Linear 2-DOF Haptic Interface

Application Description

A haptic interface is a robot that doesn’t normally move on its own. It is moved by a human. Its purpose is to fool the human into feeling something that isn’t really there. For example, a linear motor could mimic a compression spring or a clicking push-button, just by changing the control algorithm. Although stiffness (force/displacement) profiles are shown here, stiffness, damping and inertia are all possible.

You will design and build a 2-Degree-of-Freedom haptic interface using 2 linear (prismatic) actuators that you will also design and build. The robot can be any serial or parallel design.

Requirements

- 1 Linear Actuator
  - Simulink Model
- 1 2-DOF Mechanism
- Real-Time Controller
- Sensors & Circuits
- Power Electronics

Constraints

- $1000 UBCD
- $400 CAD
- No Bread-boards

Goals

- 2 Linear Actuators
- All CCTs on PCB
- Built-In Technical Evaluation Tools
- Autonomous Motion Algorithm
- Cool & Creative Virtual Environment
  - Visual Interface
  - User does not have to be told what is being simulated - they can tell by feeling it
**Teams**

You will work in TEAMS of 4, subdivided into two GROUPS of 2:

1. Motor Group
2. Control Group

**Motor Group Task**

Design, build and optimize an actuator. Refer to your ELEC 342/343 notes for ideas on how to design the requested style of motor. Make a second copy if time permits.

The motor project consists of 1 or 2 motors each comprising:

1. Rotor (moving part)
2. Stator (stationary part)
3. Position Sensor (for control)

**Control Group**

Implement a controller and the supporting electronics. You may use the 8051 micro-controller from your 2nd year design studio course or any other micro-controller you choose. Refer to your ELEC 341 notes to model and simulate your system and design your controller. You may use commercial motors & sensors for Parts I & II while your Team-mates develop their motor.

The control project consists of 5 parts:

1. System model and simulation
2. Real-Time Controller
3. Digital electronics for position sensors
4. Current amplifier to drive motors
5. Simple temporary mechanism to demonstrate controller

**Team Task**

Integrate the motor and controller into a cohesive unit.

The control project consists of 5 parts:

1. Adapt system model and simulation to match your motor(s)
2. Robot mechanism
3. Adapt Controller to new motor/robot
4. Adapt Digital & Power electronics to new motor/robot
5. Adapt & finalize robot task to new hardware
Evaluation

The Project will be evaluated in three parts. The following is a GUIDELINE of what is expected. In Parts I & II, it is acceptable if certain components are in a reduced state of development while others are in a more advanced state of development.

The 2 most important criteria is that:

- You are on track to delivering a finished product in the FINAL DEMONSTRATION
- You can show the DESIGN WORK that led to what you are demonstrating

1. Part I (Week 5): Proof-of-Concept
   - Informal Demonstration (10%)
     - Progress on control system
       - Functioning micro-controller
       - System model started (some values determined)
       - Digital / Power electronics on breadboard or proto-board
       - Drawings of mechanism (some parts built)
     - Proof-of-Concept motor
       - Initial stator/rotor design (some parts built)
       - Initial sensor design (some parts built)
       - Rotor moves on its own

2. Part II (Week 9): Component
   - Demonstration (15%) + Initial Report (10%)
     - Working control system
       - Simulation model of commercial components
       - Implemented using 1 or 2 commercial motors / sensors
       - All circuits implemented on proto-boards or PCBs (no breadboards but full integration not required)
     - Working motor
       - May require further optimization
       - May require duplication (2nd copy)

3. Part III (Week 13): Integration & Evaluation
   - System Demonstration (50%) + Report (15%)
     - Integrated robot with your motor(s)
     - Complete system model (if possible - one axis is acceptable)
     - Controller controls both axes
     - All circuits implemented on PCBs
     - All mechanical / circuits / wiring neat, clean & reliable
     - Able to justify all design decisions

Self-Evaluation

- All members must agree and sign
- Part I & II
  - 200 points per group
- Part III
  - 400 points per team