Robotics Education with NAO
-Beauty in Behaviors of Human and Humanoid Robot

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Background

In the future, humanoid robots are expected to live with us in our daily lives.
The future generation will need to understand the challenge of this cohabitation to realize a society where we can efficiently and effectively cooperate.

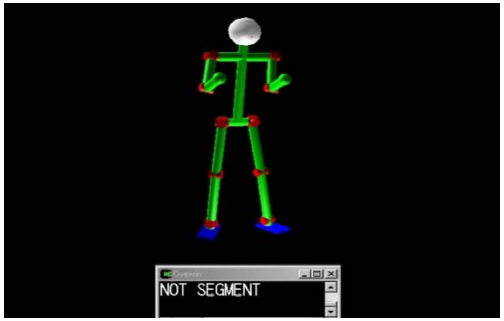
Educational Partnership Program
launched by Aldebaran Robotics

Background

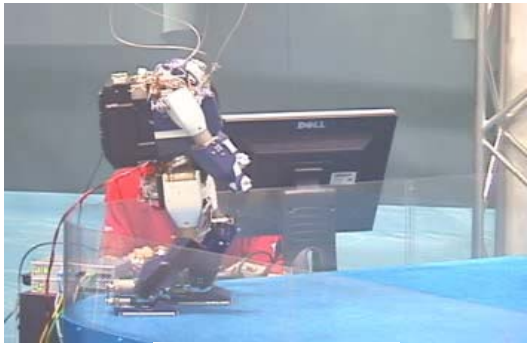
Laboratories in the Department of Mechano-Informatics of the University of Tokyo participated in the educational program, and purchased 30 small humanoid robots (NAO) last year.

Our laboratory have 12 NAOs and use them for education and research.

Why Behaviors of Human and Humanoid



segmentation

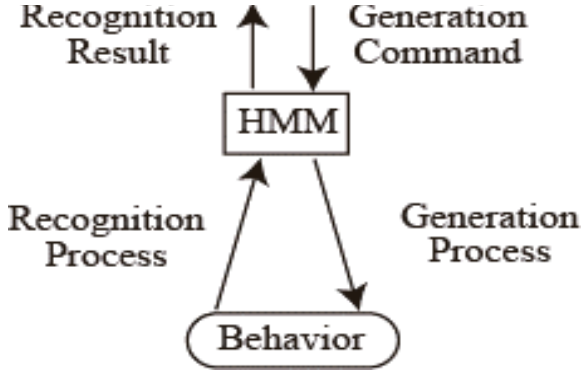


interaction

natural language

Humanoid Robot Intelligence based on Behaviors

motion prediction



motion-verb

Winter Semester

Mechanical Engineering Seminars:

- Each professor set the original theme.
- 3rd grade undergraduate students choose which seminars to take.
- 3 or 4 students participate in each seminars.

Prof. Nakamura and I offered a course entitled

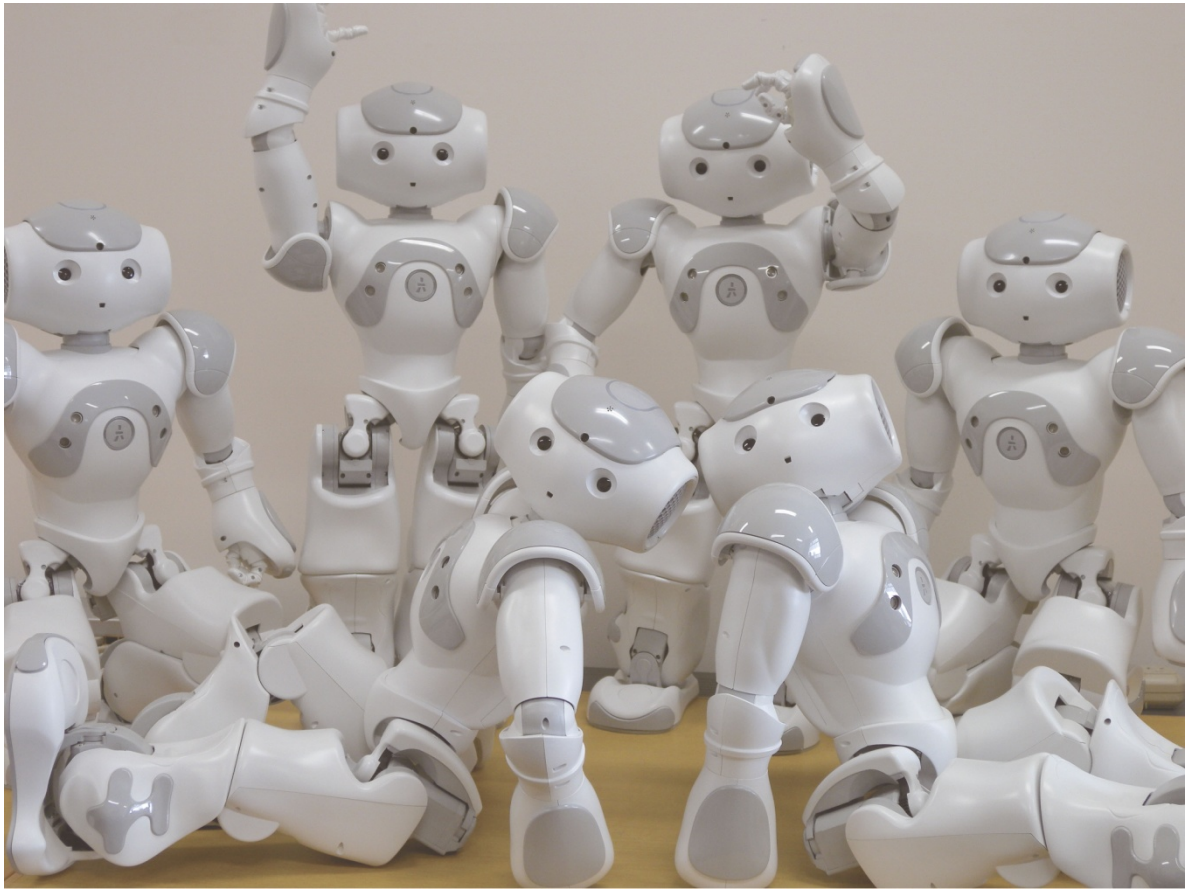
"Beauty in Behaviors of
Human and Humanoid Robots" .

“Beauty in Behaviors of Human and Humanoid Robots”

The long term aim is to pursue sophisticated behaviors of humanoid robots based on the interdisciplinary knowledge from robotics, arts, and other kinds of fields.

Prof. Kitago laboratory (a Tokyo University of the Art, Sculpture laboratory) joined our seminar.

“Beauty in Behaviors of Human and Humanoid Robots”



poster to announcement of our seminar for 3rd grade students

Programming NAOs

Teaching and Playback

Students set a sequence of key frames for postures by using **Choregraphe** software provided by Aldebaran Robotics.
The interpolation of the key frames generates seamless behaviors of NAO.

Group A Group C

Group B Group D

Programming NAOs

We assumed that beauty appears in the harmony of behaviors and environment. They designed robot behaviors which synchronized with music.

Team A

Team B

Team C

Sket ents

We t rt,

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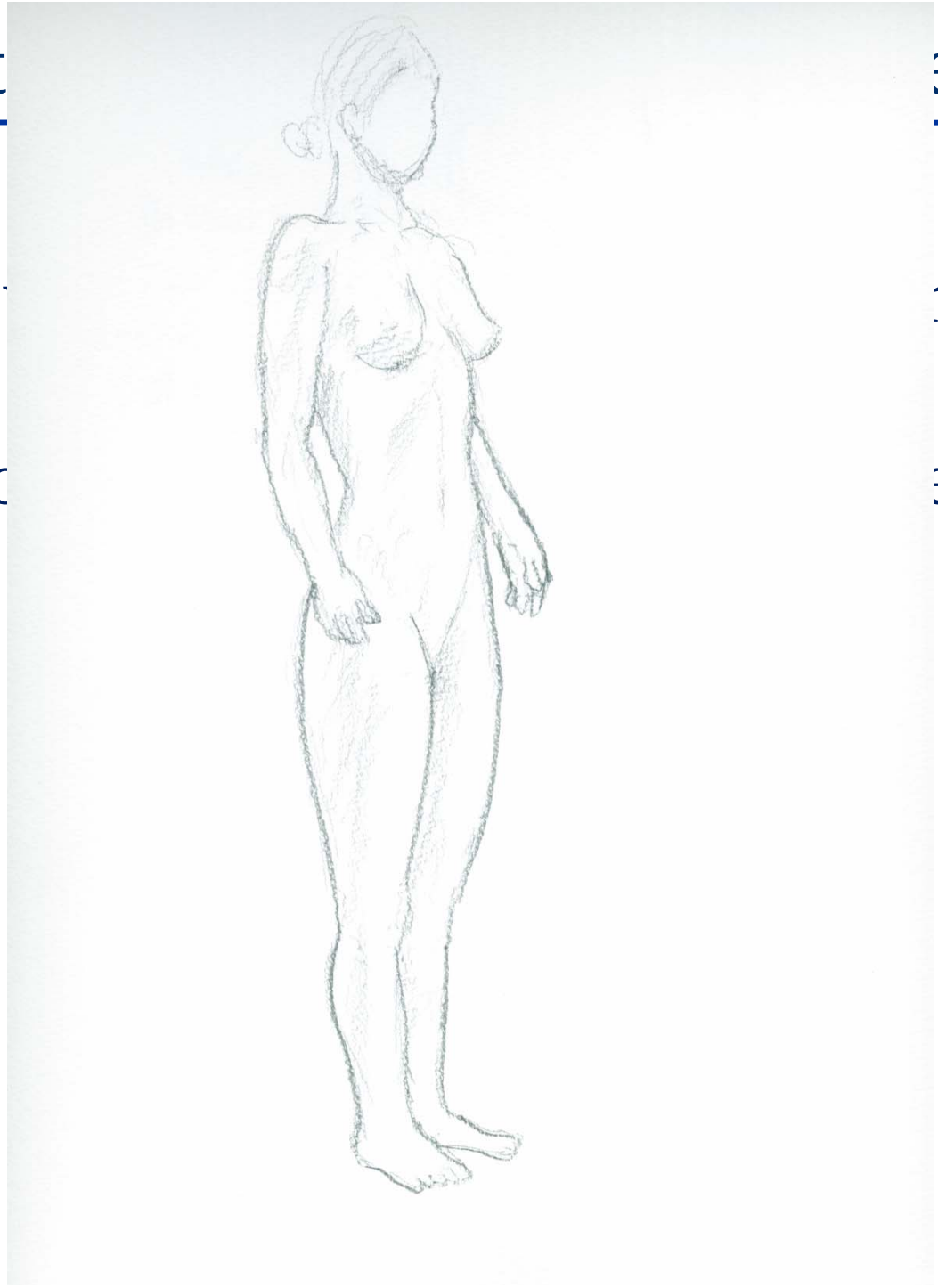


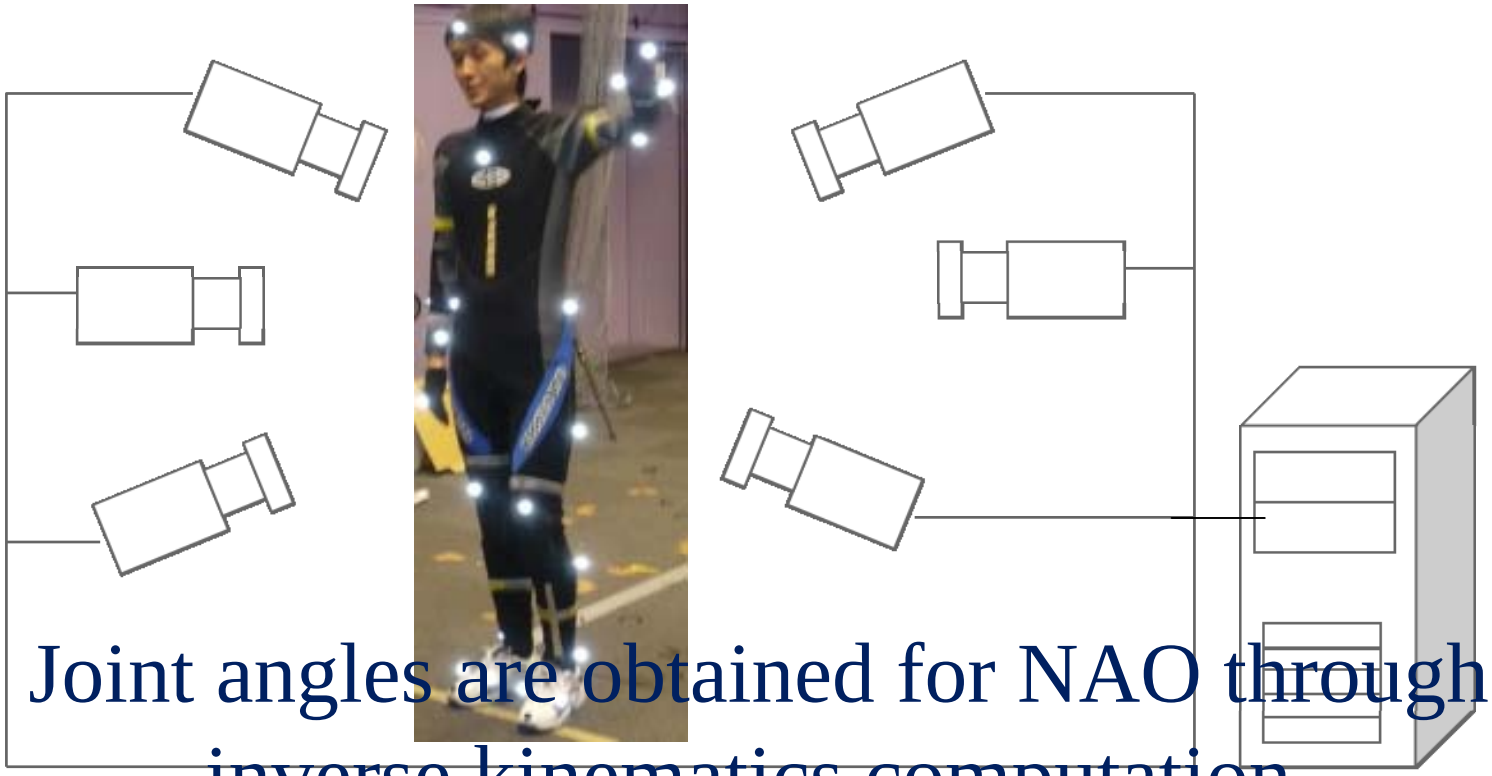
Enhancement of Our Research

Imitation Learning

NAO observes human behavior,
and performs the same behavior.

A performer with markers is captured
by optical motion capture system.

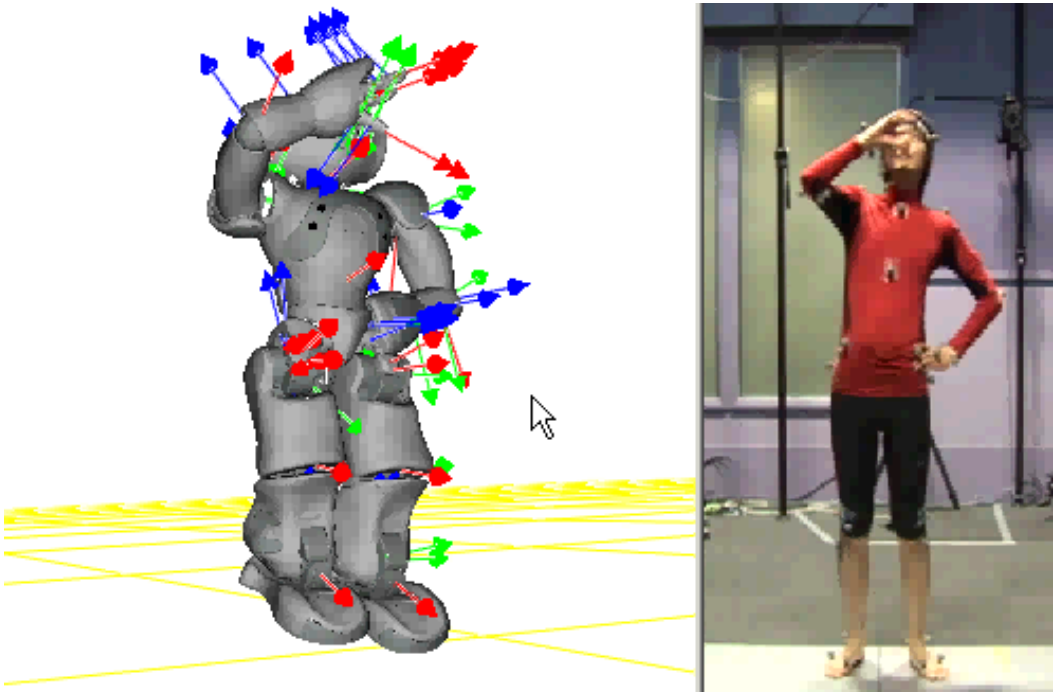
Enhancement of Our Research



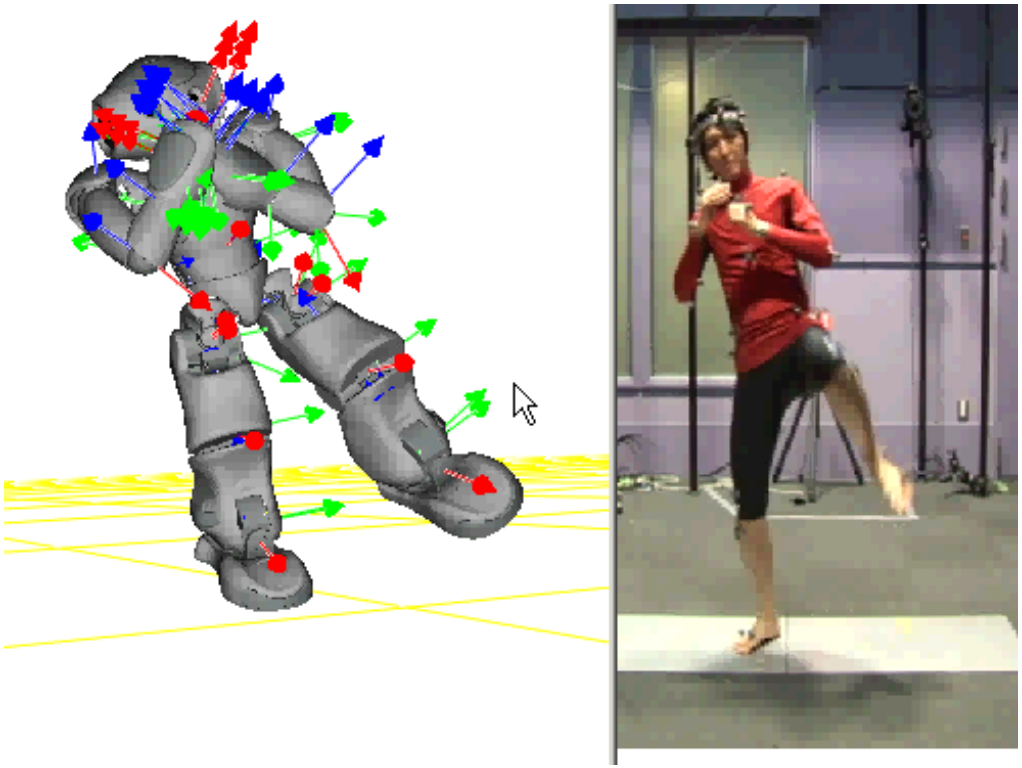
Joint angles are obtained for NAO through inverse kinematics computation.

NAO performs the same motions as human, and memorize them.

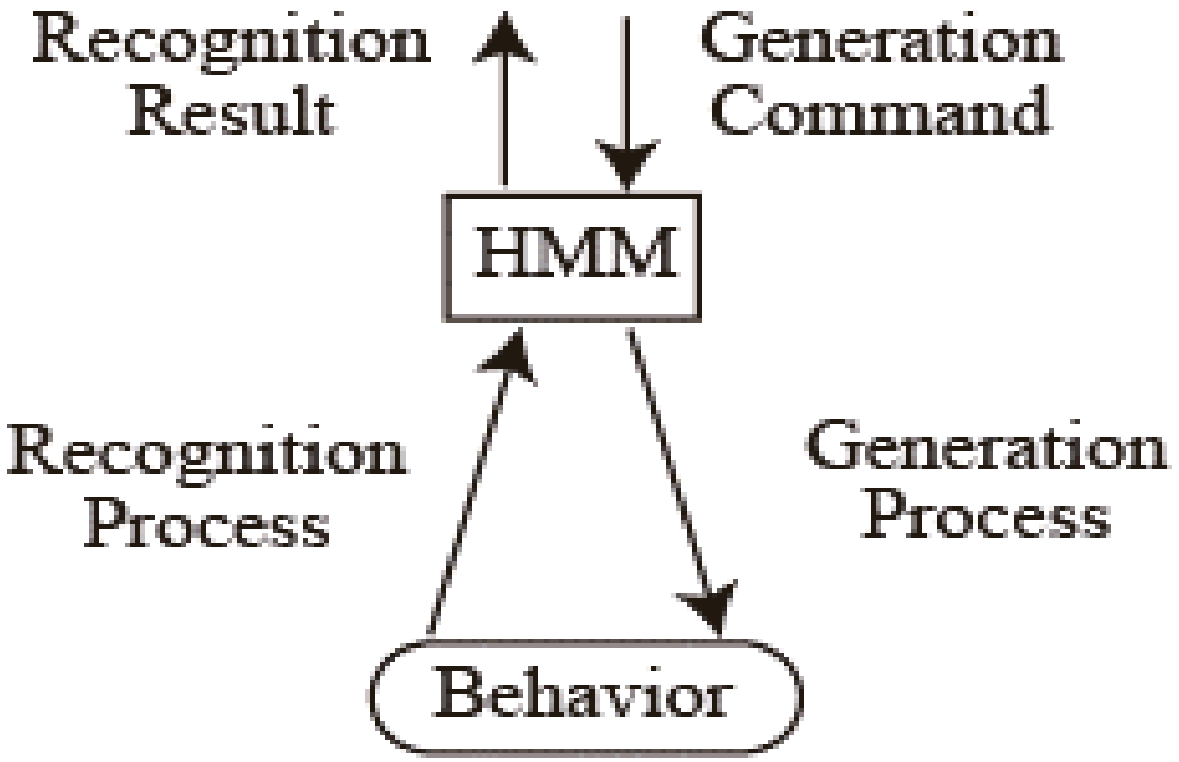
Imitation Learning



Imitation Learning



Intelligent NAO



Intelligent NAO

Motion Language Model

(Semantic Graph)

motion patterns

latent states

words

0.1 0.05 0.0 0.0 0.2

play run throw

ball player

• • •

a player throw 0.5

a player throw a ball 0.45

a player run 0.3

• • •

Natural Language Model

(Syntax Graph)

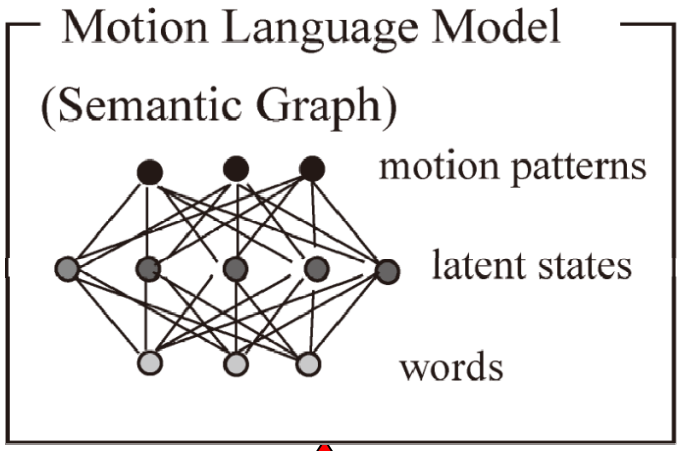
words

word classes

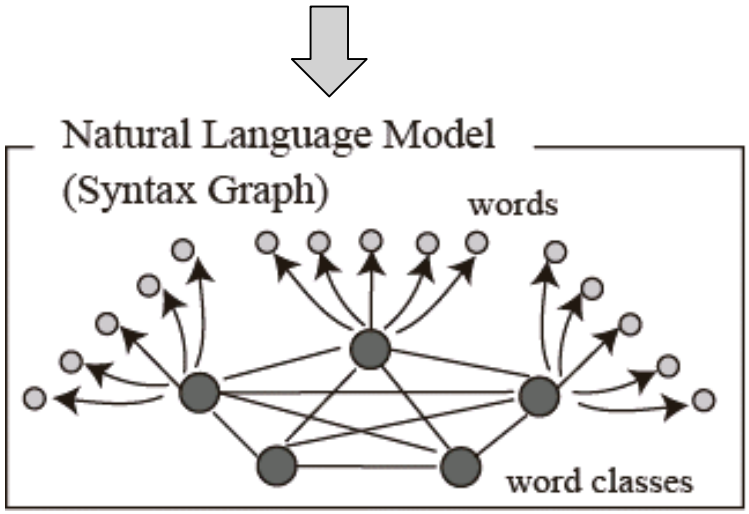
Intelligent NAO

evaluation

throwing pattern 0.5
walking pattern 0.45
running pattern 0.3



a player throws a ball



a throws a
ball player

Implementation of the Intelligence into NAOs

Speech

↓ utterance

Speech Recognition

↓ sentence

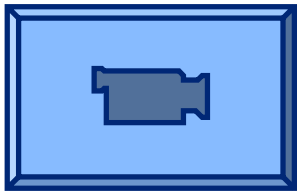
Morphological Analysis

↓ words

Associate motions

↓ motion symbol

generate motions



[Demonstration in the French Embassy, Octorber.2010]

Summary

We participated in an Educational Partnership Program by Aldebaran Robotics, and start to use small humanoid robots for education in an undergraduate course. In our seminar, we aim to make sophisticated behaviors of humanoid robots, which is a long term challenge. We also used NAOs to enhance our research of intelligent robots.

Acknowledgements

Thanks to
Prof. Hiroshi Kaminaga, Prof. Satoru Kitago, Mr. Seiya Hamano, Mr. Kazuhiro Komoda, Miss. Marie Konoya, Mr. Yukako Hayashi, Mr. Kensho Hirasawa, Mr. Yuki Kataoka, Mr. Toshio Moriya, Mr. Ryotaro Hashimoto, Mr. Takuhiro Kaneko