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The Application of Automation in the Construction of Smart Houses

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Анотація

Дана робота розкриває суть поняття «Розумний будинок» та «Автоматизація будинку». Також розглядаються основні принципи, сфера використання, проблеми та перспективи даної технології.

Ключові слова: автоматизація, автоматизована будівля, комп'ютери і сенсори, центральний комп'ютер, контролер, моніторинг, керуючий сигнал, перемикачі, провідні мережі.

Abstract

The work describes the essence of the concept "Smart House" in general and "Home Automation" in particular. It also studies its main principles, spheres of application, problems and prospects of the technology.

Keywords: automation, autonomous building, computers and sensors, central computer, controller, monitoring, control signal, switch, wired networks.

An autonomous automated building is a building designed to be operated independently from infrastructural support services such as the electric power grid, gas grid, municipal water systems, sewage treatment systems, storm drains, communication services, and in some cases, public roads [1]. There are several terms applied to describe the following technology. Autonomous automated houses are sometimes called Intelligent Buildings, Intelligent Homes, Smart Houses.

The design and development of smart houses encompass an enormous variety of technologies, including Building Management Systems (BMS) and building controls. Their purpose is to control, monitor and optimize building services, e.g., lighting, heating, security, alarm systems, ventilation, filtration, climate control, remote access to audio-visual and entertainment systems, etc.

The idea of creating the automated house is really appealing and popular. The first efforts to make an automated autonomous house were done in the previous century. The origins of Intelligent Buildings and Building Management Systems have roots in the industrial sector in the 1970's, from the systems and controls used to automate production processes and to optimise plant performances. The concepts and applications were then adapted, developed and modularized during the 1980's, enabling transferability of the technology and systems to the residential and commercial sectors. Thus in 1990 the architects William McDonough and Ken Yeang applied environmentally responsible building design to large commercial buildings, such as office buildings, making them largely self-sufficient in energy production. One major bank building (ING's Amsterdam headquarters) in the Netherlands was constructed to be autonomous and artistic as well [1].

The possibility to design fully or partially autonomous houses appeared due to the developments done in automation and automatic control. Automatic control can be defined as a set of various control systems for operating both different equipment and industrial processes. Computers and sensors linked by miles of wire and electronic adapters, enable it to control security systems, entertainment centers, appliances, lights, blinds, heating and cooling systems, swimming pool systems, and other systems that can be activated by electrical apparatus. The central computer, called a controller, ties everything together. People can interact with the home automation system via telephone, hand-held remotes, keypads, touch screen televisions, and voice commands. The control technologies allow integration, automation and optimisation of all the services and equipment that provide services and manages the environment of the building. The original basis of the control technologies is formed with the programmable logic controllers (PLC's). Newer commercial and residential applications are based on distributed-intelligence microprocessors. The use of these technologies allows the optimisation of various site and building services, often yielding significant cost reductions and large energy savings.

The core technology required by these installations has been commercially available for some years to provide autonomy of environmental control in large public buildings such as hotels and airports. A large number of sensors and actuators are available, and the network technology had matured to a high level. The more sophisticated networks such as the European Installation Bus/KNX and LonWorks have in-built checks to ensure communication between its various components. Such systems therefore demonstrate a high level of reliability, something important for the support of vulnerable people in their homes. Most of the current installations in public buildings also use hard wired networks in order to maintain reliability, and also because of the necessity to be built into new constructions where the wiring could easily be hidden. For installations in people's homes such extra wiring clearly causes complications. The installation is likely to be a retrofit, and because the wiring has to be routed between rooms there is a major disruption to life that can be quite unsettling to the kind of frail old people whom it is hoped might benefit. Networks that use radio frequency (RF) communication to provide the links between its components have clear advantages. Installations can be much more plug-and-play, and much less disruptive for the user. However there is always the problem of radio dead spots that can occur with RF links. In addition the sensors and support systems are likely to require a power supply, which for hard wired networks can easily be provided by the network itself, but for RF networks require an additional mains connection or the use of batteries. Fortunately for most sensors the power requirements are very small and batteries can last many months, and they can signal their need for replacement. Of course RF communication has become a major part of the design of portable appliances and the technology has become very efficient in use of power. There is also much interest in power scavenging systems that can use the fact that there is some human intervention to generate low levels of power. For example the operation of a light switch can be used to generate minute amounts of power but this can be sufficient for its communication needs within an RF based network. A further technique to hard-wired or RF systems uses communication via the mains wiring by superimposing the sensor information and control signals onto the mains waveform [2].

Having these technologies installed, your house really becomes smart. There are lots of possibilities with a smart house. If the homeowner selects the “going out” mode on the master panel, the computer can arm the security system and adjust the lighting and ventilation systems. If it’s time to celebrate at home instead of going out, the “party” setting might close the drapes, adjust the lighting, and tune in background music – all from one switch in the living room. The controller can be programmed to create whatever mood you want. If it is getting cold, you can call your smart house’s controller and tell it to turn up the heat. If you want your washing machine to turn itself on at a time when electricity costs less you just tell the controller when you want it to start.

In Japan, an experimental smart house has been built that seems warm and inviting – anything but technological. It, in fact, is filled with dozens of hidden sensors monitoring temperature, humidity, airflow, carbon dioxide, and even human presence in the house. Its sensors are part of a network linking three PCs with appliances, motor-driven windows and blinds, humidifiers, and so on.

Research in Holland reflects environmental concerns. On the roof of a smart house, a tunnel-like structure collects rainwater, which is sent to a holding tank. The water collected is used to flush the toilets and water the garden. It reduces the need to use costly drinking-quality water when rainwater is more appropriate.

A solar boiler heats washing and bath water in the smart house, and a row of photo-voltaic panels collects solar energy to change batteries for emergency power. Gas, electricity, and water meters are integrated with the controller so that utilities and homeowners can monitor consumption [3].

Smart house technology isn’t just a luxury for the wealthy. Those who are energy savers and environmentally minded will probably end up using at least some smart house features in their own homes.

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