Robot Morphology, Interaction Distance, and Locomotion

COMP 4510: Mobile Robotics II

Fall 2019

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Robot morphology

- Morphology: shape of the robot
- Some possibilities
  - Humanoid
  - Trashcan robots
  - Reconfigurable
  - Shape shifting
  - Biped
  - Quadruped
  - …
Why does shape matter?

• Shape influences expectations for interaction

• Differing capabilities with differing robot shapes

• Need to select shape to fit a task
Shape influences HRI expectations

- Performed a study to see how people would expect a dog-shaped robot to behave

- Some conditions had dog-like behaviors while others had unexpected behaviors (e.g., not chasing after a ball)

- People were confused when the robot did not act like a dog

Tank-like Robots

- ATRV-JR, iRobot
- This one is UML’s
Interaction distance

• User integrated with robot
  – Exoskeletons, prostheses
• User riding on or in robot
  – Robot wheelchair, robotic car
• User in same location as robot
  – Amazon Robotics’ warehouse robots, robot companions
• User able to see robot at a short distance
  – Robot arms for assembly
• User and robot separated by distance
  – Urban search and rescue, Mars rovers
How does distance influence a robot’s use?

- Determines interaction methods
  - When collocated, can use speech and gesture – and emotion might be useful
  - At a distance, a graphical user interface (GUI) is needed
- Differing methods for gaining situation awareness
Robots with faces

- We’re used to interacting with people and animals, so it seems natural to add faces to our robots
- Can provide robots with a clear front
- Can be used to show emotion
Uncanny Valley

- In 1970, Mori theorized that there would be a dip in acceptance when objects became more human-like

Image from Wikipedia page on the Uncannny Valley
David Hanson’s robots
GRACE

- CMU, with Naval Research Laboratories, Northwestern and Swarthmore

- Originally built for AAAI Grand Challenge
Cog

- MIT
- Humanoid, torso up
- Built to investigate human-like learning

- How would you interact with this robot?
Leonardo

- MIT Media Lab in collaboration with Stan Winston Studios
Leonardo

- Would this look lead to different interactions than with the robot on the prior slide?
Keepon

- National Institute of Information and Communications Technology (NICT) in Kyoto, Japan
Nursebot

- CMU
- Chop, chop!
Is a face necessary?
Telepresence Robots

DoubleRobotics

KUBI

VGo

Ava Robotics
Holonomic Robots

Vector, Waypoint Robotics

RWI B21

RWI B12
Non-holonomic constraint

A non-holonomic constraint is a constraint on the feasible velocities of a body

So what does that mean?
Your robot can move in some directions (forward and backward), but not others (sideward).

The robot can instantly move forward and backward, but can not move sideward

Parallel parking, Series of maneuvers
Reconfigurable Robots
Snake Robots
Shape-Shifting Robots

- VGTV-Extreme, American Standard Robotics
Shape-Shifting Robots

- VGTV-Extreme, American Standard Robotics
Legged Robots

Genghis, MIT AI Lab, mid-80s

Cassie, Agility Robotics, 2017

Atlas, Boston Dynamics, 2013
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Legged Robots

DRC HUBO, Rainbow Robotics and KAIST, 2015
Robot Surgery

daVinci, Intuitive Surgical
Wheelchairs
Exoskeletons
Robot Prostheses

• Hugh Herr, MIT Media Lab
Animal-Shaped Robots
BigDog, Boston Dynamics
Cheetah, Boston Dynamics
Design Considerations

• What application is the robot being designed for?

• How long will the robot need to run on its batteries?

• Will the robot need to complete multiple tasks that might need different capabilities?

• What is the environment the robot is being used in?

• Who will be using the robot?