Effectors and Movement

Admin and Reading

- Quizzes:
  - Quizzes begin Wednesday
- Reading for this slideset
  - Read chapter 6 in the book
  - Then read chapter 2
  - I'll cover them in that order.

Putting the mobile in mobile robotics

- What kinds of effectors might we use to move a robot?
  - And what kind of movement?

Putting the mobile in mobile robotics

- What kinds of effectors might we use to move a robot?
  - Legs (walk,crawl, hop, etc)
  - Wheels (roll)
  - Arms (swinging, crawl, climb)
  - Wings (Fly)
  - Flippers
  - more?

Actuators

- As book says, most common actuator is motor
  - To turn wheels
  - Chapter 6 covers various types of motors, AC, DC, Stepper, Servo
  - We have servo motors attached to our robots.
    - Motor controllers needed
      - Electric spikes
  - Beware of hitting an obstacle and drawing 'stall current'

Other Actuators

- Hydraulic and Pneumatics:
  - Pressurized Fluid or gas to move the robot effectors
    - Pneumatics for soft robots.
    - Often hydraulics are for larger robots and heavier lifting
- Safety redux:
  - Need to be very careful with actuators able to lift heavier loads.

Robotics and biological inspirations

- Lots of biological inspirations for more recent (last 20 years) robotics work.
  - How do simple animals do it?
  - Maybe we can imitate them since they don't need much computing?
  - So how do most animals move?

Robotics and biological inspirations

- Lots of biological inspirations for more recent (last 20 years) robotics work.
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  - So how do most animals move?
    - Legged locomotion
    - Turns out to be much harder than wheels/tracks.
      - But processing is good enough to do more and more of it.

Gait

- A robot's gait is the way the robot moves, the order of lifting and lowing legs etc.
- Want gait to have
  - Stability
  - Speed
  - Efficiency
  - Robustness (can recover from some failures)
  - Simplicity
    - Not burning too much processing power on this

Stability

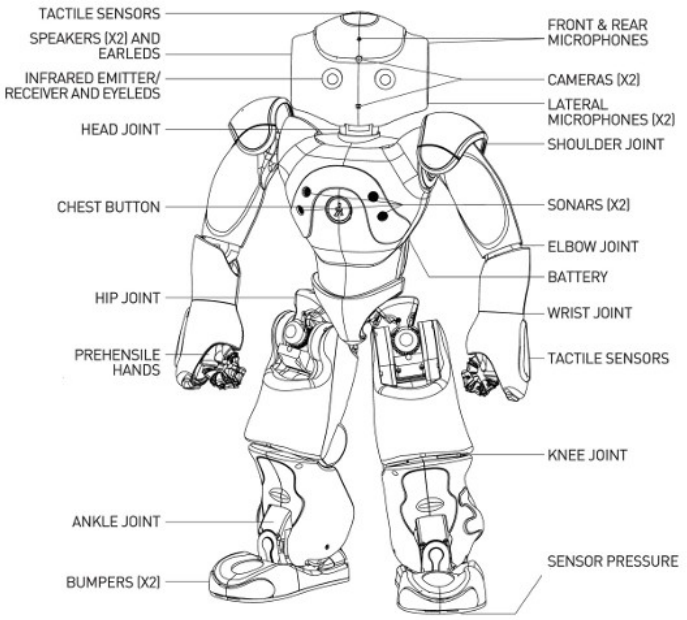
- Robot needs to be stable
- Stable: property of not wobbling, leaning or falling over while doing job
  - Particularly at rest (not moving)
  - But also while moving.
- For stability
  - Center of gravity needs to be over parts of robot holding it up (legs etc) called ground points
  - Area covered by ground points is polygon of support.

Ground points and stability

- What sort of legged gaits provide good stability?

Ground points and stability

- What sort of legged gaits provide good stability?
  - Two legs? Not so much
    - One reason Honda's robot was so impressive.
    - Notice the Nao’s big feet? That is their cheat.
  - Four legs?
    - Stable but.. we'll talk about that
  - More legs?
    - More stable usually.



Statically stable

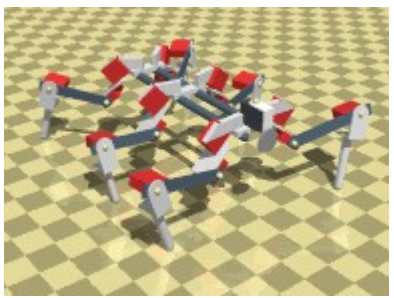
- If a robot is stable at all times while walking
  - Called Statically stable.
  - Baby crawling
    - Statically stable
  - Horse galloping
    - Not
  - Human walking?

Dynamically stable

- Body must actively move to stay stable
  - Dynamically stable
  - That human walking upright, horse galloping etc.

Tripod gait

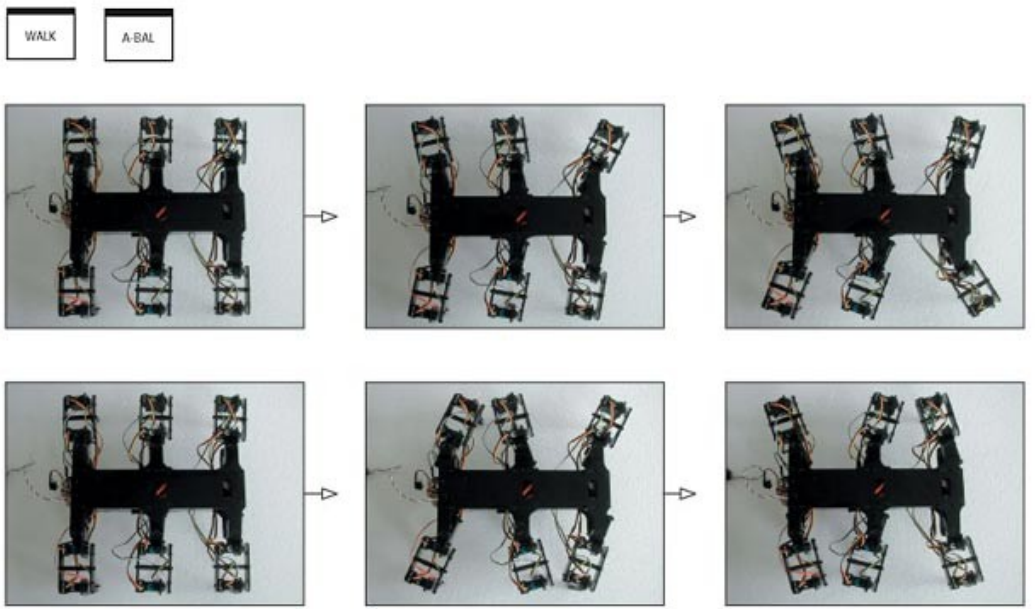
- Tripod gait is popular one for six legged robots
- Stable, efficient etc.
- In tripod gait
  - Two legs down on one side, one on the other
    - Other three legs up.
    -



- While big dog and friends get a lot of press, the roach/lizard robots actually get a lot of uses too
- https://techxplore.com/news/2023-02-lizard-inspired-robot-explore-surface-mars.html
- When sending robots to mars, what sorts of considerations do we want?

Ripple gait

- For 6+ legs ripple gait popular
- Most legs on ground
  - One from each side off ground at once
  - Statically stable
  -

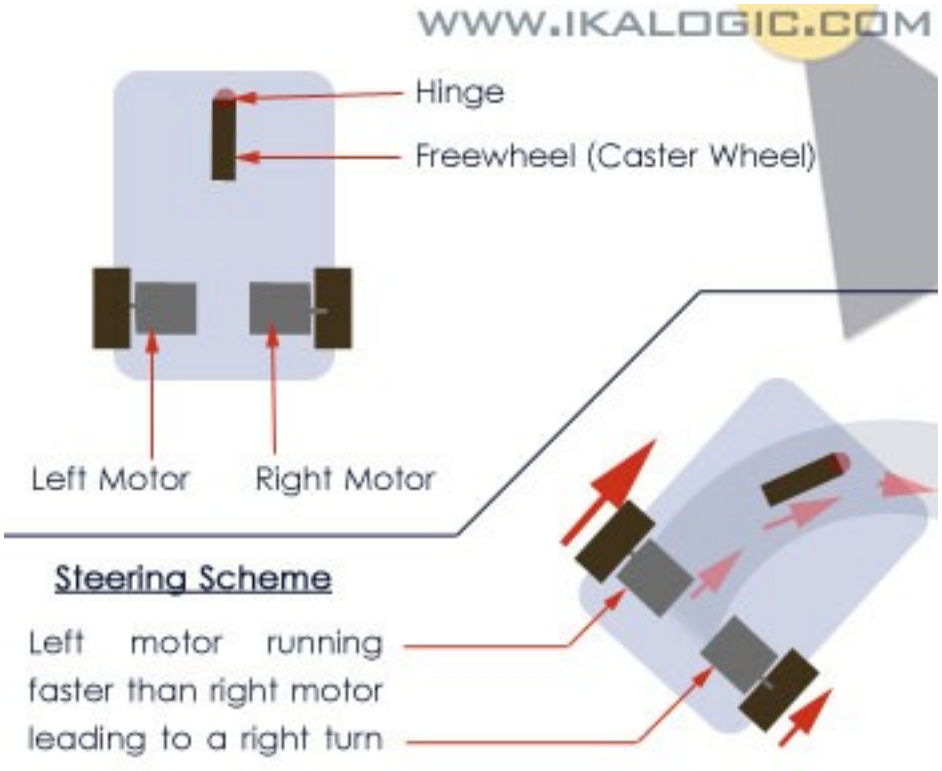


Wheels

- Legs are fairly popular in robotics today
  - But wheels are still king
  - Up till now, mars rovers went with wheels
  - Cheap
  - Effective
  - Stable (statically and dynamically with at least three wheels)
  - simple

Differential drive

- Most common budget robot locomotion
  - Two motors, one on each side of robot
    - Each turns one powered wheel
  - Other non powered wheels possible.
  - This is what we have in the GoPiGo robots
  -

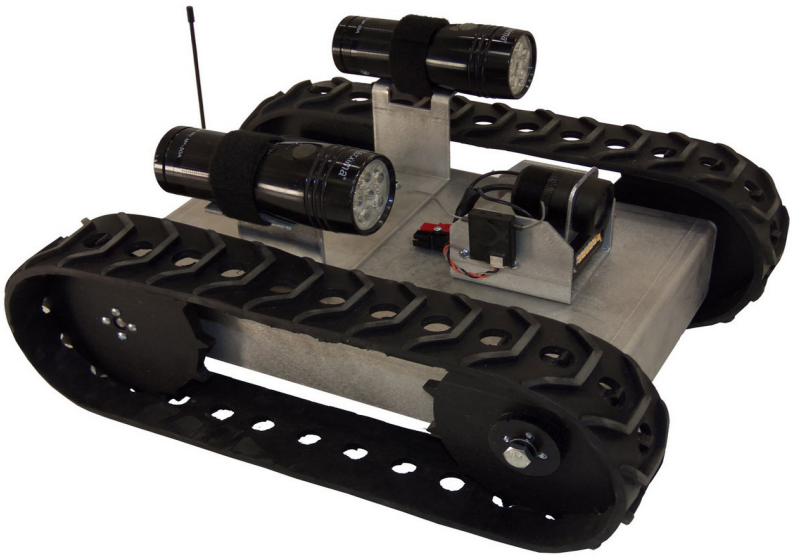


Trajectory following and destinations

- It is often easier to get to a destination than to follow an arbitrary trajectory to the destination.
  - Example?
  - Why would we care?
    - Brain surgery example
    - Or even ====>
      (not the best way to get into the garage)

Tracks

- Tracked robots:
  - Also popular these days
    - Not as much as 10 years ago though
  - Advantages
    - Little slippage when beginning forward/backward move
    - Often can handle heavier payloads
  - Disadvantages
    - Turning through slippage
    - Not so many track options as wheels



Driving the turtlebots

- Go forward from the command line
  - ros2 action send_goal <robotName>/drive_distance irobot_create_msgs/action/DriveDistance "{distance: 1}"
- Turn command from linux command line
  - ros2 action send_goal <robotName>/drive_distance irobot_create_msgs/action/RotateAngle "{angle: 1}"
    - angle is number of radians from current position

Driving the turtlebots

- Or create a publisher with a twist message
  - More on that soon