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A Review on Robot Hand/Arm That Is Controlled by Teleportation System

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***Abstract*: In this paper, we present a teleportation technique for commanding the robot hand/arm. The system interacts with the user using a novel data glove developed specifically for the purpose of evaluating the effectiveness of telepresence in telerobotics applications. The creation of a basic autonomous grab system with parallel joint torque/position control.**

Keywords: Robotics Arm, Teleportation System, Novel data glove

I. INTRODUCTION

Teleportation is the method by which a robot completes a job while being remotely controlled by a human operator. Over the years, teleportation has acquired favor in a number of professions, including the military [1]. Area of space [2]. Surgical procedures [3, 4]. Actuality [5, 6]. Exploration of the seabed [7]. In some of these systems, the robot arms are controlled through joysticks or a space ball [8, 9]. Despite the widespread use of the manipulator in a number of domains, most notably the industrial realm, executing physical in contact activities such as manipulating deformable materials remains challenging [10, 11, 12]. Cooperative work with people [13, 14]. Working in unstructured and unfamiliar situations [15]. As seen in Figures 1 and 2, A teleportation system with telepresence for a robot arm or hand: this teleportation system is comprised of three basic components: a human operating interface, a local network communication system, and a telepresence system. The telerobot system includes an arm/hand robot, a table, parallel hand-eye cameras, and global cameras. The dexterous hand is a HIT/DLR, while the robot arm is a Staubli RX60 [16]. Teleportation has been a driving factor in robotics research, motivated by the practical need of performing tasks in faraway places [17, 18].

Fig. 1. A robot arm/hand teleportation system with telepresence

Fig. 2. HIT/DLR hand with data glove and CyberGrasp

By increasing the transparency of the teleportation process, the operator's performance in such a system may be enhanced [19]. At the moment, multimodal interfaces such as virtual reality (VR)/augmented reality (AR) helmets [20], joysticks [21], contact force sensors [22], and biosignal sensors [23,24] have been developed and integrated into the teleportation system with the goal of providing immersive teleportation and increasing overall human performance. The remote robot is designed to enhance operator comfort and robot performance [19].

This article conducts a detailed assessment of the major technology, applications, and issues associated with robot control using teleportation systems. The next parts of this paper are structured in the following manner. Section 2 is a review of the literature. Specifically, in Section 3, Materials and Methods. Section 4, Various methods and the use of the teleportation system to control the robot. Section 5 illustrates some common uses. Finally, Section 6 examines future prospects for robotic hands and arms that can be controlled by teleportation.

II. LITERATURE REVIEW

Yupei Wu, Bin Fang, Di Guo, Fuchun Sun, Huaping Liu. During the month of December (2015) [25] A robotic hand-arm teleportation device utilizes a revolutionary data glove and a human arm/hand. They provide an investigation of a robotic arm-hand teleportation system that makes use of a human arm-hand and a data glove. To detect movement during robotic hand teleportation, fifteen devices are attached to the operator's fingers. Three devices are individually connected to the palm, upper arm, and forearm to record motion for robotic arm teleportation. They used the MPU9250 [26], a System in Container device that combines nine-axis inertial and magnetic sensors in a small compact.

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Liarokapis, Minas V., Artemiadis, Panagiotis K., and Kyriakopoulos, Kostas J. Juin (2013) [27] Telemanipulation Using a Dataglove and a Low-Cost Force Feedback Device with the DLR/HIT II Robot Hand. They are examining the DLR/HIT II five-finger robot hand, which has a total of fifteen degrees of freedom (DoFs), three for each finger (two DoFs for finger flexion-extension and one DoF for finger abduction adduction). Each finger's last two joints are connected by a mechanical connection made of steel wire (with a transition ratio of 1:1). The Cyberglove II collects data at a 100Hz rate. To enable the Linux operating system to manage the Cyberglove II, necessary data collection software was written in C++ (Ubuntu 12.04 x86).

Shuang Li, Xiaojian Ma, Hongzhuo Liang, Michael G. Orner, Philipp Ruppel, Bin Fang, Fuchun Sun, and Jianwei Zhang Teleoperation of a Shadow Dexterous Hand through a Vision-based Deep Neural Network. 18 February (2019) [28] To begin, they propose TechNet, a teacher-student network that is capable of learning the kinematic mappings between the robot and the human hand. Second, they build a paired human-robot hand dataset, which consists of pairs of depth pictures taken during the same move, as well as the robot hand's corresponding joint angles. Third, they provide an optimum mapping strategy that accounts for probable self-collisions while matching the shadow hand's Cartesian position and link direction relative to a human hand posture.

H.F. Machiel Van der Loos, Waleed Uddin, Maram Sakr, Camilo Perez Quintero, and Camilo Perez Quintero. Orthographic Vision-based Interface for Teleportation of Robot Arms. 11 (2018) [29] They enable direct unilateral Cartesian control of a 6-DOF robot in real-time. A joystick, keyboard, or Leap Motion may be used to control the arm [30]. This Leap Motion controller is connected to a local computer through a serial connection. An external camera provides a view of the distant environment, which transmits the picture to the local computer. They use computer vision methods to augment the camera picture with depth information from the distant site, making teleoperating the robot simpler for the user.

N. Mavridis, E. Machado, N. Giakoumidis, N. Batalas, I. Shebli, E. Ameri, F. Neyadi, and A. Neyadi Teleoperation of an Industrial Robotic Arm in Real Time through Imitation of Human Arm Movements (2010) [31] The motion capture subsystem is composed of VGA-resolution cameras (640 x 480 pixels) capable of a frame rate of up to 200 frames per second (Standard Deviation brand). The cameras are encircled by infrared LED rings and placed at a height of 2.62 meters on the corners and short-side midpoints of a rectangle measuring 6 by 4.80 meters. As a consequence, the effective capturing area has a footprint of 3m in diameter. The person is outfitted in unique clothing that has 19 2.5cm diameter luminous ball markers. The software API for the mobcap system includes a range of C++ functions that allow near-real-time reading of the tracked markers' 3D coordinates.

Brennan T. Phillips, Kaitlyn P. Becker, Shunichi Kurumaya, Griffin Whittredge, Daniel M. Vogt, Clark B. Teeple, Michelle H. Rosen, Vincent A. Pieribone, David F. Gruber, and Robert J. Wood. A Dexterous and Low-Power Teleoperable Soft Robotic Arm for Delicate Deep-Sea Biological Exploration October 3rd (2018) [32] (A) A sectorized wireless glove regulates actuators by coordinating the management of separate proportional valves that provide pressure to the arm and end-effector actuators. (B) Hydraulic pressure to separate ports is managed by a unique open-circuit seawater engine capable of operating at depths of at least 2500 m. (C) The soft arm, which is composed of modules for bending, turning, and grasping, may be employed alone or in combination with an existing manipulator system.

Fumio Kojima, Futoshi Kobayashi, George Ikai, Wataru Fukui, and Futoshi Kobayashi. Haptic Device with Two Fingers for Robot Hand Teleoperation. September 27 (2011) [33] They created ExoPhalanx, a two-finger body-mounted haptic device. The ExoPhalanx supplies force to the distal portions of the human operator's thumb and middle finger, as well as the middle finger's basipodite. Due to the ExoPhalanx's tiny size and low weight, it may be worn on the human hand. As a result, the human operator receives just one-directional force. To test the haptic device's performance, a two-finger grasping teleoperation experiment was conducted utilizing the Universal Robot Hand II and the haptic device ExoPhalanx.

III. MATERIALS AND METHODS

A. Materials

There are several materials that might be used to create equipment for human-machine interaction, including the following: (a) Leap controller, (b) Teach Net, (c) Cyber glove II, (D) Cyber Grasp, (E) Motion Capture, (F) Soft sensors, and (G) ExoPhalanx on Cyber Glove. As seen in Fig 3.

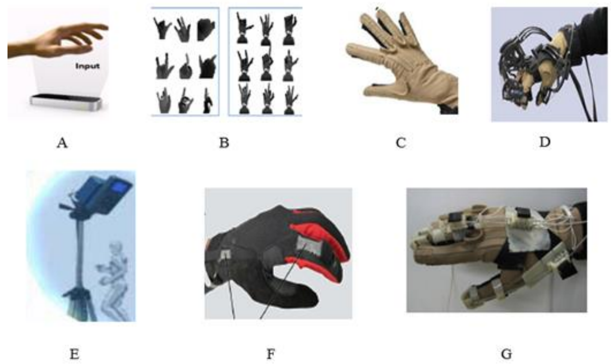

Fig. 3. Types of equipment for human machine interaction (a) Leap controller [29], (b) Teach Net [28], (c) Cyber glove II [27], (D) Cyber Grasp [16], (E) Motion Capture [31], (F) Soft sensors [32] and (G) Exophalanx on Cyber Glove [33]

B. Equations

A personal computer is also included in the suggested data glove system. Following calibration, the data glove's MCU analyses and estimates the measurements wraps them in a packet and transmits them over Bluetooth to the PC. The baud rate for data transmission is 115200 bits per second. The virtual model on the PC may be used to demonstrate the motion capture process instantly [16]. C# is used to write the interface. The system's flow diagram is seen in Fig. 4.

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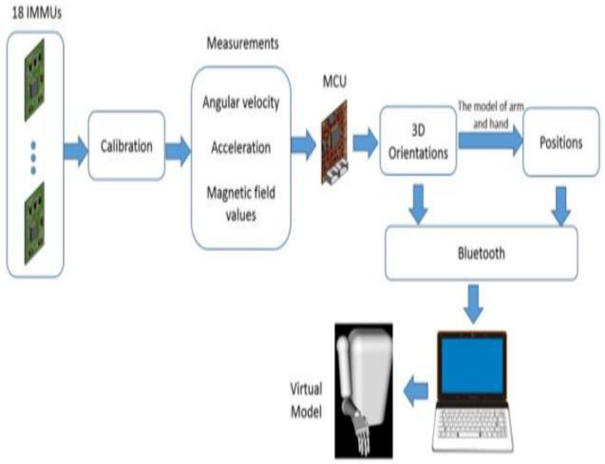

Fig. 4. The flow diagram of the data glove system

IV. MATERIALS AND METHODS

There are several methods for controlling a robot arm/hand through a teleportation system. Below here is a table that summarizes the many methods for using the teleportation system.

Table.1 Different methodologies and using the teleportation System

Author	Implementation Details	Components	Controller
Waleed Uddin (2018)	Use the hand input on the Leap controller	Leap controller, Local PC, External Camera, Robot Arm.	Leap Motion controller
Shuang Li (2019)	Use the hand demonstration then input depth Image to the TeachNet	Depth camera, 400k pairwise human-robot hand dataset, (Left)Depth images, Joint angles.	Teach Net
Minas V (2013)	Use the Cyberglove II then move the hand	Vibration Motor, RGB LED, Wrist Band (inner side), Wrist Band (wrapped), Phidgets Interface Kit 888, Flexiforce Sensor and Adapter.	Arduino Mega
Haiying Hu (2005)	Use the dataglove and CyberGrasp then move it	CyberGrasp, Staubli RX60 robot, HIT/DLR Dexterous hand. Industrial Robot Arm.	PD Controller
Mavridis N (2010)	Use CyberGlove then Motion Capture to control robot arm	Motion Capture, CyberGlove, Robotic Arm.	TeleOp Controller
Brennan T (2018)	Use Soft sensor to move the hand for the deep-sea soft robotic arm system	Soft sensor, Hydraulic tubing, RS 232 (Serial), Pump, Manifold, Accumulator, Control electronics, Gripping module, Bending and rotary modules, Mechanical ground.	Microcontroller RS 232 (Serial)
Futoshi Kobayashi (2011)	Use ExoPhalanx mounted on CyberGlove to control robot hand	CyberGlove, ExoPhalanx, robot hand subsystem, flexion sensors per finger, abduction sensors, a palm-arch sensor, sensors to measure wrist flexion and abduction, DC motor.	PC Controller
Bin Fang (2015)	Use the YoBu data glove to control the robot arm	MPU9250 [34], YoBu glove, 7DOF Schunk robotic arm, 4DOF Barrett robotic hand, MCU.	Microcontroller STM32F4

V. PROVIDES SEVERAL TYPICAL APPLICATIONS

A. Exploration of Deep-Sea

They exhibit the world's first self-contained soft robotic manipulator system designed specifically for deep-sea applications (Figure. 5). Their multi-degree-of-freedom arm is composed of modular bending, twisting, and grasping modules that are propelled by ambient low-pressure saltwater. Additionally, a ground-breaking hydraulic engine with a power need of less than 50 W is shown. The arm is teleported using a wireless glove equipped with flexible soft sensors [36]. Field trials of the manipulator system were conducted aboard a manned submersible and an unmanned remotely controlled vehicle at hydrostatic pressures equivalent to 2300 meters of ocean depth. Figure 6 illustrates earlier work on customizable soft grippers for deep-sea biological sampling (Figure 6). At a depth of 100 meters in Israel's Gulf of Eilat, (A) a fiber-reinforced "Boa" style actuator holds a whip coral; (B) a four-finger bellows-like actuator holds a brittle scleractinian coral (C) A two-finger bellows actuator grasps a glass sponge 300 meters underwater at Carandolet Reef, Phoenix Islands [38]. The green laser dots on the image's left side are spaced 10 cm apart. (D) A three-finger gripper with bellows-type actuators grasps a holothurian at 1800 m in the Channel Islands National Marine Sanctuary in California.

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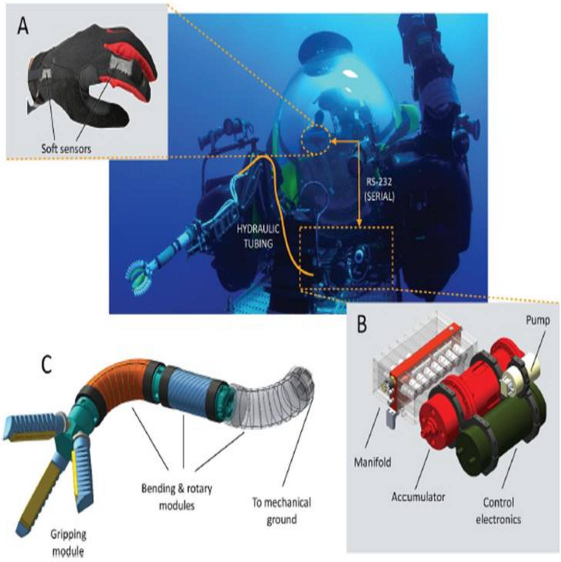

Fig. 5. Overview of the deep-sea soft robotic arm system

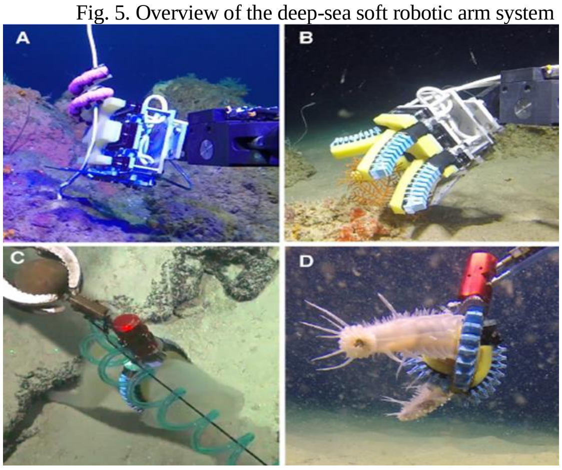

Fig. 6. Examples of prior work on versatile soft grippers for deep-sea biological sampling

B. Motion Capture Subsystem with CyberGlove

This subsystem utilizes CyberGlove to identify the operator's location. The network transmits the measured operator's posture to the robot hand subsystem. The CyberGlove has three flexion sensors per finger, four abduction sensors, a palm-arch sensor, and sensors to measure wrist flexion and abduction. Because the universal robot hand's DIP and PIP joints synchronize similarly to a human finger [33], this subsystem utilizes sensor data except for the DIP joints. A two-finger gripping experiment is used to test the ExoPhalanx's haptic feedback capability (see Figure 7). Approximately the size of a baseball, a polystyrene ball has been grasped.

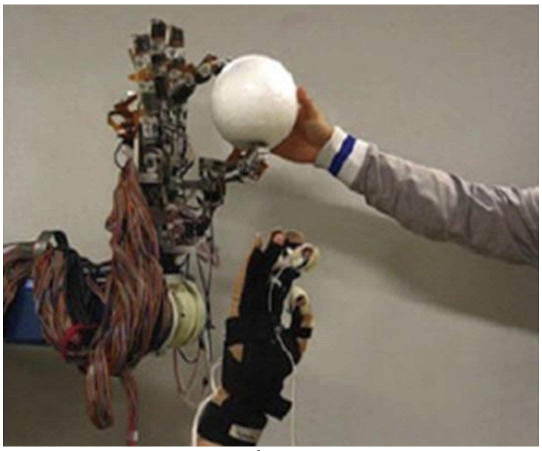

Fig. 7. Two finger grasping experiment

VI. CONCLUSION

We focused on a human-operated teleportation mechanism in our review. The multimodal teleportation system, multimodal interfaces, remote robots, communication module, robotic control module, and remote perception module are all firsts for the human demonstrator. We discussed the remaining issues and future work in skill modeling and multimodal teleportation for usage with robotic arms. Finally, we show how to operate the robot's arm through teleportation using control devices such as a CyberGrasp, motion capture, and Leap controller.

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