Automatic container model crane

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Gruppe 633

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Agenda

Introduction

System overview

Communication

Force estimation

Improvements

Introduction

- Minimally invasive surgery
- Surgical robots teleoperated by console
- Visual feedback recieved by surgeon

Introduction

- Surgeon has to estimate the force excerted by the tool
- Studies show haptic feedback reduces error rate

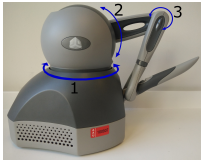
Introduction

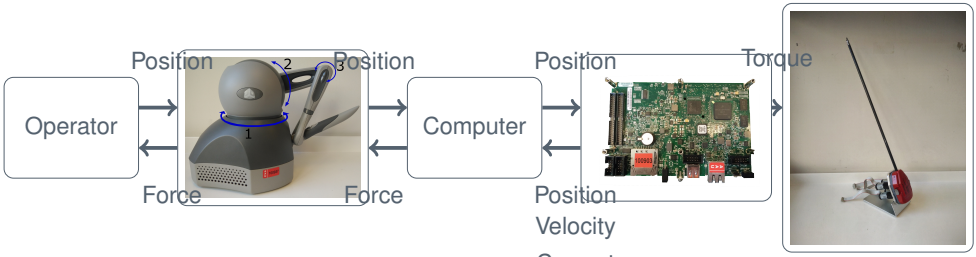
- Force feedback teleoperation of surgical tool
- Geomagic Touch
  - 3 actuated degrees of freedom
  - Cartesian force feedback
  - Outputs up to 3 N of force

Introduction

- Communication
  - Minimize delays in communication
- Force estimation
  - Sensors too expensive for shor lifetime of tools
- Control
  - Remove oscillations in force feedback

System overview





Communication

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- Our approach:

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Communication

- Requirement for force feedback: 1000 Hz
- Maximum for the initial system: 100 Hz
- Our approach:
  - Reducing the size of exchanged data
  - Changing the transport protocol
- Results: maximum of 638 Hz

- Model approach
- Nonlinearities in the EndoWrist dynamics
  - Hammerstein Wiener Models

Figure : Hammerstein-Wiener model.

Force estimation model
Linear model

- Linear model
  - Choice of inputs affects model quality
  - Inputs: effort, velocity
  - Outputs: force
- Black-box identification
  - Subspace identification
  - Hankel singular value analysis

Include picture with effort force fit here!!

Force estimation model

Hammerstein Wiener Models

- Input and output nonlinearities
  - Effort
  - Force

Include picture with effort force fit here!!

- Nonlinearities
  - Deadzone nonlinearities
  - Input/Output -saturation

State estimation

- Modeling for additional outputs allows correction of the model using an estimator
- A multiple output model that adequatley captures the dynamics of the system could be used in a Kalman filter to create a state estimate
- The state estimates can be used in a state feedback loop to change system dynamics
- Reference following capabilities can be added to the system, despite the nonlinear characteristics of the dynamics

State estimation

- The hypothesis was tested in simulation
- Simulation results show that full reference following is possible despite the input nonlinearities in the system
- While the transient behaviour of the reference value is replicated, offsets and parasitic gains need to be compensated
- Could be implemented with improved model, doesn't improve estimate of current one.