Haptic Ergonomics

There are three issues regarding ergonomics with surgical robots – interface to the robot, interface to the patient and interface to the user. Many of the existing robots incorporate a touch-screen to allow user input and give visual feedback. The apparent drawbacks with using a touch-screen display are increased complexity and design time. Surgical robots with industrial robotic arms like the Acrobot have to be fixed to the ground due to their large size and require the operating area of the patient to be immobilized by attaching it to an apparatus to the operating table. Any misalignment detected during the procedure will require the surgeon to recalibrate the robot. The Praxiteles, for example, solves this problem by reducing the size of the robot and attaching it directly to the femur. This reduces the valuable real estate in the OR and eliminates the need to immobilize the leg, but imposes additional challenges due to constraints on size and weight. Other surgical robots do not have issues with the weight of the robot resisting the user’s actions as the robots are suspended from an arm. With respect to this project in particular, there is no available literature on this issue since there are none similar products in existence. However, the non-surgical haptic device from Haption employs a system to compensate for gravity. This could reduce the strain on the user and prevent any unnecessary movement due to gravity.

Techniques to Interface with 3D Models

There are several patented methods to acquire 3D representation of bones. Praxim uses a technique called bone morphing to transform generic models to fit those of the patient. Unlike other techniques, this one allows the models to be generated without CT scans or X-rays. Mainstream techniques include 3D model reconstruction using CT images, X-rays, or optical references on the bone. Once a 3D geometric representation is computed, the model can be viewed and manipulated through a 3D visual analysis tool.

Search Details

Google Patents

Knee replacement robot

Praxim

Haptic ergonomics

3D surface detection

Google Scholar (via UBC Library proxy)

Praxim

Plaskos

UBC Library Metalib

Praxim

Orthopaedic robot

Acrobot

Abstracts

**Assessing the condition of a joint and assessing cartilage loss**

US 7,184,814

Methods are disclosed for assessing the condition of a cartilage in a joint and assessing cartilage loss, particularly in a human knee. The methods include converting an image such as an MRI to a three dimensional map of the cartilage. The cartilage map can be correlated to a movement pattern of the joint to assess the affect of movement on cartilage wear. Changes in the thickness of cartilage over time can be determined so that therapies can be provided. The amount of cartilage tissue that has been lost, for example as a result of arthritis, can be estimated.

**System and method for performing image directed robotic orthopaedic procedures without a fiducial reference system**

US 6,033,415

A method for transforming a bone image data set representing at least a partial image of a long bone to a robotic coordinate system, comprising: generating the bone image data set from a bone image; registering a bone digitizer arm to the robotic coordinate system; generating a digitized bone data set by taking bone surface position measurements with the digitizer arm; and transforming the bone image data set into the robotic coordinate system by performing a best-fit calculation between coordinates of the bone image data set and corresponding coordinates of the digitized bone data set.

**Imageless Robotized Device and Method for Surgical Tool Guidance**

US Application 20070156157

An imageless robotized device for guiding surgical tools to improve the performance of surgical tasks is provided. The method of using the robotized device may include the steps of: collecting anatomical landmarks with a robot arm; combining landmarks data with geometric planning parameters to generate a position data; and automatically positioning a guiding tool mounted to the robot arm. Particular embodiments for a limb fixation device are also described.

**Computer-assisted hip resurfacing surgery using the Acrobot Navigation System**

Proc. IMechE Vol. 221 Part H: J. Engineering in Medicine

The authors have previously reported on the laboratory development of the

Acrobot Navigation System for accurate computer-assisted hip resurfacing surgery. This paper describes the findings of using the system in the clinical setting and including the improvements that have been made to expedite the procedure. The aim of the present system is to allow accurate planning of the procedure and precise placement of the prosthesis in accordance with the plan, with a zero intraoperative time penalty in comparison to the standard non-navigated technique.

At present the navigation system is undergoing final clinical evaluation prior to a clinical study designed to demonstrate the accuracy of outcome compared with the conventional technique. While full results are not yet available, this paper describes the techniques that will be used to evaluate accuracy by comparing pre-operative computed tomography (CT)-based plans with post-operative CT scans. Example qualitative clinical results are included based on visual comparison of the plan with post-operative X-rays.

**BRIGIT, a Robotized Tool Guide for Orthopedic Surgery**

Proceedings of the 2005 IEEE

International Conference on Robotics and Automation

The BRIGIT project (Bone Resection Instrument Guidance by Intelligent Telemanipulator) aims at developing a surgical robot for orthopedic surgery. This robot should be used as a positioner of a guide providing a mechanical support during bone sawing or drilling. The planned position of the guide is obtained after a registration procedure consisting in collecting anatomical landmarks on the surface of the patient's bone. This can be done in a cooperative mode, by grabbing the tool tip, through an appropriate force control, or in a teleoperated mode via a master device. In order to facilitate the installation of the robot in the operating theatre and to improve its performance, a procedure based on interval analysis has been developed to optimize the robot placement with respect to the patient, the surgical staff, and the obstacles of the environment.

Works Cited

Nahum, Bertin. Imageless Robotized Device and Method for Surgical Tool Guidance. ZIMMER GMBH, assignee. US Patent Application 20070156157. December 14, 2006.

Lang, Philipp. Assessing the condition of a joint and assessing cartilage loss. The Board of Trustees of the Leland Stanford Junior University. US Patent 7,184,814. February 27, 2007.

Computer-assisted hip resurfacing surgery using the Acrobot Navigation System. H 221.7 (2007): 773-85. Journal of Engineering in Medicine.

Plaweski, S. "PRAXIM ACL Navigation System using Bone Morphing." SpringerLink. 15 Feb. 2007