Ranjan Mukherjee

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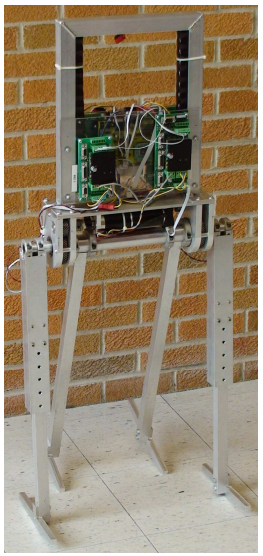
Research Interests

- Mechatronics with emphasis in robotics
- Biped locomotion
- Telerobotics and haptics
- Robotics for long-term-care facilities
- Control of under-actuated systems
- Control of flexible space structures
- Underwater locomotion

Research Highlights



Prismatic-Joint Synthetic Wheel Biped with Torso:

Small & large disturbance balancing problems

Trajectory tracking problem

Tension-aligned large aperture sensorcraft:

Vibration suppression through sequential application and removal of constraints

Honors

- Fulbright Scholarship for Research in Japan, 2008
- MSU Withrow Teaching Excellence award, 2007
- Faculty-Staff Community Service-Learning Award, Michigan Campus Compact, 2006

Professional Activities

- Assoc. Editor, ASME JDSMC, 2001-2007
- ASME DSCD Strategic Planning Committee
- IEEE Control Systems Society CEB, 2000-2007

Bipeds - How to achieve robust locomotion?

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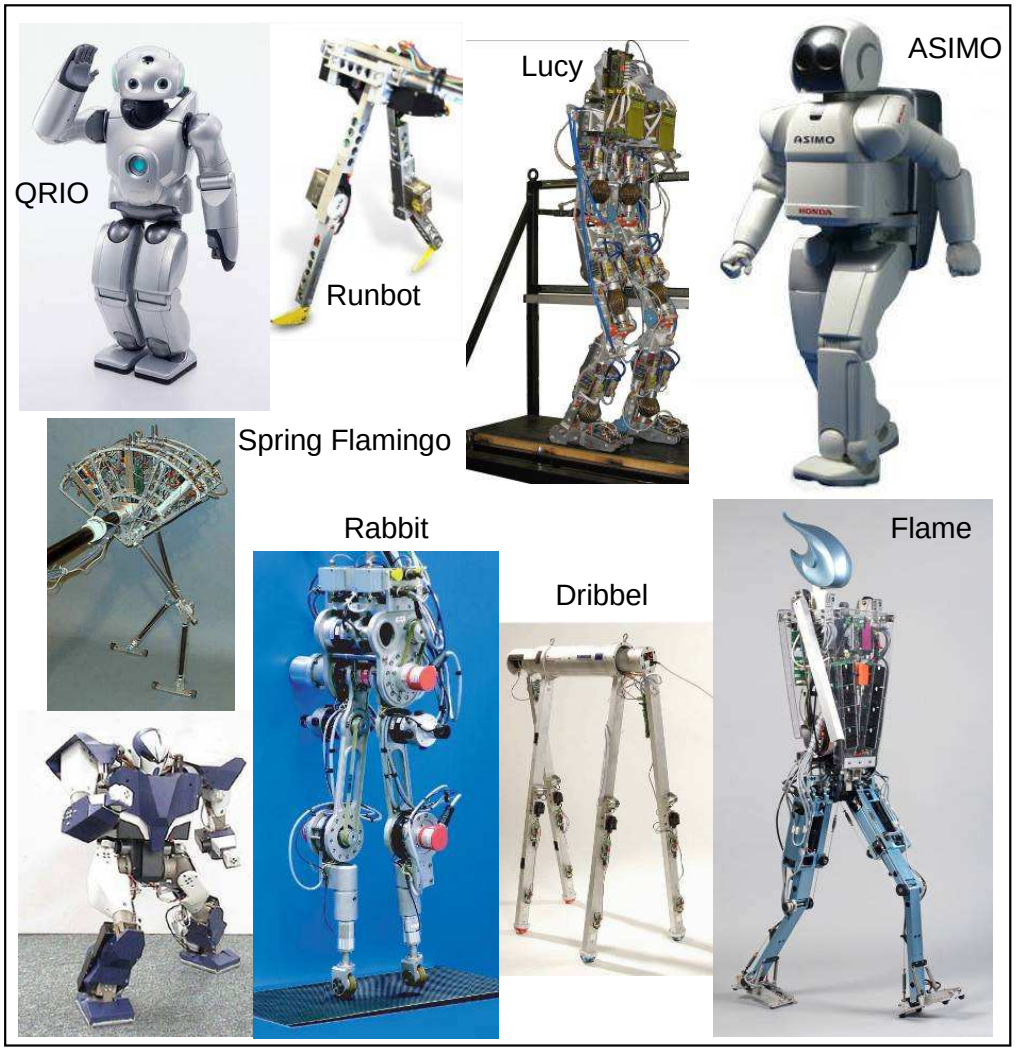
- Hundreds of bipeds have been built but none have the ability to walk over uneven terrain, run, or balance like a human
- State-of-the-art in bipeds like the Honda Asimo rely on the ZMP principle, which is conservative
- Challenges to robust locomotion stems from underactuation, hybrid dynamics due to intermittent contact, and several degrees of freedom
- Need better understanding of the mechanisms in human locomotion, remove conservatism in “design”



A small sample of the large number of bipeds that have been developed by researchers over the years

Societal Implications

- Bipedal robots are ideally suited to sharing the workspace with humans - to result in many service applications
- Will result in development of improved exoskeletons and prosthetic devices
- Will ultimately lead to a better understanding of human locomotion mechanisms

Accomplishments to Date

- Quasi-static gaits: WL-10R
  Takanishi, et al. 1980
- Dynamically balanced - ZMP
  Honda Asimo
- Passive Dynamic Walkers
  McGeer, Ruina, Kuo
- Active Dynamic Walkers - limit cycles, zero dynamics, virtual model control

Challenges

- How to deal with underactuation?
- How to deal with impacts from intermittent contacts
- How to deal with instability?
- How to achieve efficiency and robustness?
- How to achieve a minimalistic design that can provide the desired level of performance?

5/10/20 Year Vision

- 5 yrs: develop the means to enable bipeds deal with impact
- 10 yrs: concerted effort to develop bipedal systems with human-like robustness in balancing and walking
- 20 yrs: concerted effort to develop bipedal systems with human-like robustness in running. Many service applications expected by this time.