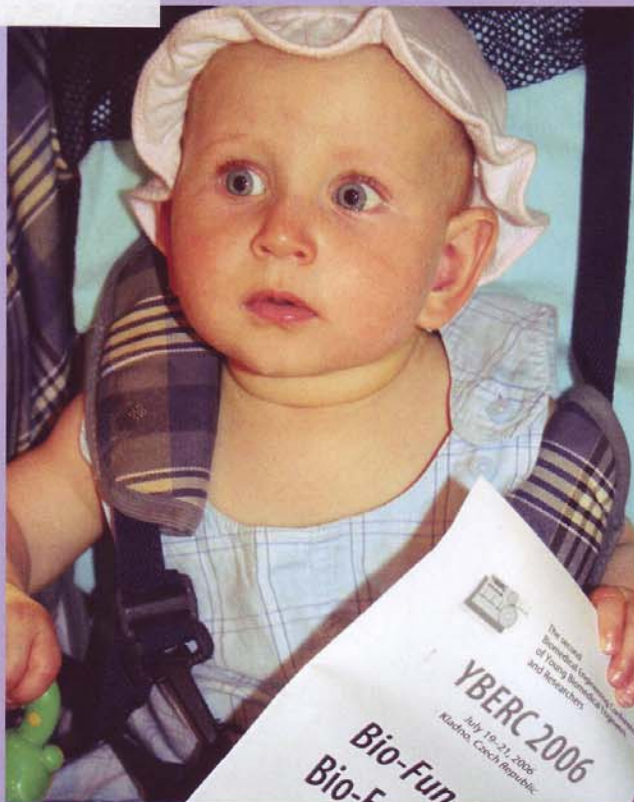


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CONTENS

THE MEASUREMENT AND EVALUATION OF THE ELECTRIC PARAMETERS OF A DUAL-CHAMBER CARDIOSTIMULATOR	61
<small>LABZA ZBYNĚK, KORPAS DAVID, PENHAKER MAREK</small>	
A REVIEW OF ULTRAHIGH MOLECULAR WEIGHT POLYETHYLENE REINFORCED WITH CARBON NANOTUBES AND ITS POTENTIAL USE IN ORTHOPAEDIC APPLICATIONS	64
<small>DANIELLE L. MILLER, TĀRUN GOSWAMI</small>	
ICT FOR SENIORS AND DISABLED PEOPLE FOR REHABILITATION	67
<small>SAMER ABDO ALRABEEI, STANISLAV KRAJNÁK, DUŠAN ŠIMŠÍK</small>	
ELECTROMAGNETIC FIELD SCATTERING IN THE MRI BASED NUMERICAL MODEL OF HUMAN HEAD	70
<small>WOJCIECH WALENDZIUK, EUGENIUSZ TARASÓW, MAREK PENHAKER, ADAM IDZKOWSKI</small>	
ELECTRONIC MODEL APPLICABLE IN BIOSUSCEPTOMETRY	73
<small>MARTIN ŠKRÁTEK</small>	
EMBEDDED TENSILE STRENGTH TEST MACHINE FM1000 – AN UPGRADE OF MEASUREMENT AND CONTROL	76
<small>TEODOR TÓTH, MARTIN PETRÍK, JOZEF ŽIVČÁK</small>	
RESULTS ON THE EVALUATION OF AN EMBEDDED FALL SENSOR	80
<small>J. POUJAUD, N. NOURY, AND J.-E. LUNDY</small>	
LOAD SPEED AFFECTS THE VALUES OF SKIN WOUND STRENGTH MEASURED BY A NEWLY DEVELOPED HIGHLY SENSITIVE TESTING DEVICE	85
<small>PETER GÁL, ZOLTÁN TOMORI, MARTIN NOVOTNÝ, FERDINAND FILICKÝ, RADOVAN HUDÁK, JÁN SABO, JOZEF ŽIVČÁK</small>	
CIRCADIAN RHYTHM IN HOMECARE	89
<small>MARTIN ČERNÝ, MAREK PENHAKER</small>	
3D RECONSTRUCTION OF LARGE TISSUE SPECIMENS USING CONFOCAL MICROSCOPY DATA AND CORRECTION OF DEFORMATIONS BY ELASTIC REGISTRATION	92
<small>MARTIN ČAPEK, PETR BRŮŽA, JIŘÍ JANÁČEK, PETR KAREN, LUCIE KUBÍNOVÁ, RADOMÍRA VAGNEROVÁ, KAREL HÁNA, PAVEL SMRČKA</small>	
CLIENT BASED PORTABLE INFORMATION SYSTEM FOR GENERAL PRACTITIONERS	97
<small>TOMÁŠ MARTINKA, LUKÁŠ BARTÁK, ZOLTÁN SZABÓ</small>	
THE INFLUENCE OF WINDOW SIZE OF AUTOCORRELATION FUNCTION ON FETAL HEART RATE VARIABILITY MEASUREMENT USING THE DOPPLER ULTRASOUND SIGNAL	100
<small>DAWID ROJ, JANUSZ WROBEL, TOMASZ PRZYBYŁA, MICHAŁ JEZEWSKI, TOMASZ KUPKA, ADAM MATONIA, JANUSZ JEZEWSKI</small>	
SOME DEVELOPMENT ASPECTS OF TELEMEDICAL SYSTEM FOR EFFECTIVE FETAL MONITORING AT HOME	105
<small>KRZYSZTOF HOROBA, JANUSZ WROBEL, DAWID ROJ, MARIAN KOTAS, MICHAŁ JEZEWSKI, JANUSZ JEZEWSKI</small>	
EDUCATION OF BIOMEDICAL ENGINEERING IN DEPARTMENT OF RADIO AND ELECTRONICS IN FEI SUT BRATISLAVA	109
<small>STANISLAV LOVÁS, OLDŘICH ONDRÁČEK, ELENA COCHEROVÁ, JOZEF PÚČIK, JOZEF ŠURDA</small>	
CONTACT-LESS MEASUREMENT OF HEAD POSTURE FOR OBJECTIFICATION AND QUANTIFICATION OF CNS DISORDERS	112
<small>PAVEL JANDA, RADIM KRUPICKA, ZOLTAN SZABO, JIRI HOZMAN</small>	
BIOLOGICAL SIGNAL SIMULATOR DESIGN	115
<small>VLADIMÍR KAŠÍK</small>	
LASER DIAGNOSTICS TECHNOLOGIES IN OPHTHALMOLOGY	117
<small>LUKÁŠ KOLARČÍK, JAN NĚMČANSKÝ</small>	
PROGRESS IN CARDIAC RHYTHM MANAGEMENT	120
<small>DAVID KORPAS</small>	
MODERN BIOTELEMETRIC SYSTEM ARCHITECTURE FOR USE BY PATIENTS AND PHYSICIANS	122
<small>ONDREJ KREJČAR, PETR FOJCIK</small>	
BIOMEDICAL DATA ACQUISITION AND PROCESSING VIA NEW TECHNOLOGY BACKGROUND	126
<small>ONDREJ KREJČAR, DALIBOR JANCKULIK</small>	
EVALUATION OF PERIODIC HAND MOTION IN PARKINSON'S DISEASE	130
<small>RADIM KRUPICKA, PAVEL JANDA, ZOLTAN SZABO, MARCEL JIRINA</small>	
PORTABLE UROFLOWMETRIC ACQUISITION SYSTEM	134
<small>WOJCIECH WALENDZIUK, ADAM IDZKOWSKI, MAREK PENHAKER</small>	

CONTENTS

AUTOMATIC SLEEP STATUS DETECTION MICHAL GÁLA, JITKA MOHYLOVÁ	138
COMPARISON OF STATISTICAL AND NON-STATISTICAL CLASSIFIERS FOR THUMB MOTION CLASSIFICATION JAN HAVLÍK, ZDENĚK HORČÍK	142
SELECTION OF A BIOMARKER OF SMOKING USING A NON-PARAMETRIC CONFIDENCE INTERVAL FOR THE YOUDEN INDEX KATARÍNA CIMERMANOVÁ	145
SIGNAL PROCESING OF ACTIMETRY AND ELECTROCARDIOGRAPHY MARTIN AUGUSTYNEK, LUKÁŠ ČAJKA	149
HUMAN MOTION ANALYSIS AND ITS APPLICATION IN SPORTS AND SPORT MEDICINE ZLATICA DOLNÁ, DUŠAN ŠIMŠÍK, JAROSLAV MAJERNÍK, ALENA GALAJDOVÁ	152
POSSIBILITIES OF INTRACRANIAL MONITORING OF LOCAL PHYSIOLOGICAL PARAMETERS RICHARD GRŮNES, KAREL ROUBÍK	156
NEW COMMUNICATION AND INFORMATION TECHNOLOGIES WITHIN THE SERVICES FOR ELDERLY PEOPLE AND PEOPLE WITH DISABILITIES STANISLAV KRAJNÁK, DUŠAN ŠIMŠÍK, ALENA GALAJDOVÁ	160
ADVANCED MONITORING SYSTEM FOR CONVENTIONAL AND HIGH FREQUENCY VENTILATION ROMAN MATEJKA, KAREL ROUBÍK	164
ALLOWING SPONTANEOUS BREATHING DURING HIGH-FREQUENCY OSCILLATORY VENTILATION KAREL ROUBÍK, MARC VAN HEERDE, VIT KOPELANT	168
THE MODEL OF THE RESPIRATORY SYSTEM AS AN EDUCATIONAL DEVICE FOR SIMULATION OF THE VENTILATORY PARAMETERS EFFECT UPON THE INTRAPULMONARY CONDITIONS JAROSLAV MAREK, KAREL ROUBÍK	171
THE ROLE OF WIRE IN MEDICINE SIMONA KARASOVÁ, PETR BERÁNEK, VÁCLAV NĚTEK, RICHARD FABÍK	175
DETECTION OF THE SLEEP DEPRIVATION OF DRIVERS MILOŠ BĚLEHRAD, PAVEL SMRČKA	179
IDENTIFICATION OF PERSONS IN CRIMINOLOGY USING GAIT PARAMETERS ANALYSIS DUŠAN ŠIMŠÍK, ZLATICA DOLNÁ, ALENA GALAJDOVÁ, DANIELA ONOFREJOVÁ	183
ANALYSIS OF THE E-SERVICES AND THEIR ACCESSIBILITY FOR SENIORS AND PEOPLE WITH DISABILITIES JANA ANDREJKOVÁ, DUŠAN ŠIMŠÍK	187
THE MEASUREMENT AND EVALUATION OF BASIC VENTILATION MODES AND FAILURE SIMULATIONS ON VENTILATION CIRCUIT VAVŘÍK DAVID, HÁJEK MICHAL, PENHAKER MAREK	191
DESIGN AND REALIZATION OF A BIO AMPLIFIER WITH SIGNAL PRE-PROCESSING FUNCTION ONDŘEJ ADAMEC	195
NEURAL NETWORKS AND ECG SIGNAL PREDICTION BRANKO BABUŠIAK, JITKA MOHYLOVÁ	197
DESIGN AND REALIZATION OF A HUMAN BODY TEMPERATURE ČAJKA LUKÁŠ, MARTIN AUGUSTYNEK, VLADIMÍR KAŠÍK	201
VALUE ANALYSIS OF SIGNALS BY MONITORING VIGILANCE OF OPERATOR JANA MRÁZOVÁ	203
UTILIZATION OF HUMAN MOTION ANALYSIS FOR SENIOR CARE DANIELA ONOFREJOVÁ, ZLATICA DOLNÁ, PETER BIGOŠ, DUŠAN ŠIMŠÍK	208
THE LABORATORY EXERCISES ON BIO SIGNAL AMPLIFIER FOR THE EEG AND THE ECG TOMÁŠ PETEREK	212
MODERN METHODS OF MEASUREMENT ECG MICHAL PRAUZEK	215
USING VIRTUAL INSTRUMENTATION IN ECG SIGNAL PROCESSING MILOŠ KUCERA, ZUZANA VASICKOVÁ, PETR ZUREK	217

CONTENS

<p>APPLICATIONS OF MEDICAL THERMOGRAPHY TO THE MUSCULOSKELETAL SYSTEM OF THE HUMAN BODY MÁRIA TKÁČOVÁ, JOZEF ŽIVČÁK</p> <p>E-LEARNING IN EDUCATION OF BIOMEDICAL ENGINEERING PETR TIEFENBACH, RADOVAN HÁJOVSKÝ</p> <p>DERIVED 12-LEAD ECG SYSTEM JAN SPIŠÁK</p> <p>SCOLIOSIS DIAGNOSTICS: THE NEW APPLICATION FOR X-RAY IMAGE ANALYSIS LUCIA HUTNÍKOVÁ, RADOVAN HUĐÁK, MARTIN PETRÍK, JOZEF ŽIVČÁK</p> <p>DETERMINATION WIDTH OF QRS COMPLEX USING WAVELET TRANSFORMATION PINDOR J., KORPAS D., PENHAKER M.</p> <p>MODELLING OF THE GAS FLOW IN THE AIRWAYS: USE OF HELIOX DURING SPONTANEOUS VENTILATION MARTIN ROŽÁNEK, KAREL ROUBÍK</p> <p>HUMAN HEAD PHANTOM FOR EXPOSURE OF ELECTROMAGNETIC FIELD ZUZANA PŠENÁKOVÁ</p> <p>POSSIBILITIES OF TOTAL HIP ENDOPROSTESIS WEARING EXAMINATION MONIKA MICHALÍKOVÁ, TEODOR TÓTH, JOZEF ŽIVČÁK</p> <p>COLOR CALIBRATION OF DIGITAL IMAGES FOR IMPROVEMENT OF MOVEMENT ANALYSIS ONDŘEJ ROZINEK, ZOLTÁN SZABÓ</p> <p>REHABILITATION VISION BY MEANS OF VIBRATION INFLUENCE ON FACE MIMIC MUSCLES ANATOLI SKURATOVICH</p> <p>LATEX - TYPESETTING SYSTEM FOR TECHNICAL AND SCIENTIFIC DOCUMENTS STEPAN OZANA, ZDENEK SLANINA</p>	<p>220</p> <p>225</p> <p>229</p> <p>232</p> <p>237</p> <p>241</p> <p>245</p> <p>250</p> <p>255</p> <p>260</p> <p>263</p>
---	--

Author	Title	Page
Mária Tkáčová, Jozef Živčák	Applications of Medical Thermography to the Musculoskeletal System of the Human Body	220
Petr Tiefenbach, Radovan Hájovský	E-learning in Education of Biomedical Engineering	225
Jan Spišák	Derived 12-lead ECG System	229
Lucia Hutníková, Radovan Huďák, Martin Petřík, Jozef Živčák	Scoliosis Diagnostics: The New Application for X-ray Image Analysis	232
Pindor J., Korpas D., Penhaker M.	Determination Width of QRS Complex Using Wavelet Transformation	237
Martin Rožánek, Karel Roubík	Modelling of the Gas Flow in the Airways: Use of Heliox during Spontaneous Ventilation	241
Zuzana Pšenáková	Human Head Phantom for Exposure of Electromagnetic Field	245
Monika Michalíková, Teodor Tóth, Jozef Živčák	Possibilities of Total Hip Endoprosthesis Wearing Examination	250
Ondřej Rozinek, Zoltán Szabó	Color Calibration of Digital Images for Improvement of Movement Analysis	255
Anatoli Skuratovich	Rehabilitation Vision by Means of Vibration Influence on Face Mimic Muscles	260
Stepan Ozana, Zdenek Slanina	Latex - Typesetting System for Technical and Scientific Documents	263

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UTILIZATION OF HUMAN MOTION ANALYSIS FOR SENIOR CARE

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Falls create a leading cause of injuries, including fatal injuries, among older adults. Because falls are so common and dangerous for seniors it's important to improve their abilities to prevent the falling and to develop an efficient method to train them in walking. The project SMILING aims to develop a programmable shoe with dynamic change of ankle angles during walk. That device and applied training procedures shall offer efficient training and lower the risk of falls for seniors. Human motion analysis tools like optical systems or gyroscope sensors will assist to monitor and evaluate quality of walk during exercises and the whole training procedure.

Keywords

senior falls, motion analysis, gait practice, training logistics

Introduction

During ageing, the elderly people can encounter limitations that result in loss of control in their lives or the threat of such loss. A fall is one of the most common events that threaten the independence of older adults. Each year up to a third of older adults living in the community suffers a fall. This number increases to almost two thirds among older adults who had a history of a fall in the past year. About half of all people in nursing homes fall each year. Most of the falls result in a minor injury of some type, most often bruises and scrapes. However, 10–15% of falls result in a broken bone or other serious injury. Only half of older adults who fall are able to get up without help. Complications resulting from falls are the number one cause of death from injury in both men and women aged 65 and older. The risk of dying from a fall increases with age. Because many falls result in injury, they often mean going to the emergency department. Research from the early 1990s shows that almost 8% of people aged 70 and older go to emergency departments each year because of an injury related to a fall. Close to a third of these people are admitted to the hospital, staying around 8 days. At least 20% of older adults living in the community have problems with walking. This increases to approximately 50% in adults 85 years old and older. Most of falls are caused by problems with walking, coordination, and balance, and most falls among older adults (older than 85) are rarely due to a single cause. For example, a decline in function can be related to age, sudden or chronic disease, or medications, and interfere with walking, changing body position, or other normal activities of daily living. These

problems are worsened by improper footwear, travel over slippery or uneven surfaces, and running or dumping. [1]

Methods

Utilization of human motion analysis for senior care handles following issues:

1. Walking problems assessment – role of the Geriatric centre, or Rehabilitation clinics,
2. Treatment and Prevention of Falls - Walking exercise with cognitive features using dynamic SMILING shoe training tool,
3. Human gait analysis – monitoring and progress in gait pattern improvement.

1. Health care for older adults focuses on function, which covers the physical, cognitive/mental (e.g., thinking and remembering), psychological, and social aspects of a person's life. "Quality of life" is a term that is often used as a single, general measurement of the combination of all these functional aspects of life. Each aspect of function should be evaluated routinely in all sites of care, such as the doctor's office, the hospital, an assisted-living facility, or the home. The goal of health assessment for older adults is to encourage and promote wellness and independent function. One approach that works well is for health care providers to rapidly screen several areas by asking screening

questions related to various areas of health and function. We concentrate here only on the overall functional status of physical functions.

Assessment of Physical Functions: Functional status (Transfer, Walking, Balance), Nutrition, Vision, Hearing. *Functional status* refers to the tasks a person can perform in daily life. These tasks are usually referred to as „activities of daily living“ or *ADLs*. The self-care tasks (e.g., bathing, eating, etc) are especially important, because these are the basic ADLs considered essential for independent living. Healthcare providers usually ask whether the person requires the help from someone else to complete these basic tasks. They will also ask about the person's ability to manage household affairs, such as using the telephone, stove, or washer. These are called *instrumental ADLs*. Although it is not practical to test someone's ability to perform ADLs for self care and to manage household affairs in the doctor's office, other functions can be assessed during an office visit: *walking ability*, *balance*, and ability to *transfer* from one position or surface to another (e.g., from sitting to standing or bed to chair, etc). It is important to wear proper footwear during an assessment, so that your healthcare provider can see whether the problem is actually physical or is possibly related to your shoes. Proper footwear means comfortable, flat, hard-soled shoes. Healthcare professionals may use formal, standardized tests to assess balance and mobility. However, simpler tests (like those described above) are often enough for routine assessments and follow-up recommendations, such as the need for a cane or walker.

Transfer: A common way to evaluate the ability of a person to transfer is to ask him or her to stand from a seated position in a hard-backed chair, while keeping the arms folded. Inability to complete this task suggests lower leg weakness and the possibility of future disability. *Walking:* From a standing position, the older person will be asked to walk back and forth over a short distance, usually using any walking aid (e.g., a cane) that he or she uses routinely. The person may also be asked to get up from the chair, walk about 10 feet, turn around, walk back to the chair, turn around again, and then sit back down. Normally, a person should complete this „Timed Get Up and Go“ test in <10 seconds. People who take longer than 10 seconds may be at increased risk of falls. Those who take 20 seconds or longer require further evaluation. Walking speed can also be used to predict possible future disability. People who can walk 50 feet in 20 seconds or less can usually walk independently in normal activities. *Balance:* Balance is often tested several times, doing balance exercises that become more and more difficult. The person being assessed is first asked to stand with his or her feet side by side, and then with one foot in front of the other at varying distances apart. Difficulty with balance in these positions is associated with an increased risk of falling. [1]

2. Assessment in the SMILING project is the role of the Specialised Geriatric Centre of St. Lucas in Košice. It offers basic and specialised ambulant, as well as institutional treatment for elderly and long time chronically sick people within the region of Košice. The main aim of this centre is to comprehend the range of general health care, intensive care, geriatrics, diabetology and physical rehabilitation.

Logistics in the clinic consists of the 3 departments that provide specific services to the people:

Department 1 – services:

- Palliative medicine
- Long term hospitalisation
- Gerontopsychology
- Services of the hospice
- Geriatrics
- Physiology, balneology and manual rehabilitation treatment

Department 2 – ambulance provide following services:

- Geriatrics
- Diabetology, the disorders of the metabolism and nutrition
- Balneology, physiology and manual rehabilitation treatment
- General medicine
- Internal medicine

Department 3 – united diagnostic and therapeutic system provides services:

- Medical informatics and biostatistics
- Physiology, balneology and manual rehabilitation treatment
- Radiology

The horizontal structure of the Geriatric centre enables to use departments sorted into three different parts of medical treatment:

1. Department of Geriatrics – focused on the provision of diagnostic, therapeutic treatment and rehabilitation of the patients older than 65 years, mostly with the health problems (cardiovascular, pneumatic, metabolic, movement, neurological, psychical motoric and sensual disorders) and those who requires a complex approach due certain level of polymorbidity. The concept of the geriatric care is to support, empower and improve the health condition of elderly people and to enhance the services of geriatric care.
2. Department of Long-term Hospitalized Patients – provides the medical treatment and care to patients whose condition doesn't require technically demanding diagnostic and therapeutic procedures. This group of patients needs long-lasting treatment, care and rehabilitation with everyday check-up.

3. Department of Physical Therapy&Rehabilitation – ambulant care is aimed on the diagnostic and therapeutic tasks in case of the disorders of functionality of human motion systems. The main task is to keep the autonomy of the patient to be self-sufficient in the home or work environment. The basic activities for this therapy are – manual therapy, physical training, ergotherapy, bath-therapy, massages, motion therapy, electrotherapy, etc.

3. Walking is marked out by “regular” multiple repetitions of movements of body segments, step by step. As a result of this, the description of walking talks usually about what happens in the course of a one step cycle, assuming that the following step cycles are all the same. In this case it is the so-called rational approximation that is conditioned by a difficult analysis of movement taking place in a greater space. Nevertheless, we have to take great variability that can occur among different individuals into account or with one and the same individual. Elementary spatio-temporal parameters of a step cycle (Fig. 1) can be found while using procedures that do not require complicated measuring devices. This group of characteristics usually includes:

Cadence is defined by the number of steps in a standard time unit (number of steps/min). *Step length* is given by the distance between the same points on both feet (usually between heels) in the double support phase. *Stride length* is defined by the distance between two successive foot contacts of one and the same leg. *Walking base* is the distance between feet, usually measured from the heel centers. The relative simplicity of measuring these parameters does not downgrade them. However, it has a limited testifying value. It doesn't inform us about the position of the segments in the kinematic chain or the magnitude of the affecting forces. The objective and complex assessment of locomotive activities, including walking, requires simultaneous use of more methods that serve for the determination of basic kinematic and dynamic parameters completed by electromyographic examination of the muscle activity.

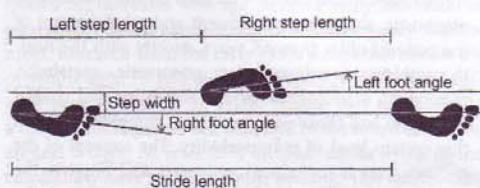


Fig.1: Basic spatio-temporal parameters of the step cycle.

Results

Prevention of falls depends on the causes and risk factors and may include the following: exercise or physical therapy, identification and correction of hazards in the home environment, occupational and behavioural therapy, changes in medication, nutritional or vitamin supplementation, drug treatment (e.g., hormones), use of assistive devices to help with balance and stability. Many conditions that cause walking problems are only partially treatable, i.e., usually, people won't be able to walk as well as they did before. The goal of treatment is usually an improvement in function. Of course, this all depends on the number, type, and severity of the conditions that are contributing to the walking problems. *Medical therapy* can greatly improve some walking problems as well as *physical therapy* can result in modest improvements. Certain exercise programs can increase walking speed in older adults with knee arthritis, Parkinson's disease, or stroke. Generally, the most consistent effects are from programs that combine a variety of different exercises such as leg resistance training, balance, and flexibility exercises. *Surgery* can also result in modest improvement for people who have spinal disc problems or arthritis of the knee or hip and also the products of orthotics and prosthetics can reduce walking problems. Other mobility aids such as canes and walkers can take the load off painful joints and increase balance and stability. Footwear can also be easily corrected. In one study of older men, shoes with thin, hard soles provided better balance and surer footing than other shoes, even shoes that were thought to be more comfortable (e.g., running shoes). In general, well-fitting walking shoes help maximize balance and improve walking. [1] Physical exercises using a mechatronic device can develop an improved gait pattern for elderly. So it is combined exercise with physical and cognitive effects.

Project SMILING (Self Mobility Improvement in the elderly by counteractING falls) aims to develop a prototype of the modern rehabilitation system. The main target of the system is to improve stability and motoric functions during the gait and to act as a tool for fall prevention for elderly people whose risk of falls is higher than in younger population. SMILING project develops a shoe with motorised 4 buttons in the sole. The height of buttons is changing after each step. In such way the patient has to adapt his balance and gait parameters to permanently changing position of the sole. The patient is forced to change angles in ankle joint, but also in the knee and hip joints. [4]

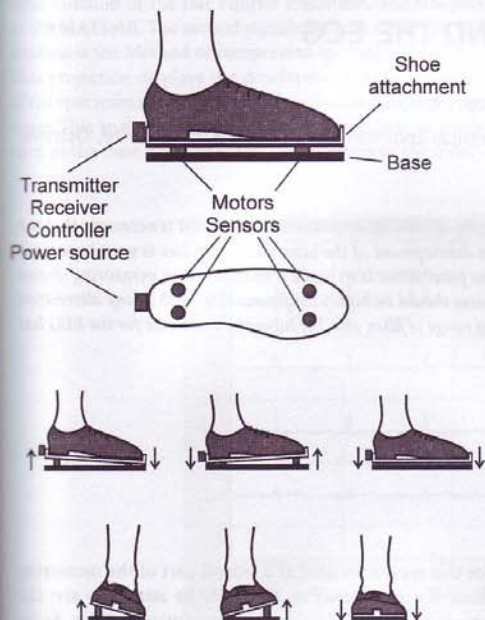


Fig. 2: Example of implementation of the wearable device.

Discussion and Conclusion

The paper describes walking problems with a risk of falls, and first results from the development of a dynamic shoe to treat gait pattern of elderly in a physical and cognitive training procedure monitored by tools of human gait analysis. The research task is very complex and success depends on a good international cooperation of multidisciplinary

experts. Our specific role is work on the development of the logistics in the Geriatric centre of St. Lukas in Košice concentrating on an efficient assessment and treatment process of seniors in cooperation with Human motion laboratory at the Technical University of Košice. This paper was created as a part of work in project SMILING, 6FP and is granted by EC.

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