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

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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

Symbolization of motion segmentation

motion prediction

interaction

natural language

Humanoid Robot Intelligence based on Behaviors

Recognition Result
Generation Command

HMM

Recognition Process
Generation Process

Behavior

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”.
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
Around 10 students from the University of Tokyo and Tokyo University of Art attend our seminars. They discussed the beauty of behavior, sketched humans' movement talents, programmed NAOs, and gave presentations on their works in groups of 3 or 4.

“Beauty in Behaviors of Human and Humanoid Robots”
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
We visited Tokyo University of Art, and sketched human talent in order to observe human attitude and behaviors in details.
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.
Joint angles are obtained for NAO through inverse kinematics computation.

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

Motion Language Model
(Semantic Graph)

- motion patterns
- latent states
- words

Natural Language Model
(Syntax Graph)

- words
- word classes

- a player throw
- a player throw a ball
- a player run

0.5
0.45
0.3

...
Intelligent NAO

A player throws a ball

Evaluation

throwing pattern: 0.5
walking pattern: 0.45
running pattern: 0.3

Motion Language Model
(Semantic Graph)

natural language model

(Natural Language Model
(Syntax Graph)

words

motion patterns

latent states

words

a player throws a ball
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, October.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.
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