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Assessment of body injury of a fencer protected by dedicated clothing with the use of a sword

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1. Introduction

Fencing is one of the sports in which injuries are very rare. Occurring injuries relate primarily to technical problems of the player's equipment and its dynamics of operation due to the contact nature of this discipline [1]. Injuries resulting from puncture wounds occur sporadically and their effects tend to end up injuring the competitor. This reason is caused by such circumstances as: non-compliance with the safety conditions or the use of worn-out equipment (without technical examination) [2]. Fatal injuries of a competitor are a combination of certain conditions resulting primarily from the technical quality of the equipment. This study presents a case of fatal injury. The aim of the study was to estimate the probability of a fencer being pierced by a swordsman's protective suit and causing a stab wound in the groin area of the left forearm along the brachial artery.

2. Studies and results

In order to estimate the probability of puncturing the swordsman's clothing and leading to the breakage of an element of the sword blade, an appropriate test stand was developed, where dynamic piercing of the fabric fixed with a membrane and on the backing animal tissues was carried out. As a result of these tests, several results were obtained to assess the strength of the jacket material and the force to break the blade tip. The results are presented in Figure 1.

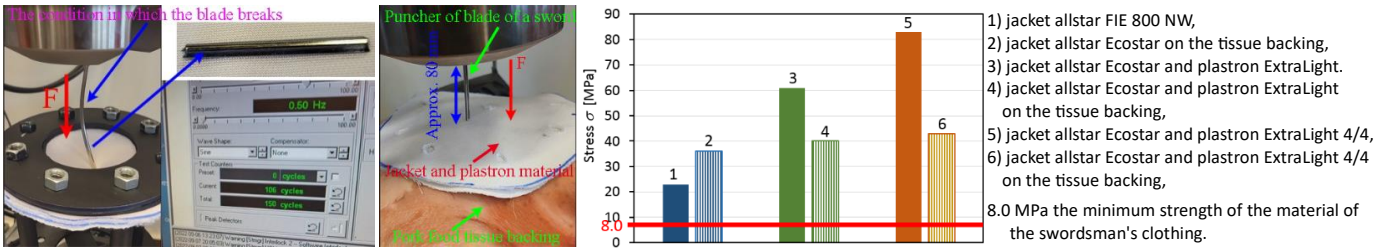

Fig. 1. Exemplary tests of estimating the puncture of a fencer's uniform: (from the left, a piercing stand without and with a pork food tissue backing, the strength values of the jacket material are summarized)

3. Reference

1. Swatowska M., Akbaş A., Juras G. Injuries in high-performance fencers -a review. *Archives of Budo* 16: 261-269, 2020.
2. Bryant W.M.D., Turner W., Clinton H. A prospective cohort study of collegiate fencing injuries. *Current Sports Medicine Reports* 18(10):361-366, 2019. Doi:10.1249/JSR.0000000000000637.

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Selected aspects of using mechatronic sensors for muscle fatigue analysis

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Muscle fatigue analysis has been the subject of many studies using electromyographic signals and analysis methods such as Fast Fourier Transform (FFT), Short-Time Fourier Transform (STFT), and Wavelet Transform (WT). Wavelet transforms have been effective in studying dynamic movements. However, there are no studies that have analyzed muscle fatigue in the context of rowing ergometer exercise using Discrete Wavelet Transform (DWT). In this research a method for determining muscle fatigue in the lower extremity was proposed during dynamic cyclic movement on a rowing ergometer using DWT, Mean Frequency (MNF) and Median Frequency (MDF) was proposed. Fig. 1 shows the muscles analyzed during movement.

The proposed methodology utilizing DWT has proven to be an interesting tool for assessing muscle fatigue during physical exertion.

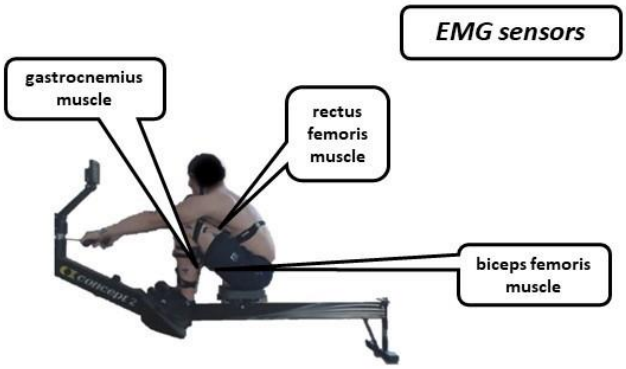

Fig. 1. Placement of EMG electrodes on the muscles: rectus femoris, biceps femoris and gastrocnemius.

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"Wheelstair" – the design of an innovative wheelchair add-on

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Wheelstair® is an innovative add-on to the wheelchairs that allows to traverse stairs and take longer walks without any assistance.

The device features are as follows: **independence** (*no need for assistance to get in/out of the house, office, or a shop ect.*), **safety** (*negotiate stairs safely and with ease*), **simplicity** (*easy to use and operate*), **mobility** (*allows you to move in any places*), **agility** (*suitable for narrow spaces*), **versatility** (*allows you to reach hard-to-reach places*), **universality** (*fits most of wheelchair models*), **convenience** (*detachable when not needed)* and **design** (*color customization*).

The end result of years of work are fully functional prototypes that meet the expectations of the users reported during meetings and workshops, taking into account the variety of types and models of wheelchairs available on the market.

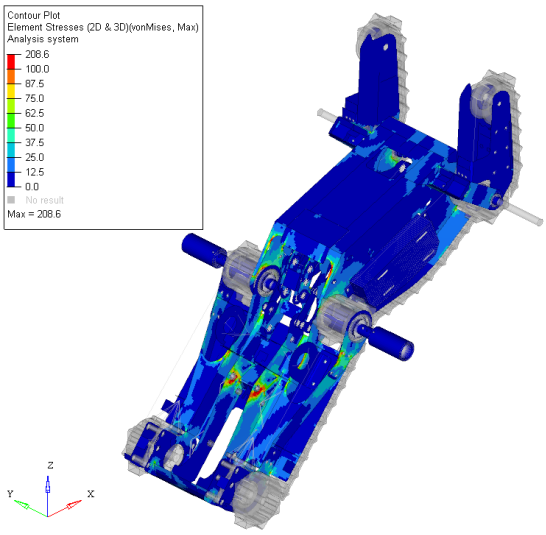

Figure 1: Example of structural strength calculation result

Figure 2: "Wheelstair" an innovative wheelchair add-on

The project was partially funded by the National Centre for Research and Development, Poland under Grant No. POIR.01.01.01-00-0913/18-00.

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Barbell velocity in different snatch variations

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The analysis of the available literature allowed us to confirm the validity of the verification of strength training loads based on the velocity of movement. In the literature, data can be found on speed changes in exercises with a simple movement structure, such as the squat, bench press, or hip thrust. Athletes from different sports often use different variants of Olympic lifts in their programs, so the aim of the research was to assess the velocity of the barbell during various variants of snatching with changing external load. The research material consisted of 56 attempts in 4 variants of snatching the barbell by two athletes professionally training in weightlifting, who were medalists of the National Championships. The attempts were recorded using the Vicon system (Figure 1) with the Plug-in-Gait-Lower-Limb model and were subject to a detailed analysis in the context of the average and maximum speed of the barbell during the second phase of the pull. Four variants of the barbell snatch were analyzed: hang power snatch, power snatch, hang snatch and snatch. The smallest decrease in velocity with increasing load occurred during the hang snatch. (Figure 2). This position is more suitable for non-professional weightlifters as it is less demanding in terms of movement technique, mobility, and, as confirmed by our analysis, in terms of maximum velocity values

Figure 1. View of the weightlifters during the tests

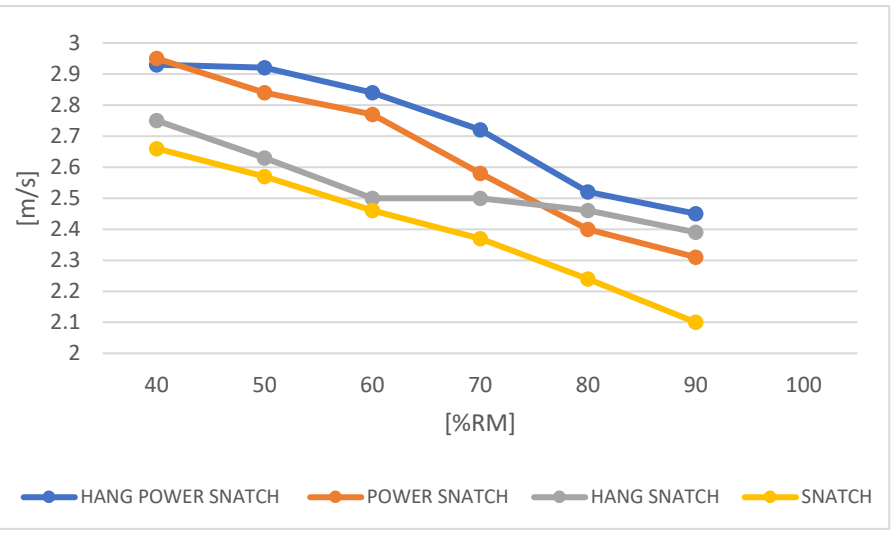

Figure 2. Maximum velocity of barbell in different snatch variations

Scientific work was financed by the University of Józef Piłsudski Academy of Physical Education in Warsaw - MZB No. 5

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Concept of topology optimization of surgical implant used in ventral hernia repair.

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The study refers to topology optimization of surgical implants used in the treatment of ventral hernia. It is preliminary research that aims to create an optimized mesh implant compatible with human abdominal wall. As a study example, a square membrane finite element (FE) model (10x10cm) is considered with 3 fixed supports in three corners and load of 10 N applied to the fourth one (Figure 1). The objective of the optimization is the most uniform distribution of reaction forces values with the changing thickness of the elements simulating changing thickness of the implant. The optimal distribution of the reactions would help to avoid a pick of junction force and thus the tissue-implant connection break. Initial thickness is 0.2 cm and changes in elements for each run of program. In house code created in Python communicates with Marc Hexagon FEM software and changes each element individually until obtaining the best results of reactions in model supports. The model with resultant thickness of the elements is presented in Figure 2.

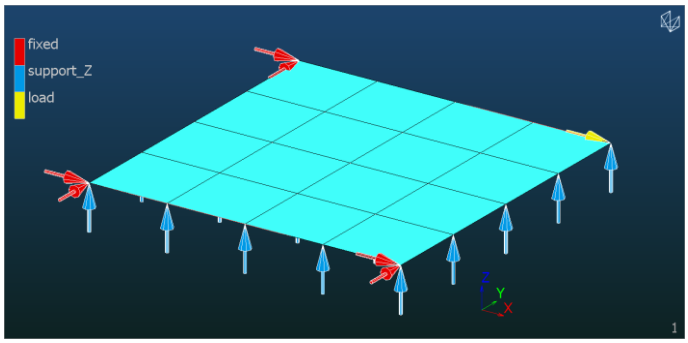

Figure 1 Model boundary conditions and load

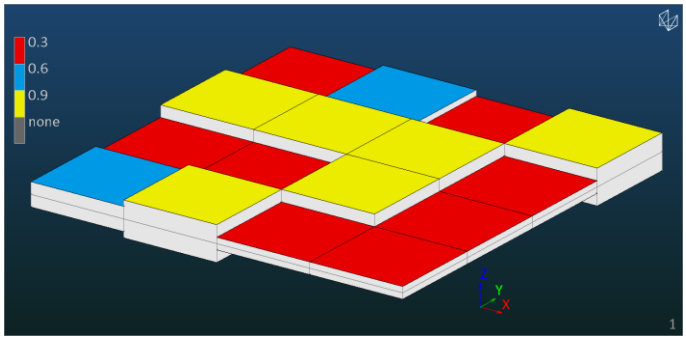

Figure 2 Geometry of the membrane model with optimal thickness of each element

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

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Motion analysis of a single somersault 'wildcat' in snowboarding along with modeling the conditions of multiple rotations

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Snowboarding is a relatively young sport. High level of snowboarding proficiency shows more than sliding down the slope and includes doing tricks after having jumped up in the air. Stages of work have been conducted, which allowed to describe the kinematic phase of flight, the assessment of this motion, design and produce a model regarding progressive and circular motions factors of the snowboarder – snowboarding set layout, determine the edge conditions for a double flip's realisation and validate the model. As a result we got an application which can be used by coaches in the practice planning process, and also while searching for ways to develop snowboarder's skills in safe conditions.

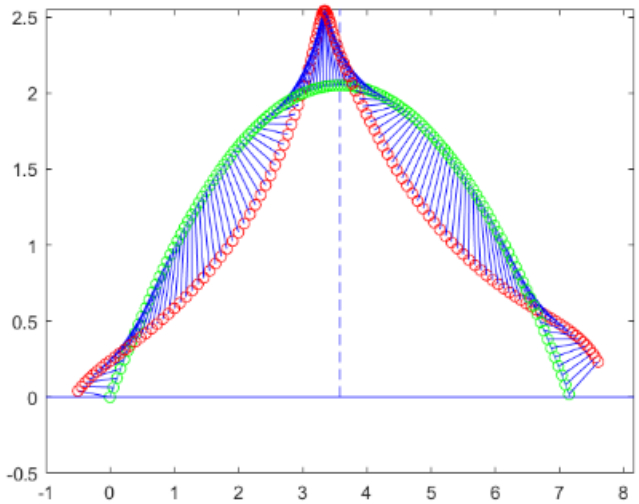

Figure 1: animation of the model showing one of the variants of performing a double somersault; the green circles are the center of mass, the red circles are the center of the athlete's shoulder girdle, and the blue segment represents the body axis of the snowboarder.

Figure 2: link to the video material in the form of a QR code showing the modeling of double somersault in the created application (variant from Figure 1).

ADDITIONAL INFORMATION: element of research project no. 0014/RS4/2016/54

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Engineering support for the implementation and documentation of patient care in hospital conditions

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The created IT system uses engineering process support tools to improve the communication of medical staff and to complete tasks reported by the patients (related to their needs) as quickly as possible. The developed algorithms for optimizing care processes uses standards, e.g. ICNP and NLP algorithm solutions that facilitate the automation of creating medical documentation at the place of care. For the implementation of the system, information about the location, personnel resources of the staff, and their workload were used, which allows the optimization of staff work, which translates into an increase in the quality of services provided and allows optimization of their costs. The algorithm optimizing the care process aggregates staff tasks related to patient care generated directly from HIS systems, from individual care plans created and patient-reported needs.

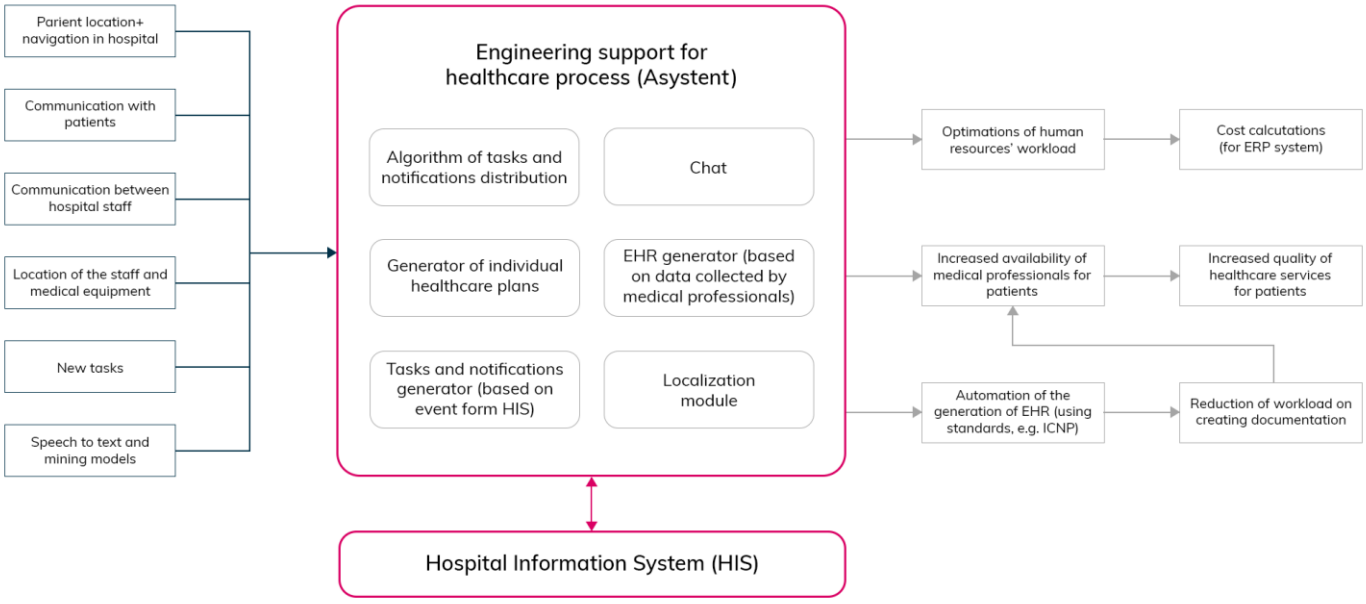

Figure 1: Elements of the engineering support system for care processes in the Asystent Gabos system

ADDITIONAL INFORMATION: Regional Operational Program of the Silesian Voivodeship for 2014-2020 (ERDF), WND-RPSL.01.02.00-24-0389/19-005, MOSCATI - personalized medical communicator optimizing the processes of nursing and caring for patients in hospital conditions.

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Low-cost motion tracking systems in the kinematics analysis of VR game

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Motion tracking has numerous applications in virtual reality, including gaming, training, rehabilitation, sports, education is essential in creating avatars in VR. When assessing the performance of physical exercises of VR users using motion tracking, a proper analysis of the kinematics of individual joints provides the basis for broader conclusions. The objective of this study is to compare the range of motion measurements of the ankle joint obtained through two low-budget motion tracking systems, namely the Kinovea video system and the Vive Trackers sensor-based system using the eMotion measurement app. The results obtained by performing a motor task barefoot and in sports shoes were compared. The Vive Trackers with the eMotion measurement app have the potential to be widely used in biomechanical applications. In the future, a larger study incorporating more complex movement sequences should be conducted.

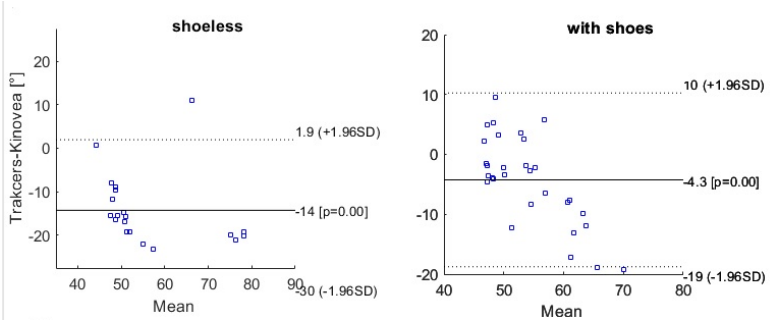

Figure 1: the Bland-Altman plots for the results obtained from the analysis of video recordings and data collected by Vive trackers for measurements taken barefoot and in sports footwear.

Acknowledgements: 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.

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Założenia do budowy modelu numerycznego kończyny górnej człowieka

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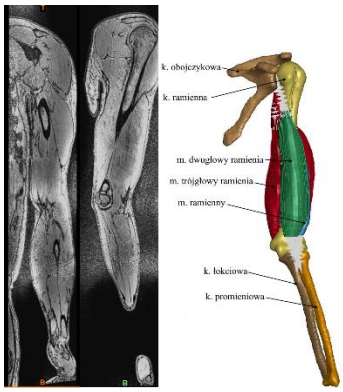
Celem publikacji jest zaprezentowanie procesu rozwijania modelu numerycznego spersonalizowanego układu mięśniowo – kostnego kończyny górnej człowieka z wykorzystaniem metody elementów skończonych. Na opisywany numerycznie układ składają się trzy mięśnie i układ czterech kości. Wymiary geometryczne pozyskano na podstawie obrazów uzyskanych z rezonansu magnetycznego kończyny górnej. Model numeryczny kończyny charakteryzuje się zaimplementowaniem różnego typu elementów skończonych wraz z odpowiednio zaimplementowanymi modelami konstytutywnymi. Szczególny wysiłek został tutaj położony do odwzorowania części pasywnej i aktywnej mięśni. Wartości parametrów opisujących aktywną część mięśnia wyznaczono na podstawie badań eksperymentalnych i analiz teoretycznych. Brakujące parametry (definiujące pasywną tkankę mięśniową) zaczerpnięto z literatury ze względu na brak możliwości przeprowadzenia pomiarów *in vivo*. Opracowany model odwzorowuje w drodze symulacji komputerowych ruch zgięcia i wyprostu realizowany w stawie łokciowym. Aktualnie model podlega weryfikacji i poddany jest studium wrażliwości pod kątem procedur kontaktowych oraz uwzględnienia powięzi mięśniowych.

MOTYWACJA

Rys. 1. Pomiary z wykorzystaniem elektromiografii EMG i dynamometru izokinetycznego Biodex – badania własne

OBIEKT BADAŃ



Rys. 2. Przekształcenie obrazów DICOM z rezonansu magnetycznego na model geometryczny kończyny górnej

ANALIZY NUMERYCZNE

Rys. 3. Model dyskretny kończyny górnej

Praca została sfinansowana/dofinansowana przez Wojskową Akademię Techniczną w ramach projektu nr UGB 22-840.

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Video analysis of motion reactions in infants during optical flow

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Introduction:

Optical flow is a topic discussed in many fields such as neuropsychology, automation and robotics. We can understand optical flow as the perception of movement of visual objects.

Methods and materials:

Ten videos of infants' motor reactions were analyzed and subjected to two trials: P1 when the image moved (stimulus: optical flow); P2 no visual stimulus. The NORAXON program was used to analyze the videos, where an analysis of the range of motion in the shoulder joints of infants was performed.

Aim:

To compare the angular changes in the shoulder joints after between the two trials in which the infants participated.

Results:

There were no significant differences in changes in limb ranges of motion between trials, but significantly more upper limb movements were shown during the visual stimulus trial.

Figure 1: Analysis of ranges of motion in the shoulder joint - example

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Using motion analysis for evaluation of the correctness of the mapping of a dance sequence

Anna NIEDZIAŁEK, Kamil SYBILSKI, Michał Stankiewicz

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The aim of this study was to evaluate the accuracy of dance sequence representation using motion capture. The study analysed the movement of people performing West Coast Swing dance routines. Dancers of varying levels of proficiency took part in the study: beginners, intermediate and advanced dancers. Five dance figures were selected based on the initial measurements taken and then divided into three dance sequences according to level of difficulty.

Prior to the study, four main comparative parameters were determined: ankle joint angle, knee joint angle, trunk tilt and elbow joint flexion. The choice of parameters was consulted with the trainer. A marker system from VICON was used to analyse movement. Markers were placed on the participants' body and tracked for each sequence. Based on the measurements taken, the results were compiled into graphs and the correctness of the execution of each sequence was assessed.

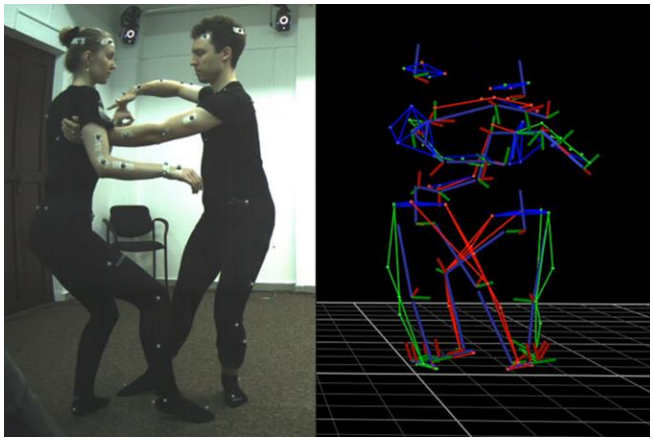

Figure 1: Arranging markers on the body of the dancers, representation of the characteristic figure.

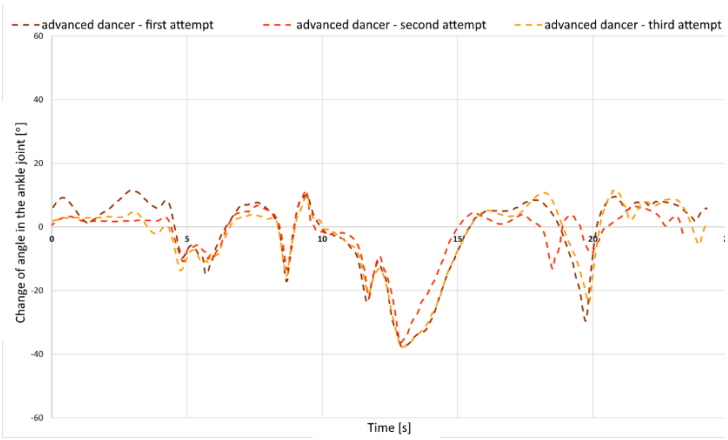

Figure 2: Change of angle in the ankle joint.

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Problems of measuring spinal movement during suspension therapy

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Marker-based motion analysis systems rely on manufacturer-defined standards that ensure, among others, precise measurements, ease of operation and calibration. Changing the configuration and going beyond standard applications always involves certain limitations and need to deal with various types of problems. This study discusses issues related to adapting the Vicon motion analysis system to the unique requirements of measuring the displacement of a patient's vertebrae during suspension therapy. The paper presents the characteristics of the standard system configuration, its limitations in terms of planned measurements, and the final solutions that allow the measurements to be carried out correctly. Technical issues related to the arrangement of cameras and shaping their field of view, the use of non-standard markers and addressing the issue of objects reflecting light in the cameras' field of view are also discussed. Additionally, the paper addresses issues related to smoothly adjusting the size of the camera mounting frame and camera calibration in a common, fixed coordinate system.

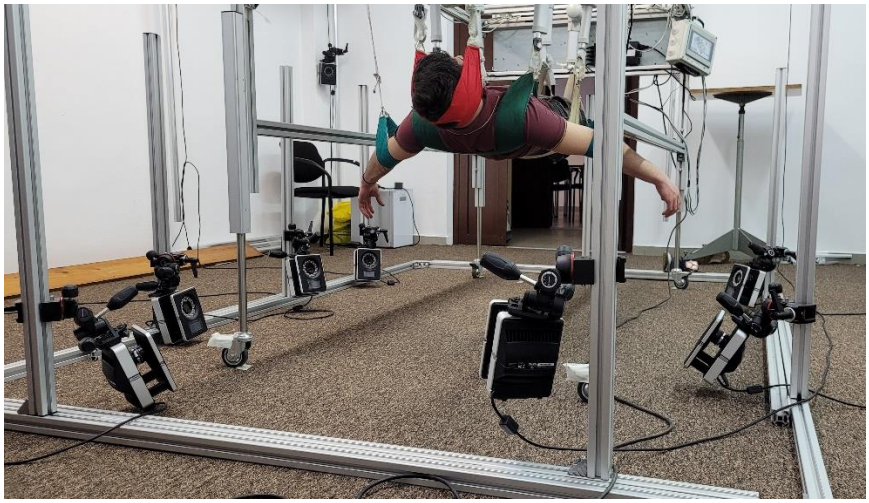

Figure 1: System configuration

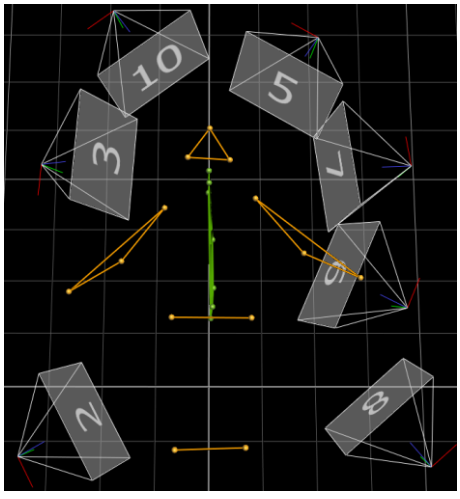

Figure 2: View from the Nexus software

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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Numerical modeling of mechanical wave propagation using the elastograph measuring head attachment in non-invasive assessment of the liver condition

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Modern diagnostic medical devices supporting the process of condition and assessment of human organs are characterized by a high level of reliability and are widely used. One of such devices is the FibroScan® elastograph used to assess the percutaneous condition of the liver, i.e. its steatosis and fibrosis. The idea is to extend the functionality of this diagnostic device for the assessment and verification of the harvested liver organ in real conditions. For this purpose, it is required to develop appropriate attachments for the scanning head of the apparatus, imitating the layer of tissues located between the surface of the human skin and the liver. The cap designed in this way, on the one hand, will protect the surface of the examined liver against mechanical damage caused by the excitation of a mechanical wave, and on the other hand, the measurement values will correspond to the general measurement methodology. The aim of the work is to develop reliable numerical models that allow mapping the properties of mechano-acoustic physical models of these tissues. Identification of mechanical wave propagation in the liver organ center and scaling these models based on liver phantoms. The Ogden material model was proposed in the research. In the further stages of the work, this model was subjected to a comprehensive iteration in the frequency range of 1.0-5.0 MHz and the stiffness of the liver organ of 1.5-12.5 kPa and its steatosis below 300 dB/m. On the basis of the developed numerical models of cap (Fig. 1a) for the scanning head of the elastograph, numerical analyzes were carried out for three types of material intended to represent the mechano-acoustic parameters of tissues imitating the skin layer and tissues surrounding the liver. Sample results are presented in Figure 1. A good agreement was obtained between the results of numerical simulations and the results of liver phantom tests.

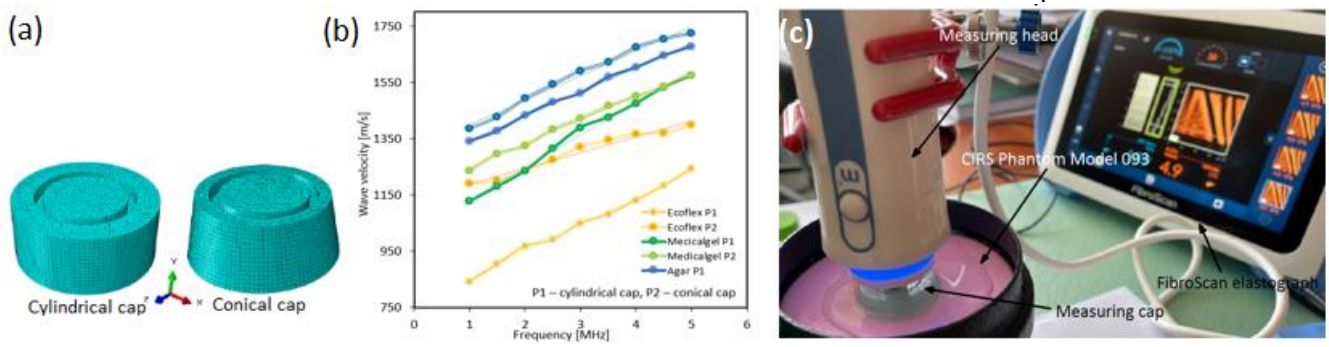

Fig. 1. Sample tests and results: (a) numerical models of caps, (b) sample results from numerical analyses, (c) measurement stand

The work was carried out as part of the project POIR.01.01. 01-00-0462/21, co-financed by the European Regional Development Fund under the Smart Growth Operational Program 2014-2020.

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Diagnosis of muscle tremor in Parkinson's disease – pilot study

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Tremor is an impairing symptom of Parkinson's diseases, which affects the activities of daily living and reduces the quality of life in over 75% of patients. Currently, tremor diagnosis is primarily based on clinical assessment, which is associated with overall misclassification, therefore there is a strong need for new technological objective diagnostic method for a better characterization of tremors.

Therefore, the aim of this study was to create a new objective method of tremor assessment.

We assessed 10 participants with Parkinson's disease (age: 69.3±12.0 y/o, height: 168.3±7.1 cm, weight: 69.0±7.5 kg). According to the clinical assessment with UPDRS-III all subjects presented tremor in upper limbs. Tremor was assessed by innovative custom-made inertial measurements unit (IMU) with micro-module sensor structure attached to the both upper limbs, which allows to increase the precision of tremor assessment. We assessed rest, kinetic, and postural tremor during the different conditions.

Results of our pilot study confirmed that all subjects had tremor of upper limbs. Even though clinically Parkinson's disease tremor is present at rest, we recorded other types of tremor. The frequency of postural tremor was 3-7 Hz, rest tremor was 4-9 Hz, and kinetic tremor was 2-9 Hz.

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Classification and decision rules as a tool to support medicine

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Data mining is the process of discovering information in datasets, that is, detecting patterns, relationships, or dependencies that can later help make certain decisions. Increasingly, data mining is being used in medicine. This work shows the use of data mining techniques in predicting the occurrence of a secondary stroke episode.

The study sample is nearly 400 patients affected by ischemic strokes and described using 40 attributes. The first step of the research was feature selection. There were 4 models built: one containing all features and 3 containing features extracted using feature selection (2 – variables indicated in the literature, 3 – chi-square test, 4 – PCA). Then classification was applied to see if the features selection gave the expected results (Figure 1). There was also an extraction of decision rules that showed associations between patient characteristics and the incidence of secondary stroke episode.

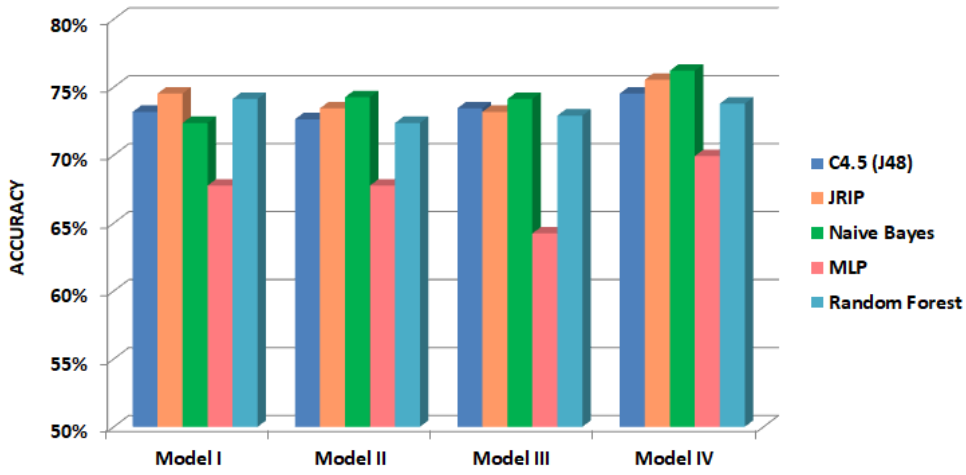

Figure 1: Comparison of correctly classified instances in each model

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The COP time-series regularity and the level of attention devoted to posture

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Our aim was to study how using a light fingertip touch during postural tasks changes sway regularity (Sample entropy) and level of attention devoted to posture. During quiet standing we introduced conditions of both sensory deprivation (closing the eyes), which leads to redirecting attention to postural control, and to introduce additional feedback (light touch), which distracts from postural control and verify it by introducing dual task paradigm (i.e. measuring simple reaction time to an unpredictable auditory stimulus).
Results suggest that using a light fingertip touch decrease postural sway and increase COP irregularity, thus possibly increase the level of automaticity. Sample entropy is more sensitive for changes of flow of attention resources during controlling different postures than simple reaction time task.

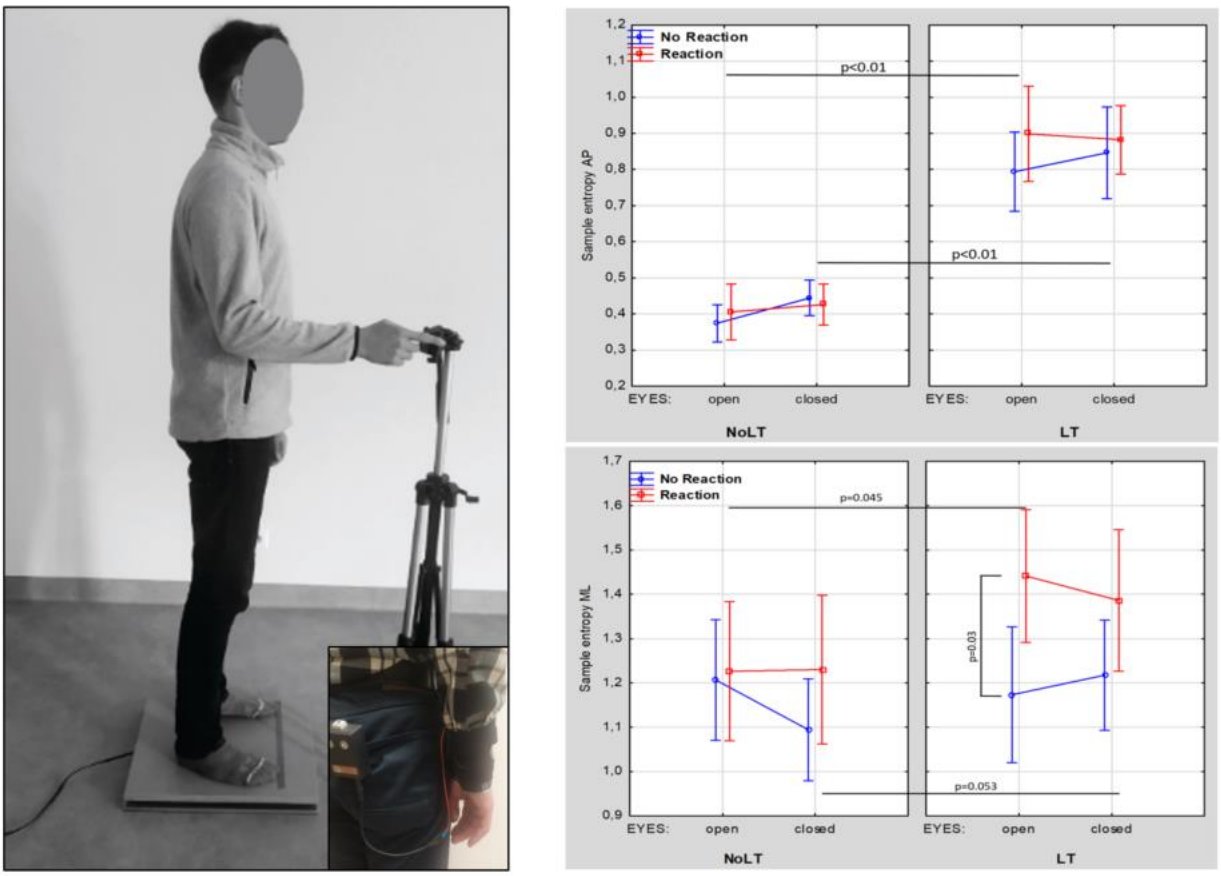

Figure 1 Measurement setup and results of COP time series sample entropy in ap/ml direction

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Development of an exoskeleton made with the use of additive manufacturing technology for the elbow joint

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Short description of researches or project assumptions should be included The paper presents the design and prototype of the exoskeleton supporting extension and flexion of the upper limb within the elbow joint. An actuator was selected for the developed design form (Fig. 1), shape optimization and strength calculations were performed. After obtaining the correct results, a prototype (Fig. 2)was made, which was subjected to tests confirming the correct operation of the system.

Figure 1: exoskeleton model

Figure 2: prototype testing

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Possibilities of using biomechanical research to assess the correct body posture while playing string instruments

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Playing string instruments is associated with long-term adoption of an uncomfortable, forced and asymmetrical body posture. Repetitive arm movements associated with, among others, holding the instrument may adversely affect the body posture of musicians as well as cause diseases and injuries of the musculoskeletal system. One of the elements of music education is the assessment of the correct body posture when playing instruments. However, it should be borne in mind that such an assessment is very subjective and largely depends on the knowledge and competence of teachers. Taking into account the results of scientific research indicating a high percentage of musicians suffering from injuries and illnesses during their careers, there is a need to develop research methods that would allow for an objective, quantitative assessment of the musculoskeletal system and the correct body posture of musicians while playing. As part of the work, research was carried out to assess the possibility of using measurements of loads acting on the feet while playing the violin to assess the functioning of the musculoskeletal system.

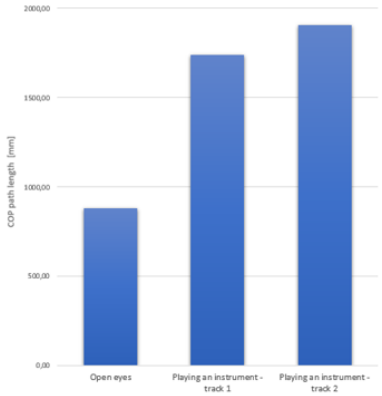

Figure 1: Average path length values for the examined items.

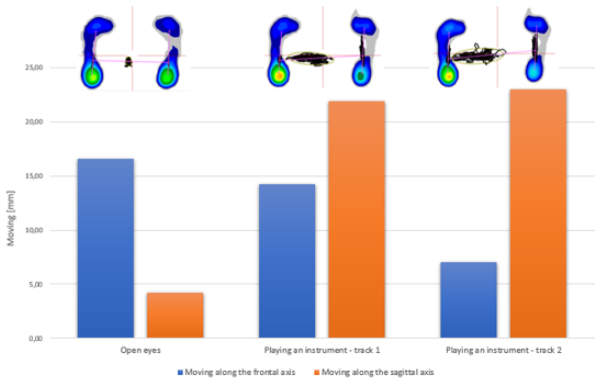

Figure 2: Average moving center of mass values for the tested positions.

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Analysis of VR influence on limits of stability

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Numerous studies have been conducted in the area of human balance and equilibrium research, aimed at enhancing these abilities, restoring them after illnesses or accidents, and training individuals to prevent falls. Virtual reality (VR) technology is increasingly being used for rehabilitation or training purposes. The purpose of this investigation was to determine if introducing oscillating scenery through VR could influence a person's limits of stability. Sixteen healthy adults participated in the study, completing ten trials each. During each trial, participants were instructed to lean forward and backward as far as possible in response to an auditory cue, without lifting their heels or toes. Two trials were conducted without the use of VR, while four involved oscillating scenery, one used stationary scenery, one displayed darkness, and two reference trials that did not require VR technology or leaning were conducted. The study's results demonstrated no significant statistical distinctions in the maximum angles achieved during VR and non-VR trials.

Figure 1: Scenery used during measurements

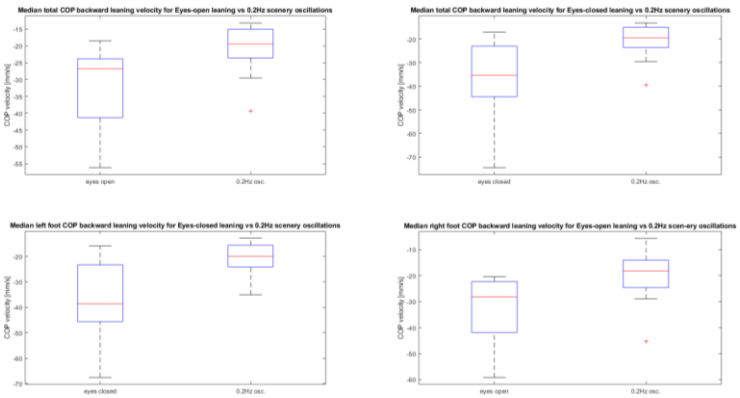

Figure 2: Results obtained during our work

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The reliability evaluation of the Landmine punch throw test

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Background: Landmine punch throw is a commonly used exercise that develops strength and speed of movement. The Force velocity profiling measurement method allows to adjust the parameters of this exercise to the needs of the athlete, and for more accurate, more individualized control of the training process. The information provided by the landmine punch throw test allows us to assess the athlete current ability to generate power. As a measurement method used in diagnostics and sports training, it has not been validated so far, therefore the purpose of this study is to assess the measurement reliability of the landmine punch throw test.

Methods: Fifteen male, healthy, physically active subjects, aged 18-30 (24.13±2.82) years, volunteered in this study. The measurements were performed using Theia motion analysis system (Theia Markerless, Inc.; Kingston Ontario, Canada) equipped with 8 video cameras. Each subject performed two repetitions of the Landmine punch throw test, successively with a load of 20 kg, 25 kg, 30 kg, and 35 kg. The mean velocity (m/s) and peak velocity (m/s) during the concentric phase of each repetition were analyzed. Reliability between repetitions was calculated for each load separately.

Results:

Table 1. The reliability of Landmine punch throw test

	Load (kg)	ICC	Mean ± SD	CV	SEM
mean velocity (m/s)	20	0,83	1,47 ±0,31	20,99	0,08
	25	0,85	1,16±0,25	22,08	0,06
	30	0,87	0,98±0,18	19,20	0,04
	35	0,74	0,82±0,12	14,87	0,03
peak velocity (m/s)					
	20	0,93	2,55±0,58	22,89	0,15
	25	0,90	2,09±0,52	24,86	0,13
	30	0,93	1,71±0,38	22,22	0,09
	35	0,82	1,41±0,26	18,57	0,06

Conclusions: The observed high reliability of the Landmine punch throw test allows to consider it as a reliable tool for assessing the power of the upper limbs.

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Rejestracja zmian wartości sił podparcia ciała w trakcie terapii w podwieszeniu

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Podczas projektowania urządzeń rehabilitacyjnych bardzo ważna jest znajomość wielkości sił eksploatacyjnych oddziaływujących na konstrukcję oraz pacjenta w trakcie normalnego trybu pracy. Szczególnie trudno jest wyznaczyć obciążenia w urządzeniach wykonujących złożone sekwencje ruchu. Stąd celem badań opisanych w niniejszej pracy było sprawdzenie ww. sił podczas terapii w podwieszeniu. Badanie zostało przeprowadzone przy użyciu system Noraxon Ultium i kompatybilnych z nim czujników siły, przedstawionych na ilustracji 1. Pomiary przeprowadzono w trakcie sekwencji terapeutycznych na zautomatyzowanym urządzeniu, przedstawionym na ilustracji 2. Czujniki mierzyły siły działające na podwieszkach po obu stronach głowy, klatki piersiowej oraz miednicy. Uzyskane wyniki zestawiono w postaci wykresów obrazujących zmianę przenoszenia obciążenia w trakcie terapii pomiędzy poszczególnymi podwieszkami. W dalszej części prac zostaną wykorzystane do modyfikacji konstrukcji urządzenia.

Ilustracja 1: Czujniki siły

Ilustracja 2: Urządzenie do terapii w podwieszeniu

Praca została sfinansowana/dofinansowana przez Wojskową Akademię Techniczną w ramach projektu nr UGB 22-840

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The influence of infill density on mechanical properties of 3D printed PLA

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Fused deposition method (FDM) used in polylactide (PLA) processing gives possibility to obtain personalized devices, especially in medicine. The research aimed to influence the infill density on mechanical properties of PLA. Two types of PLA were used: standard (PLA) and impact (iPLA). Specimens were made by FDM with the infill density 15, 25 and 35% and gyroid infill pattern. Tensile test was carried out to estimate ultimate tensile strength (UTS), strain (ε_{UTS}), Young's modulus (E) and Poisson's ratio (v). DIC method was use for displacement measurements. Comparison of mechanical properties of two types of PLA, showed that standard PLA has higher values of UTS and E than iPLA. The infill density influenced mechanical properties to a small extent for both types of PLA. For iPLA the increase of UTS value was observed for infill density of 25 and 35% compared to 15%. Higher value of infill density for PLA did not result in better strength. Similar effect was observed for values of E and ε_{UTS}. The only change was observed for increasing infill density from 15 to 25% for iPLA.

Parameter	iPLA			PLA		
	Infill density [%]					
	15	25	35	15	25	35
F_{max} [N]	997.9 (35.6)	1130.7 (63.8)	1138.7 (27.9)	1434.7 (18.4)	1406.7 (15.7)	1375.1 (26.9)
UTS [MPa]	24.9 (0.9)	28.3 (1.6)	28.5 (0.7)	35.9 (0.5)	35.2 (0.4)	34.4 (0,4)
ε_{UTS} [-]	1.15 (0.07)	1.25 (0.01)	1.25 (0.02)	1.23 (0.02)	1.25 (0.02)	1.23 (0.03)
E [MPa]	2342 (124)	2634 (142)	2626 (33)	3235 (20)	3230 (90)	3246 (51)
v [-]	0.30 (0.03)	0.27 (0.04)	0.27 (0.04)	0.33 (0.03)	0.36 (0.03)	0.37 (0.04)

Figure 1: Mechanical properties of iPLA and PLA obtained from tensile test and digital image correlation (mean value and standard deviation)

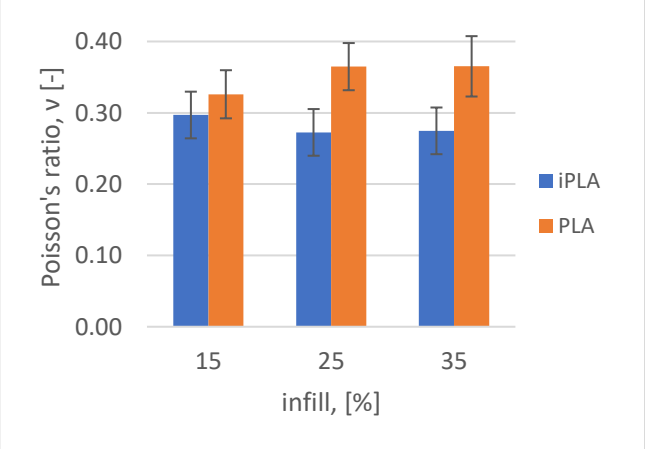

Figure 2: Poisson's ratio for tested specimens

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Numerical analysis of the posterior dynamic stabilization system of the lumbar spine

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The main aim of study was the development of the construction of the posterior system of dynamic stabilization of the lumbar spine, based on existing constructions. The research was carried out on four proposed constructions of posterior dynamic stabilization systems of the spine, which were attached into the motion segment of the spine at the L1-L2 level (Figure 1). Verification of the proposed stabilization structures was carried out on numerical simulations using the finite element method, which took into account the manner of transferring loads through the posterior column of the spine and the occurrence of degenerative changes of the intervertebral disc.

The obtained results of numerical analyzes for all considered constructions were compared with each other depending on the adopted method of load transfer. Based on the stress distribution in the constructions and the surrounding structures, as well as the obtained values of displacements and strains of the system, the effectiveness of the designed concepts was assessed.

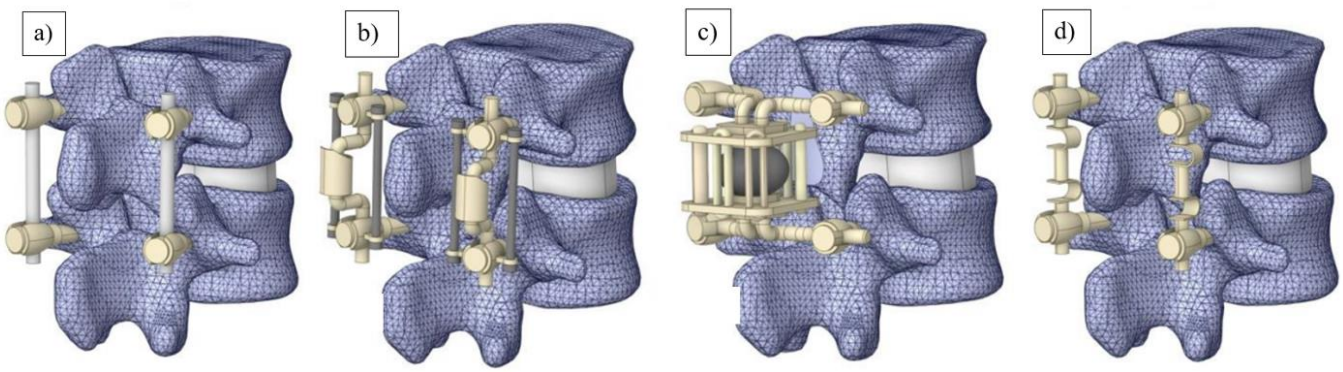

Figure 1: Geometric models including the assembly of the L1-L2 motion segment, taking into account geometrical simplifications: a) reference concept, b) concept no. 1, c) concept no. 2, d) concept no. 3

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Data mining in medical applications

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Inflammatory bowel disease (IBD) is a term that refers to chronic and recurrent diseases of the gastrointestinal tract. It includes Crohn's disease (CD) and ulcerative colitis (UC). Therefore, additional information obtained during the analysis can certainly provide a potential way to differentiate UC and CD. This paper proposes a way of combining two approaches to data analysis (statistical analysis and exploration algorithms) by using statistical methods to search for significantly important knowledge, which is then directly applied to exploration methods. Our study included 152 patients with CD or UC. The data collected included not only biochemical blood parameters, but also very subjective information such as interview data. The built-in classification model was able to assign patients to the appropriate group with very high precision (sensitivity = 0.84, specificity =0.74, AUC = 0.93). The constructed model was able to distinguish ulcerative colitis from Crohn's 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)

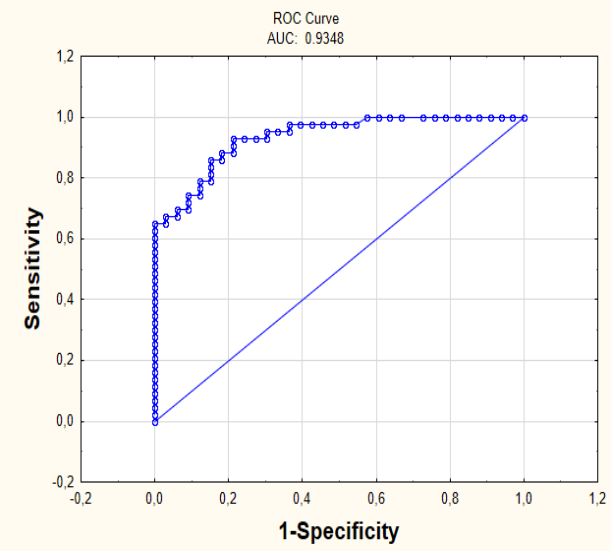

Figure 1: Roc Curve

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Isokinetic testing on the Biodex System 4 in evaluation of young football players

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The isokinetic testing of muscle strength is an objective and repeatable method for evaluating the performance of individual muscle groups and the risk of injury. In children, this method is not very popular, and there are few publications regarding the established normative data for the youngest athletes.

In prospective study, 27 young football players were evaluated. In all subjects knee muscle testing was performed on the Biodex System 4 Pro isokinetic dynamometer at velocities of 60°/s, 120°/s and 180°/s. We followed average peak torque (PT), peak torque to body weight (PT/BW), classic H/Q ratio and their correlation with age, height, body weight and BMI index .

In young football players, there were differences between dominant lower limb and the non-dominant lower limb. The classic H/Q ratio differs from the norm established for adults and, according to many authors, indicates a muscle imbalance. There is a correlation between BMI index and PT/BW of the extensors of the non-dominant leg.

Velocity	Non-dominant	Dominant
180°/s	**47,60%** ± 9.45 (28,57 - 67,26)	47,27% ± 10,39 (23,63 - 72,00)
120°/s	48,29% ± 7,15 (34,10 - 68,80)	**49,11%** ± 8,95 (30,81 - 74,29)
60°/s	47,06% ± 8,48 (34,75 - 69,81)	**48,73%** ± 10,67 (26,53 - 86,70)

Figure 1. Classic H/Q Ratio at 60°/s, 120°/s and 180°/s.

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Physical validation method of CFD simulation results for blood vessel flow with bifurcation

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Understanding blood flow through bifurcated blood vessels plays a key role in optimizing medical interventions for cardiovascular diseases. Fighting against these diseases is currently one of the primary goals of medicine and related sciences. Computational Fluid Dynamics (CFD) has emerged as a powerful tool for simulating and analyzing blood flow dynamics in complex vascular networks. However, to ensure the accuracy and reliability of these simulations, validation becomes crucial. As part of the research, a method for physically confirming the quality of simulation results regarding the shear stress values acting on the inner wall of the blood vessel model has been developed and tested.

The aim of this work was to develop a simple and cost-effective method for testing simulation results obtained using CFD in the real world.

Wall Shear Stress (WSS) was simulated using ANSYS software, employing the Bird-Carreau model for blood as a non-Newtonian fluid (flow velocity: ~1.4 m/s, bifurcated blood vessel following the Murray's law). The result is presented in Figure 1. To conduct a physical simulation, a blood vessel model was constructed using transparent epoxy resin. The inner walls of the model were then coated with a thin (~0.4 mm) layer of water-soluble plastic mass (PVA). The entire model was subsequently connected to a device generating water flow at a velocity corresponding to the simulation.

The results of the physical simulation are consistent with the CFD computer simulation of WSS values. This can be observed in Figure 2, where PVA was washed away first in areas where the computer simulation predicted the highest WSS values (yellow area).

The described method can serve as an effective means of validating the results of computer simulations of blood flow in blood vessels.

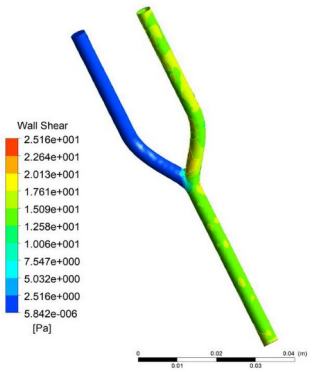

Figure 1: Results of simulation

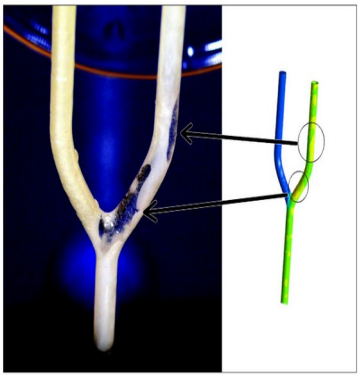

Figure 2: Comparison of the results from the physical simulation (left) and the CFD simulation (right)

Silesian University of Technology, Faculty of Biomedical Engineering, Department of Biomechatronic
Silesian University of Technology, Faculty of Mechanical Engineering, Department of Computational

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INFLUENCE OF SIMULATED VISION DEFECT ON REACTION TIME

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The purpose of the study was to determine the effect of simulated visual impairment on reaction time. Twenty-five people took part in the study. The average age of the group was 27.6 years. All subjects described their level of sleep as very good and reported that they were not visibly tired.

The study used a reaction time meter from alpha-electronics and vision simulation glasses from the company: Wolfgang Moll.

Before the test was conducted, each participant was introduced to the principle of operation and instructed to press the button located in the center of the table as quickly as they could as soon as they saw a light sign or heard a sound. Before the test, the subjects took a short test consisting of 10 stimuli.

The tests were conducted without glasses and with glasses simulating a visual defect: cataract, diabetic retinopathy, retinitis pigmentosa. The studies took place in random order. Each study consisted of 30 stimuli (sound as well as light).

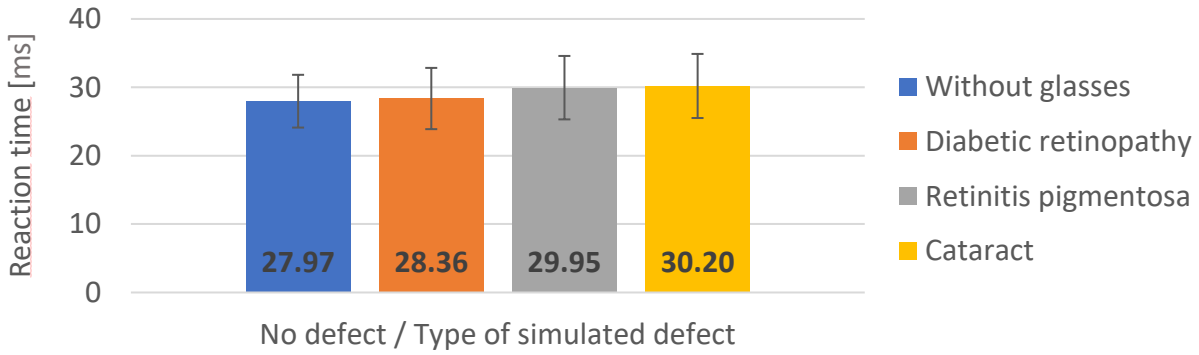

Figure 1: Reaction time without and with glasses simulating visual impairment.

It was shown that reaction times during simulated visual illness were not significantly different from natural conditions. In contrast, a slight difference may have occurred due to artifact. The cataract disease simulator results in a blurred image with a slight tinting which could mean that the light stimuli were not as clear, thus increasing the reaction time.

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LONGITUNDINAL ANALYSIS OF PHYSICAL ACTIVITY

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Physical activity has many health benefits. It helps maintain both physical and mental fitness. In the literature, 5,000 steps/day is used as a threshold to demarcate between a sedentary lifestyle and a lifestyle characterized by low levels of activity. In contrast, the recommended daily number of steps is 8,000 - 10,000 steps/day, depending on age, gender and health status. The purpose of the study was to determine the level of physical activity in Polish society.

Physical activity was measured in a group of 60 subjects over a period of 23 months. The subjects were tasked with daily monitoring of the number of steps, distance traveled, and the number of calories burned using activity monitors, i.e. smartband or smartwach. All data were regularly collected in a single database created for the project. The continuous activity measurement was verified by measuring heart rate, which was taken automatically every 30 minutes. The project also included surveys on lifestyle, physical activity and expressing opinions on regular physical activity monitoring.

The highest average number of steps was observed in the months of June-July, i.e. during the summer months, when the weather is favorable for walking and engaging in physical activity. The least activity was recorded in the months of January-February, where the average number of steps did not exceed the value of 6,000 steps/day. During the analyzed period only in the case of 5 months the average number of steps exceeded the recommended value of 8,000, which indicates a low level of activity of the analyzed group. The survey indicates that the use of activity monitors had a motivational effect on increasing physical activity.

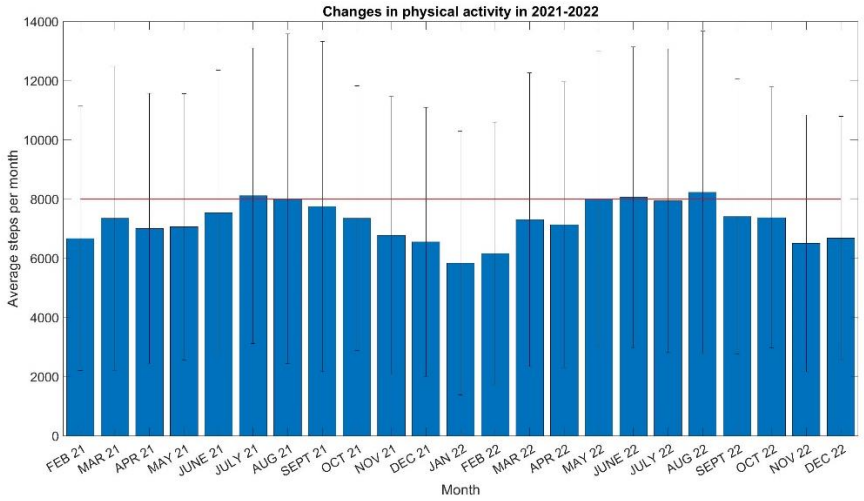

Figure 1: Changes in physical activity in 2021-2022.

This research was funded by the National Science Center Poland, project: "Mathematical model of prediction of health consequences in musculoskeletal system as a result of sedentary lifestyle", grant number: 2019/35/O/ST8/02719.

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Properties of a biodegradable PLGA coating containing dexamethasone applied by ultrasonic spray coating on a Ti6Al7Nb alloy substrate

Karolina GOLDSZTAJN, Julia LISOŃ-KUBICA, Joanna JAWORSKA, Katarzyna JELONEK, Marcin BASIAGA, Marcin KACZMAREK, Janusz SZEWCZENKO

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Among the biomaterials used in orthopedics, the most commonly used are titanium alloys, such as Ti6Al4V and Ti6Al7Nb. However, their use requires modification of the surface to improve biocompatibility. One of such methods is the application of biodegradable polymer coatings, which, apart from limiting the release of alloying element ions from the implant surface, can also be a matrix for the release of mineral and active substances that can support the process of bone union. However, due to the friction forces occurring in the implant-bone system, the applied coating must have appropriate mechanical properties. The paper attempts to assess the mechanical properties of a biodegradable PLGA coating containing hydroxyapatite and dexamethasone, deposited by ultrasonic spray coating on a Ti6Al7Nb alloy substrate. The scope of the research included microscopic observations, surface topography tests, adhesion of the coating to the substrate by scratch-test method and Pin-On-Disc abrasion tests.

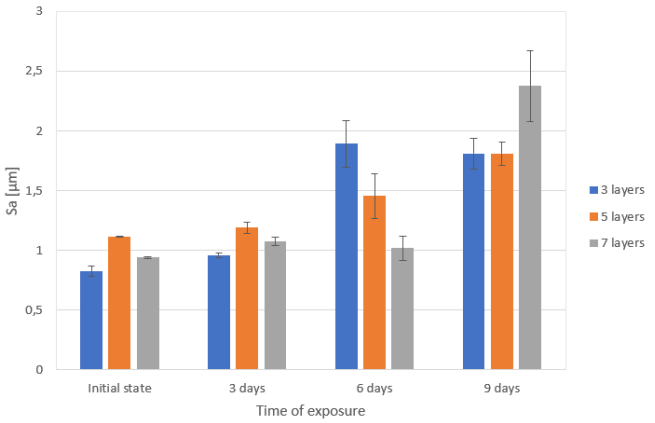

Figure 1: The mean values of the Sa parameter of the coatings

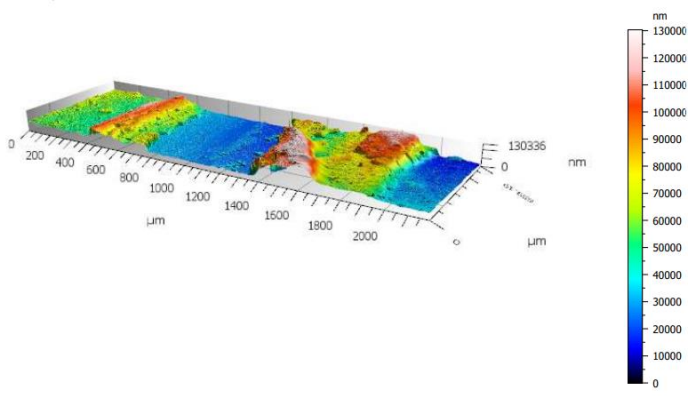

Figure 2: Visualization of abrasion of 5-layers coating after 6 days in PBS

Silesian Univeristy of Technology, Faculty of Biomedical Engineering, Department of Biomaterials and Medical Device Engineering
The Centre for Polymer and Carbon Materials of Polish Academy of Science

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Evaluation of the performance properties of the author's highly porous implant for the treatment of discopathies manufactured by SLM in Ti6Al4V alloy

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The development of additive technologies allows for the production of implants with characteristics and properties impossible to obtain by conventional methods. The paper presents the results of a preliminary evaluation of a designed spinal implant with a diamond macrostructure produced by SLM technology with Ti6Al4V. According to the design, the implant was characterized by 65% porosity and spherical pores with a diameter of 600 µm, providing optimal conditions for bone tissue overgrowth. The FEM analysis (ANSYS) and static compression test confirmed that the design provides sufficient mechanical strength for physiological and higher loads. The actual porosity and pore structure determined based on SEM observations, helium pycnometry, and micro-CT showed an open, homogeneous character of the obtained structure. Although the nominal pore size and actual porosity turned out to be smaller than designed, the values obtained were within the ranges providing good conditions for the penetration and maturation of bone tissue.

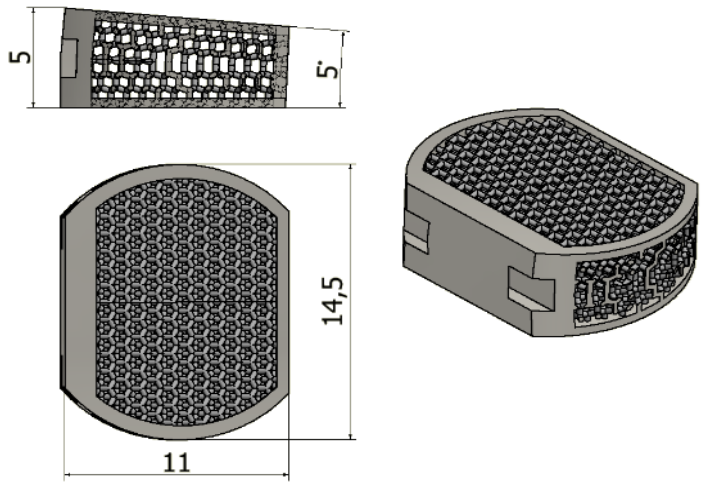

Figure 1: Model of the designed implant

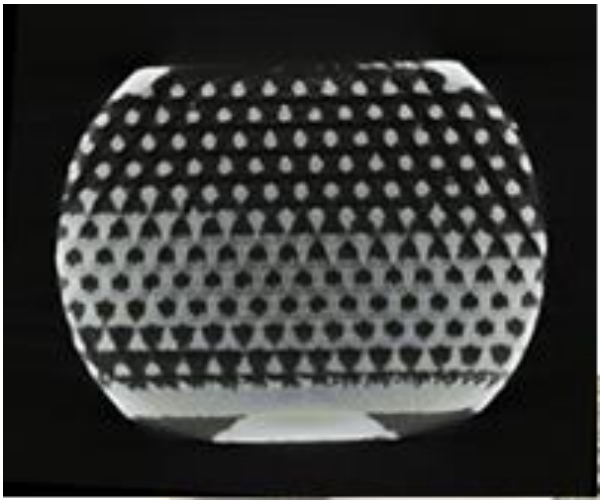

Figure 2: Transverse scan of the sample taken during micro-CT from the central part of the implant

ADDITIONAL INFORMATION: Special thanks to ChM sp. z o.o. for the production of the implants used for the research

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The use of generative design in the development of a personalized zygomatic bone implant for additive manufacturing from titanium alloy

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Corresponding Author: Kinga Sekuła, 249947@student.pwr.edu.pl

In this article, we explore the use of generative design to develop a patient-specific zygomatic bone implant. Generative design offers a different approach that uses algorithms to create multiple design options based on specific constraints and goals. Our study applied generative design techniques to create a zygomatic bone implant. We used a combination of parametric modelling and generative design software to design and optimise the implant's geometry based on a set of predefined criteria. These criteria included factors such as implant fit, its stability, biomechanical performance, and aesthetics, such as how it complements the anatomy of the patient. Our results show how generative design can improve the design process for zygomatic bone implants. Through this technique, we were able to quickly create and evaluate a large number of design options and then choose the two best implants. In conclusion, generative design has tremendous potential in developing patient-specific implants.

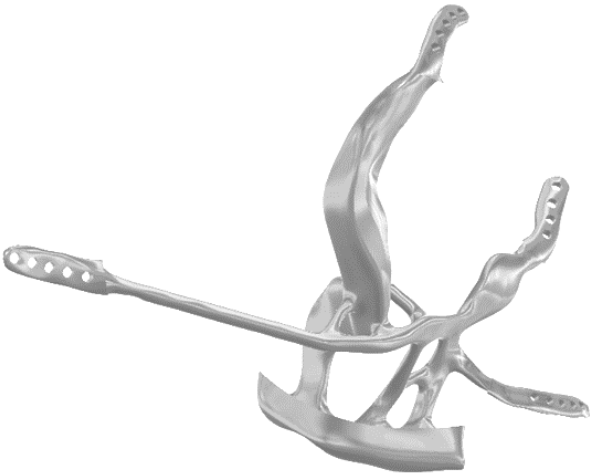

Figure 1: Geometry of patient-specific zygomatic bone implant design with generative design for 250 N load

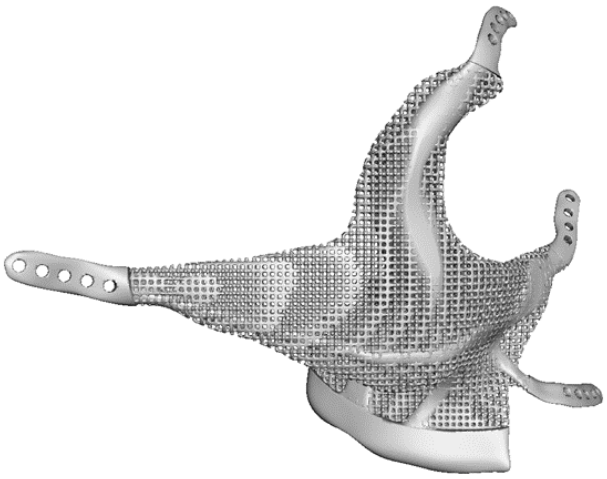

Figure 2: Geometry of patient-specific zygomatic bone implant design with generative design for 250 N load with scaffolding structures

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EFFECT OF SELECTED PRINTING PARAMETERS ON MECHANICAL PROPERTIES OF SAMPLES MADE OF ELASTOMERIC MATERIAL

Authors

Karolina WILIŃSKA, Marta KOZUŃ

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The presented paper concerns the mechanical properties of samples manufactured from elastomer type material (TPU) using additive manufacturing techniques (MJF method). For the study of mechanical properties, specimens of different thicknesses and different orientation with respect to the working platform of the 3D printer were produced. The mechanical properties were determined using a uniaxial tensile test until rapture. The tests conducted showed the influence of the thickness and orientation of the samples on their elastic properties. In addition, the effect of the method of determining the longitudinal modulus of elasticity, on the elastic properties of the produced specimens, was demonstrated.

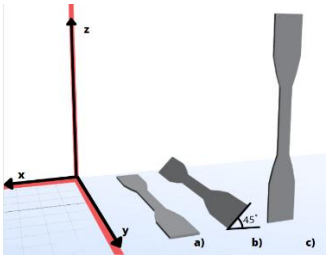

Figure 1. Orientation of samples (horizontal – a, diagonal – b, vertical - c)

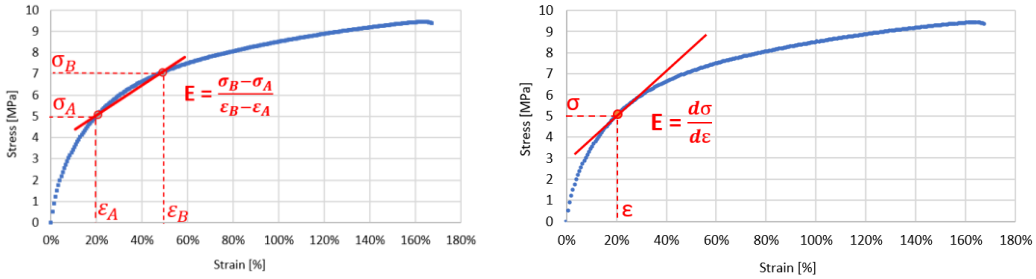

Figure 1. Method of determining the longitudinal modulus of elasticity

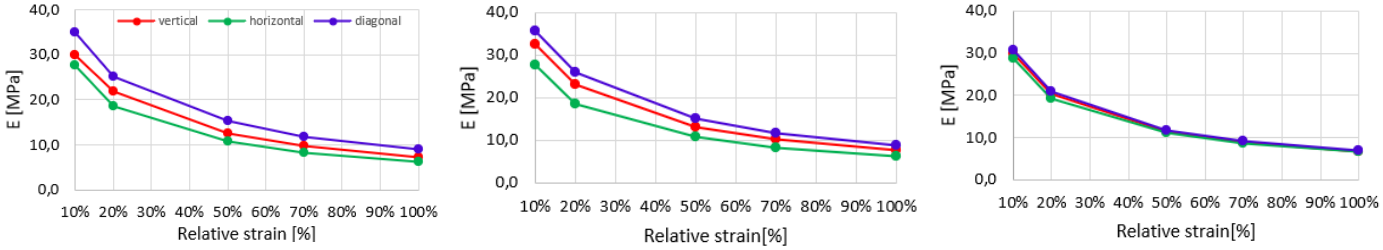

Figure 3. Comparison of the tangent longitudinal modulus of elasticity obtained for specimens with thicknesses: 0.5mm (on the left), B. 0.6mm (in the middle), C. 0.7mm (on the right)

KN BioAddMed, Department of Mechanical Engineering, Wroclaw University of Technology, Wroclaw, Poland
Department of Mechanics, Materials and Biomedical Engineering, Faculty of Mechanical Engineering, Wroclaw University of Technology, Wroclaw, Poland

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The use of foamed filaments in biomechanical hand prostheses

Authors

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The discussed topic concerns the current problem of amputation in Poland and the development of technology in the field of prosthetics. The author wants to focus on the application of modern technology of foamed filaments in improving some parts in prosthesis, for example a stump mount or fingertips. The idea is to use a simple FFF 3D printer with a Direct Drive extruder to print a fully personalized socket in less time than traditional development would require. The author brings attention to the fact that traditional stump mounts models are less functional and often cause users discomfort. Foamed filaments can be used to produce lighter, better-performing, and ergonomic prosthesis parts. Due to the innovative way of applying a properly modeled socket can eliminate abrasions and bedsores while remaining lightweight and replaceable. The applied technology can improve the quality of life of people with hand amputation and enable them to integrate more fully into society.

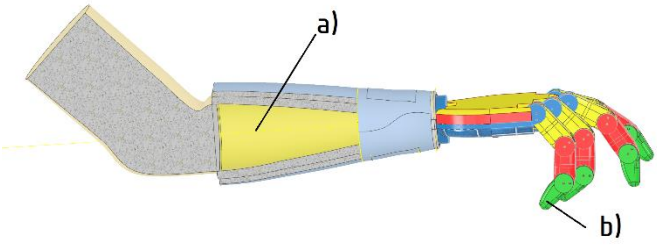

Figure 1: example of possible applications of technology in a) stump attachment, b) fingertips

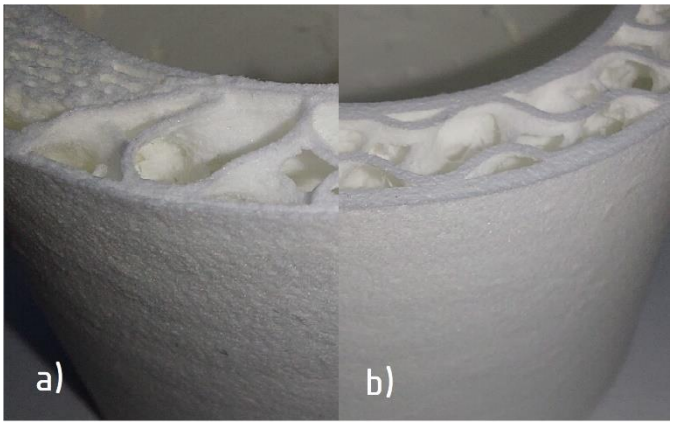

Figure 2: selecting appropriate settings within a single object

Politechnika Śląska, Katedra Podstaw Konstrukcji Maszyn, Ai-Meth; IntegralSENSO, Extral Sp. Z.O.O., Specjalny Ośrodek Szkolno-Wychowawczy Dąbrowa Górnicza.

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"Rzep_CHECK a speech therapy aid supporting the child's motor and phonetic abilities"

Karol WILK, Martyna KRAMARZ, Małgorzata MUZALEWSKA

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The purpose of this article is to present the issue of learning children how to read and modern solutions to this problem. Our proposition, which was created in the collaboration between students scientific association Ai-METH and speech therapists, is Rzep-CHECK board. It is an interactive teaching aid that was designed to help with speech therapy and early school education. The device uses RFID technology with tangible user interface and 3D-printing. It was created as a substitute for paper cards with pictures and letters and its premise rather simple. The child who's learning is supposed to create ex. the name of an animal on the picture letter by letter. The picture is placed on the top of the board and the number of diodes light up indicates the number of letters in the word. If the letter is placed correctly on the board, the light will light up green, otherwise it will be red. In December, the Rzep-CHECK was donated to the Educational Special Centre in Dąbrowa Górnicza and it's been used with therapy with children ever since.

Figure 1: Child using a Rzep-CHECK Board

Figure 2: Rzep-CHECK board with all the letters and pictures of animals

ACKNOWLEDGMENTS: Extral Sp. z o.o.; Specjalny Ośrodek Szkolno – Wychowawczy dla Dzieci i Młodzieży Niepełnosprawnej w Dąbrowie Górniczej

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"Diodoblysk - a stimulating device for children with disabilities"

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Corresponding Author: Marek Wycisło, mw307245@student.polsl.pl

Djodobłysk - is a therapeutic device used for visual stimulation of children with visual impairments by exposing them to the light of colored diodes. In addition, the device trains concentration. After pressing the LEDs, the light turns on, and after a while the colored LEDs go out by themselves. This leads to a situation where before the child lights up, for example, sector 4, the LEDs in 1 will go out. The construction of the device uses 3D printing technologies , and the control element is made of mosfet transistors. The device has passed verification and validation at the Special School And Educational Center For Disabled Children And Young People in Dąbrowa Górnicza. Where it was very well received and its stress-relieving effect on the child was noticed, which positively affects its development and progress in therapy. Now Djodobysk is used in the center as an aid in the therapy of disabled children.

Figure 1: Djodoblysk

ACKNOWLEDGMENTS: Extral Sp. z o.o.; Specjalny Ośrodek Szkolno – Wychowawczy dla Dzieci i Młodzieży Niepełnosprawnej w Dąbrowie Górniczej

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Four-legged walking platform in children's therapy - ReXio robodog

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Nowadays, animal and human-based robotic platforms are found in more and more various applications. However, there is rare to use such robots in therapeutic context. Our research are describing the results of verification tests, which included the disabled youth reaction and cooperation with four-legged walking platform Unitree Go1 EDU (figure 1). The study was made in Special School And Educational Center For Disabled Children And Young People in Dąbrowa Górnicza and focused on both groups of children and single kids. Test series have shown the positive reaction of children to walking robot in all cases regardless of the degree of disability. This paper is an entrance for debate about wider use of mobile robotics in therapy.

Figure 1: Robodog Unitree Go 1 EDU

Figure 2: Robodog show with children from SOSW

ACKNOWLEDGMENTS: Extral Sp. z o.o.; Specjalny Ośrodek Szkolno – Wychowawczy dla Dzieci i Młodzieży Niepełnosprawnej w Dąbrowie Górniczej

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Analysis of problems related to the design of the hand prosthesis

Agnieszka HOLEWIK, Oliwia GRABIEC, Wiktoria GROELICH, Anna MIRUK-MIRSKA, Natalia KRYZA, Łukasz POROSIŁO, Andrzej MICHNIK, Mariusz SOBIECH, Iwona CHUCHNOWSKA

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The project involved the development of a prosthetic hand using 3D printing and servo motors for movement control. A review of existing prosthetic hand technologies was conducted, and four design concepts were developed using Autodesk Inventor before selecting the optimal design. The selected design used servo motors to control the hand's opening and closing, allowing for a cylindrical grip. In the second phase, the team developed control algorithms using an Arduino microcontroller and selected an optimal solution for the hand. The prosthesis was assembled and tested using a servo motor-controlled finger, which was linked to a belt containing a discreetly sewn button for control. Finally, user testing was conducted to evaluate the functionality and ergonomics of the design.

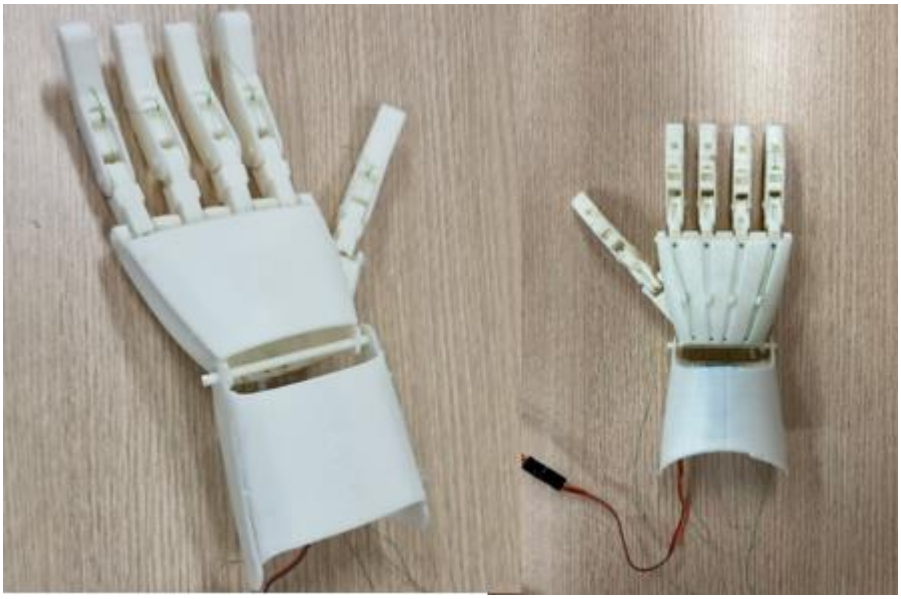

Figure 1: Assembled hand prosthesis

Faculty of Biomedical Engineering of the Silesian University of Technology, The Łukasiewicz Research Network, Academic High School of the Silesian University of Technology in Gliwice.

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Analysis of mandible morphometry in children and adolescents

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Klaudia Krutyło, klaukru641@student.polsl.pl

Morphometric methods are increasingly being used for medical diagnosis. From CT or MRI scans, anthropometric data can be obtained, which can then be used in planning treatments. Anthropometric studies of the mandibles of healthy and diseased children and adolescents make it possible to assess the development of craniofacial diseases at an early stage.

Access to CT scans allowed segmentation of the patients' mandibles and creation of 3D models with the help of Mimics software. Measurements regarding the length, width and height of the mandible were then collected and a database of normative measurements for the subjects was created. The created resource allowed statistical analysis of the results and development of the work in two directions: study of the symmetry of the mandible and the correlation of the parameters with the age of the patient, along with a comparison to single disease entities, and fitting the mandibular growth function based on nonlinear estimation.

The work has revealed important areas for research when analyzing the growth of the mandibles of children and adolescents. Understanding mandibular development will allow for accelerated diagnosis of diseases from an early age.

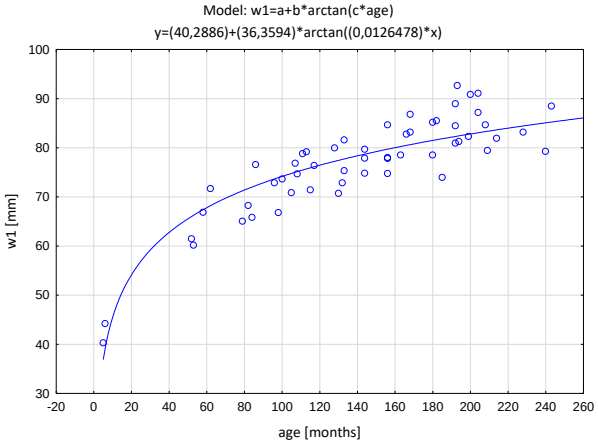

Figure 1: Length vector w1 (gn - go.l) for the cyclometric model

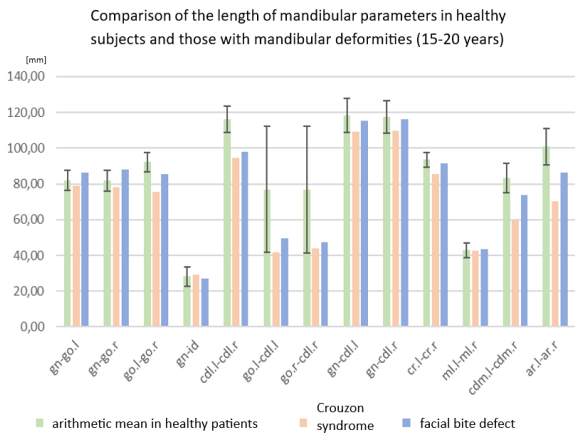

Figure 2: Comparison anthropometric measurements of healthy subjects and patients with genetic defects

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ANALIZA WPŁYWU ZMIAN STRUKTURALNYCH STRUN ŚCIĘGNISTYCH NA NIEDOMYKALNOŚĆ ZASTAWEK SERCA W MODELU ZWIERZĘCYM

Weronika DYLEWICZ[1], Agnieszka MACKIEWICZ[2], Tomasz KLEKIEL[2], Justyn GACH[3], Agnieszka NOSZCZYK-NOWAK[3], Romuald BĘDZIŃSKI[2]

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Mechaniczne zmiany w strunach ścięgnistych nie są jeszcze dokładnie zbadane u psów z MMVD. U innych gatunków obserwuje się zmiany w odpowiedzi mechanicznej zdegenerowanych strun ścięgnistych w porównaniu do strun zdrowych. Celem badań było określenie właściwości mechanicznych strun ścięgnistych prawidłowych oraz pobranych od psów z MMVD a także analiza numeryczna funkcjonowania zastawki mitralnej w obu stanach. Doświadczenie przeprowadzono na maszynie wytrzymałościowej Zwick/Roell EPZ 005 wykonując statyczną próbę rozciągania. Model numeryczny wykonano z wykorzystaniem oprogramowania Ansys Workbench – moduł Static Structural. W programie odtworzono geometrię zastawki mitralnej i zadano warunki brzegowe zgodne z jej funkcjonowaniem. Na podstawie uzyskanych wyników z statycznej próby rozciągania, utworzono krzywe przedstawiające zależność pomiędzy naprężeniem, a odkształceniem dla strun ściągniętych. Na ich podstawie dla prawidłowych strun ścięgnistych wyliczono moduł Younga równy 233 MPa, dla struny ścięgnistych zdegenerowanych wartość ta wynosiła 43 MPa. Model geometryczny został wykonany w oprogramowaniu SolidWorks, który składał się z zintegrowanych płatków zastawki oraz pierścienia, strun ścięgnistych oraz mięśni brodawkowatych. Analizy numeryczne wykonano z wykorzystaniem metody elementów skończonych, gdzie zastosowano izotropowy model materiału cechujący się liniową odpowiedzią naprężenie-odkształcenie dla poszczególnych elementów modelu geometrycznego. Stwierdzono, że charakterystyka deformacji jest różna dla strun odchodzących z płatka przedniego i tylnego. Na strunach ścięgnistych od psów zdrowych występują deformacje wzdłużne od 0,53317 do 2,5947 mm, a dla strun ścięgnistych od psów z MMVD mieszą się w zakresie od 0,35501 do 2,6363 mm. Stwierdzono, że wartości deformacji są większe dla próbek zdegenerowanych w porównaniu do odpowiadających im próbek zdrowych. Charakterystyka deformacji na strunach ścięgnistych odchodzących z płatka tylnego jest podobna pomiędzy analizami. Wśród wszystkich przedstawionych wyników obserwuje się tendencję do obecności najmniejszych deformacji na strunach marginalnych, natomiast najwyższe wartości uzyskiwane są w pobliżu przejścia tkanki struny ścięgnistej w tkankę mięśnia brodawkowatego, co również potwierdzają badania eksperymentalne. Struny ścięgnisty w próbie rozciągania najczęściej pękają w pobliżu mięśnia brodawkowatego.

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Walker for a child with osteogenesis imperfecta

Julia JAGODYŃSKA, Kacper SNARSKI, Dominika IWAN, Anita GRYKO, Piotr PROCHOR

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Currently available solutions of walkers are mainly dedicated for children with movement disorders. These designs are characterised by limited adjustability and the lack of trunk support. The proposed design of a walker has an adjustment of both upper limb and torso support as well as it is possible to adjust the angle of the wheels. The walker was made to provide the best possible stability while keeping low mass of the structure. Moreover, it has adjustable tilt and height of trunk and upper limb support, which are adjusted to fit the child's anatomical parameters.

Figure 1: Prototype of walker

Figure 2: CAD model of walker

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The concept of an assisting and rehabilitation stationary device for the elderly

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The table is a modern solution aimed for the elderly. Its tabletop is equipped with 4 modules, each allowing to train different activities, such as quick reactions, patterns memorising, manual skills and control of muscle contractions. Due to its innovative form, it is useful device for supporting therapies in psychogeriatric centers. Important advantage of the device is the possibility of exchanging modules to adjust them for individual patients according to their needs. In addition, the modules have the ability to operate without being connected to the table, which allows better organization of rehabilitation procedure. All modules are connected to the system allowing to gather data for creation of databases.

Figure 1: CAD model of device – view 1

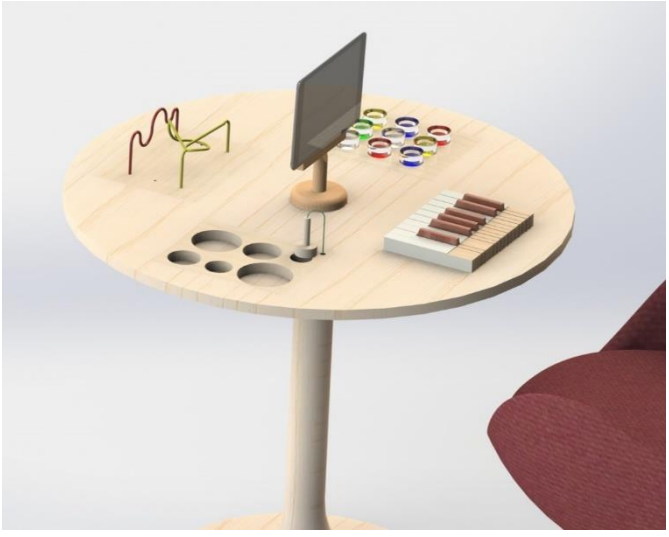

Figure 2: CAD model od device – view 2

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The MRI-based 3D printed brain: An Interactive Arduino Project

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This work aimed creation of an interactive model of the brain based on MRI. The digital model has been created in the InVesalius program, and the real model was 3D printed in SLA technology. The printing process was previously prepared in the PreForm program. The printed brain model was then connected to the electronic system, the main component of which was the Arduino Uno Rev3 board with four sensors from the Grove series. The first part was devoted to the neuroanatomy and neurophysiology of selected areas of the brain - the temporal lobe, parietal lobe (figure 1) and frontal lobe, occipital lobe (figure 2). After that, MRI imaging, the physical basis of the examination, and the characteristics of the MRI were discussed. In addition to the electronic system itself, the code in C ++ is described, which is responsible for reading the values from the sensors and controlling the diodes.

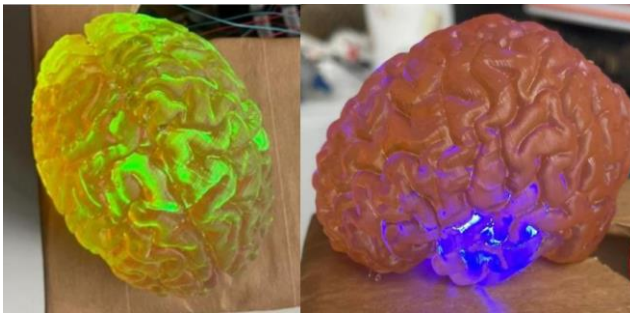

Figure 1: Parietal lobe and temporal lobe

Figure 2: Frontal lobe and occipital lobe

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Model studies of hydrodynamic parameters of the human circulatory system

Natalia MĘDROWSKA, Natalia POPARDA, Monika ŚWIDERSKA, Igor WAŻYDRĄG, Zuzanna ZAJĄC, Karolina SZAWIRAACZ, Justyna WIĘCEK, Roman MAJOR, Grzegorz MILEWSKI

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Cardiovascular disease is one of the most common causes of death in Europe and worldwide. In Poland, they account for almost 50% of all deaths and are the main cause of hospitalization [1], and with the aging of the population, the number of patients is steadily increasing. The aim of this project was to present opportunities given by a hybrid mock up circulatory system in order to enable study of the effects of changes in cardiovascular parameters on the work cycle of the heart with and without the aid of a parallel left ventricle assist device. Theoretical studies of the effect of changes in the heart's parameters on its duty cycle using the mock up system were described in the paper.

Figure 1: The mock up circulatory system used for model studies

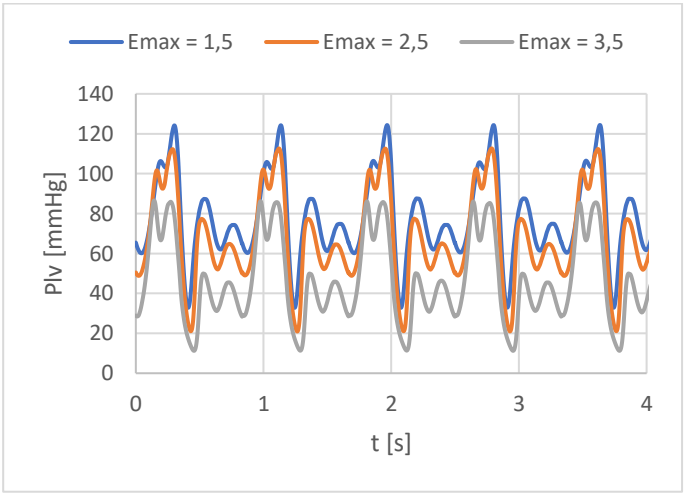

Figure 2: The graph of pressure change in the left ventricle over time at different elastance values

Project financed by FutureLab PK as part of project no. 73 "Optymalizacja doboru parametrów pracy komory wspomagania serca w oparciu o biomechaniczny system „sztucznego pacjenta – SERCE”"

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Evaluation of the mechanical properties of low viscosity acrylic bone cements

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The aim of this work was comparison of surface and mechanical properties of bone cements used in human and animal orthopedics. The mechanical properties were determined by compression tests, a contact angle was observed with a goniometer and the surface free energy was calculated by Owens-Wendt model. Two states of material (initial and after aging process) were considered. The aging process changed the nature of the surface to the hydrophilic and caused an increase in the polar component of the surface free energy. The obtained compression curves are similar, showing both linear and plastic regions.

Two acrylic bone cements were used on this study: Synicem (Synergie Ingenierie Medicale, France) and Cemex X radiopaque, low polymerization temperature and low viscosity (TECRES S.p.A., Italy).

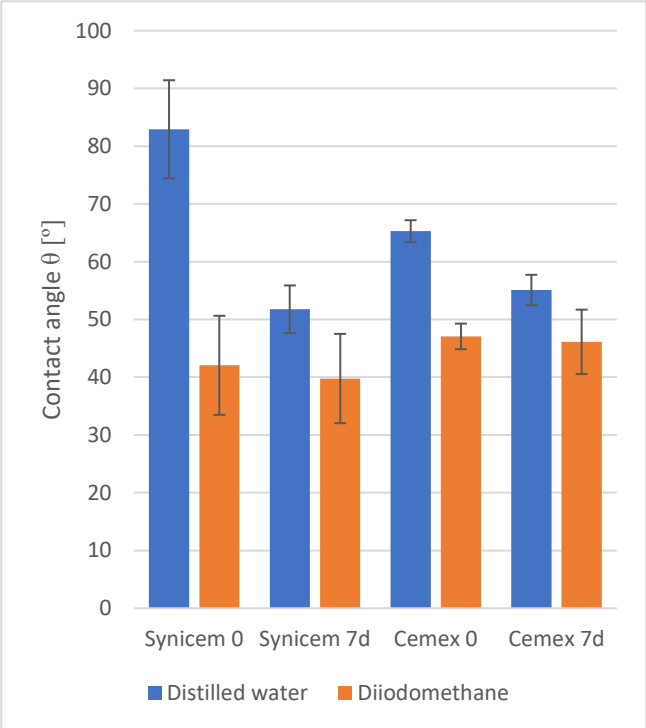

Figure 1: Contact angles (average value and standard deviation)

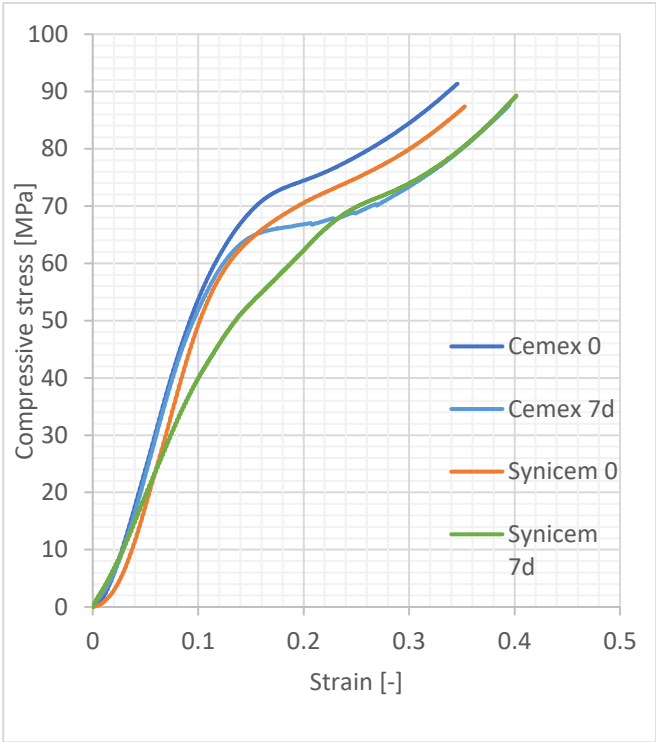

Figure 2: The average courses of the bone cement compression test

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Piezoelectric properties assessment method for bone tissue

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With our growing understanding of different processes occurring inside the human body we can apply that knowledge to design implants with certain properties allowing for easier and smoother integration process. One of the effects with the proven ability to do so is the piezoelectric effect present in bones due to theirs type I collagen content. The aim of this work was to design and build a device that would be able to measure the direct piezoelectric effect of bone tissue during mechanical tests and record the data on the connected PC. This work presents the development and current state of such a device and briefly explains the importance of piezoelectric effect in bone tissue.

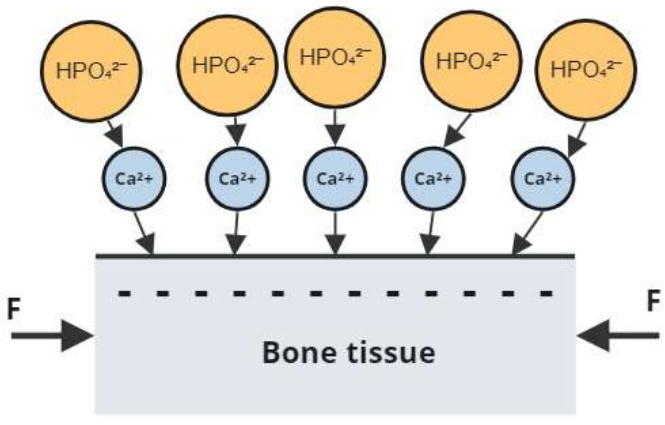

Figure 1: Apatite layer formation induced by loading of bone tissue

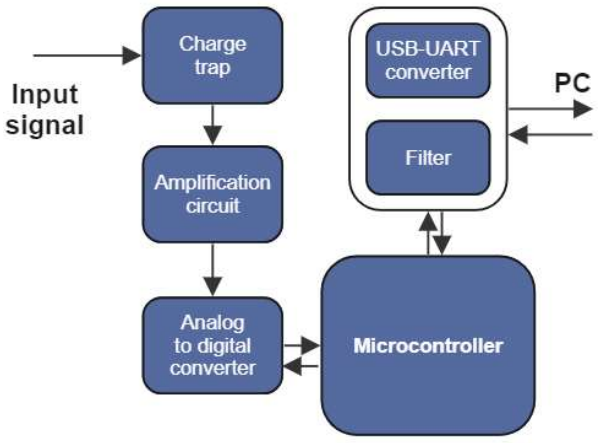

Figure 2: The block diagram of the circuit

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Determination of mechanical properties of biomorphic materials

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The study was carried out with the aim of introducing a developing branch of science - implantology - and the growing interest in biomorphic materials. The main task was to conduct bending strength tests and compare the obtained values to the strength properties of human bone, which the tested materials, in the form of an appropriately prepared implant, could replace, for example, as a result of the occurrence of cancerous lesions in a particular bone fragment.

Strength tests were performed using static three-point bending test (carried out on an MTS Criterion testing machine) and Dantec Dynamics digital image correlation system for two research groups of wood samples (hardwood and softwood). The first group was left in its raw state and subjected to appropriate drying (25 pieces). For the second group, a pyrolysis process was carried out at four temperatures: 400°C, 600°C, 800°C and 1000°C (12 pieces).

It was shown that the samples in the raw state are characterized by significantly higher values of the mentioned parameters, compared to carbonized samples, whose internal structure became increasingly porous with increasing pyrolysis temperature. For oak samples (in the raw state), the highest values of the tested mechanical parameters were registered, thus "falling within" the ranges of bending strength of the human (femoral) bone.

Acknowledgments: The research was funded as part of a grant from the National Science Center (National Science Centre) under the project: 2021/41/B/NZ7/04098.

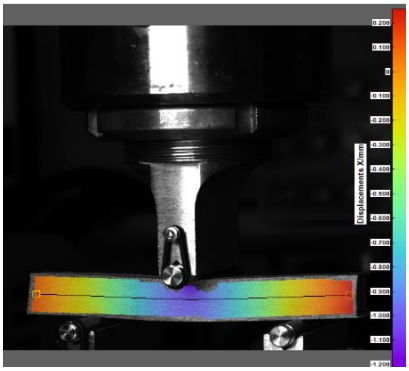

Figure 1: Example of deformation (displacement) map obtained by digital image correlation system

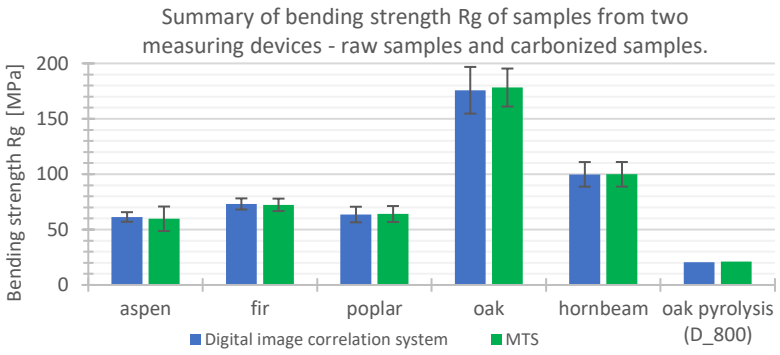

Figure 2: Summary of obtained bending strength results (for "most important/significant" samples)

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Detection of blood pump thrombosis from an acoustic signal

Amber CHAIMAE, Diana TSOI, Jeremi KRAJEWSKI

Blood pump thrombosis is a medical condition that occurs when a blood clot forms within a mechanical heart valve, which can lead to serious complications such as heart attack and stroke. Recent research has demonstrated that spectral analysis of the acoustic signal produced by a blood pump may be utilized to potentially non-invasively detect blood pump thrombosis. In this study, through spectral analysis of the acoustic signal, we want to create a reliable approach for identifying blood pump thrombosis.

Filtering and periodogram are two different methods that were used to process the data. The filtering method analysed the audio signal by computing the FFT and calculating the ratio of the amplitudes of the 3rd and 4th harmonics. If the ratio was greater than 0.8, a message box was displayed indicating that the device is not working properly, otherwise, it was assumed to be working. The periodogram method, on the other hand, measured the power spectral density (PSD) of the acoustic signal acquired from the device. The ratio between the maximum amplitudes of the 3rd and 4th harmonics of a specific fundamental frequency was then calculated by analysing the PSD. We conclude that the device is deemed functional if this ratio is greater than 1.

An extensive dataset of acoustic signals from patients with and without blood pump thrombosis was collected, and the spectral content of these signals was analysed to determine the amplitude ratio of the third and fourth harmonics. The goal of this work was to develop a reliable method for detecting blood pump thrombosis using spectral analysis of the acoustic signal. A mathematical model can be created based on the findings of this study in order to correctly anticipate the presence of blood pump thrombosis from the acoustic signal.

The use of spectral analysis to detect blood pump thrombosis from an acoustic signal has the potential to revolutionize the way this medical condition is diagnosed. With further research and development, this method could become a reliable and non-invasive tool for detecting blood pump thrombosis, improving patient outcomes and reducing healthcare costs. The filtering and periodogram methods can provide a starting point for developing more sophisticated methods for spectral analysis and detecting blood pump thrombosis from the acoustic signal.

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Analysis of gaze behavior of handball players performing penalty throw

Artur STĘPNIAK, Agata GUZIK-KOPYTO, Anna MILLER-BANAŚ, Robert MICHNIK

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Engineering support for sports training undoubtedly plays a key role in improving techniques especially among athletes with low experience. Handball is one of the most dynamic, injury-prone and fast-decision-making sports, where the assistance of specialized engineers using modern systems for biomechanical analysis of game elements allows an objective assessment of their correctness and safety.

The purpose of this study was to analyse eye movement using an eyetracking system of handball players performing penalty throws. The study was conducted using the Tobii Glasses 3 eye-tracking system on a group of 18 handball players of junior and senior clubs, where fixations and their duration were analysed.

Analysis of the results showed a longer duration of fixations within the goalkeeper than in the empty goal spaces, which may mean that during the penalty throw, the players analyse the movements and positions of the goalkeeper.

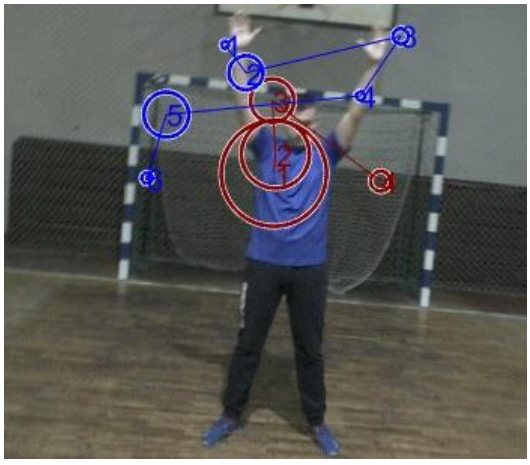

Figure 1: Example of fixation points

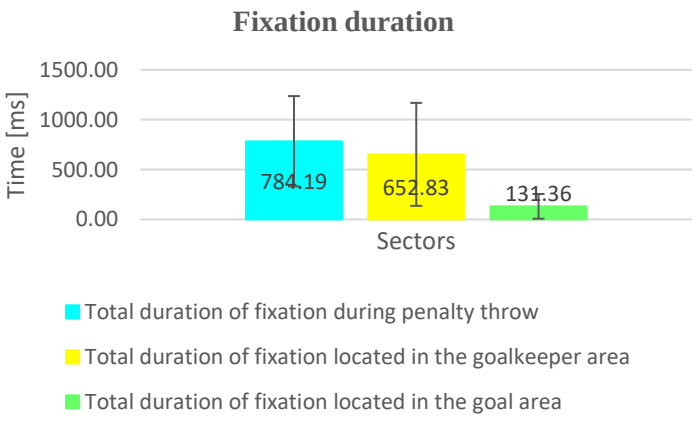

Figure 2: Total fixation duration in the analyzed areas

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Selected issue of vibrodiagnostics in biomedical research

Tomasz KAŁACZYŃSKI , Kinga SŁONIMSKA , Adam MAZURKIEWICZ , Marcin GŁOWACKI *

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The use of vibrodiagnostics for non-destructive testing has wide approach in diagnostic of technical systems. In presented paper showed result of used the method for research of behavior of bone and bone - bone fixator system under mechanical extortions. It were investigated by analyzing of response value on selected vibration parameters and coherence function. Basic estimators of vibration for bone model and bone - bone fixator were identified.

Figure 1: Bone with vibration sensor

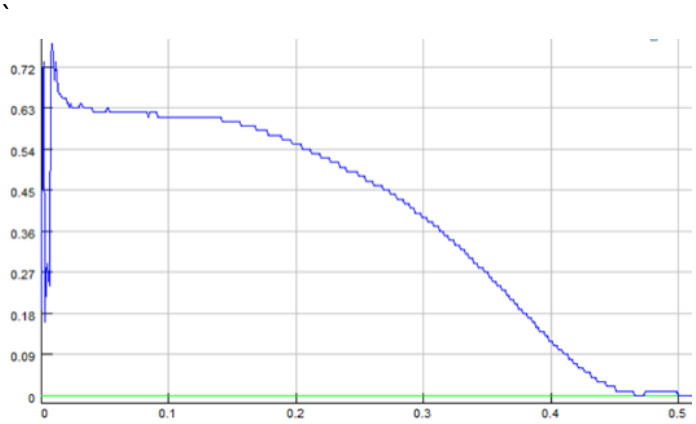

Figure 2: Exemplary Coherence function for investigated bone

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Project of a rehabilitation walker for the elderly people

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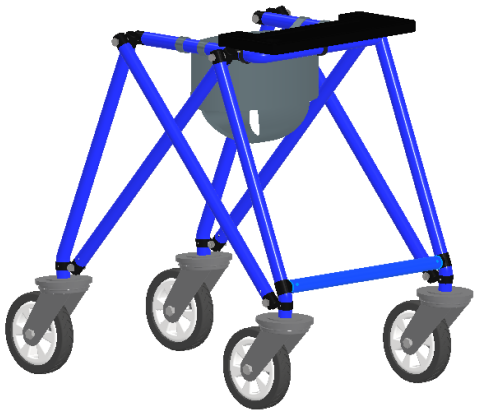
Difficulties related to independent movement appear with age. Increasingly, older people suffer from dysfunctions of the musculoskeletal system associated with joint pain, limb injuries, weakness and problems with maintaining balance while walking. Elderly people decide to use innovative rehabilitation equipment to support their daily activities.

In order to develop the concept of a new model of a rehabilitation walker that would provide the user with better support while walking and reduce the risk of tipping over, a review of available solutions on the Polish market was made. This task allowed to compare individual elements of rehabilitation walkers, including: frame, wheels and additional elements. What's more, a survey of people using walkers provided the necessary information about the innovations that should be introduced in current equipment. The criteria analysis made it possible to choose the optimal solution from among the three concepts.

After the analyzes carried out, an optimal model of a rehabilitation walker was developed, consisting of an aluminum frame with an innovative folding system for transport. In addition, the model is equipped with 4 wheels rotating around its own axis, a fabric seat and a table with a hole for drinks.



Picture 1 The developed model of a rehabilitation walker.

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