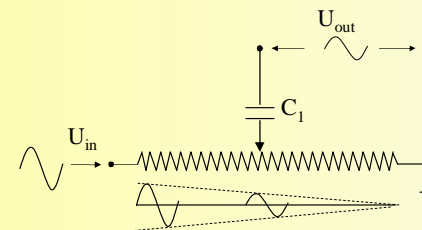
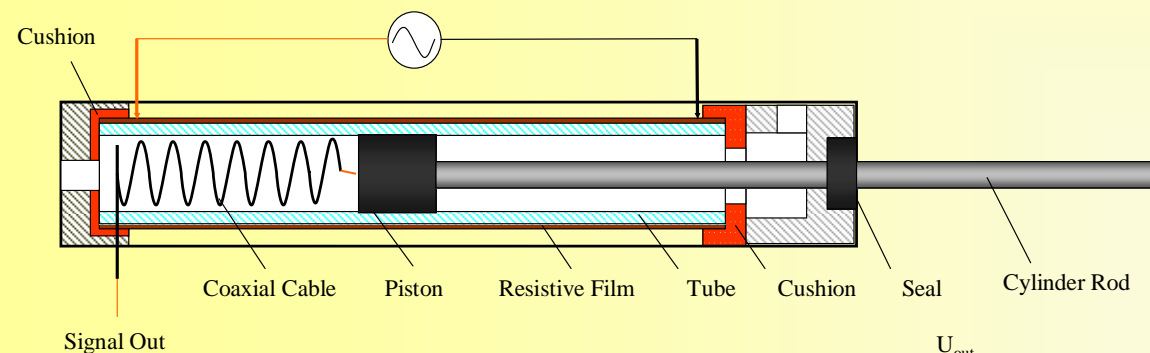




Position Sensing for Every Pneumatic Cylinder

Haihong Zhu, Wayne J. Book
Georgia Institute of Technology

Introduction to Sensor Embedded Actuator



Basic Principle

- Resistance variation corresponding to piston position
- Capacitively coupled AC signal pickup
- Sensing capability inherent to the cylinder

Implementation

- Resistive film applied to exterior of cylinder tube
- Alternating voltage penetrates insulation and reaches piston
- Two alternatives for leading the signal out
- Signal is processed by standard LVDT signal conditioner

Advantages

- Performance similar to LVDTs
- Non-contact sensing
- Reduced cost
- Space savings

Applications

- Industrial manufacturing and control, robotics, Etc.



Pneumatic Actuator Can Replace Hydraulic Actuator

Pneumatic Actuators In Comparison to Hydraulic Actuators

Advantages of Pneumatics

- Faster response
- Compliance (depends on application)
- Clean working media
- Low sensitive to leakage

Disadvantages of Pneumatics

- Poor controllability (speed and displacement control)
- Compliance (depends on application)

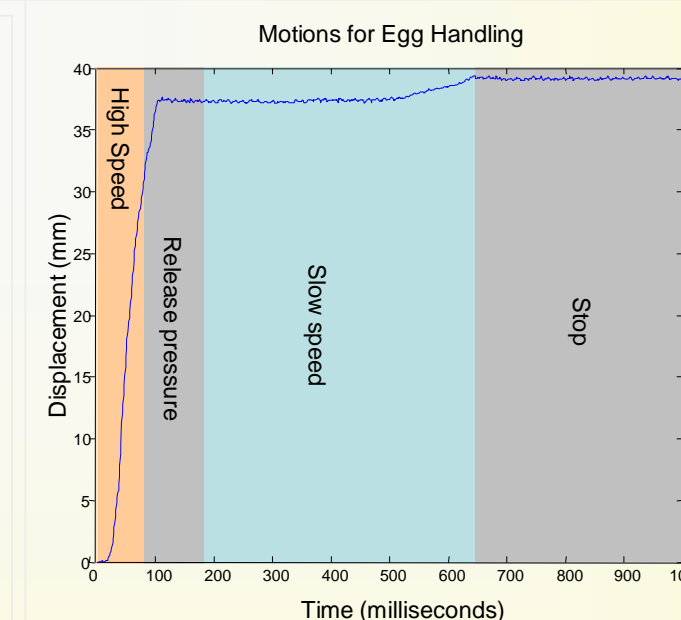
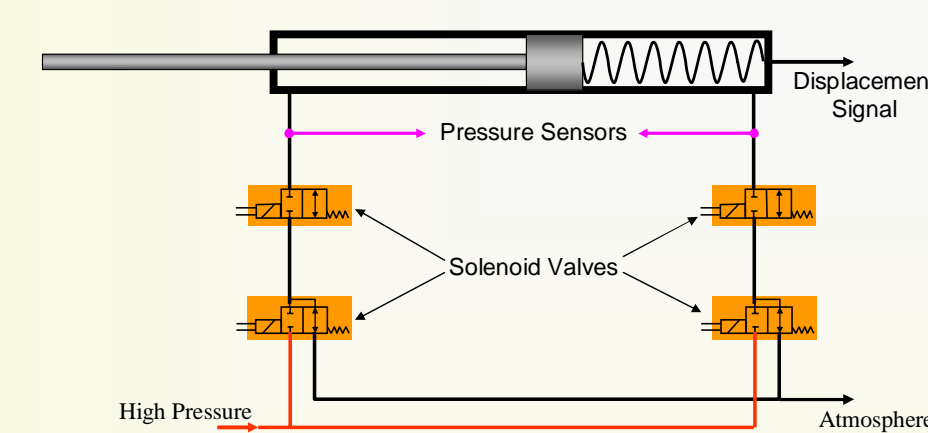
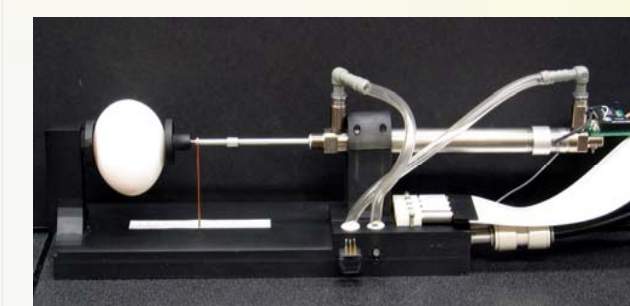
Solutions

Higher Frequency PWM control (>1000Hz) + Displacement Sensor

- Accurate displacement control
- Smooth pressure control
- Wide range of speed control (0.9 ~ 1513 mm/s)
- Only need to use simple on/off valves

Bi-port Pressure Control

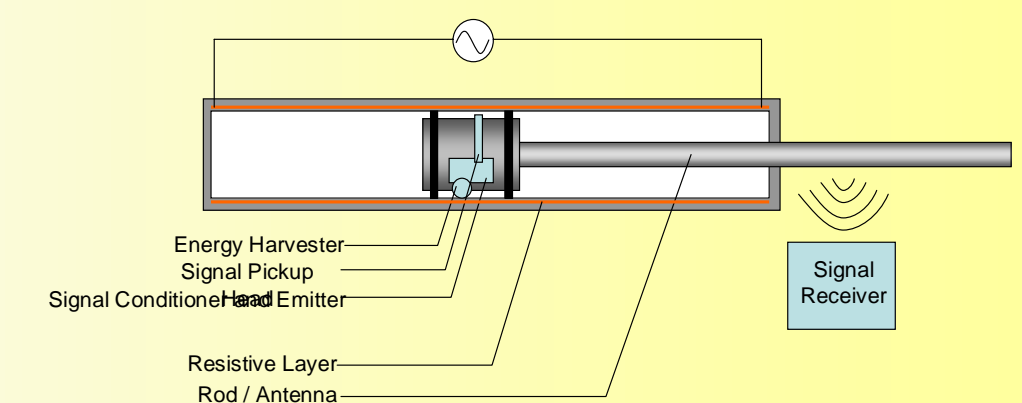
- Compliance is controllable



Future work

Ubiquitous sensor embedded actuator

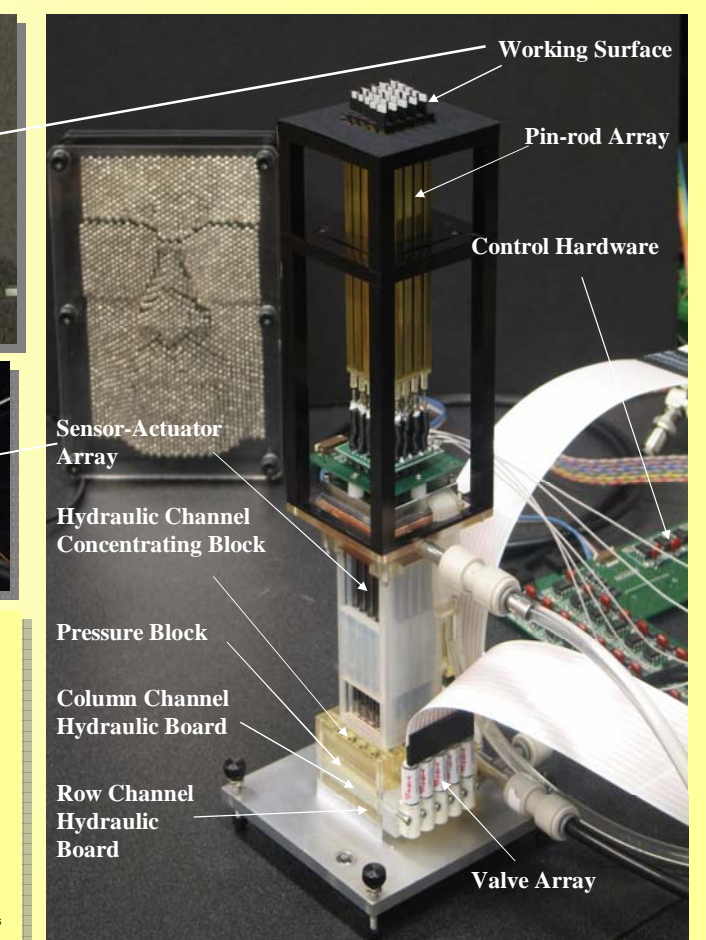
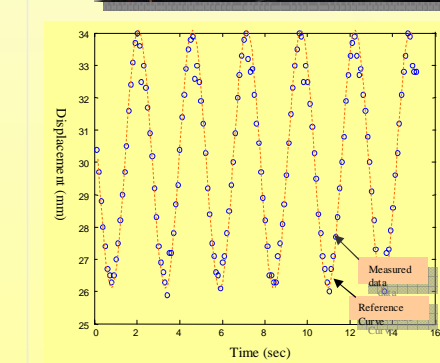
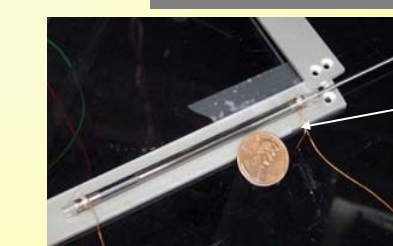
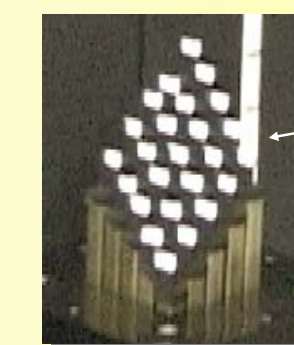
- Sensor in every actuator
- Power via energy harvesting
- Sensing via wireless transmission



Digital Clay

Composition

- Micro miniature actuator-sensor arrays
- Fluid power system
- Control system

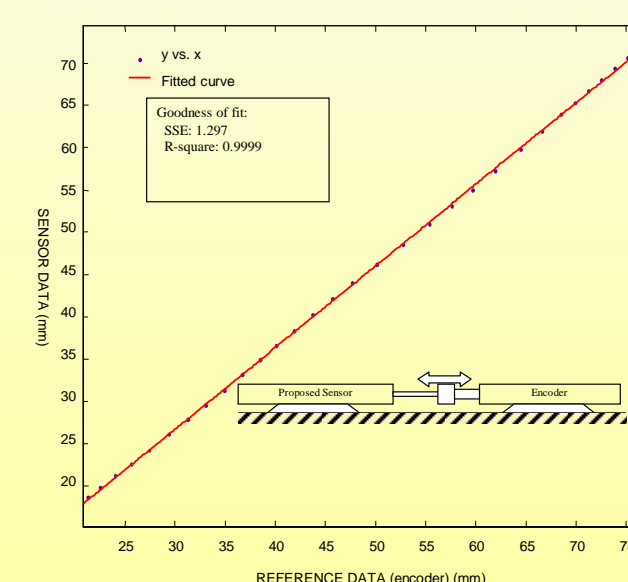
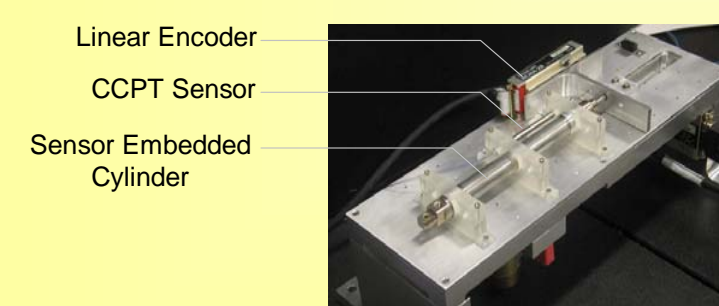


Sensing Performance

Non-Linearity (< 0.5%)

Non-Repeatability (<0.01%)

Longevity (> 2 million cycles)



Application Example

Digital Clay

3D human-machine haptic interface

- Tangible 3D shape/surface
- Computer controlled
- Haptic/semi-haptic style
- Can be digitally edited / transferred

