# INTELLIGENT HOUSE AND ITS ENVIRONMENT CONTROL SYSTEM

**Luděk Chomát**
Doctoral Degree Programme (3), FEEC BUT
E-mail: xchoma00@stud.feec.vutbr.cz

**Petr Malounek**
Doctoral Degree Programme (2), FEEC BUT
E-mail: xmalou01@stud.feec.vutbr.cz

Supervised by: Petr Pivoňka
E-mail: pivonka@feec.vutbr.cz

## ABSTRACT

Automation is an integral part of all recent technological and production processes. Automation processes are increasingly used in domestic sector, which opens big possibilities for development of logic control of such objects. Currently, we cannot imagine our life without automation in industry. In the close future, the automation will not be only there, but it will be for example in family houses as a standard in order to decrease energy losses with respect to ecological impact on environment.

## 1. INTRODUCTION

In study programme Electrical, Electronic, Communication and Control Technology students acquaint themselves with principles of modern motor control methods, binary control and optimal regulator setup. Goal is to introduce students to new modern methods of continuous and discrete process control so that they are well prepared into practice. Therefore it is more suitable to work on a real model which is better for understanding of given problems. For illustration was chosen intelligent house control system and its environment where students can try to control technological processes and later employ these experiences in field.

In the 21$^{st}$ century we meet more often not only with usage of automation processes in industry but also in family houses. Automation in family houses is not only for facilitation of normal life and elevation of comfort, but primarily for decrease of energetic and economical losses. In this paper we will deal with control systems design of an intelligent house and its environment. First let's clarify what is an intelligent house [1]. In an intelligent house are used all the technologies which we meet today during design and realization of family houses. It is a modern system whose task is to create comfort and to regulate heating system for lowering costs. Intelligent house is independent and conforms to people's needs and environment. To implemented functions of an intelligent house belong for example: access systems (drive gateway and electromechanical locks), house lighting, ventilation, heating system (furnace, fireplace, solar panels, geyser and heat pump), irrigation

system, pumps etc. The brain of an intelligent house is a processor of a control system which reacts according to its software on external inputs. Thanks to this, the control system controls house which lives its own life. To these external inputs belong for example: pressure measurement, humidity, temperatures, cheap rates signal, security devices reports, water-level relay signal, remote control, outdoor illumination, etc. Basic properties of an intelligent home are: to control all needed activities in home, to ensure safe operation, to control heating system, to respond to remote control, to save money and to conform to posed requirements.

## 2. ANALYSIS

Output of this project is to create a physical model of a parcel with a family house model. It will serve as a trainer where the students design, implement and verify process control during creation of house infrastructure and its environment. Created model will be used in following courses: Digital Control Technology, Regulator Optimization and Discrete Event Systems. Model is divided into four parts which are connected together. Created model makes it possible to work in teams on four workplaces. Structure of the physical model (figure 1) consists of regulation [2] (heating system regulation and of hot water supply regulation with utilization of renewable resources), of motor control [3] (regulation of motor for opening the gate to parcel and the garage) and of logic control (light timing and garden watering). Last workplace serves for visualization of all technologic processes of the family house and its environment. Every part is controlled by a PLC from company B&R and visualization is shown on a touch panel [4][5].

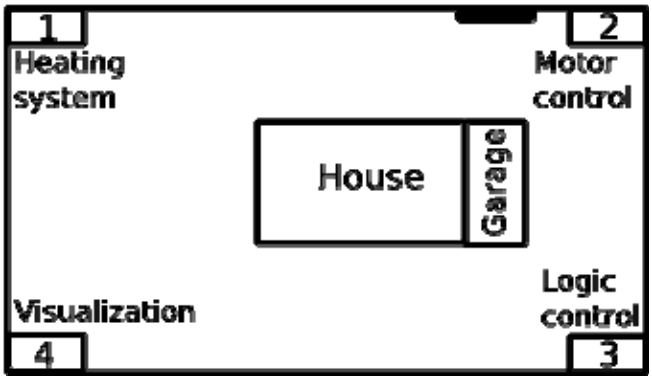


**Figure 1:** Working surface

### 2.1. HEATING SYSTEM AND WARM-UP OF SUPPLY WATER REGULATION, WITH UTILIZATION OF RENEWABLE RESOURCES

Among the most significant control parts of the model belongs the heating system regulation. To the workplace number one (no. 1) is connected a programmable machine that performs the management of the process. Using the machine can be controlled three-way valves, circuit pump and also the amount of gas in the furnace. Of course it is possible to monitor all the output values of the technological process. This process is simulated on an ATMEL microchip [6] and it allows to model real house processes more accurately. The microchip is programmed for behavior according to the diagram shown on picture number 2. There are created mathematical dependencies between the various heat losses, which are taken from a real smart house. Task for the students is to regulate room and water temperature to the desired value. Thermal circuit is affected by outdoor temperature, solar radiation

and fireplace. Outdoor temperature can be set using the potentiometer from -25°C to 40°C and the temperature is displayed on the LCD. Fireplace has four different degrees: not firing, burning at least, medium and maximum. With the switch you can set the temperature level of the fireplace and LED diodes indicate that state. Solar radiation can be set also using the potentiometer and displayed via LCD display on the model. It is also possible to involve noise and disturbance in the process that are also present in a real smart house. State of the whole workplace no.1 is displayed using LED diodes, LCD display and can be controlled by switches and potentiometers.

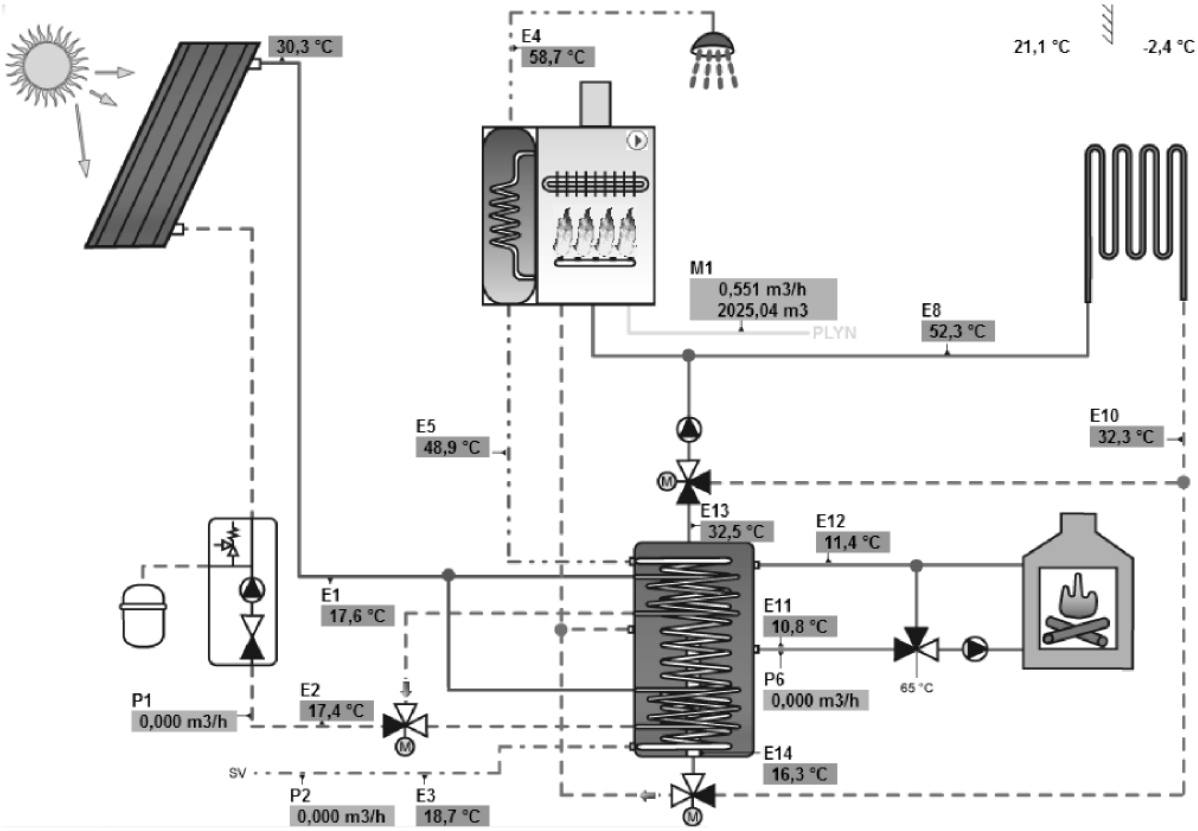


**Figure 2:** Scheme of heating system and warm-up of supply water regulation [7]

## 2.2. SYNCHRONOUS MOTOR CONTROL

Students are introduced to control and setup of synchronous motors on the second workplace. Model is equipped with an entry gate which is controlled by an electric motor. The synchronous motor is controlled by ACOPOS system connected to a PLC. Students have to control this synchronous motor and according to it is controlled a small motor on the model. Model is equipped with limit switches and emergency switches that serve to detect location of the gate. Garage opening is made likewise. Thanks to two motors can students test multi-axis control. Gate opening and garage opening is controlled by switches placed on the model. All signalization is displayed by LED diodes.

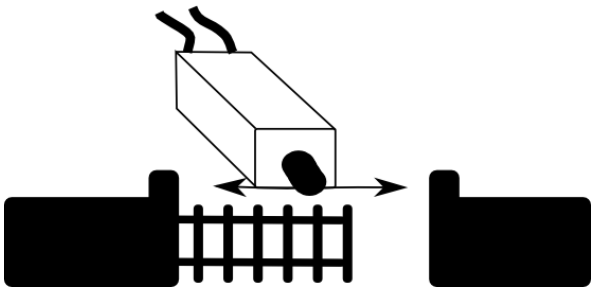

**Figure 3:** Gate controlled by synchronous motor

### 2.3. LOGIC AND SEQUENTIAL CONTROL

On workplace no. 3 the student learn about logical and sequential controlling. Workplace is divided into two parts: timed lighting and garden irrigation. Student's task is to program automatic light switching while using data from motion sensor and to create schedulable lighting system in the house, both for the inhabitant's needs and for safety reasons. All the switches, motion sensors and lights are located on the model. Furthermore, it is possible to water the lawn using multi-area irrigation. Lawn watering depends on soil humidity and on rain. Irrigated area is identified with green LED diodes and dry or over-irrigated area with red LED diodes. Simulation of the lawn state is controlled by a microprocessor and the model allows to set manually whether it rains or not.

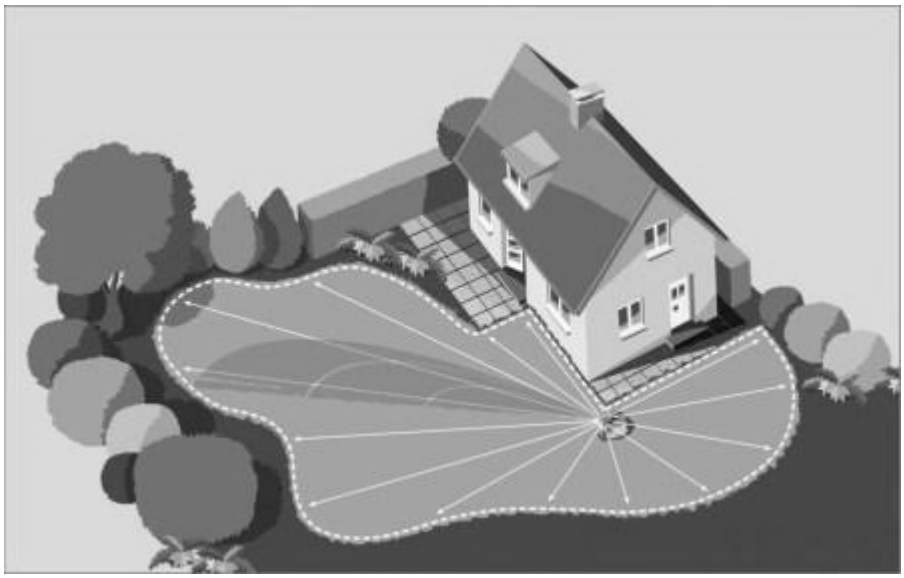

**Figure 4:** Garden irrigation [8]

### 2.4. VISUALIZATION OF TECHNOLOGICAL PROCESS

The last workplace serves for visualization of the whole technological process and students must display it on the touch-screen. All the three previous workplaces are displayed there. The panel displays input and output signals, shows necessary graphs with history, controls the intelligent house and informs users about the changes in the process. The workplace no. 4 allows access to all the input and the output signals of the intelligent house. Other work-places provide only the signals which are needed for solution of the certain exercise.

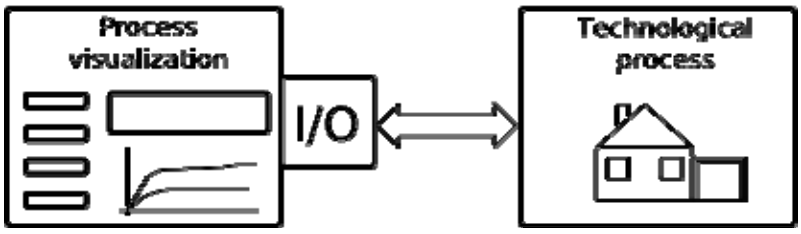


**Figure 5:** Visualization of process

## 3. CONCLUSIONS

Created trainer of physical model contributes our faculty by improving education and by increasing motivational levels. Graduates will able to create sequential control, heating system regulation, motor control and visualization of not only one-family house, but also of complicated automation suits. Students will able to solve automation processes in practice and represent Faculty of Electrical Engineering and Communication to public. Created trainer is intended for students of bachelor and master programmes. Created workplace is useful for students in their practical projects and also in their bachelor and diploma theses. Trainer is designed for further upgrades such as improvement of technological processes and also for the possibility to use new renewable resources.

## ACKNOWLEDGEMENT

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