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МОЖЛИВОСТІ ВИКОРИСТАННЯ РІШЕННЯ ПРОМИСЛОВОГО ОБЛАДНАННЯ В СИСТЕМІ СВІЙСЬКОЇ АВТОМАТИЗАЦІЇ

ВОЗМОЖНОСТИ ИСПОЛЬЗОВАНИЯ РЕШЕНИЯ ПРОМЫШЛЕННОГО ОБОРУДОВАНИЯ В СИСТЕМЕ ДОМАШНЕЙ АВТОМАТИЗАЦИИ

THE POSSIBILITIES TO USE INDUSTRIAL EQUIPMENT SOLUTION IN HOME AUTOMATION SYSTEM

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У роботі описується використання промислової автоматизації у сфері автоматизації будівель, яка знижує вартість проектування та будови систем та підвищує функціональні можливості порівняно з існуючими вже системами, що вже застосовуються та запропоновані до купівлі/продажу. Через збільшення площі використання ці системи будуть застосовуватися у великій кількості, що дозволить без збільшення витрат, підвищити їхню надійність. Прикладом вирішення, доведеного до прототипу, у роботі представлено систему керування та контролю котеджного саду і комерційну величезну систему Automation Platform.NExT™.

Ключові слова: *автоматизація промисловості, автоматизація будівлі, смартдом, смартсад, мобільний додаток, веб-додаток, пристрій ПЛК.*

В данной работе описывается использование промышленной автоматизации в области автоматизации зданий, что дает снижение стоимости проектирования и строительства систем, повышает функциональные возможности по сравнению с существующими уже системами, которые применяются и которые предложены к купле/продаже. В связи с увеличением площади применения эти системы будут производиться в больших количествах, что позволит без увеличения затрат повысить их надежность. Как пример решения доведенного до прототипа в работе представлено систему управления и контроля коттеджного сада и коммерческую огромную систему Automation Platform. NExT™.

Ключевые слова: *автоматизация промышленности, автоматизация здания, смартдом, смартогород, мобильное приложение, веб-приложение, устройство ПЛК.*

This work describes the use of industrial automation solution in building automation. This approach reduces the cost of system design and construction. It increases functionality compared to existing in-use and offered to buy systems. These systems, due to their increased use, will be produced in larger quantities which will increase their reliability without increasing costs. As an example of the prototype implemented in this work, a system of management and control home garden and the commercial, huge system Automation Platform.NExT™ are presented.

Keywords: *industrial automation, building automation, smart home, smart garden, mobile application, web application, PLC device*

Introduction. The modern house is more and more like a complicated machine than a simple construction that provides a roof over his head. Once the electrical system was simple, enough for one light bulb in the middle of the ceiling of the room one or two outlet and switch on the wall near the door. In the event of a short circuit you had to screw the new fuse and it was over the trouble.

Now our expectation is much higher: we expect not only a larger number of light points and sockets, but also better protect the electrical installation to be safe for the households. We require better grounding and zeroing.

We require TV outlets in several rooms. We require a computer network around whole home, Wi-Fi coverage in the house and garden with Internet access. We require intercom, electric blinds, fire detectors, home theatre in the living room, remote control and mange home heating and watering the garden, monitoring in the absence of residents, communication with the security company for the safety of residents during their presence in the property, control of home solar and wind power plants and many other installation.

Background. Each control system, independently controlled, consists of three PLCs, SCADA and HMI modules. They differ on sensors, actuators, and process control algorithms. The huge development of control systems owe, that the largest costs in the operation of the building and industry are generated by employees, and control systems remove employees from these process [1].

A programmable logic controller (PLC), or programmable controller (PC) is an industrial digital computer which has been ruggedized and adapted for the control of manufacturing processes, such as assembly lines, or robotic devices, or any activity that requires high reliability control and ease of programming and process fault diagnosis.

Supervisory control and data acquisition (SCADA) is a control system architecture that uses computers, networked data communications and graphical user interfaces for high-level process supervisory management, but uses other peripheral devices such as programmable logic controllers and discrete PID controllers to interface to the process plant or machinery.

The operator interfaces which enable monitoring and the issuing of process commands, such as controller set point changes, are handled through the SCADA supervisory computer system.

However, the real-time control logic or controller calculations are performed by networked modules which connect to the field sensors and actuators. The human machine interface (HMI), in the industrial design field of human–computer interaction, is the space where interactions between humans and machines occur.

The goal of this interaction is to allow effective operation and control of the machine from the human end, whilst the machine simultaneously feeds back information that aids the operators' decision-making process [2].

Review existing solution. Consider the case of home garden control when a landlord is very far away from home and cannot afford anybody to take care of the garden or economically such an order is unpro-fitable.

There is no way out, he must learn to take remote care of the garden.

One of the systems for automatic irrigation of plants is Daisy.si. From the website product description [6], we learn that it is suitable for watering inside the house, verandas or balconies. It is resistant to moisture sunlight.

The system is low energy consumption; its battery lasts up to two years. Different colored LEDs inform the user of the system on the state of soil moisture. On the basis of the optimization algorithm, water is gradually released from the container when the sensor informs the system about too low soil moisture.

The Daisy.si system for more demanding users has a web application where you can select the watering parameters of your plants according to your taste. Communication with the web application is via wireless data transmission.

Looking at soil watering systems we come to RainCommander. He is very technologically advanced.

From the web side of the manufacturer [7] we learn that it supports sprinklers located in 12 zones. One feature of the system is Wi-Fi connectivity, so users can control the sprinklers by using a web or mobile application. The system has ability to control both single zones and all sprinklers at once.

The next system to present is Skydrop.

On the web site of the manufacturer [8] we learn that the garden is divided into zones based on information such as: type of soil, species of vegetation, and type of sprayer.

Watering program additionally depends on atmospheric condition. A mobile application that connects to the device via a Wi-Fi network is avai-lable for the system. Through it, the user can, among other, edit the frequency of watering, monitor the status of the system, and receive reports from the system.

The last system to consider is the Niwa Hydroponic System. On the web site of the manufacturer [9] we learn that this smart home system not only allows for automatic watering plants but also for lighting them.

Niwa Hydroponic System is recommended when growing edible plants. We use the provided mobile application to operate this device. It allows you to plan the best development condition for selected plants.

You can also use it to edit the frequency of watering and other activities related to the cultivation of plants.

Functional and non-functional assumption for designed system. The biggest disadvantage of the presented systems is their price. In the practical part of the article is presented a project consisting of low cost electronic components used in both industrial and building automation.

Although the mobile application is only part of the whole system once it is included in cost of sales of the devices.

On the other hand, it is available for free on Android mobile devices through Google Play or Apple-powered devices through the App Store and for Windows Phone from Microsoft Store.

The reason for the high prices of building automation and garden automation systems lies in the high cost of paid software developers.

Electronic circuits are manufactured in China, where production costs are low. The software is produced in the US, where production costs are high.

The idea of building automation and gardening has been widespread by Americans.

This is a huge market for products that manage large buildings, but they can also automate the work of an average person's home.

Most of these types of projects are created in the US, so the developer's pay must be adapted to the US labor market.

This in turn generates the high cost of the final product that the company could reap a profit from the sale.

The second problem for system users is the lack of native support for the devices. In Poland, small, backyard garden mainly run by elderly people.

During the Polish People's Republic, the main language taught in schools was Russian. The systems: Daisy.si, RainCommander, Skydrop, Niwa Hydroponic System only have application in English. Another major problem that has previously analyzed systems is the lack of utility offline.

They do not have a list of activities to do in the garden, to which the user could type in the task he invented and then execute them and then unmark them.

Those who have such a list do not show it in offline mode. When managing a home garden, take care of the same things as the industrial garden: spraying plants, fertilizing, weeding, sowing and planting, preparation of scions, extracts, slurry, trapping of snails, egg whites, harvesting fruits, vegetables, herbs, remove whole or parts of plants.

Lack of this functionality makes it difficult to work in the garden. As you can see, gardening is more than just watering.

The fourth drawback of the presented systems is the lack of access to the garden data via a web browser (expect Daisy.si).

It is worth mentioning that in Poland a lot of, especially older people use the Internet only via an Ethernet cable attached to a desktop computer.

Finally, it is important to note that the GUI of the presented applications is not responsive, which is a major handicap for older people with vision problems.

Design of the smart garden management and control system. The purpose and result of my research was to design and build a garden management device in the image and similarity of control systems used in industry and the faultless systems presented above.

The solution of the problem is to create an Internet and mobile application, which is the task manager for the owner supports its activities, offering watering plants in these conditions specifically defined.

This involves the construction of the whole system, which transfers the data to the server using a computer to be accessible to the user mobile application regardless of whether the garden is big or small, whether it is eg used as a backyard or for industrial purposes. In this example, the user can retrieve data on the current state of the garden (soil moisture, temperature and humidity).

Based on this data he decides what action to take on the plants. These tasks are provided by a mobile application for PLCs that actuate the valves in the garden. PLC is an embedded system, and based on the received data from the master management system and the sensors data generates control signals for the actuators.

The idea of watering is to set up hoses in the watering places and activate them when the sensors show low humidity values.

Mobile application is designed for Smartphone running Android 5.0 or higher because it is most popular. Data transmission with the server with the database of plant parameters in the garden is done via the Internet [3].

Sensors and devices are connected to a microcontroller board using 1-wire protocol.

The 1-wire bus requires only one data line (and ground) for communication with central microcontrollers. We use a USB connection to connect the Arduino to the PCs. Of course, Smartphone also has access to the Internet.

The mobile application uses the SQlite database because Android has built-in eg support. The mobile application was made in the Android Studio. As a PLC module, DFROBOT board is used because it is compatible with the Atmega 32U4 microcontroller in the Arduino Leonardo range and is cheaper.

Another important element of the project is the temperature and humidity sensor DHT11. It allows you to measure the air temperature in the 0-50 Celsius scale and the relative humidity from 20% to 80%. It is connected to the microcontroller via a single-wire interface. The next element of the system is the humidity sensor of the soil.

This is an analogue sensor that increases the voltage when the humidity increases. Actuators are solenoid valves for water supply hoses in the space of possible shortages.

At a time when the soil moisture falls below 30 % and the air temperature is positive, watering the plants starts to reach 70 % of the soil moisture.

The Arduino module has been programmed with an IDE dedicated to this module and when it is connected via a USB cable to a computer with an IDE installed.

In our project the software was generated for the Arduino board Leonardo. The HTML 5, CSS 3, Bootstrap 3, PHP, JavaScript and SQlite were used for web application design.

The website has been tested in four browsers: Mozilla Firefox, Microsoft Edge, Google Chrome and Opera Neron. The test showed full responsiveness of the site [4; 5].

The mobile application has two tasks; one is a task manager in the garden and second allows you to receive measurements from the server by connecting to the web browser of the mobile device.

For this reason, the responsive website is so important in the whole project that returning back to the task manager only requires the back arrow to be pressed.

The reading of the measurement of parameters within a module application has not been implemented, because it is assumed that the users will be elderly people who will not always have access to the Internet.

Their use of the application is limited to task manager. For this reason, it was considered that the GUI should not be expanded.

The application for the elderly should be very easy to use.

The test mobile application was made in Android Studio, tasks are written to data base SQLite.

This means that when you open the application again, you have access to the task list and you have ability to create, delete and edit tasks. The mobile application is very easy to use and it was one of goals of the prototype.

The commercial, huge system used in both industrial and building automation. The most technologically advanced system is the Automation Platform.NExT™ [10]. From the leaflet included with the product, we learn that Automation Platform.NExT™ sets new opportunities for SCADA / HMI. Provides maximum scalability in one flexible, modular development environment.

This enables Platform.NExT™ to provide a wide range of application capabilities while maintaining high temporal design efficiency.

Platform.NExT™ environment is based on the concept of plug-in, which allows for maximum co-operation with other systems in order to integrate third-party components in a single environment and the use of extensive technology capabilities NET.

The graphical environment is based on WPF technology and supports advanced XAML graphics tools.

The availability of VB.NET provides great application capabilities. The NExT™ Automation Platform guarantees maximum safety. It offers security features that cover all the solutions available in the typical SCADA systems of recognized manufacturers. Automation Platform.NExT™ is based entirely on recognized market standards, providing reliability and openness. XAML and WPF technologies ensure the most efficient graphics processing technology.

MS SQL Server and Azure ensure data archiving with the ability to collaborate with other relational databases. SCADA application design files are based on the XML standard. Advanced programming capabilities are available through VB.NET. Communication with external devices is accomplished using many integrated protocols and OPC UA (OPC Unified Architecture) technology.

Automation Platform.NExT™ uses modern OPC UA technology for efficient communication with compatible applications.

The I / O server offers a wide range of communication drivers that allow direct connection to external devices. Communication drivers for Siemens, Rockwell, Schneider, Omron and many others are available.

The Automation Platform.NExT™ architecture has been developed to integrate with IT applications, enterprise management, and decision support.

The Automation Platform.NExT™ environment is geared towards maximizing productivity.

Fast communication, real-time data management, and optimized graphics processing make full use of graphics accelerators and DirectX capable of delivering high-performance and high-performance solutions.

The Automation Platform.NExT™ is an environment based on SCADA concept of web access.

Building network applications is easy and effective. Maximum performance is achieved through the use of Silverlight technology and the use of HTML 5. Technologically advanced and intuitive environment allows you to build Platform.NExT™ Automation SCADA applications in an efficient and optimal time. A rich library of objects for easy design works and provides opportunities to create modern and advanced graphical synoptic screens.

Technology plug-in allows you to use components originating from third-party software, which allows almost unlimited expansion functions built SCADA applications [10].

The unmatched openness and flexibility of the Movicon software architecture makes it an ideal SCADA HMI surveillance system for any manufactu-ring sector. Today's automation world needs to be flexible, which means the ability to deliver the product on time, according to customer requirements, without sacrificing the secrets of technology.

PROGEA offers an effective guarantee to protect your investment and allows you to stay competitive in the world by using only one MOVICON software platform. Software for all automation applications, from control level (PLC, HMI) to SCADA / MES across the enterprise. Progea solutions are also tailored to the surveillance of intelligent buildings.

The company's engineers are leading experts in software supervision and control (SCADA / HMI).

Movicon BA offers all the advantages of open systems software for the integration and visualization of automation systems for modern buildings, residential, industrial, service and large agglomerations.

The enormous years of experience in developing assumptions for implementation and deployment have allowed PROGEA to deliver the right solution that meets the most demanding system integration needs with just one product - powerful open source HVAC (Heating, Ventilation, Air Conditioning) plant control software, lighting, Control, energy consumption, security, surveillance of IP cameras, TVCC (Closed Circuit Television), fire protection systems, lifts and all other building automation devices. PROGEA software solutions are designed for all types of infrastructure, empowering users with tools for navigating and controlling control systems from individual buildings to whole infrastructure blocks.

This means that large hospitals, airports, businesses, hotels, tunnels and many other places around the world can be visualized, monitored and controlled by Movicon software. PROGEA integrates systems such as: HVAC, lighting, energy consumption, safety, fire protection, elevator supervision for full control over these areas. Integrated alarm with live video, alarm acknowledgment via web browser, Pocket PC, and mobile phone, gives you complete control over all your operations [10].

The illustrated example shows that not only simple amateur solutions but also complex commercial systems tend to be used industrial equipment solution in home automation system.

Conclusion. The experiment showed the possibilities to use industrial equipment solution in home automation system on the example of garden management and control.

Given that the whole system was made for a small amount of money, one might wonder whether it is really worthwhile to buy from the big companies the ready solution.

The answer to this question is ambiguous, depending on what the future user expects. A person with a large garden in which care is dedicating a lot of money, probably opt for a solution with an established position among companies gardening, even though it will be made in old technology.

The less demanding person will choose cheaper solution, as a gift will be provided with a system made in a newer technology.

The first step in the system development plan is to transfer measurement to an FTP server.

Experiments with the prototype were implemented using an SFTP server. The Arduino board is too weak to send data directly to this server. You must install the middleware on a local, standard personal computer.

The next step may be to optionally display the measurement results in a mobile application foe more demanding users.

Another suggestion is to add functionality to the control of soil irrigation. At present, the user can only supervise whether the parameters set at the beginning are practical.

More knowledgeable people in horticulture may need such functionality. There is also a need to provide applications for users of niche mobile devices such as Apple or Windows Phone.

Implementing a cross-platform mobile application will be the next step in prototype development as the most expensive commercial systems make mobile applications available on many mobile devices. In the future, there is a parallel existence in the market of solutions for large and small systems with interfaces that enable data transfer between them.

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