A Cognitively Motivated Architecture for an Anthropomorphic Artificial Communicator

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Research Context - Scenario

The context of this work is the project *D3-System-integration* of the Collaborative Research Center *SFB 360* which is concerned with situated artificial communicators. The scenario consists of task-oriented, mixed-initiative dialogs between an instructor and a constructor who collaboratively build aggregates from the „Baufix" wooden toykit. The agent is able to play both roles, that of an instructor and that of a constructor.

A cave-like virtual reality installation serves as a development environment in which the user is equipped with data gloves, a microphone and optical position trackers.

Perception

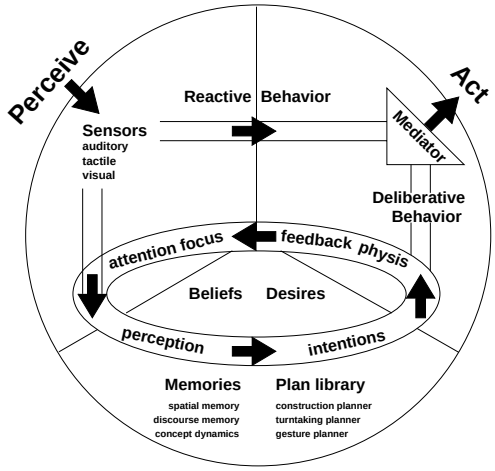
- modeling of virtual view and touch sensors
- detectors for turn-taking signals
- attention foci, releasing mechanisms
- perception of scene information (virtual constructor)

Reactive Behavior

- secondary actions (embodiment)
- gaze tracking, focusing
- reflexes (releasing mechanisms)
- self-activating, hierarchically layered

Architectual Ideas

- *hybrid architecture* with parallel, asynchronous, concurrent processing in perception, reason and act
  - *deliberative* module (Belief-Desire-Intention kernel partly based on JAM), *reactive* module (behavior-based)
- explicit representation of goals (*Desires*) , differentiation between persistent top-level goals and instantiated sub-goals
- plan library represents possible courses of action as *plans* with preconditions, context-conditions, effect and an utility function (goal-driven as well as data-driven plans)
- simple plans enable direct instantiation of behaviors, more complex plans govern dynamic self-contained planners
- modular structure to facilitate integration of different modules (memories, planners, reflexes) with different representation forms
- plan with the highest utility becomes the *Intention* and is allowed to manipulate internal variables, to sub-goal as well as to instantiate behaviors to act



Deliberation

- *Beliefs* consist of currently relevant facts, which are asserted by different memories either on demand or when important facts arise, they are part of the working memory
- activation values for beliefs (forgetting)
- episodic memory module
- assembly planner module
- simple spatial memory module
- extended goal representation format (possible to declare additional constraints) which allows for the dynamical adaption of plans
- emotions evolve in the context of goal attainment or goal failure and may influence the action selection process
- rudimentary turn-taking abilities (conversational role, conversational state)

References:

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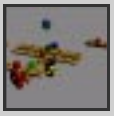
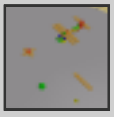
Example dialog: Episodic Memory

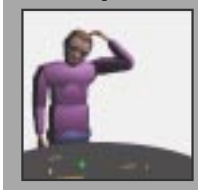
User: Take a three-hole bar.
Max: Okay.
[*Max confirms and creates a bar which appears on the table.*]
User: Put the front bolt in the middle hole of the bar.
Max: Sure. [*Max assembles.*]
User: Put the propeller in the middle hole of the prop-blade.

Max: Yes. [*Max assembles.*]
[*The context of constructing a toy aeroplane allows Max for anticipating the unfinished propeller as such and the three-hole bar as a prop-blade. Therefore Max is able to perform the right action.*]
User: Turn one prop-blade perpendicular to the other.
Max: Okay. [*Max assembles.*]
User: And now do the same thing again but use a five-hole bar.

Max: Sure. [*Max assembles.*]
[*Max conceptualized the propeller building episode and he is able to change this concept in parts. He dynamically adapts the plan for this concept to the environment.*
He decides to use the yellow screw and the five-hole bar to be able to build a propeller. As one five-hole bar is missing he creates one.The concept of a five-hole propeller is now permanently added to Max's sLTM.]
Max: The five-hole propeller is finished now.

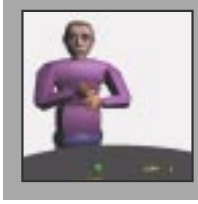




Example dialog: Cooperative Assembly Task



User: Explain the assembly of a propeller.
Max: Lets build the propeller together. First a screw has to be inserted into the middle of a three-hole-bar.
[*The User takes the turn and proposes an instruction.*]
User: Insert the yellow screw into the bar.
[*Environment: A yellow screw is inserted in the first hole of a bar.*]
Max: No, that was the wrong hole.
[*Environment: The wrong action is undone,the yellow screw is pulled out the bar.*]

Max: I show it to you again. A screw has to be inserted into the middle of a three-hole-bar.
User: Insert this screw into the middle of the three-hole bar.
[*Environment: The assembly is performed.*]
Max: Okay. Now, insert this screw into a three-hole-bar.
[*During his explanation Max points at the yellow screw.*]
User: You do it.
Max: Okay. I will perform the action.
[*Environment: The objects are connected as instructed.*]



Max: And now the bars need to be turned crosswise to each other.
[*Max shows the rotation using a gesture.*]
[*A long pause occurs and Max takes the turn.*]
Max: Well, then I will do the construction-step.
[*Environment: The objects are rotated as instructed.*]
Max: Great. We have just completed the assembly of a propeller.