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MANAGEMENT OF AN INTELLIGENT BUILDING

The paper characterizes some selected aspects of intelligent building technology. Various functions are described that enable optimal controlling of the devices operating in accordance with previously programmed instructions and with current information. Such control is aimed at ensuring economic functioning of the building by reasonable and sound management of its resources (chiefly the energy) and to guarantee safety and comfort of the inhabitants. Examples of realization of these functions are presented, together with the computation – visualization software. The DomoSim visualization – designing software is characterized, that is intended for control and automation purposes.

1. INTRODUCTION

An intelligent building is provided with an integrated and compact management system (*BMS – Building Management System*) and a set of fittings and devices, sensors and detectors ensuring the control process. Each of the elements is coupled with the others, and transmits the information of its current state or operation with the help of proper sensors and detectors. These elements reply to the obtained data in previously programmed manner [7].

Such solutions are known and implemented from 40 years, both in private and office objects, in new and adapted buildings [1,3,8].

Objectives of intelligent building management are [2,7]:
- reduction of operational cost, with special attention paid to energy saving;
- ensuring safety of the inhabitants and the building;
- improvement of the comfort of building usage.

This goal is achieved with the help of several various functions. Management may be proper and effective thanks to the use of modern technologies and equipping the building with various sensors, detectors, control and automation elements [3,7].

Management is accomplished by:
- the information collected by the system (the check, monitoring);
- appropriate analysis of the operation;
- proper decisions.

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2. REALISATION OF BASIC FUNCTIONS OF BUILDING MANAGEMENT

Basic functions belonging to the building management system are shown in Figure 1 [7].

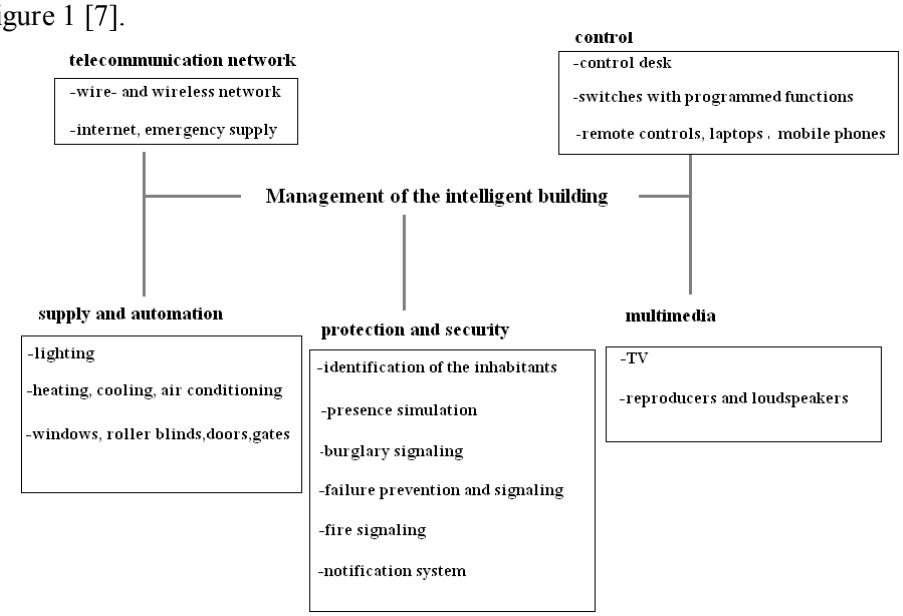

Fig. 1. Basic functions of intelligent building management

Equipment of the building in automation systems enables optimal controlling of operation of power receivers, according to previously programmed instructions and current information related to temperature, insolation, presence of inhabitants. Hence, the control enables reasonable and economical use of available power resources, and security [5].

The function realizing the supply and automation (Figure 1) when properly programmed, ensures complex control of lighting of the whole building, based, for example, on measured light intensity [9]. The lighting may also operate in replay to motion sensors, e.g. from the MCR group. In this situation it is constrained to a given room. Such a solution may be used in staircases. Microwave motion sensor based on emission of high frequency and low power radio wave may operate through glass or wood. It is a safe, reliable, and power saving device. Once it is provided with a twilight sensor and potentiometer it allows for automatic switching the lighting on in programmed conditions. At the same time, it prevents switching the light on by daytime. The lighting may be controlled with the help of the Exta control system [10].

Proper management of natural daylight may be achieved by controlling of the shutters.

Figure 2 illustrates possible lighting control on the example of the DomoSim program (chapter 4). This goal may be attained with the help of dimmers that adjust the lighting intensity to the required level [10].

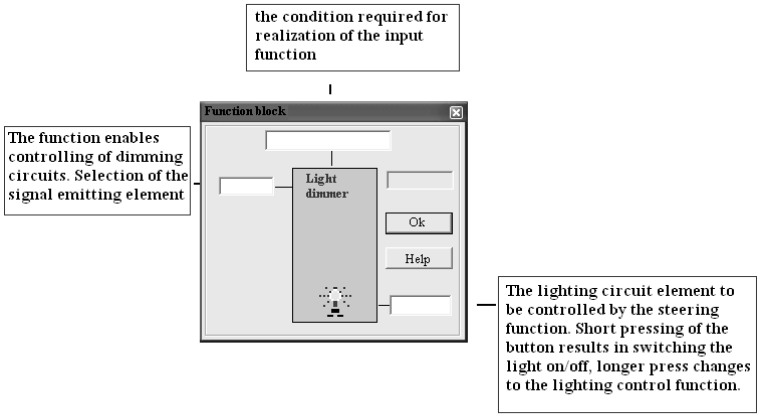

Fig. 2. The function changing the lighting intensity on the example of the DomoSim program

The information on current air condition (humidity, carbon dioxide) also allows to control the ventilation, air conditioning, and filtration.

The functions pertaining to the supply and automation also realize heat management. For most of the solutions full control of heating and cooling is possible. Operation of this function should be individually adjusted for each room. It may be performed based on the heating curve. The devices automatically switch on or off according to the signals related for example to temperature [8]. In winter ventilation may be considered as an additional heating system, since the heat exchanger it is provided with, recuperate the power used for heating the air flowing inside [9].

The shutter control system may operate both based on time signals or using the information coming, for example, from twilight or temperature sensors. The windows provided with controlled shutters prevent overheating of the room in summer.

In such condition the building interior is protected with outer shutters in the windows, on southern and western walls, that are automatically or manually controlled [14]. Appropriate shutters control also prevents cooling in nights.

Figure 3 shows the function of heating control [13]. The planned ventilation is also provided thanks to central power management.

The system that is additionally provided with weather sensors/weather stations may decide of closing the windows.

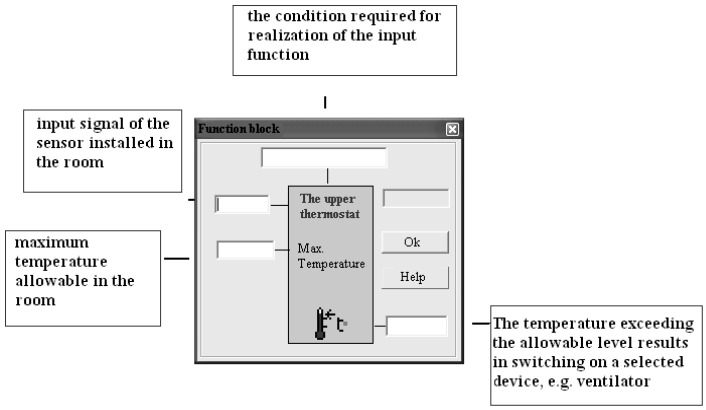

Fig. 3. The heating control function on the example of the DomoSim program

In this group of functions the switches controlling the doors and gates are programmed.

The duty of securing safety and protection (Fig. 1) seems particularly important. It includes the fire protection system that, in reply to the signals obtained (smoke, dangerous temperature growth), undertakes the action even when inhabitants are absent. It notifies proper service and inhabitants, switches off power supply, starts the air extractors, closes the fire walls and seals.

Figure 4 shows examples of the functions carrying the fire protection into effect.

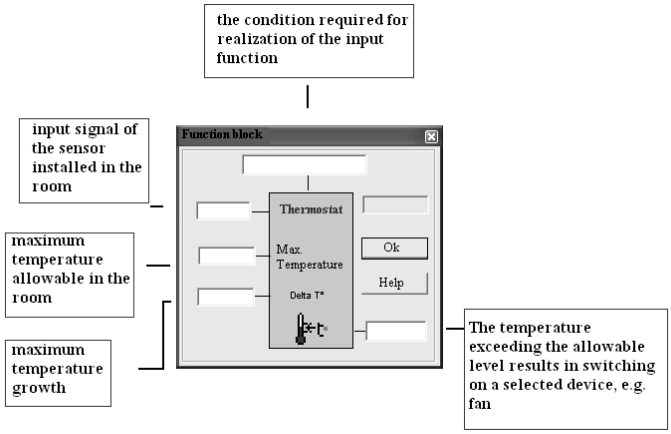

Fig. 4. The fire protection function on the example of the DomoSim program

The BMS System is also provided with burglary protection. Thanks to monitoring and infrared protection barriers it signalizes any untypical events and sends appropriate information. A specific burglary protection is provided by

simulation of building inhabitants presence. The duties belonging to this group include also identification of the persons and vehicles [4,7].

Another type of preventive mean includes breakdown protection, among others by automatic switching off the devices that are unnecessary when inhabitants are absent.

Further group of the functions (Fig. 1) consists in multimedia and loudspeakers control. It plays lower role and allows using the TV signal in any room. Sounding control with the use of remote controls or laptops enables receiving music programs in a selected room, provided that a CD reproducer with disk changer is available and loudspeakers are assembled in the walls. This function belongs to the group that gives comfort to the inhabitants.

Universal wiring or wireless communication allows using a computer, stationary phone, and internet in any room.

An intelligent building should be provided with emergency supply. It is of particular importance considering the need of supplying the alert system.

The control function, Fig. 1, includes the control desk that is the system centre. It allows to observe operation of integrated equipment and current changes. This is also facilitated by specifically programmed switches and remote controls. The bistable switches [10] may be of remarkable importance in this case. They enable independent controlling of any device from many locations. The control may be performed by means of a laptop or mobile phone.

3. REVIEW OF COMMON PROGRAMS SERVING THE BUILDING MANAGEMENT

The computer market includes many computation – visualization programs that may be used for analysis of power flow in the building. They enable determining the power demand and its possible generation [5,11].

The software that allows to determine the power demand, the rate of air flow or the temperature distribution is called DesignBuilder [6]. It is characterized by easy modeling of a real building and possible dynamical analysis of the power flow in it [5]. In order to compute the power characteristics of a building the DesignBuilder software uses the EnergyPlus (a modern simulation tool). It may provide, for example, visualization of temperature distribution. Such a visualization analysis may, for example, suggest extraction of the warm air from the upper storey down [using proper fans] in order to stratify temperature in the building [6].

The program Audytor OZC 3D assists the design computation of thermal load of the rooms. It is helpful in determining the heat demand and drawing up the Energetic Certificates [6]. The building model data required for these purposes may be imported from the Autodesk Revit Architecture 2012 software.

The TRNSYS program is used for dynamical simulation of the building, mostly what concerns heating, air conditioning, and ventilation [6].
In the domain of energetic simulation the idea of BIM becomes more important, together with the applications ArchiCAD, Bentley Systems, RevitAutodesk [12]. The most important quality of BIM consists in possible definition of a virtual model that includes full information on the building in an integrated form, that may be updated according to current needs. The program performs 3D modeling and enables automatic evaluation of the costs of particular solutions.

The system BAS of building automation allows to integrate the technical fittings with a view to optimize the power expense [11] with the use of the IT technology. Integration of intelligent systems of the buildings is conducive to reasonable and economic use of the energy [13]. As an example of such an approach the additional daylight lighting of the rooms or the lighting systems operating in the follow-up mode (following the motion of persons) [11].

The DomoSim visualization-designing software is usually used for intelligent systems in which the meaning of control and automation is of particular importance.

4. CHARACTERISTICS OF DOMOSIM SOFTWARE

The program is provided with graphical functions that enable preparing the building plan [4]. Simulation of its operation becomes possible already at the designing stage. The functions of the DomoSim program includes the control of:

- the lighting (light dimming, creation of advanced light scenes);
- garage and entry gates;
- heating, individually for each of the rooms and their users, according to time schedules;
- watering of lawns and gardens;
- pumps, electric catches e.g. of the doors, electrovalves (water, gas).

The program includes 512 combinations (24 of them of priority meaning [13]).

Figure 5 presents a plan of fittings of an intelligent individual house, inclusive of locations of the PIR-type sensors, control box, manipulator, and signaling device. For purposes of lighting control 7 motion sensors of PIR type and a twilight sensor are used. Alternatively, the lighting may be controlled with the use of a time schedule switch.

In the bathroom a motion sensor switches the lighting on or off, according to presence signaling. It controls ventilation with the use of virtual elements and memory bits.

For purposes of controlling the lighting of windowless rooms the reed relays of cross connection are used.

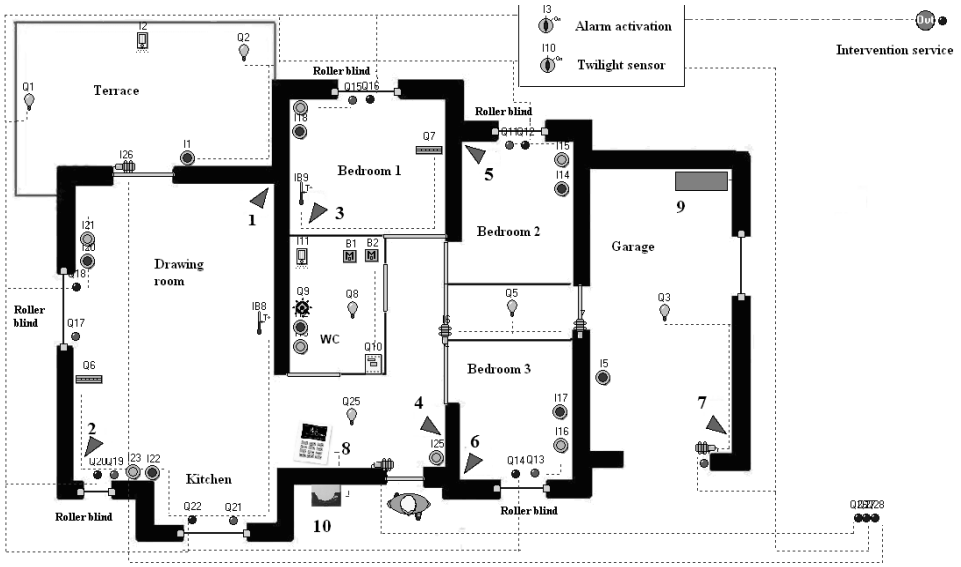

Fig. 5. Plan of arrangement of intelligent fittings of an individual house
Denotations: PIR sensors (1)-(7), manipulator (8), control box (9), signaling device (10)

Thermal management of the building is controlled similarly. Temperature is adjusted by means of sensors (with module output to electrovalves of the heaters) or according to time-schedule (Fig. 6), taking into account such factors as the outer temperature, presence of the inhabitants, night- or day-time.

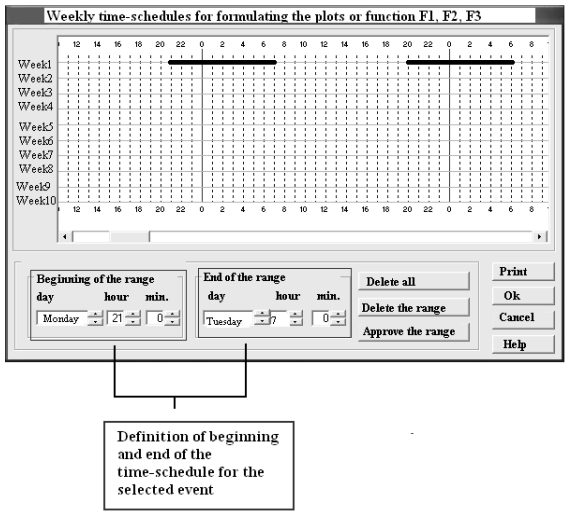

Fig. 6. Example of a time-schedul

5. SUMMARY

Designing an intelligent building not necessarily leads to large expense. Nevertheless, the cost will be repaid within several or even more than ten years.

One of the design criteria consists in saving the electric and thermal energy. Reasonable management of the power resources gives a definite advantage. The operational cost of an intelligent building may be reduced even by 50 percent as compared to conventional solution. Moreover, the intelligent house ensures security and comfort of the user. The main constraint in designing modern fittings lies in imagination of the end user. Therefore, the use of the software that enables visualization of the building provided with the home automation elements becomes important.

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