The University of British Columbia
Electrical & Computer Engineering

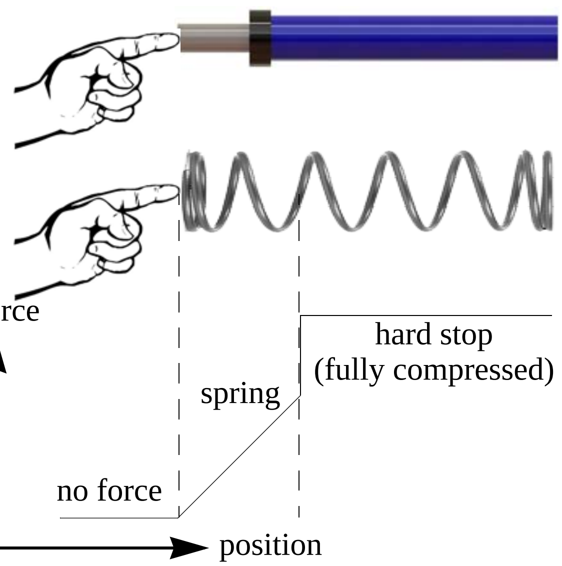
ELEC 391 - Design Project

Linear 2-DOF Haptic Interface

Application Description

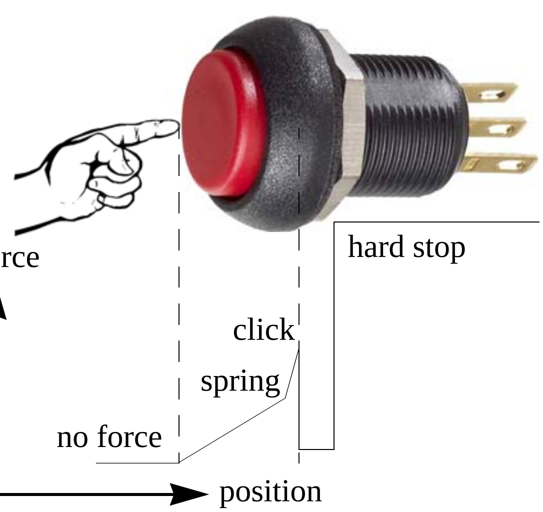
A haptic interface is a robot that doesn't normally move on its own. It is moved by a human. Its purpose is to fool the human into feeling something that isn't really there. For example, a linear motor could mimic a compression spring or a clicking push-button, just by changing the control algorithm. 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