the system. As the results, 4 out of 7 participants answered they felt the nursing desire to help the space and 3 of them who had stayed long in the room also answered their tidy-up behaviors were improved. However, one of the system requirements, “the users feel that the provided information is reflected to the actual state”, was not satisfied enough. It is necessary to consider the method to clearly present the mechanism of the system to introduce it for practical use.

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