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Simulation Model of the Neurocognitive System Controlling an Intellectual Agent Displaying Exploratory Behavior in the Real World

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SUMMARY

The paper presents the neurophysiological mechanisms of human exploratory behavior. The possibility of modeling such behavior in an intelligent agent based on a multi-agent neurocognitive architecture is shown.

An autonomous software agent has been developed, in the control multi-agent neurocognitive architecture of which a system of intrinsic motivation is provided for the implementation of exploratory behavior. This behavior is aimed at forming the completeness of the functional representation of the fragments of the "intelligent agent - environment" system observed with the help of the agent's sensors. Intrinsic motivation is an algorithm for stimulating an intelligent agent to perform certain behavioral programs by forming an internal stimulus (reward) to perform this program in a multi-agent neurocognitive architecture.

It is shown that in the process of exploratory behavior, an intelligent agent immersed in a communicative environment forms a speech and information model of the world due to the dynamic formation of functional systems based on the cooperation of neural agents.

INTRODUCTION

The paper considers the neurophysiological mechanisms of human exploratory behavior and the possibility of modeling such behavior in an intelligent agent based on a multi-agent neurocognitive architecture.

The aim of the work is to develop a simulation model of a neurocognitive control system for an autonomous robot performing exploratory behavior in a real environment.

The task of the work is to develop an autonomous software agent, in the control multi-agent neurocognitive architecture of which a system of internal motivation to perform exploratory behavior is provided.

METHODS

Model of the exploratory behavior of an intelligent agent is proposed to be designed on the basis of a multi-agent neurocognitive architecture.

The control neurocognitive architecture of an intelligent agent is an invariant of the organizational and functional structure of the intelligent decision-making process. An invariant based on a multi-agent neurocognitive architecture consists of software agents-neurons (agneurons) of varying degrees of complexity that perform a sequence of mandatory operations: recognition of input patterns, emotional evaluation, goal setting, synthesis of an action plan, proactive modeling, plan execution management.

Figure 1 shows a diagram of a multi-agent algorithm for the intrinsic motivation of the exploratory behavior of an intelligent agent.

The system of intrinsic motivation means an algorithm for stimulating an intelligent agent to perform certain behavioral programs by generating an internal stimulus (reward) for the implementation of this program in the form of obtaining additional energy in a multi-agent neurocognitive architecture.

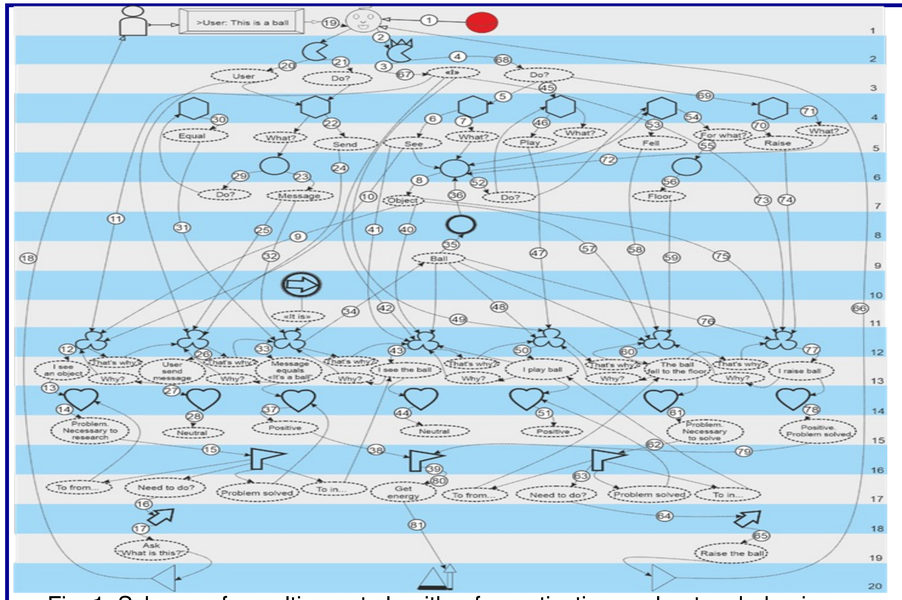

Fig. 1. Scheme of a multi-agent algorithm for motivating exploratory behavior.

At all levels of the neurocognitive architecture, in exchange for the information they have, agents receive energy from counterparties, thus “prolonging” their lives. In turn, this coordinated behavior of agneurons allows the intelligent agent to reach the target state, colored by a positive emotional assessment, which leads to the acquisition of new knowledge and additional energy.

RESULTS

To conduct experiments on the training of managing neurocognitive architectures, research behavior has developed a prototype of the control system of an autonomous agent, which has two information processing channels: visual (video camera) and verbal (keyboard). Figure 2 shows a three -dimensional image of a certain part of this architecture, built by the graphic visualization of the used software complex.

In the process of research behavior, an intellectual agent forms a speech model of the world in the form of conceptual agneurons of various types, which are combined into multi -agent facts in the form of event agneurons, which in turn form a related information network. This is possible due to the fact that the exchange of messages between agneurons, intellectual agents and communication with the user occurs in a natural language. In the process of such an exchange, the ontology of the “Intellectual Agent-Environment” system is formed.

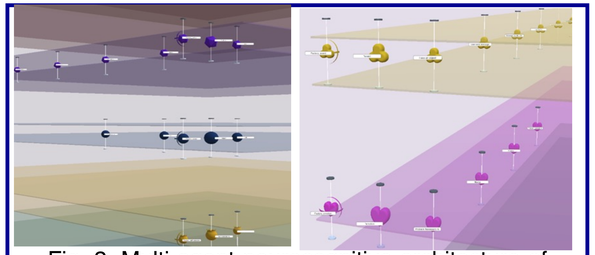

Fig. 2. Multi-agent neurocognitive architecture of an intelligent agent

CONCLUSIONS

1. The main result of the work is the conclusion that the approach to the design of intelligent systems based on multi-agent neurocognitive architecture is able to provide simulation of the neurophysiological mechanisms of human exploratory behavior.
2. An autonomous software agent has been developed, in the control multi-agent neurocognitive architecture of which a system of internal motivation is provided for displaying exploratory behavior aimed at forming the completeness of the functional representation of fragments of the agent-environment system observed with the help of the agent's sensors. One of the essential features of a holistic functional representation is a natural language description of the current situation, thanks to which the agent forms an interconnected information network "intelligent agent-environment". The agent extracts this information from dialogues with other agents (users, software agents and robots) in the communicative environment.

ACKNOWLEDGMENTS

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