# 論文の内容の要旨

論文題目　Memory of Motion Patterns and Symbol Acquisition for Humanoid Robots based on Auto-Correlation Metrics and Associative Memory Neural Networks

（自己相関距離と連想記憶ニューラルネットワークに基づいたヒューマノイドロボットの運動パターンの記憶と記号獲得）

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Symbols are important for intelligent systems. Extracting important informations from specific physical experiences and memorizing them as abstract symbols enable one to apply the acquired information to other specific situations. Terrence Deacon explains the developmental process of symbols as three stages which consists of icon, index and symbol. Icons refer to specific physical objects based on similarity of the patterns. Indexes are the relationships between icons based on physical causality. Symbols are referential relationships without physical causality. According to Deacon, developments from lower stages to higher stages emerge from learning associations in the lower stages.

Memory systems for humanoid robots are expected to have these functions, to self-organize symbols from accumulated associations of specific patterns. Among patterns, bodily motion patterns are important as indicated by the concept of Mimesis, which is about development of symbols and communications from observation and imitation of others' motion patterns. Therefore we use motion patterns of humanoid robots as the patterns to be accumulated in memory.

We developed a memory system of observed motion patterns, which forms symbolic representations of motion patterns and maintains symbolic and specific representations hierarchically. It consists of auto-correlation based feature vectors and an associative memory neural network with a nonmonotonic activation function. Feature vectors clarify the global distribution of motion patterns as hierarchical clusters. The feature vectors are stored into the associative memory network by Hebb rule. The associative memory maintains as attractors not only the stored specific patterns but also the newly formed patterns at the centers of clusters of stored patterns which correspond to the symbols of motions. Attractors are controlled by the one parameter of nonmonotonicity of the activation function. Specific patterns are the attractors when the nonmonotonicity is large, and symbolic patterns are the attractors when it is small. The bifurcation diagram of the attractors depending on the nomonotonicity shows the specific-symbolic hierarchical encoding of motion patterns. In order to obtain patterns to be stored into the associative memory network, segmentation of motion patters is necessary. We proposed a segmentation method based on auto-correlation. In addition, we proposed a self-organizing dynamics of the nonmononicity, since it has to be appropriately chosen by manual to some degree in the above proposed method. It is based on the population dynamics of the associative memory and the attractors are the discrete states representing the hierarchical correlations of the motion patterns.