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Arm stabilizing keyboard overlay

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This paper presents the application and construction of a device that stabilizes the upper limb when working with on a keyboard. The designed solution helps a person with motor disabilities characterized by reduced motoric abilities of the body. A suitably prepared stand with a keyboard and stiffening handgrip allows the use of a computer despite the reduced motor capabilities of the user. Clamps allow to fix the pad to the desk, protecting it from dropping during uncontrolled movement. The design limits the movement of the attached hand to the stabilizer, beyond the keyboard work area.

Arm stabilizing keyboard overlay was tested heavily at the Special Educational Center (Specjalny Ośrodek Szkolno-Wychowaczy) in Dabrowa Górnicza, where it was used in real-world educational settings. Feedback from this testing phase played a key role in initiating several critical improvements to enhance both its functionality and safety.

Fig. 1. Arm stabilizing keyboard overlay in use during the test in Dąbrowa Górnicza

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Application for self-care of the elderly

Kacper SNARSKI, Julia JAGODYŃSKA, Piotr PROCHOR

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The concept of a self-care app for the elderly is a step forward in making the lives of seniors comfortable and safe. Currently, there are not many widely available solutions of this type on the app market. Our population is aging year by year, so simple solutions such as phone apps can significantly improve contact between the doctor, the family and the elderly.

The concept of the project has a built-in medication reminder system and an alarm can prevent health and life-threatening situations. It will also feature a location function, so the family can keep track of the elderly person's whereabouts. In further stages of development, the application also envisages the possibility of connecting home electronic medical equipment, so that it will be possible to read data such as heart rate, saturation, blood sugar levels and many other parameters that can be modified according to the needs of the patient.

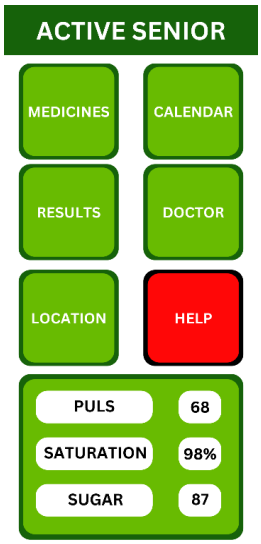

Figure 1: Sample application visualization

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The study of the impact of ankle and knee injuries on changes in parameters assessing postural stability

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The aim of the study was to assess the postural stability of female basketball players, taking into account their history of knee and ankle injuries or lack thereof. The research group consisted of 12 basketball players aged 15 to 20, whose diverse injury histories formed the basis for detailed analysis. Changes in the Center of Pressure (CoP) position were recorded using dynamometric platforms during the tandem stance trial (which involved standing with one foot behind the other in a straight line with eyes closed for 15 seconds). The study analyzed the positional variables of CoP as presented in Table 1. Figure 1 depicted a graphical representation of the 95% confidence ellipse area along with the coordinates achieved by the points during the trial. This study represents a significant step towards understanding rehabilitation processes in sports, particularly in the context of precise diagnosis and tailoring treatment programs to the individual needs of athletes.

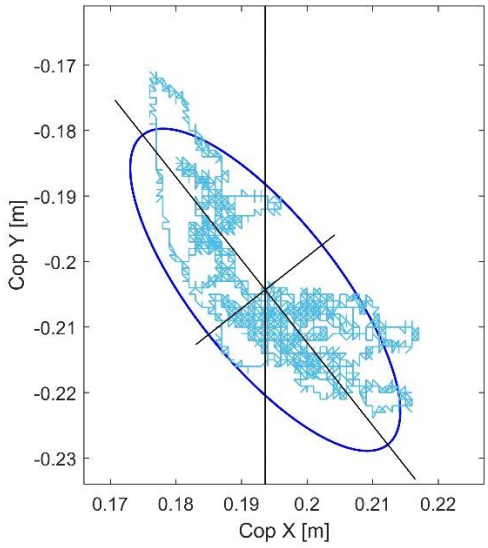

Figure 1: Illustration of the calculation of the 95% confidence ellipse. The feature is equal to the area of the ellipse

	No ankle or/and knee joint injury	Ankle or/and knee join injury
Posterior lower limb		
Principal sway direction [°]	38.854	57.916
95% Confidence ellipse area [m^2]	0.00209	0.00092
Range ML [m]	0.0438	0.0421
Ratio of amplitudes [-]	0.853	1.109
Abs coefficient of sway direction [-]	0.732	0.698
Anterior lower limb		
Principal sway direction [°]	28.093	34.499
95% Confidence ellipse area [-]	0.00186	0.00194
Range ML [m]	0.0447	0.0552
Ratio of amplitudes [-]	0.667	0.742
Abs coefficient of sway direction [-]	0.747	0.863

Table 1: Comparison of mean values parameters for a limb without injury and for a limb with injury to the knee or ankle joint, taking into account their configuration during the trial

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Robotherapy - implementation of advanced robotic systems in children's therapy

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Use of advanced robotics in order to help people is often viewed as the use of data collection and surveillance, supporting devices in geriatrics, treatment of the effects of neurodegenerative diseases with rehabilitation robots or anthropomorphic and zoomorphic robots engaging patients with developmental and emotional disorders. Use of advanced industrial robots such as cobots used in those applications is unusual. This paper will present the results of building a prototype of the educational station (figure 1) with Universal Robotics cobot and the results of research and tests conducted during robotherapy sessions with children (figure 2). Verification tests took place mainly in Specjalny Ośrodek Szkolno-Wychowawczy in Dąbrowa Górnicza and focused on working with individual units but also groups of children of different ages and degrees of disability. Study shown positive results in children's perception of advanced robotics, their immense willingness to work with the station and noticed potential to improve their abilities and behavior because of it.

Figure 1: Educational station with Universal Robotics cobot and its creators: Gałeczka Ł. (on the left), Nowak J. (on the right)

Figure 2: Robotherapy session with disabled kids in SOSW

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Biomechanical analysis of the drop jump test in a group of female soccer players

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Jumping test is a crucial component of pre-season player evaluation, as it is used to access a player's readiness to sport participation, among other factors. Eighteen female football players took part in the study. The objective was to analyze parameters related to characteristic time moments and forces during the drop jump (DJ) trial, which involves jumping from a 0.34 m wooden box onto two force plates and achieving the highest possible upward thrust as quickly as possible. Figure 1 illustrates the visual component of the ground reaction force for the left limb. The biomechanical evaluation of the DJ test includes determining parameters as presented in Table 1. Results were calculated for each player from two repetitions. The findings suggest that a numerical data-based approach can offer significant insights, revealing differences between limbs that should be taken into account during player assessment.

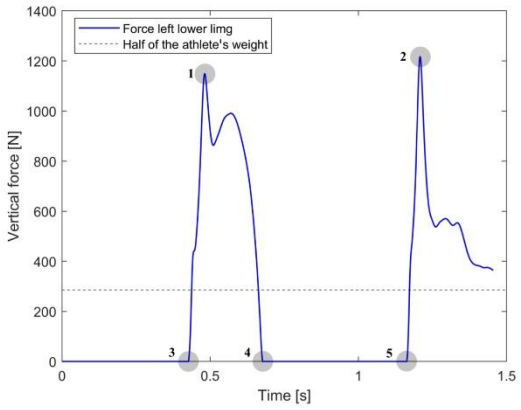

Figure 1: The vertical component of the ground reaction force: 1,2 - The maximum values of force, respectively, for takeoff force and landing force; 3 – the touchdown time; 4 – the takeoff time for the jump; 5 – the landing time

	Mean value	Standard deviation
Maximum takeoff force [BW]	2.188	0.559
Difference in maximum takeoff force [BW]	0.376	0.346
Maximum landing force [BW]	2.739	0.708
Difference in maximum landing force [BW]	0.630	0.591
Contact time [s]	0.387	0.132
Relative strenght index [-]	1.364	0.486
Jump height [m]	0.275	0.040
Difference in touchdown time (L - R) [s]	0.018	0.049
Difference in takeoff time (L - R) [s]	0.005	0.004
Difference in landing time (L - R) [s]	0.004	0.006

Table 1: Compilation of the obtained parameters from the drop jump trial for all players

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Interactive toy for sensory integration therapy

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Sensory stimulation plays a key role in therapeutic interventions for children with disabilities, particularly in improving visuomotor coordination and sensory integration. The development of the "Color Snake" an interactive therapeutic device, is an example of an innovation in this field. The device is designed to engage children through a series of games and activities that emphasize identifying and matching colors, thus enhancing learning through interactive playing. The inclusion of light animations provides immediate feedback on task completion, which not only reinforces learning, but also adds a sensory reward element. "Color Snake" was tested heavily at the Specjalny Ośrodek Szkolno-Wychowaczy in Dabrowa Górnicza in April 2024, where it was used in real-world educational settings. Feedback from this testing phase played a key role in initiating several critical improvements to enhance both its functionality and safety. These modifications ensure that the device meets the stringent safety requirements necessary for therapeutic tools for children.

Figure 1: Prototype of the device in the early stages of development during functional testing.

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MODELING OF ANCLE FOOT ORTHOSIS (AFO) FOR A HEMIPLEGIC PATIENT

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The aim of the research was to model an individual orthosis for a child with hemiplegia and to analyze the strength of the orthosis in order to best fit the powder-printed orthosis to the patient. The research material consisted of a scan of the lower limb of a child with hemiplegia. The model has been properly processed and the feet have been corrected. The finished orthosis model was subjected to MES analysis. In the ANSYS program, the model was given PA12 material, the forefoot was loaded, and a force of 224 N acted parallel to the ground in the direction corresponding to the metatarsal flexion, the force was obtained during gait analysis in the BTS SMART system. The applied force caused a slight deformation in the metatarsal area, especially on the outside of the orthosis. Increasing the load may result in permanent damage to the orthosis.

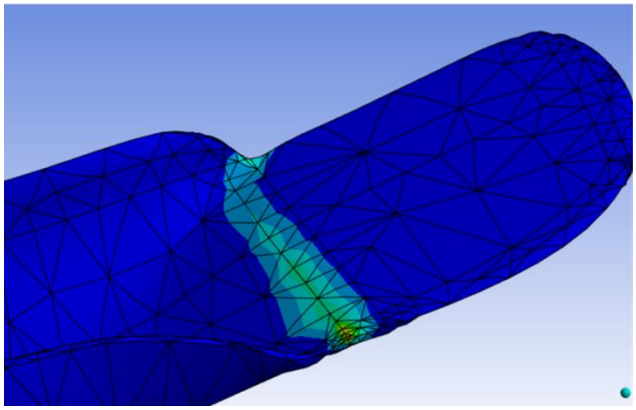

Figure 1: Figure showing the result of the MES analysis

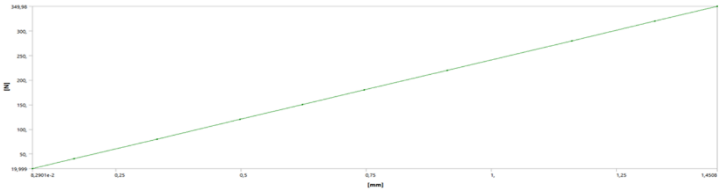

Figure 2: Graph showing the relationship between the loading force [N] and the deformation [mm]

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„Influence of the diversity of the human body abdominal wall shape on its mechanical behaviour: Finite Element Simulation."

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Julia NIEMIERKO, Katarzyna SZEPIETOWSKA

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The study presents the impact of the diversity of the shape of the human abdominal wall on its mechanical response by means of finite element simulations. Plane strain is assumed and the two dimensional analysis is performed. The finite element models are based on two cross-sections of the abdominal wall of a woman and a man. The abdominal wall tissues were segmented from two sets of computer tomography images using Mimcs(Fig.1) (Materialise) .Two-dimensional models of the abdominal wall were created in 3-Matic from axial cross section around 3rd lumbar vertebra (Fig.2). Static analysis were performed in Marc Mentat. The isotropic, linear-elastic material model is used. The model was loaded with intra-abdominal pressure, and the boundary conditions were modelled as a fixation at the site of the spine. The final step of the work is to obtain the deformation and compare the results.

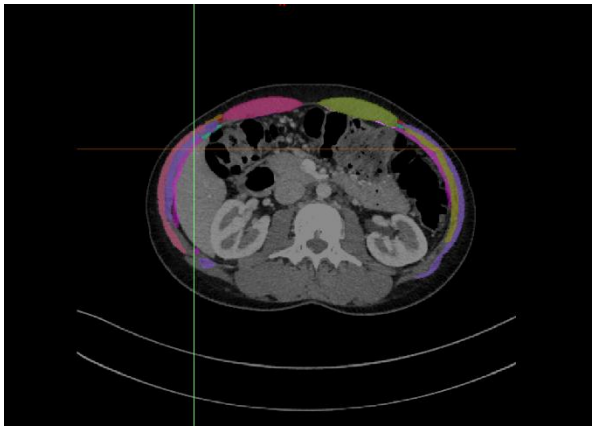

Figure 1: Axial section of human - CT image

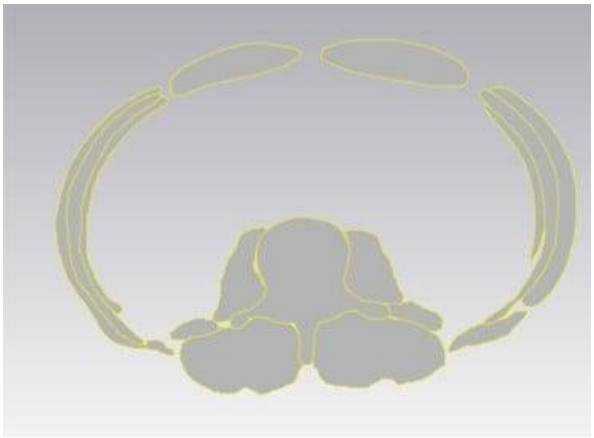

Figure 2: Example of 3-Matic model of abdominal wall muscles

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Finite element model of the human abdominal wall: influence of hyperelastic parameters on the mechanical behavior

Wiktoria KORBUT, Aleksandra KONDRUSIK, Zuzanna IWICKA, Julia NIEMIERKO, Katarzyna SZEPIETOWSKA

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To understand the human abdominal wall mechanical behavior, computational modelling may be useful. There are currently some research which differ from each other in the method of modelling. This particular finite element model is prepared on the basis on woman CT images (Figure 2). Firstly, Mimics and 3-matic are used to reconstruct 3D geometry of the abdominal muscles. Then model is imported to Marc Mentat, (Figure 1) in which half of the model is considered with symmetry boundary conditions. We assume hyperelastic material - the Holzapfel-Gasser-Ogden model. Boundary conditions, where displacements have been constrained, were applied around the entire perimeter of the model. The load introduced into the model is intra-abdominal pressure in the standing position. The aim of this study is to examine how changing the parameters of the material model affects the mechanical behavior of the model. Sensitivity analysis is performed to compare the influence of the material model parameters on the abdominal wall deformation.

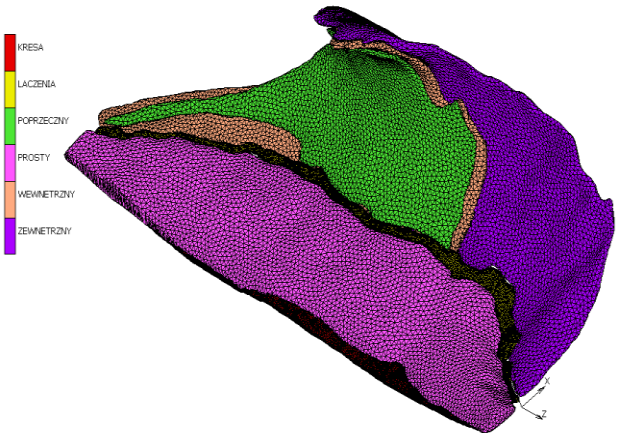

Figure 1 Human abdominal wall meshed in Marc

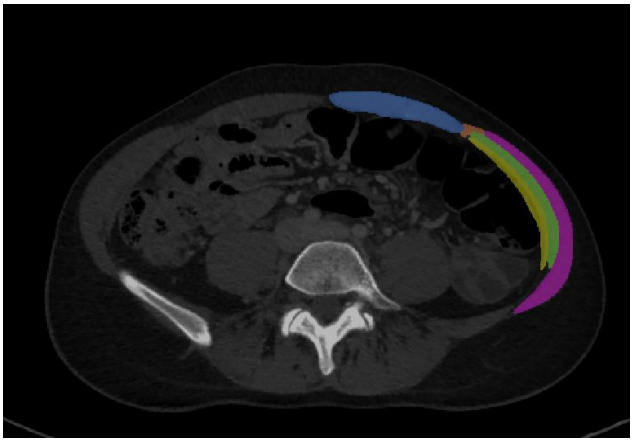

Figure 2 Axial section of human - CT image

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"Interactive breathing exercisers and their impact in speech therapy"

Karol WILK, Julia NOWAK, Paweł ŁÓJ, Małgorzata MUZALEWSKA

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We have prepared a thorough examination of the utilization and effectiveness of interactive breathing exercisers within the realm of speech therapy. Breathing exercises have long been recognized as essential components of speech therapy interventions, particularly in cases of disorders such as dysarthria and apraxia. However, traditional methods often lack engagement and fail to provide real-time feedback, hindering patient motivation and progress. Our devices address these limitations by incorporating elements of gamification, biofeedback, and personalized guidance. We explore the potential benefits of integrating such technology into clinical practice, including increased patient engagement, adherence, and ultimately, improved therapeutic outcomes.

The devices have been in use in the Educational Special Centre in Dąbrowa Górnicza since September 2023.

Figure 1: The device in use

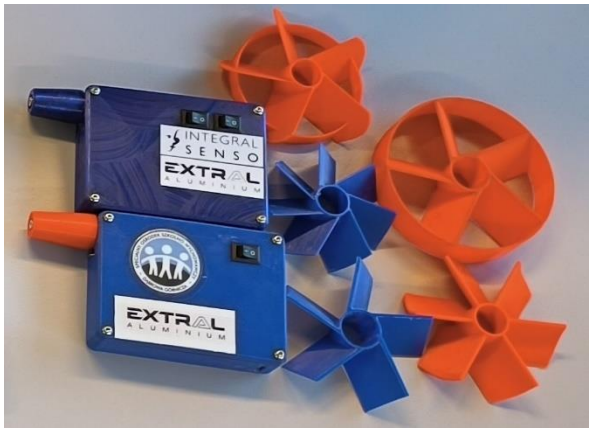

Figure 2: The set of devices with different fans

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Analysis of the effects of wearing masks on postural stability and gait parameters

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The aim of the study was to determine the effects of wearing face masks on two of the most basic human motor functions – standing and walking. Three types of face masks were taken into account – surgical, cotton and sports masks, compared with not wearing any mask. Postural stability has been analyzed using a Zebris FDM-S platform through the Rombergs Test with eyes open and closed on a group of 16 people (mean 24±5 yrs, 64±12 kg, 172±10cm), and gait analysis was run using a Zebris FDMT treadmill via a 1-minute treadmill walking test at a preferred speed on a group of 11 people (21,2±0,4 yrs, 62,1±7,2 kg, 171,3±7cm). CoP data (example on figure 1) and gait parameters (example on figure 2) were gathered and analyzed statistically using Kruskall-Wallis and Wilcoxon tests. It has been discovered that none of the seemingly existing differences were statistically significant (p value > 0,05). Considering that, the negative influence of wearing face masks on postural stability and gait was deemed clinically insignificant.

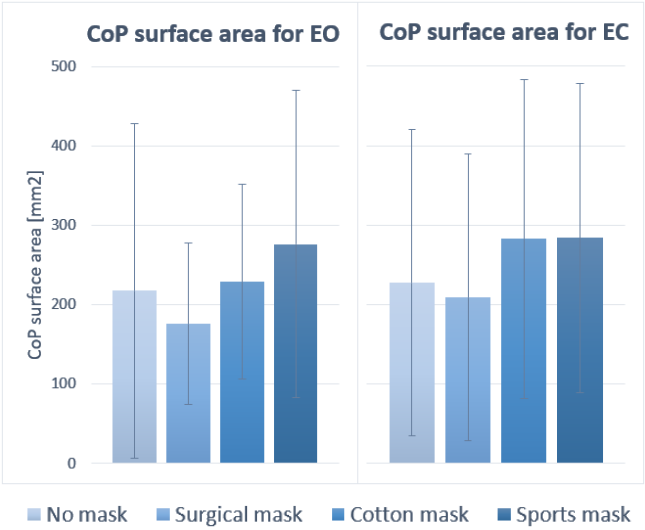

Figure 1: Exemplary postural stability analysis data – CoP surface area for eyes open (EO) and eyes closed (EC) for four trials

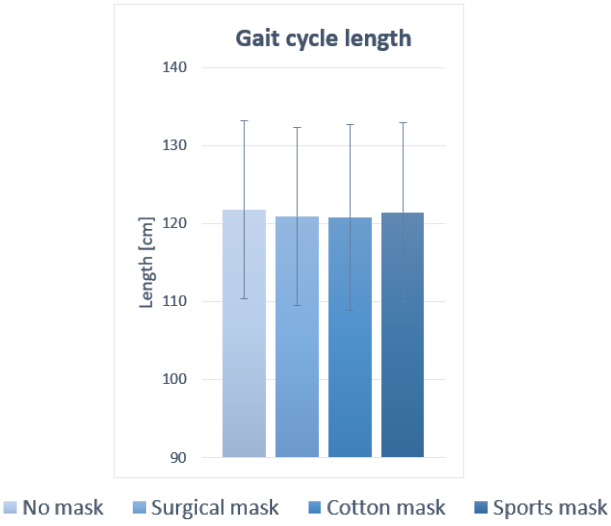

Figure 2: Exemplary gait analysis data – gait cycle length for four types of trials

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System supporting the rehabilitation process

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The aim of the study was to develop a system to support the performed movements of the upper and lower limbs in the rehabilitation process. The patient, in cooperation with the physiotherapist, would have to perform specific movements, usually of a repetitive nature. The idea behind the system is for the physiotherapist to determine the appropriate movement patterns and their parameters, e.g. ranges of motion, number of repetitions, for the rehabilitated limb. The advantage of the system would be the ability to independently perform exercises at home that have been assigned by the physiotherapist. Another aspect of the developed system is the so-called biofeedback in the form of simple movement games supporting the performance of restful movements, and at a later stage, voice messages informing about the types of necessary correction, of the movement performed. In addition, the idea of the system was its availability and low cost, so that the solution could reach the widest possible audience.

Figure 1: sensors attached to the hand with an elastic band

Figure 2: developed movement game

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Scooter attachment enabling driving on snow and mucky ground

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The subject of the invention is scooter attachment enabling driving on snow and mucky ground. Currently, there is a lack of similar designs adapting a scooter or a bicycle to move in conditions of increased snow cover or mucky ground. The most common solutions are characterized by the removal of the front wheel to implement a structure with skids in their place. The project consists of 4 substructures (2 front and 2 rear), 2 dedicated axles (front and rear), clamps, skids and connecting elements (nuts and bolts). The prototype was realized as part of a charity initiative to raise money for a sick girl.

Figure 1: Prototype of scooter with attachments

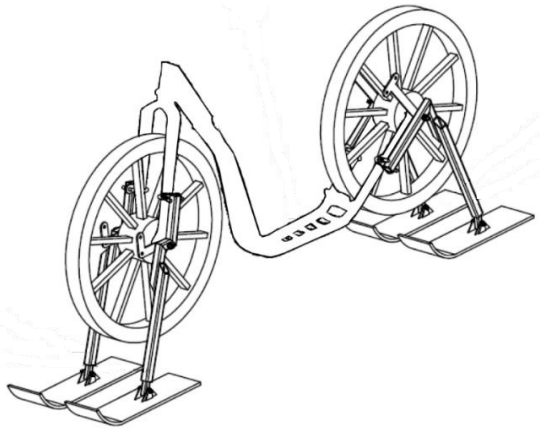

Figure 2: Scooter model with attachments

Project carried out as part of the activities of SKN ORTHOS.

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Cardiac contraction sensitivity analysis using hybrid cardiovascular simulation system

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Mechanical heart support devices may be the answer to the ever-increasing demand for hearts for transplantation. Existing devices have their drawbacks, the solution to which requires the development of new designs. Cardiac simulation systems can significantly speed up the process of finding new solutions and facilitate the diagnosis of problems at the in vitro stage. To this end, a sensitivity analysis of a hybrid cardiovascular simulation system adapted for parallel operation with LVAD was carried out using the OFAT approach, which made it possible to estimate the influence of single parameters on the conditions in the electro-hydraulic part of the system. The influence of single modifiers of the diastolic function, maximum ventricular elastance and resistance of the mechanically simulated valves was tested. The information obtained from the tests and analyses allowed the development of guidelines for reproducing conditions similar to specific pathological conditions.

Figure 1: Hybrid cardiovascular simulation system with the POLVAD LVAD connected for the studies.

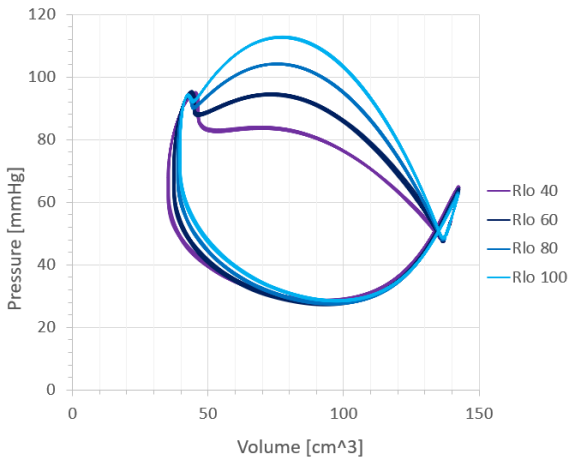

Figure 2: Examples of changes in the pressure-volume relationship of the left ventricle caused by a change in the value of the aortic valve resistance

Part of a project financed by FutureLab PK no. 86;
Part of collaboration with Institute of Metallurgy and Materials Science PAS

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Evaluation of tissue anastomoses obtained with surgical sutures and tissue adhesives using animal skin and aorta as examples

Zuzanna ZAJĄC , Sylwia ŁAGAN, Karolina SZAWIRAACZ, Roman MAJOR, Przemysław KURTYKA, Maciej GAWLIKOWSKI, Aneta SAMOTUS

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There are many methods of tissue anastomosis, depending on the type of tissue material, or the requirements, the method of tissue anastomosis is selected individually for each clinical case. Traditionally, surgical sutures are used for this purpose, however other solutions are also known. The use of cyanoacrylate-based tissue adhesives is one of them. The purpose of this study is to compare the mechanical properties of anastomoses obtained using a cyanoacrylate-based adhesives and suturing anastomoses, taking into consideration several standard adhesives available on the market. Two types of porcine tissue material were used for the study: skin and aorta. Wettability tests were performed on the surface of porcine tissue materials. The surface free energy (SFE) of the tested tissues was determined using two models: Owens-Wendt and van Oss-Chaudhury-Good. Static tensile tests were performed to determine the evaluation of the tensile strength of the tested anastomoses.

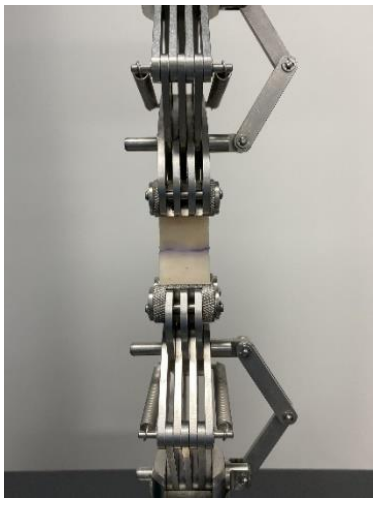

Figure 1: Sample of pig skin bonded with tissue adhesive placed in the holder of the testing machine

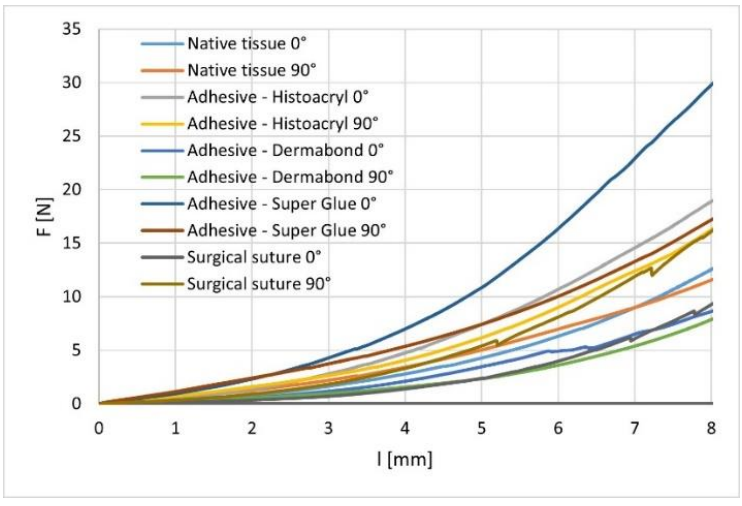

Figure 2: Graph of average force-extension curves for skin anastomoses

ADDITIONAL INFORMATION: The work was supported by FutureLab PK as a part of the project nr 73 - Optimization of the operating parameters of the cardiac support chamber based on the biomechanical system "artificial patient - HEART"

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Dynamometric mat for gait analysis and rehabilitation

Authors

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The dynamometric mat for gait analysis and rehabilitation is a device created through the collaboration of the students scientific association Ai-Meth with the Special School in Dąbrowa Górnicza. It is a response to the lack of interactive devices used in gait rehabilitation at that school, especially in the case of children. The mat allows for measuring the pressure force of the feet on its surface using sensors consisting of piezoresistive foil. Then, the measurements are transformed into a pressure map, where foot positioning is detected using machine learning model. Upon detecting correct gait, gratification is provided in the form of a light and sound signal. The mat consists of multiple modules that can be connected to each other in order to adjust its length. User will have a possibility to choose different modes of mat's working depending on the rehabilitation's goals. The device is still in the development phase, but the initial tests at the target school have ended positively.

Figure 1: Initial tests at the Special School in Dąbrowa Górnicza

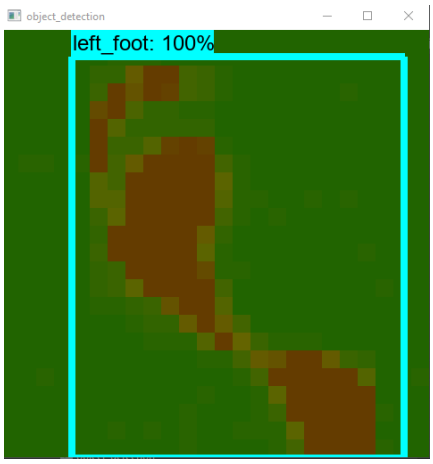

Figure 2: Detected foot during tests

ADDITIONAL INFORMATION: Politechnika Śląska, Katedra Podstaw Konstrukcji Maszyn, SKN AI-METH; Integral SENSO, AIUT, Specjalny Ośrodek Szkolno-Wychowawczy Dąbrowa Górnicza

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Interactive Piano for children's therapy

Stanisław GIREK, Daniel ŚLUSARZ, Łukasz GAŁECZKA, Małgorzata MUZALEWSKA

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The interactive piano for child therapy is a device designed to support the development of children with limited motor skills. Thanks to the audio gratification signal and the adapted button force, even children with paralysis can operate the device. The system is based on a spring mechanism with a monostable button, and the whole is enclosed in a housing made using FFF technology. Additionally, by connecting more buttons, the device can function as an enlarged piano based on Arduino Nano, which ultimately allows for the device itself to be used for a variety of children's games. The device has been tested at the Specjalnym Ośrodku Szkoleniowo-Wychowaczym Center in Dąbrowa Górnicza on children ranging from cognitive norm to severe impairment. Tests on patients made it possible to find out the pros of this solution and the drawbacks that need to be improved in the next iterations.

Figure 1: An independent prototype of the device - one note

Figure 2: Testing of the device at SOSW Dabrowa Górnicza

ADDITIONAL INFORMATION: Politechnika Śląska, Katedra Podstaw Konstrukcji Maszyn, SKN AI-METH; Integral SENSO, Specjalny Ośrodek Szkolno-Wychowawczy Dąbrowa Górnicza, AIUT.

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How does induced acceleration of the one treadmill's belt in the pre-swing gait phase change muscle force in older adult? – preliminary study

Michalina BŁAŻKIEWICZ-JANECZKO

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Introduction. The aim of this study was to analyse the impact of external perturbations involving the acceleration of one treadmill's belt during the pre-swing phase on muscle force distribution in older healthy women.

Material and Methods. The study included two elderly women (age: 64/ 62 years old; body weight: 59/ 58 kg; body height: 162/ 160 cm). The kinematic and kinetic parameters of the perturbed gait were recorded in an interactive real-time gait analysis laboratory (GRAIL, Motek Medical B.V., Amsterdam, Netherlands). GRAIL comprises an instrumented treadmill with two split belts, a motion capture system, and synchronized virtual reality environments. The participant wore sole athletic shoes and walked at a constant speed of 1 m/s. Unexpected perturbations were applied to the left treadmill belt during the toe-off phase. These perturbations included acceleration of the left lane, causing the standing foot to move forward. The participants underwent five perturbations. Five gait cycles without perturbations were extracted and five gait cycles for the left lower limb, which included perturbations, were extracted for each woman. OpenSim 4.4 software and the gait2392_Simbody model were used to calculate the muscle forces of the 43 muscles controlling the perturbed limb. The maximum peaks recorded for each muscle were used for analysis.

Results and conclusions. The study revealed that 37 muscles experienced an increase in their maximum strength during perturbation; however, statistical significance was observed in only 23 of these muscles. Conversely, the strength of 6 muscles (tibialis anterior, vastus medialis, lateralis and intermedius, pectineus, gluteus medius first component) decreased (Figure 1).

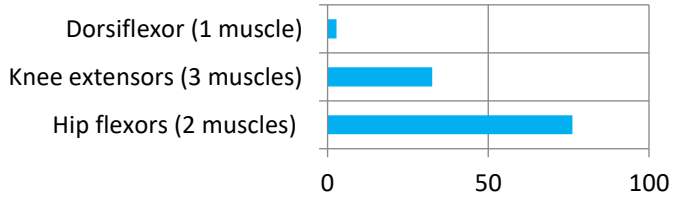

Figure 1: Percentage of muscle force loss during perturbations.

This research was funded by the Józef Piłsudski University of Physical Education in Warsaw, grant number UPB no. 2 (114/12/PRO/2023). I would like to thank Karol Kowieski, Martyna Jarocka, Agnieszka Zdrodowska and Katarzyna Kaczmarczyk for their help in data collection.

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Selected aspects of the application of virtual reality in biomechanical research

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Scientific research focusing on the impact of VR technology on the human body, especially in the context of physical activity, is the subject of numerous studies. VR-based applications are becoming increasingly popular in various fields, including sports. However, there are also negative effects associated with the use of simulated environments, such as cybersickness. Comparative studies present differences in physiological and psychological responses between natural and simulated environments. The integration of VR technology with other systems, such as electromyography (EMG), has been applied in rehabilitation and sports. By using EMG in conjunction with a natural VR environment, the authors set out to investigate the impact of VR use on muscle fatigue. To achieve this, they applied a proprietary algorithm based on discrete wavelet transform (DWT). This paper discusses selected aspects of an innovative approach to measuring muscle fatigue using VR and EMG.

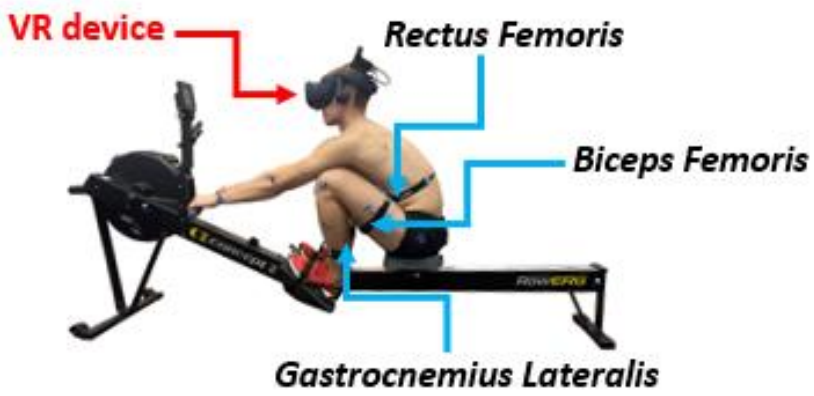

Figure 1: The methodology used in study (rowing in simulated environment) with placement of EMG electrodes on the muscles (Blue line).

This work was financed/co-financed by the Military University of Technology under the research project UGB 22-719

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Implant biomaterial: mechanical and corrosion properties of hexagonal nano-TiO_2

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The study investigated the synthesis and characterization of hexagonal titanium dioxide nanotubes (hTNTs), focusing on their structural, electrochemical, corrosion, and mechanical properties. The fabrication process involved sonoelectrochemical anodization of titanium foil in various electrolytes to obtain titanium oxide layers with different morphologies. Electrochemical measurements confirmed a more positive open-circuit potential, lower impedance, higher electrical conductivity, and higher corrosion rate of hTNTs compared to compact TiO_2. Nanoindentation tests revealed that the mechanical properties of the hTNTs were influenced by their diagonal size, with decreasing hardness and Young's modulus observed with increasing diagonal size of the hTNTs, accompanied by increased plastic deformation.

Overall, the findings suggest that hTNTs exhibit promising structural and electrochemical properties, making them potential candidates for various applications, including biosensor platforms.

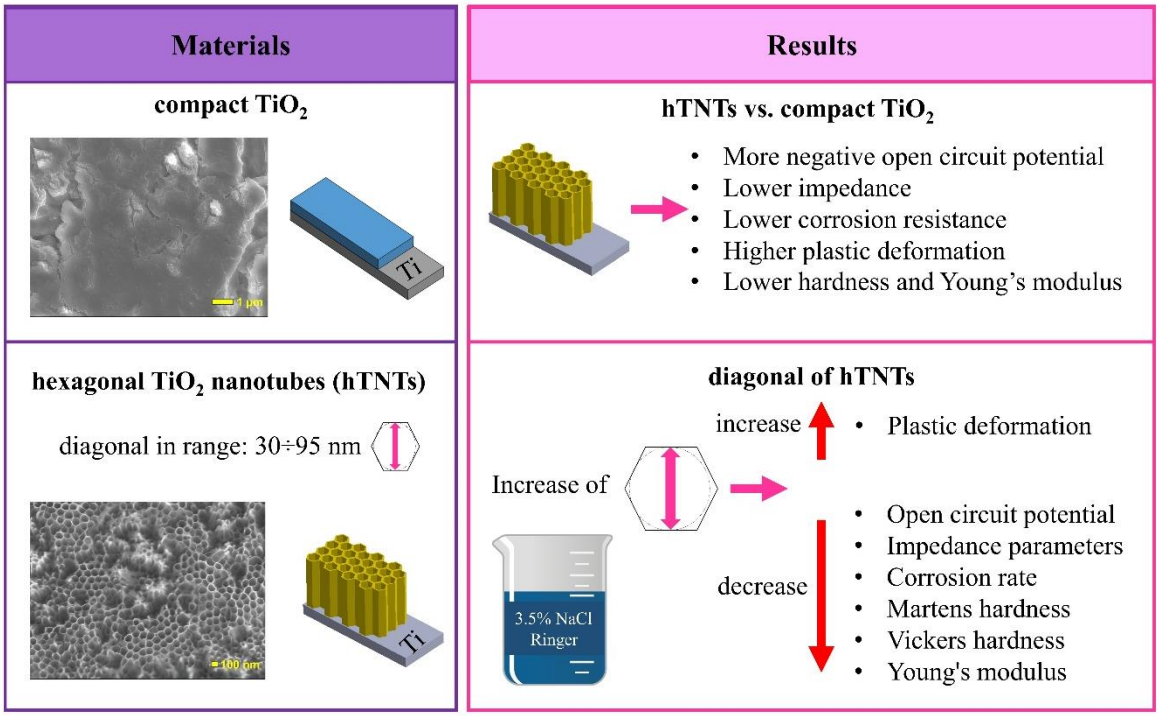

Figure 1: Graphical abstract of research on hexagonal TiO_2 nanotubes.

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Computer methods to analyze the displacement of breast cancer lesions

Adrianna SZUMIEJKO, Mariusz PTAK, Mateusz DYMEK, Bartosz DOŁĘGA-KOZIEROWSKI, Jakub SKÓRNIAK, Rafał MATKOWSKI, Piotr KASPRZAK

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This study focuses on the challenge of accurately locating breast tumors due to positional changes during MRI examinations, impacting surgical planning. A methodological process is outlined, integrating pre-qualification assessments, 3D scans, MRI, and USG imaging, with segmentation and finite element analysis. An artificial neural network predicts tumor displacement, aiding in creating a detailed surgical plan and 3D-printed breast models. By utilizing various techniques including image fusion and additive manufacturing, a detailed surgical plan is developed for lumpectomy surgery in the supine surgical position. This innovative approach demonstrates significant potential in improving surgical accuracy and efficacy for breast cancer patients, assisting in pathomorphological justification and enhancing preoperative planning. Transparent 3D-printed breast models offer valuable assistance to surgeons in visualizing tumors with greater precision.

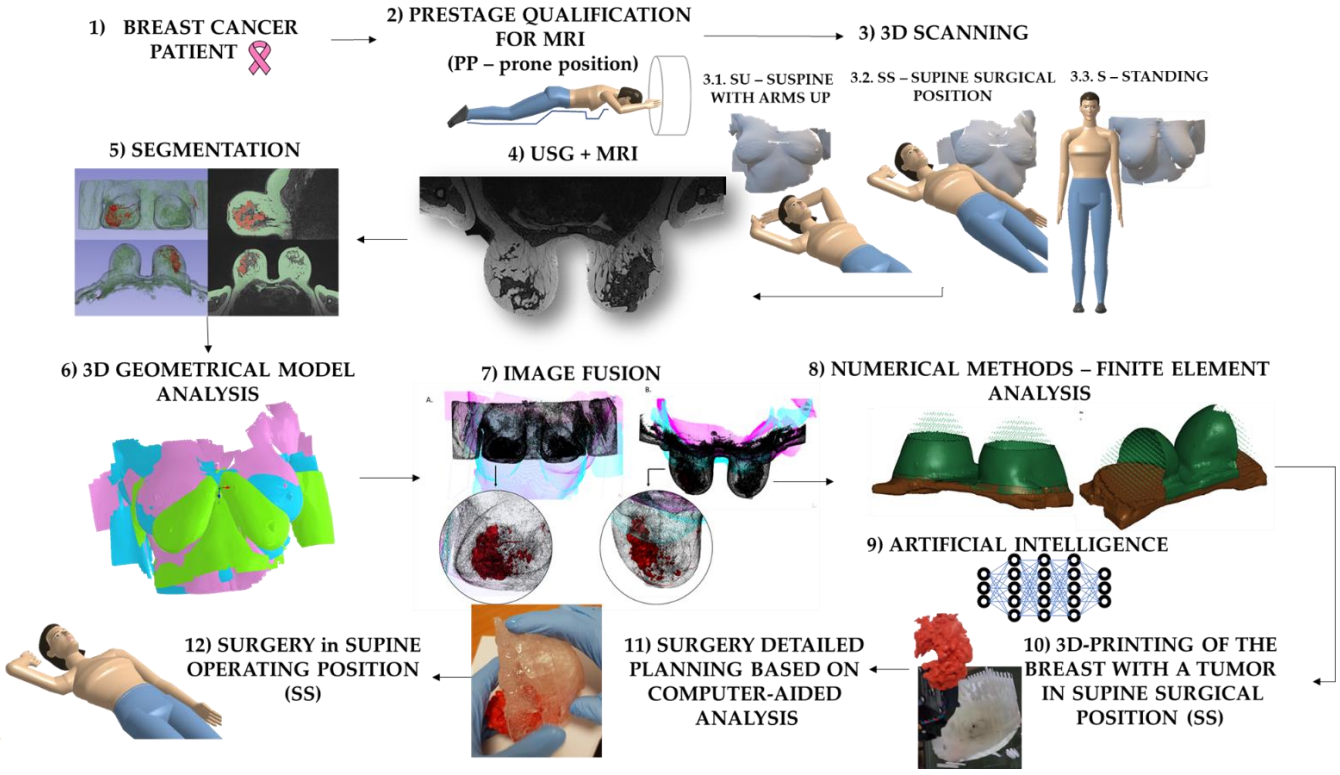

Figure 1: Methodological process for the breast cancer patients treatment

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Topological optimisation of simplified hernia implant with particle swarm method.

Szymon Kalinowski

Katarzyna Szepietowska, Eric Florentin, Izabela Lubowiecka

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In this study we aim to optimize surgical implant used in abdominal hernia repair. The goal is to obtain reduced and more uniformly distributed forces in fasteners connecting the implant with substituted tissues. This should result in less likelihood of failure and thus lowering the hernia recurrences. We are controlling the forces by changing thickness of different areas of the implant model. The membrane model of implant is defined by means of finite element method. The loads are applied to implant as forced displacements at the model edges, where the connections are located. The material model is assumed as linear elastic and isotropic with Poisson's ratio 0.3 and Young's Modulus of 16.155 MPa. The optimised surface of the implant has been described using 3rd and 4th polynomial expansion of quadratic surface equation for lowering the number of unknowns during optimisation. To avoid the local spikes of thickness (Figure 1) we are also using a surface smoothing method that is ensuring the assumed differences between adjacent elements (Figure 2).

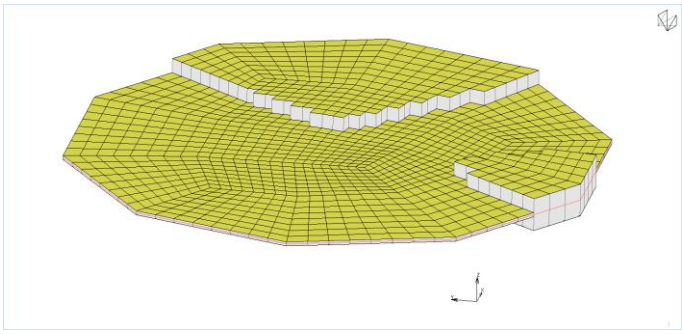

Figure 1: Model before applying smoothing algorithm

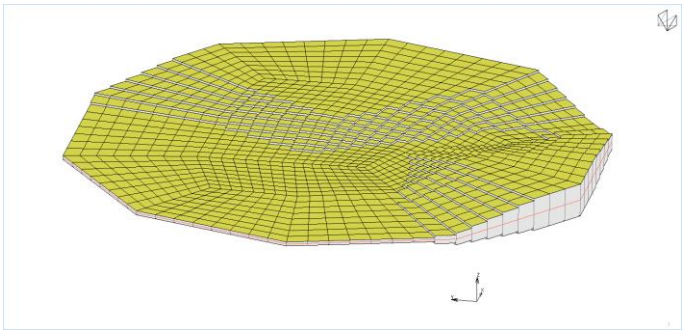

Figure 2: Model after applying smoothing algorithm

This work was supported by the National Science Centre (Poland) [grant No. UMO-2017/27/B/ST8/02518]

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Numerical analysis of periodontal loading for different treatment configurations using the straight-arch technique

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The aim of the study was to develop an accurate numerical model of the skull base and to test the effect of different configurations of the straight arch method on the loads occurring in the periodontium. Computed tomography scans were used to obtain the geometry of the compact bone, spongy bone, and teeth. Additionally, intraoral scans were taken with an intraoral scanner of the dental arch with orthodontic brackets in place. A wire was attached to the brackets. Using these geometries, a finite element mesh was created, and material data taken from the literature was assigned.

The developed numerical model was used to analyse the effect of the value and position of the load on the pressure present in the periodontium. The numerical model was constrained in the upper part of the skull. The load was defined as the force acting between a wire hook and a mini-implant placed in the bone between the 5th and 6th tooth.

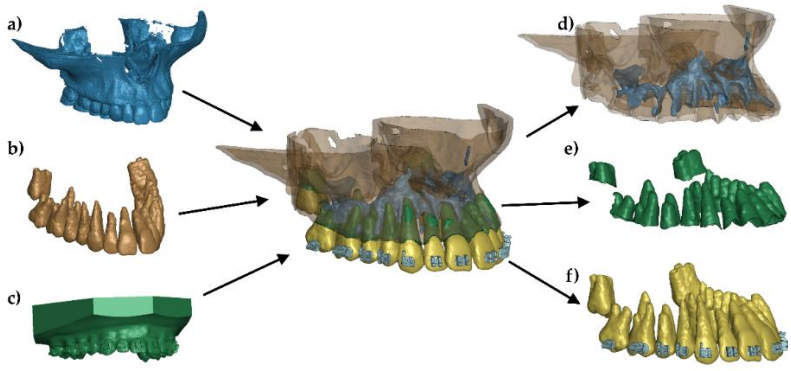

Figure 1: Combination of CT and 3D scanning to represent the structure of the stomatognathic system.

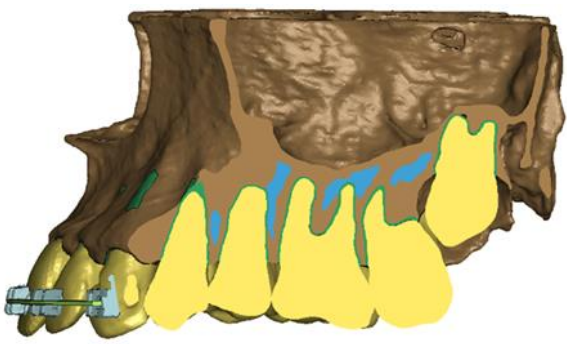

Figure 2: Cross section.

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Analysis of impact interactions from traffic accidents on the implant-mandible connection using numerical analyses

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In this work, the interactions between the mandible and the airbag were subjected to a preliminary analysis. Particular emphasis was placed on analyzing the influence of the shape of the implant on the possibility of generating cracks in the area of the jaw bone. To study the mentioned phenomenon, the finite element method (FEM) with an explicit approach was used. To map possible bone damage (Fig. 1a), the smoothed particle hydrodynamics (SPH) destruction model was used, which enabled tracking the development of the crack around the inserted implant. The condition for crack initiation was the value of the limit strain (ε_{gr}) occurring on individual elements. By giving the entire system appropriate masses, the aim was to reproduce possible accident scenarios. The degree of probability of mandibular fracture was also determined depending on the type of implant used and in relation to the reference model in which no implantation occurred. Additional information about the possible course of the mandible fracture was obtained from tests carried out on a specially prepared test stand. The station included an air bag and a mandible model with an implant fixed on a frame (Fig. 1b). The entire phenomenon was recorded using the Phantom VEO 710L high-speed camera.

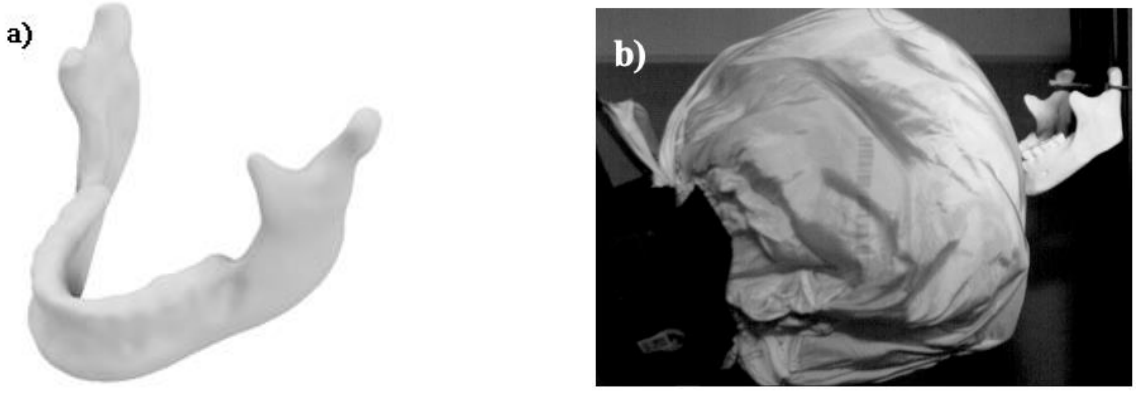

Figure 1: Model of the mandible and view of the test stand: (a) Model of mandible used in numerical analysis; (b) Mandible – airbag interaction during experimental testing

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Fatigue analysis of dental prostheses manufactured from biomaterials for additive manufacturing.

Adam NOWICKI, Karolina OSYPKO, Dariusz PYKA, Maksymilian STĘPCZAK, Mirosław BOCIAN, Jakub SŁOWIŃSKI, Mikołaj KAZIMIERCZAK

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In this study, the authors analysed the fracture mechanism of dental prostheses currently used in implantology. As input parameters, a bruxism-induced load was used, for which the average parameter in the population under consideration is 500 N. This load was set at a cycle frequency of 2 Hz for 100,000 cycles, which is expected to correspond to several years of denture use. To this end, the authors developed a test methodology and a handle accordingly, which is supposed to simulate the work of the prosthesis. Scaling was carried out on an ABS photopolymer resin. The resin was previously tested in a static tensile test and a 3-point bending test, in order to obtain the basic material parameters that were used to analyse the operation of the prosthesis.

Figure 1: Próbki wytworzone z ABS-Like

Figure 2: Próbki zamocowane na układzie badawczym

Reference

1. Kappert, P. F., & Kelly, J. R. (2013). Cyclic fatigue testing of denture teeth for bulk fracture. *Dental Materials*, *29*(10), 1012–1019. https://doi.org/10.1016/j.dental.2013.07.001
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Experimental evaluation of natural cork material as a protective add-on for American Football helmets

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Most novel technologies are trending towards increasing helmet compliance external and/or internal to the helmet shell, and leveraging new energy-dissipative mechanisms in materials and structures. Cork, a natural, light-weight, compressible, and sustainable material, has recently emerged as an intriguing candidate for enhancing kinematic energy absorption in sports equipment. The presented study evaluates the performance of two proposed cork liners, one internal and one external, implemented in an American Football helmet. The modified helmets were tested in impact conditions consistent with the National Football League's helmet evaluation program. The initial findings show that, compared to the control helmet, the average reduction in HARM value for helmet with the cork inner layer was 12% for 5.5 m/s and 5% for 9.3 m/s, and 10% for 5.5 m/s and -6% for 9.3 m/s for the helmet with the cork outer layer. The results of this study demonstrate the potential for a natural and sustainable solution to improving football helmet safety.

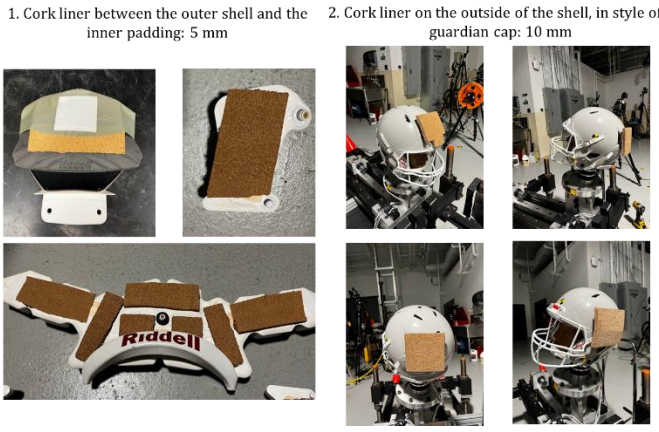

Figure 1: Modification summary

	Configuration	C		D		F		R	
		5.5 m/s	9.3 m/s	5.5 m/s	9.3 m/s	5.5 m/s	9.3 m/s	5.5 m/s	9.3 m/s
		Reduction factor [%]							
HARM	Inner Layer	7	2	-14	-13	12	15	85	26
DAMAGE		-11	-16	-17	-14	12	41	-6	-59
HIC		70	20	-11	5	-15	-6	397	65
HARM	Outer Layer	9	-10	12	-4	18	9	5	-13
DAMAGE		0	-10	9	0	0	15	0	-21
HIC		33	-13	-5	-1	11	3	10	-1

Figure 2: Summary of calculated parameters and reduction factor with an indication if the value is higher (red) or lower (green) than for the reference test

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Reconstruction of fatal blunt impact of construction prop to head utilizing Multibody modelling and uncertainty analysis

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Corresponding Author: Mariusz Ptak, mariusz.ptak@pwr.edu.pl

A fatal accident was reconstructed during which a falling construction prop impacted the victim's head. Based on the available evidence, a set of preliminary multi-body dynamics simulations was conducted using a CYBID V-SIM solver. This preliminary uncertainty-based analysis lead to determination of initial conditions for the consecutive detailed finite element analysis. For the finite element analysis, two accident scenarios were considered: with and without a safety helmet. A validated numerical helmet model was developed. While the helmet model absorbed significant energy (245% of the certification requirement), high deceleration and Head Injury Criterion values obtained from a numerical head model ultimately indicated fatal injury in both scenarios. This study provides a valuable contribution to the area of biomechanics and occupational safety and highlights the importance of following safety protocols and regulations at construction sites.

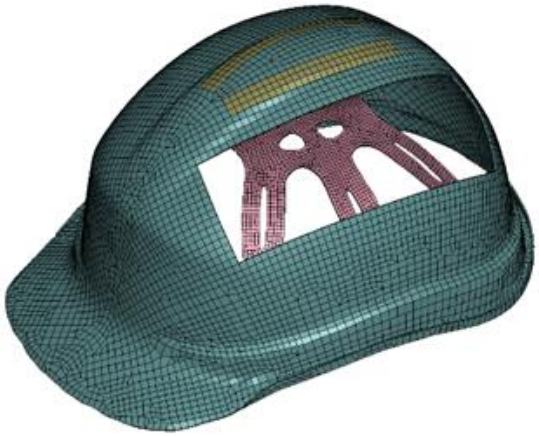

Figure 1: Numerical model of the safety helmet of the approach used for the accident analysis

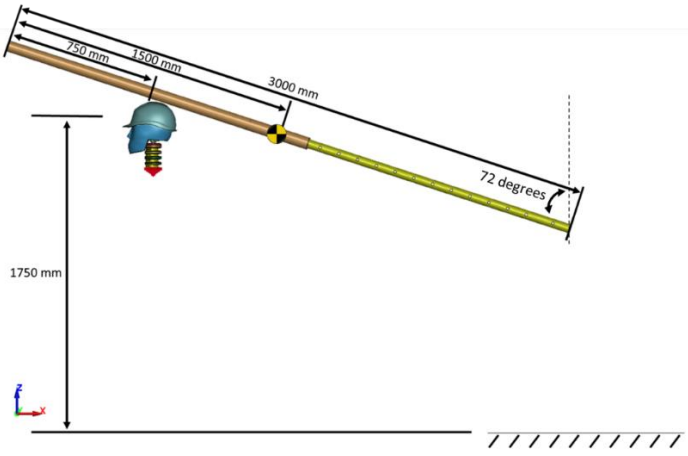

Figure 2: Example configuration of the finite element analysis

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Biomechanical Analysis of Female Head and Neck Injuries

Ricardo Alves de Sousa, Afonso Carvalho Silva, Joana Pinto and Marcos Gomes

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It has been 20 years since sex and gender differences were first seen in brain injury research. Yet, most women, their doctors, courts and other intervenients are still unaware. This project directly addresses United Nations' sustainable Development Goals (SDG) to promote gender equality in terms of studying the particularities of traumatic brain injury for female individuals, once the vast majority of literature either does not perform such distinction or just address male patients.
The BAFHTA project has been developing female specific head (Figure 1) and neck models (Figure 2) to accurately evaluate the sequelae of traumatic events to the head.

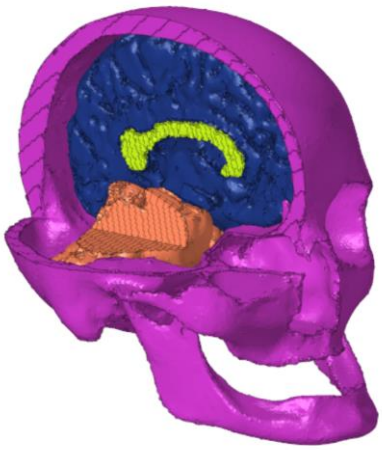

Figure 1: The Female Finite Element Head Model

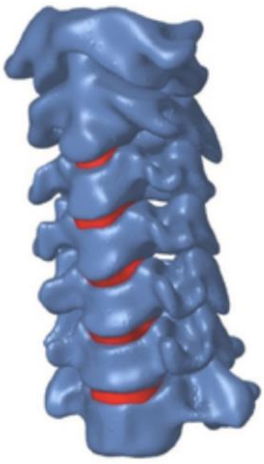

Figure 2: The Female Cervical Spine Model

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Stroke analysis for ballistic testing using pig's head as an example

Karina KRAWIEC[a], Dawid LARYSZ[b], Krzysztof JAMROZIAK[a], Celina PEZOWICZ[a], Dariusz PYKA[a]

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In the present study, the authors focused their attention on the examination of the amount of energy required to puncture the various layers of the helmet-head system to determine the critical parameters in terms of TBI (traumatic brain injury) [1,2]. For this purpose, a quasi-static puncture of the biological system in the form of a pig's head was carried out as the system most like the human head (Fig. 1). The amount of work required to puncture the brain, skin, muscles and skull within the frontal bone was analyzed (Fig. 2). Dynamic impact tests of the biological system in the form of a pig's head were carried out to assess the damage caused by being shot with a 9x19 mm FMJ[1)] projectile Parabellum and 7.62x54R mm FMJ projectile LPS. Next, energy absorption tests of finished 2 helmet liner systems were performed to verify the amount of energy as a function of strain rate change according to norm NIJ HG2[2)]. The determined strength parameters will be used for further work on the effects of blunt trauma on selected components of a soldier's head protected by a combat helmet.

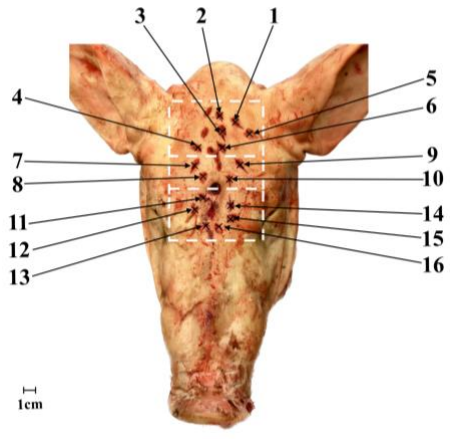

Figure 1: Places of piercing the pig's head (1-16 puncture spots).

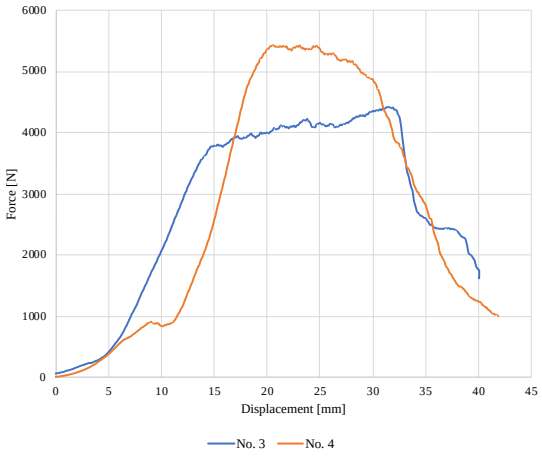

Figure 2: The penetrating force in the brain area.

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[1)] FMJ – Full Metal Jacket, [2)] NIJ – National Institute of Justice Standards, HG – handgun.

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Numerical investigation of ballistic trauma in human skin protected by Aramid/DCPD under impact load of .44 Magnum

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A body injury known as behind armor blunt trauma (BABT) is brought on by the armor's rear surface deforming when a bullet strikes it. The type of fibers used, the fabric's geometric design, and the properties of the ammunition used can all affect how severe an injury is when wearing textile body armor [1,2]. The article focuses on numerical study of injuries to the human body resulting from a non-penetrating .44 Magnum bullet impact at a speed of 436 m/s that is shielded by an aramid/DCPD composite ballistic shield. The materials used in the fabrics in the experimental study were the identical aramid CT 716 yarns and had similar surface weights [3]. By selecting some random spots on the skin within the zone of greatest pressure, the pressure applied to the skin during the bullet impact was measured. By comparing the measurement of the maximal displacement on the skin with the back face signature (BFS), the impact's severity was also estimated. It was observed the maximum pressure did not exceed 6 MPa after a maximum deflection of 4.5 mm.

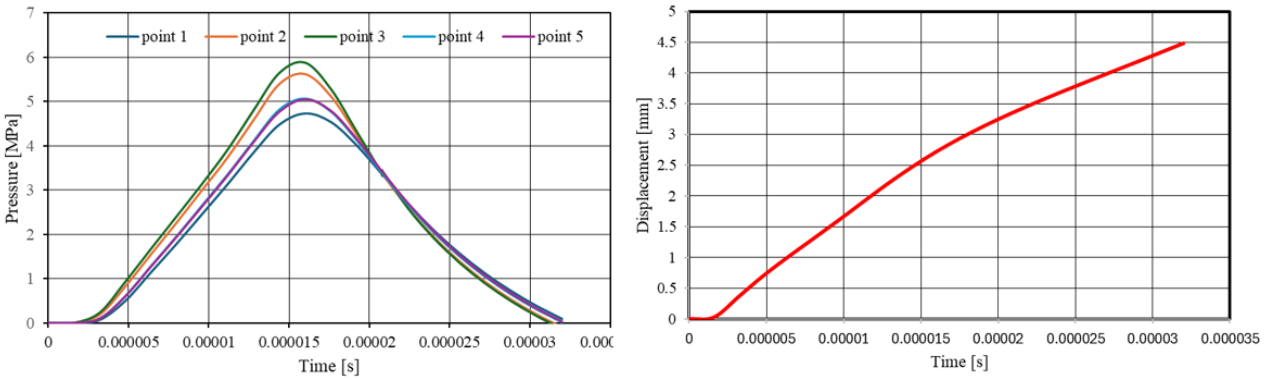

Figure 1: Maximum pressure plot and displacement on the skin after impact

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Application of data mining techniques for predicting post-stroke neurological deficits

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The study involved the analysis of data from 178 patients who experienced ischemic strokes and received treatment at the Department of Neurology in the University Clinical Hospital in Bialystok. Each patient's profile consisted of 31 characteristics, including, among others: baseline information, test outcomes, comorbidities, and administered treatments, as well as the NIHSS scale at admission and at discharge. Only patients with a first incident stroke, over the age of 60, who survived were included in the analysis.

The first stage of the research concentrated on choosing attributes and investigating their influence on accurately grouping patients into various neurological deficit categories. The next step of the study involved constructing models that included all attributes, as well as attributes extracted through feature selection. Then we employed classification techniques to determine if feature selection delivered the anticipated outcomes. For the classification process, we opted for methods that allowed easy development of decision rules: J48, JRip, PART, CART, and Random Tree. We utilized the ACC (overall accuracy) metric for evaluation. The final stages of the study involved formulating classification rules and extracting action rules.

Below are few selected action rules:

[heparin, 1] ∧ [ACEI-ARB, 1] ∧ [diabetes, 1] ∧ [total cholesterol, 0→1] ⟹ [NIHSS change, 1 → 4]
[heparin, 1] ∧ [ACEI-ARB, 1] ∧ [diabetes, 1] ∧ [total cholesterol, 0→2] ⟹ [NIHSS change, 1 → 0]
[LDL, 0] ∧ [CRP, 1] ∧ [glucose, 0→2] ⟹ [NIHSS change, 0 → 1]

algorithm/ model	Model 1 (31 attributes)	Model 2 (14 attributes)	Difference
J48 (C4.5)	57,30%	66,29%	8,99%
Jrip	61,80%	61,24%	-0,56%
PART	55,62%	57,30%	1,69%
CART	66,29%	65,73%	-0,56%
Random Tree	47,75%	50,00%	2,25%

Figure 1: Comparison of model accuracy

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Methodology for conducting vertebral displacement measurements of the spine

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Suspension therapy is a rehabilitation method that aims to relieve stress on joints, muscles and tissues. This method is widely used by physiotherapists, because thanks to various types of suspension, as it allows for the achievement of traction and mobilisation, which is of great importance for many disease entities. The paper discusses selected aspects of measuring the movement of a person's spine during suspension therapy. This therapy was implemented on a prototype device that automatically, under the supervision of a physiotherapist, enforces reciprocal movements of individual body segments. Due to the required high accuracy of the measurements, an optoelectronic marker system was used to analyse the movements. The system was suitably modified to allow the recording and analysis of spinal vertebral motion in the supine position. The results of the aforementioned work are the displacement characteristics of individual structures, from which the relationship between the motion of the forcing elements (actuators) and the vertebrae was determined.

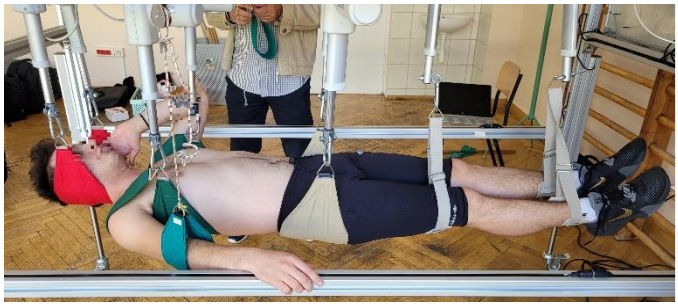

Figure 1: prototype device for suspension therapy

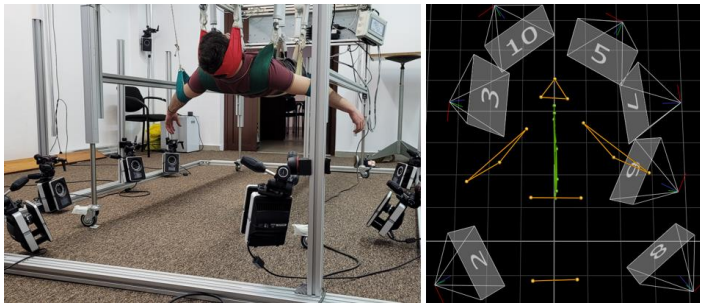

Figure 2: measurement station and virtual patient model used for spinal motion analysis

ADDITIONAL INFORMATION: This work was financed by The National Centre for Research and Development under research project Rzeczy są dla ludzi/0080/2020

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Data mining methods for medical recommender systems

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Medical recommendation systems play a key role in personalizing diagnosis and therapy by analyzing patient data and providing personalized medical recommendations. Using advanced machine learning algorithms, these systems are able to suggest best clinical practices and optimal therapeutic approaches, helping to improve the quality of healthcare and patient outcomes. Inflammatory bowel disease (IBD) is a term that refers to chronic and recurrent gastrointestinal conditions such as Crohn's disease (CD) and ulcerative colitis (UC). The constructed classification model was able to assign patients to the appropriate group with very high precision (AUC = 0.93). The constructed model was able to distinguish ulcerative colitis from Crohn's disease, demonstrating the potential of integrated analytical methods in improving diagnostic approaches to IBD. In addition, these results suggest the feasibility of using recommender systems in tailoring diagnosis and therapy for individual patients with inflammatory bowel disease.

Variable	Coefficient	p-value	OR
Current/past smoker	-4.449	0.000**	0.012
Blood in stool	2.671	0.000**	14.454
MCV $[fL]$	0.176	0.015*	1.913
PLT $[x10^3/\mu L]$	0.0002	0.019*	1.201
Neutrophils $[x10^3/\mu L]$	-0.041	0.041*	0.96
Monocytes $[x10^3/\mu L]$	0.048	0.031*	1.049
Eosinophils $[x10^3/\mu L]$	0.096	0.004*	1.101
Basophils $[x10^3/\mu L]$	0.750	0.002*	2.118
AlAT $[lU/L]$	0.029	0.001*	1.029
Creatinine $[mg/dL]$	-0.346	0.019*	0.708
Sodium $[mmol/L]$	0.149	0.000**	1.162
Potassium $[mmol/L]$	-2.448	0.017*	0.086

Table 1: Coefficients with the p-value and odds ratio (OR)

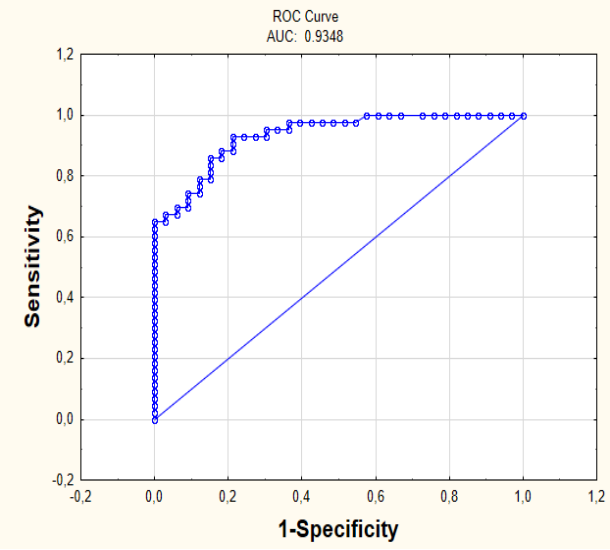

Figure 1: Roc Curve

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Flowable dental resin composites - physicochemical properties of materials

Sylwia ŁAGAN, Aneta LIBER-KNEĆ, Agnieszka CHOJNACKA-BROŻEK

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The flow dental resin composites (FDRC) are one of the modern dental materials. Due to their properties like low viscosity, FDRC are used in many areas of application, e.g. reparation of denture fractures [1], reinforcement composite bridges [2] or in two-layer structure system of anterior composite crown restorations [3]. In all of this applications, the FDRC must interact with other class of materials (e.g. polymers, ceramics, alloys and hard dental tissues), under oral and occlusal conditions. For this reason, it is crucial to evaluate the physicochemical properties of flowable dental materials. In the present study, the chemical composition, density and roughness of two FDRCs (everX Flow – bulk and dentin shade, GC Corporation, Japan and Flow-Art, Arkona, Poland) were evaluated. The chemical composition was analyzed by laser-induced emission spectroscopy (LIBS) using an elemental analyzer. Mechanical compression test with recording of load-unload curves was carried out on a strength machine.

	everX Flow	Flow-Art
Main monomers in matrix	Bis-MEPP, TEGDMA, UDMA	Bis-GMA, TEGDMA, UDMA
Fibers	E-glass fibers	-
Particulate fillers	Barium glass	Barium-aluminum-silicon glass, pyrogenic silica
Filler rate (w/w), %	70	61%
% of fibers (w/w)	25	Nd
% of particle fillers	Barium glass: 42-52 Silicon dioxide: trace	Nd
% of resin matrix (w/w)	Bis-MEPP: 15-25 TEGDMA: 1-10 UDMA:1-10	Nd
Average length of fibers, µm	140	-
Diameter of fibers, µm	6	-

Figure 1: Composition of materials [4,5]

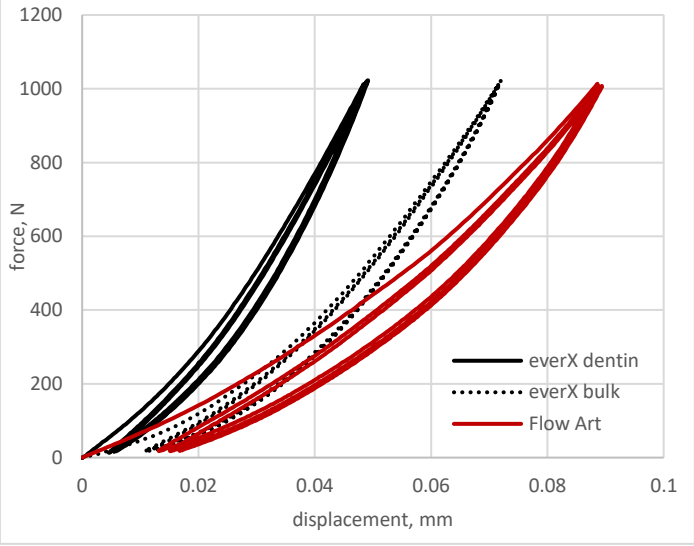

Figure 2: Load-unload loops

[1] BIJELIC-DONOVA J., et al., *Crack propagation and toughening mechanism of bilayered short-fiber reinforced resin composite structure – Evaluation up to six months storage in water*, Dent. Mater. J., 2022, 30, 41 (4), 580–588, DOI: 10.4012/dmj.2021-321.
[2] SZABÓ V.T., et al., *Fatigue resistance of dissected lower first molars restored with direct fiber-reinforced bridges – an in vitro pilot study*, Polymers, 2023, 15, 1343, DOI: 10.3390/ polym15061343.
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Comparison of virtual reality tracking system and marker-based optical motion capture system for squat assessment”

Czajkowska U., Żuk M., Mraciniak B., Pezowicz C., Popek M., Łopusiewicz M., Bulińska K.:

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Tracking systems for virtual reality (VR) technology are continually evolving to enhance immersion in virtual environments. Indirectly, it also provides opportunities for obtaining information about human movement. This study aims to compare joint kinematics of the right lower limb during squats. Data were recorded and analyzed using both a multi-camera motion tracking system (Vicon Motion Systems Ltd., Centennial, CO, USA) and an HTC Vive Trackers sensor-based system with a custom eMotion application. The repeatability of the results was assessed by calculating parameters such as Average Inter-trial Variability (AIT), Average Intra-protocol Variability (AIP), and Mean Absolute Value (MAV). The results can be a step towards developing advanced feedback systems for users of VR applications to support training and rehabilitation.

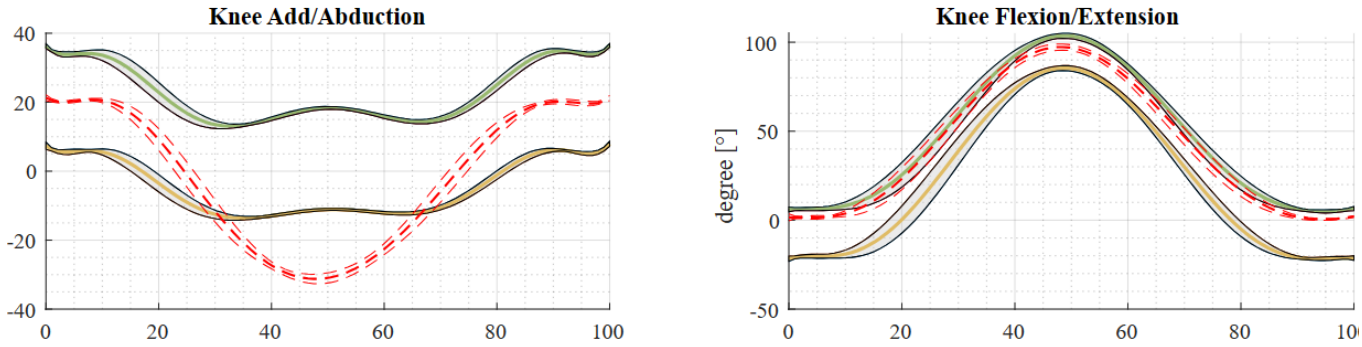

Figure 1: Example graphs of averaged squat performance for one person. Yellow: Simplified6DOF± SD protocol (HTC Vive Trackers), green: ISB6DOF± SD protocol (HTC Vive Trackers), red: Plag-in-Gait model ± SD (Vicon system).

ADDITIONAL INFORMATION: This work was supported by the The National Centre for Research and Development in Poland, in frames of the project: “eMotion-system for computer aided workout and rehabilitation using motion capture technology and virtual reality”, LIDER/37/0200/L-10/18/NCBR/2019.

List of Author’s Universities, Research Centers or Companies;

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Electronic Health Records (EHR) Management with the usage of Natural Language Processing (NLP)

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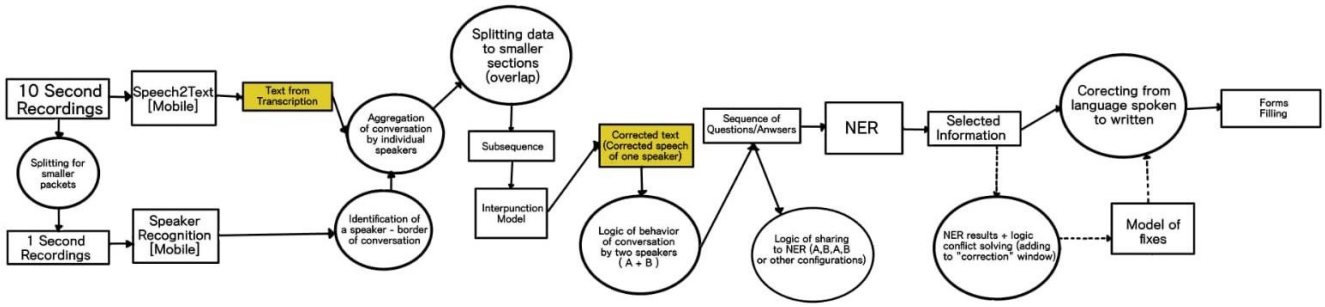
The created IT system uses engineering process support tools to improve the medical documentation management process using natural language. The developed NLP algorithms based on artificial intelligence (AI) and machine learning (ML) models and Text Mining text mining tools facilitate the process of obtaining information from a casual conversation between a patient and a doctor during a routine medical visit. Then, data is extracted from the obtained text (natural language) in terms of relevant information that will be used to create electronic medical records. The final area supported by the developed algorithms is the process of automatic matching of data to form fields, which are the basic element according to which medical documentation is created manually (keyboard entry) in HIS-class IT systems.



Architecture of processes and implemented AI models in the SKRYBA application,
enabling obtaining a reliable medical note based on a conversation between a doctor and a patient.

ADDITIONAL INFORMATION:
Regional Operational Program of the Silesian Voivodeship for 2014-2020 (ERDF),
UDA-RPSL.01.02.00-24-0123/21-00, SKRYBA - Intelligent Doctor Assistant.

Gabos Software Sp. z O.O. , 40-065 Katowice, Poland

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Assessment of the electrochemical properties of a surface-modified by EPD method shape memory alloy

Barbara RYNKUS, Karolina GOLDSZTAJN, Alicja KAZEK-KĘSIK, Anna TARATURA, Ada ORŁOWSKA, Janusz SZEWCZENKO, Zbigniew PASZENDA, Marcin BASIAGA

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Currently, implants used in the cardiovascular system are usually based on NiTi shape memory alloys. However, their use may be associated with certain disadvantages, which include allergic reactions or thromboembolic complications. For this reason, the use of NiTi alloys, requires appropriate surface modification to provide improved biocompatibility and minimize blood coagulation. Such modification may be the application of SiO_2 coating. Among the many methods available for applying coatings to the surface of biomaterials, electrophoretic deposition (EPD) can be highlighted, in which the properties of the resulting coating can be controlled by changing the process parameters.

The purpose of this research was to determine the electrochemical properties of NiTi alloy surface modified by SiO_2 coating by EPD method at different process parameters: particle concentration and voltage. Electrochemical tests were carried out by potentiodynamic method. Based on the obtained polarization curves, the corrosion potential and polarization resistance were determined. The results showed that the use of SiO2 coating contributes to improving the biocompatibility of NiTi alloy, and the different process conditions make it possible to obtain a coating with varying electrochemical properties.

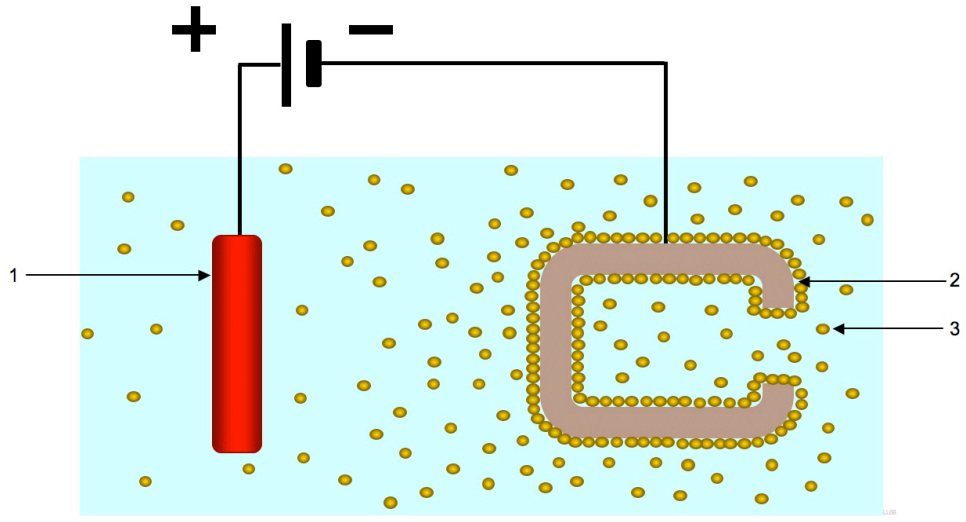

Figure 1: Electrophoretic deposition diagram (EPD); 1 - anode, 2 - cathode, 3 - charged SiO_2 particles

ADDITIONAL INFORMATION: This research was funded by the National Science Centre, Poland, allocated on the basis of the decision No. 2023/49/B/ST11/03301

Silesian University of Technology, Faculty of Biomedical Engineering, Department of Biomaterials and Medical Device Engineering;
Silesian University of Technology, Faculty of Chemistry, Department of Inorganic Chemistry, Analytical Chemistry and Electrochemistry;
Silesian University of Technology, Biotechnology Centre

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Comparison of mechanical properties of lattice structures fabricated from PLA and ABS by incremental technology for medical applications

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The purpose of the study was to investigate the mechanical properties of lattice structures fabricated using FDM technology with PLA and ABS materials. Six different lattice geometries were analyzed, namely gyroid, cross, X cell, Schwarz P cell, rings, and asterisk (Figure 1.). Uniaxial compression tests were conducted at a loading rate of 1 mm/min, followed by morphometric analysis using computed microtomography (example on Figure 2.). The findings revealed significant differences between the tested groups, with ABS samples demonstrating lower plasticity and strength compared to PLA samples. This research contributes to a better understanding of how material choice and lattice geometry impact the mechanical behavior of FDM-printed structures, offering insights for applications in various fields such as engineering and biomedical sciences.

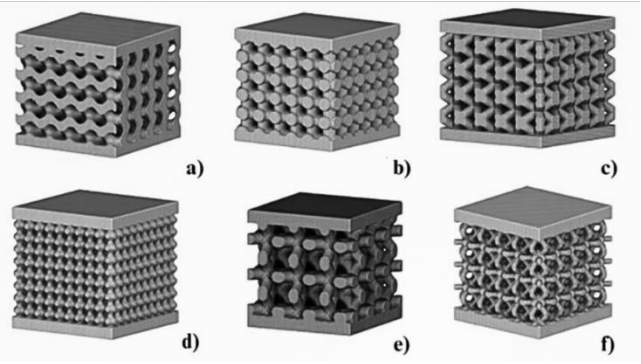

Figure 1: Sample geometry for the group of: a) gyroid b) cross c) X cell d) Schwarz_P cell e) rings f) asterisk

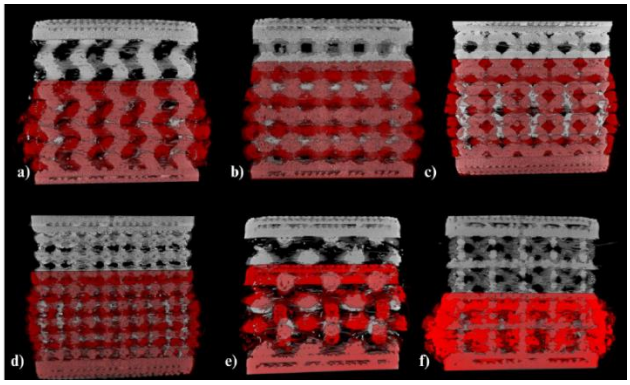

Figure 2: MicroCT images depicting sample heights before (white) and after (red) mechanical compression tests for the following geometries: (a) gyroid, (b) cross, (c) X cell, (d) Schwarz_P cell, (e) rings, and (f) asterisk.

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The contribution of vision to countermovement jump height

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The purpose of this study was to investigate the role of vision to the countermovement jump (CMJ) height. The research was conducted on 7 physically active male students. Each participant performed 12 CMJs wearing ski goggles in two visual conditions (6 with full vision and 6 with no vision, in random order). Participants were instructed to jump as high as possible. Two synchronized Kistler 9286A force plates with Noraxon MR3 software were used to measure ground reaction forces during CMJs. CMJ height was estimated based on the net impulse method. No significant differences were found between the height of CMJs with full vision condition (0.475 ± 0.055 m) and with no vision condition (0.479 ± 0.059 m). However, looking at the results of individual subjects, only two participants achieved greater CMJ heights in the full vision condition than in the no vision condition. The results of this preliminary study should be considered surprising and encouraging for further research into the performance of motor tasks in no vision conditions.

Figure 1: laboratory testing set-up (no vision conditions)

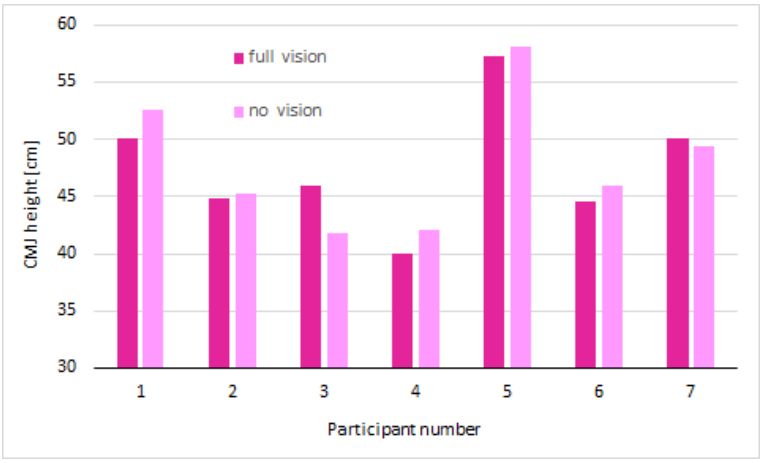

Figure 2: height of the countermovement jumps of each participant performed in two visual conditions (full vision and no vision)

ADDITIONAL INFORMATION: This research study was supported by the Minister of Science of the Republic of Poland under the "Regional Excellence Initiative" program.

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Pattern recognition from surface electromyography (sEMG)

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The aim of the study is to establish EMG patterns of muscle activations. The surface electromyography (sEMG) and acceleration (ACC) data were obtained through studies conducted on 30 healthy individuals. Eight sensors of the EMG DELSYS system were used in this study. Sensors had been attached to four superficial muscles on the right and left upper limbs. Each subject performed isometric exercises in three forearm positions in a sagittal plane, i.e. each forearm was positioned at approximately 90° at elbow joint, with an external load equaled 3 kilograms. Using postprocessed data, two classification methods were applied for pattern recognition from the sEMG data by using MATLAB: Tree (decision trees) and SVM (support vector machine). The first task involves distinguishing between relaxation state and isometric contraction state performed under the giving load (3 kg). On the base of training results we obtained that accuracy of each model is ranging between 97-100%. These satisfactory outcomes are used for further studies.

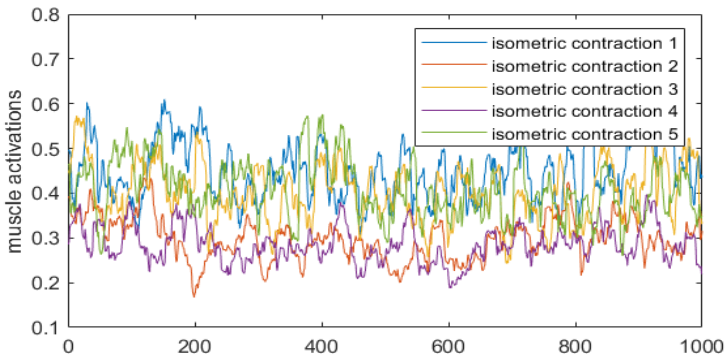

Figure 1: Isometric with external load (3 kg) - forearm supination position, with the forearm positioned at a specified angular position (~90 degrees). Chosen data from 5 trials

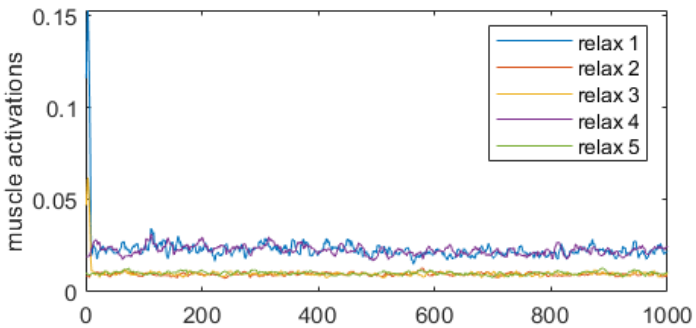

Figure 2: Relax. Chosen data from 5 trials

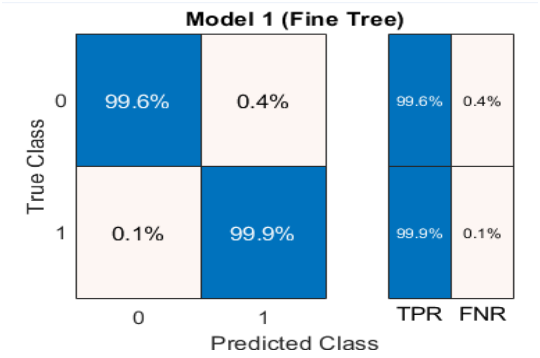

Figure 3: Training results of used classification method: **Tree.** Accuracy (Validation): **99,7%.**
0 – relax, 1 – isometric with external load (3 kg)

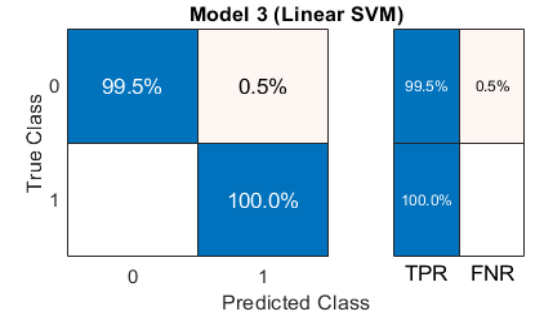

Figure 4: Training results of used classification method: **SVM**. Accuracy (Validation): **99,7%.**
0 – relax, 1 – isometric with external load (3 kg)

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USE OF THE UP AND GO TEST TO DIAGNOSE MULTIPLE SCLEROSIS

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Multiple sclerosis (MS) is a condition that can affect the brain and spinal cord, causing a wide range of potential symptoms, including problems with vision, arm or leg movement, sensation or balance. It is a disease that is lifelong. It can cause disability, although it can sometimes have a benign course. It is most commonly diagnosed in people between 20 and 40 years of age.

The Up and Go test can be used to check these parameters. It is a simple and quick test to assess movement commonly used by physical therapists. It allows for the evaluation of mobility and dynamic and static balance. The test consists of getting up from a chair, walking 3 metres, turning around, returning to the chair and turning around and returning to a sitting position.

The aim of this study was to determine the impact of multiple sclerosis on functional mobility using the Up&Go test according to gender.

The Up&Go test was conducted to determine the degree of neurological impairment. During the Up&Go test, each subject wore 3 Noraxon IMU sensors. These were located on the right and left foot and upper spine. These sensors allowed the calculation of the duration of the entire test and the times of the individual steps, as well as walk cadence, walk stride time, walk step count. The study involved 51 participants (34 women and 17 men) with a mean age of 37.75 years, all of whom were in stage I or II multiple sclerosis.

Table 1. Timing of the entire Up and Go test, individual test phases and temporal and spatial paramiters.

	Total time [s]	Stand Duration [s]	Walk Duration [s]	Turn 1 Duration [s]	Turn 2 Duration [s]	Sit Duration [s]	Walk Cadence [steps/min]	Walk Stride Time [s]	Walk Step Count [steps]
Norm	8.77±1.49	1.22±0.2	3.09±1.14	2±0.3	1.07±0.22	1.39±0.29	117.36±12.44	1.05±0.1	4.56±1.66
People with MS	8.94±2.09	0.96±0.26	3.84±1.75	1.75±0.49	1.07±0.35	1.17±0.39	129.01±18.43	0.94±0.14	6.14±2.4
MS – Man	9.31±2.79	1.06±0.34	3.48±2.17	1.89±0.58	1.18±0.45	1.3±0.46	120.36±16.52	1.01±0.15	6.15±2.51
MS - Woman	8.75±1.6	0.91±0.2	4.04±1.43	1.68±0.42	1.02±0.27	1.1±0.34	134.12±17.56	0.9±0.11	6.14±2.34

Based on the duration of the up and go test, it can be concluded that the disease has a more severe course in men. An increase in the walk step count value and a decrease in the walk stride time value may indicate that an imbalance is occurring.

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Influence of lifestyle on physical fitness of high-school students - generation Z

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As part of the project, a survey was carried out to assess awareness of healthy lifestyles and physical activity levels among high school students. Questions in the questionnaire included: daily hours of sleep, water intake, number of steps taken and recommended weekly physical activity. A total of 72 people completed the questionnaires.

Stability is the ability to maintain a desired body position without the assistance of another person and to return to a state of equilibrium once lost. In the case of human posture, it is the ability to restore the correct position of the body in space, which may have been lost due to external forces or due to body movement. The consequence of the loss of this ability is the occurrence of falls. One method of assessing a person's ability to maintain body balance is static posturography tests, which are performed while standing still on a dynamometer platform. The platform used in the present study was the Zebris platform. Forty-two subjects were tested. The subject stood with eyes open during the first trial and texted while standing on the platform during the second trial.

Table 1. Average parameter values obtained from the stabilography test.

Test conditions	Path length [mm]	Left Forefoot [%]	Right Forefoot [%]	Left Backfoot [%]	Right Backfoot [%]	Total load on right lower limb [%]	Total load on left lower limb [%]
Eyes open	195.84±87.17	33.98±9.09	33.46±9.96	66.02±9.09	66.53±9.96	49.78±4.24	50.22±4.25
Eyes open + SMS writing	211.48±73.46	33.40±8.69	33.28±9.88	66.60±8.69	66.72±9.88	48.33±4.23	51.66±4.23

The Up & Go test is a simple and quick test to assess movement, mobility and dynamic and static balance. The test involves getting up from a chair, walking 3 metres, turning around, returning to the chair, turning around and returning to a sitting position. The study used 3 sensors included in the Noraxon MyoMotion suit, which were located on the right and left foot and the C7 vertebra. Thirty subjects were studied.

Table 2. Timing of the Up and Go test, individual test phases.

	Total time [s]	Stand up time [s]	Walking time 1 [s]	Turn 1 time [s]	Walking time 2 [s]	Turn 2 time [s]	Sit-down time [s]
Whole group	10.26±1.48	1.38±0.49	2.32±0.48	2.15±0.32	1.60±0.62	1.30±0.3	1.50±0.38

The research carried out led to the following conclusions:

- 93% of the students surveyed have a physical activity factor of medium or high.
- Texting causes deterioration in postural stability.
- The time obtained by the high school students during the Up and Go test was within normal limits at 10.26 seconds.

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The effect of rhythmic auditory stimulation on changes in gait parameters

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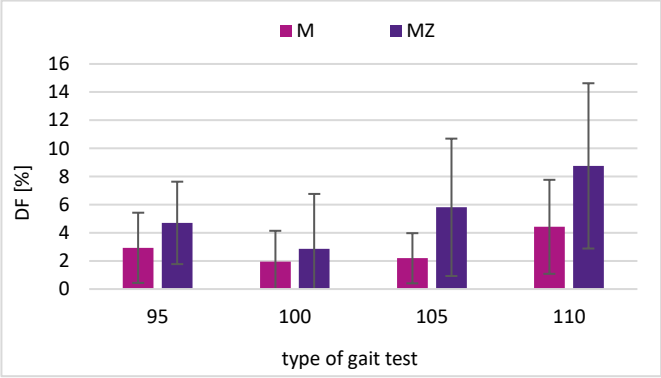
The aim of the study was to evaluate the effect of metrorhythmic stimulation in the form of a metronome and music with variable tempo on gait modification. Seventeen healthy subjects were tested. For the study, 3 IMU (Movella) sensors are placed on the body of each subject: 1) the pelvis, 2) the right shank, 3) the left shank. A Xiaomi Mi 8 Lite smartphone was used for the study. The smartphone had an application version ras-mobile-0500 installed, which was developed as part of the Ras4NoW project. A metronome and a midi file of an accompaniment (piano) were selected as metrorhythmic beats. The following types of measurements were carried out as part of the present tests:

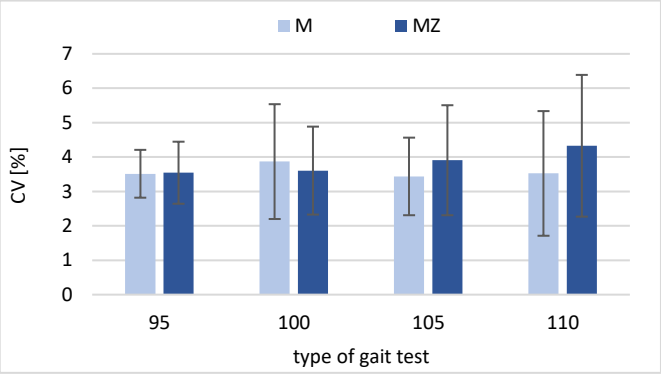
PT - gait test without metrorhythmic stimulation to determine the subject's natural walking speed,

PM.../PMZ... - gait tests with stimulation in the form of a metronome / in the form of music:

a) PM100/PMZ100 - at a tempo corresponding to the natural gait frequency,)
b) PM95/PMZ95 - at a tempo corresponding to 95% of the natural gait frequency,
c) PM105/PMZ105 - at a tempo corresponding to 105% of natural gait frequency,
d) PM110/PMZ110 - at a tempo corresponding to 110% of natural gait frequency.

The percentage difference between the set metrorhythmic step frequency and the detected step frequency (DF [%]) was analysed. For each measurement with metronome and music, the coefficient of variation of the detected frequency (CV [%]) in successive gait cycles was also calculated.





The application of metrorhythmic beats at a reduced rate and at an increased rate leads to a change in the step frequency. The metronome was found to provide a better match between stepping frequency and metrorhythmic beat rate

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