Humanoid Robots as a Passive-Social Medium – A Field Experiment at a Train Station –

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ABSTRACT
This paper reports a method that uses humanoid robots as a communication medium. There are many interactive robots under development, but due to their limited perception, their interactivity is still far poorer than that of humans. Our approach in this paper is to limit robots' purpose to a non-interactive medium and to look for a way to attract people's interest in the information that robots convey. We propose using robots as a passive-social medium, in which multiple robots converse with each other. We conducted a field experiment at a train station for eight days to investigate the effects of a passive-social medium.

Categories and Subject Descriptors
H.5.2 [**Information Interface and presentation**]: User Interfaces– *User-centered design, Interaction styles;* I.2.9 [**Artificial Intelligence**]: Robotics

General Terms
Design, Experimentation, Human Factors, Verification

Keywords
Passive-social medium, Human-robot interaction, Communication robot, Robot-robot communication

1. INTRODUCTION
Over the past several years, many humanoid robots have been developed that can typically make sophisticated human-like expressions. We believe that humanoid robots will be suitable for communicating with humans, since their human-like bodies enable actual humans to intuitively understand their gestures, to the extent that humans sometimes unconsciously behave as if they were communicating with peers. In other words, if a humanoid robot effectively uses its body, people will communicate naturally with it. This could allow robots to perform communicative tasks in human society such as guiding people along a route [1]. Moreover, recent studies in embodied agents [2] and real robots [3] have revealed that robots can be used as a medium to convey information by using anthropomorphic expressions (Fig. 1(a)). In addition, several advantages of robots over computer-graphic agents have been demonstrated [3, 4].

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(a) Robots as medium in station **(b) View of Station**

Figure 1. Scenes of the experiment

On the other hand, a robot's interaction capability is still far poorer than that of a human due to its limited sensing capability. This shortcoming is particularly noticeable when we introduce robots into our daily lives. Although the appearance of a humanoid robot often makes people believe that it is capable of human-like communication, it cannot currently engage in such sophisticated communication. At the forefront of robotics research remains the pursuit of sensing and recognition. For example, how can we make a robot recognize humans' postures and gestures or its environment? The results of such research should eventually be integrated into robots so that they can behave as ideal interaction partners that are capable of human-like communication. Pioneering research works in human-robot interaction (HRI) have revealed what robots can accomplish, such as museum guidance [5, 6], perspective-taking [7], operation support [8], behaving as a well-mannered servant, and support for language study [9]; however, a robot's ability to inform humans is still quite limited.

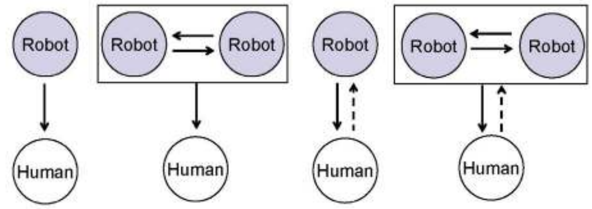
Instead of struggling with the problem of insufficient interactivity built into a robot, we are exploring an alternative approach to maximizing the information that a robot system can offer to people, particularly focusing on attracting ordinary people's interest to the information. This new strategy is based on showing a conversation between robots. For example, Kanda et al. proved that users understand a robot's speech more easily and more actively respond to it after observing a conversation between two robots [10]. We named this kind of medium the "passive-social medium." Figure 2 illustrates the difference between this medium and other forms of human-robot interaction. At times, robots have been merely used for presenting information to people, which we call a passive medium (Fig. 2(a)). This is the same as a news program on TV where an announcer reads the news. On the other hand, many researchers have been working to realize robots that act as an interactive medium (Fig. 2c) that can accept requests from people as well as present information to people. However, due to difficulties with sensing and recognition, the resulting interactivity and naturalness is far from what people expect in a human-like robot.

The robot-conversation-type medium, on which we focus in this paper, is named a passive-social medium (Fig. 2(b)). It does not accept requests from people, as in the case of a passive medium, but attracts people's interest to information more than does a passive medium through its social ability, i.e. the expression of conversation. We believe that a "passive-social medium" is a more natural way to offer information to people than a simple passive medium. This is rather similar to a news program on television where announcers discuss comments told by others. Figure 2(d) shows what we call an interactive-social medium, but it has a weakness in its interactivity, as in the case of a conventional interactive robot medium.

To summarize these arguments, we are interested in two factors of robots as a medium: social expression (one robot or two robots) and response (whether it is interactive in a real field or not). By comparing the four robot-medium types (a) – (d), we investigate the optimal usage of robots as a medium.

Regarding the role of the robots, we assume that they will be used for advertisements and announcements. This is one of the simplest use of a medium. Moreover, since a robot seems novel enough to attract people's attention, we believe that this assumption is reasonable for earlier applications of robots. In order to study such robots as a medium, it is important to conduct a field experiment where ordinarily people pass without having any motivation to interact with the robot, which is unlike having a subject come into a laboratory.

The opening of a new train station (Fig. 1(b)) gave us a unique opportunity for real-world experimentation. We conducted a field experiment at the train station for eight days, where the robot was used to announce various features of the new train line. Through this experiment, we reveal the effects of a passive-social medium.



(a) passive (b) passive-social (c) interactive (d) interactive-social
Figure 2. Robot(s) as medium

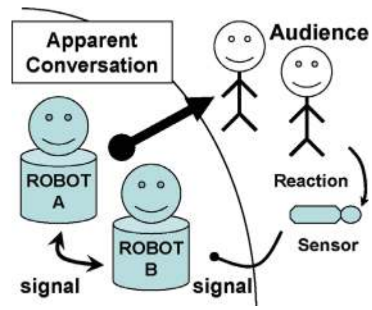


Figure 3. Outline of multi-robot communication

2. MULTI-ROBOT COMMUNICATION SYSTEM

The system consists of a sensor and humanoid robot(s) (Fig. 3). The robots' behavior was controlled by a scenario-controlling system, which we expanded from our previous system [11] by adding a function that makes the robots change their behavior (thus, the scenario they are acting out) when a human is around. The robots' behavior is written in a simple scripting language that is easy to prepare.

2.1 Design Policy

The system implements social expression capabilities and interactivity that perform reliably in a real field. The social expression capability is based on a system we had already developed [11] that allows precise control of conversation timing and easy development. Regarding the interactivity, we limited it to be very simple but robust. The system immediately responds when a person comes close to the robot(s) by making the robot bow to the person. This limited-realistic interactivity is realized with a laser range-finder placed in front of the robot. We did not use any other sensors such as audition or vision, because outputs from such sensors are uncertain in a real field. Thus, what we refer to as "limited-realistic interactivity" is very different from that in some interactive robots, such as Robovie [6, 9, 12], where people may enjoy the unpredictability of unstable sensing capability. We decided on this implementation because unstable interactivity does not work when the purpose is to inform people. Users would be frustrated if they could not retrieve the information they needed.

2.2 Humanoid Robot

We used the humanoid robot Robovie [12] for this system. Figure 1(a) shows "Robovie," an interactive humanoid robot characterized by its human-like physical expressions and its various sensors. We used humanoid robots because a human-like body is useful in naturally catching people's attention. The human-like body consists of a body, a head, a pair of eyes, and two arms. When combined, these parts can generate the complex body movements required for communication. Its height is 120 cm and its diameter is 40 cm. The robot has two 4x2 degrees of freedom in its arms, 3 degrees of freedom in its head, and a mobile platform. It can synthesize and produce a voice through a speaker.

2.3 Sensor

To detect a human approaching a robot, we used a laser range-finder. The laser range-finder that we used is the LMS200 made by SICK. This sensor can scan 180˚ degrees horizontally, and it measures this range within a 5-m distance with a minimum resolution limit of 0.25˚ and 10 mm.

The output is used to make the robots look at (turn their heads toward) the human passing by them. We simplified the output from the sensor by dividing the sensor's detection area into 19 areas (Fig. 4) because 9˚ is a reasonable range to view when a robot looks at a walking person. The sensor sends a signal to the system according to the distance of the human, "1~19." If a

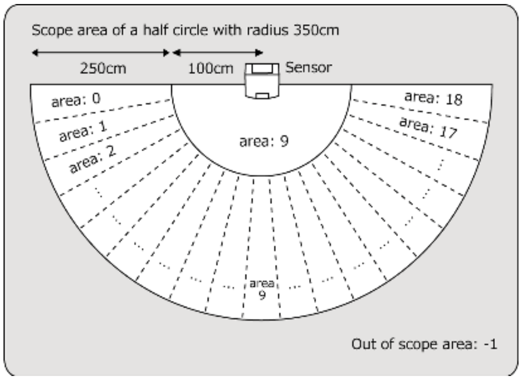


Figure 4. Sensing Areas

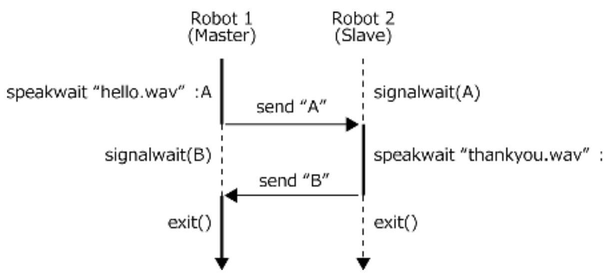


Figure 5. Example of signal exchanges

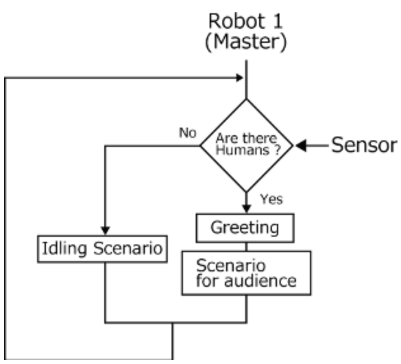


Figure 6. Example of restrictive reaction

human comes closer than a set distance, this sensor considers that the human is in front of the robot and sends signal "9." If there is no human in the area, this sensor sends signal "-1." In the case that more humans are in the observation range, only the closest is considered.

2.4 Scenario-controlling System

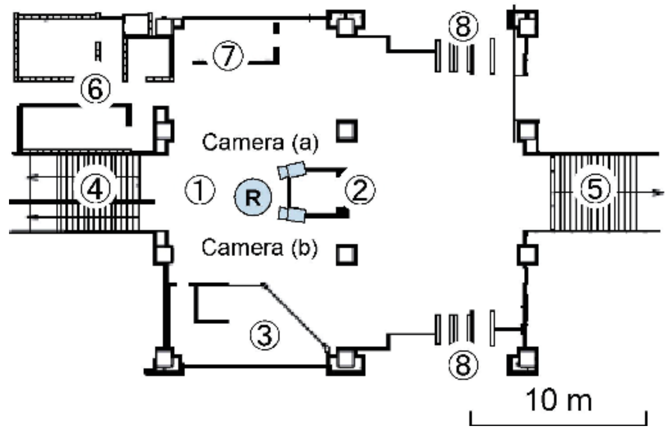
The system is based on our scripting language for multi-robots [11], with a new function for changing the scenario that the robots act out when a human presence is detected. The scripting language has adequate capabilities for describing multi-robot communication and is simple enough for developer to easily use it to control the robots' behavior.

In this system, a set of robots interpret script files and execute scripts written in this language. One robot becomes the master. The master robot receives signals from the sensor, decides which scenario to execute, and informs its partner robot about it.

Figure 5 shows an example of the scripting language. In Fig. 5, after Robot1 finishes playing the voice file "Hello.wav," it sends signal "A" to Robot2. At that time, Robot2 is waiting for signal

Table 1 Example of scenario announcing station and travel information

Social condition
Robot1: *Thank you for using the train.* *Robot2:* *Hey, you said this train can go to Osaka. Where can I go in Osaka, and how long does it take?* *Robot1:* *It takes 30 minutes to Nanba and 40 minutes to Honmachi.*
Non-Social condition
Robot1: *Thank you for using the train.* *I said this train can go to Osaka. Where in Osaka can I go, and how long does it take?* *It is 30 minutes to Nanba and 40 minutes to Honmachi.*



1 : Experiment field **2 :** Elevator **3 :** Shop **4 :** Left stairway **5 :** Right stairway **6:** Toilets 7 **:** Vending machines **8:** Ticket gates

Figure 7. Station map

"A." After receiving the signal "A," Robot2 plays the "thankyou.wav" file and sends signal "B." When Robot1 receives it, this scenario is finished.

Figure 6 shows how the system works in the interactive condition. If Robot1 (master robot) notices there is a person around, it decides which scenario to execute and sends the corresponding signal to its partner. When there is no human around, the robots play the idling scenario.

In this way, we realized a system that is capable of interpreting its environment and executing scenarios accordingly.

2.5 Example of a Script

Table 1 shows an example of a scenario that was actually used. In the interactive condition (see 3.3), when a human approached, the robot(s) turned their faces toward the direction of the person and bowed while saying "Hello." After that, the robot(s) started to play the scenario (social or non-social depending on the condition, see 3.3) for announcing station and travel information (Table 1).

3. EXPERIMENT

3.1 Method

Gakken Nara-Tomigaoka Station was opened in March 2006 as the terminal station of the Keihanna New Line, belonging to the

Kintetsu Railway. The Keihanna New Line connects residential districts with the center of Osaka (Fig. 1b). Station users are mainly commuters and students. There are usually four trains per hour, but in the morning and evening rush hours there are seven trains per hour. Figure 7 shows the experiment's environment. Most users go down the stairs from the platform after they exit a train.

We set the robot(s) in front of the left stairway (Fig. 7). Robot(s) announced information toward users mainly coming from the left stairway. The contents are described in 3.4.

We observed how the users reacted to the behaviors of the robot(s). For the observation, we set cameras on the ceiling nearby (Fig. 7, cameras (a) (b)).

Since there are four conditions (see 3.3), we prepared a time slot for each condition within a day. Moreover, since the number of users is different between the daytime and night, we divided the experiment time into four time slots that each cover both daytime (when there are mainly non-busy people) and night (when there are mainly busy commuters) to avoid incorrect results due to the difference in the number of users (Table 3).

3.2 Participants

All station users who passed by the robot(s) were assumed to be participants. Their behavior was observed by video. We requested users who stopped to watch the robot(s) to answer a voluntary questionnaire. We obtained permission to record video from the responsible authorities of the station, and a notice was displayed in the station about the video recording.

3.3 Conditions

The following four conditions were prepared to investigate two factors: social expression and limited-realistic interactivity.

Passive condition (*P* condition)
In this condition, one humanoid robot was installed (Fig. 8(a)). The robot had a sensor in front of it, though the sensor was not used. The robot continued to play the five scenarios (see 3.4) announcing station and travel information randomly.

Interactive condition (*I* condition)
One humanoid robot was installed as in the P condition, but the robot had limited-realistic interactivity. That is, it had a sensor (laser range-finder) in front of it and changed the scenario according to the position of the human. Concretely, if there was no person near the robot, the robot played the idling scenario. In this scenario, robots talk to themselves (an example is shown in Table 2). When the sensor detected a person within a semicircle of 3.5 meters, the robot stopped playing the idling scenario, looked at the person, bowed and said "Hello." After that, while one or more person was within the range of 3.5 meters, the robot started to play the five scenarios announcing station and travel information randomly.

Passive-social condition (*Ps* condition)
Two humanoid robots were installed (Fig. 8(b)). The robots had a sensor in front of them, but the sensor was not used. The robots continued to play the five scenarios announcing station and travel information randomly by communicating with each other.

Non-social condition (a) Social condition (b)

Figure 8. Social expression

Table 2. Example of idling scenario

Social condition
Robot1:
I'm hungry.
Robot2:
Me too. Let's eat a battery later.
Non-Social condition
Robot1:
I'm hungry.
I am going to eat a battery later.

Interactive-social condition (*Is* condition)
Two humanoid robots were installed as in the Ps condition. The robots had limited-realistic interactivity: the robots had an operating sensor in front of them and changed the scenario according to the position of the human. Concretely, if there was no person near the robots, the robots played the idling scenario. (In this scenario, robots chat with each other.) When the sensor detected a person within a 3.5-m-radius semicircle, the robots stopped playing the idling scenario, looked in the direction of the person, bowed and said "Hello." After that, when one or more person was within a range of 3.5 meters, robots started to play the scenario of announcing station and travel information by communicating with each other.

3.4 Content of Scenarios

In each condition, there were five scenarios of announcing station and travel information as follows:
1) Travel duration to Osaka
2) Information about ATR
3) Where passengers can go on this train line
4) Information about east Osaka (connected by the new line)
5) Facilities near the station.

These scenarios lasted about three minutes each on average. Table 1 shows a part of the scenario announcing travel duration to Osaka, which is shortened by the new line. In the interactive condition, there were five idling scenarios in addition to the information scenario. Table 2 shows one of the scenarios. These idling scenarios lasted about 30 sec on average. After the fourth day, we changed the contents of these information scenarios.

3.5 Measurement

Questionnaire
We requested station users who stopped to watch the robot(s) to answer a questionnaire. We obtained answers from 163 station users. The questionnaire had three questions as follows in which they rated items on a scale of 1 to 7, where 7 is the most positive:
- Feeling of being addressed by the robot

(a) Ignoring (b) Noticing

(c) Stopping to watch (e) Touching (f) Changing course to investigate

(g) Talking about robot(s) (h) Watching with child (i) Taking pictures

Figure 9. Station users' behaviors toward the robot(s)

Table 3. Schedule

Daytime (per hour)	Night（per 30 minutes）
14:00~15:00	18:30~19:00
15:00~16:00	19:00~19:30
16:00~17:00	19:30~20:00
17:00~18:00	20:00~20:30

- Interest in the content of the information the robot(s) is announcing
- Enjoyment

Analysis of Behaviors

We analyzed all videos from cameras and recorded during the experiment period (Table 3) of the eight days of the experiment. In total, about 5,900 people were observed. As a result, we found the following types of people's reactions to the robots.

(a) Ignoring

People passed by without noticing the robot(s) (Fig. 9(a)); 2,964 people showed this behavior. This case was noticed about 370 times a day.

(b) Noticing

People passed near the robot(s) and saw the robot(s) but did not stop walking (Fig. 9(b)); 2,039 people showed this behavior. This case was noticed about 260 times a day.

(c) Stopping to watch

People passed near the robot(s) and stopped to watch the robot(s) (Fig. 9(c)). Usually, after they finished listening to one or two of the information items that the robot(s) announced, they left. This case was noticed about 110 times a day.

Note that (c)~(i) are not mutually exclusive and (c) is inclusive of (d) ~(i). For later analysis, we only used (c).

(d) Staying

This case is a type of "Stopping to watch," where people stopped to watch the robot(s) and continued listening to the information that the robot(s) announced for an extended time. There were five kinds of information, and the robot(s) repeated these randomly; therefore, the same information appeared many times during their stay. However, they kept watching the robot(s) without getting tired. This case was noticed about once a day.

(e) Touching

In this case, people touched the robot as soon as they approached. In particular, two cases were found most frequently. In the first case, they touched the shoulder of the robot and confirmed its feel. In the second case, they held an arm as a robot raised it while motioning to explain information (Fig. 9(e)). In some rare cases, we found that people pulled up the arm of a robot and hugged a robot without thinking that the robot might break. This case was noticed about three times a day.

(f) Changing course to investigate

In this case, people changed their course to come near the robot(s) to investigate (Fig. 9(f)). This case was often noticed about 50 times a day.

(g) Talking about robot(s)

In this case, some people talked to each other about the robot(s). Usually, they talked with their friends, but in rare cases, some people talked with others whom they appeared not to know (Fig. 9(g)). In this figure, they talked about the fact that the robots had a conversation with each other. This case was noticed about seven times a day.

(h) Watching with child

In this case, people watched robot(s) with a child. This case was noticed about found fifteen times a day. We show some examples as follows.

- A child found the robot(s) and came to watch while pulling along his or her parents.
- A person found the robot(s) and called his or her child to watch.

Usually, parents and children watched the robots eagerly. Some of the children sat down to watch (Fig. 9(h)). However, we found some cases where the parents turned their attention in another direction as they lost interest in the robot(s) in contradiction to the eagerness of the children. On the contrary, we also found some parents who watched the robots eagerly while the children turned their attention in another direction as they lost interest in the robot(s).

(i) Taking pictures

In this case, people took pictures with a camera or a mobile phone. For some of them, it seemed more important to take pictures than to listen to the information that the robot(s) announced. This case was noticed about seven times a day (Fig. 9(i)).

We found these typical nine cases as described above. Then, we summarized cases (d)~(i) into "(c) Stopping to watch" because these cases were not mutually exclusive and numbered too few for statistical analysis. As a result, about 900 people were categorized in the "Stopping to watch" category.

3.6 Hypotheses

We examined the following hypotheses in this experiment.

Hypothesis 1:

If the robot(s) is "interactive" with people by bowing to them before announcing the information, the people will get a stronger feeling of being addressed by the robot.

Table 4. Data of Stopping Conditions

Condition	Number of stopping to watch	Number of ignoring or noticing	Rates of Stopping to watch
P	197	1278	0.134
I	214	1330	0.139
Ps	242	1264	0.161
Is	246	1131	0.179

(A: Number of persons stopping to watch, B = Number of persons ignoring or noticing, C = Rates of persons stopping to watch, A + B = Number of All persons, C = A / [A + B])

Hypothesis 2:

If the robot(s) is passive toward people without reacting to them, the people will pay more attention to the information coming from the robot(s).

Hypothesis 3:

People are more likely to stop to listen to the robot's conversation in a two-robot condition than in a one-robot condition.

3.7 Results

Verification of hypothesis 1: Feeling of being addressed

Figure 10 shows the results of "Feeling of being addressed by the robot." A two-way (sociality x interactivity) between-group ANOVA (analysis of variance) was conducted, which showed a significant difference between the interactive condition and the passive condition. The interactive condition is higher than the passive condition ($F(1,136) = 4.63$, $p<.05$), but there is no significant difference in the sociality factor ($F(1,136)=.18$, $p>.10$) and an almost significant effect in interaction ($F(1,136)=2.97$, $p=.087$). That is, the interactivity of the robot gives people a stronger feeling of being addressed by the robot.

Verification of hypothesis 2: Interest in information

Figure 11 shows the results of "Interest in information." As the result of a two-way between-group ANOVA, the Passive condition is significantly higher than the Interactive condition ($F(1,136) = 4.11$, $p<.05$). There is no significant difference in the

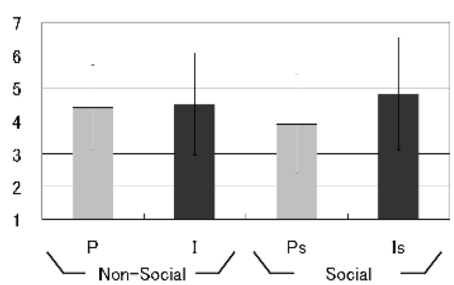


Figure 10. Feeling of being addressed by the robot

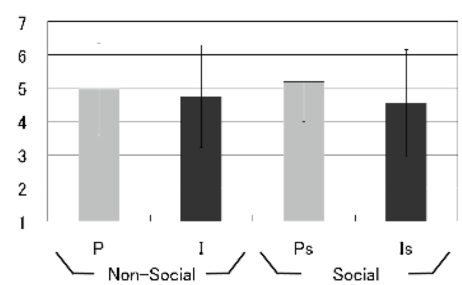


Figure 11. Interest in information robot(s) announcing

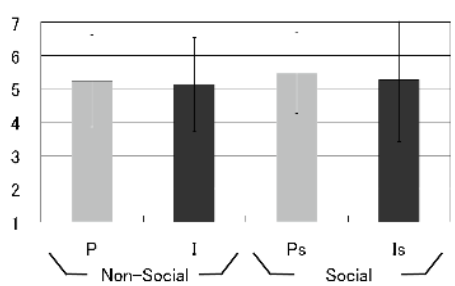


Figure 12. Enjoyment

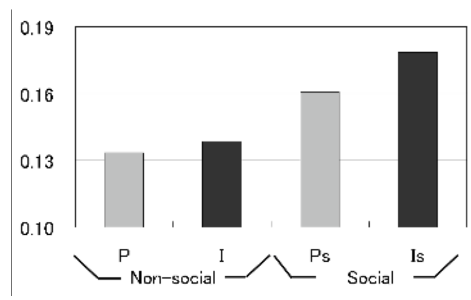


Figure 13. Rate of "Stopping to watch"

sociality factor (F(1,136)=.00, p>.10) or interaction (F(1,136)=.97, p>.10). That is, the limited-realistic interactivity of the robot(s) makes people more likely to lose interest in the information.

Verification of hypothesis 3: Rate of stopping to watch
Table 4 and Figure 13 shows the results of the number of people "Stopping to watch" for each condition. From the results of the Chi-square test, we see there are significant differences between the conditions. The "interactive-social" condition is significantly high, while non-social conditions ("interactive" and "passive") are significantly low. That is, people are more likely to stop to listen to the conversation of two robots.

Analysis of Enjoyment
As a result of a two-way between-group ANOVA, there is no significant difference in either the sociality factor (F(1,136)=.27, p >.10), the interactivity factor (F(1,136)=.18, p>.10), or interaction (F(1,136)=.30, p>.10).

- **Summary of Results**

The results indicate that limited-realistic interactivity of the robot gives people the feeling of being addressed by the robot(s). On the other hand, it makes people lose interest in the information. From this result, we believe that using "interactive" as a medium does not necessarily provide a good result in its current form, since such performance has limited realistic use in a real field. Moreover, the non-social conditions had a lower chance of making people stop at the robot. These findings indicate that the passive-social medium is promising because the system has a better chance of getting people to stop and become interested in the information announced by the robot.

4. DISCUSSION

4.1 Contribution to HRI research

As one of its major contributions, this research demonstrated the positive potential of communication robots at a train station: people at the station sometimes stopped at the robots and listened to the robots' speech. Important information was also reported because people's reactions were observed at the station. Previous research focused on museums [5, 6], universities [13], and schools [9] where people have a tendency to be interested in robots. Therefore, it was not clear how ordinary people would react to such a human-like robot that talks to people. Moreover, in a train station there are many people who do not want to interact with the robots and who are typically busy with their travels. We believe it is worthwhile to conduct a field experiment at such a busy place as well as places where people are highly interested in robots.

Mainly non-busy people seemed to stop walking to interact with the robots as we expected, and the majority of the people did not even look at the robot as they passed through the station. On the other hand, several people were very interested in the robots, performing such actions as talking about the robots while looking at them, touching and talking to them, and looking at them for a long time, which has also been observed in different field trials at places such as a science museum.

4.2 Contribution to robot design as a medium

This research showed how a robot as a medium at a public place, such as a station, should be designed. The experiment revealed that low-level interactivity by the robot increased the feeling of actually conversing with the robot but decreased people's interest in the contents of the utterances. That is, low-level interactivity can introduce an obstruction for robots as a medium for conveying information to people.

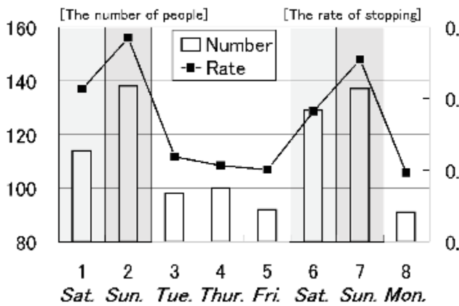


Figure 14. Number and rate of "Stopping to watch" on each day

Regarding the interactivity of robots, researchers are examining ways to improve this. Robots are capable of finding human faces, postures, gestures, and so forth within laboratories, but a real field such as a train station is still a difficult environment for using such sensing capabilities. This research demonstrated one alternative approach for using robots in a real field.

4.3 Effects of robots as passive-social medium

Although we have used robots as a passive-social medium at a science museum [6] and a *manzai* performance [11], we have not revealed the effects of robots as a passive-social medium in comparison with other forms. In both trials, robots got people's attention so that they crowded around to see the robots. One of the difficulties has been that when people have a strong interest in robots, it is difficult to identify the effects of the passive-social medium because people appreciate an encounter with any kind of robot due to its novelty.

The experimental results revealed that a two-robot condition (passive-social and interactive-social conditions) was better than a one-robot condition in terms of getting people to stop at the robots. Once people stopped, these conditions did not make any difference. Instead, a lack of interactivity (passive-social and passive conditions) produced the advantage of attracting people's interest in the contents of the utterances. Thus, the passive-social condition proved to be the best for this purpose among the conditions tested in the experiment.

Although the experiment revealed the positive aspect of passive-social medium on the "interest" aspect, it is not clear how naturally the passive-social medium offers information compared with other types of medium. The experimental results revealed effects when people glanced at the robot to decide whether to stop; however, the results did not reveal effects after stopping at the robots. The difficulty is in experimental control. In this experiment, we controlled the contents that the robots said. Two robots (passive-social condition) enable us to play a bigger variety of scenarios than it is possible with a single robot. For example, one robot might ask a question to another, after which the other would make a response. Use of such a stage effect, however, would cause differences not only due to the conditions (passive-social vs. passive) but also due to the different contents of utterances. Thus, we did not implement such techniques in this experiment. Probably, adding such a feature would make robots more enjoyable and make interaction with people more natural. Demonstrating such effects will be one of our future studies.

4.4 Novelty Effect

Previous research reported a novelty effect, which is the phenomenon of people rushing to interact with a robot at the beginning and then rapidly losing their passion to interact with it [9]. A similar phenomenon might be expected at a train station because there are many people using the station daily to commute to their offices and schools. However, this was not observed. Not so many people gathered around the robot, and the frequency of stopping at the robot did not decrease (Fig. 14). Perhaps, then, robots are not such novel objects for ordinary people at a station.

4.5 Limitations

Since this research was conducted with only one particular robot, Robovie, with a small number of utterances, and at a train station in a residential area, the generalities of robots, stations, and contents are limited.

Regarding the generality of robots, a previous research work demonstrated little difference in people's responses to different robots [14], so we expect that a similar response can be obtained with different humanoid robots. Regarding the generality of stations, people's reactions will probably be different at a busy and crowded station in an urban area; however, it would be difficult to conduct such an experiment at a busy and crowded station due to safety problems. As for the generality of contents, we believe that the setting was realistic for conducting an experiment. We tried to make the contents as simple as possible to reveal basic differences among conditions. When this kind of robot is used for real applications such as advertisements and announcements, we expect that the contents will be more sophisticated, including the use of humor, which could more effectively elicit people's reactions and possibly weaken the differences among conditions.

5. Conclusion

A field experiment was conducted at a train station for eight days, using the technology developed for a multi-robot communication system. The robots' task was to inform passengers of station and travel information. The purpose of the experiment was to identify the best way of informing users. The effects of two factors, social expression and limited-realistic interactivity, were studied. The results indicate that a passive-social medium (social but not interactive) was the most effective way of attracting people's interest in the information; the interactivity was useful in giving people the feeling of talking with the robots. This implies that we should use different forms of robots according to the purpose: a passive-social medium for advertising and an interactive medium for peer-to-peer conversation, such as guiding along a route and exchanging detailed information adapted for each individual.

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