A Protolanguage for an Infant Robot

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The Problem: The research problem is to endow an embodied social creature with a natural protolanguage comparable with that of a child learning her mother tongue. Kismet (see Fig. 2) is a robot for social interaction that has been developed in the lab [2] which lends itself naturally to such a task. Protolanguage is a subset of natural language which develops and extends as the infant grows, but at all stages is characterized by a limited lexicon and a lack of grammatical rules. Nonetheless, it is a meaningful and flexible communicative system adequate for the interactions of the caretaker-child type that the robot is designed for.

Motivation: We are interested in building a socially intelligent machine. Social beings such as ourselves have evolved language as a highly sophisticated communication system, where each act of speech is intended to benefit the speaker in some way. There are similar reasons for Kismet to be able to interact with its caretakers using a "natural" proto-language. It has a rather limited set of means of manipulating the world to its benefit, so it should have good means of getting humans to do the job. This will also make the robot more believable for the naive caretaker, and will result in increased interaction. Finally, the complexity of interaction in the rich linguistic environment will boost the robot's ability to learn more sophisticated behaviours.

Previous Work: Development of a natural protolanguage for Kismet builds on all the previous work on the robot [2]. The linguistic behaviour will interact with all other perceptual and social capacities, and it will be enhanced by the ability to recognize vocal affect [3] as well as words in robot-directed speech.

Recent work in robotic language acquisition focused on the evolution of artificial languages in a population of agents [7] or on word acquisition grounded in perceptual channels [6]. We hope to address the more novel question of grounding language acquisition primarily in social interactions.

Approach: We take a developmental perspective on the task which also draws on current ideas in the fields of psycholinguistics and language acquisition [1, 4]. We believe that the first step in the formation of an utterance happens at the pragmatic level where a manipulative intent is released. The robot speaks when its internal drives have to be satiated via the achievement of some goal in the world, which can be accomplished by vocalization. Initial vocalizations consist of conversational and canonical babbling (articulated polysyllabic utterances), which have been implemented on Kismet.

We then use the social modelling technique [5] to teach the robot to associate particular vocal patterns with the expected effect on the environment. Thus the robot learns to use its vocal abilities in specific ways which are meaningful in the context of interaction with the caretaker. In this respect Kismet is developmentally equivalent to an infant under one year old. We expect that if the human-robot interactions are qualitatively similar to those between parent and child, the robot should learn the same basic categories for early vocalizations.

Difficulty: Language is a hard problem both for psychology and artificial intelligence. We do not know the mechanisms of language acquisition in children, although there are many detailed accounts of its stages of development. Difficulties also lie in integrating linguistic behaviours with the rest of the robot, as well as the robot's limited perceptual and pragmatic abilities compared to human children.

Impact: Spoken language is one of the most powerful social tools for humans. When transfered to the domain of human-robot interaction, it has the advantage of requiring no special skills from the caretaker, who intuitively interprets the communicative acts as meaningful. Potentially, this approach can be pursued in developing social interfaces for end-user oriented applications and artificial creatures.

A robot that learns the language in the same way as children do will not be manipulating meaningless symbols, but using its linguistic knowledge to express its needs and manipulate the world. An observer could describe such a

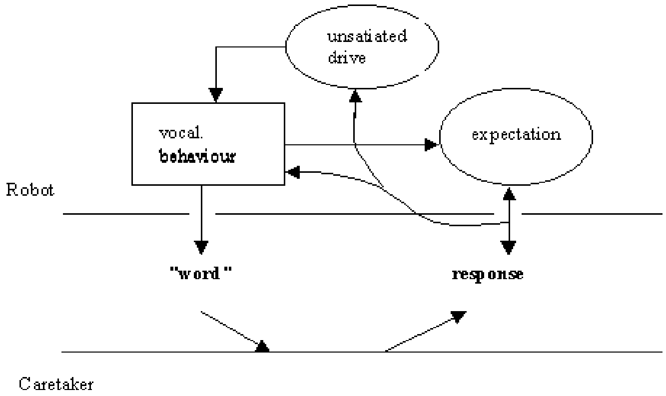

Figure 1: A Protolanguage Scenario: High-level description.

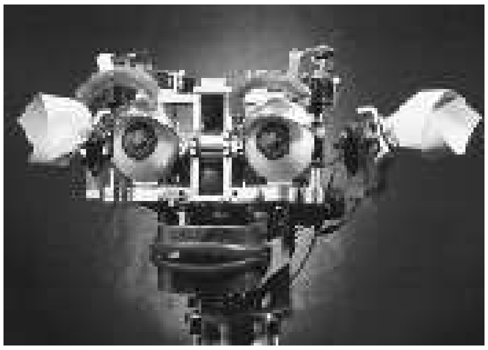

Figure 2: The Sociable Robot Kismet [2].

language at all levels, from pragmatic intentions of the speaker to the phonemes that are produced and heard. The whole exercize will pave the way for fully socially able machines.

Future Work: After the proto-language phase is complete, the research will focus on designing a mechanism for rapid object-word acquisition, then consider grammatical development. We hope to eventually teach Kismet how to speak in a meaningful way.

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