Practical in Humanoid Robotics

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About Me

- Maker for hobby
  - Electronic Engineer
  - Software and Computer Engineer
  - Finishing my PHD in Computer Sciences
Motivation

DARWIN

SOUL

PLEN

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Humanoid Robot

Humanoid refers to any being whose body structure resembles that of a human: head, torso, legs, arms, hands.

But it is also a robot made to resemble a human both in appearance and behavior.
Why do we need a motion specification?

- Difficulties for researchers in robotics:
  - Industrial copyright
  - Programs are not re-usable in different robot families, even different versions of same robot families
  - Have to choose OS based on the drivers provided
  - Not easy to share a robot remotely with other collaborators in different locations

Motion Commands

Windows? Linux? Mac OS? Embedded OS?
Project goals OpenSource OpenHardware

- **Whatever: (cross-model)**
  - Provide a network-enabled interface for independent of the controller libraries
  - Access to other robots & simulators.

- **Whoever: (cross-platform)**
  - User interface must be cross-platform: support Linux, Mac OS X and Windows.

- **Wherever: (cross-network)**
  - Good quality of service across the Internet.
Basic Components of Humanoid

**Sensors**
- Proprioceptive sensors
- Exteroceptive sensors
- Proximity sensors
- Tactile sensors
- Vision sensors
- Sound sensors

**Planning and Control**

**Actuators**
- Hydraulic and electric actuators
  - DC motor
  - Stepper motor
  - A Servo motor
- Piezoelectric actuators
- Ultrasonic actuators
- Pneumatic actuators
Legged locomotion is much easier to accomplish (and much safer to develop and test) on smaller humanoids.

The SDR-4X was recently developed by Sony as a domestic robot capable of handling uneven surfaces and stairs on the fly.

Honda's P3 humanoid.

Honda now has another smaller and lighter android known as P3.
Locomotion

<table>
<thead>
<tr>
<th>STANCE</th>
<th>SWING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loading</td>
<td>Initial Swing</td>
</tr>
<tr>
<td>Response</td>
<td>Mid Swing</td>
</tr>
<tr>
<td>Mid Stance</td>
<td>Terminal Swing</td>
</tr>
<tr>
<td>Terminal</td>
<td>Double Swing</td>
</tr>
<tr>
<td>Stance</td>
<td>Stance</td>
</tr>
<tr>
<td>Pre Swing</td>
<td>Double limb</td>
</tr>
</tbody>
</table>

- Initial floor contact
- Contralateral toe off
- Heel rise
- Initial contact of the contral limb
- Toe off
- Swinging limb opposite to stance limb
- Vertical tibia
- Initial floor contact
Degree of Freedom (DOF)

- The degrees of freedom is the number of independent parameters that define its configuration.

- The term is widely used to define the motion capabilities of robots.

- Consider a robot arm built to work like a human arm.
Prices for Human Sizes Robots

- Poppy Child Kit
  - +- 9.000 u$$

- Big Size Servo Motor
  - 20 x 2.000 U$$ = 40.000 u$$. 
Parts - Kits and Prices.
Parts

Brackets

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Parts

Aluminum
Parts
Servo Motor

- Digital or Analogic Servo Motors
- Micro controlled Servo Motors
Micro controlled Servo Motor with PID

- PID is the most commonly used servo control algorithm:
  - Proportional
  - Integral
  - Derivative

- PID systems can be understood by way of analogous physical models.
Micro controlled Servo Motor with PID
Servo Motor – Video and Practical
Main Board Control
3D Choreography - Practical
Sequencer – Practical
Dancing – Video and Practical
Artificial Intelligence

Artificial intelligence (AI) is a branch of science, which deals with helping machines find solutions to complex problems in a more human-like fashion.

Borrowing characteristics from human intelligence, and applying them as algorithm in a computer-friendly way.
Recognition Technology

1. Recognition of moving objects
2. Posture/gesture recognition
3. Environment recognition
4. Sound recognition
5. Face recognition.

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Sound Recognition

Many Robots can distinguish between voices other sounds.

He can respond to his name, face people when being spoken to, and recognize sudden, unusual sounds such as that of a falling object or a collision, and face in that direction.
Facial Recognition

Many Robots has the ability to recognize faces, or the human being is moving.

It can individually recognize faces. Once they are registered it can address them by name.
Architecture - Specification Standard

Abstraction

Configuration Spec

Command Spec

Communication Spec
Architecture - System Overview

Client/Server

Configuration Spec

Command Spec

Communication Spec

Client

Server

Client/Server

Asimo Library

Pioneer Library

Simulator
Architecture - Robotalk Server

- Server Daemon
  - CClientConnection
    - CClientConnection
  - Class Interface
    - Robot Daemon

Provide:
- Buffering
- Scheduling
- Panic, etc.

Issue Robot Driver Calls

CRobotDriver

Read and Write TCP/IP sockets
Architecture - CClientConnection

Server Daemon

CClientConnection

Read

Command Queue

Playback Queue

Write

Return Queue

Robot Daemon

Priority Queues

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Architecture - CClient

Function calls

CClient Class

Class Interface

Broadcast cache

Return cache

Read Daemon

Commands to the server.
(Blocking/Nonblocking)

Feedback
(Nonblocking)

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Architecture - Communication Modes

- Direct mode:
  blocking & instantaneous, for debug purposes

- Delay mode:
  nonblocking, instantaneous or delay

- Playback mode:
  nonblocking, adaptive caching based on channel quality

- Broadcast mode:
  periodic query feedback
Direct Mode

Client ← Server

Sync system clock

Function call

Client

Cache

Clock

Command Cache

Return Cache

Robot Daemon

return
Delay Mode

Client ← Server

Sync system clock

Clock + Delay

Function call

Client → Command Cache

Robot Daemon

Command Cache → Return Cache

Return Cache → Error signal

Client → Return

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Playback Mode

Length of the sequence

Client → Server

Function call

Client → Cache

return

Clock

Delay

Command Cache → Playback Cache

Robot Daemon

error signal

Return Cache
Broadcast Mode

Broadcast call

Client

Cache

Command Cache

Return Cache

Robot Daemon

Delay

return

data
Conclusions

- Motivations
- System Structure
- Four Network Command Modes
- Future Extensions
  - Exclusive control
  - Data channels
  - Controlling multiple humanoid robots
  - Virtual humanoid robots
Virtual Humanoid

Server

Site A
Pioneer Library

Site B
Camera Library

TIF/QuickTime™ decompressor are needed to see this picture

Puma Library

Virtual Humanoid

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Conclusion

Main Board DecaCore
Conclusion
References


== http://plen.jp/playground/wiki/about

== www.airspacedefense.org

== All CODES in

https://github.com/splash2018
Thank you!
Contact

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