PLCs used in smart home control

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Abstract. This paper presents the realization of a smart home automation using Siemens PLCs. The smart home interface is realized using the HMI Weintek eMT3070a touchscreen, which shows the window for controlling and monitoring the lighting, room temperature, irrigation systems, swimming pool, etc. By using PLCs, the smart home can be controlled via Ethernet and it can be programmed to the needs of tenants.

1. Smart home

The concept of intelligent house (SMART HOME) appeared due to the need for comfort, safety and tranquility in a house. Through it, we can create and manage an entire world with our touch, this being done with a flexible and discrete control system, suitable as well for the inside as for the outside of the house. The Smart Home has the advantage of modular functionalities, which supports the addition of new options or required equipment at any time.

It offers the possibility to create pre-defined scenarios for different equipment or installations in the Smart Home. It also uses information technology to monitor the environment and, according to certain conditions, to control electronic devices and to communicate with the outside world wherein the Smart Home lies. All these are meant to offer more comfort, improved energy efficiency and high security level.

The home automation can include the control of:
- **Lighting**: lights enabled on different areas of the house depending on usage and necessities, depending on the season or time of the day; illuminating the access ways over night or lighting for surveillance; we can talk about the design of the lights to induce comfort and a pleasant ambience, depending on the scenario previously created through the control console; we can also talk about illumination of the front of the house, the garden or the pool, according to time or in various configurations - party in the garden, on the terrace, watching movies, night mode, etc., the only limit is the imagination of the owner;
- **Heating**: personalized temperature control in each area of the smart home or in time intervals, with the possibility of changing the scenario anytime through the local control panel or remotely, through internet or phone;
- **Blinds and sunshades** (ventilation and air conditioning): obtain the desired level of lighting or shading through their control; they can be automatically lowered or raised depending on the desired scenario or on the command of the owner;
- **Irrigation**: this means watering your lawn or plants from the intelligent home through automatic irrigation according to schedule and soil moisture level or through manual or remote control;
- **Swimming pool**: preparing the water temperature in the pool in case you desire to use it after work or during vacations. Remote control of the pool can be done by sending an SMS or over the internet. The automatic dosing system will send status messages for: absence of chemical substances for water treatment, water quality issues, etc;
- **Security System**: the house can “be taught” to call the owner or close people, if there is an alert situation. These alarms can be sent in case of plumbing issues, gas leaks, electricity outage or cases that would cause material damage [1].

When we suggest an integrated smart home system, we aim primarily to simplify and improve comfort, thus, a simple press of the button it is enough to lower the blinds, to turn off all lights in the house, to set the temperature, to arm the anti-theft system; these facilities will save us time, will increase the comfort level and will also reduce energy consumption. All these facilities are available through remote, as well as through the internet.

### 2. PLC SIMATIC S7-1200 System control

PLC performs two main tasks of process automation [2-4]:
- inspecting the process by monitoring the status of PLC inputs, using sensors, buttons, limit switches, the state variables in the process, etc;
- processing information from inputs and generating the necessary commands to actuators of the automated process, according to a specific program.

PLC is meant to replace wired circuits with contacts and relays, which are performed by simulating software in the PLC.

The PLC monitors and controls a machine or a process with the help of the STEP7 program, which provides interrogation I/O modules through input addresses (% I) and commands the process through output addresses (% Q). [5], [6]

SIMATIC S7-1200 PLC programming TIA Portal was done in the LAD language program, taking into account various scenarios for the smart home.

STEP 7 Basic Software V12 is programming software for the SIMATIC S7-1200 automation system, and it allows the usage of the following functions to automate the facility [7]:
- The configuration and parameterization of hardware
- Defining communication
- Programming
- Testing
- Develop documentation
- Generate display screens for the SIMATIC basic operating panels.

The TIA Portal programming environment provides configuration, parameterization and programming components such as controller, visualization devices and network elements.
TIA Portal has two modes of presentation: Portal presentation (provides an overview of tools activity for project processing, Figure 1) and project type (presents an overview of all structural parts of the project).

The PLC used in the paper is the SIMATIC S7-1200 series from Siemens, processor CPU 1215C DC / DC / DC, model 6ES7215-1AG31-0BX0 (Figure 2).

After the completion of the project configuration and PLC model selection, the TIA Portal programming environment will automatically switch to project presentation from the portal (Figure 3) and the window opens with the hardware configuration.
Here, the actual realization of the smart home program begins, depending on issues that should be monitored and controlled [8].

3. Achieving control programs

3.1. Lighting
Light control can be performed manually or by command switches from digital PLC inputs (% I0.0), and through the motion sensor (% I0.2) conditioned by a crepuscular sensor (% I0.3), which blocks the turning of lights on during the day.

There is a general switch (% I0.1), which will simultaneously stop and start the lighting all over the house, or it can be controlled from the Weintek panel interface.

3.2. Irrigation
It is automatically switched on according to soil humidity measured by a humidity sensor [9]. Its value is sensed by the PLC through analog input % IW78.

If the soil humidity is below the set reference value, it opens an electro valve irrigated circuit (output% Q3.2 of PLC) and grass irrigation shall be performed (Figure 4).

If soil humidity read by the humidity sensor will be higher than the maximum humidity of reference, it will command the closing marker % M3.1, which will break the electro valve circuit El6% Q3.2, electro valve will be closed and the irrigation stopped (Figure 5) [10].
4. Creating the control interface for HMI

EMT3070 HMI touchscreen panel is produced by Weintek that facilitates creating a graphical user interface for a large number of PLCs on the market. EMT-3000 Series is designed for industrial use.

Achieving the HMI interfaces from command of the house in Easy Builder Pro for panel Weintek eMT3070 [11]

After establishing the scenario and implementing it in the programming of the PLC in TIA Portal, the command interface of the program is realized and windows are established for each activity. A window is set for each activity (lighting, irrigation, temperature, blinds, pool, etc.), but there also is a main window command.

The main window allows access to all home automation (Figure 6) and creating a username and password permits hierarchical access to the command of certain processes through user classes [12].

Figure 5. Shutting down the automatic irrigation

Figure 6. Main window

Similarly, interfaces will be created for all the automatic equipment that is preprogrammed in the TIA Portal for PLC. Examples of the automatic control of the pool (Figure 7) and of the sprinkler irrigation control can be viewed (Figure 8).

Opening or closing the electro valve which starts the sprinklers circuit can be done automatically, through the humidity sensor or manually with an ON / OFF switch.
5. Conclusions
In this paper, we intended to highlight how the comfort level can be increased when we choose to implement a smart home system. Using the PLC to implement a smart home system presents a number of advantages, of which the most important are: decrease the number of wiring, lower consumption of
energy, fast adaptation to different applications, manage the consumption of energy more efficiently [13].

In this paper we presented a smart home automation using Siemens PLCs and TIA Portal V12 software. PLCs allow controlling the region through Ethernet, but are used for both monitoring and control.

The Smart house control was performed using the Weintek eMT3070a touchscreen and the application was made in EasyBuilder Pro program.

The present study was conducted in the Ladder of TIA Portal language control program.

Future objectives are achieving smart home monitoring and control through web interface and application development on platforms such as iOS, Android, etc.

References

[1] Lung C, Sabou S and Buchman A 2014 Emergency radio communication network controller implemented in FPGA, International Symposium for Design and Technology of Electronic Packages SIITME 2014, 20th Edition, Bucharest, Romania, October 23-26, pp 193-196
[2] Mărgineanu I 2005 Automate Programabile, Ed. Albastră, Bucharest, Romania
[3] Oprea C and Barz C 2014 Automate programabile în acțiuni, Ed. Risoprint, Cluj-Napoca, Romania
[4] Webb J W and Reis R I 2000 Programmable logic controllers, Pentice Hall, New Jersey, USA
[5] Dunning G 2002 Introduction to Programmable Logical Controllers, TWI Press Inc., Terre Haute, Indiana, USA
[6] Popescu D 2011 Automate programabile. Construcție, funcționare, programare și aplicații, Matrix, Bucharest, Romania
[7] *** Siemens S7-1200 Programmable controller system manual
[8] Barz C, Oprea C, Erdei Z, Pop-Vadean A and Petrovan F 2014 The control of an industrial process with PLC, International Conference on Applied and Theoretical Electricity (ICATE) Craiova, Romania, October 23-25
[9] Mitar S 2014 Design and Development of Air Temperature and Relative Humidity Monitoring System With AVR Processor Based Web Server, 8th International Conference And Exposition On Electrical And Power Engineering (EPE), Iasi, Romania, October 16-18, pp 38-41
[10] Lei S Y 2013 Servo-control System Design of Automatic Production Line Based on PLC and HMI, 2nd International Conference on Frontiers of Mechanical Engineering and Materials Engineering (MEME 2013), Hong Kong, October 12-13, pp 1381-1385
[11] Barz C, Latinovic T, Balan A, Pop-Vadean A and Pop P P 2014 Using HMI Weintek in command of an industrial robot arm, IOP Conf. Ser.: Mater. Sci. Eng. 85 012003
[12] ***www.weintek.com
[13] Jinsoo H, Chang-Sic C, Wan-Ki P et al. 2014 PLC-Based Photovoltaic System Management for Smart Home Energy Management System, IEEE Transactions On Consumer Electronics 60(2) 184-189