EECE520 A.I. Class Term Project

AIBO

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Introduction - AIBO?

- A.I. Robot
- あい-ぼう [相棒]
- A robot pet of SONY

Introduction - AIBO?

- Line-up

ERS-110
May 1999

ERS-210
Oct. 2000

ERS-220
Nov.2001

ERS-311
Sept.2001

Introduction - Robot Pet?

- Virtual Pets
  - Tamagochi, Pokemon Pikachu, Digimon
- Raising Simulation Games
  - Creature, Princess Maker
- Interactive Dolls / Robot Pet
  - Furby, Shelby, Tekno, iCYbie, NeCoRo

Furbies

Tan

White
w/ Black Spots

Giraffe Spots

Smoke Grey

Shelby

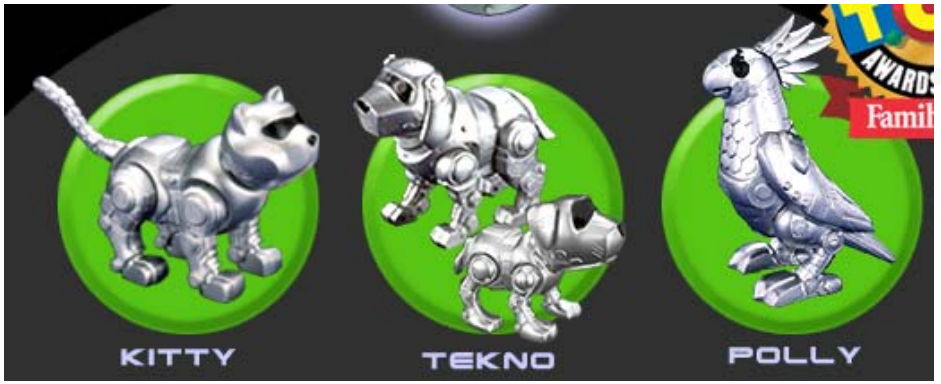
Midnight Black

Lemon Drop

Mellon Ball

Aqua Marine

Blue Moon

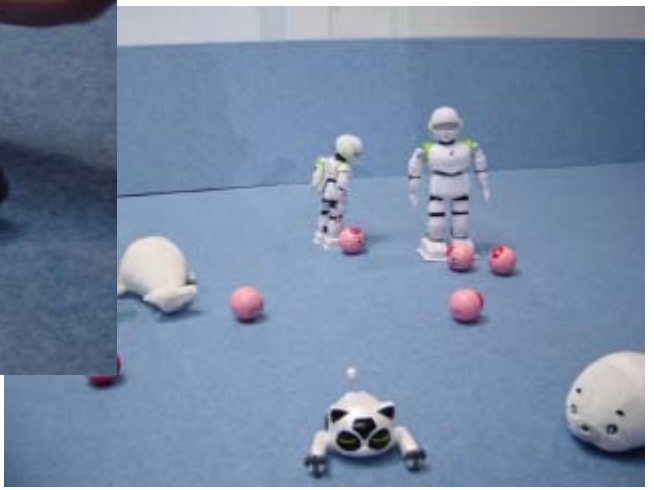


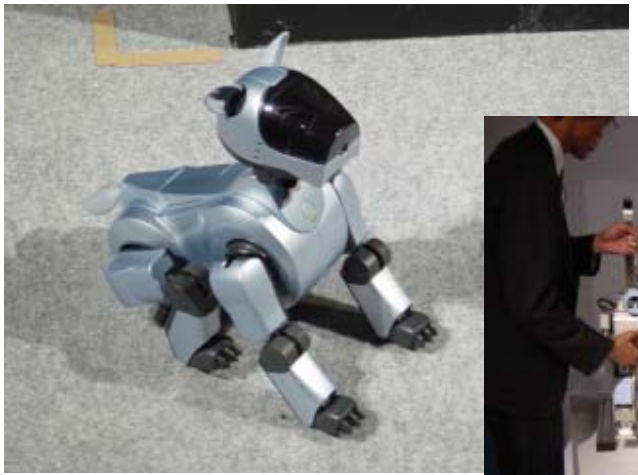
i-Cybie

NeCoRo

SDR-4X


Toy Robot Playroom
BANDAI
TAKARA





Specification - Hardware

- 64-bit MIPS RISC CPU
- 32MB SDRAM
- Memory Stick Media for AIBO
- Built in Clock
- PC Card Slot Type 2 (ERS-200 Series)
- Sensors
  - CMOS Camera, Stereo Microphone, Temperature, Acceleration, Pressure, Vibration, IR Distance
- 20 DOF on Legs, Tail, Head, Mouth & Ears

"AIBO" ERS-210:

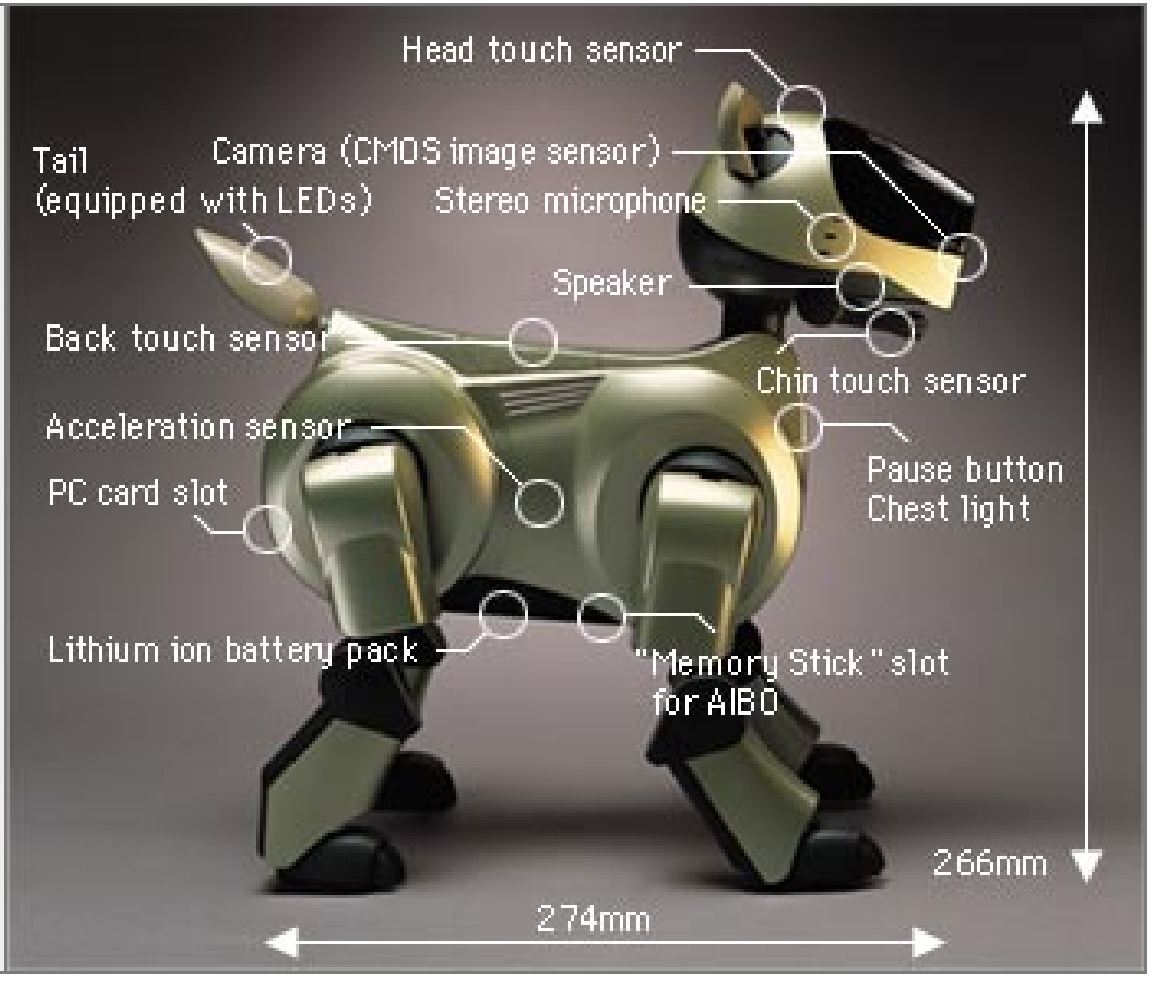
Components	Body, Head, Tail, Leg x 4, "Removable"
Program Storage Medium	Memory Stick for AIBO
Movable Parts	Mouth: 1 degree of freedom Head: 3 degrees of freedom Legs: 3 degrees of freedom x 4 legs Ears: 1 degree of freedom x 2 ears Tail: 2 degrees of freedom Total: 20 degrees of freedom
Input/Output	PC Card slot Type2 In/Out Memory Stick slot In/Out AC IN Power Supply connector Input
Image Input	CMOS Image sensor
Audio Input	Miniature Microphones
Audio Output	Miniature Speaker
LCD Display	Time, Volume, Battery condition
Built-in Sensors	Temperature Sensor Infrared Distance Sensor Acceleration Sensor Pressure Sensors (Head, the Back, Chin & Legs) Vibration Sensor
Built-in Clock	Date & Time
Power Consumption	Approx. 9W (tentative) Standard operation in autonomous mode
Operating Time	Approx. 1.5Hours (tentative) Standard operation in autonomous mode
Charging Time	Approx. 2 hours (with a supplied AC Power Adaptor and the "Lithium Ion Battery pack" ERA-201B1)
Dimensions(W/H/D) (not including ears and tail)	Approx. 152 x 281 x 250 mm (Approx. 5.98 x 11.06 x 9.84 inches)
Weights(including a battery and a memory stick)	Approx. 1.5kg (Approx.3.3lb)
Color	Gold/Silver/Black
Supplied Accessories	AC Adapter, Lithium Ion Battery Pack ERA-201B1(1), Ball, Documentation, etc
Operating Temperature	41 F to 95 F (5C to 35C)
Operating Humidity	10% to 80%

The main features of the "AIBO" ERS-210:

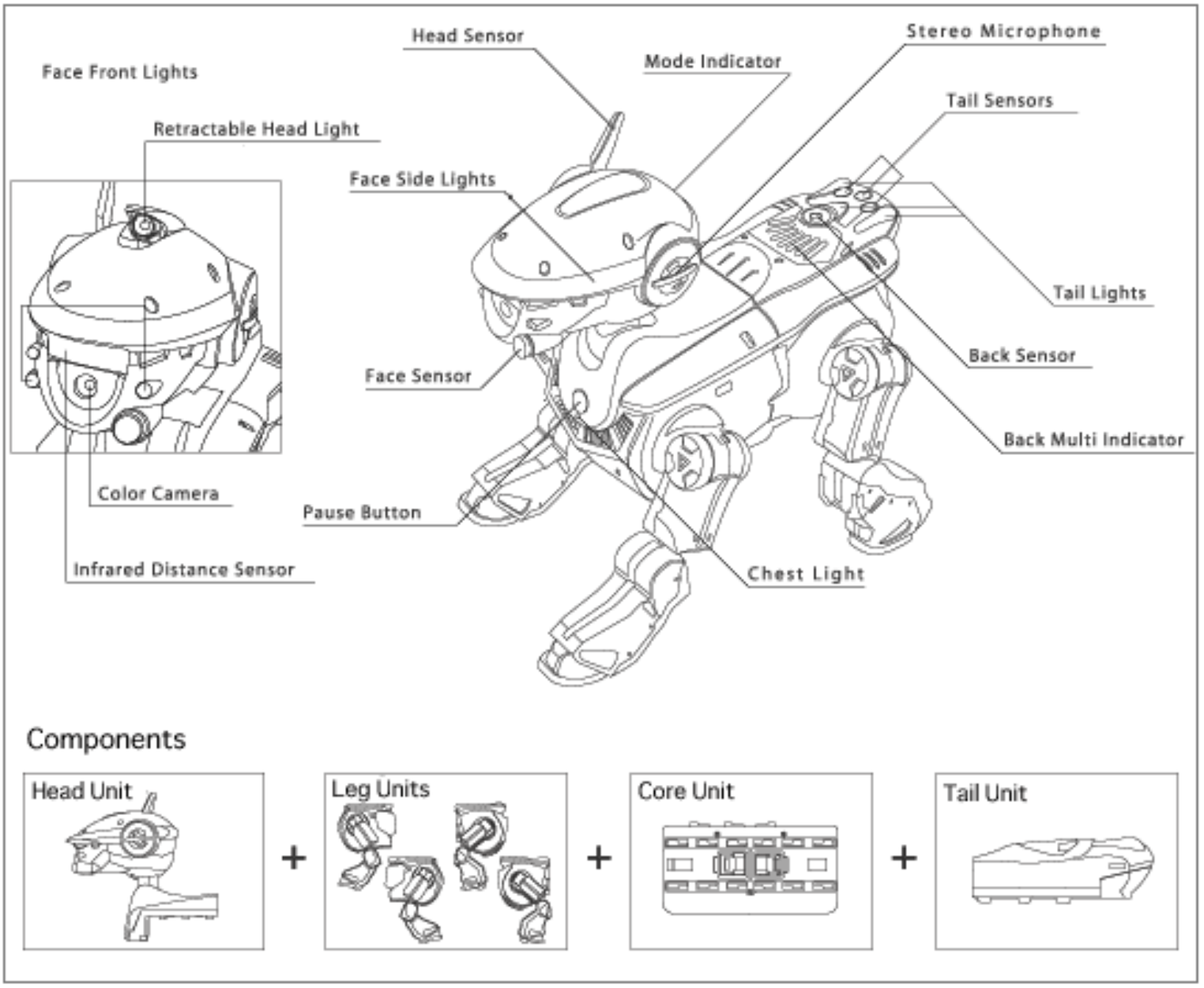
- Head touch sensor
- Camera (CMOS image sensor)
- Stereo microphone
- Speaker
- Chin touch sensor
- Pause button Chest light
- Back touch sensor
- Acceleration sensor
- "Memory Stick" slot for AIBO
- Lithium ion battery pack
- PC card slot
- Tail (equipped with LEDs)
- Joints (20 "degrees of freedom")

Weights (including a battery and a memory stick) : Approx. 1.5kg (Approx.3.3lb)

Dimensions (W/H/D) (not including ears and tail) : Approx. 152 x 281 x 250 mm (Approx. 5.98 x 11.06 x 9.84 inches)



AIBO "ERS-220" Exterior



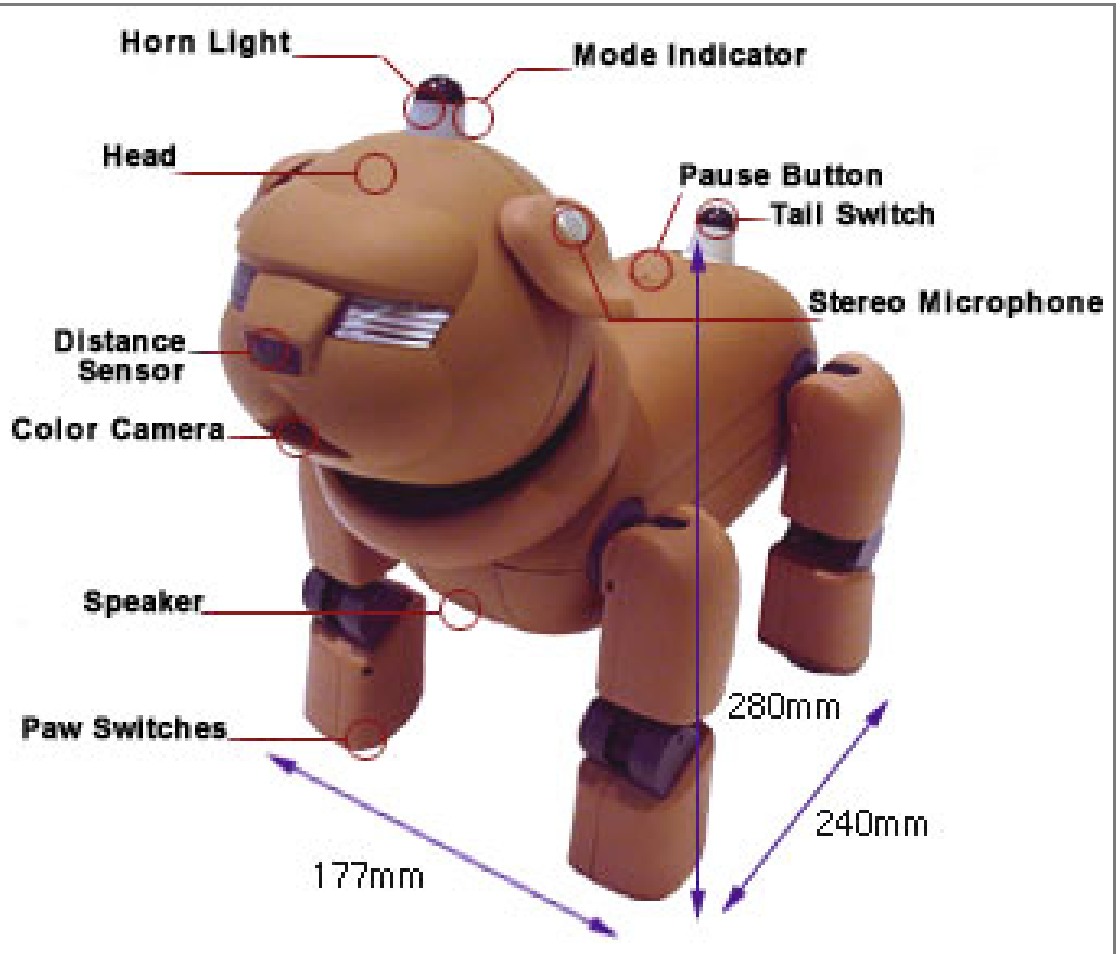
AIBO "ERS-311 / ERS-312 / ERS-31L" Exterior

* Photo is "ERS-31L"

- Mode indicator
- Horn light
- Head
- Stereo microphone
- Distance sensor
- Color camera
- Speaker
- Paw switches
- Back light
- Pause button
- Tail switch

Mass Approx. 1.5 kg (3 lb 3 oz) (including the battery pack and the "Memory Stick")

Dimensions Approx. 177 * 280 * 240 mm (6 * 11 1 / 8 * 9 7 / 8 inches) (w/h/d)



Specification - Software

- AIBO-ware
- PC Applications for AIBO
- Development
  - R-CODE
  - OPEN-R SDK
- Aperios / OPEN-R

Functions

- Instincts
  - Love, curiosity, movement, hunger & sleep
- Expressing Emotions
  - Happiness, sadness, anger, surprise, fear and dislike
  - Tonal language, motions, LED
- Learning
- Voice(Tonal language) recognition
- Mimic, Humming, Sing a song
- Object tracking & Face recognition
- Take pictures

Functions - AIBO-ware

- AIBO-Life & AIBO-Life2
  - Raise from toddler to child, teen & adult
  - Interacting with AIBO accelerates the maturing.
  - Teach Actions
  - Give a name to AIBO
  - Tell your name

Functions - AIBO-ware

- Hello AIBO
  - Fully matured adult AIBO
  - 75 Voice Command Recognition
  - Mimicking
  - Social behaviors

Functions - AIBO-ware

- Party Mascot
  - Games
  - Song & Dances

- AIBO Speed Board
  - Skate with voice commands
  - Record and replay routines

Functions - AIBO-ware

- AIBO Explorer
  - Fully matured AIBO
  - Surveillance mode
  - Hyperactive Boost mode

- AIBO Recognition
  - Fully matured AIBO
  - Owner Recognition
  - Self Recharging on Energy Station

Functions - PC Apps

- AIBO Fun Pack
  - Check AIBO Status
  - Download Photos

- AIBO Messenger
  - Notice e-mail received
  - Read e-mail
  - Read favorite websites

Functions - PC Apps

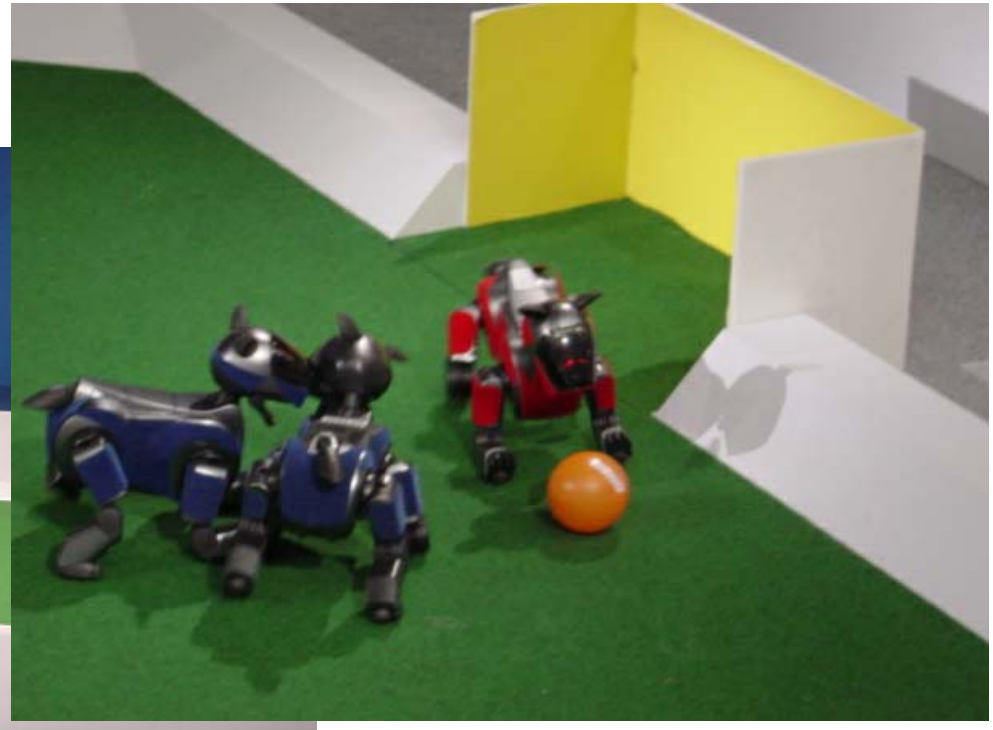
- AIBO Navigator
  - Control and Navigate
  - Wireless LAN
  - Video and sound monitoring
  - Take Picture
  - Send commands
  - Force feedback Joystick support

Functions - PC Apps

- AIBO Master Studio
  - Create and edit original sound, motion, LED data and Behavior
  - Voice recognition
  - Wireless LAN debugging
  - Import/Export Actions for other AIBO wares

Functions

- Robot Soccer?



Programming AIBO

- R-CODE
  - Easy to learn, simplified PL
  - R-CODE Interpreter
  - AIBO Master Studio
- OPEN-R SDK
  - Advanced programming
  - OPEN-R API
  - Based on gcc (C++)

Programming AIBO:R-CODE

- Features
  - Similar to BASIC
  - Control statements
  - Subroutines
  - Variables (16-bit integers)
    - System variables support sensor data
  - Addition/Subtraction
  - Stacks

Programming AIBO:OPEN-R

- Features
  - OO designed OPEN-R API of system layer
  - Full control of joints & displays
  - Full access to sensors
    - Image data, wave formatted sound data
  - Network supports
  - High level functions are not supported.
    - Gait, Voice & Object Recognition, MIDI

Improving with A.I.

- A.I. Techniques
  - Problem Solving - Search
  - Inference with Knowledge Base
  - Planning
  - Learning

Improving with A.I.

- Newly suggested functions:
  - ‘AIBO, come here!’
  - ‘Go, get the newspaper.’

‘AIBO, come here!’

- Scenario
  - Owner: ‘AIBO, come here!’
  - AIBO: Tries to find where its owner is.
    ‘Where are you?’
  - Owner: ‘At the kitchen.’
  - AIBO: Finds the way to the kitchen.

‘AIBO, come here!’

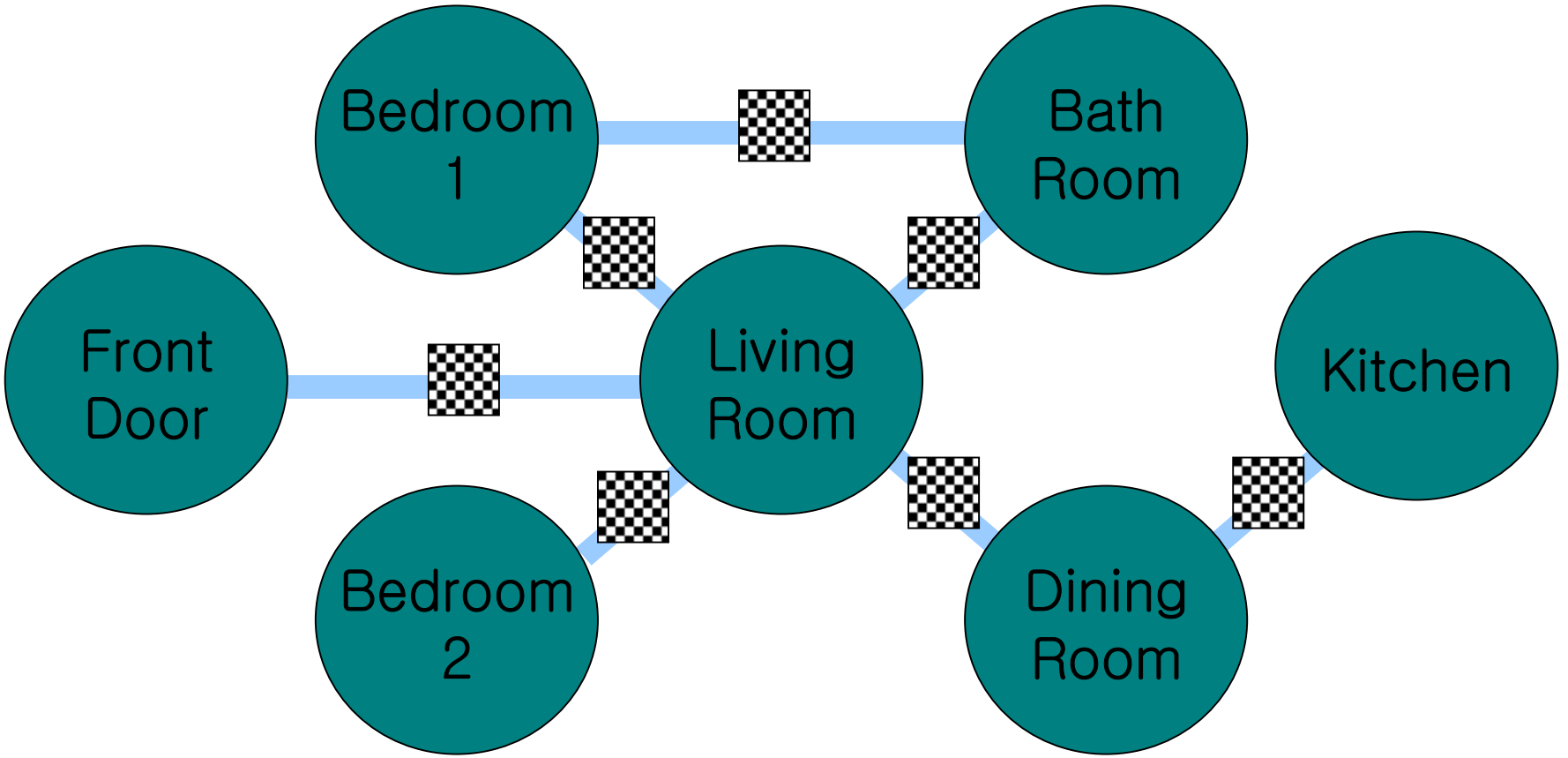
- Required Functions
  - Map Construction
  - Way finding (Search)
    - BFS, DFS, IDS
  - Recognizing the door

‘AIBO, come here!’

- Map Construction
  - Manual
    - Owner manually constructs the map of the house and uploads to AIBO’s memory.
  - Automatic
    - AIBO wanders around the house and constructs the map by itself.
  - Semi-automatic
    - Owner takes AIBO to each place of the house and tells where it is.

‘AIBO, come here!’

- Map Construction

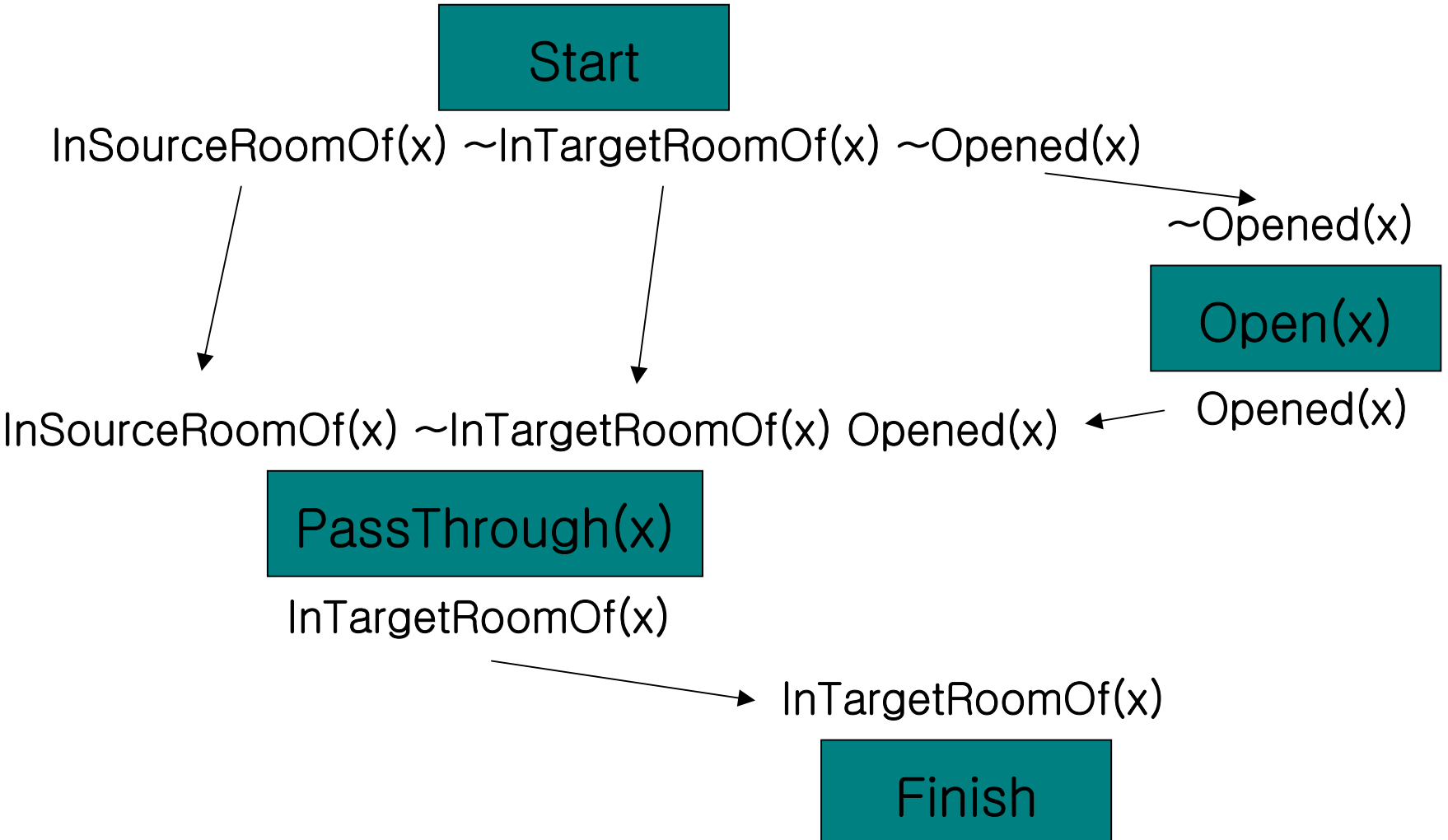


‘AIBO, come here!’

- Door recognition
  - Tagging the doors
  - CyberCode
    - Jun Rekimoto (DARE2000)
    - Gives ID and Orientation
  - Tagging the path (on the floor)

Figure 1: Examples of CyberCode visual tags (top: tags used in several contexts. bottom left: earlier prototypes. bottom right: a concatenated type for more "bits").

‘AIBO, come here!’



‘Go, get the newspaper.’

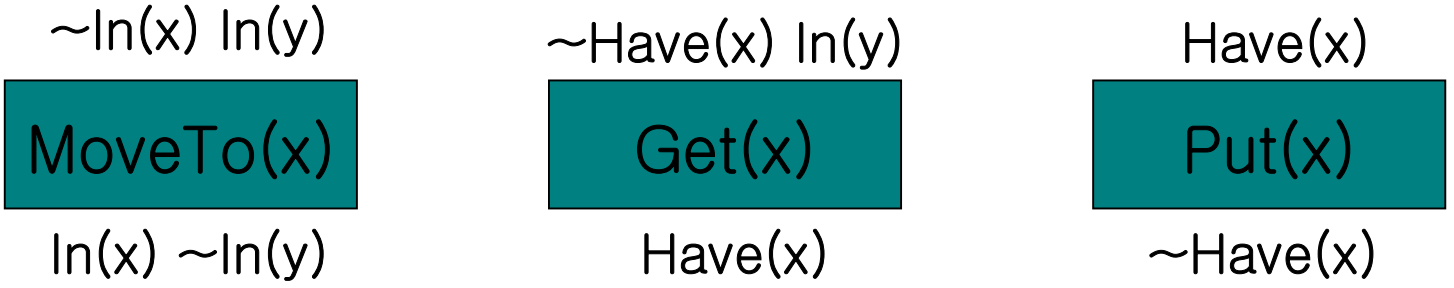
- Scenarios
  - ‘Go, get the newspaper.’
  - ‘Take this to the living room.’
  - ‘Take the newspaper to daddy.’
  - ‘Turn off the lights.’

‘Go, get the newspaper.’

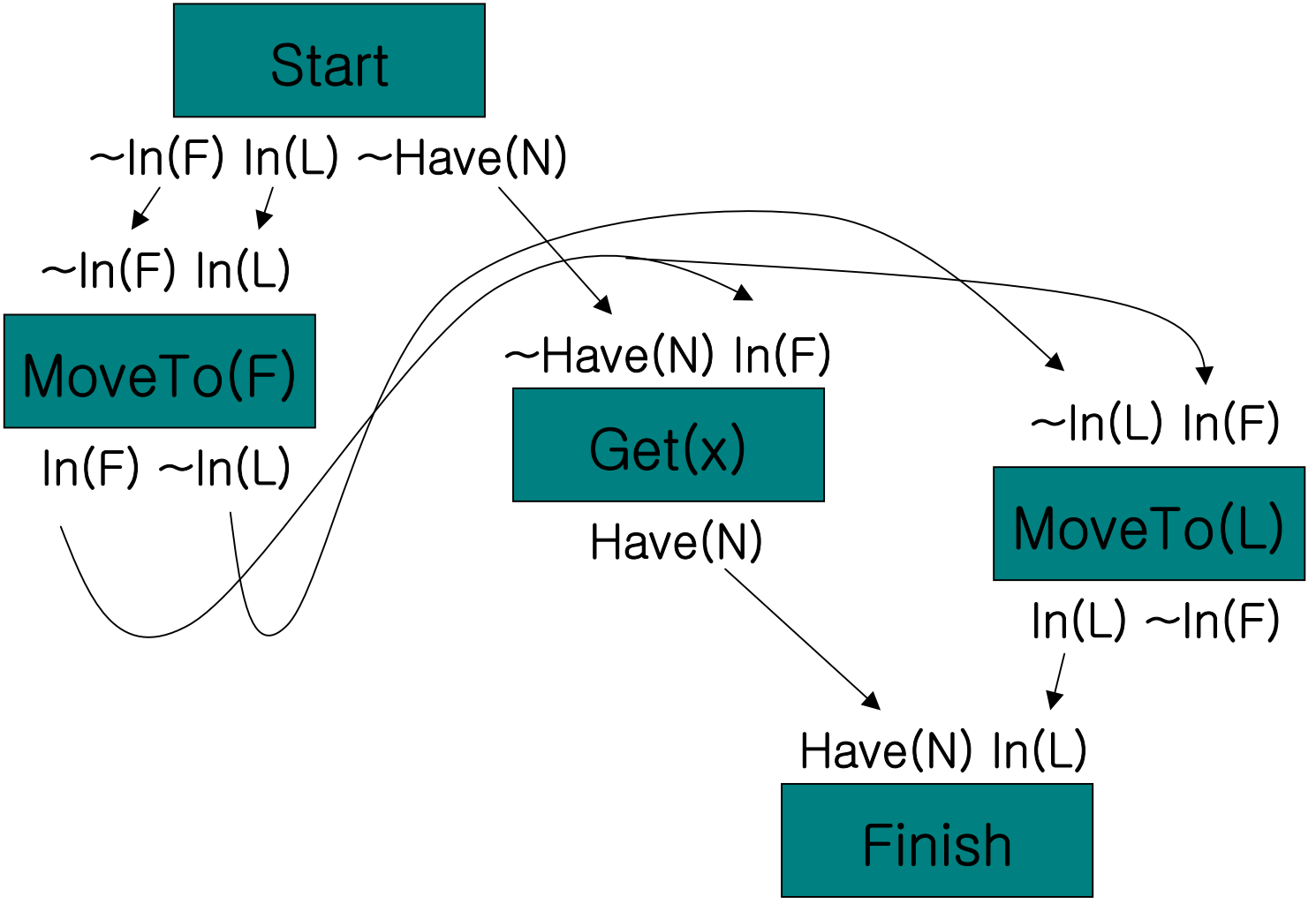
- Required Functions
  - Way finding (previously described)
  - Planning
  - Physical Requirements
    - Make AIBO strong enough to carry small objects. : Design an AIBO basket(tray)?
    - Make AIBO to be able to turn switches on & off. : Humanoids?

‘Go, get the newspaper.’

- STRIPS Operators



‘Go, get the newspaper.’



Conclusion

- AIBO
- Currently Supported Functions
  - Simple rule-based behaviors
  - Learning
  - Voice recognition
  - Face and object(color) recognition

Conclusion

- Newly Suggested Functions
  - ‘AIBO, come here!’
    - Map Construction
    - Way finding - Search
  - ‘Go, get the newspaper.’
    - Way finding – Search
    - Planning