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Lodz University of Technology

MEDICAL UNIVERSITY OF LODZ

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Technical Program

Dec. 10, 2019, Lodz University of Technology

9:00	Welcome address, Prof. Grzegorz Granosik (TUL)
9:10 - 9:40	Research of Morita Laboratory - Rehabilitation Support Robots and Devices, Prof. Yoshifumi Morita (Nitech)
9:40 - 10:10	Research of Kato Laboratory - AI Technology-Based Dementia Screening from Elderly Speech, Prof. Shohei Kato (Nitech)
10:10 - 10:30	Why does a senior need strength? - Dr. hab. Joanna Kostka (UMeD)
10:30 - 10:50	Coffee break
10:50 - 11:30	Research of Kozłowski Laboratory, Dr. Piotr Sauer and Mr. Marek Trączyński (PUT) The Compact, Portable Knee Rehabilitation System Wearable hand rehabilitation system with force feedback
11:30 - 11:50	Research at Human Centered Robotics Laboratory, Prof. Grzegorz Granosik (TUL)
11:50 - 12:10	Design for users with special needs - universal design, Prof. Anna Miarka and Dr. Katarzyna Caban-Piaskowska (ASP)
12:10 - 13:30	Lunch
13:30 - 14:00	Recovery from Stroke, Prof. Hirofumi Tanabe (SUMS)
14:00 - 14:15	Training Device for Extensor Digitorum Muscle of Plegic Fingers after Stroke, Miss Shuhan Da (Nitech)
14:15 - 14:35	Objective assessment of changes in body posture and its consequences in postmastectomy women recommendations for rehabilitation, Dr. Katarzyna Hojan (DoR Poznan)
14:35 - 15:05	Stoma-Alert - new monitoring and diagnostic tool for patients with intestinal stoma, Prof. Michał Mik (UMed) and Dr. Rafał Zawiślak (TUL)
15:05 - 15:15	Model of commercialization of interdisciplinary research projects – case study of the 'Stomia-Alert' project, Mrs. Joanna Mik-Wojtczak (Phin)
15:15 - 15:40	Coffee break
15:40 - 16:20	How can we promote neurorehabilitation and neural repair after stroke? Prof. Elżbieta Miller (UMed)
16:20 - 16:50	Poster session, Student Association for Neurorehabilitation (UMed)
16:50 - 17:20	Poster session, Robots for Humans - Student Association (TUL)
17:20 - 17:30	Closing address, Prof. Yoshifumi Morita (Nitech)
17:30 - 18:00	Human Centered Robotics Laboratory tour and discussion (TUL)
19:00 - 21:00	Dinner Party

Dec. 10, 2019, Dr. K. Jonscher Municipal Medical Centre

10:00 - 13:00	Hospital tour and discussion, Prof. Elżbieta Miller (UMed)
13:00 - 14:30	Lunch

Nitech: Nagoya Institute of Technology, SUMS: Shonan University of Medical Sciences, TUL: Lodz University of Technology, PUT: Poznan University of Technology, DoR Poznan: Department of Rehabilitation at the Greater Poland Cancer Centre, Poznań, UMed: Medical University of Lodz, ASP: Strzeminski Academy of Fine Arts, Lodz

2019 Japan-Poland International Workshop
on Technologies supporting rehabilitation and medical services

Welcome

It is my pleasure to introduce you to the Technical Program of the joint Japan-Poland International Workshop on Technologies in rehabilitation and medical services.

Our Japan-Poland meetings have already short tradition, and we can say this is the fifth edition. All thanks to very energetic prof. Yoshifumi Morita from NITech. Everything started with his visit in Łódź in 2017, and his seminar presentation for the Institute of Automatic Control, Lodz University of Technology (TUL), followed by the student visit of Mr. Reiya Nishio who stayed with our Institute for 2 months. Then came our visit in Nagoya in October 2018 – our travel to Japan and joint workshop in NITech was related to participation of student team in World Robot Summit. Shortly after that prof. Morita was in Łódź due to the student research performed at TUL by Mr. Masakazu Nomura. This year we already had visit of Dr. Zubrycki in Nagoya and workshop focused on human-robot interaction. And now it is time for Japan-Poland Workshop on Technologies supporting rehabilitation and medical services.

We will have quite intensive day today and a half day tomorrow. We will have 13 presentations of experts and 10 presentations of students working in Scientific Associations, we will also have two practical visits in Human Centered Robotics Lab and rehabilitation ward in Jonscher Municipal Medical Centre, both followed by discussion sessions.
All focused on main objectives: to share knowledge and promote mutual understanding - on post-stroke rehabilitation, and medical services related to elderly people and stoma patients. We want to strengthen collaboration between Medicine and Engineering, between Poland and Japan, and possibly create novel rehabilitation and supportive devices.
We brought together medical doctors and rehabilitation specialists, engineers, designers and business. I am sure this mixture of expertise, combination of different forms of knowledge exchange, and this venue will give great results. New thoughts, ideas, and joint projects.
Our Japan-Poland Workshop has an open formula of scientific meeting of IEEE RAS Polish Chapter. We have quite large group of guest students from different levels: Engineering course, Master level, and PhD candidates.

I would like to mention also supporters of our workshop, they are: project Stoma-Alert financed by National Center for Research and Development, and companies: BIOFARM and TROMED.

I wish you great scientific experiences and pleasant time in Łódź.

Welcome to Japan-Poland International Workshop 2019 and the Lodz University of Technology.

Grzegorz Granosik

Research of Morita Laboratory
- Rehabilitation Support Robots and Devices -

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Abstract: Morita laboratory has been conducting research projects on human support technology as follows; rehabilitation support robots and devices (nine projects), direct robot teaching device for easy to use of industrial robot, assist control of an electric power steering system, and so on.
We have been developing rehabilitation support robots and devices based on the needs and opinions of rehabilitation sites in cooperation with engineering and medical researchers including Professor Hirofumi Tanabe, medical doctors, rehabilitation therapists, manufacturing engineers by using advanced technology and simple technology. In this presentation some of them are introduced based on the research results of our journal and conference papers.
Recently, we have focused on hand rehabilitation for restoring motor function in hemiplegic patients after stroke. In hand rehabilitation, it is important to reduction of spasticity of finger flexor, facilitation of finger extensor, table exercise with handling objects, and repetition of them. They are conducted by therapist’s hands and support. In order to help therapist’s manual therapy, we developed a piston device for finger (PDFin) to reduce spasticity, a treatment device to promote finger extensor (PARKO), and training/testing device for adjustability of grasping force (iWakka). The recent research results of clinical trials are introduced.
We developed a neuro-rehabilitation robot for restoring motor function of hemiplegic upper limb (NR-Robo). The key to rehabilitation is to repeat normal movements and relearn normal movement patterns in the brain. We created an environment where patients can repeat normal movements by himself/herself. The therapeutic effects of training with NR-Robo are introduced. It was confirmed that the A-ROMs and MASs of elbow extension and rotation of the forearm were improved after training. We developed a self-standing-up training support robot for restoring motor function of hemiplegic lower limb (STATR). Currently, the assembly of the robot was almost complete. The design concept and robot configuration are introduced. We found a new cause of non-specific low back pain by our developed proprioceptive inspection device (PROTED). The fundamental results are introduced.
In Japan, we need useful robots and devices that can truly help therapists and patients. Such useful robots and devices are currently essential due to Japan’s super-aging society. We hope to collaborate with you!

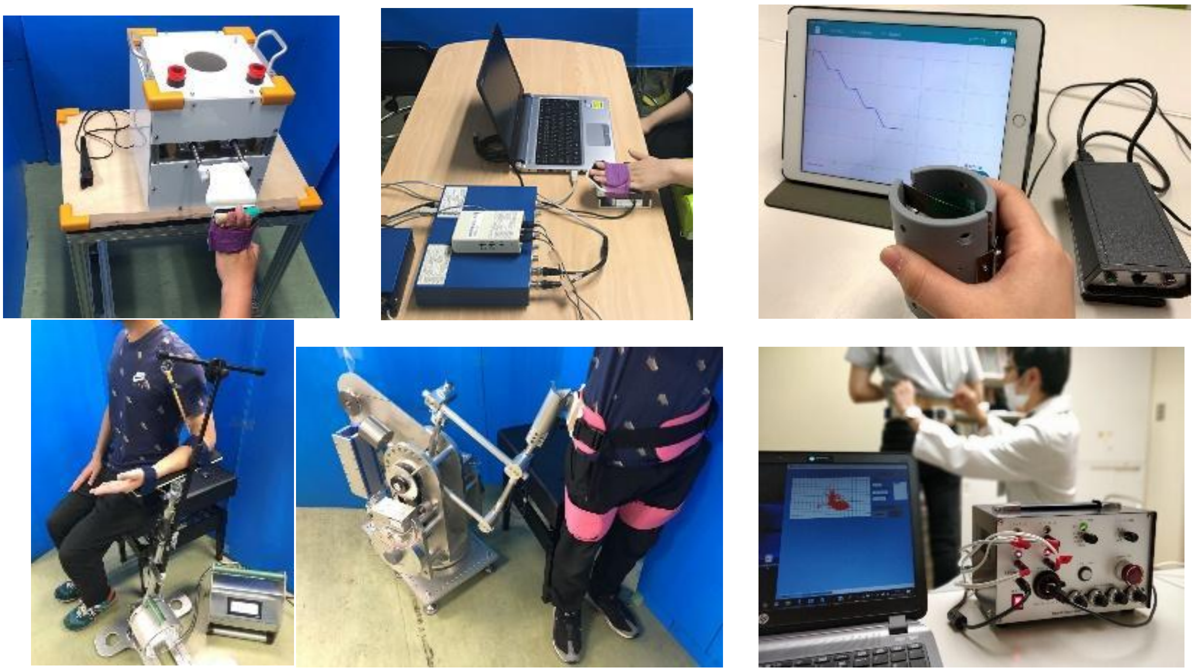

Fig. 1 Rehabilitation support robots and devices developed by Morita Laboratory (up from left: PDFin, PARKO, iWakka; down from left: NR-Robo, STATR, PROTED)

Research of Kato Laboratory
- AI Technology-Based Dementia Screening from Elderly Speech -

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Abstract: Having an aging rate of 28.1% (the highest in the world), Japan has the most serious super-aged society in the world. The ratio in Poland is 18.7% and it is also rapidly increasing. We thus have several challenges for elderly policies towards fruitful and sustainable longevity society. It is no doubt about dementia is one of the pressing challenges in developed countries. World Health Organization reported that 46.8 million people were estimated to be living with dementia in 2015. And, the number will almost double every 20 years. Dementia will be a risk for social and economic activities in the world. With this serious situation, preventing dementia may be a key role for aging societies to keep social activities. Early detection of cognitive decline is the first solution to prevent dementia.

To solve this problem, we have studied novel approaches to the early detection of mild cognitive impairment (MCI) and mild Alzheimer's disease (mAD) in the elderly, in which we focused on the acoustic and prosodic features of speech sounds and cerebral blood flow activation during the subject's answers to the cognitive tasks. In this talk, we firstly introduce our sophisticated AI technology-based detecting cognitive impairment of elderly people, from analysis of speech sound and fNIRS signals (Figure 1), and show the discriminative performance of mAD versus healthy control (HC) with 90% accuracy and MCI versus HC with 75% accuracy, using SPCIR, speech prosody-based cognitive impairment rating. Secondly, we report an examination of classifying dementia of frontotemporal lobar degeneration (FTLD), amyotrophic lateral sclerosis (ALS), and mild Alzheimer's disease (AD). As a result, three groups of FTLD, AD, and ALS were classified with 68% accuracy, and three groups of AD, non-AD and healthy control (HC) were classified with 84% accuracy. The results suggest that speech analysis-based screening is effective in classifying the target diseases.

The final goal is to check Cognitive Decline easily "anytime, anywhere", not at hospitals, Our technology makes a service application of Cognitive dysfunction assessment that are suitable for early stage screening, especially detecting Mild cognitive impairment. This technology is applicable to all Health care ICT devices.

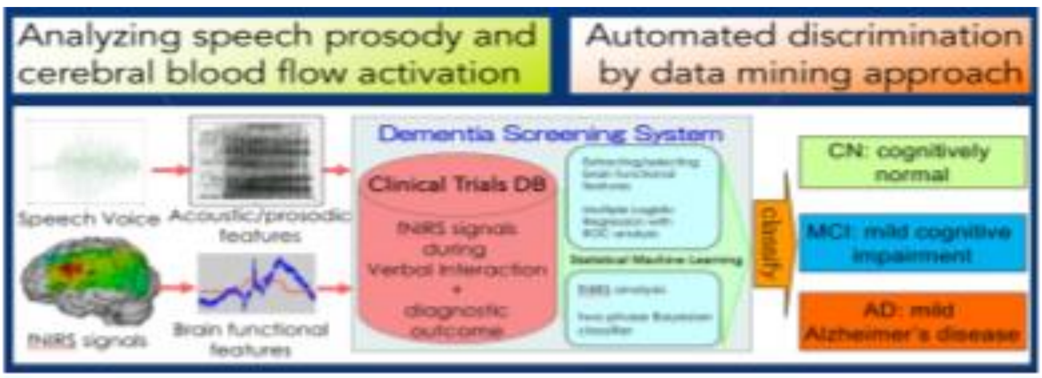


Fig. 1 AI Technology-Based Detecting Cognitive Impairment

Why does a senior need strength?

J. Kostka
Department of Neurological Rehabilitation Medical University of Lodz, Poland

Abstract: Peak muscle mass and strength is reached between the second and fourth decade of life. Then, with age, they gradually decrease. Age-related loss of muscle mass and function has multiple causes and is associated with various modifying factors. These factors include: lifestyle (primarily a reduction in physical activity and sedentary behaviors), loss of motor units, decline of anabolic hormones (mainly testosterone), nutritional disorders (especially decrease of protein intake), deterioration of muscle blood circulation, insulin resistance, fat infiltration of muscles, mitochondrial dysfunction, several diseases (inflammatory conditions, osteoarthritis, neurological disorders). According to various studies the loss of lean body mass of legs is 1–2%/year and a strength loss is 1.5–5%/year.

The process of progressive and generalized skeletal muscle disorder with aging is called sarcopenia. The prevalence of sarcopenia in the community-dwelling older adults is up to 33%, but in long-term facilities or in a group of patients with debilitating diseases the incidence may be even higher. Sarcopenia is associated with many adverse outcomes including falls, fractures, hospitalization, worse prognosis for surgical treatment, physical disability, frailty syndrome and mortality. Stroke-related sarcopenia is a specific type of sarcopenia. In stroke patients, apart from the classic factors affecting muscle function, the problem is exacerbated by factors associated with brain damage.

According to the last opinion of the European Working Group on Sarcopenia in Older People 2 (EWGSOP2) muscle strength is the most reliable measure of muscle function. Handgrip strength is the most popular, easy and available method for measuring muscle strength in older adults. Some studies indicate correlation between handgrip strength with strength of other muscles. That is why this measurement may be used in screening. The cut-off point for sarcopenia (for handgrip strength) is <16 kg and <27 kg for women and men, respectively. Also *chair stand test* with the cut-off point >15s for five rises is recommended as a simple tool for muscle function assessment. For scientific purposes or when it is necessary to perform an in-depth analysis of muscle function, more complicated devices are used for muscle strength and power assessment.

references	participants	compared muscle	correlation
Bohannon RW, Percept Mot Skills. 2012	34 adults over 60	knee extension muscle	r= 0.56-0.68 (p<0.001)
Bohannon RW, Muscle Nerve. 2012	164 healthy men and women (18-85 years)	knee extension muscle	r=0.772 - 0.805 (p<0.001)
Samuel D Arch Gerontol Geriatr. 2012	healthy volunteers aged 60-82	knee extensors knee flexors hip extensors hip flexors hip abductors hip adductors	r=0.78 (p<0.001) r=0.78 (p<0.001) r=0.71 (p<0.001) r=0.77 (p<0.001) r=0.69 (p<0.001) r=0.56 (p<0.001)
Wiśniowska-Szurlej A Biomed Res Int.2019	209 older people aged 65-85 from long-term care facilities	strength of lower limb measured with chair stand test (s)	r=-0.27 (p<0.001)
Takahashi J, J Phys Ther Sci. 2017	31 inpatients with hemiparetic stroke	shoulder flexors shoulder extensors elbow flexors elbow extensors hip flexors knee extensors ankle dorsiflexors	r=0.68 (p<0.001) r=0.75 (p<0.001) r=0.77 (p<0.001) r=0.78 (p<0.001) r=0.51 (p<0.001) r=0.55 (p<0.001) r=0.71(p<0.001)

Table 1. Handgrip strength correlations with other muscle strength measurements

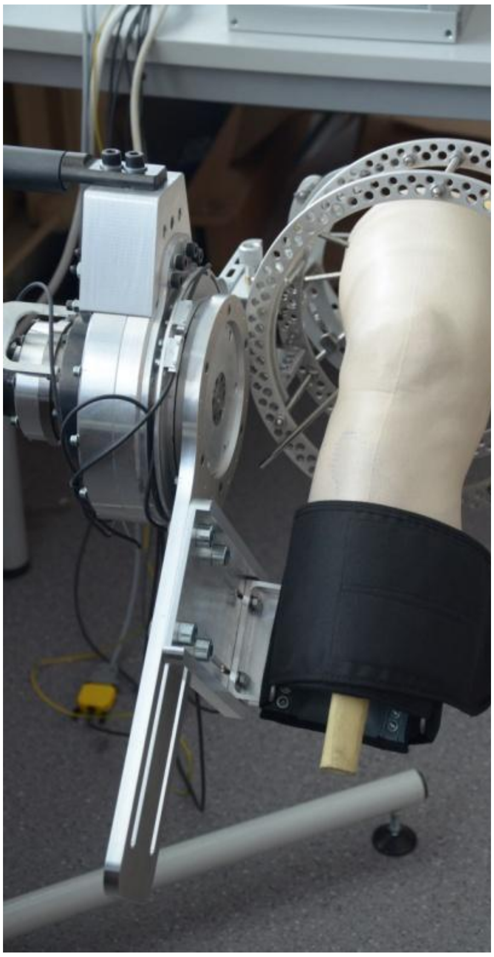
The Compact, Portable Knee Rehabilitation System

P. Sauer, K. Kozłowski, M. Trączyński
Institute of Automation and Robotics, Poznan University of Technology

Abstract: This work is focused on examining the possibility of increasing the effectiveness of knee rehabilitation by means of robotic systems. The purpose of the research was to design a rehabilitation system for the knee joint. This system will be used by children (6-18 years old) who have carried out a extension of the femur using Ilizarov apparatus. This project was realized in cooperation with medical team from Department of Orthopedics and Traumatology, University of Medical Sciences in Poznan.
The designed system consisted of the following subsystems:

- Executive module - a rehabilitation robot supporting knee movement,
- Control subsystem - as part of the project, impedance control was developed and implemented, which enables active knee rehabilitation,
- A measuring module that allows measurement of kinematic parameters, i.e. trajectories of selected points of the patient's limb in space during rehabilitation, measurement of angles between segments of the limb, their speed and acceleration,
- User interface, which is a separate application that connects to the master computer via a radio network,
- The security module is a multi-level security system that includes hardware and software security.

During the project two modular devices were designed and manufactured, The first prototype is a rehabilitation manipulator for the knee with one degree of freedom (Fig. 1a). As part of the project, a second construction of a rehabilitation robot was developed which takes into account the movement of the axis of rotation in the knee joint. Based on the analysis of the trajectory of the characteristic point on the tibia (the point located at the junction of the tibia and femur), special hinges were developed, which are the main element of the rehabilitation robot. Figure 1b shows the view of the rehabilitation robot with changeable position of the rotation axis.


a)

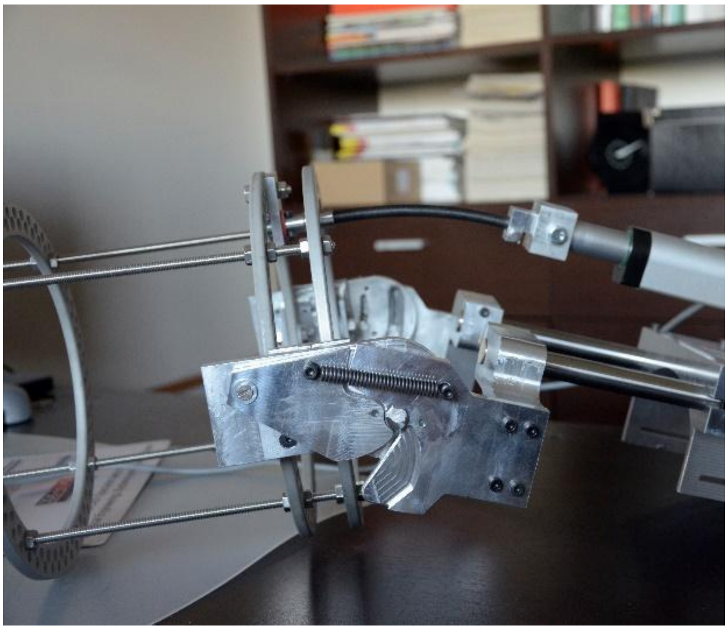

b)

Fig. 1 Two modular knee rehabilitation manipulators

a) the manipulator with one degree of freedom

b) the rehabilitation robot with changeable position of the rotational axis

Wearable hand rehabilitation system with force feedback

M. Trączyński, K. Kozłowski, P. Sauer
Institute of Automation and Robotics, Poznan University of Technology

Abstract: A constantly growing number of people affected by physical disability caused by diseases and injuries requiring post traumatic treatment and low availability of advanced and inexpensive rehabilitation systems induced the authors to become interested in this subject.

The aim of the work was to design, manufacture and program a hand rehabilitation system capable of improving effectiveness and speed up convalescence process. Designed robotic manipulator can decrease physiotherapists involvement during patients demanding treatment, which can result in increasing the treatment quality and the number of patients rehabilitated at the same time. Small size and portability of the system could allow the users to undergo rehabilitation at their own in their homes, which may have a positive impact on treatment progress.

The device is intended for people with neurological and orthopedic injuries resulting from stroke, Parkinson's disease, musculoskeletal disorders and upper limb injuries. The system relies on the neuroplastic abilities of nerve tissue to create new connections and self-repair by stimulating the proprioceptive system. Proposed system has two 1 DOF robotics arms allowing for independent movement around the thumb four fingers MCP joints. Each arm is equipped with the latest generation force sensors and is driven by digital servo. This approach and embedded ARM controller allowed the authors to implement force control algorithm. Built-in sensors can be used for the measuring treatment progress. In the project, the authors used interdisciplinary knowledge in the field of mechanics, electronics, control, and basics of anatomy. The design and functionality of the device was consulted in terms of physiotherapy.

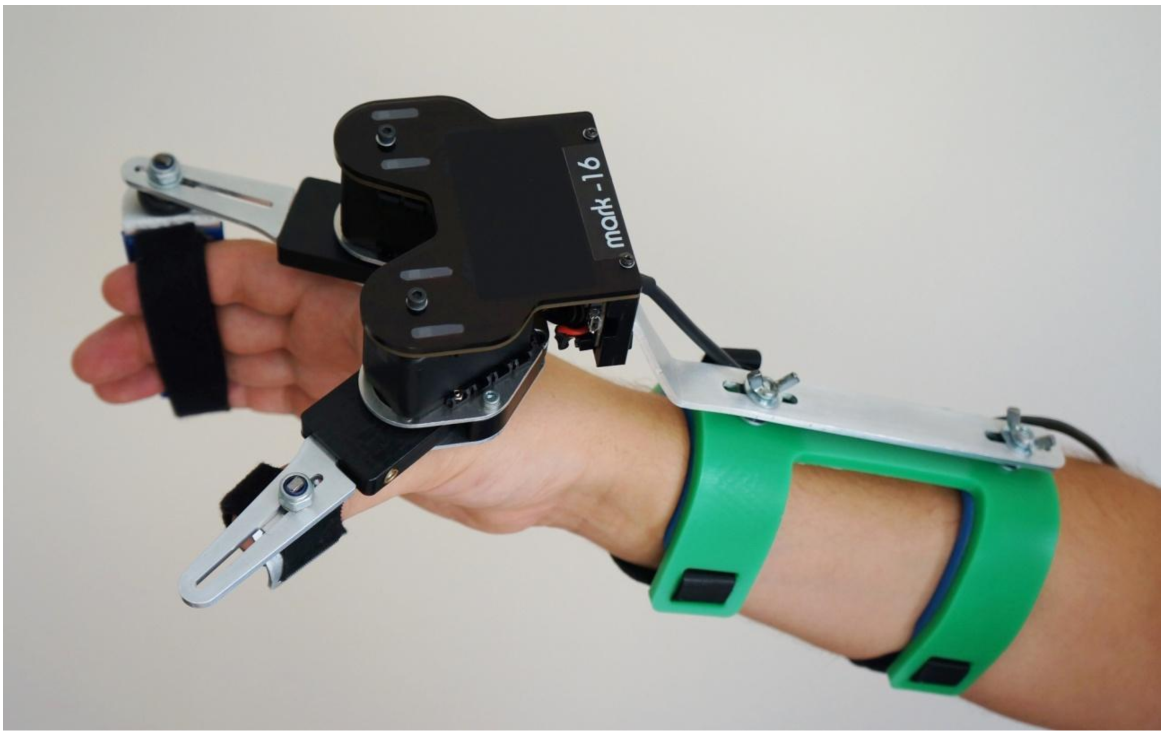


Fig. 1 Wearable hand rehabilitation system with force feedback

Research at Human Centered Robotics Laboratory

G. Granosik
Institute of Automatic Control, Lodz University of Technology

Abstract: Human-centered robotics is a vision to address how robots can live among us, assist people, and take over tasks where our current society has shortcomings. The research on such idea at our Institute started long before the actual laboratory was established. In 2009 the prototype of the rehabilitation robot for lower extremities was developer. It has 5 DOF and can actively move the leg in the 3D space combining movements in sagittal and coronal planes, exercising knee flexion, hip flexion and adduction; and it can be used for people lying in bed (as shown in Fig. 1). The main advantage over existing similar solutions is that it provides simultaneous two-plane motion exercises for the knee and the hip. One of the methods for programming the exercises is following the therapist's movements and recording trajectories. Compliance control applied to each axis allows detecting the patient's force counteraction and muscle spasticity. Additionally, various protection systems that allow the robot to be used for rehabilitation therapy of persons with locomotive disabilities are presented.

Another project was devoted to children with Autism Spectrum and their therapists – and was caller Robotherapy. Interdisciplinary groups of students in the fields of Automatic Control and Robotics at the Lodz University of Technology and Industrial Design (Strzeminski Academy of Fine Arts) were cooperating to recognize problem and create interactive devices to support it. A total of nine educational devices have been created in various forms to support sensory therapy as well as applications enabling programming of these devices, as shown in Fig. 2. They can apply various stimuli of varying intensity, according to the therapeutic plan - it can be sound, light, temperature, vibrations or movement. With interactive software and toys, children learn to enter into relationships, learn the right behaviors and reactions in contact with the environment.

The Human-Centered Robotics Lab is also equipped with the Research Platform called Kube consisting of robotic cell (with two Kuka iiwa cobots) and an operator console with haptic devices and 3D visualization system connected via Ethernet, as shown in Fig. 3. Platform can be used for fundamental robotics research, human-robot interaction tests, and prototyping robotic assembly tasks.

In the most recent human-centered project we present the methodology and results of designing a robot for presenting epileptic seizure, as shown in Fig. 4. The goal of the project was to create a prototype device for series of pilot workshops for improving teachers reactions during an epileptic seizure and their attitudes towards epileptic students. The goals of the design process were to design a robot for presenting most important parts of epileptic seizure (especially generalized tonic-clonic seizure): (1) the particular movement of a whole body, especially limbs, with high muscle tension simulation and oscillation of limbs with varied amplitude and frequency, (2) Ictal cry, and (3) widening of the eyes. The robot is based on a distributed architecture with separate modules for communication and audio (in head) and motor controllers (in torso and limbs).

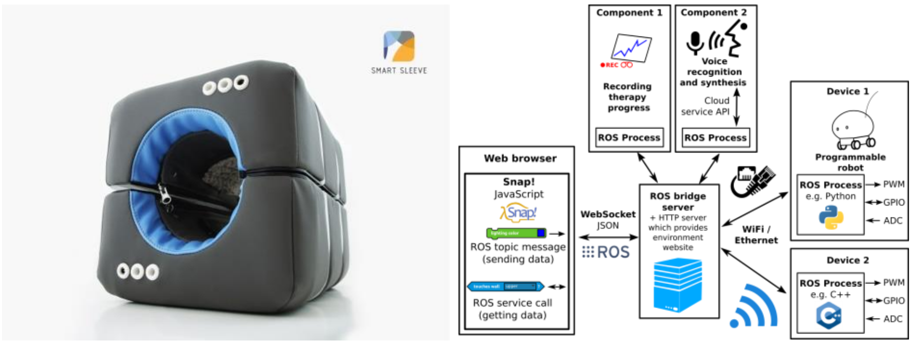


Fig. 1 Rehabilitation robot

Fig. 2 Smart sleeve for sensory therapy and a structure of ROS based controller

Fig. 3 Kube – the Kuka iiwa based universal research platform

Fig. 4 Robotic phantom to imitate an epileptic seizure

Design for users with special needs - universal design

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Abstract: Poland is struggling with the problem of population aging. However, awareness of the need for extensive action is still insufficient. Conducting research and classes with students of the design department in the field of design, we take actions to encourage young designers to broadly look at the needs of potential consumers and users. We try to show the great potential that lies in design skills for users with special needs. That is why we have been familiarizing students with the idea of universal design for several years. We try to widely propagate this idea by showing that, in almost every field of design or business, universal solutions can greatly help and develop the capabilities of a company or a designer. Seniors naturally appear and will increasingly appear both as consumers and employees - full-fledged, but sometimes with special needs. Awareness of the need to adapt jobs or commercial offer in the range of products and services to the needs of specific users, which are seniors, will be everyday life. The education of empathic designers who are aware of the essence of universal design is one of the responsibilities of a university with a design profile. Also for economic reasons, seniors may be an interesting purchasing group, as their number is systematically increasing and also their purchasing power is increasing. With the senses of senses of old age, we can, together with students, experience the difficulties faced by seniors. In addition, we show that universal design can also positively affect the relationships and emotions of all users from children through young people, mothers with young children, people with disabilities to seniors. We show the results of our research and their effects in the form of student projects as an interdisciplinary team at various design, marketing and management conferences.

Fig. 1 Simulator of senses of old age and an example of universal product

Recovery from Stroke
- Effect of constraint-induced movement therapy for chronic severely paralyzed hands in randomized study with an independent rater -

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Abstract: Most stroke survivors get hemiplegia. Especially upper extremity and hands get severe. On the other hand, lower extremity is easier to be recovered. 80 percent of patients are able to walk again. Most doctors and therapists believe patients recover from hemiplegia within 6 months from stroke. No recovery after 6 months. That is what they believe. Japanese medical insurance will not cover any medication after 6 months. Nowadays we have started understand No recovery after 6 months is not true. Some reports proof it. If hemiplegia patients use bad side of hand and leg for some period intensively, they can recover even after several years after from stroke. Recovery of arm, hand means brain where control them recovered. Fig.1 is called cerebral cortex. Point A are where primary Motor Area(M1)is. In another words, this is where switch for left hand is. If nerves from this switch is damaged by stroke, patient gets plegic hand. Then brain try to create another switch for plegic hand. Most of case, it will be behind M1 where it is called Sensory area or in front of M1 where it is called promotors area or the another side of M1. However newly created switch is not as good as old switch. It only moves hand a little. Chance of regain perfect switch increases only if patient does proper repetitive movement for 6 hours for 2 weeks. This rewire of brain is called Cortical reorganization of brain. Constraint Inducement therapy is hot for chronic stroke patients with hemiplegia. Effectiveness of CIMT is well known globally as most recommended therapy. In CIMT, we use very sophisticated technic in order to get proper movement. The Active Ranges of Motion of the fingers and wrist joint sufficient for each movement are specified as the indication criteria. The most frequently adopted grade in CIMT reports is Grade 2, and efficacy has also been reported for Grade 3 and Grade 4. The criteria for Grade 5 represents severely paralyzed hands that are only able to slightly extend the joint of one of the fingers, and only a few studies have been reported worldwide. I will talk about the effect of constraint-induced movement therapy for chronic severely paralyzed hands in a randomized study with an independent rater (Fig.2).

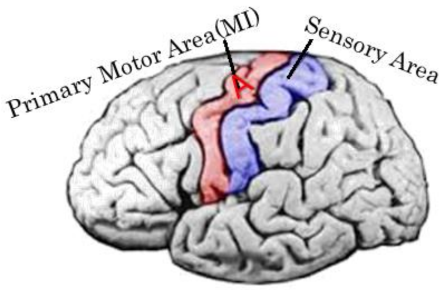

Fig. 1 Cerebral cortex illustration **Fig. 2** Tanabe therapy used in grade5-Citherapy

Effect of Introducing EMG Biofeedback to a Finger Extensor Facilitation Training Device for Hemiplegic Patients after Strokes

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Abstract: Biofeedback systems have been developing rapidly in recent years as rehabilitation methods for hemiplegic stroke patients. To investigate the value of our developed device named PARKO for the extensor muscle training of these patients, we made the hypothesis that the patients can increase the muscle activity of extensor of the paralyzed finger extensor by using biofeedback of electromyography (EMG) signal. The purpose of training with the PARKO is to strengthen the finger extensor of the hemiplegic hand. We conduct clinical test using an A-B-A-B design to verify the introduction effect of biofeedback of EMG signal.

In our experiment, a hemiplegic patient participated in an A1-B1-A2-B2 training session with the PARKO. Figure 1 shows the training scene. During the A sections, the subject was training without any feedback, while in the B sections, the subject was training while receiving feedback from the EMG signal on the screen. Since muscle activity generates EMG signals and large output in extensor digitorum muscle is expected in a successful treatment, we evaluated the effectiveness of each training trial by recording EMG signals for the extensor and flexor digitorum muscles with the result shown in Fig2. It can be found in the A sections that, A2 showed a 1.36 times improvement over the A1 section due to the effect of the biofeedback system from the B1 section. For the B sections, a tendency for rapid growth can be clearly seen in both two B sections, as the subject utilized the biofeedback system to find a more rewarding position during the procedure.

By comparing the EMG values from each section, we were able to conclude that the training with the PARKO became more effective when the biofeedback system was applied. This also demonstrated that, by using a biofeedback system, it would be possible for stroke hemiplegic patients to conduct highly efficient self-rehabilitation.

Fig. 1 Training with the PARKO

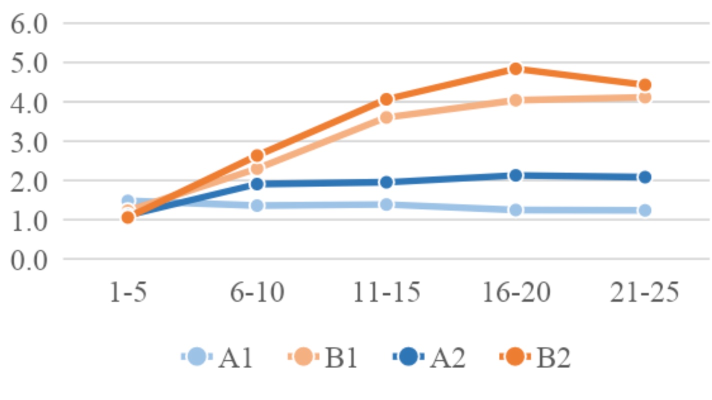

Fig. 2 The ratio of extensor and flexor muscle iEMGs when collated into groups of five

These results were published in the proceedings of Int. Conf. on Control, Automation and Systems 2019 (ICCAS2019 in Jeju, Korea), pp.184-187 (2019.10)

Objective assessment of changes in body posture and their consequences in post-mastectomy women - recommendations for rehabilitation

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Abstract: Women who have undergone a unilateral mastectomy (BG) understand the important role played by external breast prostheses (EBP). As previous was shown, for these groups of women, EBP have a function in posture, balance, shape, self-appearance and appearance to others, as well as providing them with a sense of wellbeing, self-confidence and femininity. Prospective studies of women treated surgically for breast cancer have demonstrated that a unilateral mastectomy causes significant changes to overall body posture, such as an asymmetry of the trunk and shoulder girdle, an increase in the forward lean of the trunk, and an asymmetry in the position of the scapula. The unilateral EBP distorts postural muscle activation and trunk symmetry, which can develop over time. In my studies authors look for the best medical, comprehensive equipment for objective assessment of body motion (trunk) in BG. In one of study which was conducted in fifty-one BG due to breast cancer (divided into subgroups: without EBP, with three different weight EBP). Surface electromyographic data were collected using a 4-channel electromyography (EMG) device (Noraxon TeleMyo 400, Noraxon, Scottsdale, AZ, USA). EMG signals were detected using electrode pairs applied at the L3-4 level over the erector spinae muscles (ES). The aim of the study was to determine if the weight of EBP can affect the biomechanics of the trunk during functional movement. Results of this study showed that the weight of EBP did not contribute to posture changes in BG. It means that the postural asymmetry cannot be affected by the mechanical external load on one side of the body. This finding did not support the traditional concept of prescribing to wear EBP which should have the same weight as the removed tissue to someone who underwent a mastectomy. We compared both sides of the trunk. The mean level of activity of ES was not affected by the weight of EBP during all the functional body tests (□ > 0.05). There was no change in the activity of ES between the two sides (the mastectomy and non-mastectomy side of the body) in the most symmetrical movements of the trunk (□ > 0.05) even though different weights of EBP were used. Next, this the aspect in the body posture and muscle condition led us to consider their influence on the whole-body movement dynamics like balance or body-weight distribution in BG. Both issues were measured using standard pedobarography and the center of feet pressure (CoP) variability assessment, which are very commonly used quantitative clinical tools. The objective of this study was to assess the plantar pressure and CoP progression in BG by comparison with healthy subjects. The next objective was to assess differences in the plantar pressure and CoP progression in BG, wearing EBP differing in weight and to find out which weight of EBP gave results closest to the control group results. There were no statistically significant differences in CoP features between BG (without prosthesis) and the healthy subjects. We did not find any statistically significant differences in the CoP features tested between trials using different weight of EBP in BG. The weight distribution on the supporting surface did not differ statistically significantly in spite of the differing weight of EBP. At least we wanted to measure the influence on effect of EBP on temporal and spatial gait parameters in BG. The 3-D accelerations of human

trunk during walking were measured with The DynaPort MiniMod TriAcc (DynaPort1 MiniMod, McRoberts BV, The Hague, the Netherlands) which contains three orthogonally oriented acceleration sensors. The gait parameters taken into consideration were: walking velocity (WV), cadence (C), step length (SL), step time (ST) and L-R asymmetry which was calculated as the difference between the left and right step time divided by the bilateral average. The comparison between the results of the gait parameters with and without EBP of the age groups shows that younger women with EBP walk faster with longer step length and shorter step time than during a gait without prosthesis. The gait without prosthesis was slower ($p<0.001$), SL was shorter ($p<0.01$), C and the step time asymmetry was lower ($p<0.01$) compared with the subject from the control group. Our previous studies were conducted using different tools but none gave us satisfactory assessment of trunk movement in women who underwent unilateral mastectomy. ~~Maybe~~ the indication to the selection of weight of EBP may have to be more thoroughly verified.

Fig. 1 Placement of EMG electrodes

Stoma-Alert - new monitoring and diagnostic tool for patients with intestinal stoma

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Abstract: Intestinal stomas are the surgical exterioration of either small or large bowel through the anterior abdominal wall. In Poland the number of patients with ileostomy (stoma of the small intestine) is more than 6,000 people, and with colostomy (stoma of the large intestine) more than 33 000 people. There are more than 40 000 people registered with a stoma in our country. This whole group of people is the recipient of the results of our project and it will benefit. For comparison, in US there are about 800,000 people with an intestinal stoma. Every year, surgeons make intestinal ostomy in 120,000 new patients. Complications of the stoma are a very serious clinical problem and can affect most patients with a stoma. The incidence of early and late ostomy complications ranges between 20% and 70%. More complications are related to ileostomy than colostomy - 55% and 39%, respectively. They are not only a clinical problem, but also an economic one, because each of them requires classification and appropriate therapeutic treatment. After discharge patients with stoma complications meet difficulties with maintaining contact with stoma nurse or surgeon.

There are some aims of our project: 1. new classification system and the semantic model of the intestinal stoma and stoma complications based on photos and videos. The first goal provides data to the next step: 2. semi-automatic application helping patients to describe uncomplicated and complicated stoma and suggest the treatment modalities. The application will also cooperate with the consultancy centre (stoma nurse, surgeon) to provide the further course of action depending on the state of diagnosed changes (possible stoma complications). The application will use stoma images and 3-D short videos of stoma taken and sent by patients also to monitor the pathological alterations in stoma by the comparison of photos stored in the archive.

The IT system will enable remote diagnosis of the stoma and patient's condition. We assume that it will reduce the costs of diagnostics and will reduce the time needed to react in cases requiring sudden medical or surgical intervention as much as possible.

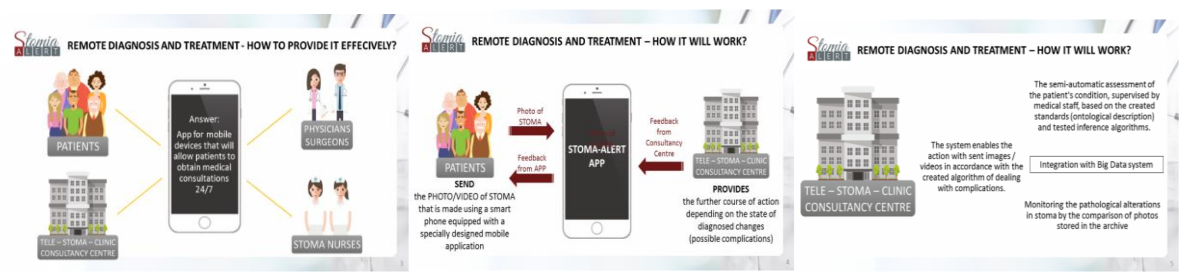

Fig. 1 The scheme of action of Stoma-Alert system

Model of commercialization of interdisciplinary research projects – case study of the 'Stomia-Alert' project

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Abstract: Colorectal cancer and inflammatory bowel diseases are the main indications to creation of intestinal stoma. The substantial group of ostomy patients may need continuous monitoring from medical staff (stoma nurse and surgeon). This results from high risk of stoma complications in postoperative period after discharge from the hospital.
The Stoma-Alert IT system will enable remote diagnosis and suggest the treatment of stoma complications in semi-automatic modality as well as in cooperation with consultancy center (medical staff: stoma nurse and surgeon). The IT system gives benefits not for patients but also for medical market, stoma companies and health system (reducing costs of diagnostics).
The first idea of the project was born from cooperation between consulting company, medical staff and engineer staff and developed during several meetings. Finally, industrial & scientific consortium consisted of PHIN Consulting LTD (Leader) and Lodz University of Technology – Institute of Automatic Control (Partner) realizes the 1st phase of the project – industrial researches related to creation of an ontological model of the stoma and its complication together with automation of the process of classification in complicated stoma. The first phase will be followed by the 2nd project, where consortium plans to achieve the final product (Stoma-Alert IT system) with element of augmented reality, which will be the subject of industrial research and development works.
Taking into consideration several models of commercialization used in business practice and discussed in management sciences, consortium deliberates a few alternative modes of market implementation of the final product: a) participation of a pharmaceutical/ stoma company in the 2nd stage of product development, resale rights to solution or grant a license to this company; b) independent (within the existing consortium) realization of the 2nd stage of the project, subsequently resale rights to final solution to a stoma company or c) independent (within the existing consortium) realization of the 2nd stage of the project, next grant a license to a stoma company.
Undertaken economic analysis indicate that the most profitable way of commercialization is to engage a selected pharmaceutical/ stoma company in the product development under the second stage of Stoma-Alert project and grant a license in order to implement the Stoma-Alert IT system to the market.

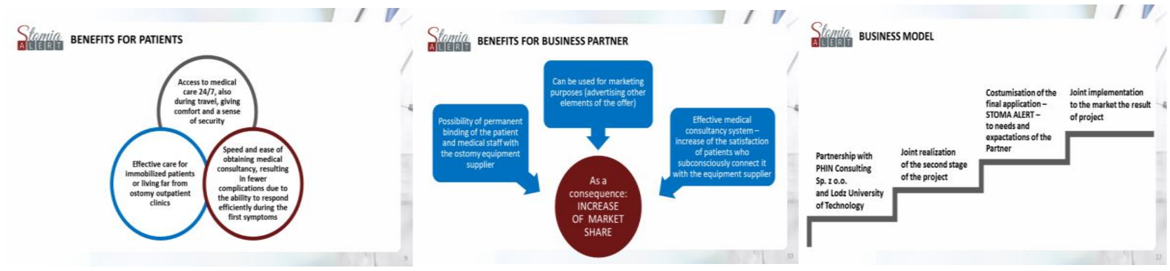

Fig. 1 Benefits for patients and the market. Business model for Stoma-Alert IT System

How can we promote neurorehabilitation and neural repair after stroke?

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Abstract: Stroke is a neurological disease that affects mainly older people. Currently, the number of first strokes increased approximately by 68% and also the number of the disabled people is increasing largely in the world. Consequences of stroke have an impact on many different areas of functioning such as motor dysfunctions, speech and language problems, cognition impairment as well as swallowing, sensation, vision and social participation problems etc.). Therefore, the complex rehabilitation program is very needed to facilitate and promote brain recovery and neural repair. The movement dysfunction is one of the key problems after stroke. Motor relearning during rehabilitation program is based on repetition. Therefore, intensive, repetitive task-specific training, which involves the active practice of task-specific motor activities, is recommended after stroke. Neuroplasticity is a hallmark of spontaneous and functional recovery after stroke. This process is based on strengthening existing synaptic pathways, and then creating new connections. The human brain, after damage, has the ability to restore its function, through the use of a distributed neural networks, which are located in the regions that were not be touched by the brain injury. There are many different factors that have an impact on neuroplasticity after stroke. These factors are able to boost the creation of new axons and support the augmented elaboration of spines and dendrites. In medicine there are several drugs that can induce neuroplasticity and neuronal growth. However, there are not involved in reducing infarct volume or in enhancing brain reperfusion. Many studies evaluate the potential role of D-amphetamine, Levodopa, Fluoxetine, Niacin, Inosine and Citicoline in improving motor recovery in post-stroke patients or in animal models with different results. Currently, there is also the huge development and innovations of the next-generation rehabilitation robots that can lead to significant benefits in neurorehabilitation. Robots can conduct both the movement controllability as well as the measurement reliability. Therefore, it is perfect tool for doctors and therapists for facing with the neurorehabilitation challenges. Individually, tailored rehabilitation to each patient with different abilities, functional needs, and interests is the most important challenge in post stroke care. Therefore, the personalization of a prescribed rehabilitation program and is also crucial to an assistive device. More autonomous use of robotic therapy systems makes the personalization of the human technology interface very important. There are three main types of lower-limb rehabilitation robotic systems: stationary systems (exoskeleton-type devices and programmable foot end-effector devices), over ground walking systems and wearable robotic walking devices. The another thing used in neurorehabilitation is virtual reality training and interactive video gaming that allows patients to interact with the environment and also gives patient feedback about their activities. This kind of therapy is a very attractive and motivating. It can be much more effective stimulation of functional tasks with a higher dose than traditional therapies. Those methods are used for improving not only motor function (upper limb, global motor function, gait, balance) but also for cognitive function. The advantage of this therapy is that it can be used without direct supervision of the therapist, e.g. in a home environment.

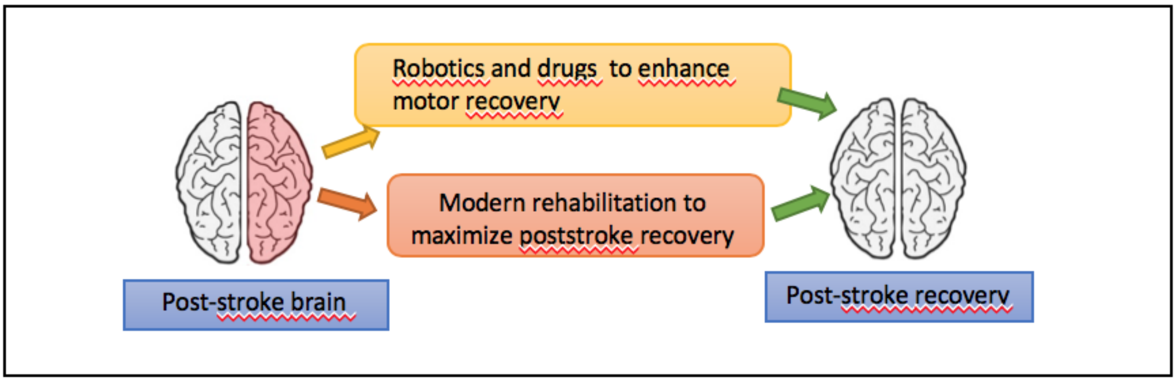

Fig. 1 An impact of robotics, drugs and modern rehabilitation on recovery

Effectiveness of post stroke rehabilitation – two years observation Case study

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Introduction: Stroke is the third most common cause of death and the main cause of permanent disability and lack of independence in adults. In Poland around 60 000 new cases of stroke are registered every year. Early and comprehensive rehabilitation after a stroke in necessary to regain psychomotor performance.

Case report: The presented clinical case refers to a patient after strokes. the patient went through a 6-week rehabilitation program in the Neurological Rehabilitation Department.

Methods: The following tools were used to assess the effectiveness of the treatment: Barthel Index of Activities of Daily Living (Barthel ADL), Rankin, National Institutes of Health Stroke Scale (NIHSS). The study assessed functional efficiency from two years ago, as well as at reception and discharge.

Results: In the present case first and foremost, the patient's ability to carry out daily self-care activities improved (Barthel ADL 3 versus 10).

Conclusion: The presented case indicates the need for long-term rehabilitation, that may ultimately facilitate significant functional improvement.

Type of scale (norm- max. symptoms)	Neurological Rehabilitation		
	two years ago	admission	discharge
ADL[1] (20-0)	3	6	10
Rankina (0-5)	5	4	4
NIHSS[2] (0-42)	13	10	8

Table 1. Comparison of the results of functional and psychological assessment of the patient

[1] Activities of daily living
[2] National Institutes of Health Stroke Scale

Kinesitherapy	Physical therapy	Pharmacotherapy
passive exercise	sollux	Beto Zk
active - passive exercise	electrostimulation	Atoris
free active exercises		Acard
mobilization of small joints		Tolura
breathing exercises		Rimal
balance exercise		Tetralysal
manual skills and self-service exercises		Soolantra
exercises general rehabilitation		Diuresin
postural therapy		Ointment made with neomycin and hydrocortison
active erect position, preparation for walking		Kalipoz prolongatum
PNF/Bobath		

Table 2. Summary of physiotherapy and pharmacotherapy used

Rehabilitation in multiple sclerosis- case report

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Introduction: Multiple sclerosis (MS) is the most common disease of neurological system. Pharmacological treatment together with kinesiotherapy, physical therapy and psychological treatment allow to partially regain the functions lost due to MS relapse and slow down the disease progression.

Case description: Patient with paresis of lower limbs due to MS was admitted to Neurological Ward of Jonscher Hospital of Lodz. As a result of MS relapse the patient experienced decrease of efficient mobility, decrease of lower limbs strength, impaired locomotor efficiency and difficulties on a daily basis and self service range. At first the patient was weekly hospitalized, then he was admitted to Neurological Rehabilitation Ward on four-week rehabilitation programme.

Methods: Lovett Scale, Barthel Index for Activities of Daily Living (ADL), Rankin Scale, Benton Visual Retention Test, The Montreal Cognitive Assessment (MoCA), Beck Depression Inventory (BDI).

Results: Improvement in self service (ADL 14 vs 18/20), gait improvement- unaided gait, improvement in Rankin scale was observed (4 vs 3).

Conclusion: Cases after MS relapse such as mentioned above need rehabilitation, which can lead to significant functional improvement.

Methode	Results before rehabilitation	Results after rehabilitation
Lovett[3] for upper left limb	4/5	4/5
Lovett for lover right limb	3/5	3/5
Lovett for lover left limb	2+/5	2+/5
Barthel ADL[4]	14/20	18/20
Rankin scale[5]	4/5	3/5

Table 1. For medical methods

[3] Lovett scale estimates muscle strength; range 0-5; 0 no movement, 5 active contraction with full resistance
[4] Barthel Index for Activities of Daily Living assesses functional independence; 0 unable, 20 independent
[5] Rankin scale that measures degree of disability where 0 is lack of symptoms, 5 is severe disability

Methode	Results before rehabilitation	Results after rehabilitation
BVRT[6]	5 correct, 11 incorrect	5 correct, 11 incorrect
MoCa[7]	24 pure points	27 pure points
BDI[8]	5 points, lack of depression features	2 points, lack of depression features

Table 2. For psychological methods

[6] Benton Visual Retention Test measures visual perception and visual memory

[7] The Montreal Cognitive Assessment detects cognitive impairment range 1-30; 24-light cognitive impairment, 19- dementia

[8] Beck Depression Inventory; range 0-63; 10-27-moderate depression 28<severe depression

Rehabilitation after Craniocerebral Trauma in Annual Observation – Case Report

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Case Report: On 14th August 2016 a 27-year-old patient was admitted to Military Medical Academy University Teaching Hospital with a head trauma. General condition of the patient upon admission to the hospital - very severe - 3 pt GCS. CT scan of the head was performed, which showed – extensive subdural haematoma over the left hemisphere of the brain with size up to 1,3 cm thickness, causing severe mass effect with pressure. A left-sided fronto-parietal-temporal craniectomy was summarily performed and acute haematoma was decompressed. On 16th September 2016 PEG was set up. On 24th Novemver 2016 roku patient was discharged from the hospital. 5th December 2016 roku patient – conscious, very superficial logical contact, tries to follow simple instructions. Tetraparesis. Patient needed help of other poeple, didn't walk – was first admitted to Neurological Rehabilitation Ward. On 19th April 2017 a plastic surgery was performed on the fronto-parietal-temporal bones and Codubix prothesis was implanted. On 6th September 2017 patient was admitted to Rehabilitation Ward for a second time.

Methods: Patient underwent comprehensive rehabilitation between 5th December 2016 - 22nd February 2017 roku and 6th September 2017 - 11th October 2017. The functional efficiency was examined, as well as metal state at the admissions, discharges and nowadays. 4 scales were used - Barthel ADL, Rankin, MoCA and Ashworth. After completing the stay at Neurological Rehabilitation Ward patient was learning how to talk with a help of quad cane. After the second stay patient was walking without using any tools while being safeguarded. The efficiency was improved. Impaired coordination and balance was greatly reduced. Muscle strength of upper right extremity improved. One year after craniectomy patient was moving within his apartment by himself and walking up- and downstairs and outside while being safeguarded.

Results: In depicted case, first and foremost, the self service improved (result in Barthel Activities of Daily Living Index: change from 0 to 20 and Rankin scale: change from 5 to 0). Thanks to comprehensive, continuous and systematic rehabilitation the patient became a self-reliant person. Results of functional and psychological tests are summarised in the table.

Conclusions: Depicted case shows necessity of conducting long-term rehabilitation, which may result in major improvement in functioning.

Type of scale	Rehabilitation				
	Admission	Discharge	Admission	Discharge	Nowadays
Barthel ADL (0-20)	0	2	9	15	20
Rankin (0-5)	5	5	3	2	0
MoCA (0-30)	0	2	6	10	15
Ashworth (4-0)	KGP 4, KDP 4, KGL 3, KDL 3	KGP 3, KDP 3, KGL 1, KDL 1	KGP 2, KDP 2, KGL 0, KDL 0	KGP 1+, KDP 2, KGL 0, KDL 0	KGP 0, KDP 0, KGL 0, KDL 0

Table 1. Results of functional and psychological tests

Rehabilitation Attitude for Improving Neuroplasticity in Stroke Recovery

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Reducing brain injury and enabling maximum recovery of post acute stroke patients are the major goals of stroke management. One of the key factors on which therapy effectiveness depends is the early implementation of treatment and rehabilitation. Due to the high plasticity of the brain, immediate and long-term rehabilitation allows reducing the neurological deficit. Neuroplasticity is a compilation of natural processes occurring in the brain throughout its life. The term refers to the ability of nervous cells to strengthening existing synaptic pathways and create new intercellular connections, associated with reorganization, adaptation, and self-improving of the brain, learning and memory processes. Thus, phenomenon of nervous system plasticity enables spontaneous and assisted recovery of post-stroke patients. However, the compensatory plasticity of a damaged brain, which takes place in critical conditions, is a completely different process than plasticity in a properly functioning brain. Existing connections between brain centers, even if they remain active, become weaker. The restore of brain function is based on the distributed functional neural networks, which are located in the regions that are not touched by the brain infarction. Regenerative processes within the brain tissue are limited and are regulated by tissue environmental properties created by many different factors (the classic neurotrophins, ligands of Glial cell Derived Neurotrophic Factor (GDNF), and neuropoetic cytokines) that have an impact on neuroplasticity after stroke.

The process of post-stroke recovery can be modulated and amplified by suitably carried rehabilitation.

The Table below shows methods used as independent therapies or in addition to the conventional treatment.

Restorative/rehabilitative Post-stroke Therapies	Short characteristic
Repetitive task training (RTT)	Motor learning based on intensive, repetitive task-specific training
Aerobic Training	Aerobic training with the stimulation of brain plasticity
Constraint-Induced Movement Therapy (CIMT)	Intensive therapy of the affected arm with limiting the use of an intact limb, in order to reorganization of cortex area responsible for innervation of affected upper extremity
Strength Training	Progressive resistance training which improves muscle strength
Robotic-assisted Rehabilitation	Robotic devices use end-effectors, such as exoskeletons or harnesses in order to guide or assist the planned motions
Mirror Therapy	Mirror therapy aims to give the impression that the affected side is a non-paretic side
Computer-based Virtual Reality Training	Usedo to improv both motor and cognitive function, introduces the patient to the virtual world and enables his interaction with the environment and allows him to receive feedback about his activities
Noninvasive Brain Stimulation (NIBS)	These methods noninvasively modulate brain activity in order to restoring the interhemispheric balance by inhibiting healthy hemisphere or stimulating the lesioned one.
Neuromuscular Electrical Stimulation	Increases muscle contraction, improves motor skills, enhances serum BDNF level
Magnetic Field	Increases neuroplasticity and functional recovery after stroke by enhancing level of neurotrophic factors

Table 1. Methods used as independent therapies or in addition to the conventional treatment

Rehabilitation Program Patient with Multiple Sclerosis – One year Observational Study

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Introduction: Multiple sclerosis is a progressive disease of a central nervous system. It is said that 2 300 000 people on the world and approximately 700 000 in Europe are suffering from MS. The disease is also called young adult's disease, because age of onset falls on 20 to 40 years of age. Women get sick more often than men.

Case study: The case concerns thirty-three years women, which was admitted to a neurorehabilitation ward in Karol Jonsher's hospital in Lodz in order to improve sense of motor skills. Patient has diagnosed the multiple sclerosis (type remitting-relapsing). CT scan showed heterogenous outbreak, which seems to be dependent on MS. As a result of the disease woman suffer from spastic paresis of lower limbs with weakened muscle strength. Rehabilitation team tried tilt the patient to an erect position. After treatment and rehabilitation process there was observed paraparesistic gait with two-wheeled support and therapist's help.

	Before rehabilitation	After rehabilitation
Lovett Scale (5-0)		
Lower Right Limb	2+	3
Lower Left Limb	1	2
Babinski's symptom		
Lower Right Limb	+	+
Lower Left Limb	+	+
Ashworth's modified scale (0-4)		
Spasticity Lower Right Limb	1	1
Spasticity Lower Left Limb	3	2
Barthel ADL Scale (20-0)	6	12
Rankin scale (0-4)	4	4

Table 1. Comparison of the results of the tests used, 2018

	Before treatment	After treatment
Barthel ADL scale	9	13
Rankin Scale	4	3
MOCA scale (30-0)	26	23
BDI scale (30-0)	24	15

Table 2. Comparison of the results of the tests used, 2019

Kinesitherapy	**Physiotherapy**	**Pharmacological treatment**
1. Passive exercises 2. individual general exercises 3. isometric exercises 4. poisometric muscle relaxation 5. non-weight bearing exercises 6. mobilisation of small joints 7. balance and proprioception exercises 8. Burger's exercises 9. Conducted exercises 10. active verticalization 11. PNF 12. preparation for locomotion 13. the motoring activities 14. learning to walk on crutches and auxiliary equipment	1. cryotherapy 2. tonolysis 3. Magnetic field 4. pneumatic massage	1. Baclofen 2. Pantoprazole 3. Cital 4. Ketoprofen-SF 5. Clemastinum 6. Atrovent 7. Nebbud 8. Furaginum 9. Trittico CR 10. Ibuprofen 11. Enterodr 12.Taromentin 13. Sebidin 14. Kalipoz-prolongatum 15. Medrol

Table 3. Summary of physiotherapeutic and pharmacotherapeutic treatments used learning

Results: The therapy has resulted in an improvement in muscle strength according to the Lovett scale by one point and also a significant improvement in the functioning according to the Barthel ASL scale.

Conclusions: In case of SM, it is worthwhile to apply long-term therapy, because it seems to be the only condition a significant improvement in the quality of life and daily functioning of patients.

Design of a device supporting plegic hand rehabilitation

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Abstract: The purpose of the work is to create a device that helps systematic hand exercise of plegic hand. The sooner the patient begins to exercise the hand, the greater the likelihood of recovery. The designed device should accompany the patient throughout the day, mobilizing to exercise hands in the form of an "electronic physiotherapist".
Most of the available solutions for rehabilitation are adapted to the hand, which is at least partially functional. These devices are usually sensorized glove, which allows the patient to exercise in virtual reality simulation. [1] Exoprostheses are used for the rehabilitation of the plegic hands, which, due to their size, prevents the patient from using them throughout the day.[2] The available solution developed by Christian Medical College in 2013[3] is based on an electronic system without a patient interface, external power supply and storage of collected data. Noting these deficiencies, we decided to construct a patient-friendly device that would facilitate the work of physiotherapists. We developed "Handle IT" device with a color display, accelerometer and the ability to save data. By using flex sensors used in gloves to remotely control robots, we have the opportunity to measure the correctness of the exercise. The design of the mentioned college contained 5 sensors, which significantly increased the price of the construction. Given the need for proper muscle stimulation, we should activate the hand from shoulder to fingers. We used an accelerometer that checks the displacement of the entire hand. The use of the LCD display gives the patient the opportunity to become familiar with the exercise, check his result along with a summary of the whole day of training and reminders to connect the device for charging. The selected display model stood out from the others by the presence of an SD card port, which contain graphics with exercise instructions used in the program. In addition, the SD card save the patient's results from each exercise day so that the physiotherapist after the end of the exercise cycle can draw a graph from the data and check the patient's progress. As we want the easiest way to put the device on an inert hand, we will use fasteners in the form of conductive magnets, which, when connected, will turn on the device as a result of closing the electrical circuit and turn it off in an antagonistic way. In terms of construction, we decided to use highly flexible silicone and a lycra double-finger glove. During the prototyping of the assembly method on the hand, there was a problem with flex sensor cooperation with the hand. In order for the sensor to be in constant contact with the hand (without standing), we designed flat spiral straps with loops that work together with the hand and hold the sensor in the right place.
We conducted tests on the dependence of the sensor deflection angle on its resistivity. The collected data show that as the angle increases, resistance increases smoothly. During the initial assembly of the system, we noticed how important the optimization of electricity consumption is, so that the lithium battery can power the system throughout the day. As a result, we pre-programmed screen blanking for the break from exercise. Price optimization is also an important element of the project of the construction (approx. PLN 300).

We are going to develop the project so that the device connects to the application using the wifi module. This will allow the physiotherapists to track the patient's progress and send them short text messages.

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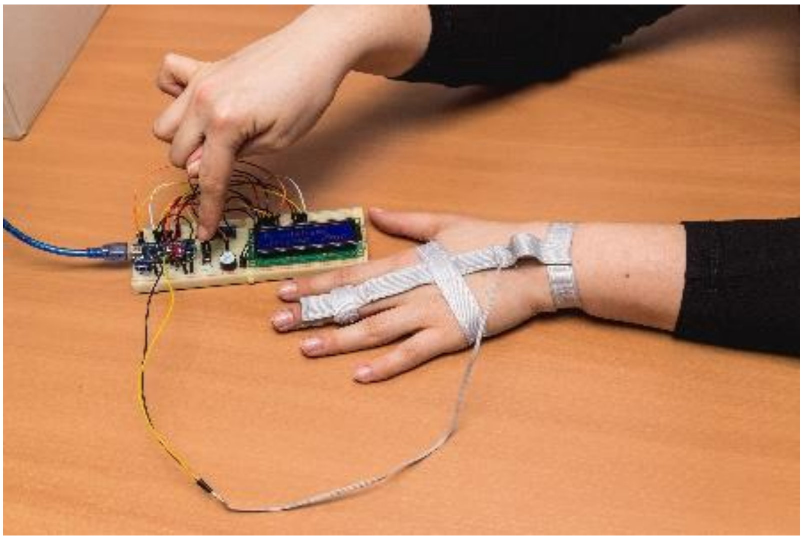
[2] „Design and Development of a Hand Exoskeleton Robot for Active and Passive Rehabilitation„ International Journal of Advanced Robotic Systems, Oscar Sandoval-Gonzalez, Juan Jacinto-Villegas, Ignacio Herrera-Aguilar1,Otniel Portillo-Rodiguez, Paolo Tripicchio, Miguel Hernandez-Ramos,Agustín Flores-Cuautle Carlo Avizzano, 05 February 2016

[3] „A Sensorized Glove and Ball for Monitoring Hand Rehabilitation Therapy in Stroke Patients” Conference: Texas Instruments India's Educators Conference (TIIEC), At Bangalore, India, April 2013



Overview of soft robotics devices towards on construction of a prototype device for passive therapy for the plegic hand

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Abstract: This study aims to review available literature and create the prototype device preserving the anti-spastic exercise model that allows patients to exercise at home.

The therapy of the paresis of the upper limb is considered the most difficult part of the process of rehabilitating patients after a stroke. We can divide the paresis of the upper limb into two groups, the first is a decrease in muscle tone (plegic) appearing immediately after a stroke, the second group is a permanent limb cramp (spasticity) which is a consequence of giving up hand exercises when there is a decrease in muscle tension and it prevents any precise movement of the hand.[1]

To prevent permanent spasticity, post-stroke therapy should be carried out immediately after stroke because it gives the best chance of restoring all functions. Currently, hospitals are undergoing various therapies based on therapeutic exercises compatible with the antispasmodic model, aimed at re-learning the muscles of proper movement and functioning. For the results of such therapy to be sustainable, patients should continue exercising on their own even after returning home.[1]

[pic.1]

Reviewing the available literature, we found devices and prototypes, created to develop and extend hand therapy of people with paresis. Overall, we can divide them by construction into stationary and mobile devices.[2] Stationary devices available on the market, such as "Hand of Hope" by Reha-Robotics [3] or AMADEO [4] are complex and can perform exercises based on the anti-spastic model. They also must be under the control of qualified personnel. During the research, we found a very large number of wearables that could be used for hand rehabilitation [5], which can be divided due to actuators used in them on silicone [7, picture 1], actuators based on McKibben's artificial muscles construction [6, picture 2] and mechatronic system [8, picture 3]. In all cases, their operating principle is similar, i.e. the actuators placed on the glove, under the airflow [6,7, pic. 1 and 2] or DC power [8, pic.3], bend or straighten, setting the fingers in motion. They are small, lightweight, easy to use and gives the ability to do most rehabilitation exercises.

[pic.2]

None of the currently used robotic gloves can fully perform exercises following the anti-spastic model. Particularly they do not have any functions that allow the right movement of the wrist. This means that despite the exercise, the patient may acquire incorrect habits, which in turn will make life very difficult. This is probably the main reason why such devices are not used daily.[5]

Based on collected information [5] the goal is to create wearable, using silicone actuators due to their ease of manufacturing and better adapting to the natural movements of the hand [7], which will allow performing

[pic.3]

passive exercises on both fingers and wrist, so that the anti-spastic model can be also preserved during independent patient exercises without the need for constant supervision of hospital staff.

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Validation of iWakka device for hand rehabilitation in Polish hospital environment

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Abstract: The study aims to explore the use of the device iWakka (*Fig.1*.), as support for rehabilitation of persons after stroke as well as people with cerebral palsy. Rehabilitation of persons after stroke is associated with combating the problem of reduced muscle tension. Spastic paralysis is a complex therapeutic problem. The most common lesions in children with cerebral palsy are so-called spastic paralysis, which can be manifested in musculoskeletal injuries.
The iWakka is a portable device developed in Japan from 2012. Rehabilitation with iWakka due to bio-feedback based training of adjustability for grasping force (AGF) of patients. The iWakka includes a grasping device, a control box, and an tablet with the UI. The task of the patients is to retrace a given target pattern by appropriately adjusting their strength to obtain a trajectory maximally similar to the given one. Each pattern moves from right to left during the exercise.
Two experiment were conducted, one in after stroke patients in the Jonscher hospital and other in patients with cerebral palsy with Instytut Centrum Zdrowia Matki Polki in Lodz.
Research at Jonscher's hospital lasted 18 days. Altogether, 22 patients ages 49 to 87 took part in the study, which divided into a treatment group (a group of 10) and a control group (a group of 12). A normal day of research treatment group looked like this: healthy hand test + paresis hand test + iWakka training (5 minutes) + CIT (*Constraint-Induced Movement Therapy)* (10 minutes) + break (15 minutes), after which the training + break was repeated three more times. The normal day of the control group looked like this: healthy hand test + paresis hand test + CIT (15 minutes) + break (15 minutes), after which the training + break was repeated three more times. During tests, trajectories made during tests were recorded. The possibility of adjusting grip force (AGF) was also further analyzed. Patients at the beginning and end were subjected to assessment of functional efficiency and motor skills using the RMA (*Rivermead Motor Assessment*), FMA (*Fugl-Meyer Assessment*), ADL (*Activities of Daily Living)* and NIHSS scales (*National Institutes of Health Stroke Scale*). Besides, STEF tests (*Simple Test for Evaluating Hand Function*) and Box and Blocks were also carried out.
Research at the Instytut Centrum Zdrowia Matki Polki in Lodz lasted 10 days. The study involved 6 persons, who were also divided into a treatment group (3 people) and a control group (3 people). The study looked the same as in the hospital. To evaluate the improvement of hand dexterity, we used FMA, STEF and Box and Blocks.
The results of tests in the Jonscher hospital and the Instytut Centrum Zdrowia Matki Polki in Lodz showed that the AGF of most participants from the treatment group improved slightly, while in the control group reduced *(Fig.2.).* Whereas in other tests

(RMA, STEF, FMA, Box & Blocks) a higher number of points in tests were usually scored by the control group.
Based on the results of tests, the positive effect of therapy is visible in some patients. The second experiment of patients does not receive any visual improvement. It follows that the results of the studies are ambiguous as regards the impact of rehabilitation using iWakka therapy on a paresis hand.

Fig.1. iWakka device.

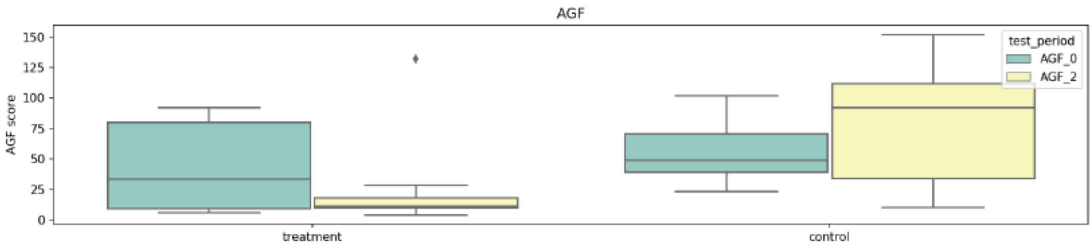

Fig.2. Comparison of (before (0) and after (2)) results between control and treatment groups.

***Software for data analyses and results comparison for iWakka hand therapy*.**

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Abstract: The goal of the work is preparation software allowing data analyses and comparison for iWakka hand therapy. The iWakka device is designed to train the control of the grip strength at specific time trajectories. It can also be used to assess the condition of the person doing the training. The prepared software will facilitate the assessment of patient indicators, their statistical analysis, and visualization. The result of the work will be prototype software, documentation, and description of results derived from the actual use of the iWakka device. During research at Jonsher Hospital using iWakka device lasting almost six months lead by the student of the Lodz University of Technology, we collected a large number of files containing numeric data. After training, data was sent via email. To evaluate progress, I wrote simple python scripts and I downloaded data from the mail server to my local device using *Imaplib* and *Email* package. To read large amounts of numeric data Pandas library was useful. To evaluate progress, we use *the adjustability of grasping force (AGF).* Initially, we generated excel files *(Chart 1)* to show the data using *Openpyxl* library. The main measure was the adjustability of grasping force (AGF) calculated according to formula:

$$AGF = \frac{1}{T}\sum\left|\frac{(targetForce[i+1] - measuredForce[i+1]) - (targetForce[i] - measuredForce[i])}{2}\right| * (measuredTime[i+1] - measuredTime[i])$$

This work also evaluates how therapists assess the efficiency of therapy. We intend to create a prototype of a software that could help therapists or medical staff. To creating an interactive dashboard, we use Streamlit, an open-source Python library that makes it easy to build beautiful apps for visualization. *Streamlit* requires using just a few *Streamli*t commands into a normal Python to build apps. It would be helpful for medical staff and multiple therapies.

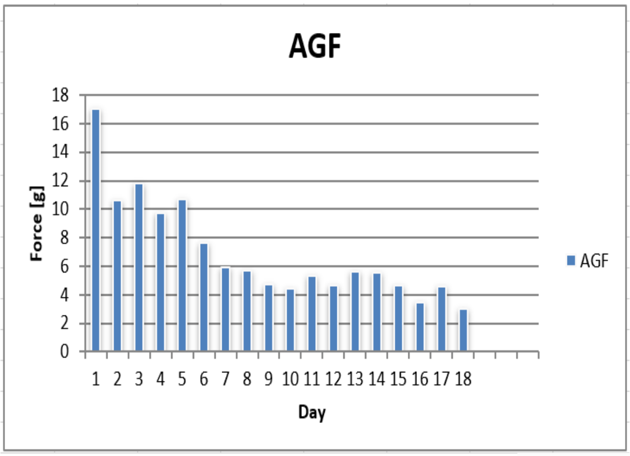

Chart 1. Sample script result.

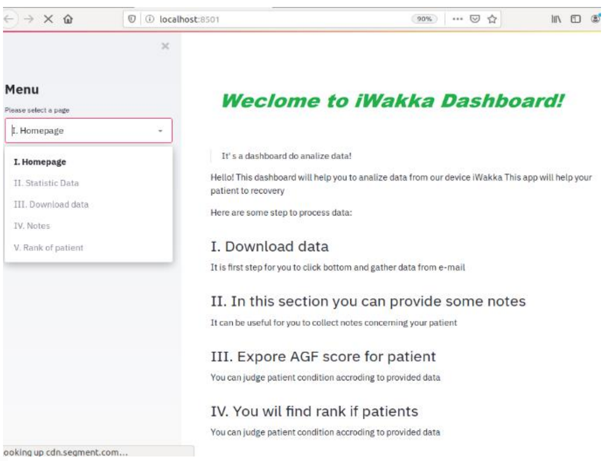

Image 1. Sample Streamlit dashboard section layout. First section with instruction.

The subject of further work is the deployment of applications to make script accessible from a smartphone.

Graph 1. Shows main concept of our work.

Use of soft robotics technologies in the construction of a rehabilitation device

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Abstract: Soft robots are used more and more often in rehabilitation equipment. Their particles are significantly safer and more delicate in comparison to their ordinary, classic version. The most often used component of soft robots would be actuators. In order to spread the knowledge about this newly created equipment, the site called „Soft Robotics Toolkit"[1] was created. Thanks to it, we get the access to information about creating, designing and testing soft robotics. One of the aspects of the site that immediately catches one's eye is a so-called „Fluidic Control Board"[2] – a platform used to operate and control soft actuators.
The literary research of all „soft" rehabilitational equipment was conducted in order to check the exact robotics element used. In most cases, the particle used were pneumatic actuators[6], such as PneuNets[3] and pneumatic artificial muscles[4] or fiber-reinforced bending actuators[5], first two of which stretch under pressure in contact with the thinnest walls. To ensure accuracy, the strengthening is installed on one of the sides. This creates less tension than it normally would have. McKibben's[4] muscles work similarly to the human ones-they shrink.
Due to the short creation time of PneuNets[3], more attention was put to the process of creating them. They are made up of a series of channels and chambers inside an elastomer. These channels inflate when pressurized, creating motion. The design of PneuNets[3] starts most commonly with creating a 3D printed two-part mold. That is later filled with silicone and placed in vacuum in order to get rid of any air bubbles. Later a piece of paper used as stiffening is embedded with elastomer, which creates the base and glued to the main body.
The prepared actuator can be connected to the Soft Robotics Toolkit Control Board[2] to operate it. The main components of the Fluidic Control Board[2] are miniature diaphragm pump, a set of solenoid valves to manage airflow and pressure sensors. The control board can be operated manually by rotary potentiometers or automatically via Arduino Mega microcontroller. All documentation needed to fabricate and operate the control board is available on The Soft Robotic Toolkit[1] website. The base structure of the board is similar to pegboard which lets users reconfigure and modify the component depending on the needs.
The later work will be concerned with creating pneumatic silicone PneuNet[3] actuators. In order to do that, many 3D printed molds have to be created. After that comes making the Fluidic Control Board[2] with accordance to the instructions on the Soft Robotics Toolkit[1] website to test the actuators.

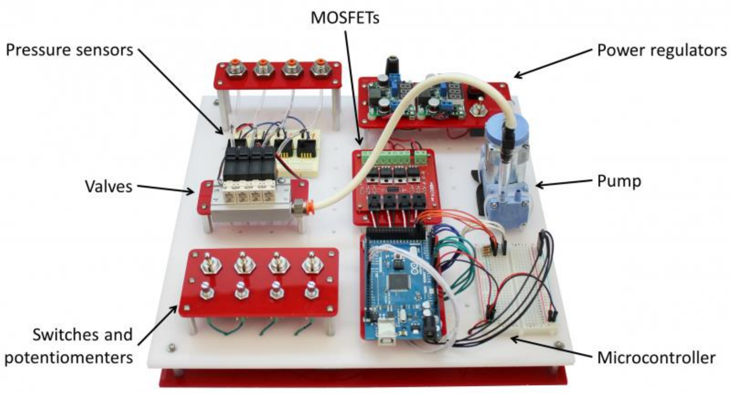

Fig. 1 Fluidic Control Board [2]

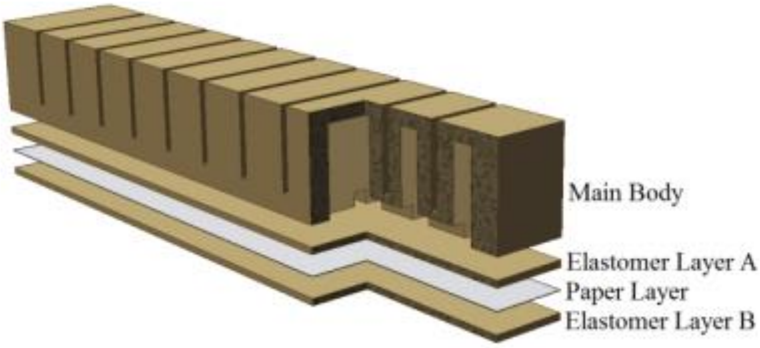

Fig. 1 PneuNets actuator scheme [3]

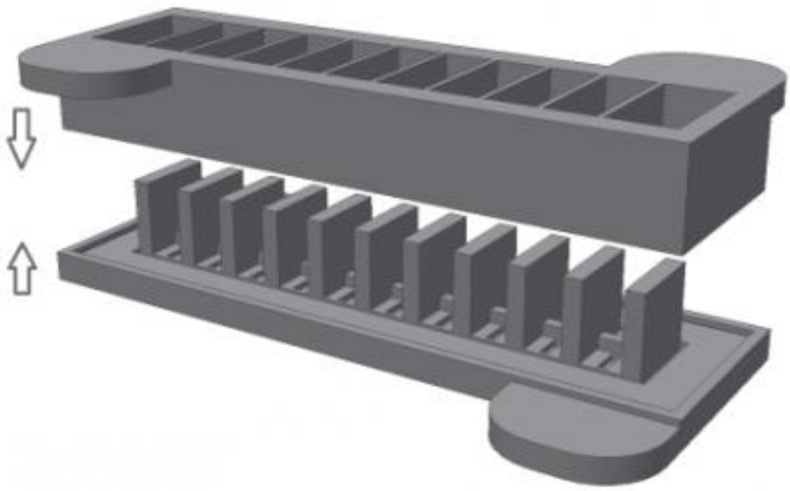
Fig. 2 Two-part mold for the PneuNet actuator [3]

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