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Assessing Mobile Robotic Telepresence Based On Measures of Social Telepresence

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***Abstract*—**The feedbacks obtained regarding the sense of presence from pilot users operating a Mobile Robotic presence (MRP) system to visit a simulated museum are reported in this paper. The aim is to investigate how much the perception of system's usefulness and ease of use is affected by operators' sense of social telepresence (presence) in the remote location. Therefore, scenarios of visiting a museum are simulated and the user operators are supposed to perform some regular tasks inside the remote environment including interaction with local users, navigation and visiting the artworks. Participants were divided into two groups, those who had previous experience of operation and interaction with a MRP system and those who never had experience. Based on the results, both groups provided different feedbacks. Moreover, there was a significant association between user's sense of presence and their perception of system usefulness and ease of use.

***Keywords*—**Mobile Robotic Telepresence, Museum, Social Telepresence, Usability test.

I. Introduction

DIFFERENT types of MRP systems in a variety of shapes have been designed and developed to operate in populated environments such as office buildings, hospitals, elderly homes, and schools. In these environments, telepresence robots perform a variety of services including educating, entertainment or assistance to people. Accordingly, plenty of studies have been done to investigate the application of MRP systems in a variety of environments. The current paper intends to evaluate the capability of telepresence robot to support the operator's sense of being fully present at a remote environment that is a main attribute in an ideal mobile robotic telepresence (MRP) system. Robotic telepresence technology allows the system operator to be present in the remote location by embodying himself into the shape of a robot. The term "Presence" was augmented in 1990s implying the sense of "being there". Presence might be a critical element in acceptance of any video conferencing system. In this paper, the experienced sense of presence when applying a social robotic telepresence to visit a simulated museum has been tested from the pilot users' perspective.

Moreover, the probable influence of user's sense of presence on his/her perception of system usefulness and system ease of use was also evaluated to identify the extent to which usefulness and ease of use are determined by the sense of presence. The exploratory approach taken in this study focus on the following overall research questions:

1- What is the effect of user operators' sense of being presence in a remote location on their perception of MRP systems to be useful?
2- What is the effect of user operators' sense of being presence in a remote location on their perception of MRP systems to be easy to use?
3- Is there any difference between experienced and novice operators in their perception of social telepresence, system ease of use and usefulness?

The ultimate aim of the study is to provide guidance to the designers regarding the role of feeling of presence as a potential factor that can influence the users' perception of the system's usability and ease of operation. Improvements in these aspects can promote users' acceptance of robotic telepresence systems.

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II. Presence

Presence is a phenomenon with different dimensions. Many researchers proposed a variety of dimensions for presence [1]; however, social telepresence and spatial presence are the most common dimensions of presence. When a technology is good enough with high quality, human will not discriminate between "actual presence, telepresence and virtual presence", p. 6, [2]. In virtual reality, three dimensions of presence have been proposed by Heeter: (1) subjective personal presence – the extent to which an individual perceive that he/she is in a virtual environment, (2) social presence – the extent to which other beings are in the same virtual environment and (3) environmental presence – the extent to which the environment gives the impression that the person is there [3]. Biocca also outlined three dimensions of presence: (1) a physical "being there", (2) a social "being with another body" and (3) "is this body really me" [4]. Biocca discussed about the evolution of virtual reality interfaces that embody the user and studied the way embodiment influences the dimensions of presence [4]. Lombard and Ditton defined another six dimensions for presence: (1) social richness, (2) realism, (3) presence as transportation, (4) presence as immersion, (5) presence as social actor within medium and (6) presence as medium as social actor [1]. They also highlighted that there is a central idea for all these dimensions called the "perceptual illusion of nonmediation" which they properly defined as presence. The perception of presence may happen in two discrete ways: either the medium turn into invisible or converts to a social entity [1]. Sacau offered more overview of presence and

discussed that researchers from a variety of areas with different perceptions offer distinct definitions for the concept of presence, therefore, there is not still a consistent theory about presence [5]. Presence is also defined as composed of two relevant phenomena [3], [4]:

- telepresence (or spatial presence): the phenomenal feel of "being there" due to innate reaction to spatial cues and based on mental models of mediated environments that generate the illusion of the environment; and
- social presence: the feel of "being together with another," due to humans' inherent reactions to social cues, based on imitation of "other minds," and naturally created models of intentionality of other humans or entity.

To keep coordinated with tradition in the area [6],[3], the term of social telepresence is used in this study, particularly to refer to interactions in mediated setting. Since social presence is mediated by telecommunication technology, it is probably more correct to call it mediated social presence or social telepresence. Even though in this study social telepresence is described as the sense of being in remote location in a mediated interaction, the definition is considered tentative and useful.

III. Social Presence Theory and Definitions

The concept of social presence in the field of mediated communication may have been originally developed in the work of Short et al. in the 1970s in an intention to describe the social psychology of telecommunication. Short and colleagues defined the notion of social presence to illustrate that mediated communication is influenced by telecommunication media [6]. They described social presence as "the degree of salience of the other person in a mediated communication and the consequent salience of their interpersonal interactions" p. 65, [6]. They illustrated that level of social presence differs based on the communication media and the degree of social presence influence the quality of interaction and how human being interact (p. 65).They described social presence to be a quality of communication medium that plays an important role on how individuals communicate. They assumed that human perceives a higher level of social presence for some media (e.g., video) and lower level of social presence for some other media (e.g., audio). They also understood that mediums with high level of social presence is perceived to be more sensitive, sociable and personal, while mediums with lower level of social presence is perceived to be less personal, insensitive and unsociable[6]. Later, researchers in computer-mediated communication (CMC) took advantage of this theory to illustrate that CMC is intrinsically impersonal due to absence of nonverbal and relational cues that are common in face-to-face communication [7]. Short, Williams et al. applied the notion of social presence to a variety of media and illustrated that they are different in their capability to express the personal aims, attitudes and motives of the individuals who are communicating and interacting [6]. They also studied and compared a variety of medium technologies and discovered that social presence is highest in face-to-face communications followed by voice/video, multi-speaker audio, telephone and texts [6]. The social presence theory is one of two main theories in social cueing. Weiming discussed that social presence involves as a factor in Argyle and Dean's theory of Intimacy [8] which will be discussed more in following sections [9]. International Society for Presence Research (ISPR) argued that social presence takes place "when part or all of a person's perception fails to accurately acknowledge the role of technology that makes it appear that s/he is communicating with one or more other people or entities [10]. Biocca and colleagues presented another definition for mediated social presence as "the moment-by-moment awareness of the co-presence of another sentient being accompanied by a sense of engagement with the other (i.e., human, animate, or artificial being)" [11]. Social presence varies from a superficial to deep sense of co-presence, psychological involvement, and behavioral engagement with the other. As a global, moment-by-moment sense of the other, social presence is an outcome of cognitive simulations (i.e., inferences) of the other's cognitive, emotional, and behavioral dispositions. These definitions outlines that the theory of social presence is itself a multidimensional concept. Due to evolution of social presence theory, it becomes apparent that not surprisingly no clear, agreed upon definition has been proposed for social presence [12]. Researchers who studied social presence define it in a slightly different way. In addition to these matters, it seems that related terms such as presence, telepresence, and co-presence are applied to similar phenomenon (even sometimes as the same thing) as social presence. The term presence is a key concept used in different areas other than communication such as online learning and virtual reality [4]. In spite of several different definitions, the concept of social presence is in fact unclear. It seems that researchers with different perspective offered different definitions for presence [13]. Regardless of efforts by [13] to unify the definitions and generate some theoretical clarity about the concept of presence generally and social presence specifically, researchers in the area of CMC and educational settings persist to redefine and classify these terms[14]. Gunawardena described social presence as "the degree to which a person is perceived as a 'real person' in mediated communication", p. 151, [15]. Alternatively, another researcher referred to social presence "as the ability of participants in a community of inquiry to project themselves socially and emotionally, as 'real' people (i.e., their full personality), through the medium of communication being used", p. 94, [16].

Tu and Corry described social presence as "the degree of feeling, perception, and reaction of being connected by CMC to another intellectual entity through a text-based encounter", p. 4, [17]. Social presence in an online lesson was defined as "a student's sense of being in and belonging in a course and the ability to interact with other students and an instructor", p. 22, [14]. At least for researchers in area of online learning, social presence definitions seem to fall on a continuum in which at one side, social presence has been defined as the degree to which others perceive an individual to be "real" and to be "there" in an online environment. Social presence at the

other side of the continuum tends to be defined beyond people's perception of an individual to be "present", to be "there" or "real". The definition concentrates on interpersonal emotional connection that exists between communicators when there is social presence which is assumed to be a positive connection [18]. Biocca and Harms insisted on clarification of the conception and put all the definitions into three category based on themes: (1) concepts that convey elements of being together including co-presence, co-location and mutual awareness, (2) concepts that imply the experience of psychological involvement including saliency, immediacy, intimacy, and making oneself known; and eventually, (3) behavioral engagement implying behavioral interaction such as immediacy behaviors by which social presence is recognized [11]. In addition to being an unclear concept, social presence has been applied in two distinctive approaches: one is to describe a property of a medium technology in mediated communication and the other one describes the perceptions, attitudes and behavior of the communicators in a mediated interaction [15]. For example, social presence has been defined as an "attitudinal dimension of the user, a 'mental set' towards the medium" and also "subjective quality of the communication medium", p. 65, [6]. Short's definition of social presence illustrates that even though social presence might be perceived as a property of the medium, this characteristic result from the influence of the medium on the communicators' perceptions, as well as their interpersonal interactions which should be relevant to a property of that perception or interaction. These interpretations of social presence build a concept that can be used in the assessment of a variety of communication media. Biocca and Harms also described 'social presence' relevant to the communicator, however, linked it also to the interaction and the medium, "It is a temporary judgment of the nature of interaction with the other, as limited or augmented by the medium" [11]. Nowak makes a distinction between social presence and co-presence, believing that social presence associates with the medium, while co-presence refers to a psychological connection [19]. Therefore, there has been always a conventional restraint for definition of the concept of social presence in mediated communication, although the concept has been used also in non-mediated interactions [20].

IV. Application of Social Presence Measures for Evaluation of Media Performance

Emergence of communication systems supports social communication and interaction between people in remote locations. These medias are developed and designed to facilitate communication for different purposes including collaborative tasks [9], educational purposes [21], e-commerce [22] and etc. They are different in shapes, however, Majority of these technologies are designed to enhance social presence. For the purpose of the current research work, communication systems mainly developed to support real-time social communication as social presence technologies will be referred to. Several researches evaluated Social presence technologies in their studies by answering to some types of questions including: How well is the performance of these technologies? How well an individual could feel to be connected to other person in the remote location through a social presence technology? Did the communicator obtain the sense of being socially and psychologically connected to an intelligent "other" and communicating with a virtual human agent? The answers to these questions are to a great extent social-psychological in nature rather than technical form. Basically, evaluation of satisfaction and quality of performance with social presence systems such as teleconferencing and collaborative virtual environments is to a large extent performed by assessing the quality of the social presence they can support.

V. Related Works in Social Telepresence

Prior researches illustrated that social relationship, type of task [23], characteristics of communication, confidence, learning choice, and involvement [24] affect the level of social presence. In addition to searching the influencing factors on the degree of social telepresence, researchers have also studied how social presence affects various situations such as learning effects, online interaction, satisfactions, enjoyment, etc. For example, Gunawardena and Zittle discussed that social presence is a significant determinant of satisfaction in users of computer mediated communication (CMC). CMC offers users the ability to make use of ''emoticons'' in order to generate socio-emotional experiences. It is advised that the teacher or the moderator build up a feel of social presence to improve the user's satisfaction of the media [25].

In assessment of MRP systems, researchers evaluated perceived presence as a tool to compare different systems with a variety of characteristics such as screen movements, speed, height, camera, and capability for zooming. Movement has been reported to be an important factor, for example, during a satellite-hub interaction. David found that a display which is turntable and can move delivers more activity, attentiveness, engagement, perceived excitement and amount of turns per second in compare to a video conferencing tool with a static display [26]. Nakanishi discovered that the camera's movement forward and backward has significant influence on the level of social presence evaluating five different situations: fixed, rotatable, movable but non-rotatable, movable, and automatically moving [27]. Social presence has been reported to be higher when the user controls the robot movement in compare to the situation in which the robot moves automatically [27]. Nakanishi conducted also two experiments to find out whether the capability of zooming in a remote camera and display's movement have any influence on the degree of perceived social telepresence [28]. They used a questionnaire particularly designed for the study and concluded that camera's zoom caused the user to experience greater sense of presence when the presenter moves during interaction, however, the zooming reduced the perceived audio and video quality in the situation that the presenter was static. The movement of the display also improved the users 'perception of social presence. In another experiment, Nakanishi reported that sliding movements cause similar

influences on social presence as the forward-backward movements [27]. Kristoffersson conducted some experiments with robot telepresence called Giraffe [29]. She arranged for some realistic scenarios in which her participants, alarm operators and health care professionals visited an elder. Later, they were asked to fill in a questionnaire with questions that evaluate perceived presence and perceived ease of use. She could find Correlations between users' feel of present and attentiveness during the virtual visit and their performance in driving the robot in different situations such as make a u turn, navigation in the environment or docking [29]. In another study by [30], she observed the way novice robot drivers, embodied in Giraff, spatially configured themselves with regard to the elder as the local user and could find correlations between the pilot users' perceived presence and the way they position themselves. She concluded that perceived presence can become apparent by the users' manner to navigate the robot [29].

VI. Research Hypothesis

For every immersive system, one of the main requirements is to enable the pilot user to feel as if he/she is present in the remote location. The degree of social presence provided by each media is an indicator of the extent to which a media is able to support a natural interaction. Therefore, we propose that a media that provides more sense of social presence can better help the user to overlook the effects of technological aspect of the media. Accordingly, in this paper, we assume that there might be a significant relation between the user's sense of presence in the remote destination and the perception of system usefulness and ease of use; therefore, we intended to test the following two hypotheses:

H1. The user operators' sense of telepresence influences their perception of system usefulness.

H2. The user operators' sense of telepresence influences their perception of system ease of use.

VII. Study Design

A. Methodology

The current study is an exploratory research work. Participants fall into two groups based on their prior experience of having interaction with an MRP system and driving it before or not. They were supposed to perform some tasks. Data that was collected focused more on usefulness, system ease of use, perception of being present in the remote location. The research work is a user-centered study and several different methods have been used to obtain user's feedback throughout different experimental phase including survey and interview. The subsequent section includes outlines of this methodology, followed by the results obtained from the user tests. Each user evaluation trial took 45 minutes long. 15 minutes of each trial was used for pre-test introductions including the training and post-test interviews.

B. Double Telepresence Robot

Double Telepresence Robot is a remotely controlled robot consisting of a base with an adjustable close to human height (can control to adjust the height between 47" and 60" tall, about 120cm to 150cm). The Robot's weight is about 15 lbs (7kg), including the weight of the iPad. At each side of cylindrical base, there are two wheels and robot can turn into different directions. The robot does not have any camera, display, speaker and microphone, however, on the top of the body, there is an ipad cradle which is used to hold the ipad or any other iOS device such as iPhones or iPod touches which can be connected to another device that is supposed to provide drive commands, control the movements and pass on the video and audio from the remote location (e.g. a computer on which a chrome browser and Double extension is installed).There is a small mirror around back that reflects the rear-facing camera which enables the pilot to look down at the robot's base helping to avoid obstacles.

C. User-Centered Evaluation and Participants

Experiments conducted in this paper involved twelve sessions with individual adults interacting with a Double Telepresence Robot. For the interaction sessions, the Double telepresence robot has been tested in a simulated museum inside the lab environment in Twente University. The area was chosen and designed in order to simulate a close to real experience of using the robot inside a real museum setting. A large part of the lab environment and some parts of the hallway have been prepared for this purpose and decorated like a painting museum. The whole set up took almost one week. The participant sample set consisted of 12 adult volunteers (Fig. 1 shows snapshots from a video taken from one of the participants). Among the participants, 9 were male and another 3 were female with the mean age of 27.8. The youngest participant was 19 years old. They were students, faculty staff (e.g. lecturers, professors) and researchers all recruited from the University. We purposely selected 50% of the participants from people who had previous experience with driving MRP system who worked in a robotics or technology-relevant sections such as computer science and human-media interaction department, and 50% from people who had never had prior experience with a telepresence robot at all coming from a non-technology related section, such as psychology and business. All of the participants expressed that they had previous experience in using computer and videoconferencing systems such as Skype. We chose experienced and non-experienced participants to hypothesize that:

H3. The perception of the system usefulness and ease of use is different between the users who had previous experience with MRP system and those who have not any experience.

Then the questionnaire is delivered to the participants and some interviews are conducted to obtain more understandings regarding how the participants perceive the interaction through the MRP system. It worth to mention that this human-robot interaction experiment is in fact a usability test in a simulated museum conducted as an initial research work to provide

guidelines for further user tests in real museums. Therefore, the results presented in this paper are a part of a bigger project.

D.Experiment Procedure

In this paper, we intend to assess the MRP system in different forms of interaction. Before the experiment starts, all the participants received some training about the procedures and the tasks they had to do. Pilot users learned how to connect to the robot and drive it through different parts of the scenarios. After the training, each participant received written instructions on the specific tasks they were asked to do through the robot and how to carry them out. The tasks for pilot users included:

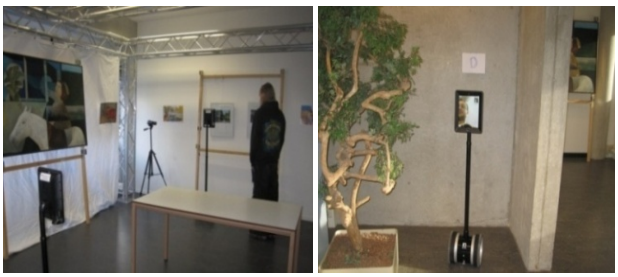
(1) Navigating in the environment;
(2) Having a conversation with a local user;
(3) Visiting the paintings in the simulated museum;
(4) Park back the robot in the allocated point.

Another person was assigned to play the role of the local user who was supposed to accompany the robot during the trial in the environment and talk and interact with the pilot user through the MRP system. To do the experiment, a hall path was marked by arrows on the wall to guide the user driver to find his way to the simulated museum where the paintings were located. Some key points were assigned in each part of the path: The MRP parking place (A), the point where the driver is supposed to meet the local user where they start a conversation (B), The lab environment in which museum was simulated (c), and finally the second parking point which was in another place (D) but still very close to the lab door. Each participant was asked to start the robot application by logging into the server and connecting to the Double telepresence robot that was parked in the (A) point.

1- Once connected, the pilot user started to move the robot from point (A) through the hallway toward point (B), where he had to meet the local visitor and start the conversation about a topic they were both interested (some topics for conversation have been proposed before they start) (S1).
2- They continued the conversation while they were moving on toward the point (C) (S2).
3- Then they started to visit the paintings. They were asked to discuss about what they see in each painting for a few seconds (the purpose was to keep the interaction between the pilot and the partner simultaneously while visiting the paintings) (S3).
4- After visiting the paintings, the pilot had to drive the robot to point (D) and park back the robot there (S4). (S stands for scenario).

(A) (B)

Fig. 1 (a) Snapshots from different scenarios of experiment- The pilot user started to move the robot from point (A) through the hallway toward the point (B), where he had to meet the local visitor. They keep on conversation while they move on toward point (C) to visit the paintings (S1, S2)



(C) (D)

Fig. 1 (b) The pilot and partner visit the paintings. After visiting, the pilot drives the robot to the point (D) for parking (S3, S4)

E. Measurements, Analysis and Findings

In this part, the measurements and results obtained from the observations, and interviews conducted with the participants are discussed. The numerical data was analyzed first for each group separately and then in comparison between experienced users and inexperienced users. Independent sample t test was run between the two groups in order to see whether there were significant differences in how Double telepresence robot was perceived. Therefore, Cronbach's Alphas was calculated on the set of items intended to measure each variable to estimate the reliability of the indices. Results showed that indices were reliable. Cronbach's Alpha for perceived presence was .093 for 6 items and was 0.91 for perceived ease of use for 16 items.

F. Perceived Usefulness

The participants were asked to state their opinions regarding the perceived usability of the Double telepresence robot. They had to give their answer to the question of "Based on the information I have received, I think the system is usable for visiting a museum?" on a 5 point likert scale from 1= strongly disagree to 5= strongly agree. The method of designating this scale has been used in numerous HRI research works and has illustrated to be reliable. Table I presents the question and the results. 33.3% of the participants agreed on this question, and 25% disagree and the rest of the participants had a neutral opinion. The mean value for the overall ease of use was M=3.08 with the standard deviation of SD= .7929. Because there were only 2 groups to compare, Independent sample T

test has been used to evaluate if there is a significant difference between the groups. The analysis results showed that there was a significant difference regarding perceived usability between the inexperienced group and the experienced group TS= t10= 3.796, p=0.004<0.05. Comparing the means between the two groups illustrated that the experienced group (M=3.66, SD= .5164) perceived the system as being more usable than the other group who had never had any experience with driving a telepresence robot before (M=2.50, SD= .5477). The reason might be because experienced users are able to get better use of the system due to their previously acquired skills.

TABLE I
RESULTS OF SYSTEM USEFULNESS

Based on the information I have received, I think the system is usable for visiting a museum?			
Groups	N	M	SD
Experienced	6	3.666	.5164
Inexperienced	6	2.500	.5477

G. Users' Comments about Perceived Usability

The participants were asked to comment in free text on why they did or did not think the Double telepresence robot was usable for the assigned tasks. Although most of the comments about the usability were not actually directly relevant to the usability, however the comments could illustrate the participants' concerns about the probable collisions in the remote environment.

Comment 1

I didn't feel comfortable to drive the robot. I could not see my back properly. Even when I shifted the camera to see my back, I still could not make a safe drive. I think I cannot use it in more populated places because I afraid to make accidents with people.

Comment 2

It was a problem when I stopped the robot, it still moves forward a little bit, so I guess I should stop the robot a few seconds sooner, before the actual place I want to be.

Comment 3

When I drive the robot, I want to see around, but I could only see my front. I couldn't see what was happening around me.

Another participant mentioned that the experience was not very real to him and he couldn't feel himself inside a museum.

Comment 4

"I guess this cannot replace a real museum visit... the experience was very virtual for me"

H. Perceived Ease of Use

Application of MRP systems should be easy to use for both remote and local users. The participants were asked about the system ease of use in every scenario starting from learning how to connect to the robot to how to park the robot back in the last point location. All the participants declared that the overall system was easy to learn and easy to use, except they have difficulties in some parts such as entering the room and driving backwards in which they faced a bit of challenge. They had to give their answer on a 5 point likert scale from 1= strongly disagree to 5= strongly agree. Overall ease of use was also calculated by another statement (I think the overall application of the MRP system was easy to use). The mean value for the overall ease of use was 3.16 with the standard deviation of 1.0298. There was a significant difference regarding perceived **overall system ease of use** between the inexperienced group and the experienced group based on the results obtained from independent sample t test TS= t10= 5.000, p=0.001<0.05. Comparing the means between the two groups illustrated that the experienced group (M=4.00, SD= .5164) perceived the system as being more easy to use than the inexperienced group (M= 2.50, SD=.6324).

TABLE II
RESULTS OF USERS' PERCEPTION OF SYSTEM EASE OF USE

It was easy to ...	Inexperienced users		Experienced users	
	M	SD	M	SD
Start the MRP application?	2.50	.8366	4.00	.6324
Connect to the MRP system?	3.00	.6324	4.16	.7527
Leave the docking station?	4.66	.5164	4.83	.4082
Navigate through the hall?	2.33	.5164	4.50	.5477
Enter a room?	3.66	.5164	4.50	.5477
Find the person you met?	4.00	.6324	4.33	.5164
Stop?	4.16	.7527	4.66	.5164
Go backwards?	2.33	.5164	3.83	.4082
Accompany the person you met?	2.50	.5477	3.83	.4082
Hold a conversation with the local person while navigating?	2.66	.8165	4.00	.6324
Visit the artworks on the wall?	2.66	.8165	3.83	.4082
Go back and dock the robot?	2.83	.7527	4.50	.5477
Hang up the call?	4.33	.5164	4.66	.5164
Hear what the person you met said?	3.50	.5477	3.83	.4082
See the person you met?	1.66	.8165	1.83	.7527
Keep appropriate distance to the people and obstacles?	2.00	.6324	3.66	.5164

Evaluation of ***each item*** for users perceived ease of use showed that there was significant difference regarding perceived system ease of use between the inexperienced group and the experienced group(the means for experienced group were higher) except for some items including leaving the docking station TS= t10= .620, p=0.549>0.05, find the person you met TS= t10= 1.000, p=0.341>0.05, stopping the robot TS= t10= 51.342, p=0.209>0.05, hanging up the call TS= t10= 1.118, p=0.290>0.05, hearing the person you met TS= t10= 1.195, p=0.260>0.05 and seeing the person you met TS= t10= .368, p=0.721>0.05.

I. Comments Regarding Perceived Ease of Use

The participants were also asked to comment in free text about the difficulties that they had when performing the tasks through the MRP system. Most of the difficulties, especially for novice participants came from keeping the appropriate distance to the people or objects, driving backward and seeing the person who they had conversation with. Another most frequent comment was regarding the simultaneous

conversation and navigation, again particularly for novice participants. The reason might be due to the amount of workload in performing both tasks at the same time; however this was less problematic for the experienced group.

Comment 1

"It was difficult for me to roll the robot backward. It was worse when I wanted to park back because I needed to shift the camera 2 or 3 times."

Comment 2

"I couldn't see his face when I was talking to him. A kind of strange. So, I stopped sometimes, turned and looked at his face."

Comment 3

"I wanted to focus on driving. When I was talking to another person, I sometimes got distracted. I didn't want to make any accident."

Some of these comments share the same reason for why the participants think that the system is not usable inside a museum environment.

J. Perception of Presence

The results obtained in this part are based on Witmer and Singer's Presence questionnaire. Based on the analysis of the data, the overall mean of sense of presence was 3.09 and the standard deviation was .796. In order to find out if there is a difference in users' perception of presence between the two groups of experienced and inexperienced users; independent sample t test has been used. The results TS= t10= 11.792, $p=0.000<0.05$ showed that there is a significant difference between the two groups. Comparing the mean value for both groups confirms the results for the independent sample t test (for inexperienced group M= 2.36. and SD=.245 and for experienced group M=3.83 and SD=.182). The pilots who had previous experience with driving a MRP, reported significantly higher on sense of presence in the remote location. The difference between the two groups is probably due to the challenges that novice group experienced during the trial.

TABLE III
RESULTS OF SOCIAL TELEPRESENCE FOR BOTH GROUPS

Questions	Inexperienced users		Experienced users	
	M	SD	M	SD
How much did the visual aspects of the environment involve you?	2.33	.5163	3.66	.5163
How much did the auditory aspects of the environment involve you?	2.50	.547	3.66	3.08
How completely were you able to actively survey or search the environment using vision?	2.16	.408	3.83	.408
How well could you localize sounds?	2.50	.547	3.66	.516
How closely were you able to examine objects?	2.33	.516	4.00	.000
How well could you examine objects from multiple viewpoints?	2.33	.516	4.16	.408

Moreover, there was a significant statistical correlation between the users' sense of presence and perceived usefulness of the MRP system. Results of a simple regression analysis illustrated that 72.4% of total variability of usefulness can be explained by users' perception of presence in the remote location. Also, significant statistical correlation has been found between users' sense of presence in the remote location and perceived ease of use. Based on the regression result, 69.5% of total variability of ease of use can be explained by users' perception of presence in the remote location. This can also explain the reason why the experienced group reported more sense of social telepresence in compare to novice users. The reason for these results might be because the user's perception of their skills and abilities may be enhanced by presence[31]. The relationship between usability and presence can be observed also in presence studies conducted by[32].

VIII. DISCUSSION OF FINDINGS

Application of MRP systems in every different areas and environments depends highly on the users' acceptance of the system. In order to enhance the acceptance among users, researchers should discover all the influencing factors to improve the system. From a pilot users' perspective, the system should allow the user to be immersed in the remote location and naturally interact with the people with the least amount of cognitive disturbance and operational workload. The system should enable the users to concentrate more on the communication and the tasks rather than operating the system. Combination of physical components including audio and visualization should support the users sense of "being there in the remote location" and the system should minimize the effect of medium in the mediated communication. Moreover, characteristics of the users are also important factors to accept the technology of telepresence robots. According to the study's results, the two groups of experienced and inexperienced users showed to have different perceptions regarding application of the MRP system. These are mostly due to the difference in their skills. People with a variety of skills and characteristics have different perceptions about a system usability and ease of use. Therefore, their level of acceptance is also different. Attention to these differences can reduce the risk of future market failures.

IX. CONCLUSION

From the results obtained in this study, we can conclude that every MRP system that can better evoke the sense of presence in the users may better induce the perception of system usefulness and ease of use and these two factors have been shown to be important factors in every technology acceptance. Telepresence robots that can support a higher degree of presence can better provide a close to natural interaction experience. Sense of presence has been introduced as one of the dimensions of quality of interaction. Therefore, robot designers should investigate and focus on the elements that can enhance the capability of robot to create the perception of presence and to improve them if they want to promote the quality of interaction. Another key conclusion is

that an understanding of the way Medias can better support transfer of social cues and social behaviors (e.g., eye contact and facial expressions) as contributing factor to promote sense of presence and increase the quality of interaction is crucial for humans to accept the communicating Medias.

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