Synergistic Intelligence Project:
A cognitive developmental approach towards
Emergence of communication

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The recent advances in information and robot technology (in short, IRT) enable us to build humanoid robots that have a large number of DoFs and various kinds of many sensors. Human-like motions are realized on these robots, and the shape and appearance have become closer and closer to us.

However, the current robotics lacks the faculties of language communication with ordinary people and of intelligent behavior generation in various situations such as at home. The fundamental relationship between humans and robots would become more important since these robots would be introduced into our lives in near future, and therefore the mechanisms of adaptation and development of both humans and robots should be taken into account in order to find the correct direction of the technology in future.

"**Synergistic Intelligence** (hereafter, SI)," the title of JST (Japan Science and Technology Agency) ERATO (Exploratory Research for Advanced Technology) Asada project, emerges intelligent behaviours through the interaction with environment including humans. Synergistic effects with brain science, neuroscience, cognitive science, and developmental psychology are expected. SI is one approach to a new discipline called ``Humanoid Science'' that aims at providing a new way of understanding ourselves and a new design theory of humanoids through mutual feedback between the design of human-like robots and human-related science.

"Humanoid Science" under which a variety of researchers from robotics, AI, brain science, cognitive science, psychology and so on are seeking for new understanding of ourselves by constructivist approaches, that is expected to produce many applications. SI adopts a methodology called "Cognitive Developmental Robotics" (hereafter, CDR) エラー! 参照元が見つかりません。 that consists of the design of self-developing structures inside the robot's brain, and the environmental design: how to set up the environment so that the robots embedded therein can gradually adapt themselves to more complex tasks in more dynamic situations. Unstructured terrains are opponents for adaptive walkers to negotiate with in order to generate dynamic motions. The caregiver's behaviour to a robot is one environmental design issue since parents, teachers, and other adults adapt themselves to
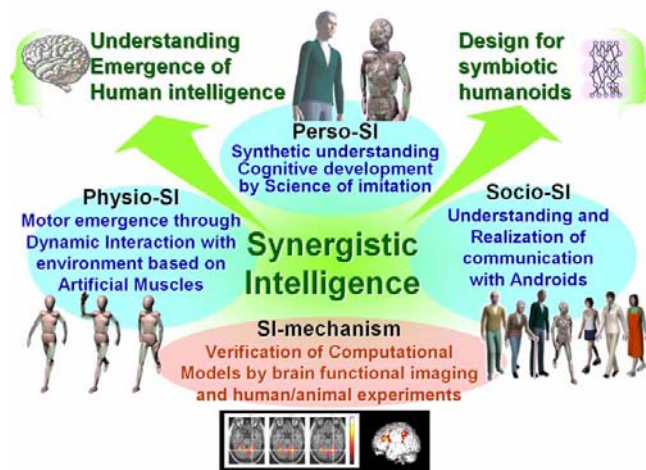
the needs of children according to each child's level of maturity and the particular relationship they have developed with that child.

One of the most formidable issues in SI is "Nature vs. Nurture": to what extent should we embed the structure, and to what extent should we expect the development triggered by the environment? A symbolic issue is "Language Acquisition."How can robots emerge the symbol in the social context? What is the essential element in this process?

This paper presents an introduction of SI and its preliminary studies on emergence of communication. The project aims at building cognitive developmental artificial agents (humanoids), understanding natural agents (humans), and their mutual feedbacks (see Fig.\ref{fig:SIov}). The project consists of four groups: (1) Physio-SI: whole body dynamic motions such as walking, running, and jumping, (2) Perso-SI: cognitive developmental robotics including body image, imitation, and language communication, (3) Socio-SI: emergence of communication and society by androids, and (4) SI-mechanism: neuroscientific supports for Physio, Perso, and Socio-SIs.

References
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