DD2410

Lecture slides
Locomotion

Many means of locomotion

- Wheels
- Tracks
- Legs
- Flying
- Swimming
- Crawling
- ….

Some key issues for locomotion

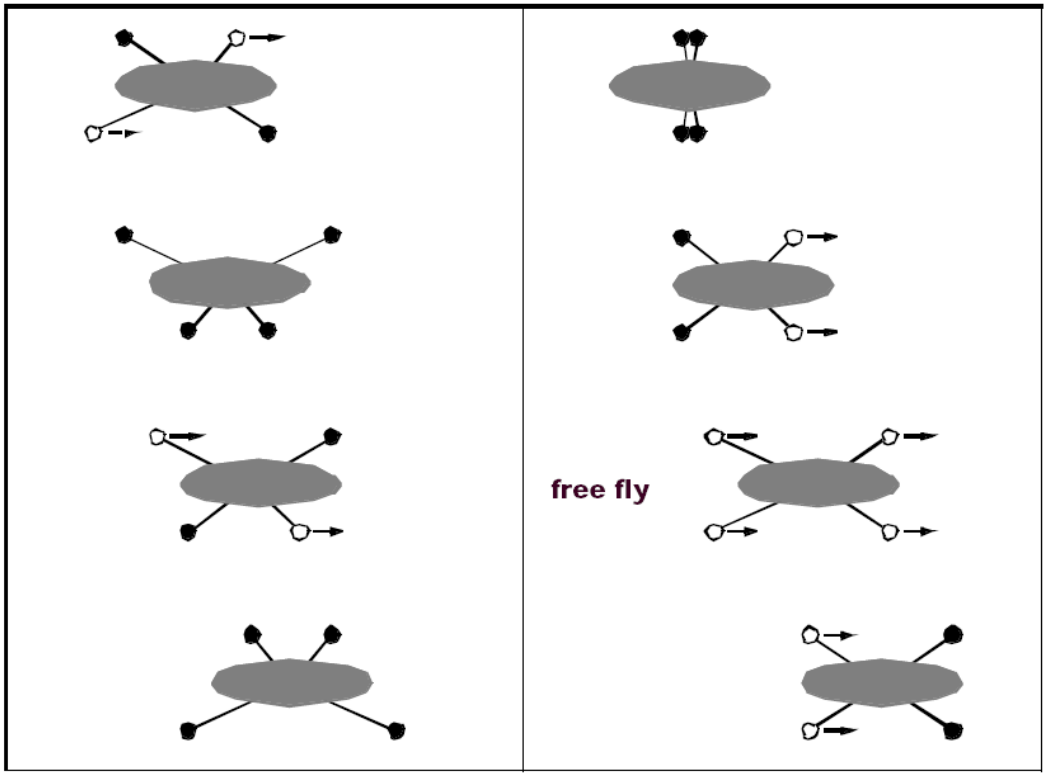
- Stability
  - Number/geometry of contact points
  - Center of gravity
  - Static/dynamic stability
  - Type of terrain
- Contact characteristics
  - Contact point/path size and shape
  - Angle of contact
  - Friction

Legged locomotion

- Point contacts between robot and ground
- Pros
  - Potential for handling rough terrain well
  - Only contact points need to be OK, ground in between does not matter
- Cons
  - Mechanically complex
  - Power hungry

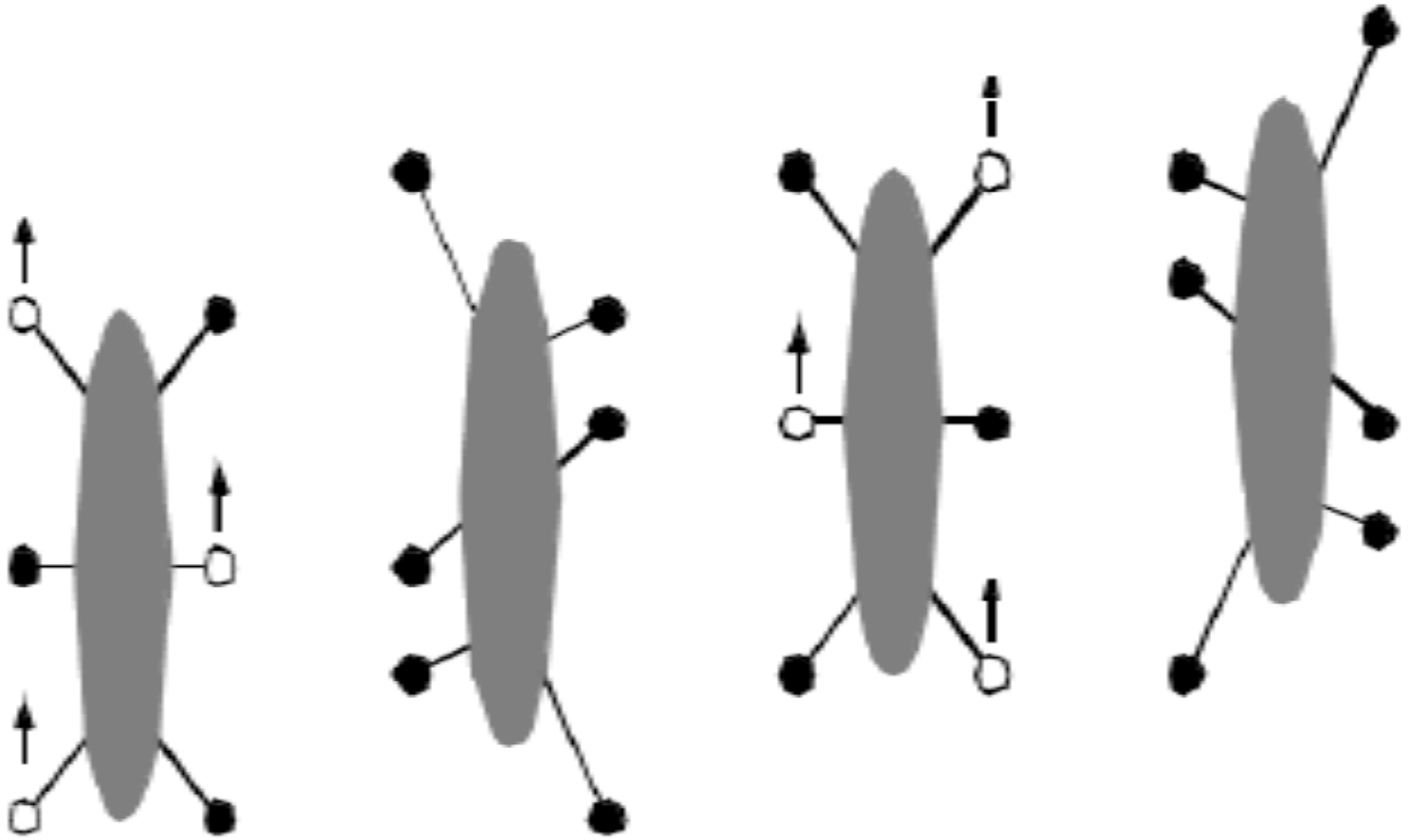
Gait

- Gait = sequence of lift and release events for the individual legs
- More legs gives more possible gaits



Statically stable walking

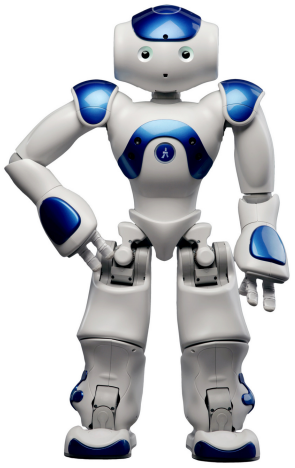
- Move the legs in groups of 3 legs



Two legged robots (Bipeds)

- Japan/Korea almost alone on the market before

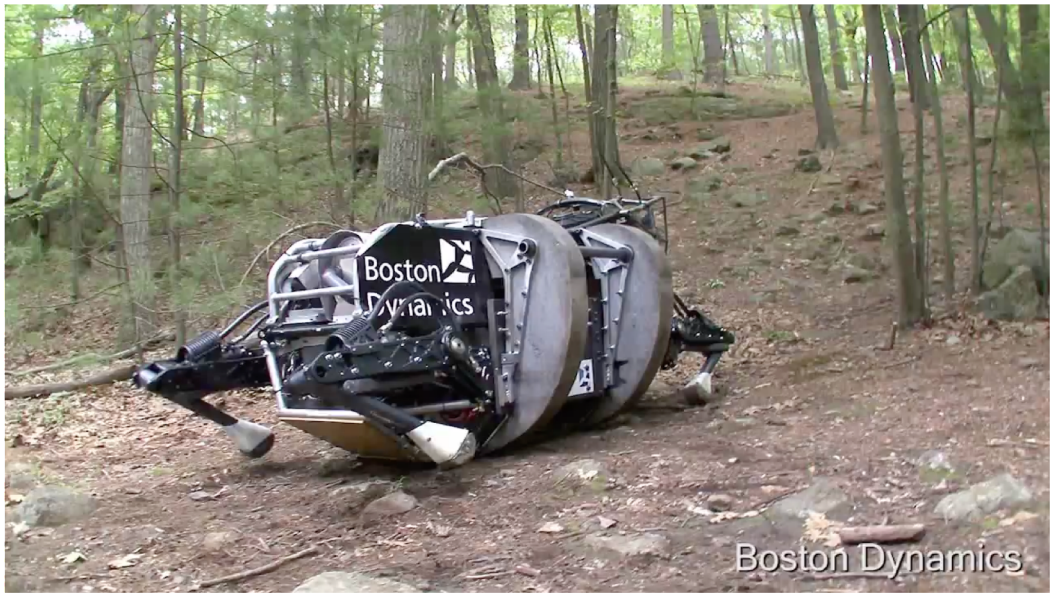
Two legged robots (Bipeds)



- Now also in Europe and USA

Quadrupeds

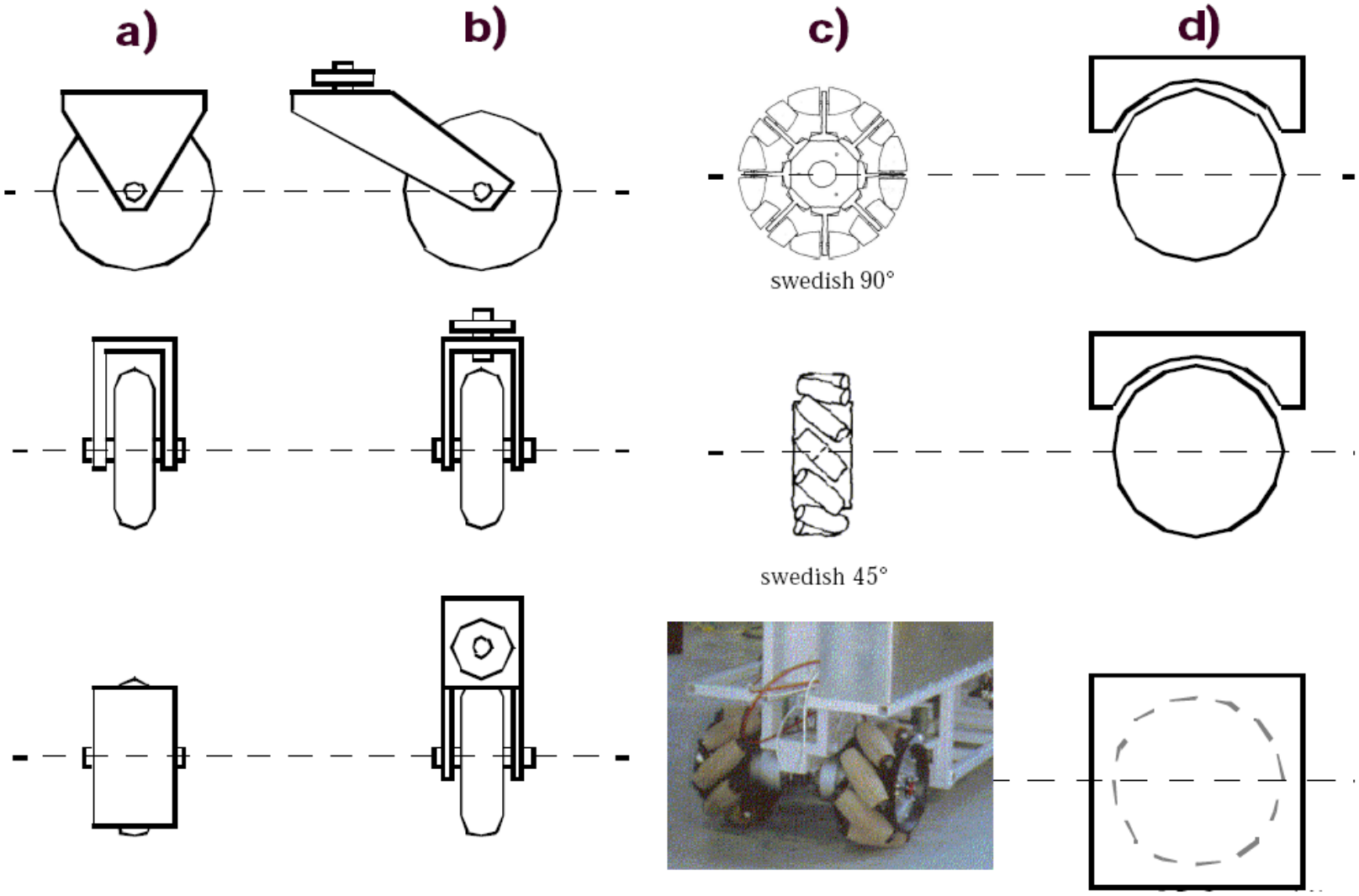
- Statically stable when still and for some gaits



Wheeled locomotion

- Most popular means of locomotion in robotics (and other vehicles)
- Simple to implement and highly efficient
- Bigger wheels gives better handling of rough terrain
- Wheeled robots typically designed so that balance is not an issue

Wheel design



Suspension

- With more than 3 wheels you typically need suspension
- Will lose contact with ground unless perfectly flat otherwise
- Primitive solution: let the wheel itself act as suspension

Wheel configuration

- Cars have highly standardized wheel configuration
  - they all drive in the same type of environment, the road
- Robots are highly diverse
  - Application determines configuration

Maneuverability

- Highest level of maneuverability → omni-directional
  - Can move in any direction in the plane independent of the robot's orientation
  - Typically implemented with Swedish or spherical wheels
  - Can also be achieved with motorized caster wheels
- Circular (or close to) robots with differential drive simpler to implement and are quite maneuverable

Study Swedish wheel

Slip/skid steering

- Mostly for outdoor platforms
- Wheels or tracks
- Turn by applying different speed to wheels
- Skidding/slipping makes it hard to predict motion
- Extremely energy inefficient when friction is high

Wheels and legs
H2020 Project “Centauro”

RoboSimian another wheel-legged robot

- JPL's entry in the DRC

Flying robots
Unmanned Aerial Vehicles (UAV)

- Increased interest
- Two main types
  - Fixed wings
  - Multirotor (rotary-wing)

Pros and cons with fixed wings and multirotors?

- Fixed wing:
  -
  -
  -
  -
- Multirotor (rotary-wing):
  -
  -
  -
  -

Pros and cons with fixed wings and multirotors?

- Fixed wing:
  - Can glide. Moves fast
  - Longer range
  - Cannot stand still
  - Need larger area for start/stop

- Multirotor (rotary-wing):
  - Can stand still (“hover”). Easy to change height.
  - Can fly close to ground
  - Start/stop on small area
  - Limited range

Videos: multi-rotor

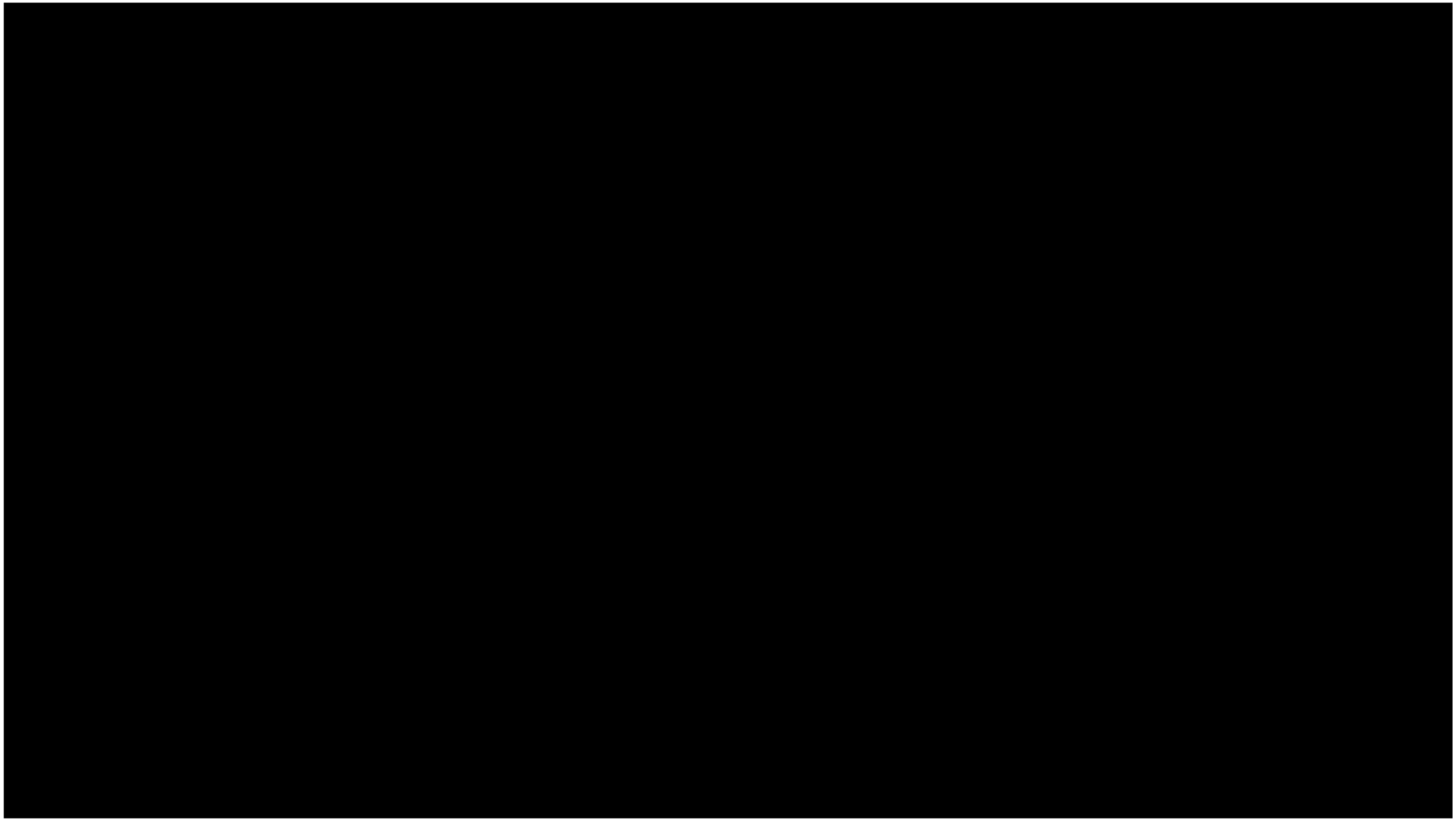
The Flying Machine Arena
Quadrocopter Ball Juggling

ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Precise Aggressive Maneuvers for Autonomous Quadrotors

Daniel Mellinger, Nathan Michael, Vijay Kumar
GRASP Lab, University of Pennsylvania

Video: Zipline in Rwanda with fixed-wing



Demo