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Intelligent Building Emergencies Control System Requirements

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***Abstract*—The work is devoted to identifying the requirements for an intelligent building emergency control system. To prevent emergencies, the system must perform certain functions aimed at preventing the consequences of identifiable accidents. The paper presents an analysis of existing Smart Home systems. Functional and non-functional requirements for the system are developed. Built a diagram of the precedents for the intelligent control system of emergencies in the building, which will further be used in the implementation of the system. And also justified the need to implement the system because of improving the quality and timeliness of response to emergencies.**

Keywords—requirements for the intelligent system, emergency control, suitability assessment.

I. INTRODUCTION

Intelligentization of buildings, digital transformation of enterprises, smart technologies are rapidly developing trends of our time. It is no secret that comfort in the home and life, the ability to reduce the cost of utility bills and safety are fundamental principles of every person's life [1].

The idea of the article is to identify the requirements for ensuring the safety of human residence in the home. Often accidents occur not only due to human fault, but also due to the failure of equipment, communications, systems failures. In order to keep people safe in their place of residence and recreation, it makes sense to create an intelligent emergency control system in the building. Creating a system requires, first of all, a thorough analysis of its requirements.

The purpose of this work is to formalize the requirements for an intelligent building emergency control system on utility networks.

To achieve this goal, it is necessary to analyze existing solutions in the subject area, to study the process of responding to the emergence of emergency situations on utility networks in the building and to identify quality metrics to assess the suitability of the system implementation according to the requirements highlighted in the work.

II. MODERN SOLUTIONS FOR THE SMART HOME

The human desire to make life easier, more comfortable and safer throughout the development of mankind leads to the fact that every year there are more and more devices and systems that allow not only to simplify and automate some routine operations, but also help to control such objects as a house or apartment. And the control of the house or apartment becomes not only faster but also more effective [2].

In the following section, some home control systems are reviewed in terms of the features provided to users, system characteristics and applicability.

A. Smart Home Systems Characteristics Description

Let's take a look at HiTE Pro [3], Rostelecom Advanced Security [4], and Stop-Truble Basic [5] systems for smart home control, as well as PS-Link PS-1203 Guard [6], Ring Alarm Home Security System [7], and VKU “Max” [8] for smart home control.

HiTE Pro, Rostelecom Advanced Security, Stop-Trouble Basic and Ring Alarm Home Security System use both wired and wireless device connections. HiTE Pro supports RJ-45, USB and Wi-Fi connection protocols. Rostelecom Advanced Security – Z-Wave, RJ-11, USB 2.0 and Wi-Fi. Stop-Trouble Basic – RF 433. Ring Alarm Home Security System – Ethernet, Wi-Fi, Z-Wave, ZigBee, Bluetooth (installation only).

PS-Link PS-1203 “Security” and VKU “Max” have only the ability to connect devices wirelessly. The PS-Link PS-1203 “Guard” uses Wi-Fi communication protocol, while the VKU “Max” uses Wi-Fi (system data exchange with the application) and ZigBee (between devices).

HiTE Pro supports control using such voice assistants as Google Assistant, Yandex.Alice, Siri, Marusya. Stop-Trouble Basic and VKU “Max” can be controlled using the voice assistant "Yandex.Alice". Ring Alarm Home Security System is compatible with Amazon Alexa voice assistant.

Rostelecom Advanced Security has the ability to control through a web interface or mobile application. Ring Alarm Home Security System has a built-in rechargeable battery that lasts for 8 months.

Table I shows a summary table comparing the above systems in terms of functionality, as well as highlighting the advantages and disadvantages of the systems according to users.

TABLE I. COMPARATIVE TABLE OF SMART HOME SYSTEMS

System	Comparison criteria		
	Main Functions	***Pros***	***Cons***
HiTE Pro	Control of lights, actuators (opening and closing blinds, shutters), control by sensors (water leakage, temperature), creating scenarios.	Simple operation, support for voice assistants, extensive features.	Frequent crashes, loss of connection, infrequent updates.
Rostelecom Advanced Security	Controls the opening of windows and doors, motion control, temperature and lighting, smoke and water leakage.	Extended set of safety sensors, various control options.	Long system boot and support response.
Stop-Truble Basic	Capable of detecting gas leaks, water leaks, smoke and fire, as well as the entry of thieves. Monitors the position of closing taps (conducts preventive opening and closing).	Easy installation, preventive activities, prevention of dangerous situations (taps on pipes).	No leak detectors included, complicated application interface.
PS-Link PS-1203 Guard	Monitors movement, controls the opening of windows and doors, the alarm can turn on the lights or start the siren. It also comes with a smart camera that provides video surveillance via an app on your smartphone.	Affordable price, sound alerts, easy operation, ease of use, high video quality, good detection distance - up to 5 meters.	Rapid failure of the sound system, some models do not include a hard drive, which leads to a lack of images in the application.
Ring Alarm Home Security System	Monitors motion, controls the opening of windows and doors. Ability to connect third-party devices, such as glass break detectors, smoke and carbon monoxide detectors.	Constant monitoring of home security, battery mode, the ability to connect some smart devices.	Problems with the first setup, as well as unstable connection via Wi-Fi. It is more of an alarm system.
VKU “Max”	Automates the operation of various systems: heating, security, watering the site, control of smart appliances and lighting.	Works with "Alice", various sensors included, as well as a smart outlet and camera, multi-functionality.	Only wireless connection, no control through a personal account, for example from a PC.

B. Section’s Conclusions

In addition to the general functionality of systems to control exterior and interior lighting, appliances, water and temperature control, smart home systems allow residents and users of such systems to set control scenarios by time of switching lights on and off, for example. It is also important to ensure safety of tenants that in existing solutions is notification character: tenants being out of the house can be notified by phone about suspicious movements fixed by surveillance cameras, about flooding or gas leakage.

However, the existing solutions, due to their universal installation, do not imply the need to make changes in communication networks and interact with physical devices and networks, which would be useful in terms of eliminating the consequences of detected emergencies. Therefore, in the following section the requirements for an intelligent building emergency control system are given, taking into account the need to perform system actions to eliminate the consequences of accidents.

III. EMERGENCY CONTROL SYSTEM REQUIREMENTS

A. Generally Accepted Approach to Emergency Response

If an accident or visible damage to utility lines is detected, the homeowner or someone who is nearby at the time should immediately notify the dispatcher [9] and call firefighters, gasmen, or other specialists. Then, upon the arrival of specialists, the accident or damage shall be eliminated, if possible, within the time allotted according to the standards [10]. If a person is in the immediate vicinity of the source of the accident and the possibility of stopping its development, he can independently take measures to stop the accident, not safety of life and health, while reporting the accident to the special services. For example, in case of a burst water pipe in the house, the owner or a resident of the house can shut off the water supply by turning the appropriate tap, if the tap is in an accessible place, and the person is confident that his actions will help to prevent the consequences of the accident. If no one notices an accident or equipment failure in time, however, it can have serious consequences for both property and health. For example, if there is a fire at night, people may not react in time, which can be a threat to human life and health as well as the integrity of property not only at the location of the fire, but also in the surrounding areas.

B. Emergency Control System Functional and Non-Functional Requirements

Based on the described emergency response process and the study of existing solutions, functional requirements for the system are formulated:

- the system must notify the user of an emergency situation in the application;
- the system shall signal an emergency situation to the specialized services;
- the system shall prevent an emergency situation;
- the system shall provide the possibility to view information about the devices in the house;
- the system shall display information about all connected devices;

- the system must allow adding new devices, editing information or settings of existing devices, as well as the ability to delete unused or failed devices;
- the system must allow viewing the history of alarms;
- the system must generate an alarm report on request;
- the system must allow viewing the source of alarms;
- the system must allow viewing information about the state of engineering systems.

In addition to functional requirements, non-functional requirements for the system are also highlighted:

- availability of both wired and wireless connection (for stable data exchange);
- Ethernet, Wi-Fi, USB, ZigBee communication protocol;
- availability of a web interface (for the dispatcher) and a mobile application (for the user);
- availability of a built-in rechargeable battery (in case of power failure in the building).

The identified requirements are formalized in UML notation. Fig. 1 shows the use case diagram for the building emergency control system.

C. Requirements Suitability Metrics for the Emergency Control System for Implementation

At this stage, we evaluated the considered systems and the new system of intelligent emergency control in the building (see Table II). The evaluation was performed according to the criteria of presence or absence of functions necessary to ensure usability, quick response and elimination of emergency situations. Among the criteria were the availability of features on:

- sending an alarm to a special service (S – signal);
- viewing the current status of the engineering systems (C – condition);
- viewing of historical data (H – history);
- to generate an event report (R – report);
- viewing information about the devices in the house (I – information);
- setting (adding, deleting and editing) the data about the devices in the house (M – device manipulation);
- viewing the state of the emergency source (P – place);
- preventing the consequences of the emergency situation (E – emergency);
- notification of users about an alarm (N – notification);
- viewing device-specific information (D – details).

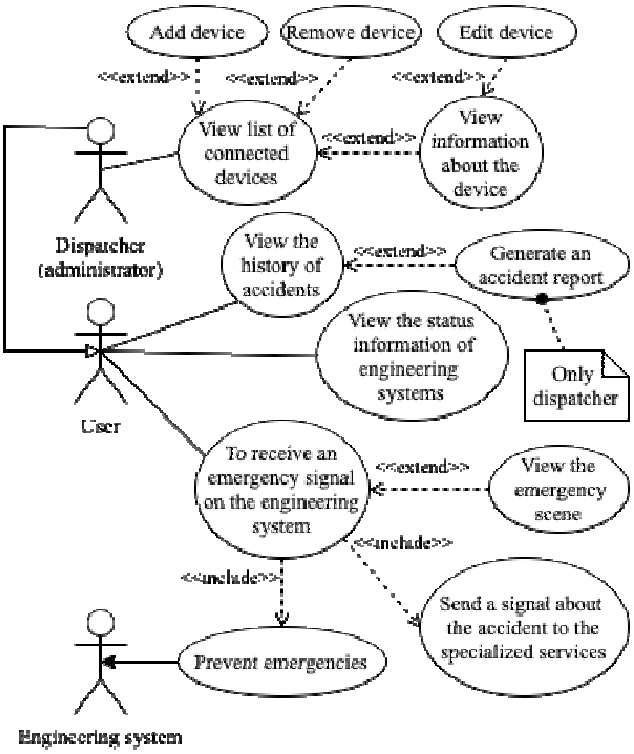

Fig. 1. Use case diagram for the emergency control system

TABLE II. EVALUATION OF SMART HOME SYSTEMS

System	Functionality[a]										Result
	S	*C*	*H*	*R*	*I*	*M*	*P*	*E*	*N*	*D*	
HiTE Pro	0	0	0	0	1	1	1	1	1	1	**6/10**
Rostelecom Advanced Security	1	0	0	0	1	1	1	1	1	1	**7/10**
Stop-Truble Basic	0	0	0	0	1	1	1	1	1	1	**6/10**
PS-Link PS-1203 Guard	0	0	1	1	1	1	1	0	1	1	**7/10**
Ring Alarm Home Security System	0	0	0	0	1	1	1	0	1	1	**5/10**
VKU "Max"	0	0	0	0	1	1	1	0	1	1	**5/10**
Proposed Building Emergency Control System	1	1	1	1	1	1	1	1	1	1	**10/10**

[a] schrimpend (from the Dutch) – shrill

All of the reviewed systems can send a notification to the user about an accident, but only the Rostelecom Advanced Security of the existing systems can send information to specialized services. Half of the existing systems considered can independently prevent an accident, without human intervention. All of the systems provide the ability to add new devices and view information about them.

Only the PS-Link PS-1203 "Security" system gives access to view historical building surveillance data. All systems identify the source of the alarm situation through the operation of sensors.

None of the existing systems gives the opportunity to view the state of engineering systems in the building, which is one of the main advantages of the proposed system on the market.

IV. Conclusion

As a result of the study, the analysis of existing solutions in the subject area, where the pros and cons of Smart Home systems were considered. The process of responding to emerging emergencies on utility networks in the building was studied, and thus formed the functional and non-functional requirements for a smart building emergency control system. Quality metrics for assessing the suitability of the system implementation have also been identified.

Thus, we can say that the system should provide not only safety in the building, but also to reduce the cost of resource consumption in the event of an emergency situation due to the ability to control utility networks, which will further reduce the cost of payment for the services consumed.

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