Module 6: Intelligent Devices based on Smart Materials

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Topics Covered in the Last Lecture

- HBLS Smart Actuators
- Multilayered Piezoelectric Materials
- Design Issues
- Advanced Devices
LECTURE 38
Intelligent Devices (Part 1)
This lecture will cover

- Piezoelectric Inchworm Devices
- Inchworm devices for Actuation
- Sizes and Specifications
Piezoelectric Inchworm Devices

• Such devices are used to develop small-scale walking systems, micromanipulators and patch-clamping.

• In a simple form, it involves three piezo-actuators – (two clamps and one lateral system)

• There are six-steps in the actuation process. Depending on fixity – this may either result in worm-like movement or linear motor action. Brisbane (1964) achieved a speed of about 50mm/second using this actuator.
What is inchworm motion?
Inchworm Motion using Piezo-stack
Inchworm used as Exciter

Material: Titanium Block with Piezo-stack

Frank et al, 1999
Sizes and other Characteristics

- Size – 82 x 57 x 13 mm
- High actuation force about 150 N
- Free deflection up to 20 µm
Further advancement:

• A High Force, High Displacement, High Energy Inchworm is recently developed at Penn-state university (2010).

• This is based on two clamps and one central pusher. The clamps are a combination of spring-mass system and piezo-ceramic stack that works on the pusher.

• The pusher itself is a piezo-ceramic stack which can deflect up to 10µm.
Size and other Characteristics

- Size – 60mm x 40mm x 20mm
- Operating frequency range 0-1000 Hz
- Velocity close to 6 mm/sec
- Static Force close to 200N, Stall > 40N
Special reference for this lecture

- Micro-mechatronics by Uchino & Giniewicz, Marcel, Dekker
- Modelling and Dynamic Simulation of Vibration driven Robots, Becker et al., 2011
- A Piezoelectric driven inchworm locomotion device, Lobonitu et al., 2001