Control of Mobile Robot for Remote Medical Examination: Design Concepts and Users' Feedback from Experimental Studies

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***Abstract*—In this article we discuss movement control of a ReMeDi medical mobile robot from the user perspective. The control is essentially limited to the level of operator actions where the operator is a member of a nursing staff. Two working modes are the base of considerations: long distance (LD) and short distance (SD) movement. In this context two robot control techniques are subject of study: manual with use of a gamepad and "point and click" on a map that is related to autonomous motion with use of an onboard navigation system. In the SD mode the user manually operates the robot, that is close to a laying down patient on a settee. In the LD mode the mobile base moves autonomously in a space shared with people to the desired position. Two user studies were conducted. The results show that from the perspective of LD mode the autonomous navigation is efficient and reduces the burden of the medical personnel. In the SD case, the results show that the users were able to precisely position the robot. Besides, the users perceived the manual control with the gamepad as intuitive. In all cases the medical personnel consider this technology as safe and useful. Safety is also confirmed by patients.**

I. INTRODUCTION

Telehealth is considered as potential remedy for increasing demand for doctors of various specializations, especially in provincial hospitals or after regular working hours. Therefore, several types of medicine-related services performed remotely have been developed, ranging from telenursing, telepharmacy, telerehabilitation, telepsychiatry, telepathology, teledentistry, and telesurgery. Nowadays, this is an area of intensive activities for both research and industry.

A new contribution to telehealth has been proposed in the ReMeDi project [1]. The project aims at development of a robotic system for remote medical examination. The system consists of a mobile base with a manipulator (ReMeDi robot) operating in a hospital, and a remote diagnostican interface (DiagUI) placed at the doctor's location (see Fig. 1). A major ingredient of a success for such a robotic system is gaining

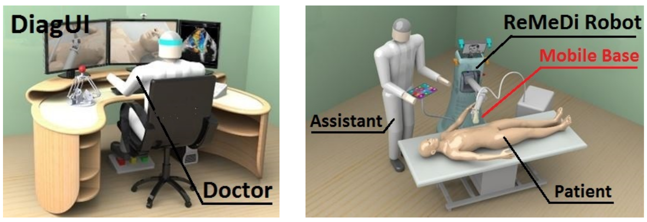

Fig. 1. ReMeDi system overview [1]

acceptance from both patients and medical personnel. Therefore, its design and implementation process is accompanied with extensive user studies [2], [3].

A significant number of modern robots are mobile one. A moveable base allows to increase workspace, improve performance and allows application of robots in new fields. One of examples is the Da Vinci robot, that can be repositioned according to the needs of the surgeon by manually pushing or pulling. These and other forms of manual control are used when precise maneuvring is needed, in particular in a direct presence of a patient. When it is necessary to move the robot over longer distances, the capability of autonomous navigation becomes useful. This is the case in telepresence robots, such as VGo [4], RP-7 [5], RP-VIT [6], Medirob AB [6], and OTOROB [7], [8]. Teleoperation of mobile robots, [9], [10] is a notable option. Various aspects of a mobile telemedicine are discussed in [11].

The ReMeDi robot mobility and control from the user's perspective are the main issues considered in this paper. Based on technical prerequisites and users' expectations we identified two key motion modes for the ReMeDi robot: long distance (LD), that corresponds to the case when the robot is being moved from one room to another and short distance (SD) movement which we refer to when a nurse is positioning the robot relative to a patient on a settee. Specific ways of control have been proposed for these two modes: *point and click* on a map (related to autonomous navigation) in the LD case and manual control with use of a gamepad in both LD and SD cases. Particular attention was paid on perceived safety and usability.

The main result of this paper is that in the context of a specific group of users (nursing stuff), a specific type of a robot (a mobile manipulator of a size comparable to a human) with a specific set of tasks (such as moving the robot for longer distances inside a medical centre, precise positioning of the robots near the settee) the proposed techniques of controlling the robot by a user are appropriate from the users' perspective. Besides, they are a good basis for more advanced techniques that can be a combination of the proposed.

This document starts with a survey of related works and the user requirements in Section II. The design concepts for mobile platform control, the research question and the study design are presented in Section III. The results are collected in Section IV and concluded in Section V.

II. BACKGROUND

A. Related work

Although there are some mobile platforms for medical applications available on the market [5], [6], [12], a limited number of studies about mobility in hospital environment has been published and they concentrate mainly on the navigation from the point A to the point B and on avoiding some static and predefined obstacles [13]. Unfortunately, the hospital environment is not easy and deterministic. A hospital is a place where a lot of people move unpredictably, some of them have additionally some disabilities (problems with hearing or seeing, decreased concentration or mobility impairments). Until now, no research describes how robots should be navigated in such difficult environment. Dynamic changes make it difficult to build a system that can fluently navigate in all conditions [14], [15].

Some similarities may be found in robots operating in real traffic or museums. In outdoor traffic, some solutions were proposed and tested for robots which could navigate autonomously among pedestrians on streets [16], [17]. Other examples are museum guide robots interacting with the visitors [18], [19], which to some extent, correspond to the hospital conditions and interaction with patients. The main motivation of these works is to build a self-contained mobile robot capable of navigating in cluttered pedestrian paths that have not been modified for robot navigation. That implies that the robot has to deal with unpredictable conditions and various hazards.

B. ReMeDi platform – user requirements

Designing of the ReMeDi robotic system was preceded by comprehensive studies of users' requirements. Partial results are presented in [2], [3]. In particular, doctors have pointed to the need of mobility for the robot. This functionality should increase usability of the robot and at the same time should not adversely affect safety. The priority of the medical staff is to be permanently available for patients and to stay with patients. This aspect should be taken into account in the course of implementation of mobility.

III. STUDY DESIGN

Evaluation of medical systems has attracted a special attention in [20]. We have it in mind when designing experimental study for evaluation of control techniques intended for moving the ReMeDi robot.

A. Research Question

In the context of moving the ReMeDi robot in the hospital environment we propose two user control interfaces. We expect that precise maneuvering of the ReMeDi mobile robot can be achieved using a gamepad. Here, a gamepad is a prototype of the future operator panel which will have similar functionality. It is not clear whether this robot control method is acceptable for medical staff. A similar question occurs for the *point and click* technique. Thanks to this technique, the staff should spend less time operating the robot. As a consequence, the ReMeDi robot has to move autonomously in spaces used by patients, without direct supervision and presence of the medical staff. This raises the question about the perceived safety, usability, and acceptance from the perspective of both: patients and medical staff. Bearing the above questions in mind, two hypotheses have been assumed in this paper.

Consider the examination phase. An assistant, a member of a medical personnel, sets the position of the mobile platform next to the patient settee, in the place considered by a doctor as suitable for a medical examination – this involves short distance (SD) movement. Manual control using a gamepad makes it possible to execute this task easily and with sufficient precision. From the perspective of a medical staff this way of control is useful and safe.

Consider robot movement between rooms. An assistant, a member of a medical personnel aims to move the platform to another room in the hospital building. It is a long distance (LD) motion. The platform will drive along corridors used by patients. The *point and click* way of steering the robot is useful, easy and intuitive. Autonomous motion along corridor is considered to be safe both from the perspective of patients and the medical staff.

At this place we would like to point out, that we admit teleoperation of a mobile platform but essentially we focus on the case when the robot is constantly accompanied by an assistant. Such a use scenario follows directly from the pilot experiments.

B. Experimental Set-Up

Two user studies were carried out in the hospital of the Medical University of Lublin in Poland. The research took place in February 2015. In total, there were involved 69 participants (36 females and 33 males).

The scene for the experimental scenario consisted of four rooms and a corridor linking these rooms. One room was arranged as examination room, the second one as maintenance room, the third room was used for observing the study, and the fourth room was used for giving instructions to the participants. The participants were instructed to sit in the maintenance room and to move the mobile robot platform from the maintenance room to the examination room through the corridor. The experimental scene was monitored with six AirLive WN-200 HD cameras connected to an AirLive NVR8 network video recorder. One experimenter was assigned the task to carry out data acquisition in the observation room as well as to monitor the behaviour of the participants. We collected video data of the whole study as well as data related to the mobile robot platform, including its position on a map at each time instant. For synchronization, videos and robot platform data were endowed with a time stamp. We used the collected platform data to calculate the position of the robot in relation to the patient settee in the examination room. The examination room was endowed with a desk and the patient settee. Additionally, we drew a square of the size 0.6m x 0.6m on the room floor in front of the settee, to which the participants had to move the robot. Finally, The maintenance room was equipped with a desk, a laptop and a chair for the participants to sit and control the robot in the *point and click* technique setting.

In the next section, we give technical details for the used mobile robot platform.

C. Mobile Robot Platform

1) Basics: For the experiments we used a mobile platform Carol [21]. The platform has been manufactured by ACCREA[1], as a testbed for technology used in the project.

The robot is designed as a differential wheeled robot with a touchscreen mounted on a post, as shown in Fig 4. Two driven wheels with two supporting castors provide adequate mobility for indoor motion. The dimensions of Carol are slightly smaller than the dimensions of the future ReMeDi robot mobile base. The length and the width are equal to 50cm and the height is 1.2m. During the experiments a laser scanner (Hokuyo URG-04) was used to detect people and obstacles during autonomous navigation as well as for robot localization on a map. Additionally a camera from the kinect sensor was used to provide visual feedback for the operator during manual motion. The safety of the system is supported by bumpers located around the robot which serve as an emergency stop.

The software and hardware are integrated on the basis of two robotic software frameworks: OROCOS and ROS that are functioning in cooperation with a real time operational system Linux Xenomai (this software set will be labelled by *XOR* from now on) as in [22]. Such a solution allows us to use both the real time modules for the tasks requiring timely response and standard ROS modules when the response time is not critical and when fast prototyping with community available modules is desirable.

[1]http://accrea.com/

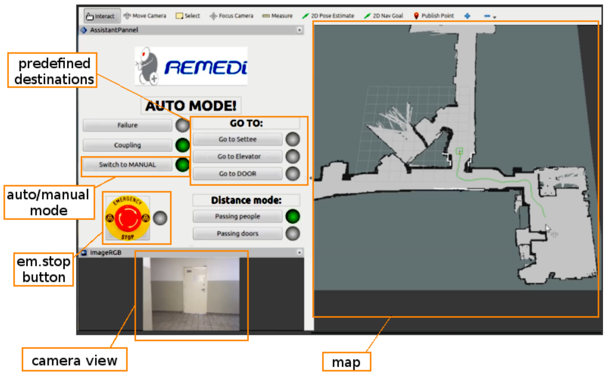

Fig. 2. Assistant's control panel

From the user (assistant's) perspective the platform should provide the following functionalities:

- to switch between the manual and autonomous mode,
- to choose a destination point on a map,
- to choose a predefined location,
- to see robot position and image from the front camera,
- to stop in case of emergency.

These functions should be reflected by the components of the assistant's control panel. Additionally, the robot should

- move in safe distance from obstacles in the autonomous mode,
- stop immediately when the danger of a collision is detected,
- determine robot position and orientation with respect to a prerecorded map.

The platform setup was adapted to serve these requirements.

2) Assistant's control panel: The core of the assistant's control panel is a GUI application running on a remote computer, connected wirelessly to the platform. The GUI application prepared for the experiment was a plugin for RViz, shown in Fig. 2. The functionalities dedicated for the experiment defined above were indicated in the figure.

During the tests, the application was running on a laptop, as shown in Fig. 4. The user chooses between two ways of steering the robot. The first is manual control using a gamepad. This technique is intended for precise maneuvering in narrow places, close to the settee with a patient. The second method is designed for long distance movement, between various parts of a medical centre. The user points the target place for the robot on a map or chooses predefined destinations assigned to buttons. When it is accepted by clicking, the robot goes to the target point using autonomous navigation.

The pad used in manual mode could be connected either to the laptop or directly to the platform. In the first case, the user may operate the robot remotely, based on the map and the camera view. In the latter case, only in the autonomous mode, the user may stay at the desk with the laptop, while in the manual mode he or she has to follow the platform.

3) Platform motion control: The two operating modes seen from the user perspective are reflected in three layers of the simplified robot logical architecture: operator, high-level system components implemented as ROS nodes and low-level system components working in a real-time regime, implemented as OROCOS components.

In the autonomous mode the motion goal selected in the assistant panel is sent to the ROS layer, where a navigation module determines a path avoiding collisions with obstacles. Based on this path, the local planner calculates velocities to be send to the platform which become the first source of velocity commands.

In the manual mode, the user controls the platform with a joystick of the game pad. The state of the joystick serves as the second source of velocity commands.

The velocity to be forwarded to the real time layer is selected in a velocity multiplexer on a base of the state of control mode selector of the assistant's panel and the state of user and system emergency stops.

The role of the real time layer is to convert the velocity commands received from ROS to low level motor control, execute those controls and provide odometry data to the navigation module. Additionally the layer is responsible also for stopping the motors in case of collision.

D. Scenario

It follows from Section III-A that we have to consider two types of study participants: a staff member and a patient. They should interact with Carol that is a prototype of the mobile base of the ReMeDi robot. For this reason two studies were designed: *Assistant - Robot Preparation Study* and *Patient - Prototype Study*. The studies correspond to situations when the ReMeDi mobile manipulator needs to be moved from the docking station or one examination room to another room in a hospital. They inspect the perception of autonomously moving robot from an assistant and a patient perspective.

1) Assistant-Robot Preparation Study: The scenario covered LD motion in autonomous and manual mode and SD motion in a manual mode. It consisted of four stages, depicted in Fig. 3. Firstly, after a short training, the participants moved the robot from a docking place to a corridor using a gamepad in the manual mode. Then they used the autonomous mode to drive the robot along the corridor until the door of the examination room. Next, they drove the robot with use of a manual mode to the examination room. This action was ended up by precise positioning of the robot next to the settee, within the square marked on the floor. The final stage was to return with the robot to the docking place in manual mode using the gamepad. During the travel along corridor in both directions, there was a person on the way, simulating a patient on a hospital corridor to be avoided.

In the second and the last stage the participants could compare operation and robot bahaviour during LD motion in manual and autonomous mode. In the third stage they could experience how to work with the robot during SD motion.

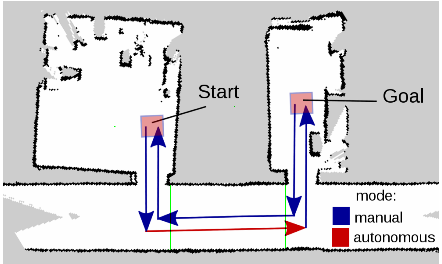

Fig. 3. Planned experiment path – red arrow indicates autonomous part of the motion and blue – manual operation with a pad

2) Patient-Prototype Study: During the experiment the assistant assists the robot and uses the navigation system of the mobile platform. Using a tablet he/she points the place on a map (the position and the orientation) which has to be reached by the robot. The robot autonomously moves from one room, through a corridor to another room. A patient - a voluntary participant is standing at the corridor that is not crowded. Thanks to the obstacle avoidance mechanism in the navigation system the mobile platform avoids people and moves to the target.

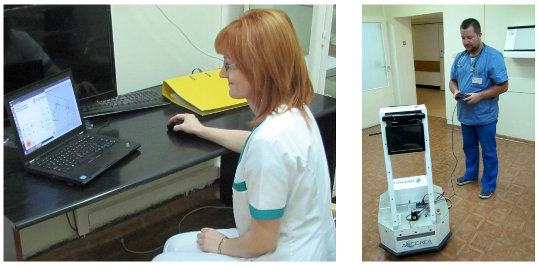

Fig. 4. Two operation modes: autonomous and manual

E. Procedure

First, a video on background of the ReMeDi system was presented to each participant. A part of the video was devoted to Carol. Next the participant was trained by the ReMeDi team how to operate the robot. Then the participant was performing the task from the scenario. At the end the participant had to fill in questionnaires. The experiment was conducted in a fully simulated environment which is separated from normal hospital activity.

F. Measures

1) Assistant - Robot Preparation Study: The results stem from two sources. The positioning accuracy and time needed to move between rooms in autonomous and manual mode come from experiment records in rosbags. Positioning accuracy was calculated as a distance from robot center to the center of the goal mark. The positioning error below 5cm means that the assistant stopped the robot within the marked square. The corridor travel time was measured as the time in which the robot center moved in selected area (marked with green lines in Fig. 3). The users' impressions and thoughts have been collected by means of questionnaires. To answer our research questions concerning usability, used the System Usability Scale (SUS), a well established questionnaire for assessing the usability of the system containing 10 items on a five point likert scale ranging from totally disagree to totally agree. For assessing the perceived safety we used the Godspeed (GS) questionnaire for perceived safety (3 items using semantic differential scales). We also used the Attitude towards technology scale (ATT) in order to gather information about participants' attitude towards technology (contains also 10 items on a five point likert) which could impact the results. Finally we asked some specific qualitative questions for improvement suggestions.

2) Patient - Prototype Study: We used the same scales as in the Assistant - Robot Preparation Study, except the SUS questionnaire because participants in this study were more passive and did not directly interact with the robotic platform.

IV. RESULTS

We conducted two user studies, one with potential assistants who need to take care of the robotic equipment and move the device from one room to another, as well as from the patients' perspective to investigate their perception concerning the robotic platform.

A. Assistant-Robot Preparation Study

1) Participants: 49 participants took part in the study (30 female, 19 male) with an average age of 30.93 (SD 8.46). Concerning their education, one participant has an apprenticeship, 15 finished high school and 33 had a graduate degree. Most of the participants (73.47%) think that the proposed medical system is a good idea. 5 data sets were not used for this analysis as there were technical errors during the study.

2) Results: Participants quite appreciated the idea of the ReMeDi system, especially to overcome the limited access to specialists, and also saving time by remote examination. However some are skeptical as they fear the system can't replace direct face to face examination. Improvement suggestions show, that displaying the system status and planned actions of the robot offer much potential for improvement. Audio signals for example. Also increasing the viewing angle and faster and more fluid movement especially in autonomous mode was mentioned.

Participants were not very decisive, if the robot should be controlled manually for LD motion (Mean: 3.02; SD 1.35) but they slightly preferred the autonomous mode. As it can be seen in Fig. 5, in most cases autonomous ride was taking less time than manual drive (mean times, respectively, 21.5s and 25.5s), however some users encountered problems operating in autonomous mode. The maximum time (80.6s) is more than maximum time in manual mode (36.5s). However, they prefer manual control for SD mode (Mean: 2.35; SD 1.18). Thus, the autonomous mode does not lengthen the time of movement of the robot between rooms compared to the manual mode but it less engages the assistant in realisation of the task.

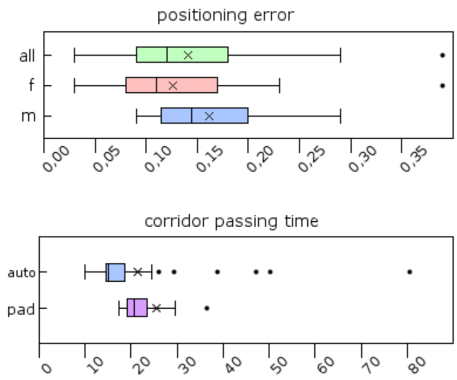

Fig. 5. Positioning precision for all, female and male participants; time to pass corridor in autonomous and manual mode, 'x' marks mean value

It was found, that female participant were significantly more precise in positioning the robot than male participants (cf. Fig. 5). The non-parametric Mann-Whitney U test (z=2.186; p=0.029) revealed a significant difference between male (Mean rank 24.53) and female (Mean rank 16.50) concerning precision. The mean distance to the goal was 13cm (SD 0.08) for female and 16 cm (SD 0.06) for male participants. It must be, however, noted that due to the platform shape user's assessment of whether the robot is positioned within the goal square could be influenced by the angle of view (position from which the participant operated the robot). From the perspective of expected needs (concerning positioning), the accuracy is satisfactory.

In general, it was highlighted that the platform is easy and intuitive to control. The System Usability Scale (SUS) reveals a score of 77.96 (SD 12.24 with a scale between 0 and 100) which can be considered as good following [23]. The Attitude Towards Technology Scale (ATT) shows a mean score of 2.37. (SD:0.70), whereas the perceived safety gathers by the Godspeed questionnaire (GS) is rated with 2.67 (SD:0.62). We also inspected the internal reliability of the questionnaires by calculating the Cronbach‘s Alpha. For the 10 SUS items the Cronbach's alpha was 0.78 (acceptable reliability) and for the 10 ATT items and 3 GS items 0.92 (excellent reliability), and 0.42 (not acceptable reliability) respectively. In other words, the results of the GS questionnaires will not be used for further analysis.

3) Dependencies of measurements: We conducted a linear regression analysis to evaluate the relationship between the ATT and the relating SUS. The two variables indicates are linearly related such that the overall SUS decreases with increasing ATT.

$$\text{Predicted SUS} = -6.97\text{ATT} + 92.14$$

For these data, R has a value of 0.41 which represents the correlation between the ATT and the SUS (see Table I). 16.50% of the variance of the SUSscore is associated with the Attitude towards technology.

TABLE I
MODEL SUMMARY[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.41[a]	0.17	0.15	11.23

a. Predictors: (Constant), ATTScore
b. Dependent Variable: SUSScore

TABLE II
COEFFICIENTS[a]

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95% Confidence Interval for B	
	B	Std. Error	Beta			Lower Bound	Upper Bound
1 Constant	92.14	4.92		18.72	0.0	88.23	102.06
ATTScore	-6.97	2.34	-0.41	-2.98	0.01	-11.68	-2.26

a. Dependent Variable: SUSScore

The 95% confidence interval -11.68 to -2.26 does not contain the value of zero, therefore, the ATT is significantly related to the SUS.

The Analysis of Variance (Anova) also showed a significant difference between the groups (F(1,45)=8.89, p=0.005 and t(45)=-2.98, p=0.005.) which can be seen in Table III.

TABLE III
ANOVA[a]

Model	Sum of Squares	df	Mean Square	F	Sig.
1 Regression	1122.29	1	1122.29	8.893	0.005[b]
Residual	5679.03	45	126.20		
Total	6801.33	46			

a. Predictors: (Constant), ATTScore
b. Dependent Variable: SUSScore

This shows, that the overall SUS decreases with increasing ATT (Increasing ATT means negative Attitude). In other words, the more positive the attitude towards technology, the better the SUS rating.

It was further analysed whether the gender has an impact on the resulting SUS. First the data was inspected on its normally distribution. The Shapiro-Wilk was used as it is reliable for small sample sizes [2]. (<50) If the Sig. value of the Shapiro-Wilk Test is greater than 0.05, the data is normally distributed. Unfortunately this is not the case for m (Sig.: 0.04) therefore, the SUScore is not normally distributed regarding gender. As a consequence, we conducted a nonparametric test with unfortunately no significant differences on the SUSScale.

However, we found an interesting trend for one single scale item (Mann-Whitney U test), as the question "The robot is intuitive to navigate" resulted in a mean rank of 27.98 for female and 19.18 for male participants (z=-2.307; p=0.021). As the scale was ranging from 1 (strong agreement) to 5 (strong disagreement) this means, that male participants had a significant higher agreement in intuitiveness to navigate (mean answer 1,35) than female (mean 2.10).

[2]https://statistics.laerd.com/spss-tutorials/testing-for-normality-using-spss-statistics.php

B. Patient - Prototype Study

1) Participants: 30 participants took part in the study (16 female, 14 male) with an average age of 28.77 (SD 10.58) Concerning their education, 13 had a graduate degree and 17 finished High School.

2) Results: A big majority of participant like the idea of the proposed ReMeDi system. 86.7% answered that it is "good idea", 13.3% would agree to a remote examination "if necessary". Noone chose as an answer "questionable".

The ATT reveals a score of 1,86 (SD 0.66) whereas the scale is ranging from 1 (positive) to 5 (negative attitude towards technology). The internal reliability for the 10 items was good (α = 0.874). The participants rated the perceived safety gathered by the GS questionnaire with a mean of 3.63 good (SD 0.85, scale is between 5 (positive) to 1 (negative)), however the internal reliability for the 3 items was poor (α =0.503). As a consequence, the result may not be taken very serious. However, also the specific questions show that the robot platform was perceived to be very safe. The main point concerning improvement was that the movement should be more fluent and fast.

Participants also highlighted, that audio signals could be very potential to show the intention of the robot. In general, the idea of a remote examination robot was quite liked and also that it can move autonomously.

We conducted a nonparametric Mann-Whitney U test with a significant difference (z =-2.603, p = 0.013) regarding the question "The robot avoids obstacles excellent", with a mean rank of 19.19 for female and 11.29 for male participants. In other words the ability of the robot to avoid obstacles was rated significantly more positive by male participants.

For inspecting age differences, we divided the participants' data into two groups based on the mean age which was 28.77. (Group 1 (<=28); 2 (>28)) The data regarding the two age groups was normally distributed concerning the perceived safety score gathered by the GS. Therefore, an independent-samples t test was conducted to evaluate the hypothesis that the second age group (>28 years) perceived a higher safety than the younger one. The result was significant t(27)=2.61; p=0.015. As the perceived safety scale ranged from 1 (negative perception) to 5 (positive), the mean for younger participants was 3.38 (SD 0.80) whereas for the older group 4.19 (SD: 0,70). In other words, the perceived safety was significant higher for older participants.

We also conducted a non-parametric test with a significant difference (z =-2.535, p = 0.012) regarding the perceived safety score, with a mean rank of 19.38 for those with a graduate degree and 11.44 for participant with high school degree. In other words participants with higher education had a stronger perception of safety.

V. CONCLUSIONS

We have considered two techniques of steering the mobile base by the user intended for the ReMeDi mobile manipulator.

ReMeDi mobile manipulator is a part of a robotic system of a new type designed for remote medical examination. This device has its unique characteristics. It is supposed to be operated by nursing personnel and intended to be exploited in hospital spaces that are shared with patients.

Manual control using a gamepad in SD mode resulted in high precision positioning of the mobile platform in spite of the fact that the training process was short. This observation coincides with the participants' opinions concerning realisation of precise maneuvering. *Point and click* control strategy in LD motion was used by most of the participants readily. Although this concept was completely new to them, they considered it as an advantage of the system and it was slightly more preferred than manual control of LD motion. The robot as a control system has been recognised by the medical staff as easy to control and safe. In general, participants from the medical staff appreciated the idea of the ReMeDi system. They rated the intuitiveness to prepare and navigate the robot platform quite high. The patients like the idea that the robot can move autonomously and they perceive the robot as safe. Implementation of the robot control system proved to be reliable.

The results discussed in this paper are related to the intermediate stage of the user centered design process of developing of a control system for a mobile base that is a part of the ReMeDi robot. The perceived safety and usability are designated from the HRI study. The reliability was achieved by that way. Similar studies of the final system certainly should be more versatile. In particular, they should include usability metrics (effectiveness, efficiency and usability) and a long-term deployment facing a large number of diverse situations, with metrics such as mean-time-between failures and navigation in crowded scenes.

The results justify continuation of work on the control system at least in three dimensions. The first is integration of the processing unit (now it is a laptop) and a game pad into one light hardware interface so that an assistant can carry it in one hand and operate it using the other. The manual control with a game pad seems to be sufficient but it can be extended by a power-assisted push/pull feature. The autonomous mode with *point and click* method can be simplified by adding a set of predefined target points to the GUI. Finally, the set of sensors of a mobile base could be enriched to increase the usability, perceived safety and reliability in more complex environments. The work is under way.

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