

Hybrid Assistive Knee Braces with Smart Actuators

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Principal Investigator

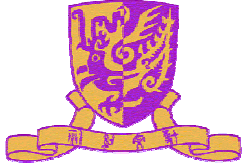
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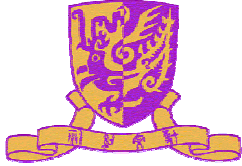
Project Team

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Introduction

- The percentage of aged persons in society is increasing, and their physical deterioration has become a socioeconomic problem
- Elderly people with weak muscle strength may not be able to walk frequently as before. In turn, their muscles would be further deteriorated
- The most effective means to avoid people from becoming bedridden is to provide a way for them to maintain their physical activities
- Osteoarthritis (OA) is very prevalent in old people
- Studies showed that adequate exercises would generate positive effects to OA patients. Some devices were developed to provide exercises; however, these devices are usually for hospital or home use and can't automatically provide assistance for people with mobility problems
- Considering the large population base and the high percentage of elderly people, devices that can help people with weak muscle strength or OA will be in great need



Exoskeleton



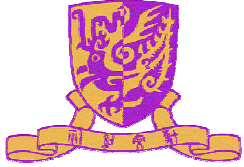
RoboKnee, <http://www.yobotics.com>



HAL, <http://sanlab.kz.tsukuba.ac.jp>



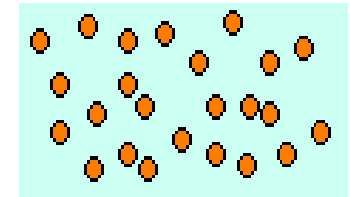
- Exoskeleton can enhance people's strength and endurance
- RoboKnee – one degree of freedom exoskeleton, powered by DC motor and batteries, can only work 30 – 60 minutes under heavy use
- HAL (Hybrid Assistive Limb) – a full body suit, also powered by DC motor and batteries, can work 2 hours and 40 minutes when fully charged



Magneto-Rheological (MR) Fluids

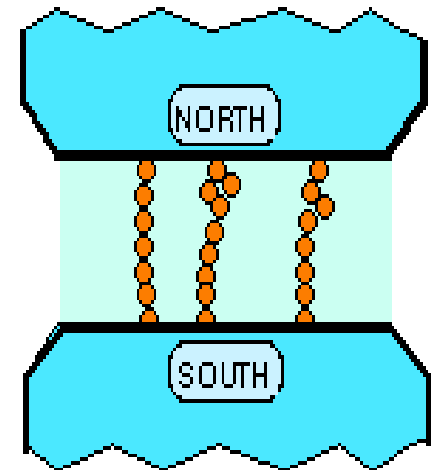
What are they ?

- Micron sized, polarizable particles in oil



What do they do ?

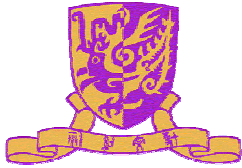
- Newtonian in absence of applied field
- Develop high yield strength when magnetic field applied
- Provide means for a quiet, fast response interface between electronic control and mechanical devices





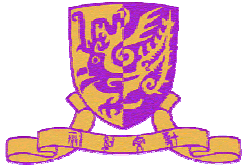
Magneto-Rheological (MR) Fluids

- High yield stress (50 kPa to 100 kPa)
- Good stability
- Fast response time (within milliseconds), can be used for high frequency applications
- Broad operating temperature range (less than 10 % variation in force output over a temperature range of - 40 to +150 °C)



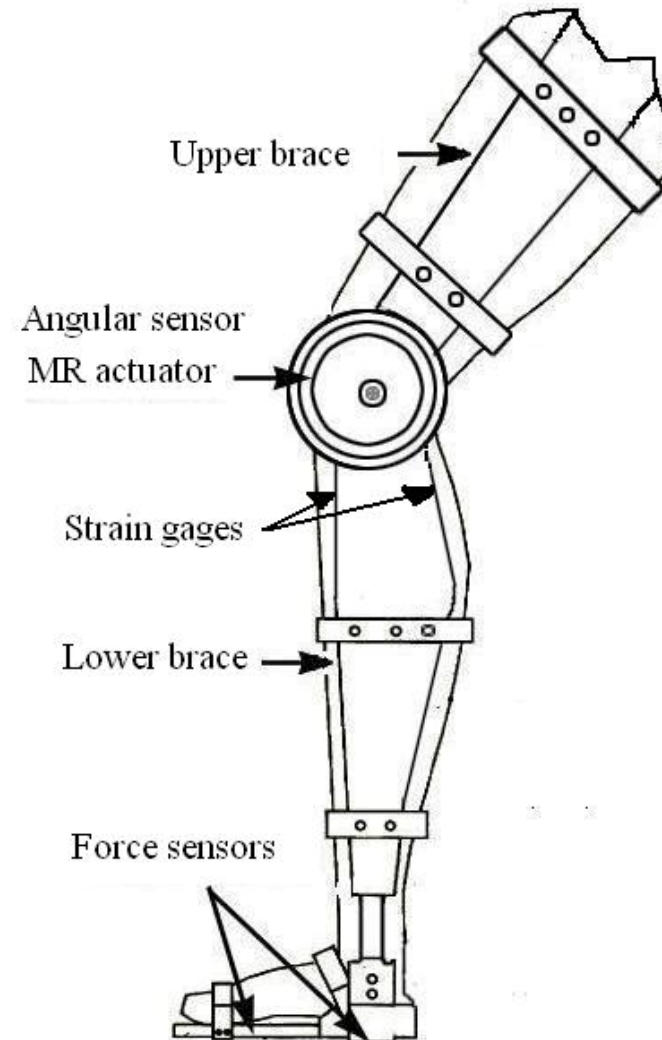
Objectives

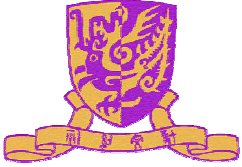
- Develop a new MR actuator that combines the advantages of MR brake (to produce controllable assistive torque while requiring little power) and MR clutch (to transfer torque from motor to knee with better safety)
- Apply the new MR actuator into a leg exoskeleton to assist disabled people



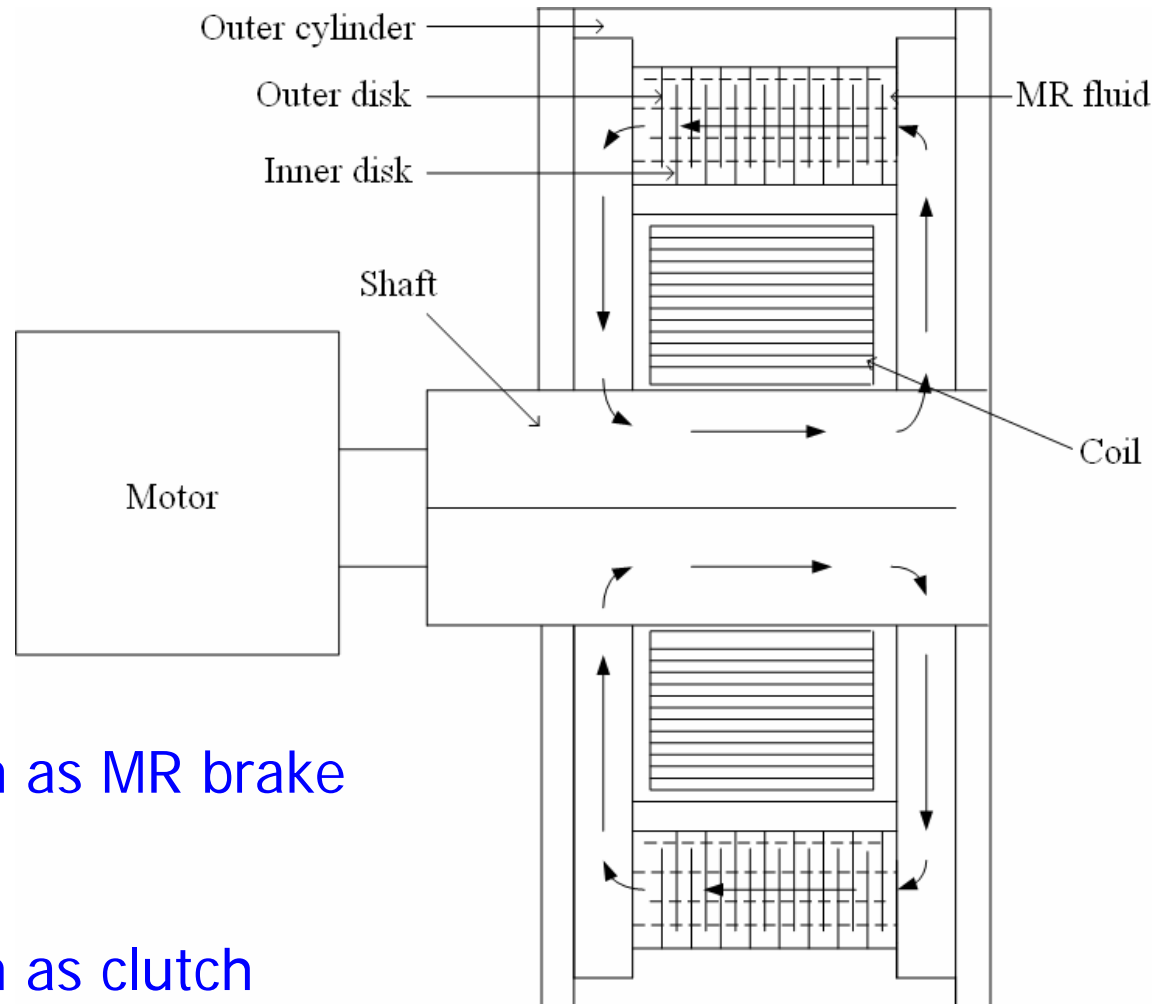
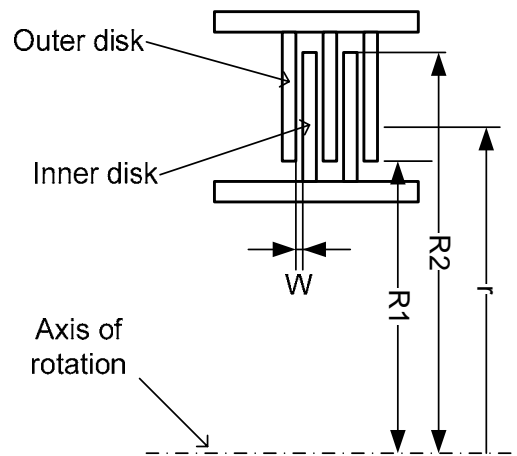
System Configuration

- Braces
 - Upper brace
 - Lower brace
- New MR actuator
- Sensors
 - Angular sensor
 - Strain gages
 - Force sensors
- Power sources
 - Energy harvested from shoes while walking
 - Battery





MR Actuator



Work conditions:

- MR actuator function as MR brake
- MR actuator is off
- MR actuator function as clutch