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Design of a Telepresence Robot Utilizing Wireless Technology for a Sustainable Development

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Abstract: Telepresence robots is an emerging field of telerobotics and has a wide range of promising applications. This technology incorporates techniques to virtually enable individuals be present at any location through wireless connection, promoting social interactions among people. Further, this paper provides an outlook on the various research considerations for developing sustainable telepresence robots, which focuses mainly on designing a semi-modularized machine. This study also enumerates the benefits of a sustainable-designed telepresence robots and proposes an optimal conceptual framework for the development of a sustainable telepresence robot. Finally, the future developments and directions of sustainable telepresence robots are also discussed.

Key Words: Telepresence robots; sustainable; semi-modularized; Telerobotics

1. INTRODUCTION

For the past few years, wireless technology has dramatically improved the way that people live in many aspects. This technology provides a means of connecting people from anywhere around the world; it removes the need to travel great distances and to allocate resources when conveying information from places far from each other (BSR and CTIA, 2011). One of the results of this improvement is the technology of telepresence robots— the application of wireless technology with robotics.

Telepresence robots give humans the sensation of being present in another location by allowing the user to see, hear, and move around the surroundings of the robot at will. The robots use two-way audio and video streaming, and software applications to communicate information and to control the movement of the robot. The possible applications of telepresence robots are very wide and promising (Luta, R., Bugtai, N., Ong, A., 2016). With the recent developments in technology, it is now possible to create telepresence robots by making a semi-modularized design consisting of common devices, gadgets, and equipment.

2. APPLICATIONS OF TELEPRESENCE ROBOTS

The most common application of telepresence robots are tele-conferences or telepresence meetings. Businessmen, researchers, doctors, professors, and other professionals would not need to travel in order to meet each other. International and local companies have explored the possible advantages of using tele-conferences (PLDT, 2013).

In the manufacturing industry, experts and technicians would be able to conduct inspections and troubleshooting without being at the site itself. In the future, telepresence robots may aid in the field of exploration by allowing people to safely explore dangerous areas like the deep sea or mines through telepresence robots (Tsui, Desai, Yanco, & Uhlik, 2011).

Telepresence has also been widely used in the field of medicine. The term telemedicine itself was coined during the 1970s which means "healing at a distance". The World Health Organization (WHO) broadly describes telemedicine as a means of providing healthcare services from afar where healthcare professionals are able to utilize and exchange crucial medical information like diagnosis and disease treatment in improving the overall health conditions of individuals, or even their communities ("Telemedicine – Opportunities and developments in Member States," 2011).

Telepresence robots are also utilized for patients that are recovering at a home environment. An example of these are the Giraffplus and RP Vita. Both of these remote robots provide two types of social functionalities: maintaining the doctor patient communication, and acting as a substitute for socializing with peers remotely. Telepresence robots also improve the wellbeing of the patient through providing companionship and entertainment. The Giraffplus integrated its video-conferencing platform with the inclusion of tele-sensors and alarm system, which detect the early stages of health deterioration, while RP Vita focuses on improving the surgical intensive care unit platform (Dahl & Boulos, 2013).

Many telepresence robots are being used to aid the lives of the people. One example is a study conducted by Koceski and Koceska, where they used a telepresence robot in order assist the elderly. The study evaluated the use of a telepresence robot in supporting the elderly accomplish their day--to--day activities independently. The telepresence robot also helped in providing the social interaction that the elderly need to overcome the feeling of isolation and loneliness (Koceski & Koceska, n.d.).

3. BENEFITS OF A SUSTAINABLE-DESIGNED WIRELESS TELEPRESENCE ROBOT

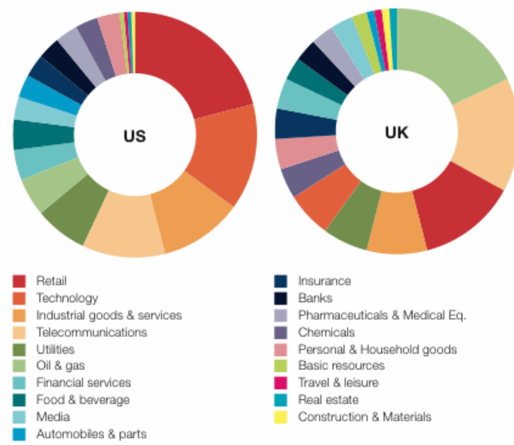

Fig. 1. Proportion of Telepresence rooms by 2020 by Industry Sector.

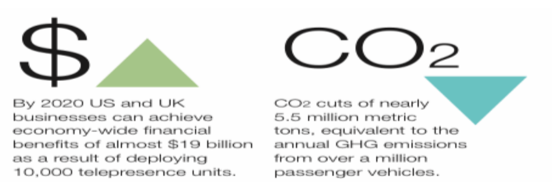

Fig. 2. Economic benefits and CO2 reduction by 2020.

According to a study, "The Telepresence Revolution", U.S. and U.K. businesses that substitute business travel with "telepresence" conferences can cut CO2 emissions by nearly 5.5 million metric tons in total and achieve total economy-wide financial benefits of almost $19 billion, by 2020 ("Video Conferencing Cuts Emissions, Delivers Quick ROI · Environmental Leader · Environmental Management News," n.d.). This study was conducted in 2012, and it shows that telepresence could leave a big impact with the environment and would help towards a greener tomorrow. Fig. 1 and Fig. 2 done by this study correlates to the reduction of travel and monitoring of remote locations adds up to more economic choices along with vast industrial applicability.

To reach the goal of making sustainable devices, one approach is through modularization. Products that are modular in nature tends to last longer compared to its integrated counterpart. Through modularization, replacement of broken down parts is easier with standardized parts that are readily available, deferring the need to buy a new model when it needs a simple fix. As modularization achieves sustainability through prolonged use with the nature of modularization it possess, enabling it to modify and maintain its performance through the years.

With broadband being more common, other benefits that come with modular telepresence robots is instant communication, meaning less reasons to cut down trees for paper, data gathering, moving around and travelling, investigating remote locations, lower costs through proper resource allocations, and self-healing (Amato et al., 2012).

4. SUSTAINABLE ROBOT DESIGN CONSIDERATIONS

An important concern in designing a sustainable telepresence robot is the challenge of modifying it to be modular. A modularized design would allow the parts of the robot to be separated and recombined at any given time (Garud, Kumaraswamy, & Langlois, 2009). Commercial telepresence robots are somehow modularized already, because some subsystems of the current robots already use standard devices and technologies. Telepresence robots which cost less than $1000 use Android or iPhone devices as the monitor of the robot (Luta, R., Bugtai, N., Ong, A, 2016). Origin Robotics' Origibot and Inbot Technologies' Padbot are examples of these robots that use phones and tablets, which can be commonly found throughout the world nowadays (Origin Robotics, 2015) ("Padbot Telepresence Robot | Best Virtual Remote Presence | Mobile Robots," n.d.).

In order to create a sustainable telepresence robot, it is proposed that the robot also uses other common devices for its other subsystems. Many current telepresence robots have parts that share many common features and capabilities ("Compare Telepresence Robots | Telepresence Robot Comparison," n.d.). Most telepresence robots are controlled from anywhere in the world by connecting to the internet through WiFi. Double Robotics' Double2 and RLDA's Boteyes allow robot control through web browsers. Other telepresence robots like VGo telepresence, Padbot, and Origibot use Android/IPhone/Windows applications in controlling the robot ("VGo robotic telepresence for healthcare, education and business," n.d.) ("Telepresence robot," n.d.) ("Double Robotics - Telepresence Robot for Telecommuters," n.d.).

For the robot's movement, the motors and wheels of small scale vehicles like scooters, hoverboard, and remote controlled cars could be used. JSK Lab's Telemba telepresence robot uses a tablet is attached to a roomba which serves as the robot's wheel and motors (Guizzo, 2014).

It is also proposed that the robot is designed in such a way that it is to be able to integrate these common parts and features. Software programming and artificial intelligence may also help in the goal of making a sustainable telepresence robot. Sensor systems, such as computer vision and collision avoidance sensors will help prevent unnecessary damage to the telepresence robot. With artificial intelligence and sensor systems, it is possible to add features like auto-charging, auto-navigation, and collision prevention, which will allow the robot to travel from one place to another safely, without needing assistance from a human operator (Halstenberg, Buchert, Bonvoisin, Lindow, & Stark, 2015).

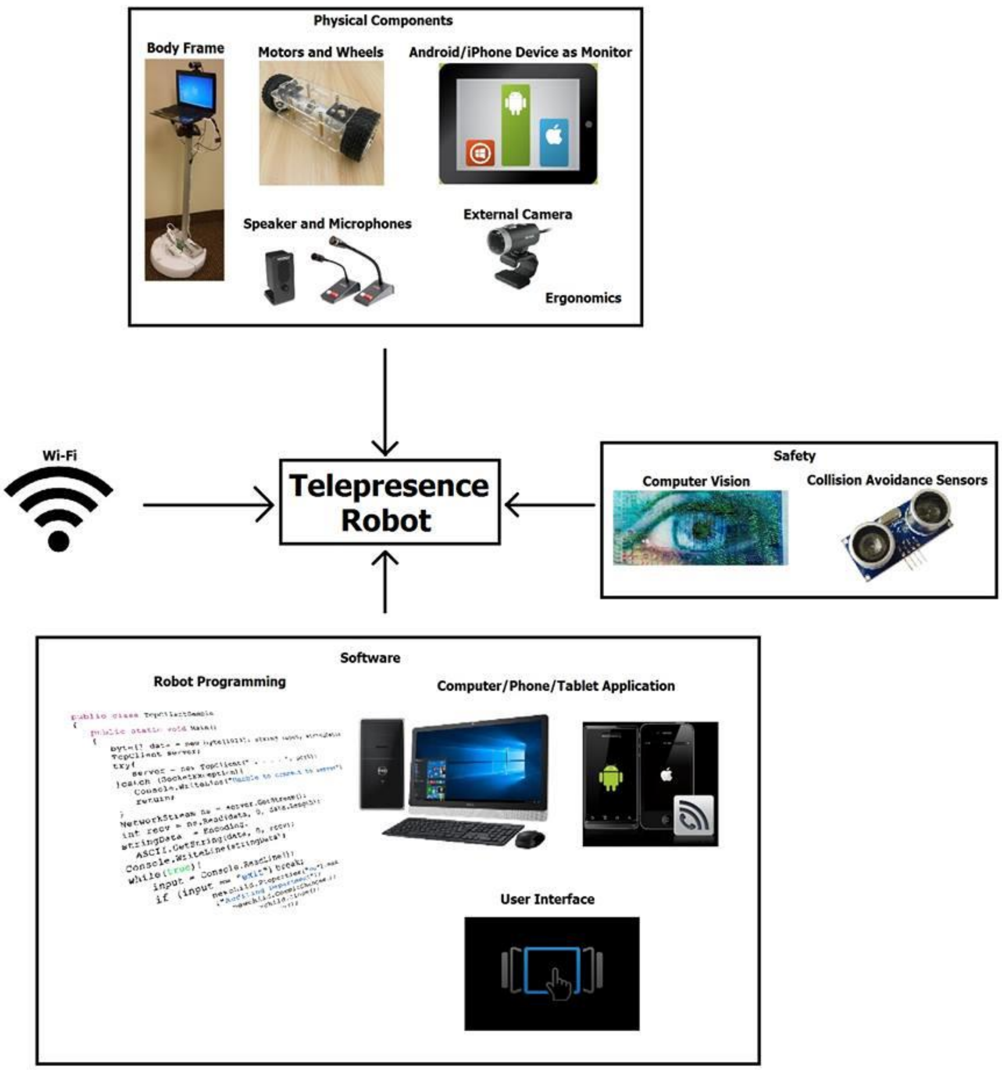

Fig. 3. Conceptual framework of the development of a telepresence robot (Luta, R., Lindo, D., Bugtai, N., Ong, A., 2016)

5. CONCEPTUAL FRAMEWORK OF A TELEPRESENCE ROBOT FOR A SUSTAINABLE DEVELOPMENT

Figure 3 above shows the proposed optimal conceptual framework for the development of a semi-modular wireless telepresence robot. Wi-Fi technology is the most ideal means of connecting the robot to the controlling device, since most places in the world have access to Wi-Fi internet. It is recommended that the robot is controlled using a computer, phone, or tablet application, since these devices are owned by many people and are commonly found nowadays. Doing this will also allow the application's programming, user interface, and other software components to be improved further since users may improve the application itself. This also means that the 'controller' of the robot is easily replaceable, and there would be no additional expenses for the robot control, since these devices are being used in daily life anyway.

It is proposed that as much as possible, the physical components of the telepresence robot should come from common devices or equipment, so that the parts can be easily replaced. The motors and wheels, which would allow the robot to move, can be taken from cheap, unused, or broken small scale vehicles. Android and iPhone tablets should be used as the monitor of the robot. With this innovation, the monitor itself may become the central processing unit of the robot since these devices are easily programmable. In cases where a telepresence robot needs to be able to transmit high-definition video streaming, an external camera may be used in addition to the Android/iPhone device.

The robot should also have a clear speaker and a noise-cancelling microphone in order for it to be able to perform clear audio communications from the robot to the operator. In order to make sure that the robot is not damaged while moving, it is recommended that a combination of computer vision and collision avoidance sensors is used. The computer vision will introduce artificial intelligence to the robot, and will allow it to detect distant obstacles through its camera. Collision avoidance sensors should be placed in some parts like the robot's base and body, since the camera alone is not capable of seeing the whole surroundings of the robot. This proposed conceptual framework emphasizes on combining common devices and technology. With this semi-modular design, the robot will be very sustainable because its parts can be easily replaced or repaired upon damage or breakdown (Luta, R., Lindo, D., Bugtai, N., Ong, A., 2016).

6. FUTURE DEVELOPMENTS AND DIRECTIONS OF WIRELESS TELEPRESENCE ROBOTS

With a recent study stating that modularization as of now is not flexible (Halstenberg, Tom, Jérémy, Kai, & Rainer, 2015), future researches may focus in the development of a fully modular telepresence robot. The main challenge for sustainability of telepresence robot technology is being disposable with the slightest of hardware problem. The introduction of modularity and its nature would benefit the environment as pre-made parts are readily available if such a concept arise. Telepresence having endless potential in application and innovation, future developments and research in modularity would benefit the sustainability of the world.

In the context of developing countries, telemedicine and professional consultations would help the populace of these nations to improve on the development towards sustainability of this country with tools such as teleoperated robots. This method long distanced communications is key if one wishes to convey important messages when being physically present is a challenge with weather, traffic, or just a long travel.

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