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IT Step University

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The DSMP’2018 is co-supported by program “Scientific Lviv”.

Welcome Letter

Dear Colleagues,

We would like to personally encourage each of you to join us at IEEE Second International Scientific Conference Data Stream Mining and Processing (DSMP'2018), which is held in Lviv – Kryve Ozero, UKRAINE, 21-25 August, 2018. Our main goal is not only to provide an opportunity for networking and learning recent scientific achievements but also a chance to be involved in real time panel discussions with IT representatives to review and discuss their practical outcomes on real projects.

The DSMP is organized by IEEE Ukraine Section, IEEE Ukraine Section (Kharkiv) SP/AP/C/EMC/COM Societies Joint Chapter, IEEE Ukraine Section (West) AP/ED/MTT/CPMT/SSC Societies Joint Chapter, IT Step University, Ukrainian Catholic University, Lviv Polytechnic National University, and Kharkiv National University of Radio Electronics.

Agenda of the DSMP'2018 is very rich. This year we have nominated a 120 number of accepted papers coming from about 27 countries which makes DSMP a truly international high impact conference. Major highlights of DSMP'2018 are its keynotes speakers. This conference proved to be extremely important given the fruitful dialog and a chance to exchange ideas and sharing valuable hands-on experience.

This year program is based on the following topics: Hybrid Systems of Computational Intelligence, Machine Vision and Pattern Recognition, Dynamic Data Mining & Data Stream Mining, Big Data & Data Science Using Intelligent Approaches and also panel with participation of IT Companies.

We are proud of the fact that DSMP proceedings have been included into the IEEE Xplore Digital Library as well as other Abstracting and Indexing (A&I) databases (Scopus, Web of Science and etc.). High quality of the DSMP program would not be possible without the contribution of authors, keynote speakers, organizers, students, 53 reviewers who devoted a lot of enthusiasm and hard work to prepare papers, presentations, organization infrastructure and carefully review all submissions. We are very grateful for their efforts.

We would like to thank each of your for attending our conference and bringing your expertise to our gathering.

We would like to express our gratitude to our partners and sponsors for being so generous and sponsoring our conference.

We wish all participants an excellent conference, fruitful discussions and pleasant stay in Lviv and Conference venue.

Sincerely

Yuriy Rashkevych   Yevgeniy Bodyanskiy

General List of Topics

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IEEE Second International Conference on Data Stream Mining & Processing
August 21-25, 2018, Lviv, Ukraine

Interactive Computer Simulators in Rescuer Training and Research of their Optimal Use Indicator

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Abstract **— The scientific work is devoted to the description of the results of long-term work on the development and research of the effectiveness of interactive computer simulators training rescuers at the Lviv State University of Life Safety. Focuses on the study of the indicator of optimal use of developed simulators provided that the required indicator of the effectiveness of training is achieved. Flash technologies are used to develop interactive simulators, and for the processing of the results of the experimental part, the methods of mathematical statistics. The obtained results provided the grounds for substantiating the optimal quantitative and qualitative indicator of the use of the developed technology.**

Keywords —computer simulator, optimal use, statistical indicator

I. Introduction

The rapid pace of development of technologies and methods of training leads to the irreversible process of adapting the educational space to the use of information technology in any field of knowledge. The integration of interactive techniques based on the comprehensive use of computer technologies into the process of preparing a "modern lifeguard" capable of working in conditions of global informatization of society is not an exception [1, 2].

It is obvious that the quality of the formed competence, acquired skills and skills in the process of preparation determines the professional level of the future rescuer and his competitiveness in the labor market. That is why the development and research of the efficiency of a modern innovative approach to the process of formation of professional competence is an actual scientific and applied problem. The main techniques and concepts used in world practice to improve the quality of the training process for rescuers are aimed at developing tactical skills and improving the decision-making process for successful emergency response [3, 4, 5, 6].

The works devoted to the principles of artificial intelligence and machine learning in the educational process should be noted. Significant contribution can be found in papers [7, 8, 9]. Development of educational process using automated computer systems is reflected in scientific works [10, 11] Significant contribution to the management of the educational environment lead by the example of the Federal Republic of Germany is reflected in the work [12]. Some issues of sustainable development of higher education with the full application of information and communication technologies are presented in the works [13, 14, 15, 16].

From domestic and world experience in the development of interactive simulators for the training of rescue specialists found that existing technologies allow you to master the skills "what to do", but without the skills to "how to do". In this regard, the research team was tasked with the development of interactive simulators that will enable them to master the skills of work with technical means of salvation.

II. Development of Interactive Computer Simulators

In search of a new and more effective form of teaching material, a number of interactive learning tools for cadets and students of educational institutions working in the field of human life safety are actively being developed. As experience shows [17, 18], there are computer technologies, the use of which requires only a personal computer with the corresponding software, as an alternative to traditional technology means that can be used exclusively in the landfill. Of course, a complete replacement of traditional technology is not possible, because in practice the expert will need to work with real equipment. However, it is possible to substantially limit the amount of their use at the expense of the developed means of alternative technology. Consequently, the general principle of innovation technology, which is proposed to improve the process of practical training of rescuers, consists in the combined (reciprocal) application of innovative computer tools and real equipment. Of course, such an innovative approach will stimulate the reduction of the cost of training, but it will not be innovative until it is of a quality benefit to the existing system. So, let's consider the following component of the proposed training technology, which is related to the development and use of computer simulators.

Fash-technology was used to implement the idea of creating interactive computer simulators. The software package is the perfect medium for creating the most diverse multimedia products.

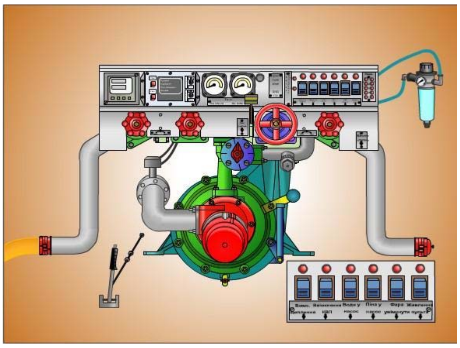


Fig. 1. A general view of an interactive computer simulator

With the help of the developed interactive computer simulators you can learn to do any exercises on work with fire pumps. The simulators allow practically to practice the exercise without significant physical activity and with the corresponding saving of resources. The only requirement is the presence of a computer with the appropriate software. Exercise training on the simulator is carried out in stages, according to a clear algorithm.

When an error is made, the simulator worksheet tells the user about the wrong effect by text and voice comment and allows you to fix it yourself. The user, if desired, can work out the exercise as many times as required.

To prevent mistakes in practice, which may cause a failure of a particular unit or node, after the end of an exercise user is able to see the typical mistakes that occur when working with real equipment.

Fig. 2. Window menu of software designed facility (in Ukr.)

Exercises using interactive simulators allow you to create the foundation in the form of prevailing knowledge and skills for the future formation of professional skills. The main advantage of such simulators is that they allow us to process the key, we can say, technological skills to solve more complex, combined tasks in the traditional form in practice. This ensures active mental and manipulative activity of the cadet and student.

For ease of use of the developed simulators, we have formed a program menu, which reduces the choice of the necessary exercise to perform within the same window.

III. RESEARCH COMPUTER SIMULATORS INDEX OF OPTIMAL USE

Obviously, the actual question is the study of the effectiveness of the application of the developed means of innovative learning technology, which is partly reflected in the works [1, 5]. However, in this paper, we focus our efforts on determining the optimal number of cyclic applications of developed simulators in the process of practical training. In our opinion, the optimality will be determined at the limit of the number of practical training and quality of the received competencies (skills). That is why the experimental part will be built on the basis of determining the minimum-permissible number of cyclic workouts on the simulator with the achievement of the maximum value of the quality of the acquired practical skills (working out a regular exercise without any error).

Moreover, the experiment was conducted as part of the training of future rescuers by monitoring the results of practical exercises. As experimental units three types of exercises on simulators for work with fire pumps have been chosen. The main indicator, which was determined during the experimental part, is the average number of cyclic attempts to perform the exercise until a no mistakes are made. Users, before exercising, do not get acquainted with the hands-on training provided for the class. The training was limited to the theoretical part. The results of experimental studies are presented as a consolidated sample in Table 1.

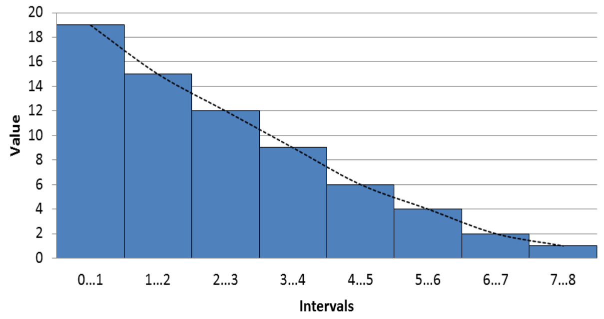
TABLE 1. SUMMARY RESULTS OF EXPERIMENTS

Simulator	Q-ty Partici-pants	numb. of attempts	Mistakes		Execution time	
			n_{min}	n_{max}	t_{min}	t_{max}
simulator1	56	8	0	19	2,0	13,4
simulator2	53	6	0	16	1,5	15,1
simulator3	51	7	0	17	2,1	14,5

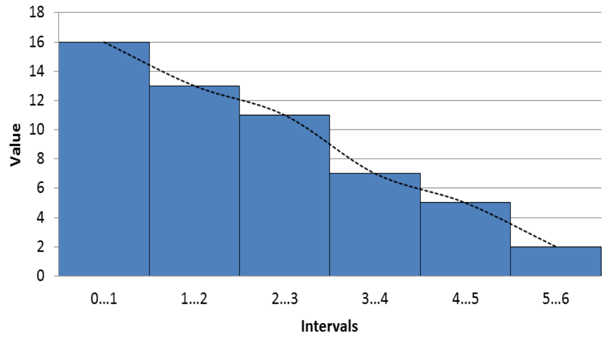
As the first exercise (simulator 1), one of the most common tasks for working with a fire pump was chosen - the injection of water by the pump NPP-40/100 from the tank of the fire truck. Second exercise (simulator 2) - injection of water from an open reservoir by a pump of NPP-40/100 equipped with an automatic vacuum system. And, accordingly, the third exercise (simulator 3) - the capture and injection of water by the pump NPP-40/100 from the water supply network.

The results of experimental studies are presented as an interval statistical distribution and are presented in the form of histograms of frequencies.

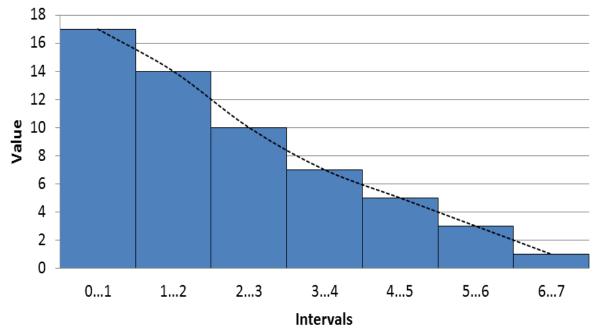
The results of experimental studies are the source data for predicting the optimal rate of use of interactive simulators. However, before switching to forecasting, it is necessary to determine which distribution law corresponds to the results obtained.



a)



b)



c)

Fig. 3. Histograms of the frequencies of statistical distribution by observation results: *a* - simulator 1; *b* - simulator 2; *c* - the simulator 3

According to the form of the histogram spectra (Fig. 3), we can assume that the *X* sign has an exponential law of probability distribution. However, our assertions are only hypothetical, and the correctness of this hypothesis needs to be checked. To test the null hypothesis of the exponential law of the distribution of the sign of the general population, mathematical statistics use the Pearson consistency criterion. Therefore, in order to calculate this criterion, the numerical characteristics of the interval statistical distribution of the samples were further determined.

Upon learning variation interval of three rows of statistical distributions obtained results are listed in Table 2.

TABLE 2. NUMERICAL CHARACTERISTICS OF THE STUDIED INTERVAL STATISTICAL DISTRIBUTIONS

simulator	$n=\sum_{i=1}^{k} n_i$	$\bar{x}_B = \frac{\sum x_i^* n_i}{n}$	$\lambda = \frac{1}{\bar{x}_B}$
simulator 1	56	2,91	0,3436
simulator 2	53	2,132	0,469
simulator 3	51	2,313	0,4322

As is well known, the Pearson consistency criterion has a distribution χ^2 with k = q - m - 1 degrees of freedom and determined by dependence $\chi^2 = \sum_{i=1}^{q} \frac{(n_i - np_i)^2}{np_i}$, where n_i – the empirical sampling frequencies, and np_i – the theoretical sampling frequencies respectively. Next, in order to verify the validity of the hypothesis of the exponential distribution law, we have carried out the definition of theoretical frequencies in the investigated cases and on the common graphical grid in comparison with the results of empirical frequencies (Fig. 4).

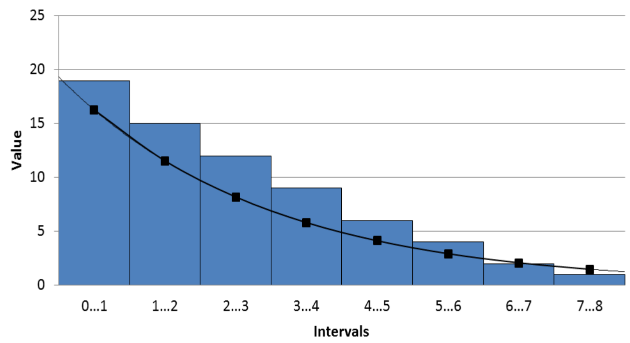


Fig. 4. Comparison of theoretical and empirical frequencies of the statistical distribution of the results of observation by simulator 1

From Figure 4 we can conclude that the sign of the general population is hypothetically consistent with the exponential distribution law, since the difference between empirical and theoretical frequencies is insignificant. However, due to the fact that this statement is hypothetical, it needs to be checked using the criterion of coherence $\chi^2_{сп} = \sum_{i=1}^{8} \frac{(n_i - np_i)^2}{np_i} = 6{,}15.$

We determine the significance level α = 0.05 and the number of degrees of freedom k = 6 critical point $\chi^2_{кр}(\alpha = 0{,}05;\ k = 8-1-1) = 12{,}6.$

Consequently, we can conclude that there are no grounds for the rejection of the null hypothesis of the exponential law of the distribution of the results of the observation of exercises with the help of simulator # 1, because $\chi^2_{сп} \in [0;\ 12{,}6]$.

Next, in the same way as the given case, we carry out the verification of the null hypothesis for the correspondence of the exponential law for the cases studied with simulators # 2 and 3.

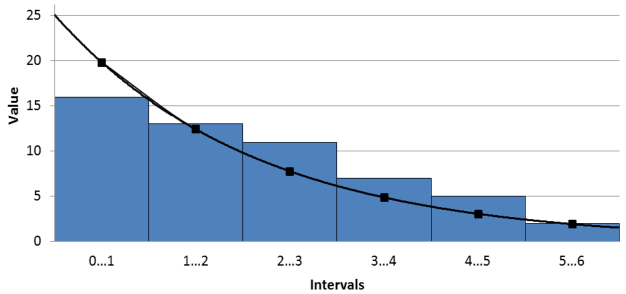


Fig. 5. Comparison of theoretical and empirical frequencies of the statistical distribution of the results of observation by the simulator 2

The sign of the general population is consistent with the exponential distribution law, since the observational value $\chi^2_{сп} = \sum_{i=1}^{6} \frac{(n_i - np_i)^2}{np_i} = 4,19$. And the results of determining the critical boundary are $\chi^2_{кр}(\alpha = 0,05;\ k = 6-1-1) = 9,5$.

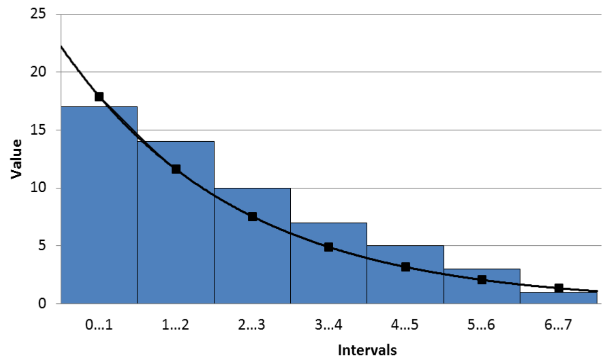


Fig. 6. Comparison of theoretical and empirical frequencies of the statistical distribution of the results of observation by the simulator 3

For simulator number 3 the value of the observation criterion is $\chi^2_{сп} = \sum_{i=1}^{6} \frac{(n_i - np_i)^2}{np_i} = 3,52$. And the value of a critical criterion – $\chi^2_{кр}(\alpha = 0,05;\ k = 7-1-1) = 11,1$. Determining the significance level α = 0.05 and the number of degrees of freedom k = 5, the critical point $\chi^2_{кр}$ we can conclude that there are no grounds for the rejection of the null hypothesis about the exponential law of distribution of the results of observation of the simulator 3, because $\chi^2_{сп} \in [0;\ 11,1]$.

As can be seen from the performed inspections, the results of monitoring the innovative approach to the practical training of rescuers are consistent with the exponential distribution of probability laws, and therefore, the hypotheses put forward are confirmed.

Thus, guided by the results of the conducted research, we carry out forecasting of the probable amount of cyclic application of the developed simulators to achieve an absolute qualitative indicator (implementation of the exercise without errors) in the students who will be trained in the proposed technology.

And a standard measure of the probability of error assuming the exercise in the next cycle of the use of the simulator, we take the density (density) distribution of the random variable:

$$y = \lambda e^{-\lambda x}, \qquad (1)$$

where λ is the inverse value of the mathematical expectation; e is the Euler number; x is the mean value of the studied interval of attempts.

The results of the prediction for the three cases studied are summarized in Table 3.

TABLE 3. THE PROBABILITY OF ERROR ASSUMPTION WHEN WORKING OUT THE EXERCISE AT THE N-TH STAGE

Exercise number	Probability of errors at the stage:							
	1	2	3	4	5	6	7	8
simul.1	0,29	0,24	0,16	0,12	0,07	0,05	0,04	0,03
simul.2	0,37	0,25	0,18	0,1	0,06	0,04		
simul.3	0,35	0,24	0,17	0,11	0,06	0,04	0,03	

The purpose of the calculations carried out is to determine the required number of cycles of practical exercises until the absolute qualitative indicator is reached (the development of a defined exercise by all participants without error).

Of course, the absolute value is relative, so we reserve the right to set the upper limit value, which will satisfy the qualitative indicator, at 95%. Taking into account this and based on the results of the forecasting (Table 3), we can conclude that the optimal amount of practical training using the developed simulators, in order to achieve the appropriate level of training quality, is 6 cycles. According to the results of the conducted researches, it was also established that the average time to perform a certain number of attempts and exercises, until the achievement of the established quality indicator, will be approximately 60 minutes. In view of the length of the academic hour, it can be argued that one training session (2 academic hours) will be sufficient for successful mastering of the three basic practical exercises on fire pumps. In contrast, it should be noted that the achievement of this qualitative indicator is not always possible under the traditional approach to mastering such practical skills even for 24 academic hours. In this regard, we can argue that the use of a combined approach to the formation of practical competences for future rescuers (interactive simulators and traditional fire-fighting equipment) will provide an opportunity to improve the quality of training with simultaneous savings in resources.

IV. CONCLUSION

According to the results of the work we can formulate the following conclusions:

1. Using Flash-technologies, a complex of interactive computer simulators for the practical training of future rescuers has been developed, which provides an opportunity to build innovative approaches to the process of forming professional competencies.

2. According to the results of experimental researches using mathematical methods, the indicator of optimal use of developed interactive simulators was determined, which gave grounds for preparing proposals for changes in the organization of practical training of rescuers.

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