NEURAL NETWORKS FOR RISK MANAGEMENT IN NATURAL DISASTERS, TRANSPORT CRASHES AND INDUSTRIAL ACCIDENTS

Stanimir Karapetkov[1], Kamen Ishtev[1], Diana Bankova[1], Elka Radeva[1], Venelin Kondov[1], Dimo Dimov[1], Petia Minkova[1], Daniela Arnaudova[1], Simeon Panev[1], Ivan Demerdjiev[2], Philip Philipoff[3*], Venkatanathan Natarajan[4], Mario Muñoz Organero[5], Mehmet Salih Bayraktutan[6], Blagovest Panev[7]

[1]Technical University - Sofia, e-mail: skarapetkov@yahoo.com
[2] "Demerdjiev, Petrov, Baev", e-mail: dpblawyers@abv.bg
[3]Institute of Mechanics - BAS, - corresponding author, e-mail: philip.philipoff.decable.dregan@gmail.com*
[4]Sastra University, India, e-mail: physics16972@gmail.com
[5]Universidad Carlos III de Madrid, Spain, e-mail: munozm@it.uc3m.es
[6]Ata.Univ. Freelancer. Erzurum. Turkey, e-mail: batuta59ms@gmail.com
[7]LevIns Insurance Company, e-mail: blago_99@yahoo.com

Keywords: *Neural Networks, Research database, Knowledge base, Risk Management.*

Abstract: *Cognitive experimental psychology system (Neural Network [1–9, 11]) for crash risk reduction in the police practice is developed in the report. The study is based on an actual accident in the city of Burgas, Bulgaria, 2022 (two dead police officers) and on an actual accident in the South EU boundary between Bulgaria and Turkey (length 245 km), 2022, (one dead police officer). In both incidents, there was no consultation with psychologists. Proposed system is particularly suitable for crisis periods and situations. A Neural Network mathematical model is used - the software of the proposed control system is based on the popular MatLab software system. This software system is embedded in all master's programs of all engineering specialties of EU technical universities. The control of rescue operations is carried out in a hierarchical form. At each level of hierarchical control is held a consultation with a specialist in the psychology of emergency situations. Decisions in the system are made based on these consultations with psychologists. Special attention is paid to migrant waves. The guards in these migrant waves can also be armed. In addition, they may be led by political forces (in non-EU countries for example). The system under development is many suitable for EU boundary defense. The hardware of the proposed control system for crash risk reduction in the police practice is based on new innovative researches. New situational schemes for actions in emergency situations have been developed. It is recommended that there be at least two police patrol cars. In addition to traditional personal protective equipment - bulletproof vests and helmets for police officers, new protective equipment for police cars has been developed (for example). A pneumatic cover is placed on the police patrol cars. It is a shell filled with compressed fluid - air. The shell protects officers from bullets and impact in a crash. If the patrol cars on the date described were operating in the city of Burgas and on the Southern border with such pneumatic covers, the officers would not have died. The proposed system reduces the risk of death in accidents in police practice. Meanwhile, the dreaded swarm of earthquakes struck Turkey and Syria. Over 50,000 people died. Finally, a "Cognitive experimental psychology system for management of natural disasters, transport crashes and industrial accidents" is developed in the report [1–14].*

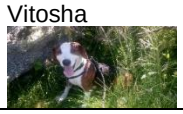
НЕВРОННИ МРЕЖИ ЗА УПРАВЛЕНИЕ НА РИСКА ПРИ ПРИРОДНИ БЕДСТВИЯ, ТРАНСПОРТНИ ПРОИЗШЕСТВИЯ И ПРОМИШЛЕНИ АВАРИИ

Станимир Карапетков[1], Камен Ищев[1], Диана Банкова[1], Елка Радева[1], Венелин Кондов[1], Димо Димов[1], Петя Минкова[1], Даниела Арнаудова[1], Симеон Панев [1], Иван Демерджиев[2], Филип Филипов[3*], Венканатхан Натараджан[4], Марио Муньос Органеро[5], Мехмед Салих Байрактутан[6], Благовест Панев[7]

Ключови думи: *Невронни мрежи, База данни, База знания, Управление на риска.*

Резюме: *В доклада е разработена невронна мрежа ([1–9, 11]) за намаляване на риска от природни бедствия, транспортни произшествия и промишлени аварии. Проучването се основава на действителен инциденти в Република България.*

1. Introduction. In the report a Cognitive experimental psychology system for management of natural disasters, transport crashes and industrial accidents is developed-2.1. Research database and 2.2.Knowledge base. **Tab. 1**

N	Rescue Operations and the assessments	Altitude of the peaks in m, Persons, Year	Assessment of the psychology situation (history and of the rescue operation)	Technical assessment (of the situation and of the rescue operation)	Rescue Operation Result
1	Vitosha	Black Top 2290 (Skoparnika) Todor Bojinov 15.02.1992	Negative	Negative	Fatal
2	Vitosha	Black Top 2290 Marieta Rajnova 31.12.1884	Negative	Negative	Fatal
3	Rila	Kalinite 2667 Michail Munzov 18.07.1999	Negative	Negative	Fatal
4	Rila	Mussala 2925 Dimitar Zlatarev 16.02.2005	Negative	Negative	Fatal
5	Pirin	Todorka 2746 Two boys snowboarders 11.01.2019	Satisfactory	Positive	Fatal
6	Vitosha 	Back Top 2290 Dog Roko 20.04.2019	Satisfactory	Satisfactory	Happy
7	The Balkans	Botev 2376 Atanas and AdrianPenchevy 05.02.2020	Satisfactory	Positive	Fatal
8	Pirin	Todorka 2746 Borislav Garibov 24.01.2021	Satisfactory	Positive	Fatal
9	The Balkans	Botev 2376 Todor Jeliazkov 02.01.2021	Negative	Satisfactory	Fatal
10	The Balkans	Botev 2376 Yang man 10.02.2021	Satisfactory	Positive	Happy
11	Rila	Kartala Yang man 21.03.2021	Negative	Negative	Fatal
12	Pirin 	Todorka 2746 Vladimir Carolrv 10.05.2021	Positive	Positive	Happy
13	Rila	Djano 2700 Irena Gancheva	No data	Positive	Fatal 20.10.2021
14	AM Struma [10]	AM Struma 46 Victims 23.11.2021	No data	No data	Fatal
15	Sofia-Georgy Semerdjiev Blv.Black Top-Arsenalsky	Sofia Two Yang Girls 05.08.2022	Negative	Negative	Fatal
16	Burgas Trapezica [10]	Burgas Yordan Iliev Atans Gradev 25.08.2023	Negative	Negative	Fatal

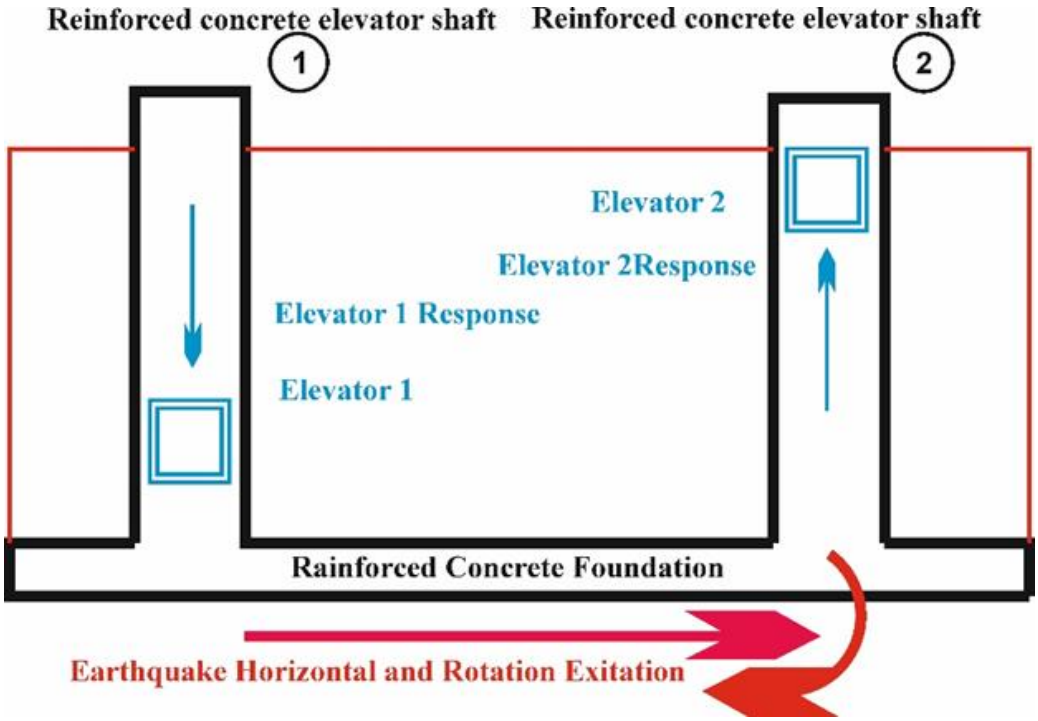
17	Turkey Boundary	Turkey Boundary Peter Buchvarov 08.11.2022	Negative	Negative	Fatal
18	Pirin	Vihren 2914 Plamen Hristov Dragan Glisich 26.12.2022	Negative	Negative	Fatal
19	Rila Paraplaner	Mussala 2925 Toma Stojichkov 09.01.2023	Satisfactory	Satisfactory	Fatal
20	Turkey Syria	Earthquakes M 7.9 6.02.2023 M 7.6 7.02.2023 M 6.4;5.8;5.2;5,2 20.02.2023	Negative	Negative	Fatal More than 50 000 victims

2. Exploration. Positions 14 and 16 of the Table 1 are described in [10]. By the position 16 of the Table 1 is shown example for INTERVENTION OF AN APPROPRIATE PSYCHOLOGIST – Burgas crash 25.08.2023 Yordan Iliev and Atanas Gradev tragedy. By the position 20 of the Table 1, by [24, 25] and by Fig. 1 it follows, that due to the demographic crisis in Bulgaria, the modern population of the country is about 7,000,000 people. They live in about 3,000,000 households. There are about 2,000,000 residential buildings in the country, at least 30% of which are vacant. The anti-seismic of its two million homes can most effectively be realized by actively control of the dynamic response of the buildings through the existing elevators. A schematic diagram of such control is shown in Fig. 4. **2.2. Knowledge base [1–9, 11]. 2.2.1. Dynamic Linear Systems with constant structure.** In the case of linear systems, the most important mathematical description – the frequency transfer function, is obtained as a quotient of the Fourier complex spectrum of the output signal to the Fourier complex spectrum of the input signal of the linear dynamic system under investigation. This frequency response function is invariant over time. In an earthquake, the initial conditions of the process are assumed to be zero. The structure of the system is unchanged. The natural frequencies are the roots of the polynomial in the denominator of the frequency transfer function. If the system has viscous type damping, the roots of the polynomial in the numerator of the frequency transfer function are the corresponding damping coefficients. **2.2.2. Dynamic Non Linear Systems with variable structure [14].** https://www.24chasa.bg/articla/13797525 For nonlinear systems, the mathematical description is more complicated. The dynamic system has a variable structure (Fig. 1) and it is not possible to introduce the concept of frequency response to relate the complex Fourier spectra of the input and output signal. These complex Fourier spectra are related by a function that is non-linear and time-varying. This property of non-linear systems can be used to create structures that, in an earthquake, dampen the dangerous oscillations that would destroy the structure. For this purpose, special building structures are created that automatically change their frequency properties at the first second of an earthquake. Special devices are provided that turn off or on the contrary turn on additional structural connections, depending on the frequency properties of the input signal. If the impact is low-frequency, additional connections are included, which immediately stiffen the structure several times. It immediately exits the low frequency region of the input signal and system oscillations are almost zero. On the contrary. If the impact is high-frequency, available connections are turned off, which immediately softens the structure several times. It immediately exits the high frequency region of the input signal and system oscillations are almost zero. This process can be realized several times automatically until the earthquake finally stops. During all this time, the structure barely moves and exhibits highly non-linear characteristics. The structure of the dynamical system is highly variable.

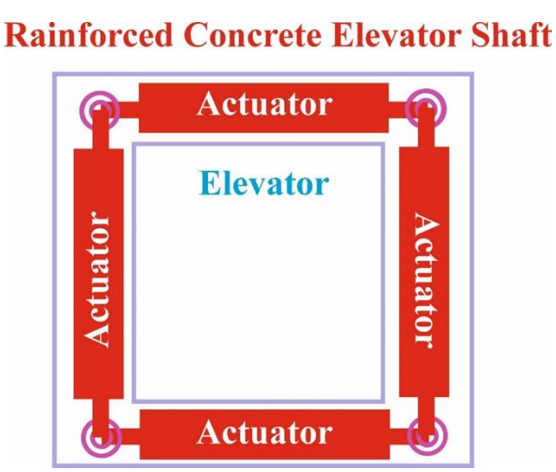
These systems (Fig. 1) do not use external sources of energy to isolate the earthquake. Their cost is not high, they are easy to design and implement. A certain difficulty is the preliminary study of the expected earthquake signals in the area. The setup of such passive systems with a variable joint structure requires high qualification in the design and is science-intensive. **2.2.3. Systems with automatically controlled dynamic response [1, 2, 8].** In the most vulnerable buildings in an earthquake (facilities from 3 to 16 floors), in which there are elevator facilities, with not much effort and funds, actively automatic controlled systems can be implemented. They use external sources of energy - for example, electricity and/or diesel generators. In the existing elevator shafts, for example, on the top floor, special inertial devices are installed. With special sensors, the parameters of an earthquake impact that has just begun are measured in real time. The computer of the elevator equipment calculates the necessary control effect. It is realized through special inertial devices installed on the last floor - working bodies that create exactly the same inertial forces as the earthquake impact just measured, but with the opposite sign. In this way, the construction facility

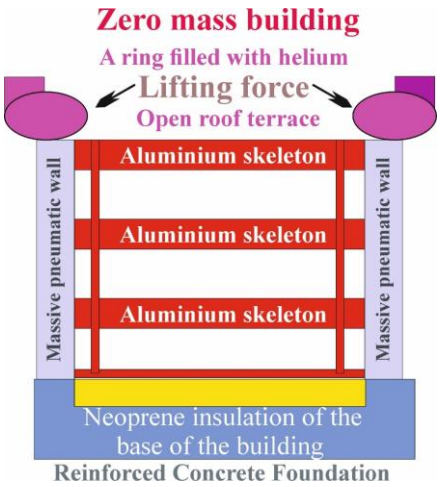
remains at rest during random earthquakes of arbitrary magnitude, frequency spectrum and duration. A known disadvantage of these automatic control systems is the need for external energy - for example, electricity and/or diesel generators. If during an earthquake the electricity supply stops, it is necessary to provide an autonomous electrical supply - for example, from backup lithium-ion batteries in the ground floor of the building and/or diesel generators. These systems protect facilities in the event of a random earthquake. The value of this innovative solution is approximately the same as the value of the existing elevator in the building.

On the 28 December 2022 press group 24 hours (24 Hours - 168 Histories [13]) **warned that a catastrophic earthquake is coming in the Balkans - position 20 from Table 1.**



a) Elevator Response [21]





b) Elevator Active Control System, c) Passive Control System

Fig. 1. Elevator Response [21]: a) Elevator Active Control System, b) and Passive Control System c)

3. Conclusions. The report developed a **NEW GENERATION NEURAL NETWORK** ([1–25]) to reduce the risk of natural disasters, transport accidents and industrial accidents. The study is based on actual incidents in the Republic of Bulgaria, described by the authors.

4. Acknowledgments: The authors of the report express their gratitude to the Bulgarian and foreign companies: СТРЕЗА ЕООД, ЗК ЛевИнс Младост 4, ПЕНТАХРОН ЕООД, GPS Control SA, Алтерко Роботикс ЕООД, Kondov & Kliqi Design Team – Italy, YARDlawfirm, „Калайджиев, Георгиев & Минчев", "Demerdzhiev, Petrov, Baev" lawfirm, Ministry of Interior Affairs for the moral and financial support of this research. Special acknowledgment for the media support by press group 24 hours and newspaper Maritca Plovdiv. The Conference is supported by Bulgarian National Science Fund Contract № КП-06-МНФ/23 - 08.08.2023

References:

1. Verbich, B., (1985), Fundamentals of soil-structure interaction // International seminar on computer aided design of earthquake resistant engineering structures / University "Kiril and Metodij", September 23 – October 04, 1985. — Skopje, 1985, (in English).
2. Ph. Philipoff, (1987), Modeling of soil-structure interaction systems under seismic loadings, Ph. D Dissertation, Institute of Mechanics-BAS, Sofia, Bulgaria, 1987 (in Bulgarian).
3. Ph. Philipoff, (1990), Analysis and modeling of civil engineering structures under seismic loadings by the dynamic condensation method, Postdoc MSc. Dissertation, TU-Sofia, Bulgaria, 1990 (in Bulgarian).
4. A. D. Poularikas (2000), The Handbook of Formulas and Tables for Signal Processing, CRC Press LLC, Springer Verlag, Boca Raton FL, New York, 2000, (in English).
5. Philipoff, Ph., Ph.Michaylov (2007), „BELENE Nuclear Power Plant Numerical and Experimental Bedrock, Layers and Surface Signals", J. Applied Mathematical Modeling, Elsevier, Volume 31, Issue 9, September 2007, Pages 1889–1898 (in English).
6. Philipoff, Ph., Michaylov, Ph., "BELENE" Nuclear Power Plat: umerical and experimetal free field signls // Siberia J. um. Math / Sib. Branch of Russ. Acad.of Sci. - Novosibirsk, 2007.- Vol. 10, N 1.-P. 105-122., {Digital signals are published: Experimental Bedrock Digital Signal Down (μ/s), Experimental Surface Digital Signal Up (μ/s), Theoretical Surface Digital Signal Theor (μ/s).}, (in English).
7. Ph. Philipoff, V.Tchobanov, M.Grammatikopoulos, Ph.Michaylov, (2009), „One Infinite Boundary Soil-Structure Interaction Mathematical Model", Siberian Journal of Numerical Mathematics, RAN - Seberian branch of Russian academy of sciences, (Математическая модель системы конструкция–среда с неопределенной границей, Сибирский журнал вычислительной математики, РАН Сиб.отд-ние Новосибирск), Том 12, №2, pp. 221–230 (in Russian).
8. SAP 2000 (2010), https://www.csiamerica.com/products/sap2000,
9. MATLAB,(2010), http://www.mathworks.com/products/matlab/ ,
10. Venelin Jivkov, Philip Philipoff, Anastas Ivanov, Mario Muñoz, Galerida Raikova, Mikhail Tatur, Philip Michaylov, (2013), Spectral properties of quadruple symmetric real functions. Applied Mathematics and Computation 221 (2013) pp. 344–350, (in English).
11. Venkatanathan, N., Ph.Philipoff, S.Madhumitha, (2015), Outgoing Longwave Radiation Anomaly Prior to the Big Earthquakes: A Study on the September 2015, Chile Earthquake, New Concepts in Global Tectonics Journal, V. 3, No. 3, September 2015. www.ncgt.org, (in English).
12. Venelin Jivkov, Philip Philipoff, (2016), Quadruple Symmetric Real Signals Spectral Even and Odd Decomposition, Building Materials and Structures, UDK: 624.9.042.7, 699.841, doi: 10.5937/grmk1603003M, N3 2016, (in English).
13. Natarajan, V., Philipoff, P., Sreedharan, V., Venkatachalapathy, H., (2016), Observation of Pre-EarthquakeThermal Signatures usingGeostationary Satellites: Implications for Earthquake Forecasting, SPIE,Journal of Applied Remote Sensing,10(4), 046004 (2016),doi: 10.1117/1.JRS.10.046004.Oct–Dec 2016, Vol. 10(4), Page from 046004-1 to 046004-13, (in English).
14. Jivkov, V, Natarajan V, Paneva A, Philipoff, P., (2017) Forecasting of Strong Earthquakes M>6 According to Energy Approach. J Earth Sci Clim Change, impact factor = 1,16, 15 Dec 2018, 8: 433. doi:10.4172/2157-7617.1000433, (in English).
15. Venkatanathan Natarajan, Philip Philipoff (2018), Observation of surface and atmospheric parameters using ''NOAA 18'' satellite: a study on earthquakesof Sumatra and Nicobar Is regions for the year 2014 (M > 6.0), Springer Science+Business Media B.V., part of Springer Nature 2018, Received: 7 May 2015 / Accepted: 22 February 2018, (in English).
16. Венелин Живков, Симеон Панев, Филип Филипов (2020), Разпространение на вълни в ограничени и неограничени пространства (Wave propagation in limited and unlimited spaces), "СОФТТРАДЕ", ISBN 978-954-334-341-9, (in Bulgarian).
17. Филип Филипов (2022), Структурен подход за решаване на някои вълнови гранични задачи (Structural Approach for Solving Some Boundary Condition Problems), Проект на дисертация за получаване на научната степен доктор на науките, Деловодство ТУ–София, Вх. N 2100-188/13 Юли 2023, (in Bulgarian).

18. Karapetkov, Stanimir (2023), Mathematical Modelling and Computer Simulation of the Vehicles, Mechanics of Mashines, 128, Year XXXI, No 2, ISSN 0861-9727, pp. 26–33, (in Bulgarian)
19. Венелин Живков, Симеон Панев, Филип Филипов (2023), ИЗ ДЕБРИТЕ НА МЕХАНИКАТА, Mechanics of Mashines,127,Year XXXI,No 1,ISSN 0861-9727, pp. 3–31, (in Bulgarian)
20. https://www.168chasa.bg/article/13468886
21. Даниела Арнаудова, вестник Марица Пловдив, брой 78, сряда 8 февруари 2023, Високоякостна стомана прави строежите непокладими, (2023), (in Bulgarian)

Даниела Арнаудова, вестник Марица Пловдив, брой 87, сряда 10 октомври 2023,
https://www.marica.bg/imoti/inovaciq-senzori-v-asansyorite-shte-alarmirat-pri-zemetresenie
https://www.marica.bg/imoti/arh-venelin-kondov-antiseizmichnite-sistemi-trqbva-da-badat-vklyucheni-v-programata-za-sanirane

22. https://www.168chasa.bg/article/13720667
23. https://www.24chasa.bg/articla/13797525
24. Stanimir Karapetkov, Ivan Demerdzhiev, Kamen Ishtev, Philip Philipoff, Venkatanathan Natarajan, Mario Muñoz, Mehmet Salih Bayraktutan, Elka Radeva, Petya Minkova, Daniela Arnaudova, Simeon Panev, Blagovest Panev, Venelin Kondov, Diana Bankova, Dimo Dimov (2023), Neural Network for Risk Management in Natural Disasters, Transport Crashes and Industrial Accidents, Proceedings of Knowledge, Science, Innovation, Technology Conference, Veliko Turnovo, April, 2023, p 563, Научна конференция „Знание, наука, технолоии, иновации" 2023, ISSN 2815-3472 (Print), ISSN 2815-3480 (CD), (in English).
25. Stanimir Karapetkov, Ivan Demerdzhiev, Kamen Ishtev, Philip Philipoff, Venkatanathan Natarajan, Mario Muñoz, Mehmet Salih Bayraktutan, Elka Radeva, Petya Minkova, Daniela Arnaudova, Simeon Panev, Blagovest Panev, Venelin Kondov, Diana Bankova, Dimo Dimov, (2023), Zero Mass Buildings, Proceedings of Knowledge, Science, Innovation, Technology Conference, Veliko Turnovo, April, 2023, p 571, Научна конференция „Знание, наука, технолоии, иновации" 2023, ISSN 2815-3472 (Print), ISSN 2815-3480 (CD), (in English).