

## INTEGRATE SMART HOME SYSTEMS INTO LOW-BUDGET HOUSING

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**Abstract:** The paper deals with some modern technologies for monitoring and conducting processes for smart buildings. It also presents a case study on the applicability of the concept of “smart home” in a “low budget” home. In principle, there are presented tangible solutions, anchored in everyday reality, which would satisfy the need for independence and freedom of modern man but also to fit into the financial reality that underlies his existence. Thus, we have tried to identify the pressing needs of each individual that can be met by a smart home, and to put them into practice taking into account the low budget we have for integrating artificial intelligence into our lives.

**Keywords:** smart home, control, monitoring, housing, sensor.

### 1. INTRODUCTION

The smart home represents a modern housing concept that integrates advanced automation and control technologies, with the purpose of increasing comfort, safety, and energy efficiency [1], [11], [16]. It allows the monitoring and control of various home systems, such as lighting, climate control, security, and energy consumption, through electronic devices and software applications.

The rapid development of information and communication technologies has led to the emergence of innovative solutions that transform traditional homes into intelligent systems capable of automatically responding to users' needs. These systems are based on sensors, [3], actuators, and programmable control units that communicate with each other through local networks or via the internet.

The implementation of the smart home concept contributes significantly to the optimization of energy consumption, the reduction of operating costs, and the increase of the safety level. Through process automation, the user can control and adjust the operation of equipment according to preferences and external conditions [12], [20].

In the current context, smart homes are becoming increasingly accessible and widespread, being used both in residential environments and in commercial or industrial buildings. The integration of these systems represents an important step toward sustainable development and the efficient use of resources [12], [22].

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The technology used for intelligent buildings may be innovative, but it necessarily relies on basic technologies. A “smart” device is equipment that, through algorithms based on logic gates, gives the impression that it can “learn” our behavior and basic needs, and, most importantly, that it does so in a personalized manner for each entity (community, neighborhood, family), and especially for each individual [13].

A smart home is a habitat—whether an apartment, office, or holiday house—that uses state-of-the-art technologies to automate systems and appliances within it [2], [8], [21]. The primary objective of a smart home is to ensure comfort, security, and utility cost savings.

Some of the characteristics of an intelligent building include the following:

- It provides data related to the performance of systems and facilities within the building.
- It monitors systems in real time and detects errors or deficiencies in building systems.
- It reports in real time and manages operations, energy consumption, and occupant comfort.
- It includes tools, technologies, resources, and systems that contribute to energy conservation and environmental sustainability.

## **2. IMPLEMENTATION OF A SMART HOME SYSTEM IN A LOW BUDGET HOME**

The research was conducted by applying a questionnaire that provides information strictly necessary for establishing a realistic and tangible conclusion. This information refers to:

- General data: name, age category, residence (urban or rural), dwelling area, monthly income level, and budget allocated to quality of life.

- Needs for improving comfort.

Regarding lighting, [7] the options presented in the questionnaire were:

- Interior lighting to be controlled manually; automatically depending on presence in the room; automatically depending on ambient light level; centrally, with the implementation of anti-burglary scenarios.

- Lighting level to be adjusted continuously (from off to maximum) or on/off only, without continuous adjustment.

For climate control, the following aspects were of interest:

- Required functions: heating; cooling; air conditioning (air quality monitoring); underfloor heating.

- Climate control elements: traditional radiators with thermal agent; electric convector radiators; fan coil units and ventilation systems; standard air conditioning units [17].

Regarding the need for an anti-burglary and fire detection system, it was necessary to determine whether such systems should exist and whether they should operate independently [14], [19].

The method of managing commands and supervision for interior and exterior lighting, climate control, etc., had to be chosen as either local or centralized.

### 3. FIBARO SYSTEM FOR A STUDIO APARTMENT

The virtual house that we created is structured as follows: bathroom, kitchen and living/sleeping area.

Considering the characteristics of the living space and the limited available budget, we used a control unit with a sufficient number of connectable devices. The chosen control unit model is Home Center Lite, capable of integrating up to 230 devices. It is equipped with a Cortex A8 processor. Through its energy management function, the Fibaro Home Center Lite can monitor electricity consumption while detecting high-consumption devices [10], [15], [18].

The next step in completing the project is to enlist the sensors and other equipment at the control station (fig. 1) [4]. At the same time, the actual enrollment of each sensor to the room it serves is also done.



**Fig.1.** Enrolling Fibaro sensors  
(<http://192.168.1.100/fibaro/en/devices/>)

During the programming phase, we “learned” the system to meet the requirements of the beneficiaries by implementing certain work scenarios (fig. 2).

Following the procedures outlined above, we have put into operation a minimal system, suitable for a studio of about 35 sqm.



**Fig.2.** Creation of scenarios  
 [http://192.168.1.100/fibaro/en/scenes/]

For lighting control [9] in the kitchen area (fig. 3) and the bathroom (fig. 4) we used two single switches from Fibaro, integrable in the existing architecture, without the need for additional wiring.



**Fig.3.** Manual operation of lighting in the kitchen



**Fig.4.** Manual operation of bathroom lighting

These switches are mounted in the device dose, connecting to the existing switches. As local actuators, in the bathroom we used a switch with a push-button switch "doorbell" and in the kitchen area we used a switch with touch control. Although the design of the latter is more attractive, we preferred not to use it in the bathroom area due to the high possibility of being operated with wet hands.

To control the lighting in the sleeping area we used a Dimmer switch 2 from Fibaro (fig. 5). It is able to adjust the light intensity according to the wishes and needs of the end customer. Using a unique algorithm, the dimmer recognizes the source of the light and calibrates it, choosing an appropriate value. In this way, we know that we use exactly the light we need for optimal energy use.

The heating system is controlled by integrating the thermostatic valve with stepper motor. Based on the cubic volume of the heated room, the Fibaro thermostat calculates how long it takes to reach the temperature we want. Moreover, the current temperature is indicated by the colour of the ring, green means a low temperature and

red the maximum temperature. This faucet also comes with a removable temperature sensor that can be placed anywhere in the room (fig. 6).



**Fig.5.** Manual dimmer operation of the lighting in the bedroom



**Fig.6.** Automatic adjustment of the radiator valve

To control the air conditioner, we used a digital thermostat MCO Home (fig. 7). The air conditioner is powered by a smart outlet that has control of the energy consumption [6], thus enabling us to have total control of the utility bills. When the electricity consumption exceeds the budget for that month, the outlet will cut off the power supply to the equipment by next month.

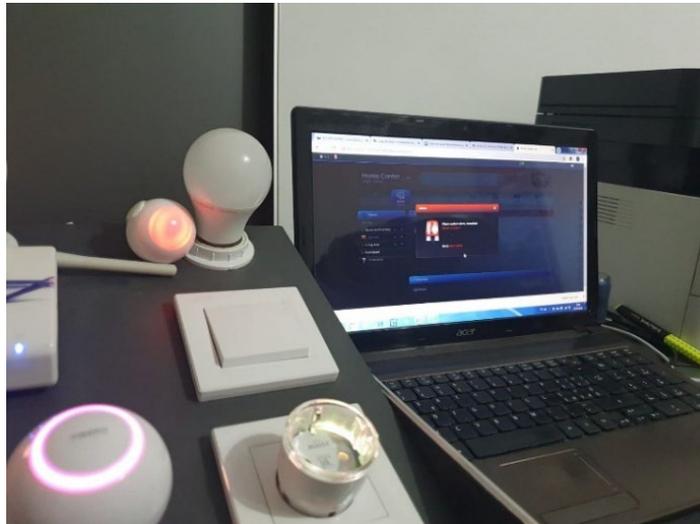


**Fig.7.** Automatic adjustment of the air conditioning system (A.C.)

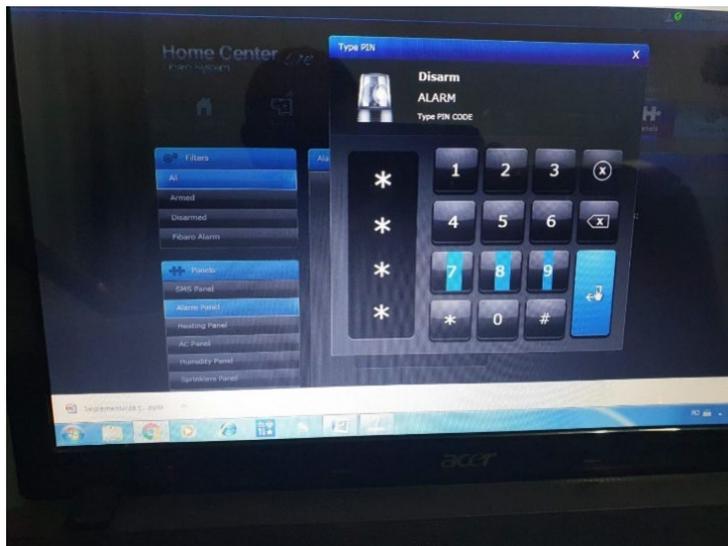
We have integrated in the architecture of the Home Center Lite a flood sensor that alerts us to every liquid leak and a multisensor that manages to detect movement, measure temperature and light intensity (fig. 8) [5]. This sensor serves as security when we leave the house or as a control for interior lighting when required.

The application interface is as complex as it is user-friendly by incorporating all the equipment that should have been physically installed in the home into the control

screen. Thus, for the control of security systems, we have integrated a virtual numeric keypad (fig. 9).



**Fig.8.** Alarm triggering by the motion sensor as well as acoustic and light warning



**Fig.9.** Enter the disarmament code using the application interface

Regardless of the actions that appear in the foreground as acoustic or visual notification, the system imperturbably coordinates the scenarios it has programmed.

#### **4. CONCLUSIONS**

Smart home technologies represent an important step toward modern, efficient, and safe living environments. The integration of monitoring and control systems

contributes to increased comfort, reduced energy consumption, and improved security. Continuous technological advancements will further expand the capabilities of smart homes in the future.

The main purpose of the paper was a curiosity about the popularity level of the idea of “smart” housing among the low-income population, but also the realization of a “smart home” concept dedicated to them that would make them realize how close they are to the benefits that such a one offers of housing.

In order to draw some pertinent conclusions, we took the following steps:

- we studied several types of “*smart home*” systems and chose the manufacturer “Fibaro” as the best in terms of quality-price ratio and the pliability to the project we wanted to develop;
- we have developed a questionnaire dedicated to low-income people to show the needs and knowledge of the target group on the concept of “smart home”;
- analyzing the answers received in the questionnaire, we designed and developed a system that lends itself to a low budget home, with the final implementation costs reaching about 1000 euros;

Following the research carried out on this subject, we have reached the following conclusions:

- the popularity level of the smart home concept is quite high among the target audience;
- there is a discrepancy between the actual costs and the ones the target group imagines regarding the implementation of this type of system, with the actual costs being much lower than they imagine;
- the main needs of the target group regarding this type of house were related to the possibility of ordering interior lighting, air conditioning systems and, last but not least, security systems.

The results of the research are in line with our expectations, the impact of the information distributed to the target group having the expected effect, namely the awareness of the real costs for the implementation of such a system.

In conclusion, the smart house concept will continue to develop alongside technological progress, becoming an essential component of future homes. The integration of artificial intelligence, IoT systems, and renewable energy sources will lead to increasingly autonomous and sustainable homes.

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