# nn

*by* Sonam Gour

**Submission date:** 22-Nov-2022 03:08PM (UTC+0530)
**Submission ID:** 1961139598
**File name:** The_convergence_of_IOT_with_VR_and_Telepresence_1.docx (2.28M)
**Word count:** 3908
**Character count:** 21340

# The Convergence of IoT with Virtual Reality and Telepresence

*Himanshu Sharma,* *II-year department Artificial Intelligence and Data Science* *Poornima College of Engineering* *Jaipur, India*

*Mayank Mishra,* *II-year department Artificial Intelligence and Data Science* *Poornima College of Engineering* *Jaipur, India*

*Raghav Sharma,* *II-year department Artificial Intelligence and Data Science* *Poornima College of Engineering* *Jaipur, India*

*Rohan Singhal,* *II-year department Artificial Intelligence and Data Science* *Poornima College of Engineering* *Jaipur, India*

*Sourabh Sharma,* *II-year department Artificial Intelligence and Data Science* *Poornima College of Engineering* *Jaipur, India*

*Sonam Gour,* *Assistant Professor Department of Computer Engineering,* *Poornima College of Engineering* *Jaipur, India*

**Abstract**—Telepresence is the fastest growing technology as it combines the Internet of Things (IOT) and Virtual Reality (VR). This is a robotic remote control that allows humans to sense their current location, where VR supplies vision and IOT provides touch and control. Before Telepresence there was only the possibility of imagining a virtual world, it was impossible to feel the virtual world. This is now possible thanks to the use of ultrasonic sensors in Telepresence. This paper mainly describes how VR can be used in various fields. For example, it can be used to develop agriculture or education. It can create intelligent virtual environments such as virtual telepresence robots in smart agriculture and virtual inclusion with telepresence robots in classrooms, and users can experience virtual reality through (VR) headsets. As mentioned, telepresence can also be used in a variety of areas such as medical training, mine maintenance and distance learning.

***Keywords—Telepresence; headset; human-robot interaction. human-computer interaction.***

## I. Introduction

The term "telepresence" describes a group of technologies that enable a person to appear or behave as if they are physically present using telerobotic in a location other than their real location.

For telepresence to give people the impression that they are in another place, certain stimuli must be shown to them. In this scenario, it is possible to perceive the user's location, movements, actions, voice, etc. for transmission and replication at a distant site. Therefore, communication between the user and the remote location is possible in both directions. Telepresence video conferencing, the most advanced kind of visual telecommunications, is a common application. A higher level of technical ability and better image and sound fidelity are used in telepresence via video than in conventional video conferencing. With the help of handheld mobile devices, technological advancements in mobile collaboration have taken video conferencing outside of the meeting space and enabled location-independent communication.

The interchange of data between all objects is made possible by the Internet of Things, which connects all gadgets. PCs, laptops, tablets, cellphones, PDAs, and other portable embedded devices are some of these items. Utilizing virtual reality, computer-simulated worlds can be made interactive. Can you guess the origin of the tangible world? Having a dream without closing your eyes, for instance, the first virtual worlds are built in virtual reality at various times, drawing users into them intellectually and physically. In other words, there must be a method to interact and experience everything. IoT is a platform that links objects and gives users access to services. It is used to build intelligent environments and gain access to data from all over the globe. An interactive universe is produced when IOT and VR collide. When a user runs an IoT device while wearing a head-mounted display (HMD), the appearance of profound mental engagement is produced. The overview of the paper is illustrated in the figure below.

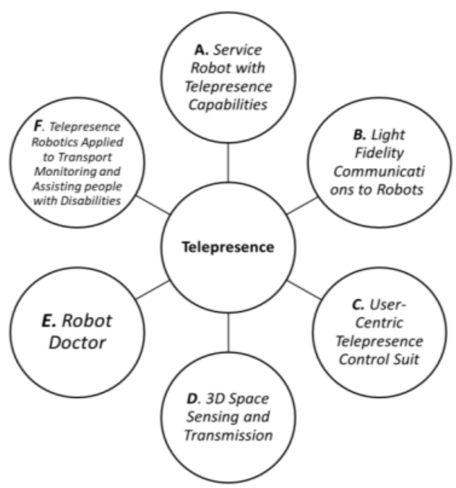



Fig. 1: Overview of the paper

## II. Different Sectors

### A. *Service Robot with Telepresence Capabilities*

In this part, Widodo Budiharto and Derwin Suhartono's proposed service robot that can transport a customer's beverage from one location to another will be discussed. Based on Google App Engine, we have created and implemented three key modules: one for command recognition, one for obstacle avoidance, and one for telepresence.

Intelligent service robots are a novel technology that are now in use and will keep gaining popularity. "A service robot is a robot that runs semi-autonomously or fully autonomously and performs services that contribute to the well-being of people and machines, other than manufacturing duties," according to the International Federation of Robotics (IFR). A customer is a service robot that is typically used to detect barriers within or outside of a space and perform specified duties for a user. Describe a task. Obstacles must be avoided, overcome, and be capable of being overcome by service robots. For planning and autonomy of service robots, reliable algorithms are needed.

Fig. 1: Intelligent Service robot

**➔ Architecture of the robot**

The vision-based service robot is based on an Arduino processor with three omni-directional wheels. Omni-directional wheels are unique in that they can rotate freely in two directions. You can roll like a normal wheel, or you can use the wheel along the perimeter to roll sideways. An omnidirectional wheel allows the robot to transform from a non-holonomic robot to a holonomic one. A non-holonomic robot that uses ordinary wheels can only control two of the three degrees of freedom it can control: forward and backward movement and rotation.

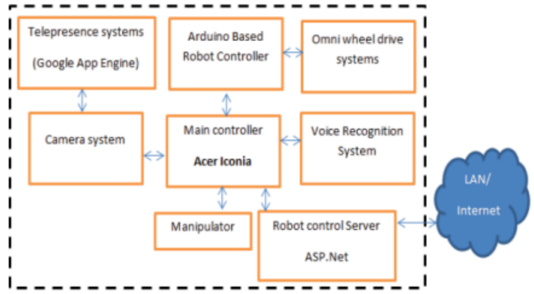



Fig.2: Proposed communication model of vision-based service robot

**➔ Obstacle avoidance Method**

A crucial part of vision-based service robots is navigation. Theoretically, he can obtain distance data from the robot's front, left, and right sides by using just three ultrasonic sensors. Therefore, as illustrated in the flowchart in Fig. 2, we suggest an obstacle avoidance model for the service robot. This technique combines the use of image sensors and ultrasonic sensors for static and dynamic obstacle identification. When the robot starts moving, information is gathered about stationary impediments. In the field of mobile robotics, obstacle avoidance techniques like the potential field method (PFM) and virtual force histogram (VFH) are becoming increasingly common. A PFM method based on attractive and repulsive potential fields to guide a robot to reach a target or avoid obstacles. PFM has the following inherent limitations: B. Does not pass between closely spaced obstacles, does not generate vibration in presence of obstacles or in narrow passages, robot does not move. This is because the attractive and repulsive forces are balanced. VFH is a fast obstacle avoidance method based on a polar histogram of obstacles that defines the direction of safe movement. VFH also has the disadvantage that results are sensitive to thresholds and expensive hardware because it uses a histogram-grid world model that is updated by rapidly triggering 24 sensor robots during movement.

**➔ Voice Recognition System**

Based on Arduino and Tigal Voice Recognition, this system. As seen below, this module enables users to develop up to 28 of their own unique speaker-independent (SI) command vocabularies as well as a small number of words that serve as the primary database of dialogues.

Fig.3: Voice recognition system using Tigal Easy- VR Shield and Arduino

Use Arduino and the Easy-VR Shield. This shield enables communication between your Arduino and your robot.

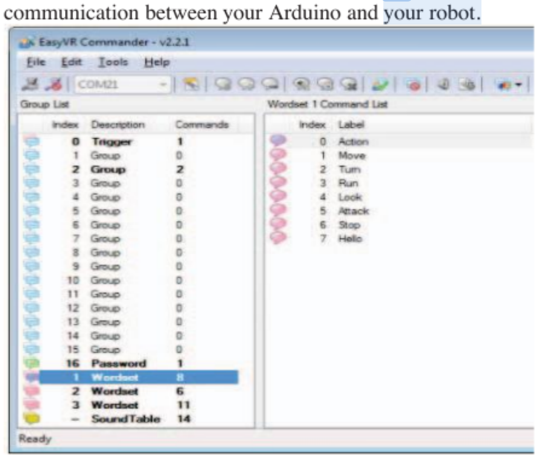


Fig. 4: Using Easy-VR Commander

It has two operating modes: a telepresence robot for remote communication and a general service robot that brings cups or bottles to customers. The algorithm for robots is displayed below.

**Algorithm 1**: Intelligent service rob recognition and telepresence capabilities

//input mode: general service robot or telepresence
If input =general mode, then
Wait for voice commands from user
End if
if input= telepresence mode then
// check if a cup is loaded or not
Checking a cup
Accept command from user
Capture face's images
Face detection and recognition using PCA
if cup loaded and face recognized
// Visual tracking using camera
While (customer! =center screen)
    begin
        Heading robot to
    end
if (position of customer at center screen)
    begin
        Go to customer
        call movingObstaclesIdentification
if moving obstacle==true and min_distance=true and goal=false
maneuvering the robot
end if
    Giving a cup
Go to home
end
    end if
end
// Function to detect and track a moving obstacle
    function movingObstacleIdentification
// Using Haar cascade classifier
moving obstacle detection
if (moving_obstacle==true) then
//estimate distance between robot and moving obstacle
distance estimation // Using Kalma filtering
// estimate velocity and direction of moving obstacle
Calculate $vO$, direction
Endif
Return $vO$, direction
end function

### *B. Light Fidelity Communications to Robots*

Robotic telepresence is finding increasing use in industries including education and healthcare. Applications for telepresence robots currently in use Wireless Fidelity (Wi-Fi) connections for both real-time data exchange and remote control of the robot. Data may be transmitted with the Li-Fi system's visible light communication mechanism up to 100 times faster than it can with Wi-Fi.

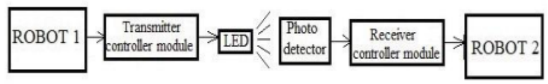



Fig. 5: Two robots VLC unidirectional communication block diagram

There are several types of modulation systems used for VLC and Li-Fi:

- On-Off Keying (OOK) sends data by successively turning on and off LEDs; it strikes a reasonable balance between system performance and implementation complexity, but the data rate may drop because of the changing brightness of the LEDs;
- Pulse Width Modulation (PWM) uses pulses to send a signal that has been modulated into a square wave, with the width of the pulses being altered according to the signal being transmitted; PWM has a modest data rate but does not alter the intensity level of pulses;
- One pulse is transmitted per symbol period, which is separated into equal time intervals, using pulse position modulation (PPM); PPM has a lower spectral efficiency and a lower data rate than OOK, but it is more power-efficient;
- The combination of PPM and PWM known as variable pulse position modulation (VPPM) changes the signal pulses by the brightness level that is set; VPPM has lower power efficiency than PPM but better spectrum efficiency;
- Overlapping PPM (OPPM) employs the overlapping of the pulse symbols, enables the transmission of multiple pulses (as in the case of PPM), and has a higher spectral efficiency than PPM and VPPM;
- Optical Spatial Modulation (OSM), a technique for single carrier transmission modulation, has the property that the input bits sequence is mapped and corresponds to a specific LED index. OSM is power and bandwidth efficient, but the performance depends on the optical quality of the transmitter and receiver units.

EXPERIMENTAL PROTOTYPE SYSTEM:

The experimental prototype, whose block diagram is shown in Fig. 6, was developed to test the viability of transferring data using light in one direction.

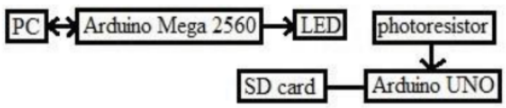
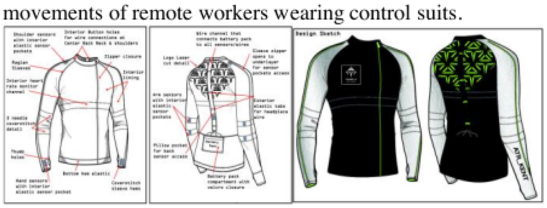



Figure 6: experimental block diagram

A photoresistor serves as a signal receiver and is connected to an Arduino UNO board, which demodulates and decodes the signal before storing it on an SD memory card. The computer allows sending data to the Arduino Mega 2560 board, whose program converts the data package into a light signal that is transmitted to the photoresistor.

### C. *User-Centric Telepresence Control Suit*

Such immersive technologies include a humanoid robot and a control system that correlates the operator's movements while giving adequate sensory feedback. A humanoid telepresence robot can be controlled with a Telesuit, a full-body telepresence control system. The suit is a part of a larger system that considers the challenges of running a dexterous bimanual robotic torso as well as the requirement for modular hardware and software to support high-fidelity immersion. It features a health-monitoring device that gathers data on things like heart rate, galvanic skin response, and breathing exertion. Since it was first introduced by Marvin Minsky, the idea of telepresence has been expanded to include a wider range of technological advancements. Minsky defined telepresence as the general idea of being there in his essay. He specifically discussed the idea of robotic devices that mimic the movements of remote workers wearing control suits.



- Fig. 7: Telesuit Construction Details

They start by thinking about their concept of agile robotic machines that function as adaptable remote tools and think about the creation of such machines as avatars—robotic representations of humans. They also consider the requirement for a control device that can relay control instructions and send operator feedback from the robot's immediate surroundings. Thirdly, they consider a scenario for the near future where interfaces are needed to enable seamless transitions between the local, distant, and virtual worlds for people. A real-time first-person video feed from a robotic avatar is displayed on a head-mounted display (HMD).
While highly correct motion-tracking IMU replaceable sensors are used to convey the operator's motions. Additionally, the operator's physical condition may be accurately checked thanks to a set of health monitoring devices. A gender-neutral, custom-made garment that blends fashion, performance, and practicality has sensors and other technology. The Telesuit system also uses a collection of adaptive algorithms to improve video transmission, command execution, and the overall telepresence experience depending on the operator and robot states.
Finally, they point out that in the context of their research, the garment's design is important for both its aesthetics and practicality. In their research on telepresence, they investigate control systems that fit with the idea of the Internet of Actions (IoA), a network of experientially intelligent robots that use a wealth of data to react and alter our experience.

### D. *3D Space Sensing and Transmission*

We expect that the 3D space sensing and transmission technique will be used in many different applications that make use of augmented reality technology.

I. *Functional Structure*

Four steps make up the 3D space sensing and transmission technique: background removal and moving object separation, 3D mesh generation for the human body, 3D mesh transmission, and 3D mesh rendering.

II. *Background removal and moving object separation*

The continuous depth image (640 x 480) that PrimeSense's OpenNI gets from the Kinect is used to create a user map, as seen in Figure 8. The user ID is represented by each pixel value in this 2D user map. When a pixel's value is 0, it shows the backdrop. The user ID of People1 is represented by pixel value 1, and the user ID of People2 is represented by pixel value 2. Therefore, a part of a non-zero pixel is regarded as the human body. Based on a publication by Microsoft, this background separation method was developed.

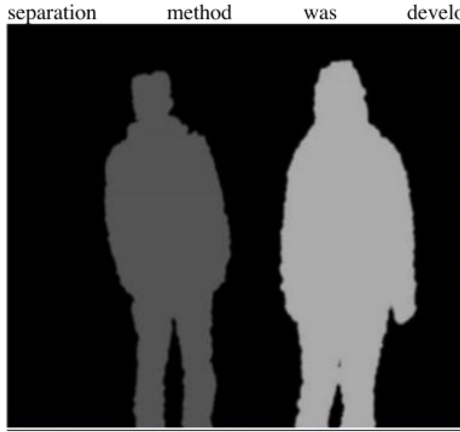


Fig 8: User map

III. *Human Body 3D Mesh Generation*

Vertices, colors, and triangle indices make up the basic elements of a 3D mesh, which is a collection of 3D pixels. If a 3D mesh has N pixels, the triangle indices show how to link each pixel to form a triangle. Vertices are made up of N 3D coordinates (X, Y, and Z), colors are made up of N RGB colors (one triangle has 3 vertices). The N vertices in the Kinect example can produce a maximum of 6N triangles. 3D coordinates about the human body's pixel are computed from the user map to make up the vertices of the human body mesh.

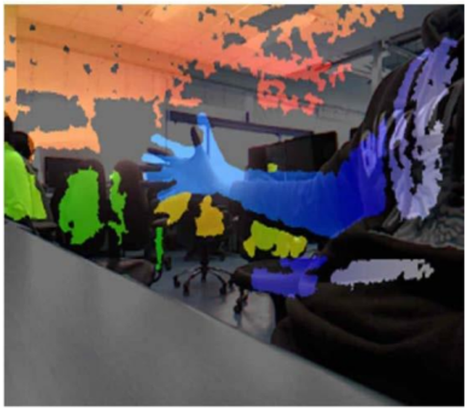


Fig 9: Difference of depth image and RGB image

### IV. 3D Mesh Transmission

Vertices, colors, and triangle indices make up the 3D mesh transmission data, which is placed in a byte array in a specific order. Unity3D was chosen as the mesh rendering engine for our implementation. The maximum number of vertices per mesh in unity3D is 65,000. The amount of user pixels is up to 80,000–90,000 when the human body is close to the Kinect. To create a mesh with less than 65,000 vertices, that case requires subsampling. A mesh with 65,000 vertices can be transmitted using a maximum of 1,300,016 bytes.

### V. Mesh Rendering

By using byte buffer parsing, the receiving party can quickly reassemble a mesh without experiencing any issues with data transfer. The stereoscopic display for HMD is the following point to think about. Using an HMD model called Star1200XL, 3D mesh rendering is conducted in our implementation. Two scenes are shown side by side in stereoscopic display, like how human eyes see.

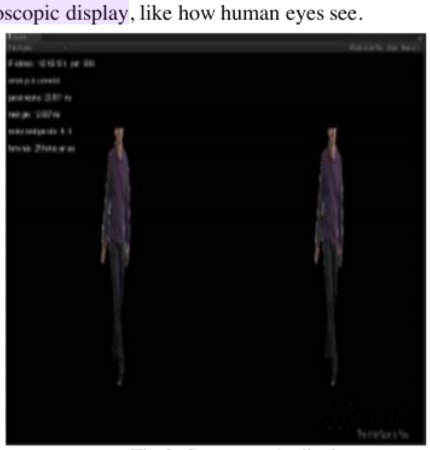


Fig 9: Stereoscopic display.

### E. Robot Doctor

One of the newer subfields of robotics is telepresence. The work's goal is to improve the Telepresence Robot to Telepresence Robot Doctor, enabling direct connection to medical sensors such electronic heart pulse rate monitors and temperature sensors for transmitting medical data to the distant doctor. Thus, the doctor can talk about the course of treatment and communicate with patients online. In non-life-threatening circumstances, this serves to increase the effectiveness of medical diagnosis and treatment approaches. Telepresence is the experience of virtual presence at a live, remote location outside of one's own physical location. Thus, while being in a remote place, the user who is experiencing visual telepresence will be able to receive stimuli and respond to them.

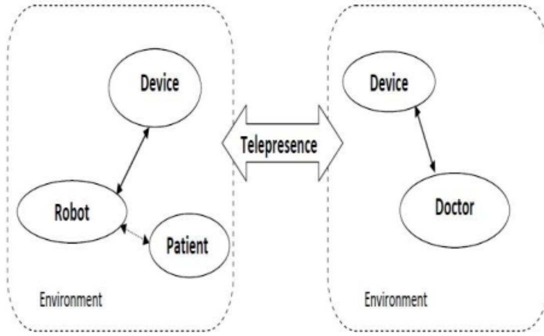



Fig:10 System overview

Users would be able to actively take part in group activities from anywhere in the world thanks to visual telepresence. Additionally, the ability to control a faraway object makes it easier for the user to feel physically present. A robot at a distance aid in conducting the user's actions. Teleoperation is the term for this. Telepresence robots have dramatically increased in popularity because of the introduction of video conferencing in portable PCs, tablets, and mobile devices. Telepresence robots are remotely controlled robotic systems that allow a user to virtually visit a remote location and interact with it using its senses and motions.

The Host (Doctor) system environment and the Robotic system environment are decided by the system overview (Fig. 10). A robot and a patient make up a robotic system. The patient discusses medical information with the doctor through video conference while using a display device linked to the robot. A doctor serves as the host in a system that also includes a computer or laptop for communication. Communication can be eased between the patient and the doctor. Given the distance between the two systems, remote access is necessary to give the impression of telepresence. The processing of medical data is also done to ensure that the system runs well. The patient's information must always be uploaded and available for retrieval.

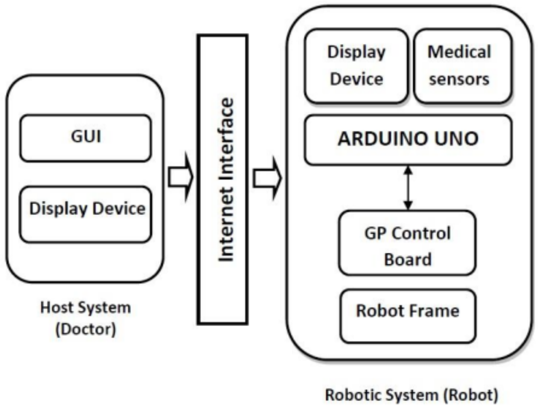


**Fig 11: System Architecture**

The host system, or doctor, and the robotic system, or robot, make up the system architecture. The internet interface eases communication between the doctor and the robot. The host system is made up of a GUI and a laptop or PC that serves as the display. The Robot is managed through the GUI. A GP control board and an Arduino Uno board make up most of the robotic system. The Arduino board is connected to medical sensors and display device, in this case a tablet. Motor driver IC L293D is used to connect motors to the GP control board.

### F. *Telepresence Robotics Applied to Transport Monitoring and Assisting people with Disabilities*

Analysis of current robotic patient aid and transportation applications is done. We looked at ways to make them into telepresence robots that can transport and help the patient on their own, meeting the demands of contemporary medicine and healthcare. The suggested technologies enable direct communication between the medical team and real-time access to data on essential functions. Two novel application models are suggested: a controllable robotic plate that can move around thanks to a mobile app and direct Wi-Fi.

**Fig 12: Flexbed robotic hospital bed**

Flexbed was the world's first robotic hospital bed which was developed in 2014 by UTS center in collaboration with KTH Royal Institute of Technology and is illustrated in Fig12.

Flexbed allows the patient to be seated based on the conditions they suffer, in various positions and changes, in critical transport situations, so that the patient is protected.

There is one more device which can be used to transport immobilized patients, i.e., HUBO FX-1 biped chair (Fig. 13). This consist of a chair which is having two legs and can rotate freely upto12 degrees. A person of maximum 100kgs is acceptable on the chair.


**Fig 13: HUBO FX-1 biped walking chair**

The limitations of this robot are related to the fact that it requires an external power source due to its high energy consumption. Also, the steps performed by the robot cannot escalate complex obstacle.

Table no 1: Comparative analysis among different object detection approaches:

| S. No | Paper title | Approach used | Advantage | Disadvantage | Finding |
|---|---|---|---|---|---|
| 1 | Intelligent Service Robot with Voice Recognition and Telepresence Capabilities | Image Processing and Internet Protocols | Complete communication model from main controller to voice recognition system, manipulator, obstacles avoidance and telepresence system | The ability of voice recognition system is not that much improved | |
| 2 | Light Fidelity Communications Applied to Telepresence Robots | Li-fi and Visible light communication | Li-Fi does not irradiate the human body and the ability to run where Wi-Fi are prohibited | When the optical field is interrupted with an opaque environment, the communication is interrupted. | |
| 3 | Telesuit: An Immersive User- Centric Telepresence Control Suit | Internet of Actions (IOA) | This would allow operators to perform daily activities and seamlessly transition into running a robot | The suit currently implements traditional haptic feedback on the hands triggered by pressure sensors on the robot's hands which are to be changed to touch features. | |
| 4 | Tangible Telepresence Service using 3D Space Sensing and Transmission | Augmented Reality (AR) | 3D space sensing and transmission technique helps telepresence service to supply more immersive and tangible experience during the service. Telepresence service user can feel as if the other party is sitting on opposite site in my place through applying 3D space sensing and transmission technique | | |
| 5 | Telepresence Robotics Applied to Transport, Monitoring and Assisting People with Disabilities | Electronic and electrical components Bluetooth connection, Wi-Fi | Telepresence robots are capable of both transporting and aiding the patient autonomously. The proposed solutions allow the medical team to communicate directly with it and have real-time access to vital functions data. | The essential problem is that by direct WI-FI, a remote control can be realized only on a short distance, of approximately 50 meters, in the conditions in which the monitoring of a patient brought on the stretcher requires a much greater control distance. | |
| 6 | Telepresence Robot Doctor | Video conferencing and remote accessing | Telepresence robots can be used in medicine and healthcare not only to save lives, but also to be part of the medical team. | The essential problem is that by direct WI-FI, a remote control can be realized only on a short distance, of approximately 50 meters | |

## III. CONCLUSION

As technology becomes increasingly advanced, the meaning of propagation becomes necessary in various applications. Therefore, telepresence, together with virtual reality and the Internet of Things, will have a major impact on intelligent agriculture, healthcare, education, and help create an interactive world.

This encourages continued research to solve problems of bipedal robot balance, energy autonomy, real-time data communication, advanced and powerful all medical and healthcare telepresence robots not only save lives, but they also become part of the medical team.

AR has come a long way but still has some distance to go before industries. But within 5-10 years, AR might soon pave the way for ubiquitous computing of a more natural kind or even human-machine symbiosis.

## IV. REFERENCES


1. Muralindran Mariappan, Brendan Khoo [1], "Design and Development of Communication and Control Platform for Medical Tele-diagnosis Robot (MTR)" International Journal of Networks and Communications 2013, 3(1): 12-20 DOI: 10.5923/j.ijnc.20130301.02.

2. Ronald Azuma, Yohan Baillot, Reinhold Behringer, Steven Feiner, Simon Julier and Blair MacIntyre, "Recent Advances in Augmented Reality", IEEE CG&A, November 2001, pp 68-75.

3. Jo, Dongsik, Ki-Hong Kim, and Gerard Jounghyun Kim. "SpaceTime: adaptive control of the teleported avatar for improved AR tele-conference experience."Computer Animation and Virtual Worlds, Vol. 26, pp. 259-269, 2015

4. Telepresence Robot Doctor: DOI-10.1109/GET.2016.7916830

5. E. W. Tunstel Jr, K. C Wolfe, M. D. M. Kutzer, M. S. Johannes, C. Y. Brown, K. D Katyal, M. P. Para, and M. J. Zeher. Recent Enhancements to Mobile Bimanual Robotic Teleoperation with Insight Toward Improving Operator Control. JOHNS HOPKINS APL TECHNICAL DIGEST, 2013.

nn

ORIGINALITY REPORT

| 34% | 13% | 33% | 2% |
| --- | --- | --- | --- |
| SIMILARITY INDEX | INTERNET SOURCES | PUBLICATIONS | STUDENT PAPERS |

PRIMARY SOURCES

| | | |
| --- | --- | --- |
| 1 | socs.binus.ac.id<br>Internet Source | 8% |
| 2 | Paul Tota, Mircea-F. Vaida, Petre-G. Pop. "Telepresence Robotics Applied to Transport, Monitoring and Assisting People with Disabilities", 2019 E-Health and Bioengineering Conference (EHB), 2019<br>Publication | 6% |
| 3 | Yu, ChoRong, SengKyun Jo, IlKoo Jeong, and Won Ryu. "Tangible telepresence service using 3D space sensing and transmission", 2014 International Conference on Information and Communication Technology Convergence (ICTC), 2014.<br>Publication | 5% |
| 4 | Irvin Steve Cardenas, Kelsey A Vitullo, Michelle Park, Jong-Hoon Kim, Margarita Benitez, Chanjuan Chen, Linda Ohrn-McDaniels. "Telesuit: An Immersive User-Centric Telepresence Control Suit", 2019 14th | 4% |

ACM/IEEE International Conference on Human-Robot Interaction (HRI), 2019
Publication

| | | |
|---|---|---|
| 5 | Nadella Soujanya, Y. Mohana Roopa, D.Kishore Babu. "Virtual reality meets IoT Through Telepresence", 2019 3rd International Conference on Trends in Electronics and Informatics (ICOEI), 2019<br>Publication | 3% |
| 6 | Jitheesh P., Fasal Keeramkot, Mohammed Ameen T., Athira P.C., Madeena S, Arunvinodh C.. "Telepresence Robot Doctor", 2016 Online International Conference on Green Engineering and Technologies (IC-GET), 2016<br>Publication | 2% |
| 7 | journals.itb.ac.id<br>Internet Source | 1% |
| 8 | Submitted to University of Baghdad<br>Student Paper | 1% |
| 9 | "Microservices in Big Data Analytics", Springer Science and Business Media LLC, 2020<br>Publication | 1% |
| 10 | Irvin Steve Cardenas, Jong-Hoon Kim, Margarita Benitez, Kelsey A Vitullo, Michelle Park, Chanjuan Chen, Linda Ohrn-McDaniel. "Telesuit", Proceedings of the 23rd | 1% |

International Symposium on Wearable Computers - ISWC '19, 2019
Publication

| | | |
|---|---|---|
| 11 | ieeexplore.ieee.org<br>Internet Source | 1 % |
| 12 | Widodo Budiharto, Derwin Suhartono. "Intelligent service robot with voice recognition and telepresence capabilities", 2015 SAI Intelligent Systems Conference (IntelliSys), 2015<br>Publication | <1 % |
| 13 | Paul Tota, Mircea-F. Vaida, Ligia Chiorean. "Mesh Networks with Interconnected Li-Fi and Wi-Fi Communications Applied to Telepresence Robots for Medical Emergency Situations", 2020 International Conference on e-Health and Bioengineering (EHB), 2020<br>Publication | <1 % |
| 14 | www.ijettcs.org<br>Internet Source | <1 % |
| 15 | librarysearch.aut.ac.nz<br>Internet Source | <1 % |
| 16 | hal.archives-ouvertes.fr<br>Internet Source | <1 % |