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STUDY ON THE POTENTIAL OF ARTIFICIAL INTELLIGENCE APPLICATION IN INDUSTRIAL ERGONOMY PERFORMANCE IMPROVEMENT

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Abstract: *The main objective the research is to analyze potential of Artificial Intelligence in order to understand how it can be integrated to improve ergonomic performance and related safety outcomes. Musculoskeletal disorders are the among the most common and expensive health problems related to occupational environments. In work processes, human operators are continuously submitted to physical, environmental, psychological, and psychosocial stress factors that can affect – amongst others – the musculoskeletal system. The effective identification of major factors that can affect the workers' health requires knowledge from several fields, such as anatomy, physics, mathematics, anthropometry, psychology, sociology, etc. On the other hand, Artificial Intelligence has grown significantly in recent years and has penetrated all fields of activity, including the field of industrial ergonomics. The human - "smart" work equipment interaction is becoming more and more a current activity and this interaction must take place in complete safety and health state. The paper aims to investigate how ergonomic performance can be significantly improved by using Artificial Intelligence. The results obtained will be integrated into operational prevention systems that will be developed in the near future.*
Key words: *musculoskeletal disorders (MSDs), Artificial Intelligence (AI), cobot, occupational, safety, health.*

1. INTRODUCTION

An industrial organization's success level lies in several different areas and risk management is recognized as one of the key business process within both the private and public sector around the world.

Regardless of the type and size, any organization faces risks that can affect the achievement of its goals. Therefore, acquiring a coherent system of concepts and rules, generally accepted nationally and internationally, becomes essential for the public and private sector today, regardless of their nature. The approaches to safety seem to put emphasis on management functions, guidelines, industry standards, quality principles, to establish the safety management system [10]. Sound and effective implementation of risk management is regarded as best business practice at corporate and strategic level as well as a means of improving operational activities. Even though hazard identification and risk assessment often require specialist knowledge, the input of employees is invaluable – particularly in issues related to the work environment [11]. When safety is a value, rather than a priority, it can be regarded as an expectation from management, employees, vendors, and the public at large [11]. Ergonomics also must be incorporated and seen as a value. It needs to be built into the safety culture and be integrated into everything any company does on a daily basis [13].

Ergonomics is an interdisciplinary science because it integrates knowledge from a variety of disciplines, such as: anatomy, physiology, anthropometry, technical sciences, psychology, sociology, occupational hygiene, etc. The International Ergonomics Association (IEA) provides the following definition:*" ergonomics* *is the scientific discipline concerned with the interactions between people and other elements of a system and applies the theories, principles, information and design methods to optimize the human well-being and the overall performance of the system"* [17].

According to the IEA, ergonomics can be divided into several main branches:

i. *Physical ergonomics* aims at the reactions of the human body to the physical and psychological demands of work. The disorders caused by repeated stress factors, vibrations, force and posture are the most common, and these should be prevented from the conception and design phase. Also, physical ergonomics targets the impact of anatomical, anthropometric, biomechanical, physiological and material environment characteristics on physical activity and the health state of the human operators. These include the consequences of repeated movements, material handling, workplace safety and comfort in using equipment, workplaces and the working environment. At the same time, it studies how environmental factors, such as temperature, lighting, noise, dust, chemicals, etc., affect the individual's well-being and productivity [17].

ii. *Cognitive ergonomics*, according to IEA, "*deals with mental processes, such as perception, memory, reason and locomotion, how they affect the interactions between humans and other elements of a system*" [17]. Main topics include mental overload, decision making, performance, human –work system interaction, stress and training. Cognitive ergonomics is an emerging branch of ergonomics that pays attention to the analysis of the cognitive processes needed by modern industry operators. Cognitive ergonomics aims to improve performance in human-machine or human - computer interaction activities through [15]:
   - The design focused on customized and adaptive interfaces between the user and the machine or computer;
   - Designing technological systems that cooperate with humans;
   - Development of training programs.

iii. *Organizational ergonomics*, also called *macro-ergonomics*, aims to optimize socio-technological systems, including organizational structures, rules and processes to maximize efficiency.

Risk assessments are vital support to decision-making process. Risk assessment supports the design review process by providing the underlying analysis on which safety decisions can be made. Risk assessment methods are being deployed in many industries, and the momentum is likely to continue. Although the level of sophistication in risk assessment processes varies the general risk assessment process applies both across and within all industries [4]. This stands valid also for ergonomic risk faced by human operators in complex socio-technical systems.

2. PROBLEM STATEMENT

Approaching the problem in traditional methods of managing musculoskeletal risks is to react when health conditions (MSDs) appear. This approach shows certain lack of understanding of the problem and sometimes provides incomplete solutions that obviously focus more on dealing with the effect than on preventing the occurrence of consequences and eliminating the causes (underlying causal factors) that often remain completely unidentified [11]. Instead, the modern approach involves preventive management, which identifies potential factors that can lead to such conditions, so that the measures being implemented are effective and prevent the onset of MSDs.

Ergonomic factors, which can lead to MSDs, are related to both body position (sitting, orthostatic), limb position, movement (lifting, pushing, pulling), speed and frequency of movements, environmental factors (noise, vibration, lighting, climate, chemical vapors, etc.) information and operations (visual or perceived information through one of the other senses), as well as work organization (tasks appropriate to the physical condition and skills of the worker, activities that will be interesting and motivating for the workers).

But, the impact of ergonomic aspects is not only related to MSDs, but also has an effect on occupational health and safety. Deficiencies in the ergonomic area can lead to serious work accidents. A worker subjected to physical and / or mental stress due to ergonomic deficiencies, may make wrong decisions, may omit certain actions, is inattentive or may be predisposed to "shortcuts" regarding safety measures, and, any of these actions or inactions can cause serious accidents.

Accidents are unintended and unforeseen events, which result in personal injury and / or material damage. Most often, industrial accidents and unsafe working conditions can result in temporary incapacity for work, permanent injury, illness or even death. In the worst case scenarios, these accidents can be collective accidents or even cause disasters. Also, dangerous incidents, which do not result in casualties, but have the potential to lead to injury, loss of life and property must be considered.

The current problem is the lack of effective automated adaptive systems, based on behavioral predictive techniques, to identify omissions, non-conformities and provide solutions so that work, in a given context, is performed safely and avoids occupational injuries or other kinds of undesired events in the working environments [12]. The aim is to obtain a fully harmonized work system that ensures work satisfaction for workers. It also includes the study of the consequences of technology on human relations, processes and institutions.

3. INVESTIGATION ON THE APPLICABILITY POTENTIAL OF ARTIFICIAL INTELLIGENCE (AI) IN INDUSTRIAL ERGONOMICS

3.1 Artificial Intelligence and Human Factor Engineering

There is debate nowadays about „what is AI". It could even appear today that there is more interest around AI than reality. Nonetheless, as governments are allotting significant amounts of capital into research and development and publishing high-level reports making notable predictions about the contributions that AI will make to productivity and safety, it is worth taking AI seriously [9].

While nowadays there are a number of current definitions of AI, for the purposes of this paper, McCarthy's definition will be used as a general insight to locate the issues. McCarthy and colleagues defined "*artificial intelligence is when a machine behaves in ways that would be considered intelligent, just like humans*" [9]. In other words, artificial intelligence (AI) is the ability of a machine / equipment to mimic intelligent human behavior. Artificial intelligence is a field that involves the creation of systems, with an architecture different from the biological systems that simulates the human brain in the way of thinking, interacting and responding. The most popular AI methods found in the literature, and employed in risk assessment, are mainly classified as Expert systems, Artificial Neural Networks and Hybrid Intelligent Systems [5].

The main human intelligent abilities that an AI system (computer or computer-controlled robot) must have are:

- The ability to reason;
- The ability to understand a given situation;
- The ability to generalize, starting from cases;
- The ability to learn from experience;
- The ability to make decisions.

Many techniques in AI have been inspired by biological mechanisms with the aim of emulate human learning and bio-evolution. One of the most representative methods inspired by the brain's biological structure is the artificial neural network, which consists from a significant amount of interconnected neurons which are co-operating each other to produce an output stimulus.

Artificial neural network (ANN) can be defined as information processing systems using learning and adaptive capabilities [1]. These systems have been applied extensively in computational modeling of subjective information, decision making and forecasting applications [2].

The increasing intelligence of machines leads to a shift from human-computer interaction (HCI) to human-machine cooperation (HMC). Future machines will either be de-signed to cooperate, or designed to learn how to cooperate, with humans. They will be able to assess and adapt to human goals [3].

In both human-computer interaction and human-machine cooperation, artificial intelligence is used so that the equipment cooperates with people, being able to evaluate and adapt to the common tasks to be performed. This means that the cooperation is based on the availability of *correct* information and synchronization both at the "right" time and in a *correct* way [15].

Since the conception and design phase of the equipment, the interaction between human operator and the equipment must be considered, and the human-system interface must take consider both the cognitive and physical human limitations. By this, the following important measures/objectives must be achieved [16]:

1. Improve efficiency and effectiveness;
2. Safety level increase;
3. Providing higher work satisfaction;
4. Improve tactile sensation;
5. Errors reduction;
6. Fatigue diminishment;
7. Reducing the learning curve;
8. Ensuring ease of operation and use;
9. Satisfying the user's needs and requirements;
10. Positive perception on the equipment.

The ISO 9241-210: 2019 standard - *The ergonomics of human-system interaction* provides a human-centered design approach, which means the development of interactive systems that aim to make systems usable and useful by focusing on users, on their needs and requirements, by applying human ergonomic factors, knowledge and techniques of use. This approach improves efficiency and human well-being, accessibility and sustainability, thus increasing simultaneously occupational safety and work performance [6].

An integrated system, which includes artificial intelligence in order to monitor activities in terms of quality and safety performance, must acquire a series of data on which to make predictive calculations and make the best decisions. The system based on artificial intelligence (AI system) must be able to absorb even human errors, more even to act preventively, so that these human errors do not occur. Along with the learning abilities of the Artificial Neural Networks, other advantage that potentiates their application in safety and risk assessment is related with the capability of analyzing large quantities of data to determine patterns under uncertain environments.

In the area of ergonomic risk assessment in the industry, artificial intelligence is already playing an important role, and the prospects of evolving significantly and rapidly in this area are very high. For example, in the heavy equipment manufacturing industry or in the construction industry, when we look at ergonomics, we should consider and deal with incorrect positions, repetitive movements and improper handling of weights.

The difference between a correct posture and an incorrect posture of the body during the lifting of a load, is given, to a large extent, by the lifting angle composed of the line of the back of the worker in relation to the vertical plane, but also to the curvature of the back. In order to identify the incorrect load handling postures, only an intelligent system based on an artificial neural network and a properly mounted video camera in the respective area is needed. The system will identify in real time problems related to posture while lifting the load and will be able to alert the worker in this respect. This is a research goal of our future work in the field.

Figure 1 highlights the above stated principle of incorrect lifting posture identification in real time, based on literature [14]. But systems based on Artificial Intelligence can act in much more complex situations than previously presented, with high impact on improving performance in industrial ergonomics. For example, monitoring the safety status (which also includes ergonomics in all its aspects) on a construction site includes the requirement of accurately knowing the workers, each individual worker.

For this the system needs certain data that can be easily updated, such as: anatomical dimensions of the body and limbs, tasks to be performed, work equipment, etc. Some data, such as those related to the behavior of the worker in certain situations, can be acquired and processed by the smart system itself.

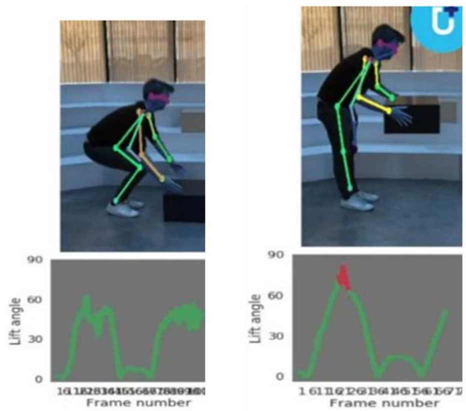

Fig. 1. Incorrect lifting posture identification in real time [14]

With this information and taking into account some of the predicted parameters: weather conditions, scheduling activities in the calendar, the ease or difficulty with which a user performs certain tasks, etc. one can easily predict what the worker is going to do. Or if what the system predicts the worker will do, but the safety conditions are not met, the intelligent system will react in such a way that those activities do not take place under unsafe conditions. It should be noted that a prediction is a statement about an uncertain event. Often, a prediction is based on experience and / or knowledge.

3.2 Human-robot collaboration and the structure of an AI system

The collaboration between man and robot is already at a rather advanced level [7]. Cobots (collaborative robots) are designed to share the workspace with humans, which make it easy to perform automation operations easier than ever, in businesses of all sizes and nature. They stand in contrast to traditional industrial robots which are designed to work autonomously with safety assured by isolation from human contact [8].

Cobot safety may rely on lightweight construction materials, rounded edges, and limits on speed or force. Safety may also require sensors and software to assure good collaborative behavior. Amazon has 100,000 cobots equipped with AI, which reduced the need to train workers to less than two days. Airbus and Nissan use cobots to accelerate production and increase efficiency [18]. There are many reasons why we intend to consider such a human - robot collaboration, among them are [18]:

- *Safety* –the collaboration between the robot and the human operator implies a very close relationship, even direct contact, between the two. Therefore, the robot must be safe, that is, the safety requirements in such cases are much higher than when the robot would work alone.
- *Cost* – if we automate only 80% of the simplest activities in the production process, the solution will usually be cheaper than if we completely automate the process. 20% of activities such as technologically difficult sub-processes can be left to the human operator. The robot can perform heavy mass manipulations or repetitive work, or work in harmful environment etc.
- *Flexibility* – cobots can usually be moved quickly to the production area and can be easily reconfigured to handle new tasks.
- *Professional development of workers* - cobots can perform difficult and laborious tasks, thus allowing workers in a company to produce faster, safer and more efficiently. Workers can thus devise new and creative methods of production and process optimization.

A block diagram of an AI system was created (Figure 2), system which collects the information from the working environment and the physiological parameters of the worker, with the support of adequate sensors; it also gathers the images from the cameras (CV) and the information entered in the database (DB); based on available data the system will be able to further process them and, if necessary, adopt the necessary decision.

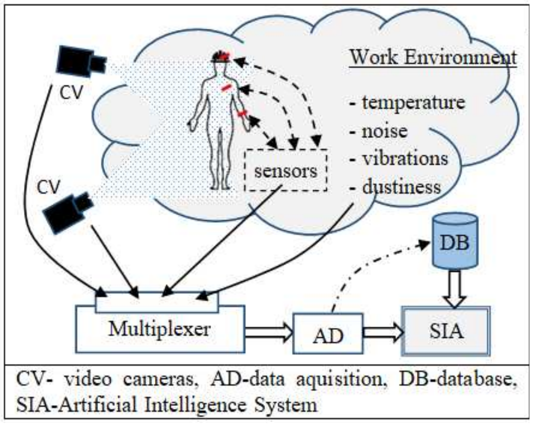

Fig. 2. Block diagram of an AI system connected to CV, sensors and DB

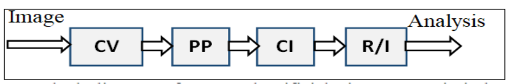

Fig. 3. Block diagram of a general artificial view system in industry

The recommended structure of an artificial view system in the industrial domain is shown in Figure 3, the meaning of the notations in the figure being the following: CV- video camera, PP- primary processing block , CI- block in which the information is compressed, R/I – block in which image recognition and interpretation is performed.

The most common way to use predictive systems is by implementing artificial intelligence in them. Artificial intelligence systems are involved in improving ergonomic performance also for workers who perform repetitive tasks for a long time, for example, workers at assembly lines. Usually, to evaluate these ergonomic risks, different evaluation methods are used, such as RULA (Rapid Upper Limb Assessment) or REBA (Rapid Entire Body Assessment), QEC (Quick Exposure Check), etc.

Systems equipped with AI can use these methods of evaluation in improved variants and adapted to the specific situations. Physical and other environmental parameters (variable outdoor temperature, noise, dust) etc. can be taken into account, in real time, so that the system can accurately assess whether ergonomic risks are within acceptable limits or not. At assembly lines in factories or warehouses, workers are assisted by cobots or wearable technologies, such as HoloLens, which can be used for training, even on the spot, on the assembly line [9]. This technology has many advantages, including in the ergonomics area, because the worker can be trained and informed in real time about the operations to be performed, the correct way to perform these operations, the safety measures to be applied, at the same time being informed about the risks he is subjected to, including those related to the co-operation with other workers, but also to the environmental conditions.

The intelligent system will even be able to assess whether a worker is capable of performing a certain task, by measuring the physiological parameters of the worker: temperature, pulse, respiratory rate, etc. as well as his physical and competence skills. This obviously leads to a greater degree of safety by avoiding hazardous situations, occurrence of accidents at work and other undesired consequences.

AI-based systems can predict situations that are about to cause accidents. In general, work-related accidents do not have a single cause, but they arise as a result of the interaction between several causal factors, such as: tired and / or inattentive workers, incompetent workers, inadequate safety measures, poor workplace housekeeping, unverified work equipment, faulty communications, etc. Sure, it is unlikely that all the non-compliance elements will cause an accident, but a combination of at least two of them is sufficient and the accident can occur.

One way to represent the requirements for the AI system, is by creating a collection of conditional rules, managed by the Occupational Health and Safety representative (Figure 4) and by defining a risk matrix, based on which the AI system can know when a security problem has arisen.

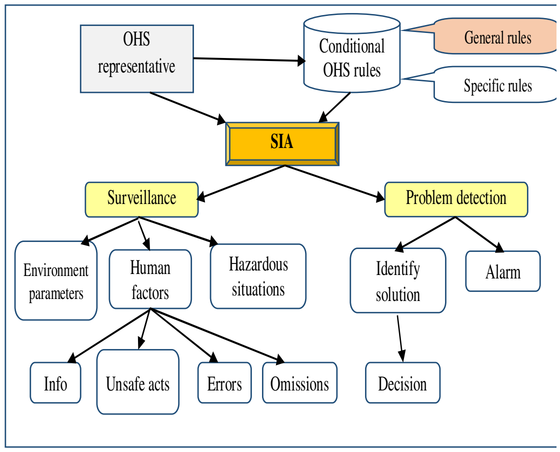

Fig. 4. Functional block diagram of an AI system based on surveillance and detection

Table 1

Samples of general conditional rules

ID	Code	Rule	Impact	Cumulative (+)
		....		
24	R24	Worker qualification	4	0.3
31	R31	Worker authorization	5	1
38	R38	Hard hat	4	0.2
55	R55	Medically fitted for job	5	1
78	R78	Bent in front	5	1
82	R82	Hand on the hip	3	0.1
109	R109	Seat without backrest	4	0.5
		....		

Table 2

Representation of the calculated parameters values in a risk matrix linked to the trigger of adequate action

Range resulting from parameter calculation	Risk level	Safety issue detection	Action
v0..v1	0	-	-
v2..v3	1	1	Early warning
v4..v5	2	2	Remedial intervention
v6..v7	3	3	Work/equipment stoppage

Each conditional rule should have a safety impact value and the AI system should compare the concrete situation, defined by the dynamic parameters, with the framing in these rules, considering the accumulation of these parameters. Some examples of general conditional rules are presented in Table 1.

In the learning process, the AI system will have to assess when a work situation is hazardous for the workers or is about to become hazardous and carry out an ergonomic risk assessment in real time, as previously stated. For this, the conditional rules specific to the activities will be defined and the activity-specific parameters will be introduced, parameters such as: frequency, duration, weight of the materials if there are mass manipulations, environmental data, etc. Based on these parameters, the AI system predicts the occurrence of the hazardous event. Then, by transposing these parameters into a risk matrix which, if some limits are exceeded, a safety problem has been detected, will command a specific alarm to be triggered, while the AI system tries to identify possible solutions to avoid the hazardous event (Table 2). As it can be seen, these possible situations can be easily foreseen by AI-equipped systems, which can detect problems, identify solutions, provide early warning and even take certain concrete technical measures to stop the evolution towards the top unwanted event, thus saving workers and minimizing property losses. And this fact must be understood by all the stakeholders as a benefit to workers because it protects them from accidents and illnesses.

The efficiency in the accurate assessment of some work situations, regarding productivity and safety, the rigorous and precise way of performing tasks, the tendency to "exaggerate" in the assessment of risks and safety measures, have created a certain state of concern, already expressed, that such AI capabilities implemented in the industry will endanger the workers' jobs.

Furthermore, sometimes there is a reluctance of workers to *collaborate* with smart equipment. All these issues need to be clarified and workers need to be informed and trained. Continuous professional training, including adaptation to technical progress, should be a common concern of both employers and each worker. Increasingly, the collaboration between human and robot will be more and more necessary, and for this, all those concerned, society in general, must be prepared.

4. CONCLUSION

Industrial safety and ergonomics are both of them human factors sciences, playing a major role in the success of an equipment design or working task. They should work synergistically to enhance each other, simultaneously improving occupational health and safety and productivity, meanwhile reducing employer costs. Both occupational health and safety and ergonomics risk assessments can be used identify and estimate workplace hazards and who are the subjects at risk and offer proper information regarding the need for effective preventive/protection measures and risk monitoring and control. Each type of assessment should be based on a holistic approach and the total load on the body should be considered.

In this article we presented some basic aspects, reflections and vectors of interest related to the significant contribution of artificial intelligence in improving performance in the industrial ergonomic field. Ergonomics is an area that contributes significantly to the state of safety, efficiency and effectiveness of workers in carrying out work tasks. However, estimating ergonomic and accidental risks in industry involves a substantial effort and related costs due to number of variables involved, complexity and lack of information.

Artificial intelligence helps to perform tasks safely and smart working equipment prevents workers from exposure to certain hazards and risks, performing high-risk tasks instead of workers. Moreover, AI systems can quickly and correctly make certain decisions in critical situations, thus avoiding work injuries.

In order to materialize optimization solutions, the studies initiated in this article by a synthesis of alternatives to improve existing solutions, but from the AI perspective, will be continued and implemented through the development of an AI system that is adaptable to as many as possible work situations and provide effective real-time remediation solutions.

The training of this AI system will be done on working situations and activities carried out in different industrial fields of activity and environments, so that the AI system will be as efficient as possible in terms of the both detection of hazardous situations and of remedies identified in view of automated implementation, so that the adopted decision to provide the best available problem solution. Also, the interfaces and the communication with the users will be executed in a way to facilitate their work and to stress them physically and mentally as little as possible.

8. REFERENCES

[1] Bahrammirzaee, A., *A comparative survey of artificial intelligence applications in finance: artificial neural networks, expert system and hybrid intelligent systems*. Neural Computing and Applications, 19(8), 1165-1195, 2010.

[2] Carrillo, J.A., Guadix, J., Grosso, R., Onieva, L., *Neural Network Application for Risk Factors Estimation in Manufacturing Accidents*, Book of Proceedings of the 7th International Conference on Industrial Engineering and Industrial Management, pp. 683 – 695, Portugal, 2013.

[3] Castelfranchi, C., *Modelling social action for agents*, Artificial Intelligence, vol. 103, pp. 157–182, 1998.

[4] Cioca, L.I., Moraru, R.I., Băbuţ, G.B., *A Framework for Organisational Characteristic Assessment and their Influences on Safety and Health at Work*, Proceedings of the 15th International Scientific Conference „The Knowledge Based Organization", vol. 2, section: Management, pp. 43-48, Land Forces Academy Sibiu, Romania, 2009.

[5] Guzman, A., Ishida, S., Choi, E., Aoyama, A., *Artificial intelligence improving safety and risk analysis: A comparative analysis for critical infrastructure,* 2016 IEEE International Conf. on Ind. Engineering and Eng. Management, Bali, Indonesia, 2016, pp. 471-475.

[6] International Organization for Standardization, *ISO 9241-210:2019 – Ergonomics of human-system interaction- Part 210: Human-centered design for interactive systems*, www.iso.org

[7] Lopez-Leyva, J., et al., *Automatic Visual Servoing Control System for Industrial Robots in Arbitrary Work Areas Based on M-Pbvs Technique*. Acta Technica Napocensis - Series: Appl. Math., Mech. and Eng., [S.l.], v. 62, n. 3, oct. 2019. ISSN 1221-5872. Available at: https://atna-mam. utcluj.ro/index. php/ Acta /article /view/1215. Accessed: 20 May. 2020.

[8] Mocan, B., et al. *Exoskeleton Robotic Systems Used as a Tool for Cardiac Rehabilitation*. Acta Technica Napocensis - Series: Applied Mathematics, Mechanics, and Engineering, [S.l.], v. 62, n. 3, oct. 2019. ISSN 1221-5872. Available at: <https://atnamam.utcluj.ro/index.php/Acta/article/view/1220>. Date accessed: 20 May. 2020.

[9] Moore, P.V., *Artificial Intelligence: Occupational Safety and Health and the Future of Work,* Accessed 4 March 2020 at: https://www.stjornarradid.is/lisalib/getfile.aspx?itemid=4061219d-3a73-11e9-9432-005056bc530c

[10] Moraru, R.I., Băbuţ, G.B., *Principles and guidelines regarding the risk management implementation: The new ISO 31000:2009 standard*, Quality - Access to Success Journal*,* 11, Issue 4, pp. 50-59, 2010.

[11] Moraru, R.I., Băbuţ, G.B, Cioca, L.I. *Drawbacks and traps in risk assessment: examples in Romania*, Proceedings of the 5th International Conference on Manufacturing Science and Educations - MSE 2011, Volume 2, pp. 363-366, Sibiu, Romania.

[12] Moraru, R.I., Cioca, L.I., *Operational safety measures in human-machine systems: an overview*, Proceedings of the 18th International Conference - The Knowledge-Based Organization: Management and Military Sciences - KBO 2012, pp. 86-91, Sibiu, Romania.

[13] Popescu-Stelea, M., Bălan, G., Băncilă-Afrim, N., *The place and role of proactive safety behavior in occupational risk management*, Quality - Access to Succes, 18 (S1), January 2017, pp. 63-68.

[14] Van den Branden, S., *Using AI and a camera feed to measure ergonomics*, Accessed 27 February 2020 at: https://medium.com/in-the-pocket-insights/using-ai-and-a-camera-feed-to-measure-ergonomics-a15cf2ee0d22

[15] van Maanen, P. P., Lindenberg, J., & Neerincx, M., *Integrating Human Factors and Artificial Intelligence in the Development of Human-Machine Cooperation*. In H. R. Arabnia, & R. Joshua (Eds.), Proc. of the 2005 International Conference on Artificial Intelligence (ICAI'05)*,* pp. 10-16, CSREA Press.

[16] Vos, G.A., *Introduction to Human Factors and the Human Centered Design Process*, Accessed 16.02.2020 at https://www.coursehero.com/file/13670569/Human-Centered-Design-Processmk/

[17] * * *, *What is Ergonomics?*, International Ergonomics Association, Accessed 18 February 2020 at https://www.iea.cc/whats/index.html.

[18] * * *, *Five reasons to consider cobots in your production*, Accessed at 6 March 2020 at https://www.dti.dk/specialists/five-reasons-to-consider-cobots-in-your-production/37893

Studiu privind potențialul de aplicare al inteligenței artificiale pentru îmbunătățirea performanței în ergonomia industrială

Rezumat: Obiectivul principal al cercetării este de a analiza potențialul de aplicare al inteligenței artificiale pentru a înțelege cum poate fi integrat în vederea îmbunătățirii performanțele ergonomice și rezultatelor legate de securitatea și sănătatea ocupațională. Afecțiunile musculo-scheletice reprezintă cele mai frecvente și costisitoare probleme de sănătate legate de exercitarea profesiei. În procesele de muncă, omul este solicitat de factori fizici, de mediu, psihici și psihosociali care pot afecta sănătatea sistemului musculo-scheletic. Identificarea factorilor importanți care afectează sănătatea lucrătorilor necesită cunoştinţe din mai multe domenii, cum ar fi: anatomie, fizică, matematică, antropometrie, psihologie, sociologie etc. Pe de altă parte, inteligența artificială s-a dezvoltat semnificativ în ultimii ani și a pătruns în toate domeniile de activitate, inclusiv în domeniul ergonomiei muncii. Interacțiunea dintre om și echipamentele „inteligente” de lucru devine din ce în ce mai mult, o activitate curentă, iar această interacțiune trebuie să aibă loc în deplină siguranță. Acest articol are scopul de a investiga modul în care performanța în domeniul ergonomic poate fi îmbunătățită semnificativ prin recurgerea la utilizarea inteligenței artificiale. Rezultatele obținute urmează a fi integrate în sisteme operaționale de prevenire ce vor fi dezvoltate în viitorul apropiat.

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