GRP PROGRESS Report

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1. The aim of research

"New approach for realization of real-time fault tolerant biped type Humanoid Robot"

New biologically inspired motion control architectures are developed for humanoid robots to make them fault-tolerant and easy to learn from others. Until now, the developed humanoid robots may not be deployed into various fields of application wit hout having a real-time programming tool. The application of imitation to humanoid r obot programming has not been formalized yet. Therefore, this paper deals with how to generate the behavior of the robot appropriate for its intrinsic mechanism more easily and naturally. Within the proposed framework for automatic generation of robo t behavior, (a) robots can learn and acquire any new motions from humans (and/or other robots) fast and easily, (b) similar motions can be adapted to the robot if both the demonstrator and the imitator have similar kinematics, (c) the imitator can find optimal motions through learning and repeated pattern recognition, (d) there is no need for analysis of nonlinear robot dynamics. Then, finally, humanoid robots may be able to behave autonomously using external motion patterns acquired by the vision sensor or downloading nominal data from its knowledge base.

2. Approach

a. Motion sensing / recognition

- Acquisition of data such as displacement, velocity, and acceleration of moving parts (each segment, link, joint, etc

b. Identification a motion features and patterns: classification.

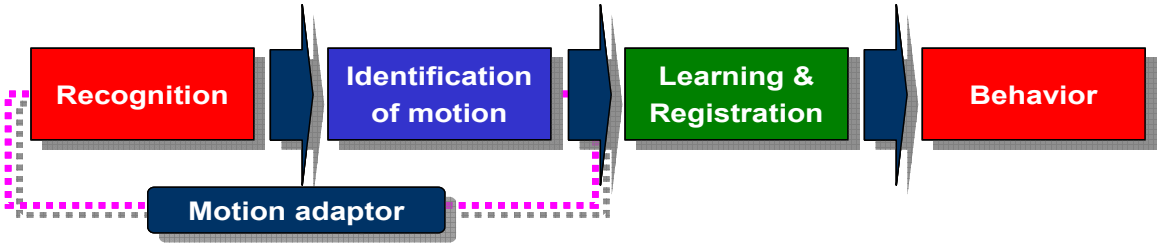
- Analysis and estimation of an input model (size, mass, center of mass, etc).

c. Comparison with the target mechanism.

- Selection of optimal motions.
- Registration of optimal motions classified by category

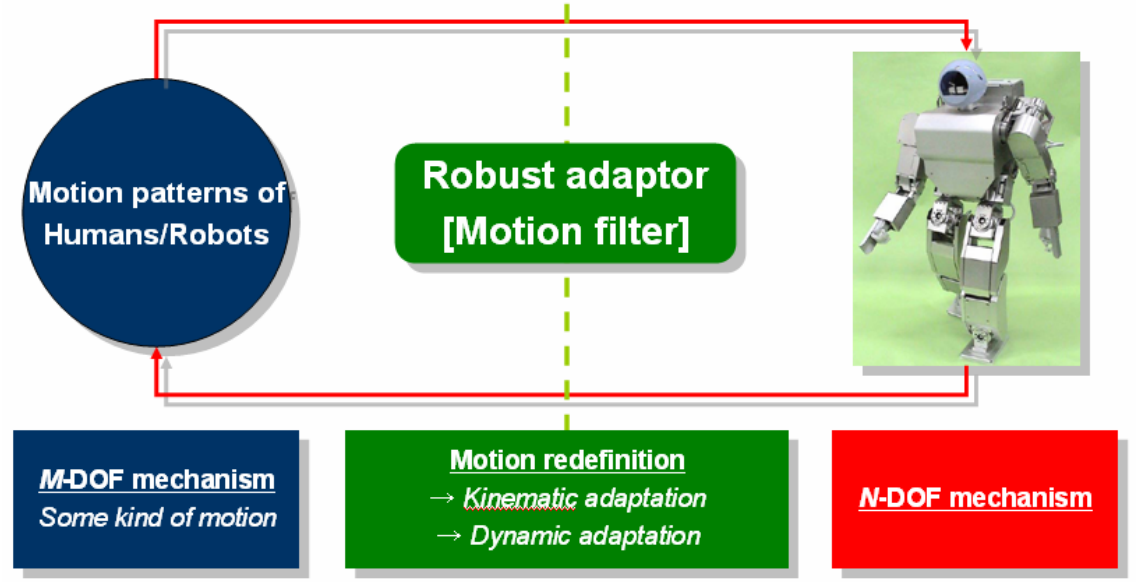
d. Realization of human-like motion based on abstract commands

- Automatic generation of overall complex behavior

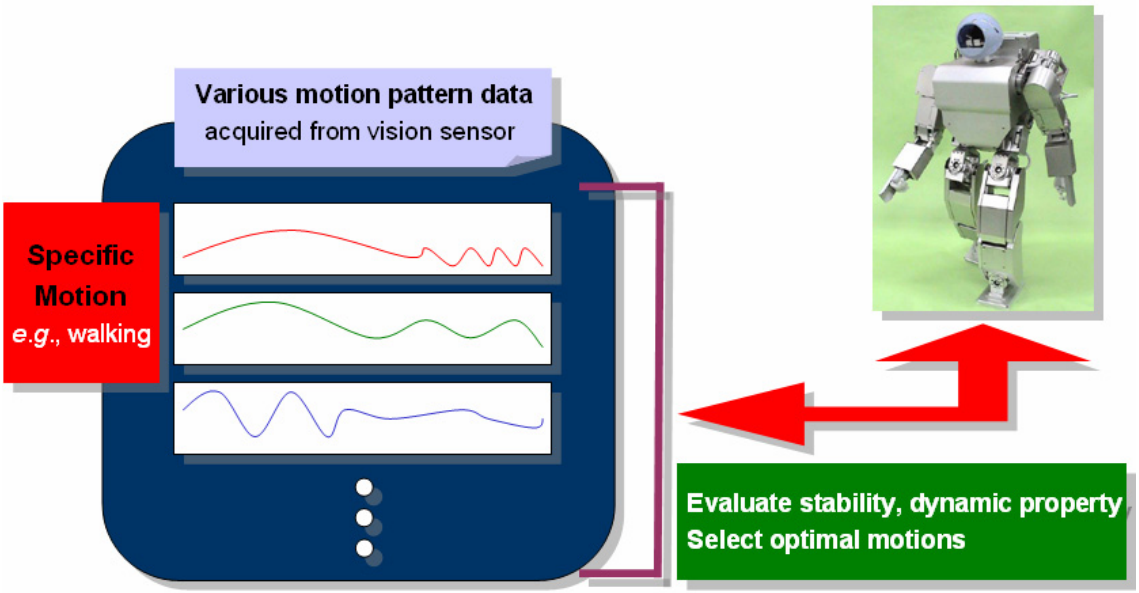


[Figure 3 The strategy of realization of research object]

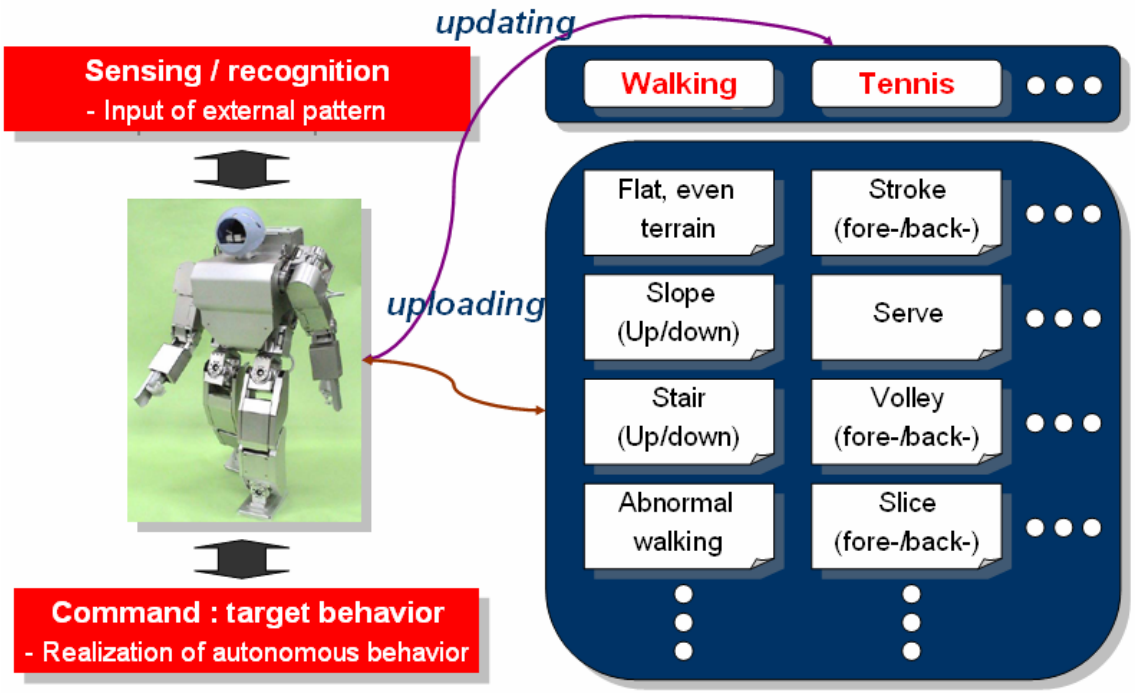
[Step 1.]: The realization of self-adjusting motion adaptor for goal-directed imitation mapping



[Step 2.]: Development of an algorithm to find optimal motions using registered motion patterns



[Step 3.]: Learning new patterns and generation new motion



3. The progress of research

- Development of motion learning algorithm using intelligent motion adaptor

: Robots can learn and acquire any new motions from human or other robot very fast and easily with the developed intelligent motion adaptor

- Application of goal-directed imitation using neural oscillator

: To produce the same effect of behavior can be realized. This announces that the imitator robot can generate compensated behaviors accordingly to achieve the intended goal of the demonstrated motion.

- Development of new entrainment-enhanced neural oscillator

: It can be applied to the goal-directed imitation learning of robots. This developed artificial oscillator model is robust model of the neural oscillator with regard to unknown inputs.

4. Future plan

Application and verification of suggested new approach and algorithm with a real humanoid robot

- Development of 3D motion adaptor

- Realization of motion learning with self-adjusting adaptor using a real humanoid robot

- Considering of new dynamic stability algorithm

5. The list of publication

- Woosung Yang, Nak Young Chong, "Goal-directed Imitation with Self-adjusting Adaptor Based on a Neural Oscillator Network", IEEE 12th International Conference on Advanced Robotics, 2005, submitted

- Woosung Yang, Nak Young Chong, "Entrainment-enhanced Neural Oscillator for Imitation Learning", IEEE/RSJ International Conference on Intelligent Robots and Systems, 2005, submitted

- Woosung Yang, Nak Young Chong, "Dynamic System Control Using Entrainment-enhanced Neural Oscillator", International Conference on Control, Automation and Systems, 2005, submitted