ІНФОРМАТИКА ТА МЕТОДИКА ЇЇ ВИКЛАДАННЯ

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INTELLECTUALIZATION OF THE SMART HOUSE SYSTEM (THE AGENT-ORIENTED APPROACH)

The paper presents some aspects of the problem of intellectualization of the «smart house» system based on the agent-oriented approach. Two types of the agents of the «smart house» – programming and intellectual – are analyzed. It is offered to use the ontology with the help of which the important concepts and logical rules concerning the «smart house» system can be described. It is proved that the «smart house» is the most evident use of the agent-oriented approach in the sphere of the Internet of Things, one of the simplest and most understandable one.

Keywords: *agent, agent-oriented approach, intellectualization, Internet of Things, ontology, smart house.*

Introduction

Problem statement. The term «smart house» or «smart home» (often «intellectual building») was first formulated by the Institute of Intellectual Building in Washington in the 70s of 20th century. It means modern office and residential premises with the integrated software and hardware control and monitoring system for all the facilities and systems located in the building (security, lighting, communication systems, microclimate), and the networks serving this building. The notion «intellectual building» is used when spoken of large office building or apartment buildings, and the name «smart home» is more appropriate for private houses, apartments or small offices. In the paper the term «smart

house» is used, as the authors consider it more appropriate and unified to join the above mentioned notions.

The basic objective of the «smart house» is to improve the safety and comfort of its inhabitants. At present, the following main systems are used to «intellectualize» buildings in the world: **centralized systems** (AMX, Crestron, Lutron); **decentralized (bus)** systems (EIB, LonWorks, C-Bus, BACnet); **radio** and **power** systems (GIRA, LEGRAND, BTCINO).

The systems of «smart houses» became popular and implemented in the middle of the 80s of the 20th century. Currently the volume of the global market of intellectual systems and automation services is about $ 20 billion. At the same time, Japan occupies one fifth of the market, North America accounts for a quarter, and the European countries account for more than 40%.

Main Body

Purpose and objectives. The purpose of the paper is to analyze some aspects of the problem of intellectualization of the «smart house» system taking into account the agent-oriented approach. The purpose stated presupposes solving the following **objectives**:

1) to consider two types of the agents of the «smart house»;

2) to determine the role of ontology when describing the important concepts and logical rules concerning the structure of the «smart house»;

3) to prove that the «smart house» is the most evident use of the agent-oriented approach in the sphere of the Internet of Things, one of the simplest and most understandable.

The scientific novelty of the study is in the interaction of the intelligent agent with the «smart house» system and in the description of the intelligent agent as a smart software bot that performs the commands and actions specified by the user of the «smart house» system.

Presentation of the main material. With regard to the «smart house» systems, the «Internet of Things» (the IoT) concept can be implemented by transferring some data from a variety of sensors used in the system to the cloud, where they will be processed and stored, as well as by sending commands from the user to the final controlled devices [1]. In turn, the user will have access to the interface (via a browser or a mobile application) designed to monitor data from sensors, as well as to control devices. But the «smart house» can be made smarter with the help of the agent-oriented approach, namely, single intellectual agents or a family of such agents (the so-called multi-agent system).

The agent-oriented approach involves breaking some applications into the large-scale granulated, loosely torn components that encapsulate more functionality than such software abstractions as methods and classes. The theory of agents and multi-agent systems offers such high-level concepts as agent roles, plans, goals, communication and negotiation protocols. Unlike traditional object-oriented software servers, which have developed means of interacting with the environment and other objects and providing certain services to clients, the agents are able to act rationally and draw logical conclusions under the conditions of incomplete and contradictory information received.

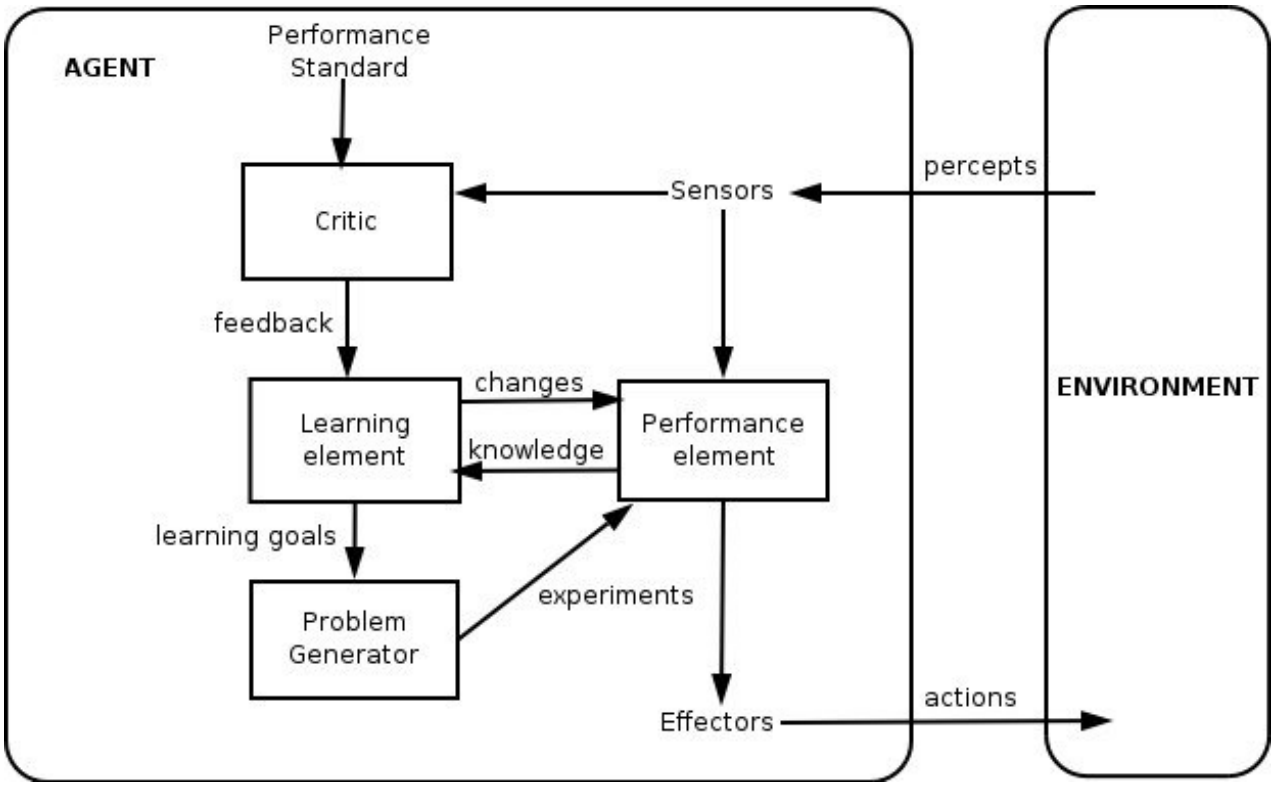
The agent is a real or virtual autonomous entity operating in an external environment, capable of perceiving and acting in this environment. The agent can communicate with other agents, manifest independent behavior, which can be viewed as a consequence of its knowledge, interactions with other agents and the goals that it has to achieve [2]. Thus, the multi-agent system is a complex system that consists mainly of agents. The model of beliefs, desires, intentions, BDI is a popular technique of designing agents [3]. In this model, «beliefs» are known to the agent information about the world, as well as the rules for deriving new information from the available ones, «desires» correlate with the planned tasks of the agent, and «intentions» – with the actions that the agent must perform to carry out its tasks. This model also includes «events» – something that can change «beliefs», «desires» and «intentions». The classic BDI models use the temporal Computational Tree Logic (CTL), however, it should be understood that literal (rather than conceptual) following such constructions can significantly complicate software development due to the difficulty of implementing the CTL.

The Internet of Things and multi-agent technologies are inextricably linked. Each participant from the real world (that is, each person and each device) is assigned a software agent — an object with some degree of intelligence that represents its interests in the virtual world. At the same time, the interconnection of the real and virtual worlds is bidirectional: decisions from the virtual world are given to reality for execution, and all the events of the real world (very often unforeseen) affect the virtual world.

Specifically, for the systems of «smart house» these agents can be of two types – a software agent, often called a bot, which can perform certain actions both independently and under the direction of the owner, and an independent intelligent agent that works with the help of a trained neural network.

The software agents-bots in the «smart house» are usually involved in routine tasks, for example, copying and transferring information to the cloud, turning on and off some elementary non-dangerous devices, and receiving standard messages.

The intelligent agent takes on more complex tasks, for example, such as adjusting all the systems of a «smart house» to the rhythm of the owner's life, managing more complex processes related to electronics (see «The diagram of the intelligent agent» below).



As an example of work of a more sophisticated intelligent agent, it can be analyzed the work of a person and a coffee maker from different perspectives. Let us suppose that in our «smart house» a human agent constantly communicates with a coffee maker agent, giving definite commands and exchanging information. Something similar can be observed in the real world. A human wants to have coffee, he turns on his coffee maker, opens a block with coffee grains and understands that they are not enough for making coffee. This man goes to the shop to buy coffee, then he returns home and turns on his coffee maker again. If to simulate this situation from the point of view of the multi-agent system, then the intelligent agent will ask to buy coffee beans or capsules before they run out. How will the request be executed? It will probably get into the queue to the agent which is responsible for the purchases, and this agent will notify the person that it is necessary to buy grains or capsules by simply adding this item to the standard shopping list marked «not enough». This all seems unattainable, but it is enough to recall such a thing as ontology (an attempt to comprehensively and thoroughly formalize a certain area of knowledge using a conceptual scheme).

With the help of ontology, one can describe important concepts and logical rules, and the intelligent agents used in the «smart house» system will be able to use this knowledge to achieve goals and to correctly interact with one another. The user can create the ontology of the house, the ontology of the workspace, and the data described in them must match each other. With this approach, it turns out that one can have both a «smart» office and a «smart» building.

The most frequent way to use ontologies is only the way to store knowledge that is rigidly structured. Moreover, this knowledge, as a rule, speaks only of a certain essence of the physical world. Why not go further and not keep the rules of interaction, the logic of the smart Internet of things in ontologies? In practice, it may look like this: when creating the agent looks at the entity to which it belongs. For correct understanding of the properties of this entity, the agent should refer to the ontology – from there it will gather information about what this entity can do, what its needs are. Does it know how to achieve these needs, how to apply its abilities? This information also lies in the ontology.

Conclusions

The «smart house» is the most obvious application of the agent-oriented approach in the field of the Internet of Things, one of the simplest and understandable, but the Internet of Things can also be used in plants, factories, and even in elementary things.

The ideas presented by the authors in this paper show the possibility of then agent-oriented approach to the tasks of controlling and decision-making in the development of the systems for improving the models of the intelligent agents when creating evolving and self-developing structures of the «smart house».

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Інтелектуалізація системи розумного будинку (агентно-орієнтований підхід)

У статті розглянуто деякі аспекти проблеми інтелектуалізації системи «розумного дому» на основі агентно-орієнтованого підходу. Проаналізовано два види агентів «розумного будинку» — програмний та інтелектуальний. Запропоновано використати онтологію, за допомогою якої можна описати важливі концепції і логічні правила стосовно системи «розумного будинку». Доведено, що «розумний будинок» — це найочевидніше застосування агентно-орієнтованого підходу в сфері Інтернету речей, одне з найбільш простих і зрозумілих.

Ключові слова: *агент, агентно-орієнтований підхід, інтелектуалізація, Інтернет речей, онтологія, розумний будинок.*