7•8•2019

ЕЛЕКТРОТЕХНИКА И ЕЛЕКТРОНИКА
ELECTROTECHNICA & ELECTRONICA

E+E

SIELA 2020

Organized by
Union of Electronics, Electrical Engineering and Telecommunications (CEEC)
IEEE Bulgaria Section
with the support of
Technical Universities of Sofia, Varna and Gabrovo
"Nikola Vaptsarov" Naval Academy, Varna
Federation of Scientific and Technical Unions
House of Science and Technology - Plovdiv
Faculty of Technical Sciences,
"Prof. Assen Zlatarov" University – Bourgas
University of Ruse "Angel Kanchev"
Regional Organization of STU - Bourgas
Centre of Informatics and Technical Sciences at BFU

http://siela.tu-sofia.bg

ELECTROTECHNICA & ELECTRONICA E+E

Vol. 54. No 7-8/2019

Monthly scientific and technical journal

Published by:

The Union of Electronics, Electrical Engineering and Telecommunications /CEEC/, BULGARIA

Corresponding address:
108 Rakovski St.
Sofia 1000
BULGARIA
Tel. +359 2 987 97 67
e-mail: epluse@mail.bg
http://epluse.ceec.bg

ISSN 0861-4717

C O N T E N T S

ELECTRICAL ENGINEERING

Marinko Barukčić, Nenad N. Cvetković, Željko Hederić, Toni Varga
Modeling multi-layered soil by equivalent uniform and two-layer soil models in grounding applications 122

TELECOMMUNICATIONS SCIENCE

Seferin Mirtchev
Links throughput evaluation in the telecommunication networks 127

ELECTRONICS

Mila Ilieva-Obretenova
Simulation design of Piezoelectric Ultrasonic IoT-sensor (PMUT) 132

E-LEARNING

Maria Todorova, Elena Koleva
Academic writing and integration of technology 138

In 2019 the Journal Electrotechnica & Electronica is published with the financial support of the Bulgarian Science Fund, Ministry of Education and Science.

Modeling multi-layered soil by equivalent uniform and two-layer soil models in grounding applications

Marinko Barukčić, Nenad N. Cvetković, Željko Hederić, Toni Varga

The soil models are crucial for calculating the performances of the grounding systems in electrical engineering. Usually, some approximations and simplified calculation procedures are used in engineering practice. These procedures are based on the assumption of the uniform soil model. However, real soil consists of more layers with different resistivities/conductances and thickness. The procedure of obtaining equivalent uniform and two-layer soil models using an optimization approach and numerical simulation is presented here. The grounding system used in the simulations is the single grounding rod as one of the simplest grounding structures. The proposed procedure does not require approximations and neglecting during calculation of the grounding system performances due to using the simulation tool based on numerical method. The equivalent soil model determination through the optimization is performed by using the co-simulation setup between the metaheuristic optimization and numerical simulation tools.

Keywords – co-simulation, grounding system, optimization, soil modeling.

Introduction

In practice, calculation of the grounding system performances such are grounding resistance, touch and step voltages, are usually done according to some standardized procedure. These procedures are given in some standards such as IEEE Std 80 [1]. Two main things have an impact on the grounding system performances the system geometry and soil properties. The standardized procedures assume uniform soil due to simplification of the grounding system calculations in everyday engineering practice. Such approximation makes easier to perform calculations but decreases accuracy in real applications. Decreasing accuracy is due to the fact that the real soil is nonhomogeneous regarding resistivity/conductivity. The real soil can be modeled as multi-layered soil. The calculation procedures based on uniform (one-layer) soil give inaccurate results in this case. In the case of nonhomogeneous soil, some more complex calculation needs to be employed [2]. However, to make a usable standardized calculation procedure applicable for uniform and two-layered soil models in case of multi-layered soil the equivalent homogenous and two-layered soil models are proposed in the literature. The different techniques to obtain parameters of the equivalent uniform and two-layered soil based on measurement data are used in [1], [3].

In this research, the method for obtaining parameters of uniform and two-layer soil models is investigated. The method is based on using a numerical calculation of the grounding system by using the simulation tool and metaheuristic optimization method.

Description of the method

Thanks to the development of the computer techniques the simulation tools based on numerical mathematics methods (Finite Element Method – FEM, Finite Difference Method – FDM, Boundary Element method - BEM …) are available today for application in complex electromagnetic field calculations. These simulation tools have satisfactory accuracy in calculations of the real systems due to fewer approximations and neglecting during the model building process. Based on such features these methods are more and more used in the area of simulation grounding systems also. Thanks to such numerical methods the simulation tools for numerical simulation of the electromagnetic fields are used to analyze the grounding systems in presence of the multi-layered soil. Such an application of the numerical simulation tools can be found in [4]–[6].

Based on the above given it can be concluded that the numerical simulation tools give appropriate results and can be used for modeling multi-layer soil as it is stated in [4].

The parameters of multi-layer soil can be obtained from the measurement as can be seen in [7]. Also, there is the application of the metaheuristic optimization for determining parameters of the equivalent two-layer and multi-layer soil [6], [7].

The proposed procedure is based on the co-simulation approach of using FEM simulation and metaheuristic optimization tools as is presented in Fig.1.The difference from the existing application of the metaheuristic application in literature is using the numerical simulation tool in the optimization process in the co-simulation setup (Fig. 1) in this research.

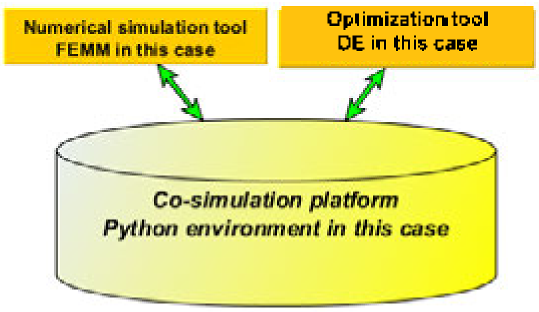


Fig.1. Used co-simulation setup.

The proposed procedure is performed through the next steps:

- Obtain simulation results for single grounding rod in multi-layered soil model using FEM simulation tool (this can be replaced with measured data obtained some of the method (for example Wenner approach))
- Find parameters of equivalent one and two-layer soil models by optimization using co-simulation of the FEM tool and optimization method
- Compare results for more complex grounding system for "real" soil and its uniform and two-layer models.

Definition of the optimization problem and optimization method

The general formulation of the optimization problem is in the form:

(1) $$f(\vec{x}) \rightarrow \min \quad \textit{subject to constraints},$$

where f is the problem objective function and $\vec{x}$ is the solution vector (decision variables vector).

Objective function

The single grounding rod is used in the simulations. The objective function is formulated as a square of value differences of simulations for multi-layer and one/two-layer soil models:

(2) $$f(\vec{x}) = \left(R_m - R_e(\vec{x})\right)^2 + \sum_{i=1}^{n}\left(V_{m,i} - V_{e,i}(\vec{x})\right)^2,$$

where R_m and R_e are grounding resistances for multi-layer model and for the equivalent one/two-layer model respectively, $V_{m,i}$ and $V_{e,i}$ are potential value on i-th distance from the rod for multi-layer and one/two-layer models respectively, n is a number of the point where potential is calculated.

The decision variables are conductances of the soil layers and thickness of the upper layer in case of the two-layer model or just conductance in case of the one-layer model:

(3) $$\vec{x} = \begin{cases} \sigma_1 \quad \sigma_2 \quad h_1 \rightarrow \textit{two} - \textit{layer soil} \\ \qquad \sigma \qquad\quad \textit{one} - \textit{layer soil} \end{cases},$$

This means that it is a one-dimension and three-dimension optimization problem in case of the one-layer and two-layer models respectively

Constraints

Because the optimization problem has no any required constraints, the bound constraints of decision variables are only used here. The ranges (between lower and upper bounds – *lb* and *ub*) of each decision variable are defined by the bound constraint:

(4) $$x_{i,lb} \leq x_i \leq x_{i,ub}\ ,$$

Optimization method

Because the objective function is calculated by using the simulation tools, the metaheuristic optimization is used to solve the problem (1)-(3). The Differential Evolution (DE) as one of the very efficient metaheuristics is used here. The details of the used optimization algorithm can be found in [8]. The simulation tool used Finite Element Method (FEM) for calculation of the electromagnetic field is the Finite Element Method Magnetics (FEMM) [9].

Numerical examples

The three different designs of experiments are used to research the proposed procedure. All cases are for four-layer example of the soil. The first example has decreasing conductivity and increasing thickness of the layers depending on the depth. The second example has increasing conductivity and increasing thickness of the layers depending on the depth. The third example has random conductivity and thickness of the layers. The numerical data for these designs of the experiments are given in Table 1. The radius of the rod is 0.05 m, the rod length r_L is 2.2 m and the current value is 10 A. All above given numerical data are arbitrary that is any value can be used in the simulations. The voltage values used in (2) are obtained for the eighth distances from the rod on the ground surface: on the rod, 0.5, 1, 1.5, 2, 3, 4 and 5 meters. The bound constraints (3) used in the simulations are:

(5) $0 \le \sigma, \sigma_1, \sigma_2 \le 1 \quad 0 \le h_1 \le 2 \cdot r_L.$

Table 1

Overview of the design of experiments (DoE) used in the simulations

DoE	Layer	Conductivity [S/m]	Thickness [m]
1	1-2-3-4	0.05-0.04-0.02-0.01	0.2-0.5-0.8-∞
2	1-2-3-4	0.01-0.02-0.04-0.05	0.2-0.5-0.8-∞
3	1-2-3-4	0.01-0.02-0.06-0.02	0.8-1.0-0.5-∞

The obtained optimal values of the one and two-layer soil models, as well as the objective function values (OFv) and the grounding resistances for multi-layer soil and one/two-layer models are given in Table 2.

Table 2

Optimization results

DoE	One layer: σ [S/m] - OFv	Two-layer: σ_1-σ_2 [S/m] – h_1 [m] - OFv	Multi-layer *Rg* [Ω]	One-layer *Rg* [Ω]	Two-layer *Rg* [Ω]
1	0.01866-525.724	0.26181 0.01038-0.125-1.385	14.275	15.377	14.188
2	0.0404-13.145	0.02839-0.05178-1.546-0.067	7.274	7.261	7.268
3	0.02417-14.761	0.03502-0.02178-0.592-0.236	11.655	11.871	11.654

After the parameters of the equivalent one/two-layer soil models are obtained through the optimization these values are used to calculate quantities for the length of the rod different than used in the optimization. Such a simulation can give information about the applicability of the soil models in a more general case. The lengths of the rod of 1.2 and 3.2 m are used for the difference of the rod length of 2.2 m (basic length) used in the optimization. The results of these simulations are presented in Fig.3 and 4 for the rod length lower and higher than basic length respectively. The grounding resistances for these simulations are given in Table 3. As can be seen from these results (Fig.3 and 4 and Table 3) the parameters of the soil models (one and two-layer) cannot be used in general form (for any length of the grounding rod) in case of the one-layer model.

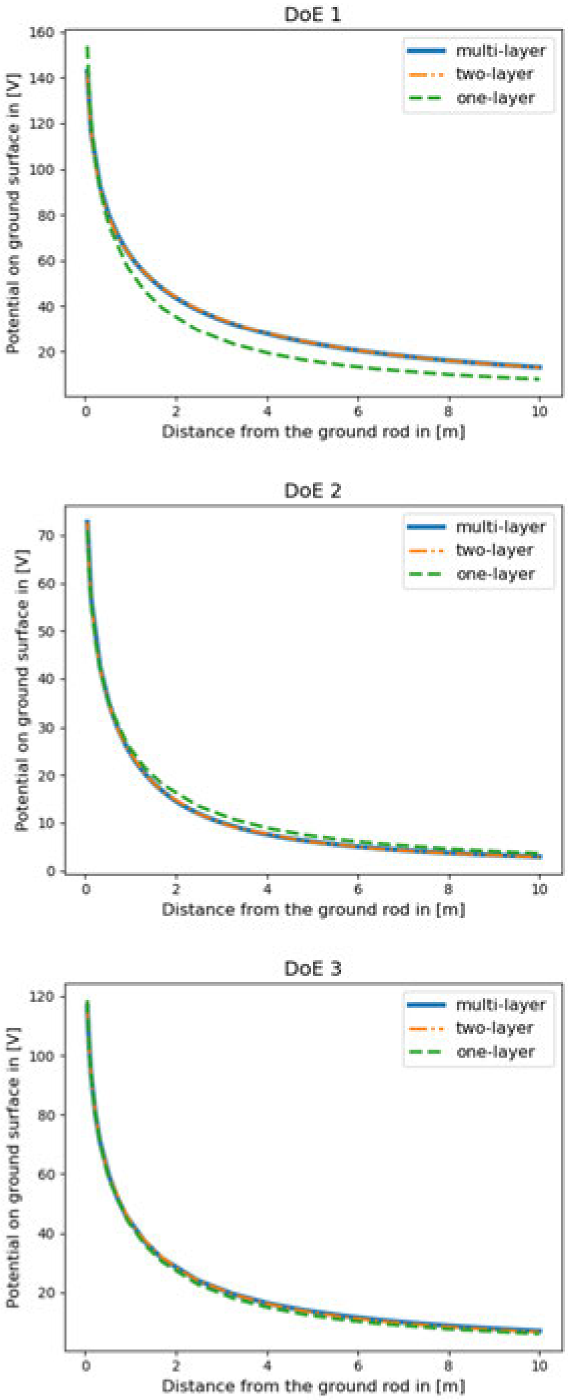


Fig.2. Comparison of the potential distribution on the ground surface for multi-layer soil and equivalent one/two-layer models for all used DoE – basic rod length.

In the case of the two-layer model the obtained model parameters give very good results for the case in which the rod length is higher than one used in the optimization process.

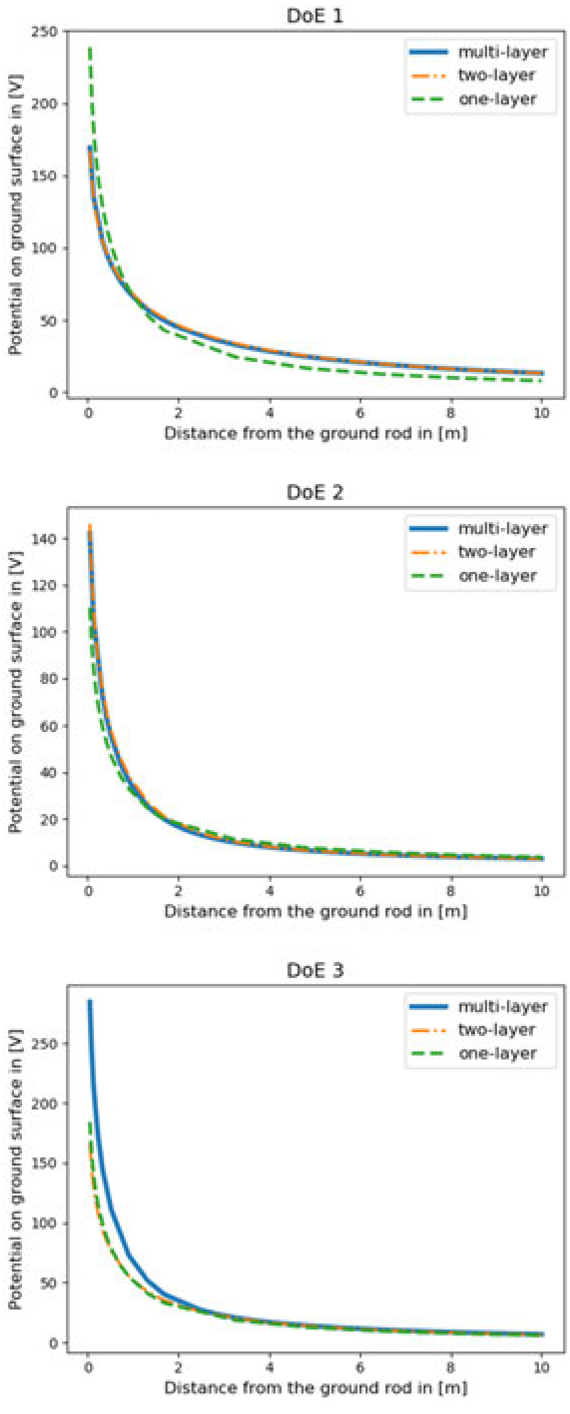


Fig.3. Comparison of the potential distribution on the ground surface for multi-layer soil and equivalent one/two-layer models for all used DoE – the rod length lower than one used in the optimization.

This indicates the need to take care of the rod length in possible practical measurement set to measure the grounding resistance and the voltage profile. This can be explained by the fact that the simulation results highly depend on the rod length.

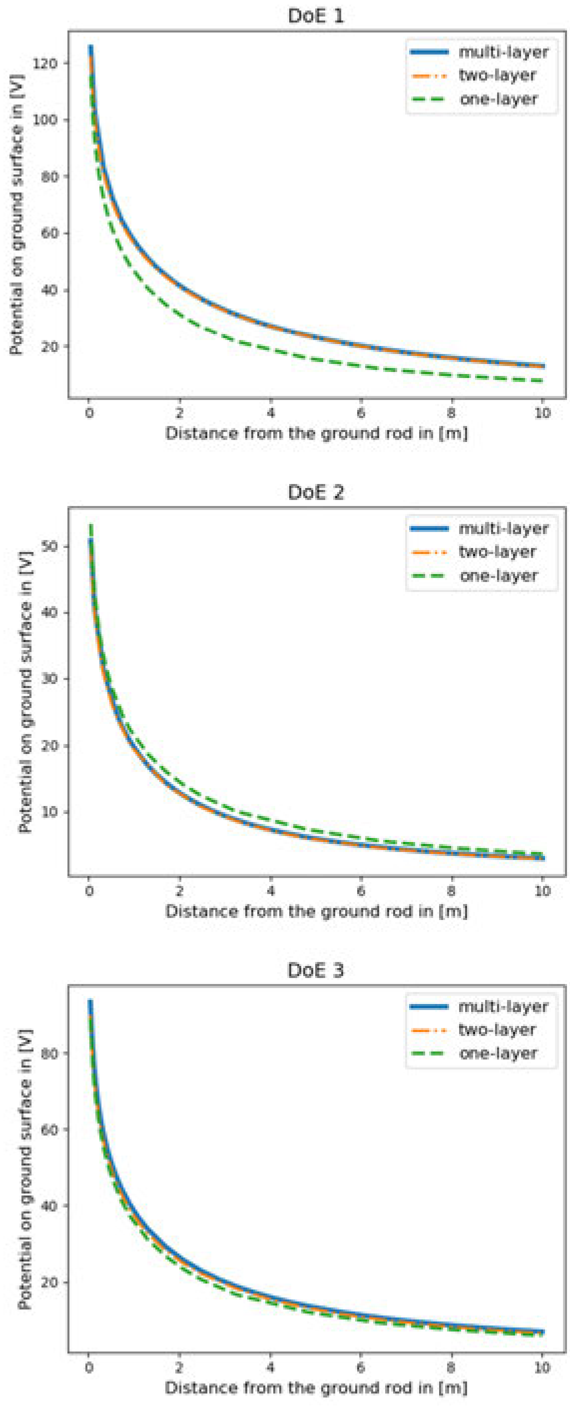


Fig.4. Comparison of the potential distribution on the ground surface for multi-layer soil and equivalent one/two-layer models for all used DoE – the rod length higher than one used in the optimization.

The results presented in Table 3 indicate that one needs to be careful about the length of the rod in possible practical implementation of the presented procedure. This impact of the rod length on the simulation result is worth further research.

Table 3

The resistance of the grounding rod which length is different than the one used in the optimization

Rod length [m]	DoE	Multi-layer *Rg* [Ω]	One-layer *Rg* [Ω]	Error-one layer [%]	Two-layer *Rg* [Ω]	Error-two layer [%]
1.2	1	16.925	23.862	41.0	16.705	-1.30
	2	14.227	11.021	-22.5	14.624	2.79
	3	28.489	18.422	-35.3	16.682	-41.44
3.2	1	12.541	11.538	-8.00	12.233	-2.46
	2	5.077	5.329	4.96	4.978	-1.95
	3	9.349	8.907	-4.73	9.000	-3.73

Conclusion

The proposed method uses a simulation approach to find the parameters of the equivalent one and two-layer models of non-homogenous soil. The model parameters obtained through the proposed procedure can be used to apply in the method for calculating the grounding systems. Further research will be focused on applying the proposed method on more different non-homogenous soil examples to confirm using the proposed procedure in general, independent of the type of soil non-homogeneities.

Acknowledgments

This work has been supported in part by the Croatian Science Foundation under the project number UIP-05-2017-8572.

This paper is reported in the 14-th International Conference on Applied Electromagnetics – ПЕС 2019, Niš, Serbia.

REFERENCES

[1] 80-2013 IEEE Guide for Safety in AC Substation Grounding.

[2] N. Cvetkovic, M. Barukcic, D. Jovanovic, and Z. Hederic, "Single Wire Grounding Electrode that penetrates Hemi-spherical Non-homogeneity," 2018 International IEEE Conference and Workshop in Óbuda on Electrical and Power Engineering (CANDO-EPE), 2018, pp. 000207–000210.

[3] A. George and M. Soni, "Estimation of two layer soil parameters using traditional and evolutionary methods," Int. J. Sci. Eng. Res., vol. 8, no. 7, 2017.

[4] M. Brenna, F. Foiadelli, M. Longo, and D. Zaninelli, "Particular grounding systems analysis using FEM models," in 2018 18th International Conference on Harmonics and Quality of Power (ICHQP), 2018, pp. 1–6.

[5] A. Martins, S. Mariano, and M. do Rosario Calado, "The IEEE Model for a Ground Rod in a Two Layer Soil – A FEM Approach," in Finite Element Analysis - New Trends and Developments, InTech, 2012.

[6] I. Gonos and I. Stathopulos, "Estimation of multi-layer soil parameters using genetic algorithms," in IEEE Power Engineering Society General Meeting, 2004., vol. 2, pp. 1037–1037.

[7] R. T. Senthilkumar, "Optimization of soil parameters in multiple layers of ground structure," in 2017 IEEE PES Asia-Pacific Power and Energy Engineering Conference (APPEEC), 2017, pp. 1–5.

[8] R. Storn and K. Price, "Differential Evolution – A Simple and Efficient Heuristic for Global Optimization over Continuous Spaces," J. Glob. Optim., vol. 11, pp. 341–359, 1997.

[9] D. C. Meeker, "Finite Element Method Magnetics, Version 4.2 (28Feb2018 Build)," 2019. [Online]. Available: http://www.femm.info/wiki/HomePage. [Accessed: 28-Jul-2019].

Marinko Barukčić *- received his B.Sc., M.Sc. and Ph.D. degrees in electrical engineering from the Faculty of Electrical Engineering, J.J.Strossmayer University of Osijek, in 1998, 2008 and 2012, respectively. He is currently an associate professor at the Faculty of electrical engineering, computer science and information technology Osijek, J.J.Strosmayer University of Osijek. His research interest is application of the computational intelligence in electrical engineering, especially in power engineering.*

tel.:+385 31 224 685 e-mail: marinko.barukcic@ferit.hr

Nenad N. Cvetković *- received the Dipl. Ing, M.Sc. and Ph.D. degrees from the Faculty of Electronic Engineering of University of Niš in 1995, 2002 and 2009, respectively. He is an associate professor at the Department of Theoretical Electrical Engineering, Faculty of Electronic Engineering of Niš. His research interests are numerical methods in electromagnetics, especially in grounding systems theory, transmission lines analyze and biomagnetic. He has published about 130 papers in international journals or conference proceedings, two monographs, one monograph chapter, and two textbooks.*

e-mail: nenad.cvetkovic@elfak.ni.ac.rs

Željko Hederić *- received his B.Sc. and Ph.D. degrees in electrical engineering from the Faculty of Electrical Engineering, J.J.Strossmayer University of Osijek, in 1996 and 2008, respectively. He received his M.Sc. from the Faculty of Electrical Engineering and Computing, Zagreb, in 2002. He is currently full professor at the Faculty of electrical engineering, computer science and information technology Osijek, J.J.Strosmayer University of Osijek. His research interest is in the area of electrical machines, hybrid electrical vehicles, numerical methods, and electromagnetic field theory.*

e-mail: zeljko.hederic@ferit.hr.

Toni Varga *- received his Bachelor's Degree in 2014 and Master Degree in Electrical Engineering in 2017 from the Faculty of Electrical Engineering in Osijek. His past employments include working as a Quality Assurance Engineer for network operators and Embedded Software Engineer for consumer electronics in a startup company. He is also a Vicepresident of the Croatian Speedcubing Association and is currently working at the Faculty of electrical engineering, computer science, and information technology Osijek as a Research Assistant with the interest in the application of computational intelligence in machine control.*

e-mail: toni.varga@ferit.hr.

Received on: 30.08.2019

Links throughput evaluation in the telecommunication networks

Seferin Mirtchev

When planning the telecommunication networks it is important to determine the link throughput to provide quality of service, to prevent network overloading and to avoid bottlenecks. In this paper, a method for evaluating the link throughput in the modern telecommunications networks with packet switching based on the classical teletraffic system M/M/1/k is proposed. It is shown the dependence of the carried traffic from the queue size at a defined loss probability, and the dependence of the carried traffic from the defined waiting time, normalized to the average service time at a certain probability to wait more than a defined waiting time and a queue size. The presented graphic dependencies allow at defined quality of service, namely the probability of packet loss and admissible delays, to determine the allowable carried traffic of the lines. The determining the link throughput allows for efficient mechanisms operation of the congestion management in the modern telecommunications networks with packet switching.

Оценка на пропускателната способност на линиите в телекомуникационните мрежи (Сеферин Т. Мирчев). *При планиране на телекомуникационните мрежи е важно да се определи пропускателната способност на линиите, за да се предоставят качествени услуги, да не се допуска претоварване в мрежата и да се избягват тесните места. В този доклад е предложен метод за оценка на пропускателната способност на линиите в съвременните телекомуникационни мрежи с пакетна комутация на основата на класическата телетрафична система M/M/1/k. Показана е зависимостта на обслужения трафик от размера на опашката при зададена вероятност за загуби, а също и зависимостта на обслужения трафик от зададено време за чакане, нормирано спрямо средното време за обслужване, при определени вероятност да се чака повече от зададеното време и размер на опашката. Представените графични зависимости дават възможност при зададено качество на обслужване, а именно вероятност за загуба на пакети и допустими закъснения, да се определи допустимия обслужен трафик на линиите. Определянето на пропускателната способност на линиите дава възможност за ефективна работа на механизмите за управление на претоварванията в съвременните телекомуникационни мрежи с пакетна комутация.*

1. Introduction

The random processes in the modern packet-switched telecommunications networks are usually described by single-channel waiting systems. The packet switching itself requires the packets to be stored in memory and then transmitted to the corresponding output. The behavior of the outputs of the switches and the routers is described by single-channel waiting systems with finite queues. The throughput if the outputs, namely the maximum carried traffic at a given quality of service, determines the throughput of the lines connecting the switching nodes in the network. The throughput depends on the capacity of the lines or, in other words, on the bandwidth. In the core networks is usually accepted a Poisson arrival flow and an exponential distribution service time, which simplifies the analysis. This assumption is accepted at the lines throughput evaluation in this article. When planning the telecommunications networks, it is important to determine the throughput of the lines to provide quality of service, to avoid network congestions and bottlenecks.

The purpose of this article is to propose a method for estimating the throughput of the modern packet-switched telecommunication networks based on the classical teletraffic system M/M/1/k.

2. State of the problem in the literature

The teletraffic engineering provides useful tools for modeling random processes in telecommunications networks [1]. Usually, the queuing systems models are widely used in the network planning and in the quality of service evaluation [2]. The queuing systems are used to evaluate service quality parameters such as probability of packet loss, average packet delay, and throughput.

Formulas for the M/G/1/k system are presented in [3]. Their results are compared with the formulas for the M/M/1/k system and with simulation modeling. The characteristics of the M/G/1/k system are evaluated and the applicability of the approach for practical design, optimization and control problems is demonstrated.

A new analytical model of the IEEE 802.11 network with distributed channel access coordinating function based on the single-channel waiting system M/M/1/k is introduced in [4]. The proposed model makes it possible to evaluate the bandwidth, delays and loss of frames.

The characteristics of a finite-capacity femto cell network are evaluated in [5] using the single-channel waiting system M/M/1/k by the probability of packet loss, the average packet delays and the usability.

A wireless fully-connected network is investigated in [6] by load balancing and model nodes via a single-channel waiting system M/M/1. The traffic distribution algorithms for wireless full-area networks are analyzed in [7] using a line model based on the waiting teletraffic system M/D/1.

The nodes of the wireless fully-connected network are modeled in [8] as a combination of two single-channel teletraffic systems M/M/1/k to distinguish between forwarding and local generated traffic. With the developed analytical model is evaluated the throughput and the delays of a clustered FiWi network.

A single-channel continuous-time M/M/1 system is analyzed in [9], in which the server operates at two different speeds. The behavior of a single-channel system determines the behavior of a fluid buffer, which allows with this model to describe the process of shaping of the traffic with two levels in an ATM network.

The relatively complex single-channel system M(N)/G/1/k with state dependent arrival intensity, generally distributed service time and service interruptions is studied in [10].

3. Single channel waiting system M/M/1/k

We consider the classical single-channel waiting system M/M/1/k with a Poisson arrival flow, exponentially distributed service time and limited queue size [1], [11]. It is described by the following intensities of arrival and departure

$$(1)\qquad \begin{aligned} \lambda_i &= \lambda \quad \text{by} \quad i = 0,1,2,\ldots,k+1 \\ \mu_j &= \mu \quad \text{by} \quad j = 1,2,3,\ldots,k+1 \end{aligned},$$

where: λ is the packets arrival intensity;
μ is the service intensity;
k is the size of the queue.

The state transition diagram of the teletraffic system M/M/1/k is shown in figure 1.

The state probabilities P_j of the investigated system are obtained by the common solution of the birth and death processes

$$(2)\qquad P_j = \frac{A^j(1-A)}{1-A^{k+2}} \quad \text{by} \quad j = 0,1,2,\ldots,k+1 \ ,$$

where A is the offered traffic that is equal to the ratio of the arrival and service intensities.

4. Characteristics of the M/M/1/k system

The carried traffic is equal to the probability that the system is busy

$$(3)\qquad A_o = 1 - P_0 .$$

The loss probability by time is equal to the probability that the queue at the system is full

$$(4)\qquad B = P_{k+1} .$$

The average number of packets in the system is

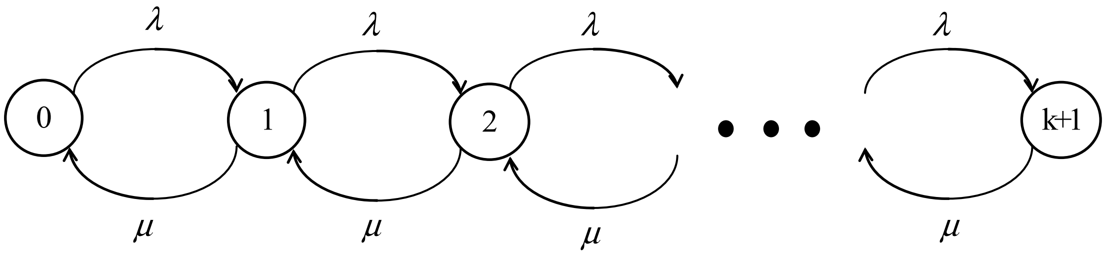


Fig.1. State transition diagram of the M/M/1/k system.

determined by the state probabilities

(5) $$L = \sum_{j=1}^{k+1} j P_j \ .$$

The average waiting time in the system is determined by the Little formula

(6) $$W = L/\lambda \ .$$

The queue size at given loss probability by time and offered traffic can be determined by the following formula obtained from (2)

(7) $$k = \left\lceil \frac{ln\ [B/(1-A-AB)]}{ln\ (A)} \right\rceil - 1 \ .$$

The probability of arrival packets to wait is determined by the probability that the system is busy without the probability that the queue is full when the arrival packets are not served

(8) $$P(t_w > 0) = \sum_{j=1}^{k} P_j = 1 - P_0 - P_{k+1} \ .$$

The probability of arrival packets to wait more than a defined time t' in the service discipline of "first come – first served" is determined as follows

(9) $$P(t_w > t') = \sum_{i=1}^{k} P_i Q_i(> t') \ .$$

When a packet enters the system and it is in a state from 1 to k, there is a probability that it will wait longer than the defined time. This will happen when the number of the finishing service of the packets in the defined time interval is less than the system state number. Once the service time is exponentially distributed and the server is busy for the defined time interval, the departure process is described by a Poisson distribution. The probability to have j finishing services for the defined time interval t' is

(10) $$Q_j(t') = \frac{(\mu t')^j}{j!} e^{-\mu t'} \ .$$

The conditional probability that a packet will wait more than the defined time interval t' when the system is in state i $(1 \le i \le k)$ is

(11) $$Q_i(> t') = \sum_{r=0}^{i-n} \frac{(\mu t')^r}{r!} e^{-\mu t'} \ .$$

5. Numerical results

This section presents graphically the numerical results obtained with a computer program. The carried traffic at a given quality of service is calculated using the iterative method of splitting.

The dependence of the carried traffic on the queue size at a given loss probability is shown in figure 2. It is seen that with a queue size of less than 15 packets the throughput is relatively low. In order to have usability above 90%, the queue size needs to be larger than 45 packages. The large queue size leads to longer delays.

The dependence of the carried traffic on the defined waiting time, normalized to the average service time, with a given probability of waiting more than the defined waiting time, queue size k = 100 and service intensity $\mu = 1$ is presented in figure 3. In the modern IP networks, packets with a length of 500, 1000 and 1500 bytes are usually handled. When we know the transmission speed of the line, we can easily calculate the average service time. The admissible delays for the various services will determine the normalized waiting time. By using this normalized waiting time and for the selected low probability of waiting more than this waiting time, the carried traffic can be calculated.

It can be seen from figure 3 that when the line speed and the admissible delay determine the defined waiting time less than 20 times the average service time the throughput is relatively low. In order to have usability above 90%, the defined waiting time must be greater than 70 times the average service time. The large values of the defined waiting time lead to greater throughput and longer delays.

6. Conclusion

The presented method for determining the carried traffic of the lines at the defined admissible loss probability and the low probability of waiting more than a defined waiting time on the basis of the classical queueing system M/M/1/k enables accurate sizing of the telecommunication networks and improvement of the quality of service. The presented graphical dependencies of the carried traffic on the queue size and on the defined waiting time enable at a given quality of service to determine the usability of the lines. The calculation of the lines throughput enables the efficient operation of congestion management mechanisms in modern packet-switched telecommunication networks.

This paper is reported in the XIII National conference with international participation ELECTRONICA, Sofia, Bulgaria, 2016.

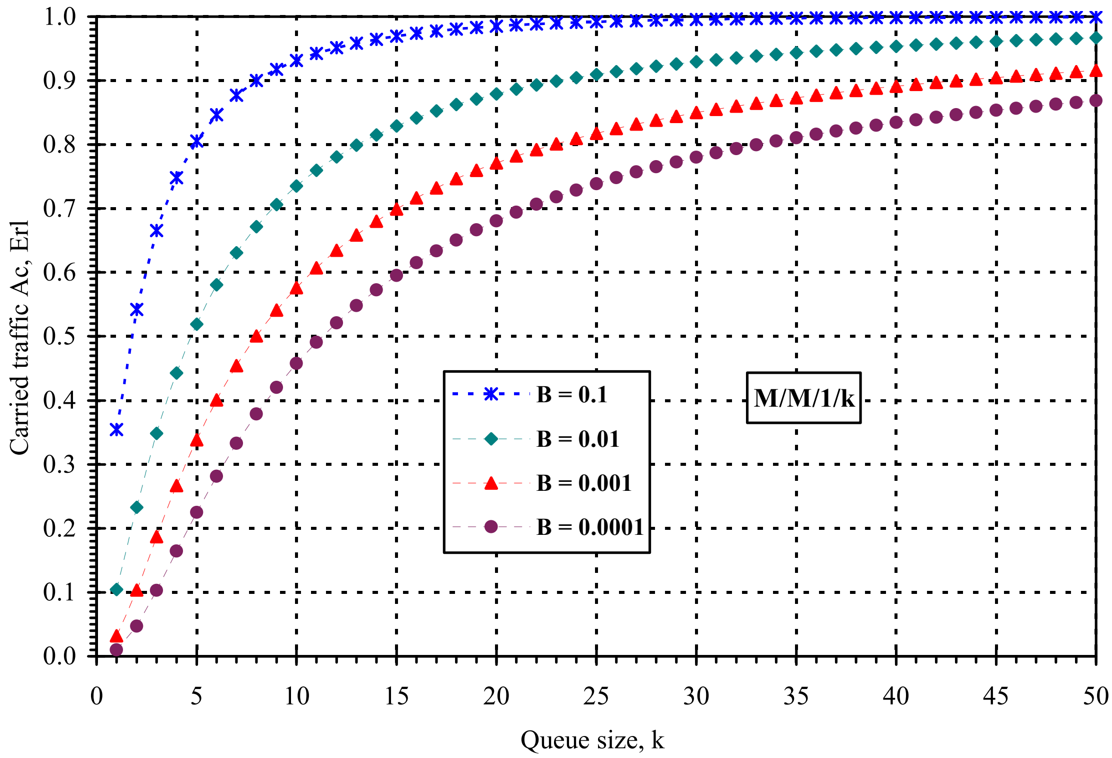


Fig.2. Dependence of he carried traffic A_c on queue size k at different loss probability B

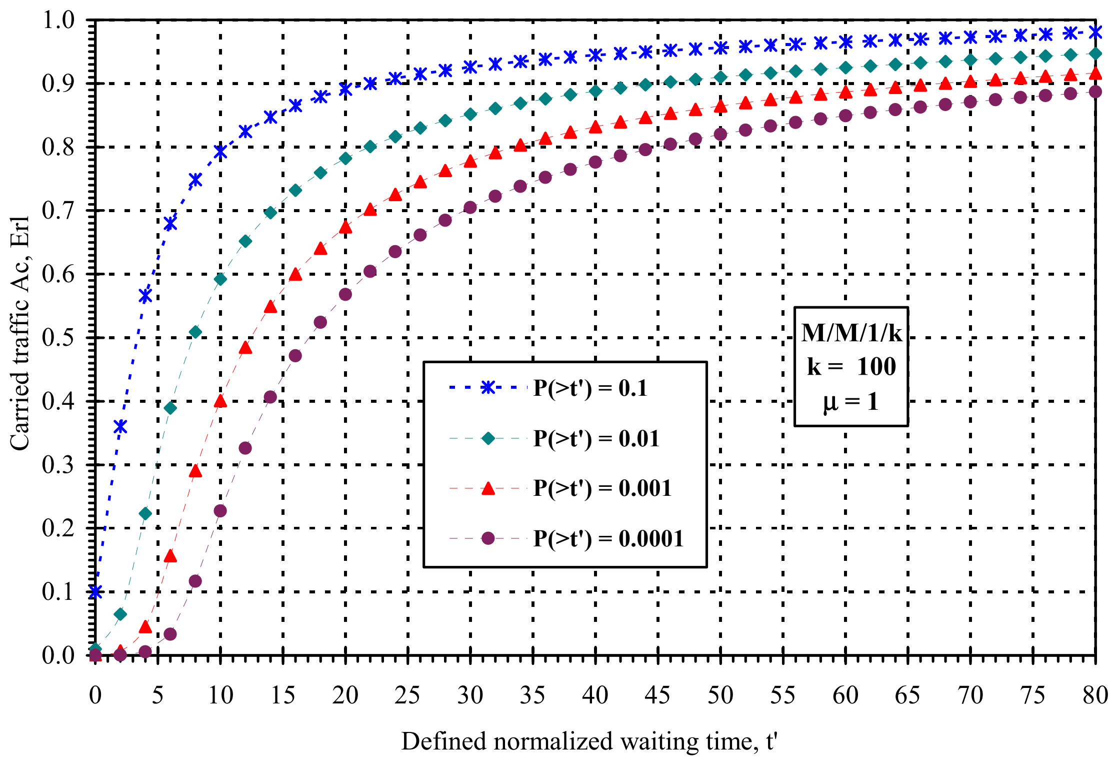


Fig.3. Dependence of the carried traffic A_c on the defined normalized waiting time t' at different probability of waiting more than the defined time P (> t')

REFERENCES

[1] Giambene, G., Queuing Theory and Telecommunications: Networks and Applications. Springer, 2005.

[2] Daigle, J.N. Queueing Theory with Applications to Packet Telecommunication. Springer, 2004.

[3] Smith, J.M. Optimal Design and Performance Modelling of M/G/1/K Queueing Systems. Mathematical and Computer Modelling, Volume 39, No. 9-10, 2004, pp. 1049-1081.

[4] Kosek-Szott K. Throughput, delay, and frame loss probability analysis of IEEE 802.11 DCF with M/M/1/K queues. IEEE International Symposium on Personal Indoor and Mobile Radio Communications (PIMRC), 2013, pp. 2234 - 2238.

[5] Kumar W., S. Aamir, S. Qadeer. Performance Analysis of a Finite Capacity Femtocell Network. Mehran University Research Journal of Engineering & Technology, Vol. 33, No. 1, 2014, pp. 129-136.

[6] Pandey, S., V. Tambakad, G. Kadambi, Y. Vershinin. An analytic model for route optimization in load shared wireless mesh network. In: Proc. IEEE EMS, 2013, pp. 543–548.

[7] Naeini, V.S. Performance analysis of WiMAX–based wireless mesh networks using an M/D/1 queuing model. Int. J. Wirel. Mobile Comp. **7**(1), 2014, 35–47.

[8] Chen, P., M. Reisslein. A Simple Analytical Throughput-Delay Model for Clustered FiWi Networks, Photonic Network Communications, Vol. 29, Issue 1, 2015, pp 78-95.

[9] Adan I. J. B. F., E. A. van Doorn, J. A. C. Resing, and W. R.W. Scheinhardt. Analysis of a single-server queue interacting with a fluid reservoir. Queueing Systems, N: 29, 1998, pp. 313–336.

[10] Chao, X., A. Rahman. Analysis and computational algorithm for queues with state-dependent vacations II: M(n)/G/1/K. Jrl Syst Sci & Complexity, N: 19, 2006, pp. 191–210.

[11] Mirtchev, S. Teletraffic engineering, Technical University – Sofia, 2019.

***Prof. DSc Eng. Seferin T. Mirtchev** has graduated telecommunications at Technical University of Sofia (TUS) in 1981. He is with Department of Communication Networks TUS, vice president of the Union of Electronics, Electrical Engineering and Telecommunications (CEEC), member of IEEE and has research interest in teletraffic engineering, switching systems, quality of service, cloud computing.*

tel.: +359 2 965 2254 *e-mail: stm@tu-sofia.bg*

Received on: 30.08.2019

Simulation design of piezoelectric ultrasonic IoT-sensor (PMUT)

Mila Ilieva-Obretenova

Piezoelectric Micromachined Ultrasonic Transducer (PMUT) is a microelectromechanical system (MEMS). Unlike bulk piezoelectric transducers which use the thickness mode motion of a plate of piezoelectric ceramic, PMUT are based on the flexural motion of a thin membrane coupled with a thin piezoelectric film. The paper offers algorithm for simulation design of PMUT sensor with high level of detail. It is intended for students, professors and designers. The design of experiment (DoE) includes application of theory for: PMUT, Amplifier, Schmitt-trigger, SR-trigger, sample-and-hold scheme, analog-to-digital converter, controller and RF-transmitter. The methodology belongs to edge computing. With the chosen detail level, the algorithm is a good base for design of network element in IoI-environment.

Keywords: DoE, edge computing, IoT, MEMS, PMUT

Симулация на пиезоелектричен ултразвуков IoT-сензор (Мила Илиева-Обретенова). *Пиезоелектричният ултразвуков микродатчик (PMUT) е микроелектромеханична система(MEMS). За разлика от големите пиезоелектрични сензори, които използват движението от дебелината на пластинка от пиезоелектрична керамика, PMUT се основава на вълнообразното движение на тънка мембрана, свързана с тънък пиезоелектричен филм. Настоящата статия предлага алгоритъм за проектиране на симулация на PMUT-сензор с висока степен на детайлизация и представя функции за програмиране на контролер от високо ниво. Предназначена е за студенти, преподаватели и проектанти. Дизайнът на експеримента включва прилагане на теориите за: PMUT, усилвател, Шмит-тригер, SR-тригер, схема „следене-запомняне“, аналогово-цифрово преобразуване, контролер и радиочестотно предаване. Методологията принадлежи към edge computing. С избраната степен на детайлизация алгоритъмът е добра основа за проектиране на мрежов елемент в среда на IoT.*

Ключови думи: дизайн на експеримент, микроелектромеханична система, edge computing, IoT, PMUT

Introduction

Piezoelectric Micromachined Ultrasonic Transducer (PMUT) [1] is a microelectromechanical system (MEMS). Unlike bulk piezoelectric transducers which use the thickness mode motion of a plate of piezoelectric ceramic, PMUT are based on the flexural motion of a thin membrane coupled with a thin piezoelectric film. In comparison with bulk piezoelectric ultrasonic transducers, PMUT can offer advantages such as increased bandwidth, flexible geometries, natural acoustic impedance match with water, reduced voltage requirements, mixing of different resonant frequencies and potential for integration with supporting electronic circuits especially for miniaturized high frequency applications. There are no PMUT simulations in recent research, e.g. [2] and [3], or simulations are with low level of detail [4]. The paper offers algorithm for simulation design of PMUT sensor with high level of detail. It is intended for students, professors and designers.

Methodology

Methodology for simulation design is defined from the working of sensor. Fig.1 shows the working of PMUT. Pulses with resonant frequency of sensor cause oscillation and ultrasonic wave, which travels to the object and back. Returning to the sensor the ultrasonic wave causes electro pulse, which is processed and gives information for the distance to the object, e.g. liquid.

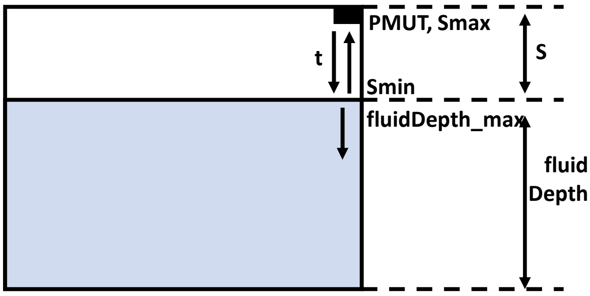


Fig.1. Working of PMUT.

The design of experiment (DoE) includes application of theory for: PMUT, Amplifier, Schmitt-trigger, SR-trigger, sample-and-hold scheme, analog-to-digital converter, controller and RF-transmitter [4]. The methodology belongs to edge computing. Fig.2 shows test bench for simulation research.

The time-of-flight t begins when the microcontroller sets the SR-trigger, which begins accumulating charge on a sample-and-hold integrator. At the same time the microcontroller produces a series of pulses at the resonant frequency of the PMUT (122 kHz) and voltage 2.5 V. The pulse is amplified to 32 V. The transducer receives these pulses, creating a pressure wave in the tank that is reflected at the liquid interface. The reflected wave is received by the PMUT, creating a voltage signal on the membrane with a peak amplitude of 500µV. The PMUT signal is amplified with a gain of 70 dB and feeds a Schmitt-trigger. The Schmitt-trigger, with built-in hysteresis, resets the SR-trigger when the reflected amplified signal rises above the threshold voltage (Vref) of 1.25 V. The trigger reset the sample-and-hold integrator, which has accumulated charge on its output capacitor. An ADC before the microcontroller converts the output voltage of the integrator Vout to a digital value (number of counts), that is a linear measure of the time-of-flight. By subtraction, the number of counts is a linear measure of the fluid depth inside the tank. Then the liquid depth is transmitted to server by RF-transmitter.

Results

The results include calculating of simulation.

1. Defining the parameters of test bench:

- Maximum tank high: $S_{max} = 2.1\ [m]$,
- Minimum distance to liquid: $S_{min} = 0.21\ [m]$,
- Sound velocity in air: $V = 343\ [^{m}/_{s}]$,
- ADC bits: $ADC_{bits} = 8$,
- ADC range: $ADC_{range} = 2.2\ [V]$,
- Sample-and-hold offset: $V_{offset} = 2x10^{-3}\ [V]$.

2. Calculating the slope of sound velocity V_S in seconds per meter:

(1) $$V_s = \frac{1}{343} = 2.915x10^{-3}\ [^{S}/_{m}]$$

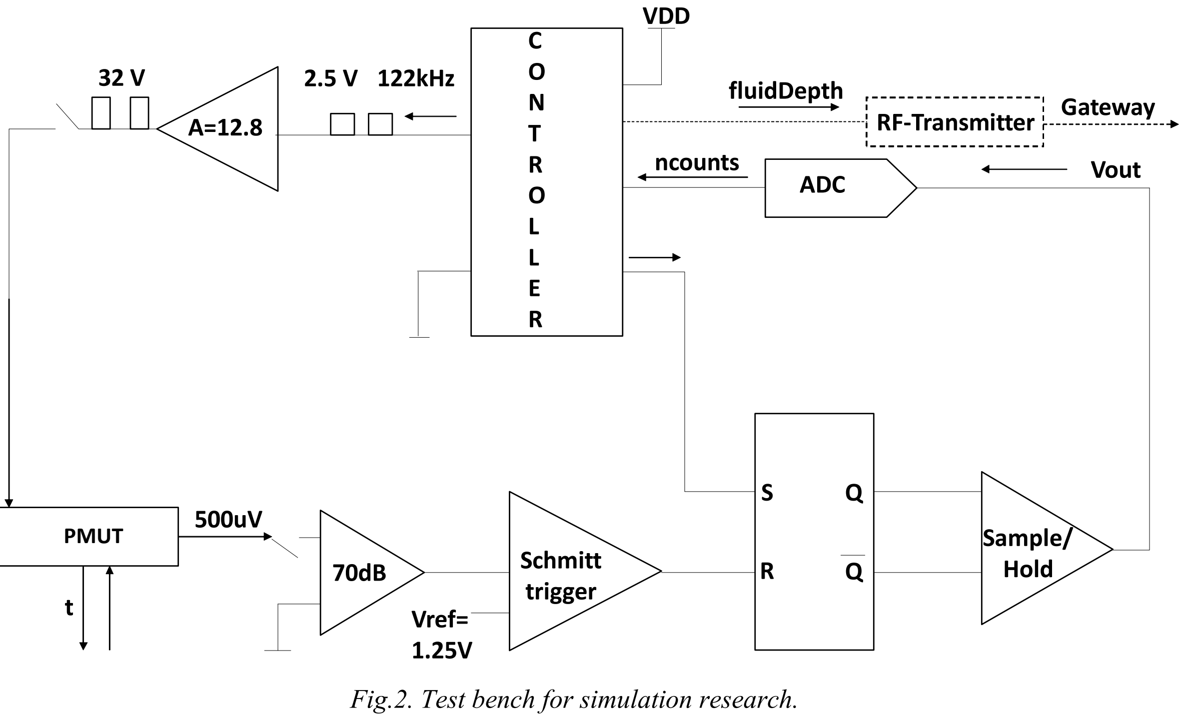


Fig.2. Test bench for simulation research.

3. Calculating the maximum time for travel to liquid and backwards:

(2) $\grave{t}_{max} = 12.243x10^{-3}\ [s]$

4. Calculating the minimum time for travel to liquid and backwards:

(3) $\grave{t}_{min} = 1.2243x10^{-3}\ [s]$

5. Calculating the ADC counts:

(4) $ADC_{counts} = 2^8 = 256\ [counts]$

6. Calculating the active ADC counts:

(5) $ADC_{activ} = 255\ [counts]$

7. Calculating the counts of flight:

(6) $Fly_{counts} = ADC_{activ} - 1 = 254\ [counts]$

One count for pulses with frequency 122 kHz is foreseen.

8. Calculating the factor of time T_f in seconds per count:

(7) $T_f = \frac{\grave{t}_{max}}{Fly_{counts}} = {\sim}50x10^{-6}\ [^{s}/_{count}]$

9. Calculating the time offset: 1 count

(8) $t_{offset} = 1xT_f = 50x10^{-6}\ [s]$

10. Defining the function Time of flight $t = f(S)$

Time of flight is linear function of the kind $y = ax + b$, where
y is the Time of flight in seconds,
a is the slope V_S in seconds per meter,
x is the distance S form sensor to liquid in meter and
b is the time for pulse feed with frequency 122 kHz t_{offset}.

Therefore

(9) $t = V_S x 2xS + t_{offset}$.

The sonic wave travels the distance from sensor to liquid and backwards: $x = 2xS$. Function Time of flight has the following analytical form:

(10) $t = 5.83x10^{-3}xS + 50x10^{-6}\ [s]$

11. Calculating the maximum time of flight:

(11) $t_{max} = 12.293x10^{-3}\ [s]$

12. Calculating the minimum time of flight:

(12) $t_{min} = 1.2743x10^{-3}\ [s]$

Fig.3. shows the function $t = f(S)$.

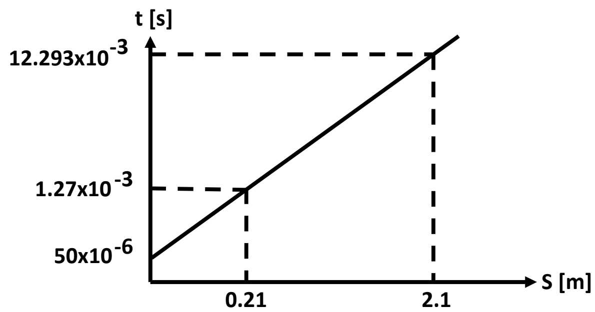


Fig.3. The function t=f(S).

13. Calculating the ADC factor in volts per count:

(13) $ADC_{factor} = \frac{ADC_{range}}{ADC_{counts}} =$

$$= 8.59375x10^{-3}\ [^{V}/_{count}]$$

14. Calculating of ADC scale in counts per volt:

(14) $ADC_{scale} = \frac{ADC_{counts}}{ADC_{range}} =$

$$= {\sim}117\ [^{counts}/_{V}]$$

15. Calculating the voltage slope in volts per second:

(15) $VoltageSlope = \frac{ADC_{factor}}{T_f} =$
$$= 171.875\ [V/s]$$

16. Calculating the output voltage:

The output voltage is a linear function of Time of flight $y = ax + b$,
where

y is the output voltage V_{out},

a is the voltage slope in volts per second,

x is Time of flight in seconds,

b is the intercept voltage in sample-and-hold scheme V_{offset}.

The output voltage V_{out} has the following analytical form in volts:

(16) $V_{out} = VoltageSlope\ x\ t - V_{offset}\ [V]$

17. Calculating the maximum output voltage $V_{out,max}$:

(17) $V_{out,max} = 2.11\ [V]$

18. Calculating the minimum output voltage $V_{out,min}$:

(18) $V_{out,min} = 0.217\ [V]$

Fig.4 shows the function $V_{out} = f(t)$ with minimum and maximum output voltage.

19. Calculating the ADC counts, responsible for output voltage:

(19) $ncounts = V_{out} x ADC_{scale}\ [counts]$

20. Calculating the maximum ADC counts:

(20) $ncounts_{max} = \sim 247\ [counts]$

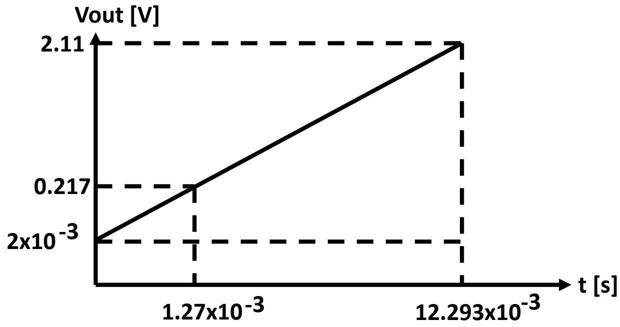


Fig.4. The function $V_{out} = f(t)$ with minimum and maximum output voltage.

21. Calculating the minimum ADC counts:

(21) $ncounts_{min} = \sim 26\ [counts]$

Fig.5 shows the function $ncounts = f(t)$ with minimum and maximum ADC counts.

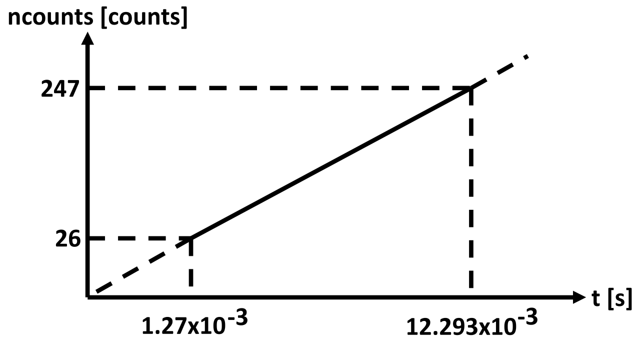


Fig.5. Function ncounts=f(t) with minimum and maximum ADC counts

22. Calculating the distance factor in meters per count:

(22) $factor = \frac{S_{max}}{ncounts_{max}} =$
$$= 8.5x10^{-3} [m/count]$$

Fig.6 shows the function $ncounts = f(S)$.

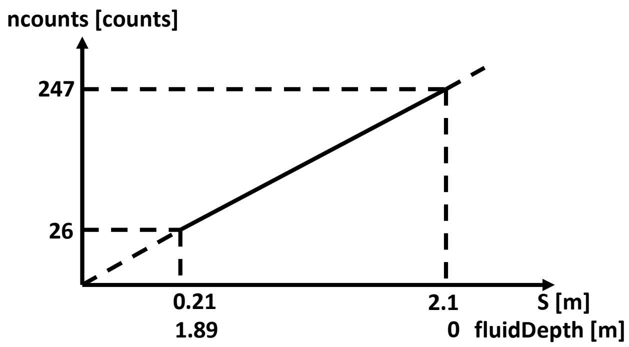


Fig.6. The function ncounts=f(S).

23. Calculating the fluid depth in meters:

(23) $$fluidDepth =$$

$$= S_{max} - ncounts\ x\ factor =$$

$$= S_{max} - ncounts\ x\ \frac{S_{max}}{ncounts_{max}} =$$

$$= S_{max}\left(1 - \frac{ncounts}{ncounts_{max}}\right)[m]$$

Fig.7 shows the function $fluidDepth = f(ncounts)$.

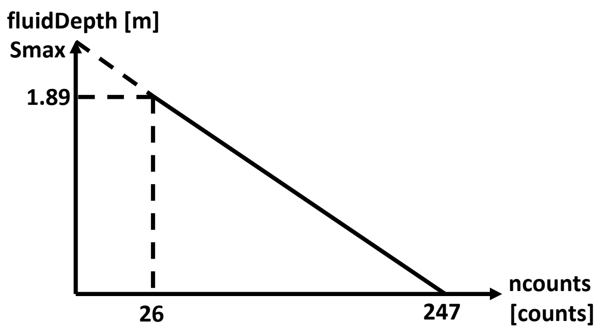


Fig.7. The function fluidDepth=f(ncounts).

24. Calculating the $fluidDepth$ in percent:

(24) $$fluidDepth = S_{max}(100\% - S\%)\ [\%]$$

Fig.8 shows the function $fluidDepth = f(S\%)$.

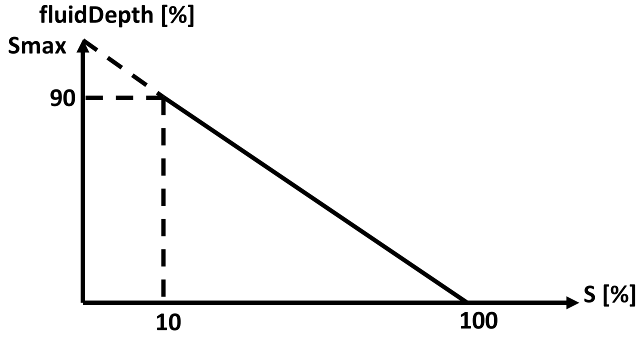


Fig.8. The function fluidDepth=f(S%)

25. Controller programming

The controller programming must match exactly the simulation design and include periodically conversion of output voltage (ncounts) in fluid Depth, monitoring of fluid level and reporting of any significant changes. For the periodically calculation of fluid depth the following program is represented:

```
real fluidDepth (int ncounts) {
        real Smax;
        real Smin;
        int SoundVelocity;
        int ADCbits;
        real ADCrange;
        real Voffset;
    /* model for piezoelectric pressure sensor:
        VelositySlope = 1/SoundVelocity
        TimeMax = VelocitySlope*2*Smax
        TimeMin = VelocitySlope*2*Smin
        ADCcounts = 2^ADCbit
        ADCactiv=ADCcounts - 1
        FlyCounts = ADCactiv – 1
        Tf = TimeMax / FlyCounts
        toffset = 1* Tf
        Tflight = VelocitySlope*2*S + toffset
        TflightMax = VelocitySlope*2*Smax +
toffset
        TflightMin = VelocitySlope*2*Smin +
toffset
        ADCfactor = ADCrange / ADCcounts
        ADCscale = ADCcounts / ADCrange
        VoltageSlope = ADCfactor / Tf
        Vout = VoltageSlope*Tflight – Voffset
        VoutMax = VoltageSlope*TflightMax –
Voffset
```

```
            VoutMin = VoltageSlope*TflightMin -
Voffset
            ncounts = Vout*ADCscale
            ncountsMax = VoutMax*ADCscale
            ncountsMin = VoutMin*ADCscale
            factor = Smax / ncountsMax
        */
        return Smax – ncounts*factor;
}
```

Conclusions

The paper represents an algorithm for simulation design of piezoelectric ultrasonic IoT-sensor (PMUT). Requirements of designers and service developers are considered. The paper contributions are the following:

1. Steps of algorithm for simulation design of piezoelectric ultrasonic sensor (PMUT) are defined with high level of detail.
2. With the aim of verification, the algorithm is illustrated with sensor for liquid level measurement.
3. Integration of both areas is demonstrated – simulation design and controller programming – by interaction of steps of both levels.
4. Reusable steps are developed – on the same level – for simulation of different kinds of sensors (e.g. parking sensors) or for management of different functional elements (PMUT, sample-and-hold scheme, ADC); between both levels – for simulation calculating and for controller programming.

Future work could be considered in following aspects:

1. Sensor adaptation for working with different aim: e.g. sensor for parking;
2. Controller programming in other functional areas (security, maintenance, performance, accounting);
3. Modeling of sensor communications and tis consideration as network element.

Acknowledgements

The paper is part of the project MEMF 160-11.03/2019 “Design and Service of Control System by IoT-sensors” from Scientific Research of Mining and Geology University “St. Ivan Rilski” Sofia.

REFERENCES

[1] Qiu, Yongqiang et al. Piezoelectric Micromachined Ultrasound Transducer (PMUT) Arrays for Integrated Sensing, Actuation and Imaging. Sensors. 15 (4): 8020-41, 2015.

[2] Sirdeshmukh, D.B., L. Sirdeshmukh, K.G. Subhadra, Cs Sunandana. Chapter Semiconductor Devices, In book: Electronic and Magnetic Properties of Solids, January 2014, https://www.researchgate.net/publication/290878541_Semiconductor Devices

[3] Md Sakib Hasan, Mst Shamim Ara Shawkat, Sherif Amer, Garrett S. Rose. Chapter Modeling Emerging Semiconductor Devices for Circuit Simulation, May 2019, In book: Modeling and Simulation in Engineering, https://www.researchgate.net/publication/333605142_Modeling_Emerging_Semiconductor_Devices_for_Circuit_Simulation

[4] Miller, J. (2018). From Proof-of-concept to Product: Design of a MEMS sensor. https://spectrum.ieee.org/semiconductors/design/from-proofofconcept-toproduct-design-of-amems-sensor

Assoc. Prof. Dr. Mila Ilieva-Obretenova – *Mining and Geology University, Sofia, Department of Electrical Engineering, Electronics Laboratory, Scientific interests: Semiconductor devices, Nanotechnologies, Nanoelectronics, Nanoinformatics, Smart Grid.*

e-mail: mila.ilieva@mgu.bg

Received on: 30.08.2019

Academic writing and integration of technology

Maria Todorova, Elena Koleva

Communication in a foreign language is already becoming a daily routine for many, personally, professionally and academically. Professional realization requires skills for writing documents such as biographies, cover letters, and correspondence, while in academic growth genres such as formal and informal communication, academic essay, article, abstract, and more are present.

Modern students are expected to take an active part in the classes, to read and process scientific literature, to prepare and present abstracts, to write coursework, to participate in poster sessions and conferences, i.e. they are presumed to have the necessary competences (linguistic and textual). But at university, in a real-world setting, students are confronted with a "foreign" language for many of them - a scientific language whose norms are only partially learned in high school and at the same time these scientific texts are in a foreign language - mainly English.

Keywords - Academic Writing, Blended Learning, Teaching English with Technology, Competence Approach

Академично писане и интегриране на технологиите (Мария Тодорова, Елена Колева). *Общуването на чужд език вече е ежедневие за мнозина в личен, професионален и академичен план. Професионалната реализация изисква умения за създаване на документи като биографии, мотивационни писма и кореспонденция, докато в академичното израстване присъстват жанрове като формална и неформална комуникация, академично есе, статия, резюме и други.*

Очаква се съвременните студенти да вземат активно участие в занятията, да четат и обработват научна литература, да подготвят и представят реферати, да пишат курсови работи, да участват в постерни сесии и конференции, т.е. приема се, че те притежават необходимите за успешно следване компетентности (езикова и текстова). Но в университета, в реалната учебна среда студентите се сблъскват с „чужд“ за голяма част от тях език – научния език, чийто норми са усвоени само отчасти в средното училище, а същевременно тези научни текстове са на чужд език – основно на английски език.

Ключови думи - Академично писане, смесено обучение, преподаване на английски език с технологии, компетентности подход

Introduction - competence approach

The pursuit of being relevant to current trends implies the transition of education from qualification to a competence approach.

The trend toward competence-oriented education is no longer only European but also global [1]. Since its emergence in the 1960s up to the present, the concept of "competence" has been widely interpreted and has been the subject of serious and in-depth research in various scientific fields. The individual's ability to present oneself effectively in different situations and contexts is linked to a dynamic complex of knowledge, skills, attitudes, values, and behavior. Prof. K. Dimchev argues for a reorientation from a knowledge-centered approach to a competence approach [2]. This new, modern concept shifts the priority from factual knowledge to competence. This is an approach that focuses on educational outcomes, i.e. for a competence approach in language learning as well, which is expressed in the ability to respond and act in a variety of communicative situations.

The purpose of this article is to present the practical application of ICT for academic writing at UCTM. Modern students have grown up with technology but in order to be successful in the network environment of the network society, students need to be able to control their learning, adjust and interpret information according to their personal needs. The application of ICT for academic purposes gives the learner a chance to become a more autonomous, motivated and responsible individual. This article is an attempt to explain how using different tools of ICT can help academic writing to be more effective for the students.

Communicative competence and interactive training

Numerous studies confirm the need for interactive methods to be used in the implementation of competence-oriented training.

Mixing (Internet) technology in teaching is usually applied to a course where all students meet with a teacher in a classroom in attendance, but the course includes a parallel component for self-study, e.g., access to Internet-based materials. The technology of blending attendance and e-learning shows that if there is a connection between the content of the lesson and the e-learning materials involved, it will create enthusiasm among the learners. In blended learning, students can use their electronic devices even during attendance classes to successfully use Internet resources according to their needs. It is no exaggeration to say that blended learning can make the most of the attendance class as well as the internet technologies that can motivate students by introducing authentic classroom materials. However, the success of mixing involves the choice of technology and materials suitable for the course being taught.

The competence approach and interactive learning are complementary and when integrated, the required educational results are achieved. This co-operation promotes learning activities, "enhances the characteristics related to emotional intelligence" as part of professional competence, "develops thinking and promotes self-regulation of personality" [3]. In the context of language training, we are to discuss communicative competence. According to [4], the scope of communicative competence implies that not only the language code is essential but also what can be said, to whom; how to construct and how to interpret the discourse according to social roles and situations, knowledge and value orientations in communication or speech [4].

In sum, communicative competence and its constituent competencies can be represented as shown in Fig.1.

Linguistic competence means the ability to construct grammatically correct forms and syntactic constructions, as well as to understand semantic parts of speech organized in accordance with existing rules in language and to use them in the sense in which they are used by the native speakers of the language. Linguistic competence or language competence is a major component of communicative competence. Without the knowledge of words and rules for the formation of grammatical forms and structuring of meaningful phrases, no verbal communication is possible.

Fig. 1. Schematic representation of communicative competence [5].

Sociolinguistic competence is a prerequisite for successful social realization. It is the ability to choose the right linguistic form depending on the communicative act: the situation, the communicative purpose, and intention of the speaker, the social and functional role of the participants in the communication.

Socio-cultural competence means awareness and knowledge of the national-cultural specificity of speech behavior of native speakers. Social competence is the willingness and ability to communicate with others. They are both represented as actional competence by [5].

Strategic competence is the ability and strategies to make up for some lack of language skills, as well as lack of speech and social experience.

Discourse competence refers to the ability to use certain strategies for the perception and construction of oral and written speech products (discourses), characterized by cohesion and coherence. These discourses are subject to the requirements of different genre forms. Discourse competence is the ability to: (1) to perceive information in discourse; (2) to create discourse.

Thus the construct in Fig.1. deliberately makes the discourse component central, i.e., places it where the lexicogrammatical building blocks, the actional organizing skills of communicative intent, and the sociolinguistic context all come together and shape the discourse, which, in turn, also shapes each of them [5].

These five types of competences have separate dimensions, but they are part of a whole and it is communicative competence. As van Ek [6] calls them, they are "different aspects of the same concept." Undoubtedly, each of them has a connection with the rest. The central one is discourse competence, which is at the center of our investigation.

Knowledge of the language or linguistic competence is not sufficient to "understand and construct texts". Therefore, textual competence or discourse competence is not 'linguistic competence but competence to use language in a specific way”. The focus of our research is "textual competence", that is, the ability to read, understand, reflect, reproduce/reproduce and produce/produce texts according to their characteristics. Textual competence, in turn, forms the basis for the acquisition of scientific textual competence, which is an important prerequisite for successful academic study. Scientific textual competence is defined as the competence to use the language, i.e. as "competence in the use of cross-domain but also domain-specific" language [7]. In this sense, it is about mastering domain-specific expressions and constructions in order to read and create texts successfully.

Academic writing

Although students have some experience of working with different text genres at school, the acquired text competencies are not sufficient to satisfy the requirements of the university. Many students find it difficult to take notes during lectures and seminars in a structured and clear manner, to participate in discussions, to read, understand and analyze/interpret specialized texts, to reflect on the reading and to process it.

Academic writing is completely different from writing in high school. It is equal to the acquisition of successful writing skills in the process of academic communication. The purpose of academic writing is to develop and improve the skills of students/doctoral students from different specializations and faculties for writing and editing texts of posters, reports, articles, diploma papers, dissertations, presentations, essays, etc. in Bulgarian and foreign languages.

The most common form of academic writing is essay writing. Essay writing requires the effective use of the language - appropriate vocabulary, adequate knowledge, good grammatical knowledge, as well as the requirements for correct writing together with the appropriate writing format. A basic requirement for enhancing written communication skills is improving the ability to read and understand texts. Specialized literature (up-to-date articles) and databases are increasingly available.

However, what usually happens in practice is that essay writing skills are limited to routine topics and most of them are repeated annually. Students are able to guess the main or frequent topics, and in most cases, they are even instructed by their teachers to memorize some important topics or materials. This helps students remember the basics and get good grades in exams. However, their writing skills never really develop. This practice hinders students' ability to express their thoughts in writing effectively. It also damages their confidence when they cannot write what they have already learned or show the knowledge they possess. Teachers need to convey these strategies that help students improve their writing skills to express their ideas the way they think.

One of the main goals of learning a foreign language for academic purposes is to develop the ability to read and understand academic texts. Different types of reading are distinguished depending on the purpose of the activity. From a methodological point of view, it is essential to note the distinction between in-depth reading, also called detailed reading, in which all the information in the text is important to the reader, and selective, also called searching, scanning, orientation, or non-deep reading, ie., reading which helps the student find a certain piece of information in the text.

Selective reading, which is characteristic of reading electronic texts, should play a leading role in the early stages of language learning when the language is not yet sufficiently proficient. With a higher level of proficiency as vocabulary and reading skills increase, profound reading provides better learning opportunities.

The second major objective of academic language training is to build and foster the ability to write. In English literature, the term academic writing encompasses the ability to create adequate texts in a variety of academic genres: from emails to a teacher or colleague, to the writing of a dissertation and a thesis.

The integration of modern technologies into foreign language learning as a result of the current trends in education is also reflected in their integration in academic writing [8] (as a subfield of foreign language training). Creating an academic text is a non-linear process that is usually described as consisting of the following stages: idea generation, structuring, drafting, concretization, and evaluation [9]. The academic essay using the wide possibilities of the essay as a genre is both a tool to develop and evaluate the textual competence of the students and thus prepares them for writing the more serious research work and a larger volume of academic texts that students themselves have to create in their learning process.

For the purpose of the current investigation, students were taught to and were expected to:

• be able to identify the problem contained in the topic;

• be able to take a position on the issue;

• be able to express this position as a clearly and accurately formulated thesis;

• be able to defend this thesis in a reasonable manner by presenting a sufficient number of convincing arguments;

• be able to create a meaningful, coherent, argumentative text to show that they are proficient in the rules and capabilities of the language.

Similar investigations can be found in [10,11].

Methodology

The study of skills building and the use of strategies for writing and correcting academic text using ICT has been done with the help of a specially adapted questionnaire containing 29 questions (Appendix 1). 13 students took part in the investigation of their discourse competence skills.

In order to complete the survey, respondents use a five-step assessment scale: Yes; Rather yes; Neither Yes or No; Rather not; No. In the inquiry, 13 valid questionnaires were collected for the purpose of the report. The assessment values are estimated according to the score correspondence table (Table 1).

Table 1

Score correspondence table

Answer	Yes	Rather Yes	Neither Yes, nor No	Rather No	No
Score	5	4	3	2	1

The stages of this study are:

1. Asking students to write an essay on a topic based on their background knowledge and school education. Analysis of their mistakes - structural, grammatical, lexical and other gaps. A further acquaintance of the students with the database, current articles and vocabulary in the field of their specialization with the help of ICT (scientific textual competence) and writing of 2 essays; (distance, self-directed learning, tailored to individual psychophysiological conditions). Analysis and feedback on their mistakes - structural, grammatical, lexical, etc. gaps (language competence).

2. Introduction to strategies for improving academic writing and ICT use.

3. Rewriting an essay on a topic in their field of study (Organic Synthesis) and evaluation according to predefined criteria after familiarizing themselves with specialized dictionaries, a minimum of 3 articles in their scientific field and strategies for academic writing.

4. Comparisons and statistical data processing.

Table 2

Results from the survey before and after the course, correlation coefficients

	$\overline{x}_i$	$\overline{y}_i$	r	Sign.
q1	3.0769	4	0.4279	no
q2	3.6923	4	0.6967	yes
q3	3.7692	4.3077	0.6233	yes
q4	3.8462	4.2308	0.7841	yes
q5	3.3846	4.0769	0.8022	yes
q6	3.4615	4.2308	0.7359	yes
q7	4.384615	4.769231	0.433	no
q8	4	4.461538	0.7868	yes
q9	3.769231	4.307692	0.5471	no
q10	2.692308	3.538462	0.4726	no
q11	2.769231	3.461538	0.6947	yes
q12	3.307692	3.923077	0.7305	yes
q13	3.538462	4.307692	0.2166	no
q14	3.384615	4.076923	0.7554	yes
q15	3.461538	4	0.5578	yes
q16	3.769231	4.384615	0.2282	no
q17	4.076923	4.384615	0.6857	yes
q18	3.615385	4	0.3138	no
q19	3.692308	4.076923	0.8108	yes
q20	3.538462	4	0.8229	yes
q21	3.153846	3.615385	0.9363	yes
q22	3.615385	4.153846	0.9021	yes
q23	3.615385	4.230769	0.8199	yes
q24	3.923077	4.230769	0.8484	yes
q25	3.153846	3.692308	0.6396	yes
q26	3.307692	3.923077	0.7455	yes
q27	3.153846	3.846154	0.6207	yes
q28	3.230769	3.846154	0.6832	yes
q29	3.538462	4.153846	0.8733	yes

Analysis of the results of the survey before and after the course

The results being discussed (Table 2) are from the initial analysis of the survey, consisting of 29 questions named "Self-assessment of English writing skills" (Appendix 1).

The means of the estimated assessment levels for all students before and after the training are presented by $\bar{x}_i$ and $\bar{y}_i$. The correlation coefficient r is estimated by:

$$r_{xy} = \frac{\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})}{(n-1)s_x s_y},$$

where s_x and s_y are the corresponding standard deviations.

The correlation coefficients are tested for significance, by applying the t-test and criterion. Two classifications are considered here – by the difference of the means before and after the training (Fig.2) as well as by the correlation coefficient. These two classifications give a different point of view for the estimated skills.

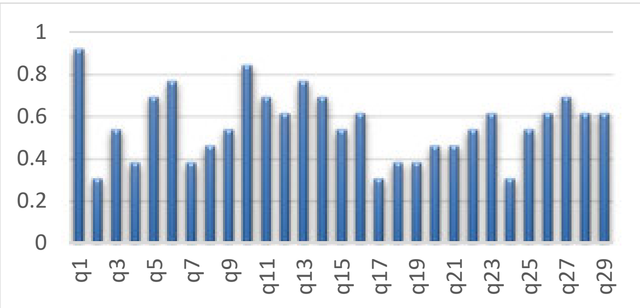


Fig. 2. Difference in mean assessment evaluation before and after the training for each skill (q_1-q_{29}).

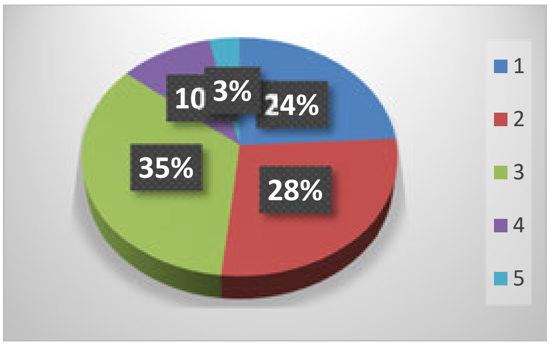


*Fig. 3. Classification by the difference of the means before and after the training: **1** (q17, q24, q2, q4, q7, q18, q19): 0.3-0.399; **2** (q21, q8, q20, q15, q25, q9, q22, q3): 0.4-0.599; **3** (q12, q26, q28, q16, q23, q29, q5, q14, q27, q11): 0.6-0.699; **4** (q13, q6, q10): 0.7-0.899; **5** (q1): 0.9-1.00.*

The first classification gives an idea about the overall mean improvement for each skill for all the students. There is an improvement in all skills. The smallest is for q17 and is 0.3077 and the biggest is for q1 - 0.9231. All results are presented in Fig. 3.

The second classification by the correlation coefficient (Fig.4), calculated for each skill and considering the evaluation result for each student before and after the training, gives an idea about the individual improvement of each student, independently of his/her initial level of knowledge. A higher correlation coefficient means that more (or all) students showed an improved level of knowledge after training connected with the considered skill. So, the training was flexible and beneficial. On the contrary, if the correlation coefficient is low, some students may have improved the given skill but others did not show improvement; or the improvement of some of the students was too big compared to the other students. That is why such skills should be considered to be improved by more interesting and/or distributed according the students' capabilities tasks.

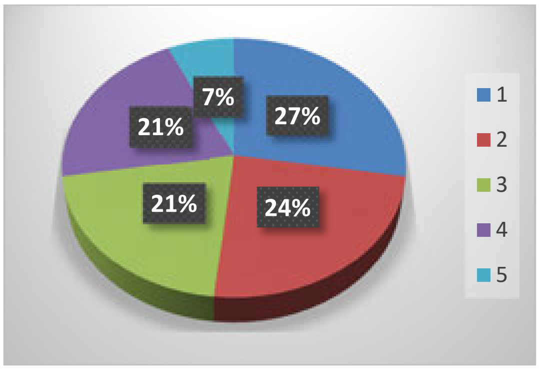


*Fig. 4. Classification by the correlation coefficients of individual assessments before and after the training: **1** (q13, q16, q18, q1, q7, q10, q9, q15): below 0.599; **2** (q27, q3, q25, q28, q17, q11, q2): 0.6-0.699; **3** (q12, q6, q26, q14, q4, q8): 0.7-0.799; **4** (q5, q19, q23, q20, q24, q29): 0.8-0.899; **5** (q22, q21): 0.9-1.00.*

1) Questions 21 and 22 are the questions with the highest correlation coefficient ≥ 0.9. These are questions about worrying about writing an academic essay. Most students realize that writing an essay is not that complicated after learning about the format and writing strategies. It is just a task that needs to be accomplished to show their knowledge and attitude on a topic by using appropriate language and conventions.

2) For questions 5, 19, 20, 23, 24 and 29, the correlation coefficient is above 0.8. These are questions concerning the use of appropriate vocabulary - we take into account the improvement of students' self-esteem after reading texts purposefully in their scientific field and expressing attitude on a

topic in their scientific field. Students also declare that after taking the course it is not so difficult for them to edit what they have written, generate ideas, and use word processing programs.

3) For questions 4, 6, 8, 12 and 26, the coefficient is above 0.7. These are questions that take into account their real writing skills, namely writing paragraphs and organizing ideas within them; use of different sentences and writing styles; writing a summary of the information read; writing an introduction to an academic essay; knowledge of the format of the academic essay. Most of the investigated students improved these skills.

There are also results like that for skill q1, which show big improvement toward the difference of means and small correlation (Fig. 5). This result shows that there were students, who significantly improved their skills while others could not. The reasons for this should be further investigated.

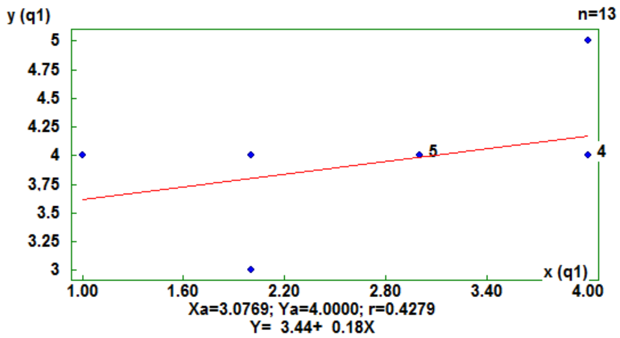


Fig. 5. Individual results for skill q1 – before and after the training. Numbers show repeated results from different students.

Conclusions

The results of the survey can be summarized as follows:

1. Reducing grammatical, structural and lexical errors by individually tracking the gaps of the students enhances their linguistic competence, which is the basis for building textual competence.

2. Access to authentic and up-to-date materials in a foreign language (English) through the use of ICTs and databases that are beyond the content of a course helps to better understand and use different concepts and content in the specific scientific field of the students for a shorter period of time and more effectively (developing textual competence by purposefully keeping notes on current articles and enriching their vocabulary according to their needs).

3. Developing critical thinking in the process of writing that professionals describe as a combination of cognitive skills related to 1) interpretation, 2) analysis, 3) evaluation, 4) formulation of conclusions, 5) explanation and 6) self-regulation.

4. The course in Academic writing was beneficial and useful for students as it was expected but on an individual level, the results showed that the more prepared students took far more advantage of the course.

5. The academic essay using the wide possibilities of the essay as a genre is both a tool to develop and evaluate students' textual competence.

At the heart of the current debate on improving the quality of education is the issue of the acquisition of competences, which are essential both during the studies and for the professional realization. Scientific textual competence is one of the key competences in the academic field. Needless to say that (scientific) textual competence (for which linguistic competence is essential) can only be developed through intensive study of different types of text, which, on the one hand, makes it possible to become familiar with existing conventions and on the other encourages the acquisition of a science-specific vocabulary.

Scientific textual competence is one of the most important competences in the academic field. It plays an essential role in achieving success in university education and later for successful professional realization. Since the technology was integrated into the field of education, the approaches and methodology in teaching have changed rapidly. This article is an attempt to explain how using different tools of ICT can help academic writing to be more effective for the students.

REFERENCES

[1] Vatsov, S. Challenges to Competence Measurement, Academic Journal of Management and Education, Vol. 3, Volume 11, 2015, pp. 78-84. 2015

[2] Dimchev, K. Linguomethodological and sociocultural aspects of language learning. // Dimchev, K. Linguistics. Language education. Methods of language training. Sofia: BULVEST 2000, 2010.

[3] Nenova, S. Emotional intelligence in economics training in vocational high schools. Turnovo: Univ. ed. "St. St. Cyril and Methodius", 2005.

[4] Boykova, F. Pragmatic Aspects of Communicative Competence, In: Communicative Competence in Contemporary Scientific Discourse, Collection in honor of the 70th anniversary of Prof. Kiril Dimchev. Sofia:Bulvest 2000, 92-96, 2005.

[5] Celce-Murcia, Dornyeiand Thurrell. A Pedagogical Framework for Communicative Competence: Content Specifications and Guidelines for Communicative

Language Teaching, Deseret Language and Linguistic Society Symposium, 19 (1), 1995.

[6] Van Ek, J. Objectives for Foreign Language Learning. Strasbourg: Council of Europe, 1986.

[7] Mitkova, N., Textual Competence in Academic Work, NBU, ISSN 1313-7875, Yearbook of Germanic and Romanistic Studies, 2016.

[8] Klimova, B. F. Making academic writing real with ICT, Procedia Computer Science 3 (2011) 133–137, 2011.

[9] Kremenska, A. VEHICCLE: A Model of Web-based Language Learning, Sofia, ACMBUL, IV. 2008.

[10] Klimova, B. F. Making academic writing real with ICT, Procedia Computer Science 3 (2011) 133–137, 2011.

[11] Akhtar, R., Asghar, T., Diffusing ICT to Enhance Students' Academic writing Skills, International journal of english and education, 4(3), 2015.

Senior Lecturer, Maria Todorova, PhD *graduated from Sofia University. Area of interest – e-learning, language teaching, ergonomics, human resources, human factors, quality management. University of Chemical Technology and Metallurgy (UCTM), Sofia, Bulgaria.*

Tel.: +359 (2) 8163495;

e-mail: mariavtodorova@uctm.edu

Assoc. Prof. Dr. Eng. Elena Koleva *- Institute of Electronics, laboratory "Physical problems of electron beam technologies" – Bulgarian Academy of Sciences, Bulgaria,*

Director of Technological Centre on Electron Beam and Plasma Technologies and Techniques – TC EPTT Ltd., Bulgaria,

Assoc. Prof and lecturer at University of Chemical Technology and Metallurgy – Sofia, Bulgaria

Scientific research areas: quality management, statistical analyses, experimental designs, modeling, optimization, standardization, electron beam technologies – welding, melting and refining, lithography, selective melting, surface modification, electron beam characterization, automation.

e-mail: eligeorg@abv.bg

Received on: 30.08.2019

Appendix 1

Self-assessment of academic English writing skills

Questions:	Before the course					After the course				
1. I am familiar with academic writing - genres, style, register.	1	2	3	4	5	1	2	3	4	5
2. I am able to write introductory sentences that fit the topic.	1	2	3	4	5	1	2	3	4	5
3. I can logically organize my ideas when writing a new paragraph.	1	2	3	4	5	1	2	3	4	5
4. I can logically support and develop my ideas when I write a new paragraph.	1	2	3	4	5	1	2	3	4	5
5. I can use the right vocabulary to communicate effectively with the reader.	1	2	3	4	5	1	2	3	4	5
6. I can use different sentence structures.	1	2	3	4	5	1	2	3	4	5
7. I can use proper spelling, capital letters and punctuation.	1	2	3	4	5	1	2	3	4	5
8. It is not difficult for me to make a summary of the information I have read in English	1	2	3	4	5	1	2	3	4	5
9. It is not difficult for me to paraphrase the information I have read in English.	1	2	3	4	5	1	2	3	4	5
10. I can write a good academic research paper in my field of study because I am familiar with the principles of writing.	1	2	3	4	5	1	2	3	4	5
11. I can write a good academic scholarly article in my field as I have a good command of English and a rich vocabulary in the field.	1	2	3	4	5	1	2	3	4	5
12. I can write a good introduction to an essay in English.	1	2	3	4	5	1	2	3	4	5
13. I can use logical paragraph ordering to support and develop my thesis.	1	2	3	4	5	1	2	3	4	5
14. It is not difficult for me to logically support and develop the thesis with reflections and examples from my own experience.	1	2	3	4	5	1	2	3	4	5
15. I can logically support and develop my thesis with paraphrases, summaries and quotes.	1	2	3	4	5	1	2	3	4	5
16. If necessary, I can successfully conduct a library survey to find information that supports my ideas.	1	2	3	4	5	1	2	3	4	5

Questions:	Before the course					After the course				
17. If necessary, I can successfully use search engines and resources to find information to support my ideas.	1	2	3	4	5	1	2	3	4	5
18. I can write a good conclusion to an academic essay.	1	2	3	4	5	1	2	3	4	5
19. I can use a word processor to write and format my essays in English.	1	2	3	4	5	1	2	3	4	5
20. It is not difficult for me to generate ideas before I write.	1	2	3	4	5	1	2	3	4	5
21. I make notes when reading articles in my field of science in order to use them to support my writing ideas later.	1	2	3	4	5	1	2	3	4	5
22. I can logically organize my ideas before I start writing.	1	2	3	4	5	1	2	3	4	5
23. It is not difficult for me to edit and improve my own writing, to improve its structure and organization.	1	2	3	4	5	1	2	3	4	5
24. It is not difficult for me to edit what I write in order to improve text, grammar, punctuation and spelling.	1	2	3	4	5	1	2	3	4	5
25. I can write effectively with time limits.	1	2	3	4	5	1	2	3	4	5
26. I can handle writing tasks quickly because I am familiar with their format.	1	2	3	4	5	1	2	3	4	5
27. I can identify the problems in my writing assignment and figure out what needs to improve after writing the draft.	1	2	3	4	5	1	2	3	4	5
28. I am familiar with and can use appropriate strategies when writing.	1	2	3	4	5	1	2	3	4	5
29. When writing an academic essay, I rely on my own thinking and resourcefulness.	1	2	3	4	5	1	2	3	4	5

ЕЛЕКТРОТЕХНИКА И ЕЛЕКТРОНИКА Е+Е

54 год. 7-8/2019

Научно-техническо списание

Издание на: **Съюза по електроника, електротехника и съобщения /СЕЕС/**

Адрес:
ул. "Раковски" № 108
ет. 5, стая 506
София 1000
тел.: +359 2 987 97 67
e-mail: epluse@mail.bg
http://epluse.ceec.bg

ISSN 0861-4717

С Ъ Д Ъ Р Ж А Н И Е

ЕЛЕКТРОТЕХНИКА

Маринко Брукчич, Ненад Цветкович, Желько Хедерич, Тони Варга
Моделиране на многопластова почва чрез еквивалентни равномерни и двуслойни модели в приложения за заземяване 122

ТЕЛЕКОМУНИКАЦИИ

Сеферин Т. Мирчев
Оценка на пропускателната способност на линиите в телекомуникационните мрежи 127

ЕЛЕКТРОНИКА

Мила Илиева-Обретенова
Симулация на пиезоелектричен ултразвуков IoT-сензор 132

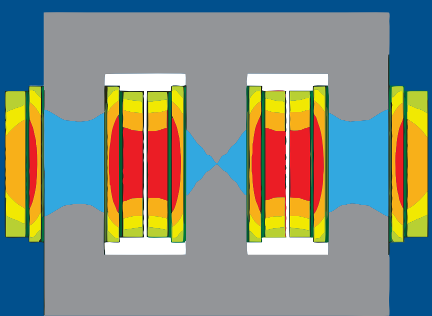
ЕЛЕКТРОННО ОБУЧЕНИЕ

Мария Тодорова, Елена Колева
Академично писане и интегриране на технологиите 138

През 2019 г. списание Electrotechnica & Electronica се издава с финансовата подкрепа на фонд „Научни изследвания“ към Министерството на образованието и науката.

SIELA
2020
3-6 JUNE

BOURGAS
BULGARIA



21th International

SYMPOSIUM ON ELECTRICAL APPARATUS AND TECHNOLOGIES

SIELA 2020 Highlights:

- shows the latest developments
- innovative applications
- electrical apparatus and technologies
- low-voltage apparatus
- high-voltage apparatus
- actuators and sensors
- power electronics
- transformers, electrical machines
- field problems, design and optimisation
- organized by CEEC
- technically co-sponsored by IEEE
- largest apparatus forum in Bulgaria
- over 120 participants