CUSTOMER SOLUTIONS

Remote Monitoring/Control/ Biomedical
- ***LabVIEW™ 6i***
- ***DAQCard™-1200***

Telerobotic Camera System for Operating Rooms

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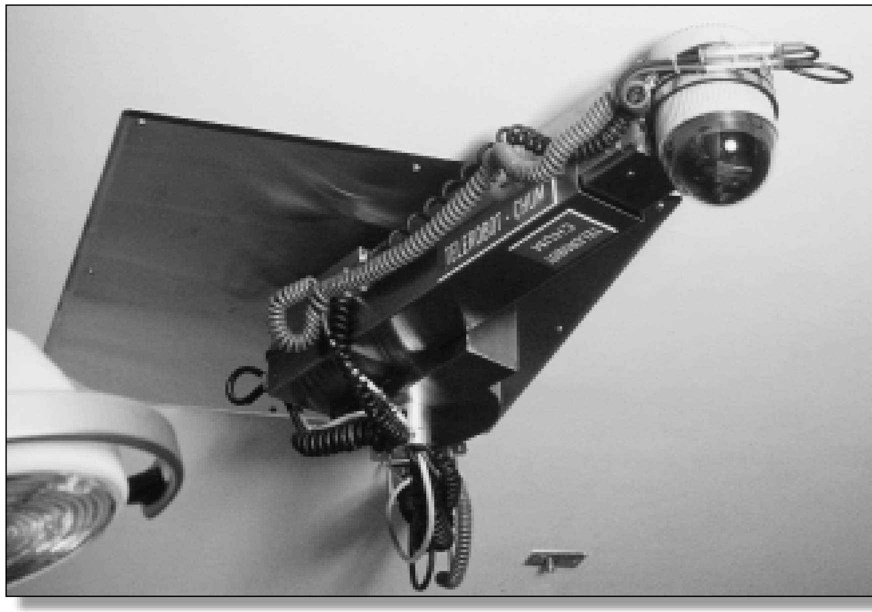
The Challenge: Creating a remotely controlled video camera to monitor operating room procedures when the position of the patient, surgical lamps, and surgeon change during the procedures.

The Solution: Using National Instruments LabVIEW 6*i* and DAQCard-1200 to design a simple, yet flexible, operating room robotic camera system and graphical user interface (GUI) for remote system control.



Using National Instruments LabVIEW 6i and DAQCard-1200, the TELEROBOT is controlled remotely and acquires images of operating room procedures.

Introduction

The ongoing advances and widespread availability of telecommunications and information systems have made interactive "telemedicine" increasingly attractive and accessible. Instead of using surgical room amphitheatres or live video produced by a video crew, surgeons often employ fixed cameras installed throughout an operating room to record surgical procedures. However, this solution is often impractical because the position of the patient, surgical lamps, and surgeons change depending on the type of surgical procedure performed. The ideal operating room camera system must have a certain number of degrees-of-freedom that users can control from remote locations when recording various surgical procedures.

Design

To move a video camera over the operating field, the robotic arm of this camera system consists of a two degrees-of-freedom rotative, prismatic manipulator coupled with a two degrees-of-freedom "pan-tilt-zoom" Panasonic wv-cs 404 camera. Users can either mount the robotic camera system underneath and on the same rotational axis as the surgical lamps, or attach it directly to the operating room's ceiling. With this strategic configuration, users can easily position the camera on a variable circular plane over the operating field. To simplify system construction and minimize the total central axis, the system height elongation axis is slightly longer than the rotational axis, giving the unit the freedom to extend the camera towards and away from the main arm for proper camera position above the patient.

LabVIEW 6i helped us quickly assemble and program a functional prototype to control the system and acquire data. Also, with the flexible and easy-to-learn graphical programming interface of LabVIEW 6i, we could quickly and easily modify the application, decreasing time spent on the experimental process.

Users can control the robotic camera system manually or through a GUI. In manual mode, a user uses two, two-axis joysticks to control the length and rotational position of the arm, as well as the pan and tilt of the camera. He or she manually controls the zoom, focus, and other camera parameters from the camera control unit. However, while users can obtain all possible system configurations using the manual control mode, it is somewhat difficult to coordinate the allowable degrees-of-freedom to obtain the desired point of view.

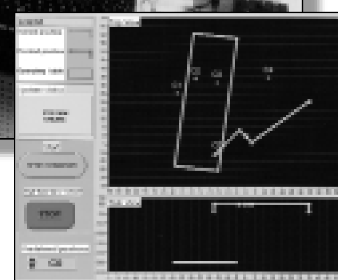
To automate the process, we developed a PC-based system controller and GUI to easily control all system motions using National Instruments LabVIEW 6*i*. LabVIEW 6*i* helped us quickly assemble and program a functional prototype to control the system and acquire data. Also, with the flexible and easy-to-learn graphical programming interface of LabVIEW 6*i*, we could quickly and easily modify the application, decreasing time spent on the experimental process.

The GUI mimics the actual position of the camera arm virtually by reproducing all system components and parameters on the control monitor. We also reproduced top and side views of the camera manipulator and operating table. We then incorporated the direct and inverse kinematics of the manipulator into the interface to operate the system in Cartesian coordinates, a common system used to quantify the distance of points from lines or planes. Users can also program different points of view, which the system can later recall to reposition the camera at the stored locations by using a simple recall position function.

With LabVIEW 6i and DAQCard-1200, we have a flexible and versatile platform that meets ongoing project demands.

Implementation

To facilitate evaluation of the prototype system, we installed it in an operating theatre equipped with an observation room. The camera manipulator was mounted directly to the ceiling of the operating room, eliminating the need to modify the current surgical lamp installation. We then positioned the control center and system hardware in the adjacent observation room. The camera control unit manipulated the system cameras and transmitted captured images to two monitors. The first monitor displayed the surgical procedure captured by the robotic camera system. The second monitor displayed images obtained from fixed operating room cameras, giving visual feedback on the robotic camera system position and a full view of operating room activities.



Surgeons using a laptop computer and National Instruments products can control the camera and view surgeries remotely.

Results

The prototype system initially filmed a minimally invasive surgery – a laparoscopic kidney removal in which the healthy donor's kidney was prepared and removed using conventional laparoscopic techniques. While the standard laparoscopic camera captured the inner-abdominal procedure, the telerobotic camera system captured an outside view of the surgical site insertions and focused on final kidney preparation and removal. Although preliminary, the images captured during this procedure required only minimal system adjustments. More importantly, the surgeons were very satisfied with the filming results.

This robotic camera system, named TELEROBOT, is an ongoing research project that will develop into other solutions. With LabVIEW 6*i* and DAQCard-1200, we have a flexible and versatile platform that meets ongoing project demands. LabVIEW 6*i* is lowering our costs by reducing development time and eliminating our need for other software platforms.

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