Chapter 1.7
Hybrid Intelligent Systems in Ubiquitous Computing

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ABSTRACT

In this chapter hybrid approach to development of intelligent systems is applied to ubiquitous computing systems, in particular, to smart environment. Different classifications of Hybrid Intelligent Systems (HIS) are looking and two examples of hybrid approach for smart environment are suggested: framework based on expert system and neural network for programming of behavior of smart objects and paradigm of context-based programming-learning of behavior of intelligent agent. Besides this chapter offers an attempt to systematize concepts for development of HIS as any introduction to methodology for development of HIS is suggested. The author hopes that this chapter will be useful for researchers and developers to better understand challenges in development of ambient intelligence and possible ways to overcome them.

INTRODUCTION

Now ubiquitous computing, ambient intelligence and smart cooperative objects are viewed as a major paradigms shift from conventional desktop application development. This view is enabled through the use of diverse hardware (sensors, user devices, computing infrastructure etc.) and software, anticipating user needs and acting on their behalf in a proactive manner (Weiser, 1991; Satyanarayanan, 2001). This diversity of hardware and software information increases the degree of heterogeneity.

In order to realize such ubiquitous computing environment, three technology areas are required:

1) Sensing technology where information on user and surrounding environment are perceived and collected,

2) Context aware computing (Schilit, Adams & Want, 1994; Baldauf & Dustdar, 2004) technology where such information are processed and properly presented to users as different services,

3) Wireless network technologies (Mahalik, 2007) where information are collected from sensors and distributed to customers – services and users.

One of most perspective technologies for sensing and perception is neural networks.

We may pick out following main features of ubiquitous computing systems (UCS):

1) distribution of obtaining and processing of sensor information,

2) variety of information needed processing,

3) necessity of learning during interaction with environment, in particular, in respect to existing of unexpected events and objects needed for including into processing,

4) key role of different kinds of human-machine interaction,

5) high requirements to security,

6) data processing in real time,

7) wide usage of embedded processing units.

There are following tasks for neural networks in development of ubiquitous computing systems:

1) perception, i.e. recognition of objects and changes in environment, in particular, invariant recognition of moving objects, e.g. recognition of gesture, position and emotions of human beings,

2) clustering and recognition of events and scenarios (sequence of events in time),

3) prediction of future events and situations,

4) indoor localization of mobile devices and continues mapping,

5) reactive behavior based managing of actions,

6) speech recognition.

From above we can formulate following requirements to neural networks for UCS:

1) Relatively fast processing of information in both learning and recalling,

2) Incremental learning, i.e. availability to perceive new information without loss of old knowledge,

3) Availability of easy extraction of structure from learnt neural network for building of symbolic knowledge for usage in machine-human interaction and planning.

On the other hand context awareness usually is implemented by symbolic based reasoning and knowledge-based techniques (Hung, Shehzad, Kiani, Riaz, Ngoc & Lee, 2004). Besides rules based approach is appropriate for human-machine interface for programming of behavior of smart objects (Tarik, Sarcar, Hasn, Huq, Gavrilov, Lee & Lee, 2008) and for any explanation for user.

The following tasks are more relevant to rule based and other symbolic techniques:

1) A prior description of behavior of smart object with respect to perceived objects/situations and context, including managing of dialog with user;

2) Reflex to perceived important situation starting determined behavior;

3) Diagnostics of sensor network;

4) Specific tasks in ubiquitous computing system, for example, dealing with medical diagnostics of patient in healthcare system, or decision making in recommendation systems;

5) Human-computer interaction based on natural language.

Therefore, obviously that hybrid intelligent system (HIS) approach based on combination of neural networks and formalized knowledge is most perspective for implementation of ambient

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