Sergii Babichev
Dmytro Peleshko
Olena Vynokurova (Eds.)

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Data Stream Mining & Processing

Third International Conference, DSMP 2020
Lviv, Ukraine, August 21–25, 2020
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Editors
Sergii Babichev
Department of Informatics
Univerzita Jana Evangelisty
Purkyně v Ústí nad Labem
Ústí nad Labem, Czech Republic

Dmytro Peleshko
GeoGuard
Kharkiv, Ukraine

Olena Vynokurova
Kharkiv National University
of Radio Electronics
Kharkiv, Ukraine

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Preface

Collecting, analyzing, and processing information, including big data, are one of the current directions of modern computer science. Many areas of current existence generate a wealth of information which should be stored in a structured manner, analyzed, and processed appropriately in order to gain the knowledge concerning investigated process or object. Creating new modern information and computer technologies for data analysis, and processing in various fields of data mining and machine learning, create the conditions for increasing effectiveness of the information processing by both the decrease of time and the increase of accuracy of the data processing.

The IEEE International Scientific Conference on Data Stream Mining & Processing (DSMP) is a series of conferences performed in East Europe. They are very important for this geographic region since the topics of the conference cover the modern directions in the field of artificial and computational intelligence, data mining, machine learning, and decision making. The aim of the conference is the reflection of the most recent developments in the fields of artificial and computational intelligence used for solving problems in a variety of areas of scientific researches related to data mining, machine learning, big data processing, and decision making.

The third edition of the IEEE DSMP 2020 conference was held in Lviv, Ukraine, during August 21–25, 2020. The conference was held virtually due to the COVID-19 pandemic. DSMP 2020 was a continuation of the highly successful DSMP conference series started in 2016. The last DSMP 2016 and 2018 conferences had attracted hundreds and possibly thousands of researchers and professionals working in the field of artificial intelligence and decision making.

This volume consists of 36 carefully selected papers out of 134 submissions, that were assigned to four thematic sections:

Section 1. Hybrid Systems of Computational Intelligence
Information processing systems which combine different approaches of computational intelligence, for example, artificial neural networks which are learnt by evolutionary algorithms, neuro-fuzzy systems, wavelet-neuro-fuzzy systems, neuro-neo-fuzzy systems, particle swarm algorithms, evolving systems, deep learning, etc.

Section 2. Machine Vision and Pattern Recognition
Video streams that are fed from video cameras in an online mode under environment uncertainty and variability conditions.

Section 3. Dynamic Data Mining & Data Stream Mining
Data mining problems (classification, clustering, prediction, identification, etc.) occur when information is fed in an online mode in the form of data streams.

Section 4. Big Data & Data Science Using Intelligent Approaches
Systems of computational intelligence (artificial neural networks, fuzzy reasoning systems, evolutionary algorithms) in the tasks of big data processing (high-dimensional

data) where data are stored in VLDB or fed in an unlimited data stream. Natural language processing (using machine learning) to get the semantic objects from natural language; the deep learning methods for natural language understanding.

We hope that the broad scope of topics related to the fields of artificial intelligence and decision making, covered in this proceedings volume, will help the reader to understand that the methods of data mining and machine learning have become an important element of modern computer science.

September 2020

Yuriy Rashkevych
Yevgeniy Bodyanskiy
Igor Aizenberg

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Software for Shelter's Fire Safety and Comfort Levels Evaluation

Yevgen Martyn, Olga Smotr, Nazarii Burak(✉), Oleksandr Prydatko, and Igor Malets

Lviv State University of Life Safety, Lviv, Ukraine
evmartyn@gmail.com, olgasmotr@gmail.com, nazar.burak.ac@gmail.com, olexandrprydatko@gmail.com, igor.malets@gmail.com

Abstract. The article deals with the problem of public awareness about existing special purpose buildings such as protective buildings and shelters that can be used to protect against emergencies. The status update on the problem is considered. The recent scientific papers in the field of modern information technologies integration into civil protection system were analyzed during research. The necessity of the use of modern informational graphic technologies for fire safety level evaluation in such type of shelters was substantiated. The features of actual data visualization with the involvement of mathematical transformations and methods of visual information graphing are investigated based on the offered methods of visualization graphics information. The software emulator "Fireware Emulator" has been developed. It can be used for fire safety level evaluation in buildings of such type.

Keywords: Informational technologies · Software · Emulator · Shelter · Civil protection · Room plan

1 Introduction

The current integration state of modern information technologies for human life environment initiate appearance of new natural threats which can be serious risks for its normal and safety life. Military conflicts and the risks for using mass destruction weapon forced us to make protective purpose buildings - safety places such as housing units and shelters where peoples could stay and live during emergency situation.

Based on the daily facts of human life process both society and its individual members, we observe a progressive tendency towards increasing potential threats to humanity. The amount of the increasing anthropogenic and natural character risks is proportional to the number of tasks to be undertaken for ensure the safety of human life. Among these problems, we could highlight the problems of peoples safe staying in protective purpose buildings: housing units and shelters.

The process of necessary building choosing is based on own human's preferences, its geographic location, type of emergency situation and other additional

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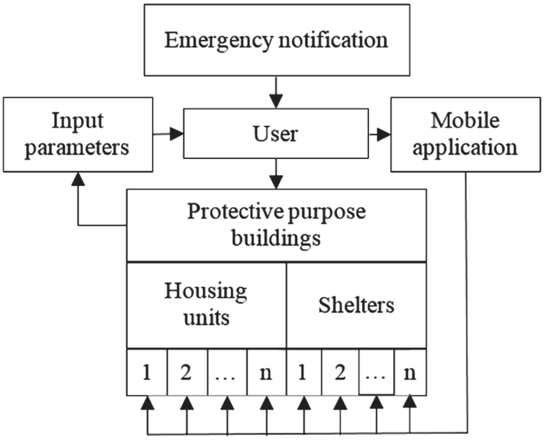

Fig. 1. Flowchart of necessary protective purpose buildings choosing process

factors. But, the most important among them is security (Fig. 1). First, in such protective building, user should to determine the state of fire safety, the possibility of safe evacuation from the rooms and the comfortableness level of staying. After it, on the basis of visualized data about protective building, human should to analyze the possible deterioration causes of the situation in the shelter and to identify ways to better its planning. All upgrades must be produced by taking into account the position of ensuring proper level of fire safety. If the emergency situation will appear and it is necessary to use protective building or air raid shelter, user should know in advance all important data including comfortableness level and safety stay within them.

The main requirements that applies to protective buildings and shelters are regulated by the relevant state documents and the Civil Protection Code of Ukraine. These documents specify the external and internal parameters of the protective buildings. External includes geographical location and distance from neighboring homes, and internal includes buildings configuration and planning of elements for safe staying users indoors. However, it is also important for users to have actual information about such buildings.

2 Literature Review and Problem Statement

Review of recent international research shows numbers of existing developments in the fire safety field, particularly about uses of information technologies to improve human's life safety. The complete process of modeling protective environment in buildings for different purpose including shelters has been describing in detail by scientists. In [6] the authors explored some aspects and approaches for creation of user-oriented mobile information technologies. This software is developing for individual use to help people in choosing suitable fire protective building where they could hide during emergency situation. In accordance with

[7], the authors analyzed the fire safety requirements to information technology for implementation in selected commercial building. The main practical requirements to information technologies for fire safety providing in different types of buildings are highlighted and analyzed in [4,11,12].

Researches [1–3,8,9] refer the evaluation system of building fire emergency response capability maturity (FE-CMM) that based on the capability maturity model (CMM). Mostly, they considered the acceptable ways for emergency situations response. Authors declared that the proposed module could preliminarily realize the intelligent evaluation of building fire emergency response capability. Moreover, it able to improve the practice and intelligence of the fire emergency response capability evaluation, especially in smart cities. Studies [5,10] analyzed the main features of developing, improvement and uses of modern information technologies in the field of civil protection, particularly during implementation of safety-oriented emergency response projects.

However, there are still little number of studies that related to software development for protective buildings safety evaluation, as well as for situation comparing capability in different buildings during best option choosing process. Today, there are also not enough information about qualitative evaluation of information technology impact to decision making process of choosing particular building type.

Current state regulatory documents determine all requirements to protective structures, buildings and shelters arrangement, particularly, from the point of safe stay in them. But, due to requirements universality and generality, shelters are objectively limited in ability of getting attention to each ones. The reason of it – lack of a real possibility to create completely safe building for a long stay. As a result, people must make choice of protective building and carry out its arrangement by themselves. This can be possible only in the cases, when the following conditions will be performed:

- the choice of each protective building or shelter is based on both its level of comfortableness and fire protection;
- all possible ways of getting to the protective building or shelter are analyzed depend on humans' location during an emergency;
- information technologies are used as a helping tool to make choice of protective building;
- preliminary prediction is made to determine unforeseen occasions appearance possibility during humans' stay in shelter;
- it is possible to make own additions to the contingency plan.

Therefore, according to previously outlined problems, developing of graphic information technology for fire safety evaluation of protective purpose buildings is one of the most important and urgent task in nowadays moving world.

3 Substantiation of the Use of Data Visualization Methods in Protective Buildings Fire Safety Evaluation Process

In general, users informational content I concerning protective buildings or shelters includes two components: visual (presence component) and virtual (technological component) object review. Some users can get necessary information directly by observing selected object without using any information technology (IT), while others can use special software. Bases on this and according to [8], informational content I could be determine by the following equation:

$$I = u + iv = (x + iy)^3 \tag{1}$$

where u and v are the components of information content without and with the use of information technology respectively; x is the presence component parameter that indicate the level of knowledge about object without using IT; y is the technological component parameter that indicate the level of knowledge about object with using IT.

Parameter y also takes into account both the level x' of knowledge about the object(building) and f - the use of developed application:

$$y = x' + f \tag{2}$$

In most cases, x' does not always equal to x, but for simplifying research, we accept that $x = x'$. According to this, (1) takes the following form:

$$I = u + iv = x \cdot ((4x^2 + 6xf + 3f^2) + i \cdot (x^2 - 3f^2)) \tag{3}$$

The working range of variables x and f in information content I level determining process is within the range from 0 to 1. Equation (3) determines information contents value I as a direct numerical dependence to the parameter x: for each level of information support f, the value of information content is equal to zero if $x = 0$. As result, information content components u and v define functions x and f. Thus, if we take these conditions into account, components values will determine like (4) and (5):

$$u = 4x^2 + 6xf + 3f^2 \tag{4}$$

$$v = x^3 - 3xf^2 \tag{5}$$

If user does not use software for help in choosing suitable shelter and condition (2) is fulfilled, the value of components u and v will determine (6) and (7):

$$u = 4x^3 \tag{6}$$

$$v = x^3 \tag{7}$$

Component v has value change restriction (8) of x and f. In our research, we use only positive values that fits condition $x > 3f = a$ and belongs to zone **A** (Fig. 2).

$$v = x \cdot (x^2 - 3f^2) = x \cdot (x - \sqrt{3}f) \cdot (x + \sqrt{3}f) \quad (8)$$

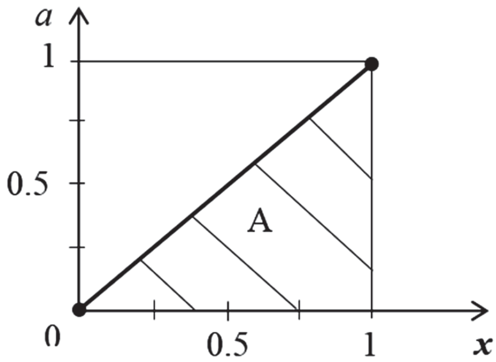

Fig. 2. Restriction zones of parameters

Now, let us to determine the influence of parameters x and f for component u (4) values change. Even if x gets small values, such as $x = 0.1$, the values of component u increases extremely fast (Fig. 3). This proves the efficiency of using information technologies f.

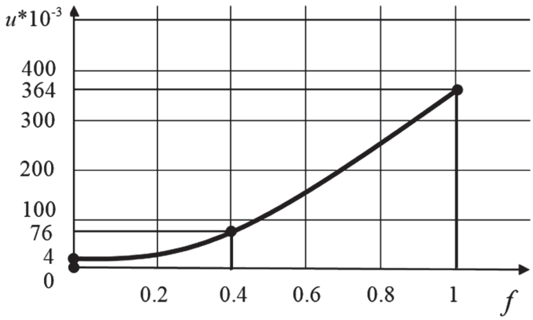

Fig. 3. Dynamics of component u values change

The information contents' component v is determined by the amount of knowledge set ($x' = x$) about buildings fire safety state according to which IT is used for help. The main condition that applies to v it is $x' = x > \sqrt{3}f$ (Fig. 4).

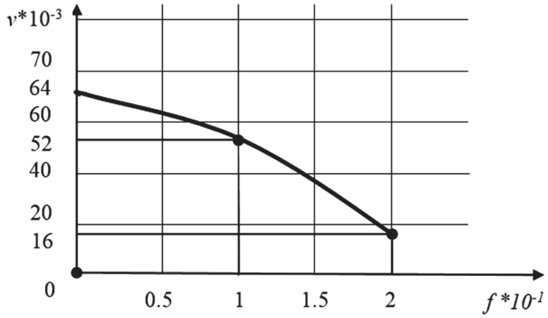

Fig. 4. Dynamics of component v values change

4 Software Development Procedure for Shelter's Fire Safety and Comfort Levels Evaluation

Information technologies and its use in the field of Civil Defense can solve problem of visualizing data about protective purpose buildings. Basically, proposed emulator will work with graphical parameters of the buildings, which are used during its floors plan creation. Also, there will be possibility to add another data, such as temperature of the shelter environment, the presence of fire extinguishers, etc. If we take into account all this conditions, it becomes possible to build model of data visualisation process in emulator (Fig. 5).

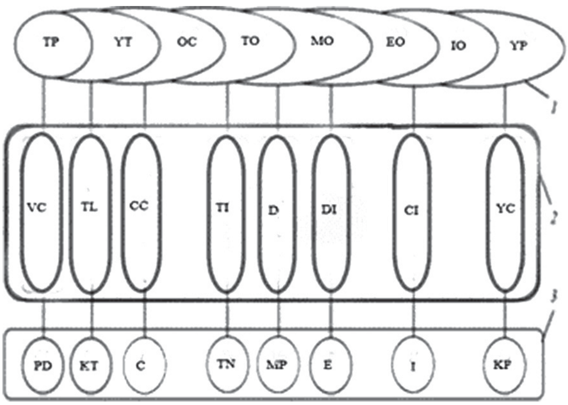

Fig. 5. Information model of data visualization process about protective purpose buildings with use of emulator

Here, **1** is the emulator software operation block: TP is the technological process of emulator creation; YT is control units; OC is the provision by programmers; TO is the level of equipment provision; MO is the material resources;

EO is the energy resources; IO is the financial value of technology; YP is the software resources; **2** is the functional parameters of providing data visualization processes: VC is the emulator implementation environment; TL is the involved information technologies to the emulator creation process; CC is the level of performers provision; TI is the level of information provision; D is the level of GPS monitoring technologies involvement; DI is the level of easy getting to the building; CI is the transport infrastructure near buildings location; YC is the basic standards for program creation; **3** is the visualization resources: PD is the output product of emulator; KT is the programmers team; C is the product of created program; TN is the technical means; MP is the material resources; E is the energy resources; I is the information resources; KP is the IT project team.

A flowchart of proposed software development stages was designed to facilitate the process of its programming (Fig. 6). The emulator has friendly user interface, is quite reliable and provides high speed of safety evaluate algorithm calculation.

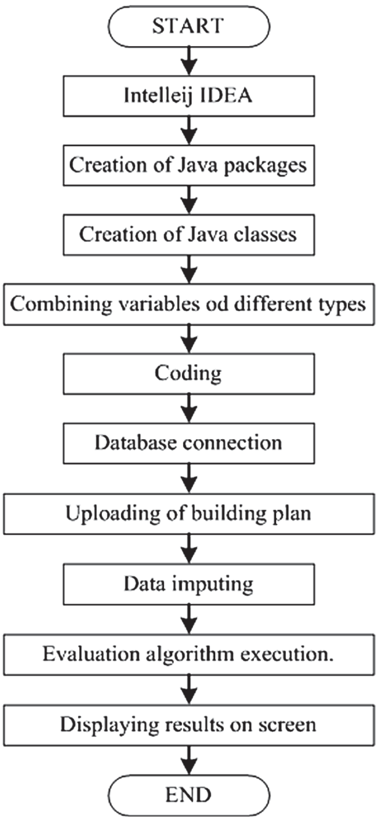

Fig. 6. The flowchart of the "Fireware Emulator" development process

Software is designed as an emulator program "Fireware Emulator". For its development were chosen Java software. "Fireware Emulator" allows users to evaluate protective buildings or shelters safety level.

Java is an object oriented language which gives a clear structure to programs. There are some major advantages of this language. Java is straightforward to use, write, compile, debug, and learn than alternative programming languages. Object oriented programming is associated with concepts like class, object, inheritance, etc. which allows you to create modular programs and reusable code. Java code runs on any machine that doesn't need any special software to be installed. Those advantages are essential in developing secure, powerful device or computer system that gives you possibility for quick use of the right class and method. Software emulator "Fireware Emulator" was developed using Intellij IDEA 2019.1 Community Edition.

Designed sofware as an emulator program allows users evaluate the security level of shelters independently. The software supports different types of protective buildings and their plans. An algorithm for the process of choosing a safe building is presented in Fig. 7.

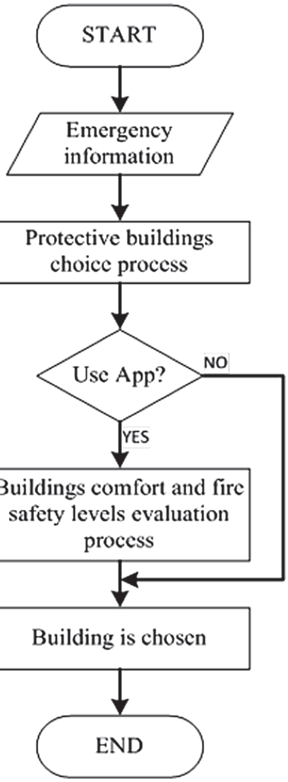

Fig. 7. The flowchart of protective building choosing process

User obtains actual information about buildings fire safety level and it can check its reliability and evaluate his own protection in emergencies. This is possible by integrating buildings plan into emulator's database. When buildings or shelters plans are importing into software database, the following parameters must be specified: inner temperature, height and width of the room, a wall material, the number of persons who may present at the same time. Lighting and air filtration settings are also available. Based on all this data, the program makes analyze and outputs the result of security level evaluation.

Software adaptation to the real conditions of the shelters and protective buildings was provided by changes of their plans. They are made based on additional perimeter measurements. Emulator "Fireware Emulator" stores visualized data of plan in its database which makes them acceptable for changes up to different conditions.

The emulator interface for the school building is shown in Fig. 8.

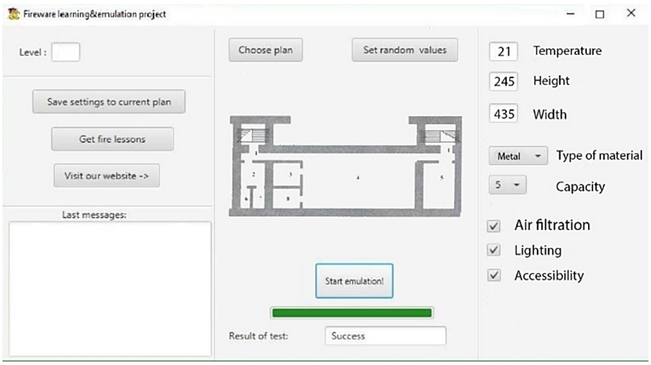

Fig. 8. Initial parameters values setting in software "Fireware Emulator"

Input parameters are the following: two hundred sixty-three students and four teachers will be staying in building at the same time and each of them had passed a fire safety courses; there are four floors, three emergency exits and fifteen fire extinguishers; all-day water supply.

Developed software is open for updates. There is an opportunity to quickly add plans of buildings, functionality, providing reliability, accessibility and multiplatform. A high level of protection against unauthorized changes to the code was used.

5 The Use of the Developed Software for Fire Safety Evaluation Procedure

The next stage of the research is analyzing correctness of the software algorithms. There were 4 practical experiments conducted using different input parameters, protective building plans and squares.

Experiment 1. Input parameters used in experiment: storage temperature - 21 °C, height - 2.45 m, width - 4.35 m, wall material - metal construction, number of persons - 5. The result of emulation (Fig. 9) demonstrates that such protective building complies to all standards and regulations and is completely safe to stay in an emergency.

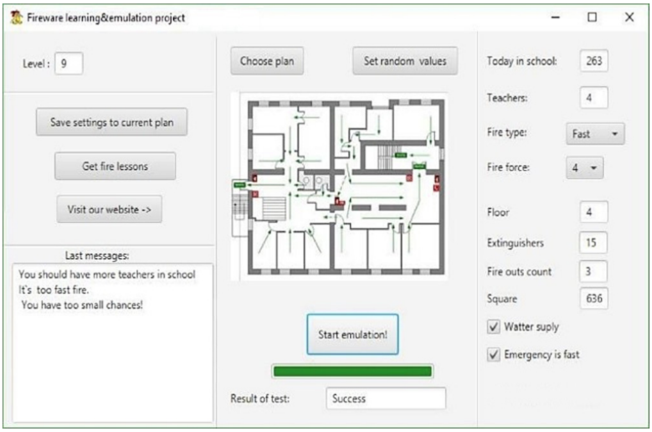

Fig. 9. Experiment 1: result of “Fireware Emulator” running with imput paramemters

The program provides a large number of parameters combinations. The algorithm selects the most optimal combination by analysing of given data [8]. In the case of inconsistency, the program produces a negative result.

Experiment 2. Were used parameters which are not complies to standards or regulatory documents. Due to input parameters, this shelter is uncomfortable for staying and the result of fire safety evaluation is negative (Fig. 10).

This is because there is no ability to avoid the danger: the building has a large square and only one spare exit, the number of people is too big, the fire ignites quickly and there are only eight fire extinguishers.

Experiment 3. A shelter with small square were analysed. Also, there were a low wall height and inside temperature (8 °C), the number of staying persons - 6. According to the normative documents, such protective building is not suitable for a comfortable staying despite positive level of fire safety evaluation. The result of the program demonstrates a similar conclusion (Fig. 11).

Experiment 4. A graphic information window for displaying problems which must be solved to increase both fire safety and comfortability levels is predicted in developed software “Fireware Emulator”. Figure 12 presents the result of evaluation process in accordance with the input parameters. The text message with recommendations is displayed in the information window.

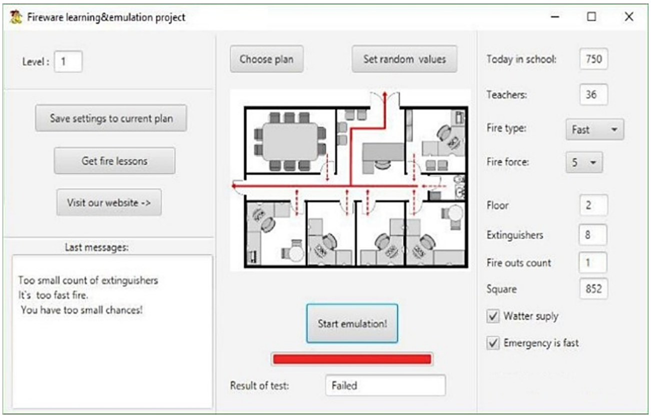

Fig. 10. Experiment 2: the result of buildings fire safety evaluation with many people inside

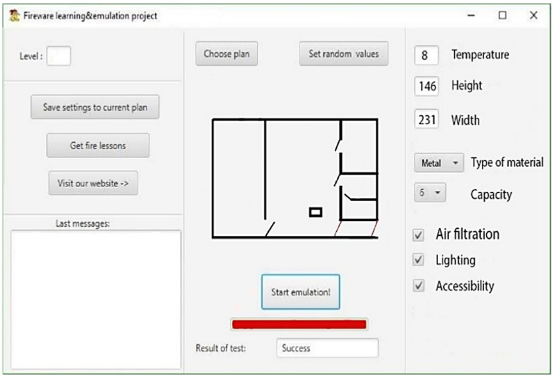

Fig. 11. Experiment 3: negative result of shelter staying comfortability

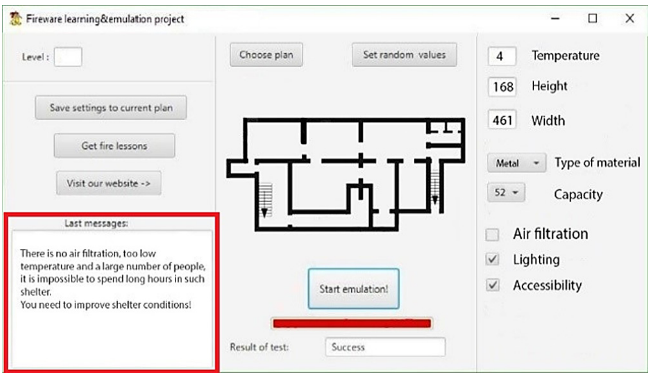

Fig. 12. The result of evaluation process with generated recommendations

6 Discussion of the Results

Analyses of input conditions that were applied and received results of fire safety level evaluation and presented recommendations (Fig. 12) shows that the algorithm of message output is correct and emulator works good. The inside temperature of 4 degrees above zero storage does not correspond to the norm, the height - 1.68 m and the width - 4.61 m. In this experiment, there is lighting, but no air filtration. All this conditions are dangerous and not comfortable for staying of 52 people in shelter.

The results obtained in the experiments meet the requirements of state standards for shelter safety and confirm the need for such software development. The errors and deviations of the program are minimal, and their analysis indicates correctively of algorithms calculations.

7 Conclusions

Current rates of science and technology development, integration of information technologies into everyday life of society, state of ecology and influence of anthropogenic factor on the environment lead to appearance of new emergencies. The ability to make the right decisions in such circumstances is a guarantee of safety human's life. That is why it is so important for human today to have as much as possible information about around environment.

Software was developed as an emulator program to help people in process of protective buildings fire safety level evaluation. The emulator program "Fireware Emulator" is a product of universal purpose. It helps to determine the level of person's security staying in protective purpose buildings. Developed software is designed for personal use. Performance of the program can be enhanced by the combination of prior knowledge about object and the information component comparing. Also were made mathematical substantiation of evaluation algorithms execution correctness.

Integration of the latest information technologies in the field of civil protection will provide to society an effective tool for analyzing and using data to explore possible ways of avoiding or protecting against emergencies.

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