COS 495 - Lecture 4
Autonomous Robot Navigation

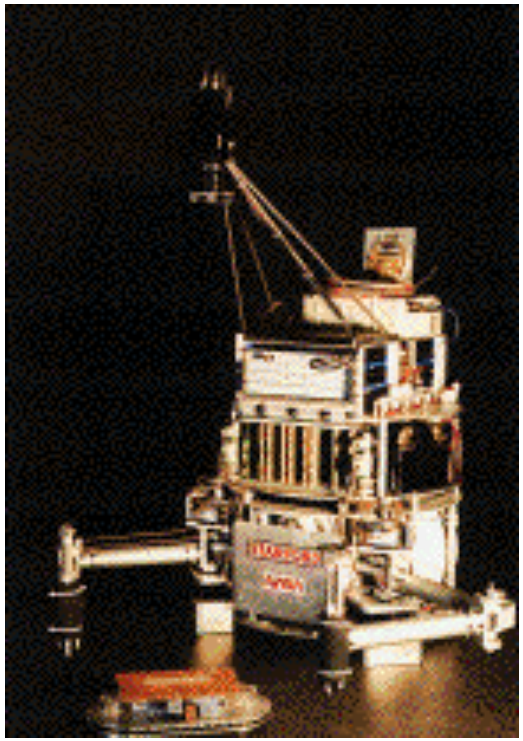
Instructor: Chris Clark

Semester: Fall 2011

Figures courtesy of Siegwart & Nourbakhsh

A Free Floating Robot

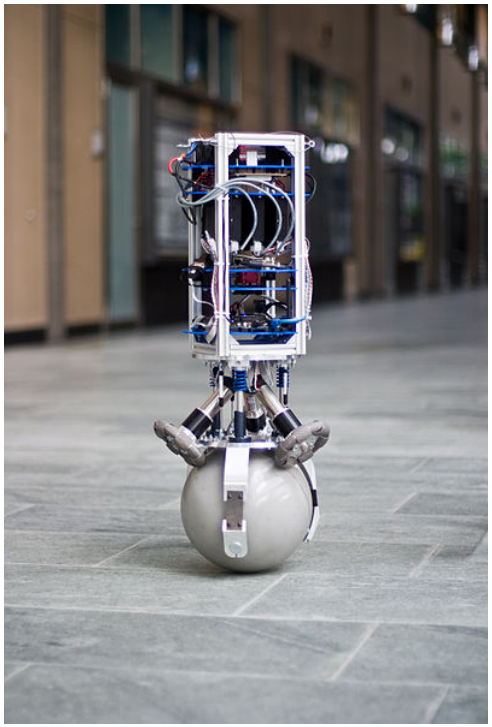
- Actuators
  - Compressed Air Thrusters
  - Momentum Wheel
  - Arm Joint motors
- Sensors
  - Overhead Vision System
  - Motor Encoders
  - Indoor GPS Pseudolites
  - Arm actuator Encoders



Courtesy of ARL, Stanford

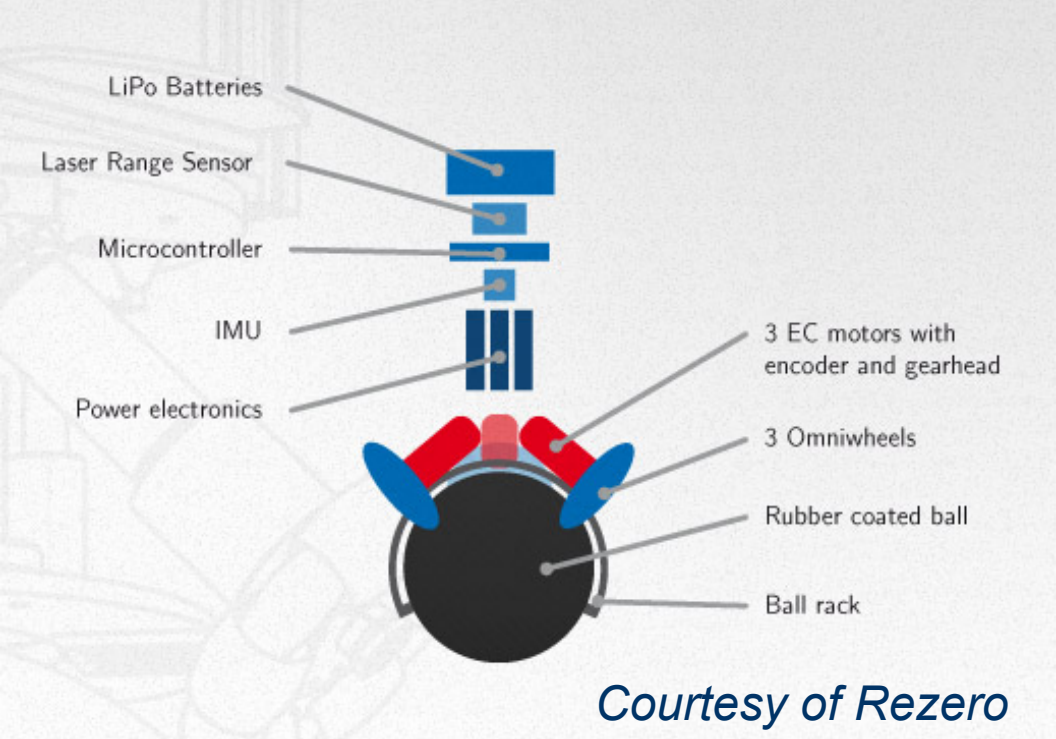
A Ball Balancing (Rolling) Robot

- Actuators
  - Three Electrical Motors
  - Three Omniwheels
- Sensors
  - Laser Range Sensor
  - Sonic Sensor
  - Rotary Encoder
  - Inertial Measurement Unit



Courtesy of Wikipedia

A Ball Balancing (Rolling) Robot



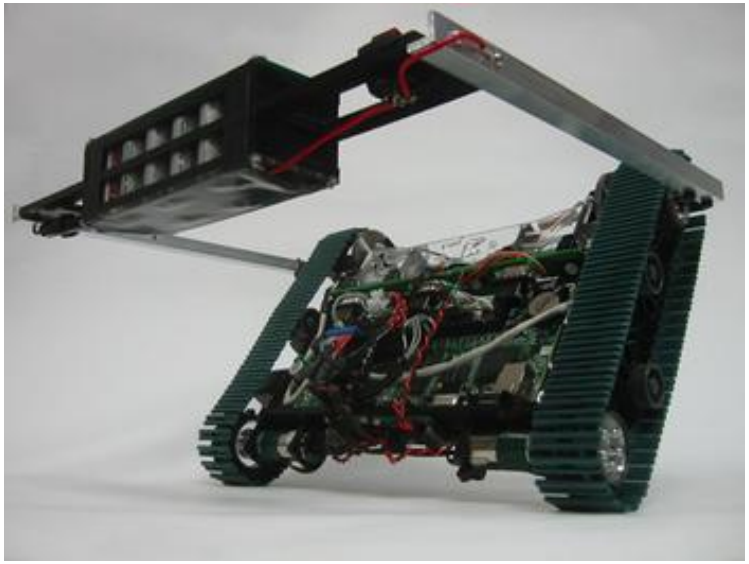
Video Link: http://www.youtube.com/watch?v=08EslPPX6f4

Balancing Robot: UCSD's Switchblade

http://www.youtube.com/watch?v=2LUpN9PZ84g

Balancing Robot: UCSD's Switchblade

- Feedback control system
- Actuators
  - Booms and tracks
- Sensors
  - Vision (video)
  - Accelerometers



Courtesy of Jacobs School, UCSD

Corkscrew Robot

- Features
  - 3 Stainless Steel Helical Coils
  - Motors to Turn Coils
    - Movement in Direction of Coil's Axis
  - Omnidirectional
  - Not yet autonomously controllable
- Advantage
  - Handle Diverse Terrain
  - Maneuverability

Corkscrew Robot

http://www.youtube.com/watch?v=RBK4Y-EOlqA
http://www.newscientist.com/article/mg21028106.300

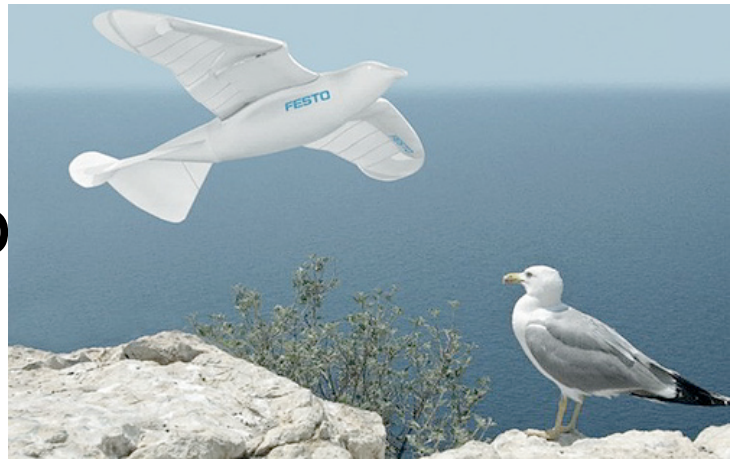
SmartBird

- Actuators
  - primary motor flaps wings and servo-motors twist them
    - The inner part of the wing generates lift, while the tips generate thrust
  - Servo-motor bends head for stability
  - Servo-motor twists tail for steering
- Sensors
  - 3 Hall-effect sensors to measure wing position
- Lightweight, energy efficient and flown by remote control

Photo: www.festo.com

SmartBird

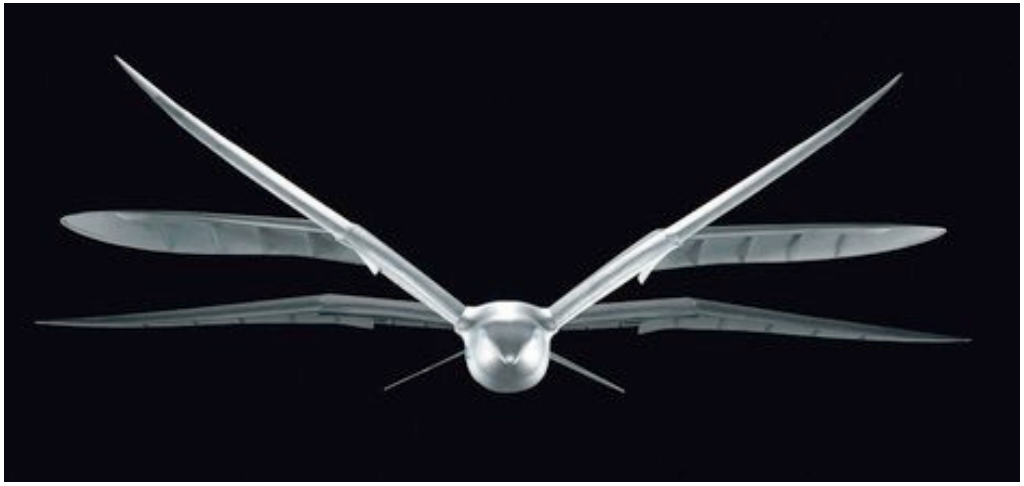
- Wingspan: 2 Meters
- Weight: 450 grams
- The exterior of the robo is made entirely out of carbon fiber



http://www.ted.com/talks/lang/eng/a_robot_that_flies_like_a_bird.html

SmartBird

- Motor in the main body of the bird
- Three hull sensors inside the motor to control exactly where the wing is at all times
- Upper wing provides most of the lift while the lower wing provides most of the propulsion



Wind Powered “Kinetic Sculpture”

- http://www.youtube.com/watch?v=WcR7U2tuNoY

Wind Powered “Kinetic Sculpture”

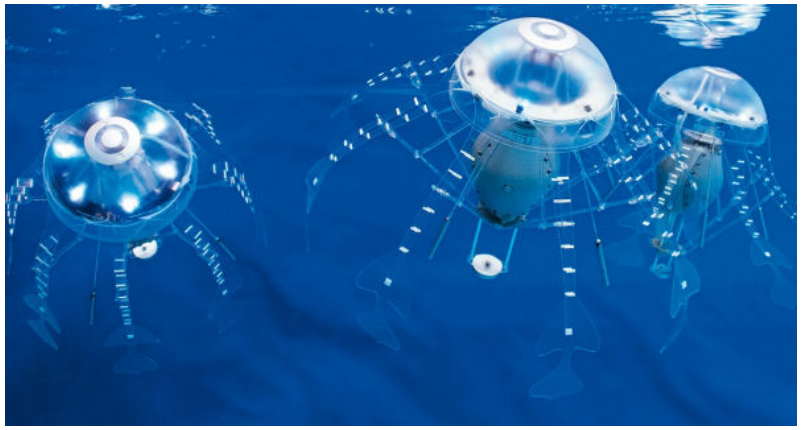
- Actuators
  - Rotary
  - Compressed Air
- Sensors
  - Mechanical sensor

Festo AirJelly

- Helium filled balloon
- Bevel gear moves eight paddled arms
- Motion based on peristaltic motion of a jellyfish
- Controlled by remote operator

Festo AirJelly

- Possible uses:
  - Military surveillance
  - Aerial photography
  - Maneuverable weather balloons
- Festo AquaJelly
  - Aquatic counterpart of AirJelly
  - Useful for noninvasive aquatic observations



AirJelly and AquaJelly

- Actuators
  - Battery powers piston which moves arm joints
  - Limbs naturally bend into an efficient waveform which pushes water downwards Arm: called Peristaltic Motion (similar to throat muscles
  - AirJelly floats with Helium. AquaJelly relies on buoyancy.
- Uses swash plate to adjust direction
  - Swash plate attached to a pendulum. Adjusting the location of the pendulum adjusts the center of gravity, tilting the jellyfish. Then, peristaltic motion pushes it in

AirJelly and AquaJelly

- Sensors
  - Pressure, light, radio sensors
  - Infrared sensors used to see obstacles surrounding it
  - Radio used to find charging station
  - Follows simple swarm mechanics

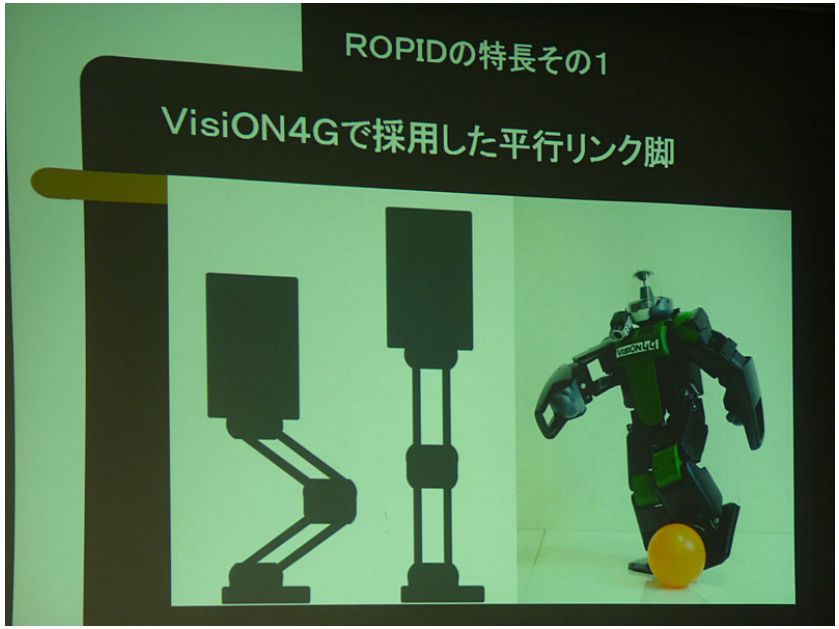
BigDog

- Actuators
  - 4 actuators per leg – 2 x hip, knee, ankle
  - Hydraulic cylinder
- Sensors
  - Gyroscope
  - Joint position
  - Joint force
  - Stereo vision♪

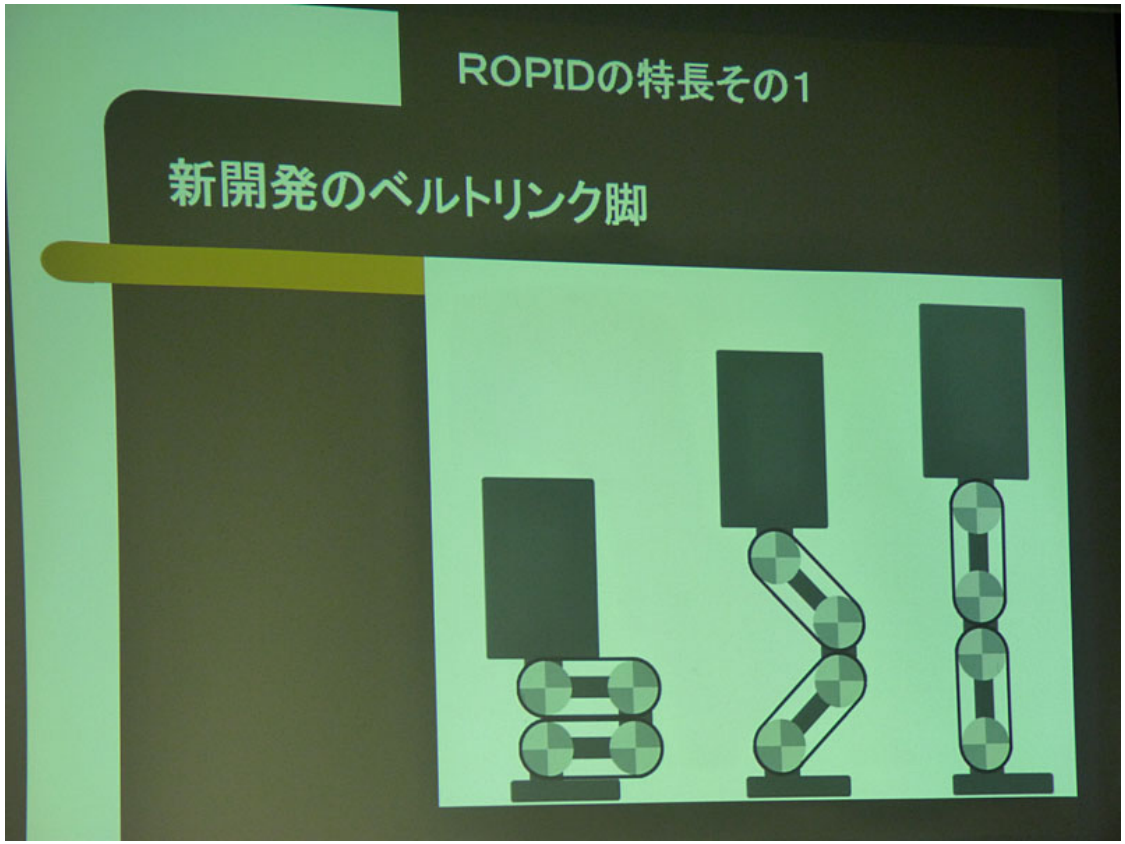
ROPID Locomotion

http://www.youtube.com/watch?v=OG7w3ALzcy

ROPID Locomotion - Legs



ROPID Locomotion - Linking Belts



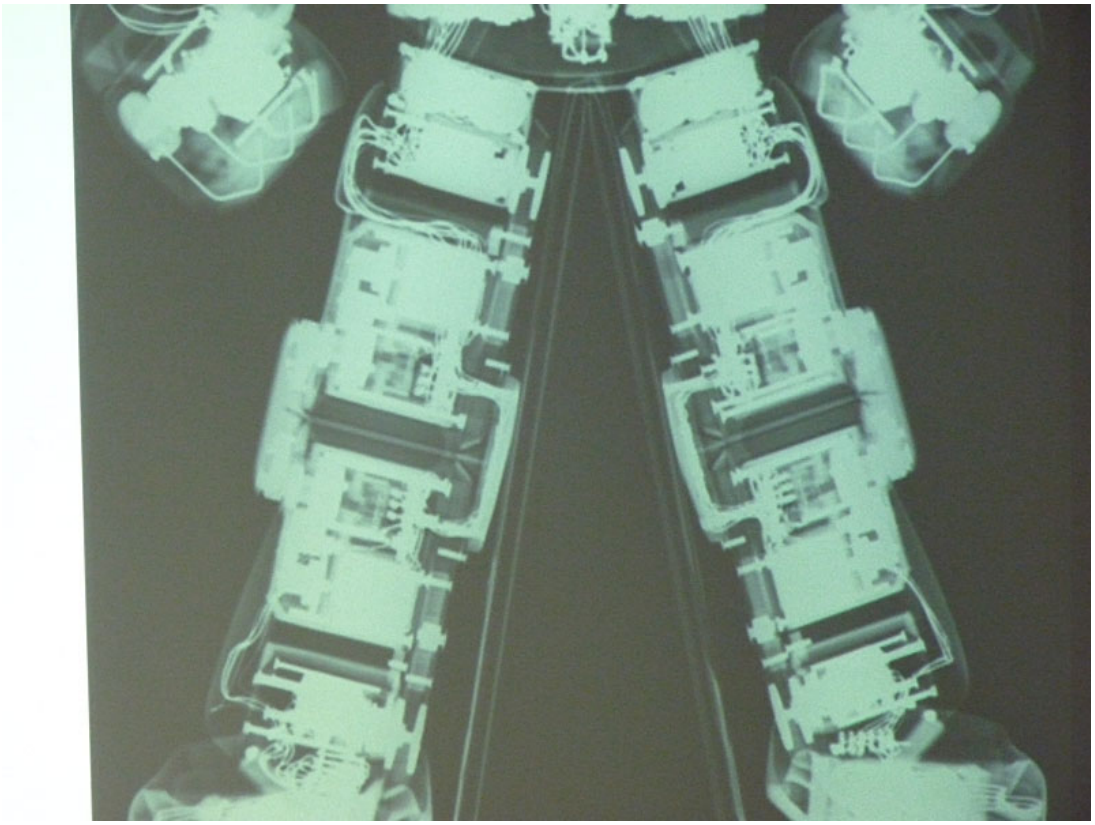
ROPID Locomotion

Lower belt

ROPID Locomotion

Upper Belt

ROPID Locomotion



ROPID Locomotion - Stability