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Neural controller for smart house security subsystem

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Abstract

The Smart House security subsystem is presented in the paper. The subsystem is based on neural controller that uses an artificial neural network of a multilayer perceptron type, a model based on the Petri nets theory and physical model based on an Arduino microcontroller. The model of artificial neural network is developed using C++ and loaded into microcontroller memory. The presented security subsystem Smart House supports processing fuzzy and semistructured data received from sensor subsystems.

Keywords: neural controller, Smart House, security subsystem, model, artificical neural network, Petri net;

1. Introduction

We now live in the period of large-scale introduction of smart technologies in all the fields of human life, viz.: smart city [1], web environment [2], smart transport [3], mobile smart systems [4], smart image processing technologies in medicine [5], etc. The increasing demands for apartments of higher standards have led to the

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appearance of 'Smart House' technologies (SH) [6] based on the development of an existing technical means. This technology, besides ensuring comfort of the owner [7], provides considerable savings, that may reach 50% [8].

The 'Smart House' system includes the following subsystems: lighting, climate control, protection, security, etc. [9]. Analysis of the current situation in this field in Ukraine [10–12] allows to talk about availability of a number of impediments causing slow speed of large-scale introduction of such technologies, viz.: high cost, low threshold for intellectualizing on the concept of Smart House. Consequently, the topical issue is to develop SH subsystems on the basis of cheap microcontrollers. The SH subsystems make it possible to reduce the total cost of the system. They use artificial neural networks to secure the higher level of intellectualizing on the concept Smart House and it functions.

2. The structures of neural controller for the 'Smart House' security subsystem

One of the first steps in the development of any system lies in the elaboration of its structure. A Smart House security subsystem (Fig.1) has been developed. It is based on the modular principles and includes a set of modules of the same type. This makes it possible to facilitate the software and hardware implementation of the subsystem. The neural controller managing the 'Smart House' security subsystem constitutes the core of the developed structure. The software implementation of the neural controller an artificial neural network (ANN) based on a multi-layer perceptron [13–15] was used, though, depending on the complexity of SH functions, other types of ANN [16, 17] as well as parallel hardware representations of neural structures [18, 19] can be used.

In general, the developed structure of 'Smart House' security subsystem includes its own neural controller for every building, each of which is managed by the SH management system. This implementation is very special since relatively cheap microcontrollers are used and the process of parameter management in each of the rooms is independent. And thus high reliability of such structure as compared to the use of one powerful controller, where, in case the microcontroller fails, the whole subsystem stops working, is secured. Along with that, to improve performance reliability industrial microcontrollers of the STM category [20, 21] or others may be used.

Generally, such structure of the subsystem can be described using the following model:

$$Mod_{room} = \left(S_{\text{sensors}}, N_{\text{neural controller s}}, Z_{\text{actuators}}\right), \tag{1}$$

where S_{sensors} – a multitude of sensor subsystems for each premises of the 'Smart House'; $N_{\text{neural controller s}}$ – a multitude of neural controller subsystems; $Z_{\text{actuators}}$ – a set of subsystems of actuators.

In its turn, S_{sensors} contains m – elements which are sensor subsystems for every specifically taken dwelling. In case there is m – dwellings for the security subsystem, we will have m – elements each of which is marked with the respective index: $S_{\text{senosrs}} = \left(s_1, s_2, \ldots s_m\right)$.

Similar expressions can be recorded for the multitude of neural controllers and performing devices, viz.:

$$N_{\text{neural controller}} = \left(n_1, n_2, \ldots n_n\right),\ Z_{\text{actuator}} = \left(z_1, z_2, \ldots z_m\right) \tag{2}$$

where s_i – a sensor subsystem for i^{th} dwelling ($i = \overline{1,m}$); n_i – a neural controller for i^{th} dwelling; z_i – a subsystem of performing devices for i^{th} dwelling.

Respectively, let us give an example of model and neural controller software development for one room, while for others it will be similar (or will be implemented under the same scheme).

Thus, it is necessary to develop a neural controller that simulates a simple artificial neural network of the multi-layer perceptron type to manage protection elements for one room. This type of artificial neural network is enough to implement the necessary functions.