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A Compact and Dynamic Design implementation of Dual Arm Tele-Surgery Robot

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ABSTRACT:

Experienced clinicians employ proximal force sensing in vascular interventional surgery to identify collisions and decrease vascular harm caused by surgical equipment. However, giving high-precision force feedback to physicians in robot-assisted tele-interventional surgery (RATIS) remains a major difficulty. This research describes the development of a haptic robot-assisted catheter operating system using a new spring-based haptic force interface. The haptic force interface can give accurate force feedback with a closed loop force adjustment system. Furthermore, to improve surgical safety, a collision protection function with a proximal-force-based collision detection algorithm was presented. The teleoperated system is transparent while there is no contact; when there is a collision, the delivered haptic force is enhanced. The results showed that the designed haptic robot-assisted catheter operating system with collision safety function was usable. For the basic tasks of visual servoing and bimanual hybrid motion/force control, we describe a unique system for achieving coordinated task-based control on a dual-arm surgical robot. In a tele-robotic framework, the robot, which is made up of a rotating torso and two seven-degree-of-freedom arms, executes autonomous computer command-based wireless target alignment of both arms using fiducial markers, two-handed gripping and force control, and robust object manipulation. The operator commands the object's intended location via Microsoft Kinect using hand motions, while the autonomous force controller maintains a stable hold. Different operation modes are dictated by gestures detected by the Kinect.

Keywords: tele-interventional surgery, robotics, Embedded controller etc.

INTRODUCTION

Medical robotics and computer-assisted surgery are two new and exciting fields of research that aim to improve surgeons' abilities by combining the best of robots and humans. A telesurgical workstation is being created for use in laparoscopic surgery in this cooperative effort involving the Robotics and Intelligent Machines Laboratory, University of California, Berkeley, Endorobotics Inc., and the Department of Surgery, University of California, San Francisco. A six-degree-of-freedom design is now in use (DOF).A gripper-equipped manipulator is controlled by a six-DOF master manipulator.
Industrial robots in manufacturing lines are the most common usage of robots nowadays. These robots are designed to navigate through a pre-programmed sequence of spots in order to do repetitive jobs using teach pendants. Industrial robots can receive limited feedback from sensors such as vision or force/torque sensors by modifying command trajectory (e.g., external change in the VAL robot programming language), but they are not meant for human contact. Even when external sensors are employed, they are customized to the situation.

Welding, filament winding, grinding, and drilling are examples of specific activities that are related to certain platforms, such as VAL or RAPID. These systems usually consist of a single robot arm with a dedicated end effector for a given purpose.

A. Existing Method

The purpose of this study is to progress toward a next-generation surgical robot system that will assist surgeons deliver healthcare more effectively, with an emphasis on design technique for constructing a compact and lightweight minimally invasive surgery (MIS) robot manipulator. The workspace needs were carefully established based on a comprehensive collection of in-vivo surgical measurements. The spherical manipulator is a natural contender due to the pivot point constraint in MIS. In order to avoid collisions, the optimal setup comprises of two serial manipulators. To determine the manipulator's ideal link lengths, a full kinematic analysis and optimization considering the MIS requirements was done. The results demonstrate that the ideal link lengths (angles) for the serial spherical 2-link manipulator used to guide the surgical tool are (60 , 50).
We present a new robotics system in the field of bio-medical application that precisely controls surgical processes over a wireless network.

Statement of the Issue

• Motion that is constant
• Design of a complex power supply

B. Proposed Approach

On a dual-arm surgical robot, we offer a unique approach for achieving coordinated task-based control for general visual tasks.bimanual hybrid motion/force control and servoing In a tele-robotic framework, the robot, which is made up of a rotating torso and two seven-degree-of-freedom arms, executes autonomous computer command-based wireless target alignment of both arms using fiducial markers, two-handed gripping and force control, and robust object manipulation. The operator commands the object's intended location via Microsoft Kinect using hand motions, while the autonomous force controller maintains a stable hold. Different operation modes are dictated by gestures detected by the Kinect.

LITERATURE REVIEW

[1] Ki-Young Kim The purpose of this study is to progress toward a next-generation surgical robot system that will assist surgeons deliver healthcare more effectively, with an emphasis on design technique for constructing a compact and lightweight minimally invasive surgery (MIS) robot manipulator. The workspace needs were carefully established based on a comprehensive collection of in-vivo surgical measurements. The spherical manipulator is a natural contender due to the pivot point constraint in MIS. In order to avoid collisions, the optimal setup comprises of two serial manipulators. To determine the manipulator's ideal link lengths, a full kinematic analysis and optimization considering the MIS requirements was done. The results demonstrate that the ideal link lengths (angles) for the serial spherical 2-link manipulator used to guide the surgical tool are (60 , 50).

S. Shankar Sastry, Murat Cenk, Frank Tendick, Michael Cohn [2] Medical robotics and computer-assisted surgery in general, as well as robotic telesurgery in particular, are exciting robotics applications. Various features of telesurgery are investigated in this study. The UC Berkeley/Endorobotics Inc./
The San Francisco Telesurgical Workstation is described as a master-slave telerobotic system for laparoscopic surgery, with kinematic analysis, control, and experimental findings. Later, various conceptual and prospective concerns in telesurgery, such as teleoperation and hybrid control, are examined, with a focus on the unique requirements of telesurgery.

Martin O Culjat, Miguel L. Franco, Catherine E. Lewis, Erik P. Dutson, Warren S. Grundfest, and James W. Bisley, Chih-Hang King, Martin O Culjat, Miguel L. Franco, Catherine E. Lewis, Erik P. Dutson, Warren S. Grundfest, and James W. Bisley [3] Over the last decade, robot-assisted minimally invasive surgery has grown in popularity, however the method is currently performed without haptic input during tissue manipulation. We've created a tactile feedback system that includes a piezoresistive force sensor, control system, and pneumatic balloon tactile display, all of which can be put directly on a day Vinci surgical robotic system. A set of novices (n 14 16) and experts (n 14 4) were instructed to undertake three blocks of peg transfer tasks with the tactile feedback system in situ to assess the influence of tactile feedback on robotic manipulation. In all three blocks, force generated at the end effectors was monitored, although tactile feedback was only active during the middle block. When the feedback mechanism was turned off, all of the subjects applied more force. When individuals were engaged, they utilized significantly less force right away while maintaining a proper grip throughout the activity. Grip force increased dramatically after the device was turned off again, returning to pre-feedback values. These findings show that robotic operations performed without tactile input use more force than is required to grab items. As a result, tactile feedback allows the surgeon to grab with less force, potentially improving robotic system control and tissue and object handling.

SYSTEM FUNCTION

PC, IC MAX232, and Zigbee are all included in this unit. The terminal v1.9B software is installed on the PC and is used to control the robot through Zigbee. The Zigbee is connected to the PC using the IC MAX232, which regulates the voltage level between the PC and the Zigbee.

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Fig.1 block diagram of robot tele- control unit

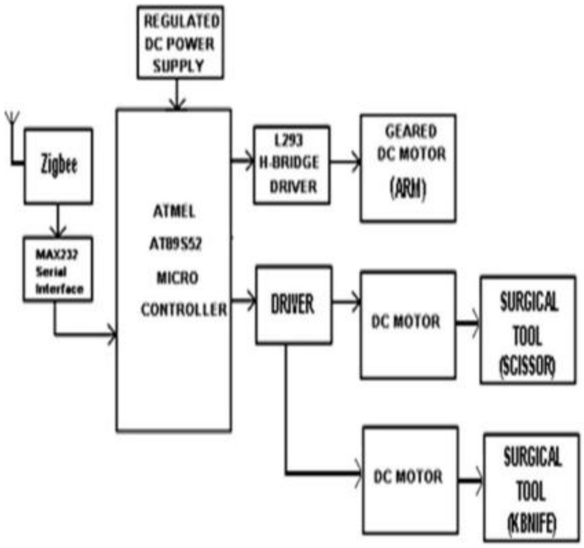

Fig.2 block diagram of tele-robot unit

This unit consists of zigbee modules, MAX232, microcontroller, H-bridge driver and DC motor. The zigbee module receives the signal coming from controlling unit and it applied to the input of MAX232 which is used to control the voltage level matching between receiving signal with controller and it provides serial data interface.
The controller controls the motion of robot arm &surgical tool motors through H-bridge driver.

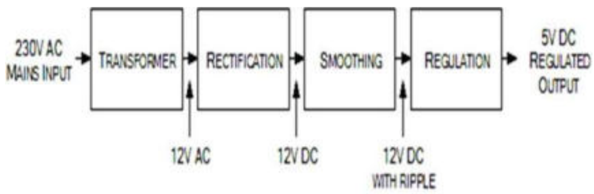

Fig.3 block diagram of power supply unit

The system is supplied a 5V DC supply, which is converted from a 230V AC source. To begin with, a step down transformer will be utilized to convert 230V AC to 12V AC. Because the microcontroller can only work with DC power, the AC power will be converted to DC using a bridge rectifier. Because the rectifier's output will contain ripples, we'll use the 2200uf capacitor to filter them out. The filter's output is fed into the 7805 voltage regulator, which converts 12V DC to 5V DC. The output from the regulator will be filtered using the 1000uf capacitor, resulting in a pure 5V DC as the power supply unit's output.

DESCRIPTION OF COMPONENTS

A. Microcontroller

The AT89S52 is a CMOS 8-bit microcontroller with 4K bytes of In-System Programmable Flash memory that is low-power and high-performance. The device is made with Atmel's high-density non-volatile memory technology and uses the industry-standard 80C51 instruction set and pinout.
The program memory can be rewritten in-system or using a non-volatile memory programmer thanks to the on-chip Flash. The Atmel AT89S52 is a powerful microcontroller that combines a versatile 8-bit CPU with In-System Programmable Flash on a monolithic chip to provide a highly flexible and cost-effective solution to many embedded control applications.

The AT89S52 includes the following features as standard: 4K bytes of Flash, 128 bytes of RAM, 32 I/O lines, Watchdog timer, two data pointers, two 16-bit timer/counters, a five vector two-level interrupt architecture, a full duplex serial port, on-chip oscillator, and clock circuits are among the features. Furthermore, the AT89S52 features static logic for operating at low frequencies and two software-selectable power-saving modes. The CPU is turned down in Idle Mode, while the RAM, timers/counters, serial port, and interrupt system remain operational. The RAM contents are saved in Power-down mode, but the oscillator is frozen, blocking all other chip functions until the next external interrupt or hardware reset.

Advantages of Micro controller

- Increased reliability through a smallpart count.
- Reduced stock levels, as onemicrocontroller replaces several parts.
- Simplified product assembly.
- Greater product flexibility andadaptability.
- Rapid product changes or development by changing the productand not hardware.

i) Robot motion control

Typical industrial controllers use closed proprietary torque-level control and only allow for a slower rate of joint trajectory adjustment. We employ the damped least-squares technique to change joint-level motion based on task space motion requirements because we're interested in task space motion. We use potential fields to exploit kinematic redundancy in our system to avoid collision and improve manipulability and grab stability.

Object identification and location

The robot must detect and locate the object, as well as find optimal grabbing locations. We doodle

to detect the object and find appropriate grip places using planar tagging systems created in the artificial reality community, particularly the VTT ALVAR tags

ii) Force control

To hold the thing securely with the robot arms, the robot must squeeze hard enough to provide enough friction to keep the object from slipping out of its grasp. To improve robustness and demonstrate closed loop stability for a compliant object, we apply the well-known integral force control with a force-dependent gain.

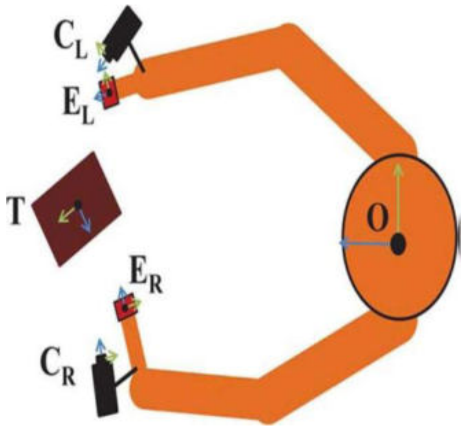

Fig. 4 the different frames of reference for the inertial frame and task frame along with the endeffectors and cameras on each arm

Load compensation

The weight and center of gravity of the load are evaluated and included into the force control to allow significant excursion in load orientation. We show that even when there are estimating mistakes and time-varying loads, the system remains stable.

Human Interface

The Microsoft Kinect sensor is used to understand the user's movements and turn them into attitudes appropriate for the work at hand. Because it is not constrained by the motion range constraint or mechanical impedance of a mechanical interface, it is more versatile, resilient, and natural for the user. The user is exclusively in charge of task sequencing and object movement; the control system maintains a secure grip.

autonomously. We believe that the human-directed tele-robotic system presented in this study, which allows for easier integration, prototyping, and human engagement, will be the cornerstone for future human-robot collaborative sensing and manipulation. This study is a follow-up to one presented at a conference on the Kinect gestural interface.

B. Zigbee Transceiver

ZigBee is a set of high-level communication protocols for wireless personal area networks (WPANs) that use small, low-power digital radios, such as wireless headphones that connect to cell phones through short-range radio. The ZigBee specification defines a technology that is meant to be simpler and less expensive than existing WPANs, such as Bluetooth. ZigBee is designed for low-data-rate, long-battery-life, and secure networking radio-frequency (RF) applications.

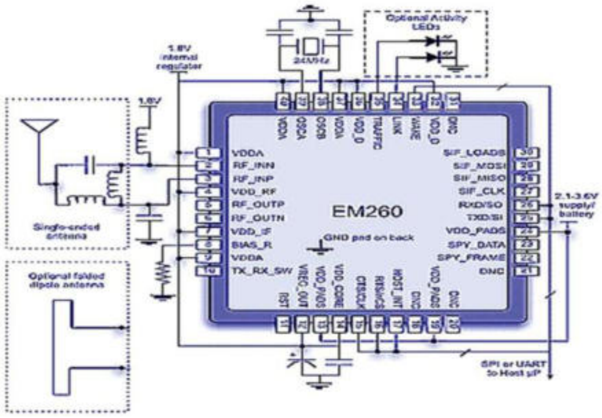

Fig.5 Schematic diagram of Zigbee

ZigBee is a proprietary wireless mesh networking protocol that is low-cost and low-power. Because of its low cost, the technology may be used in a wide range of wireless control and monitoring applications.

Low power consumption enables for extended battery life with fewer packs, while mesh networking ensures excellent dependability and range.

EXPERIMENTAL RESULT

TERMINAL V1.9b

Terminal is a simple serial port (COM) terminal emulation program. It can be used for communication with different devices such as modems, routers, wireless communication modules, embedded uC systems, GSM phones; it is very useful debugging tool for serial communication applications.

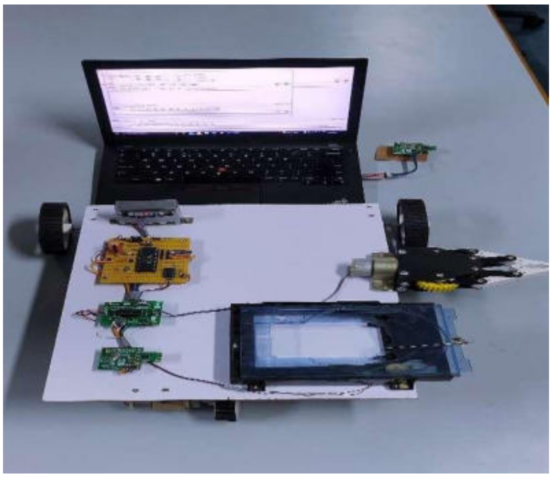

Fig.6 Experimental Result

Commands for robot operation

Short KEY	Robot Tool function
S	Scissor
K	Knife
F	Move Forward
R	Move Backward

CONCLUSION

These interconnected components were combined into a robust and versatile distributed control and communication architecture, which was proved to be effective in handling a range of objects with varying forms, surface textures, weights, and mass distributions. While we use off-the-shelf components and software in the design and demonstration, the technique is easily adaptable to various robots and platforms. Despite the large time delay, we were able to obtain reliable performance for complex motion and force targets using an industrial robot controller.

In the future, we will use wireless network protocol to handle and control robotic functions using global planning approaches.

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