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EYE TRACKING USING ARTIFICIAL NEURAL NETWORKS FOR HUMAN-COMPUTER INTERACTION

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This paper reports about an ongoing project that's aim is to develop an application surpassing a computer mouse in order to simplify the computer usage for severely disabled people. The application is based on an eye tracking algorithm using low cost components. A camera and the head position are supposed to be fixated. A color filtration method is used for the pupil detection. Calibration is provided by neural networks which we do emphasize as well as by parametric interpolation method. Neural networks use back-propagation for learning and bipolar sigmoid function is used as the activation function. The system was tested by healthy users with/without glasses resp. contact lenses. We used a simple web camera supplied with infrared light and backlight compensation attached to a head fixation device. Neural networks significantly outperform parametric interpolation techniques: 1) the calibration procedure is faster as they required less calibration marks and 2) cursor control is more precise. The system in its current stage is able to distinguish regions at least on the level of desktop icons. The main limitation of the proposed method is the lack of head-pose invariance and its relative sensitivity to illumination (especially to incidental reflections in the pupil). We plan to use wireless mini camera attached to the user's head to enhance the portability resp. a pan/tilt/zoom camera with high resolution placed in front of the computer monitor and controlled by classifiers for face and eye localization. The paper is devoted to pros and especially the cons of the selected approach and suggests a deal of its possible future uses and modifications in research (e.g. basic research in vision science or perception of art in psychology) as well as in commercial fields (e.g. marketing and advertising, industrial engineering).

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WAVE PROPAGATION IN CARDIOVASCULAR MODEL OF HUMAN ARM

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The aim of this research is to design a computational model to study the pressure and flow waves in a human upper limb. Model is based on *electromechanical analogy***.** Modelling and simulation of physiological fluid systems on the base of the electromechanical analogy consist in the creation of analogous equivalent electromagnetic systems, electromagnetic characteristics of which describe the properties of the investigated physiological system. The model of selected part of cardiovascular system is then composed of cascade connection of vessel segment's equivalent circuits. The arterial tree of human arm is selected for the investigation. Three different types of complexity of the model were implemented in order to show the influence of model complexity to the blood pressure and blood flow propagation patterns. Human hand contains two arterial arches. In our model No. 1 we consider the whole arterial tree, in model No. 2 is only one arch taken into account and model No. 3 is the simplest one with both arches neglected. In these models we can also study the effect of arterial bifurcations on blood pressure and blood flow wave propagation. The impedance mismatch rising on the bifurcations induce the back wave propagation in the vessel. These backward running waves are added to forward running waves resulting in blood pressure incensement in the part of vessel before the bifurcation. These forward and backward running waves are separated from the original signal by the methods of characteristics. Our results are compared with the representative blood pressure waveforms obtained from literature. The best agreement has the result for the most complex model as expected. In this model both arches play important role in compensation of branching effects. Resulting blood pressure curves of model No. 1. are the most stable without additional ripples and have the lower amplitudes compared to both the simpler models.

EXTERNAL FORCES IN CASE OF HUMAN DOWNFALL

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The loading of joint implant is need known for its design. The load of standing man is used usually but it is not extreme. The presentation searches the extreme joint forces and moments in the course of human downfall. The human fall was observed by camera system to record the position data of main points on human body. The 3D coordinates of foots, ankles, knees, hips, pelvis, shoulders and wrists were stored. The simulation program of human fall was compiled at PC in language C++ using simulation system CDCSIS. The program has an input data - length, mass and inertia moments for each part of human body. The data are transformed according to actual coordinates of points on the body. Then the moving and turning accelerations are calculated and joint forces and moments are determined according to the d'Alembert's principle. The results are joint forces and moments during human downfall.

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KERATINOCYTES ON HYDROGEL SUPPORT – THE EXAMPLE OF TISSUE ENGINEERING IN MEDICAL USE

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The treatment of severe burn injuries as well as chronic trophic defects represents serious medical problem. The healing process in these patients is long-lasting and rather complicated. Different methods of autografing were developed but especially in severely burnt patients the lack of donor sites is rather limitative. In the eighties cultured epidermal grafts became the very first tissue prepared in laboratory and transplanted back to the patient. However the results did not fulfil the expectations of surgeons; the take of cultured grafts was rather low because they were often destroyed by infection or desiccation. We developed the methodology of cultivation of keratinocyte grafts on poly(2-hydroxyethylmethacrylate) support. Keratinocytes were able to attach and proliferate on the surface of hydrogel sheet after its preincubation in bovine serum. These keratinocyte grafts were applied "up side down" on the skin defects. The moderate attachment of the cells to hygrogel support enabled colonization of the wound bed by cultured keratinocytes and the hydrogel cover ensured the optimal microenvironment for this process. Autologous cells were used for permanent closure of 3rd degree burn wounds, allogeneic ones stimulated the healing of 2nd degree burn wounds and donor sites. The obtained results were rather promising. Both types of keratinocytes on hydrogel support were exerted in the treatment of chronic leg ulcers in diabetics. In this case the outcomes were more diverse. Though keratinocytes cultured on hydrogel support did not become a common tool of burn surgeons they introduce the example of progresive tissue engineering product.

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SKIN WOUND HEALING: FROM BIOMECHANICAL, HISTOLOGICAL, AND SPECTROFLUORIMETRIC EVALUATION TO LOW-LEVEL LASER THERAPY IN A RAT MODEL

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The use of a simple and reproducible model is inevitable for objective statement of the effects of external factors on the wound healing process. In general, there exist two basic wound healing models, i.e. incisional and excisional. In present critical review our previously published papers in which both models of healing were used are compared to other studies. Our detailed biomechanical studies showed that on the body regions with minimal strength there may not be any difference in removing the skin suture two, three, four, and five days after surgery as well as that when compared to simple suture intradermal running suture is more appropriate for experimental use in rats. Results from our previously published histological studies showed that the healing of rat epidermis, dermis, and striated muscle is faster than but comparable to the human skin and muscle. The spectrofluorimetric studies showed that fluorescence spectroscopy might be found useful in selected redox parameters assessment during the early stages of healing and is able to visualize ischemic areas of skin. By evaluating the effects of red lasers at 635 nm and 670 nm on open skin wound healing it was found that by applying equal daily dose higher power density is more effective. In contrast, when different power densities were tested on incisional wounds by tensile strength measurement it was observed that the 635 nm laser improved wound healing by using the higher tested power density while the 670 nm laser improved healing by using the lower power density. The main difference between primary and open/secondary wound healing is in the amount of granulation tissue formation. Whereas a primary wound heals either without granulation tissue formation or with a minimal amount of granulation tissue a secondary wound needs new tissue development which includes extensive tissue formation. Accordingly, we concluded that LLLT should be wound-type specific. In conclusion, better understanding of wound healing process is essential to improve medical technologies and patients' care.

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ATROPA BELLADONNA L. WATER EXTRACT: MODULATOR OF EXTRACELLULAR MATRIX FORMATION IN VITRO AND IN VIVO

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A wound healing process often needs extensive new tissue formation which includes cell proliferation and extracellular matrix formation (ECM). In Slovak folk medicine *Atropa belladonna* L. (AB) aqueous extract is frequently used to improve the restoring of skin integrity. Hence, the aim of present investigation was to evaluate whether AB aqueous extract is able to induce extracellular matrix formation and cell proliferation using both *in vivo* and *in vitro* models. Firstly, the effect was studied in male Sprague-Dawley rats. Animals were submitted to one round full thickness excision, 1 cm in diameter, on the back. Samples for basic histology (H+E) and immunohistochemistry (anti-fibronectin; anti-vimenti, anti-wide spectrum cytokeratin; anti-α-smooth muscle actin; anti-collagen III) evaluation were removed 7 and 21 days after wounding. Results of the *in vivo* experiments demonstrated inverse relationship between AB extract concentration and wound healing effect. Whereas higher tested concentrations inhibited the healing process lower tested concentration stimulated healing (differences observed in wound re-epithelization and ECM formation). Secondly, five different concentrations of the AB extract were used in an *in vitro* study to evaluate whether the proliferation and differentiation of keratinocytes and fibroblasts was modulated as well as whether the extract induces ECM formation. Cells were cultured on glasses and after either 3 or 7 days cultivation in different AB concentration media they were processed for immunohistochemistry (anti-fibronectin; anti-Ki67; anti-collagen III; anti-keratin 19; anti-wide spectrum cytokeratin; anti-α-smooth muscle actin) as well. The *in vitro* examination showed that AB extract stimulated production of ECM formation and at the lower tested concentration stimulated cell proliferation. Moreover, AB extract acted synergistic to TGF-beta and stimulated differentiation of fibroblasts into myofibroblasts. In conclusion, in this study new information were presented and supported our previously published suggestion that aqueous AB extract is able to positively modulate skin wound healing at certain concentrations.

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LOW-LEVEL LASER THERAPY IMPROVES TRACHEAL INCISIONAL WOUND HEALING IN RATS

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Tracheotomy may be associated with numerous acute and chronic complications. Perhaps, one of many possibilities of how to modulate trachea healing may be the use of low-level laser therapy (LLLT). It has already been shown that LLLT is able to modulate, dose dependent, various biological processes including wound healing. Therefore, the aim of present study was to evaluate, from histological point of view, whether LLLT at 830 nm is able to positively modulate trachea wound healing in rats. Male Sprague-Dawley rats (n = 24) were included into the experiment. They were randomly divided into two groups: laser-treated group at 830 nm (LG) and sham irradiated control group (CG). All rats were subjected to a median incision which was performed from the second to the fifth tracheal cartilage ring. Subsequently the incision was sutured. Six rats from both groups were killed 7 days after surgery while the other rats were killed 28 days after surgery. Wounded tracheas were then removed for histological evaluation. Paraffin sections were stained with hematoxylin-eosin (basic staining) and Van Gieson (non-specific collagen staining). When compared to the control LLLT significantly reduced granulation tissue formation 7 and 28 days post wounding. On the other hand, LLLT significantly stimulated new cartilage creation which was demonstrated at both evaluated time intervals as well. The exact mechanisms at the cellular level by which LLLT stimulates cartilage repair are still not fully clarified. Nonetheless, our study for the first time demonstrates that LLLT, at present methodology, is able to positively modulate trachea wound healing process in rats. The readers should be; however, cautioned that a clinical outcome would be possible if no inter-species variability would occur. Therefore, further experimental experiments on other animal models are encouraged before our results may be extrapolated into the clinical practice.

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ISOLATION AND CHARACTERISATION OF SYNOVIAL MESENCHYMAL STEM CELLS

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Synovium and synovial fluid are good source of mesenchymal stem cells (MSCs). They have been regarded as a promising therapeutic tool for musculoskeletal regeneration, particularly for reconstructions of cartilage and bones. Synovium derived MSCs have morphologic features similar to B synoviocytes, with higher expression of hyaluronan receptor CD44 and better chondrogeneic potential *in vitro* than MSCs from other tissues. In this study we compared MSCs from synovium and synovial fluid on the base of morphological, phenotype and differentiation features. Heterogeneous population of cells with different morphology was obtained after isolation of cells from synovial tissue and synovial fluid and 4-day cultivation. Mesenchymal stem cell phenotype was confirmed by positive staining for CD105 and CD90, CD44. Cells were negative for haematopoietic antigen CD45 what was confirmed by FACS analysis. CD105+ cells were selected by immunomagnetic separation after 2 - 4 weeks cultivation. CD105 (Endoglin) binds to TGF-β3 that is the key transcription factor for differentiation of MSCs into chondrocytes. We suggested that subset of CD105+ cells could be a good marker of chondrogeneic differential potential of MSCs. The percentage of CD105+ cells in the MSC population from synovia before immunomagnetic separation was between 40-50 %, increasing to 95 % following immunomagnetic separation. FACS analysis confirmed 95 % effectiveness of this method. Von Kossa, Alcian Blue and Oil Red O staining was used to assess differentiation potential. Long term cultivation did not affect morphology and phenotype of immunomagnetically isolated synovium derived MSCs. Our results confirmed that immunomagnetic separation is a suitable method to obtain homogenous population of synovial mesenchymal stem cells.

PERSONIFICATION OF THE MATHEMATICAL MODEL OF THE RESPIRATORY SYSTEM USING COMPUTED TOMOGRAPHY

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The article describes the possibility to adjust the parameters of the mathematical model of the respiratory system for each patient individually with respect to its state of the respiratory system. The parameters of the model respecting anatomical structure of the bronchial tree are changed according the patient. It results in improved possibility to assess the efficiency of different types of artificial lung ventilation using the model. The aim of the study is to develop a method useable for adjusting the model of the respiratory system according to individual properties of the patient's bronchial tree. It allows investigating the optimal ventilatory strategy for each patient. This modification allows detail study of intrapulmonary conditions even during different lung diseases. New types of computed tomography devices allow detail investigation of the lung tissue including measuring geometrical dimensions of proximal airways and it is possible to evaluate the bronchial tree condition. The dimensions of the chosen airways are measured from computed tomography images of a patient and the measured data are compared with the morphological data of average man lung described by Horsfield. The method of least squares is used to match the parameters of the model to the individual patient. Modified model is used to simulate the effect of the individual bronchial tree upon the total lung impedance, pressure distribution, etc. A unique approach has been developed to personify the mathematical model of the human respiratory system for individual patients. It allows studying the interaction between the pulmonary mechanics and artificial lung ventilation even in significant changes in structure of airways. It can contribute to increase the patient's benefit from artificial lung ventilation and to minimize the risk of lung injury.

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MEASUREMENT AND NUMERICAL SIMULATION OF ELECTROMAGNETIC WAVE INTERACTION WITH LAYERED BIOLOGICAL STRUCTURE

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Biological tissue is a complex and highly heterogeneous material. The results from simple models phantoms of biological tissue for microwave hyperthermia at cancer therapy are not representative of the reality of different tissues, their associated shapes and boundaries, which will result in the electromagnetic propagation and power deposition rate being quite different in each tissue type. Boundaries between tissues with divergent dielectric properties may produce localized hot spots and cannot be ignored. The paper presents measurement and numerical modelling of electromagnetic wave interaction with planar layered biological structure through reflection and transmission coefficient at boundaries of biological tissues in microwave frequency range. The reflected electromagnetic energy is influenced not only by the wave impedance of each layer, but by the layer thickness as well. For measurements was used reflection waveguide method which enables to assess the complex permittivity of investigated biological materials. Measured values of complex permittivity were used for numerical simulation of electromagnetic wave interaction with biological structure. Numerical calculation both reflection and transmission coefficients at boundaries were investigated with respect to the multiple reflections of planar electromagnetic wave at boundaries and with the respect to the transmission of reflected wave between layers represented by skin, fat and muscle with known dielectric properties. The measured and numerical results show strong influence of both dielectric parameters of biological structure – dielectric constant and the conductivity on electromagnetic wave propagation and the fact, that the thickness of biological layer influences scattering parameters in biological tissue irradiated by electromagnetic wave. In the view of numerical simulation approach which allows us to evaluate coefficients characterizing propagation of electromagnetic wave in the layered structure, the next parameters of electromagnetic wave like SAR, or the presence of inhomogeneities with different dielectric characteristic in investigated structure can be calculated.

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MANAGEMENT AND ASSESSMENT OF LIFESPAN OF MEDICAL EQUIPMENT

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The state of equipment used in treatment and prophylaxis institutions is a decisive factor in diagnosis and treatment efficacy. In many treatment and prophylaxis institutions, the standard service life of the majority of medical equipment has already expired. Further use of this equipment can become hazardous to both patients and medical personnel. With an increase in the physical life of medical equipment, the annual costs of the acquisition will be reduced; however, the annual maintenance costs, energy consumption, etc. will increase, thereby reducing the amount of investment in the hospital. This means that the use of medical equipment throughout its physical life leads to the diversion costs due to

depreciation. To determine the optimal duration of the economic life of the need to identify the various factors affecting it. In practice, the analysis may be based on the available information on the extent and characteristics of the device, respectively, qualitative or quantitative analysis. To assess the optimal life is possible through the application of various mathematical models that consider account the main factors of life cycle. The main problem is the consideration of all the subtleties, which are connected with the specificity of application area - medicine. The article deals with two basic approaches to the issue of optimal life of medical equipment. The first type of optimal replacement policy devoted to finding the optimal physical life. The second approach aims at finding the optimal economic life. The paper presents two mathematical models that realize each of these approaches.

ADENOSINE A_2B RECEPTOR INTERACTION INVESTIGATION IN SILICO

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This research was devoted to study of adenosine receptors A2B subtype, which is not full studied. The research's aim was to create computer models of A2B adenosine receptor, and also its 9 activators and 15 inhibitors; using these models to analyze special features of interaction between A2B adenosine receptor molecule and molecules of different activators and inhibitors in silico. The amino acid sequence of A2B receptors was taken from open source in the NCBI data base, ID: NP_000667.1, for modeling A2B adenosine receptor and its mutant forms the MODELLER software was used. The modeling of ligand-receptor interaction was made on the supercomputer SKIF Cyberia (Tomsk State University, Russia) using AutoDock 4.0 as the part of MGL Tools 1.4.5. In this research work, realized on the unique A2B adenosine receptor computer model, it was shown, that both activators and inhibitors produce the hydrogen bindings with different amino acids as a result of interaction between them and A2B adenosine receptor and its mutant forms. The current investigation detected the amino acids, playing the main part in activation A2B adenosine receptor: Ile67, Phe173 and Glu174. Also, it was shown, that applying amino acid substitutions to the third intracellular loop potentially may cause the alteration of Ile67 and receptor adhesive site binding. To make final decision about the role of aforesaid acids in receptor activation it is needed to implement the test with A2B receptors, mutant by mentioned amino acids, in vitro.

USER ADAPTIVITY IN CLIENT APPLICATIONS OF BIOTELEMETRIC PLATFORM

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Adaptivity and friendliness of user interface is currently discussed in the professional society. Users want a simple, intuitive and graphically attractive interface. On the other hand, it is necessary to change dynamically the user´s experience as they use what best viewing area of the device. The biomedical data are not all the latest knowledge in the area. Our work focuses on exploring the possibilities and the revelation of any deficiencies in the currently used procedures and technologies. The main area of interest of our Biotelemetric User Adaptive System is to provide solution which can be used in different areas of health care and which will be available through PDAs (Personal Digital Assistants), web browsers or desktop clients. Physicians and other medical staff will not be forced to make difficult and manual work including unending paperwork, but they will be able to focus on the patients and their problems. All data will be accessible almost anytime anywhere through special applications designated for portable devices web browser or desktop clients and any changes will be made immediately at disposal to medical staff based on the security clearance. For the physicians is important see the data directly and clearly on the maximum possible viewing area. This problem can be solved by dynamical programming, when we can load only important controls and functional code from database and via dynamically controls hiding in GUI on presentation layer. In paper we also deals with a problem of visualization of measured ECG signal on mobile devices in Real Time as well as with a solution how to solve a problem of unsuccessful data processing on desktop or server. The pre-processing in GSM module processor we choose as a solution of data processing problem.

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SEGMENTATION OF HUMAN HEAD CONTOUR BY GRAPH-CUTS ALGORITHM AND ITS USE IN BIOMETRIC SECURITY SYSTEMS

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Biometric systems based on digital image processing are of growing importance. Database of such systems contain e.g. compressed fingerprints data, personal data in text format as well as photos of faces. Storing of images requires a lot of disk space despite compression techniques. Face photos are usually captured synchronously with fingerprints scanning which doesn't guarantee the fixed position of head. Consequently, images larger than necessary are captured where head represents only its fraction. Our aim is to reduce significantly the size of image storing only the face itself and not the background. Method is based on the face recognition algorithm for coarse head detection followed by segmentation which precisely detects the contours of the head. Initial video information can be obtained on-line from a web camera or off-line from a recorded video file. The next step is face detection based on the Haar supervised classifier exploiting predefined rejection cascade data. The result is a set of elliptical shapes each containing a combination of pixels similar to a human face (eyes, nose, mouth in a given spatial configuration). However, ellipse is only a very rough representation of the human head. Next step is segmentation which searches the precise contour of the human head. It is based on the graph-cut algorithm which exploits ellipse from the previous step as an input "seed region". We slightly modified traditional graph-cut algorithm such that the contour is found inside the permitted distance from the initial elliptical contour. If automatic segmentation fails, the correcting segmentation is available by enter of additional seed regions. Our method reduce the size of data 2-10 x. The similar compression savings was achieved by the elimination of background pixels when keeping the constant size of all images.

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CONTROL OF KINEMATIC CHAINS WITH ELECTROMYOGRAPHY SIGNALS

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The paper deals with the end-point control system of robot arm, or more generally with control of kinematic chains. The signals for kinematic control are gained from the electromyography (EMG) signals. In our case, robot arm with three degrees of freedom, so called SCARA was used. The paper presents the hardware proposal for the recording and adjustment of the EMG signals. Analysis of the robot's kinematic structure including the inverse kinematic task is solved. The proposed algorithms allow the movement of either a single kinematic pair or an arm end-point of the robot. OOPIC microcontroller was used, that is programmable in simple object-oriented software. The inverse kinematic task was solved by means of the Newton iteration method with Jacobian matrix in Matlab software environment.

OPPOSITE POLARITY OF THE PQ SEGMENT TO THE P WAVE - A PRELIMINARY STUDY

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Atrial repolarisation is recorded during the PQ segment and the QRS complex. On the standard 12-lead ECG, it can be registered as the Ta wave with opposite polarity to the P wave. The aim of our work was to study, whether this is valid for the PQ segment body surface potential maps and whether they differ for different patients. We constructed the P wave and PQ segment isointegral maps (IIM) for 26 healthy controls (group C, age 21-56 years), 16 hypertensives (HT, 25-76 years), 26 patients with hypertension and left ventricular hypertrophy (LVH, 32-72 years), and 15 patients with myocardial infarction (MI, 40-71 years). We analyzed values and positions of map extrema. Distributions of voltage time integrals were compared using the Pearson correlation coefficient r. The mean group IIMs P and IIMs PQ had smooth bipolar integral distributions. The individual IIMs PQ were very often multipolar. The IIM P maxima appeared mainly over the precordium, the minima mainly in the right subclavicular area. The highest maxima were in the MI group, significantly higher than in the HT and LVH. The highest peak-to-peak values were in the MI group, significantly higher than in the LVH. The IIM PQ maxima were dispersed over the upper half of the chest; the minima were located mainly over the middle sternum. The deepest minima were in the LVH group, significantly deeper than in the C and MI. The opposite polarity between IIM P and IIM PQ was found in 87 %, r differed significantly from zero in 76 %. The best correlation was in the LVH group (85 %), the worst in the MI group (67 %). The opposite polarity of the Ta wave against the P wave can be found during the PQ segment also in body surface maps. The reasons of group differences are not known yet.

QUANTITATIVE EVALUATION OF MOTOR FUNCTIONS BASED ON PERIODIC UPPER LIMB MOVEMENT

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Neurological diseases often impair the sufferer's motor skills and cause specific disturbances of motor functions. The patient's motor functions can be captured and the trajectory of the movement quantified. This approach can help to compare of the movements and to make diagnosis. We proposed and implemented an algorithm for quantification of the periodic movement. Our algorithm is motivated by the published "clouding algorithm" and enhanced by quantification function. The algorithm was tested on the non-trivial motion task, where the observed person is asked to circumscribe simultaneously imaginary eights by upper limbs in opposite directions. The movement was captured by two cameras and 3-dimensional trajectories of the hands were reconstructed. The repetitive patterns were found in the movement and mutual correlation was computed. Based on this correlation, we derived new parameter for learning of motor functions from its changing during the performance. This parameter can be included into the set of parameters (e.g. jerkiness, shakiness and timing of the movement), which we use for quantification and evaluation of the movements of the patients with Parkinson disease. The algorithm was tested and verified on 40 healthy people.

BOND TRACTION MEASUREMENT OF ORTHODONTIC BRACKETS USING ORTHODONTIC ADHESIVES AND COMPOSITE FILLING MATERIAL

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Stomatology is one of medical branches commonly using implants and orthodontic supplies. Nowadays the treatment of maloclusions using orthodontic devices is widely used in dogs. The aim of this study is to evaluate the traction bond strength of three materials in vitro. We test two light cured glassionomer cements GC Fuji ORTHOTM LC , EAGLE SPECTRUM TM – SYRINGE KIT and one light cured composite filling material 3M ESPE ValuxTM Plus. We use metal orthodontic brackets APOLLO „Roth .018 glued on the labial surface of extracted 90 dog´s incisors (3 groups with 30 teeth). Manufacturer´s instructions are kept. The aim of this study is also to propose the testing method for glue´s strength in traction and their comparison. Tear tests are performed on the testing machine Hegewald Peschke Inspekt Table Blue with chosen range of 1000 N. The results of this study can be practically used in the treatment of dog´s maloclusions.

This research has been supported by the research project 1/0829/08 VEGA - Correlation of Input Parameters Changes and Thermogram Results in Infrared Thermo-graphic Diagnostic.

INFLUENCE OF INTEGRATION OF LUNGS TO THE TORSO MODEL ON THE INVERSE LOCALIZATION OF ISCHEMIC LESIONS

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Cardiac ischemia causes repolarization phase changes in myocytes that can be visualized by difference integral maps (DIMs) obtained by subtracting integral body surface potential maps recorded in condition of healthy heart and maps recorded with manifestation of the disease. In simulation study the influence of involving lungs to a standard inhomogeneous torso model on the precision of inverse localization of small ischemic double lesions was analyzed. The method of the inverse solution was used with the inhomogeneous torso model (with cavities filled with blood and lungs included), with a homogeneous torso and with a torso with omitted lungs while the cavities were left to it. In all torso models the analytically shaped heart ventricles' model was used. Five different sizes of lesions were suggested, for each size a set of 12 double lesions was modeled and DIMs were computed. The DIMs were then used, together with the information on body torso model to inversely find the pair of lesions using two dipoles. For every inverse solution, the relative difference between the DIM and the map generated by inversely localized pair of dipoles was computed. All of the dipole pairs with their relative difference varying from the minimum by less than 1 % were divided into two clusters, representing two inversely localized lesions. The localization error was computed as a distance between the centre of original lesion and the centre of the inversely localized one. The average localization error for the homogeneous torso was 1.71 cm, for the inhomogeneous torso it was 1.28 cm and for the torso without lungs it was 1.41 cm. The inverse solution with two dipoles yielded worse results in finding ischemic double lesions for the torso without lungs than for the torso with them, but still the results were better than for the homogeneous torso.

VIRTUAL REALITY IN EDUCATION OF CLINICAL DISCIPLINES

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Utilization of modern technologies brings into education new dimensions, increases its quality, supports a specialized and professional advancement for both students and teachers, and increases scientific horizon of graduates. Creation of electronic education materials is in most cases oriented on renewing of static presentations and their

explanation using graphics tools. Many systems developed with the aim to support and control education processes have such methodology at very high sophisticated level. Effectiveness of their practical usage depends mostly on organization of educational activities. The resonant questions that still remain unanswered are personal contact of teacher and students and apprehension from possible "deceptions" while a distance study and evaluation process are realized only in on-line form. One of the alternatives reviving education is utilization of virtualization. Teaching of specialized pre-clinical subjects requires demonstrative tools that allow students to see and understand background of particular organs, muscles, bones, functional systems etc. Such equipment should offer a better way to classify their structure and functions, to reveal deeper details and other related connections. To obtain this, the 3D virtual projection system was installed at the Faculty of Medicine. The system is situated in lecture room with the capacity of 200 students and consists of large screen projection, teacher workstation and 3D camera system. Using specialized glasses the students feel an existence of 3D space. 3D virtual projection system was designed to offer complex functions of 3D presentation primarily for medical purposes to support education of clinical and health care disciplines. Furthermore, it is designed as modular what offers possibilities to adopt it to the needs of lecturers and to increase its functions when needed. All the virtual reality outputs can be easily converted to the forms that are applicable into the systems intended for distance education.

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ANALYSIS OF POSTURE STABILITY IN PATIENTS WITH VESTIBULAR DISEASES

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Patients with vestibular diseases suffer from inability to organize dynamics of postural control. Such instability can be caused by many factors. Variety of peripheral and central vestibular disorders also shows abnormal sensory organization. To maintain stability over the surface where the body contacts the ground one has to control the position of centre of mass COM and to retain it in stability area. Most of clinicians use stabilometrical methods to evaluate posture stability. This approach evaluates the posture as a complex motion but without distinction of body segments' movements. Then it is impossible to assess their effect on erecting and stable posture, and to understand the background of compensating movements. Therefore we used the motion analysis to capture patients, to analyze dynamics of body segments and to get characteristics that help clinicians to evaluate patient' status. The study was realized at the group of 16 patients with vestibular disease, including those in acute phase. Patients were captured while standing on stable and on unstable platform. They were analyzed also while rotate around vertical axis and all tests were realized with opened and closed eyes during 20 seconds. The results confirmed that the patients with vestibular neuritis were more unstable. Older patients and patients with severe degree of disease were not able to perform the unstable platform tests at all. It was shown that the changes of vestibular information disturb posture mainly on moving platform when proprioceptive information is missing. Degree of disturbance depends on affected part of vestibular system and on size of dysfunction. The methodology helped us to establish which type of balance strategy was used to maintain posture stability. It also allows evaluating various strategies to maintain balanced posture, to differentiate between motions in individual body segments and to choose optimal vestibular training.

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QUALITY MANAGEMENT SYSTEM IMPLEMENTATION IN HEALTH SERVICE FIELD

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Quality as a term is daily used in industry and also in verbal routine activities. Quality becomes phenomenon and each organization tries to provide it as a basic aspect of the product. Application of Quality Management System (QMS) according to ISO 9001 gives huge assume inside to the organization for increasing process effectiveness and brings customers trust outside the organization. QMS implementation in Health Service field is not so common than in other areas. This is the reason why ambulances and hospitals should try to improve their standard in the frame of process control. The specific sample is to implement management system to the environment, where 1 or 2 people are employed (mostly one medical doctors and his assistant). Any kind of system implemented in this area provides close mutual relation between existed entities inside of the organization. First specification is implementation, where is not any kind of hierarchy diversification, which allows the expressed allocation of responsibilities for different functions and processes. Each task is performed by 1 or 2 employees. Second specification is implementation directly in ambulance room. Advantage of that kind implementation is full contact between management (as a medical doctor) and customer (as a patient), which can bring and intermediate direct feedback from customers. This paper describes implementation "step by step" and points out practical deliverables of management system and underlines differences before and after implementation The algorithm of applied activities according to stomatology conditions are presented and supported by software product MS project.

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COMPARISON OF THE ST SEGMENT OF HEALTHY SUBJECTS AND PATIENTS WITH HYPERTENSION ON BODY SURFACE MAPS

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Myocardial ischemia is a common complication of hypertension. It can be caused by lower pressure difference between aorta and ventricles during diastole. High intra-atrial pressure increasing the tension of ventricular wall and ischemia can occur even when coronary arteries are intact. The aim of this study was to find out, whether it is possible to detect manifestation of ischemia with use of multi-lead body surface mapping of the heart electric field. Since typical expression of ischemia on a standard ECG record is depression of the ST segment, for purposes of this study we also pointed on this phase of the heart cycle on body surface maps. We constructed isointegral maps (IIM) in 16 patients with hypertension (10 men, 6 women, age 49.9±12.9 year) and in a control group involving 27 healthy young people (18 men, 9 women, age 31.0±12.1 year). ST segment was taken as the first 3/8 of the ST-T interval established from the root mean square signal. For measurement and construction of IIMs we used the mapping system ProCardio with 24-lead system after Barr. We analyzed and compared values of extrema and their locations. The mean distribution of integrals was bipolar in both groups, with maximum located in the precordium and minimum over the spine, in controls in the upper part, in HT group shifted significantly downwards. Maps of the control group resembled published data. Maxima and peak-to-peak values of the HT group were significantly lower than of the control group. Minima were in absolute value non-significantly lower in the HT group than in the controls. As both groups were at different age, it remains unclear, whether the

differences were caused by age or by other factors. This has to be proved in next studies.

VIRTUAL BIO-INSTRUMENTATION IN BIOMEDICAL ENGINEERING RESEARCH AND EDUCATION

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Virtual Instrumentation (VI) is increasingly used in many scientific and manufacturing / industrial sectors. This fact is due to its modularity, a wide range of modifiability, and ease of implementation. The aim of this work is to incorporate VI in teaching biomedical engineering. The LabVIEW is used in combination with specially designed modules in .NET environment as the main platform. Both multifunction data acquisition cards NI-DAQ and also the laboratory and the medical devices that are interconnected with a system via suitable interface (RS-232, GPIB) serves for the acquisition and generation of biological signals. Students can acquire real biomedical data (such as ECG, EEG, EMG and also non-electric signals as NIBP, spirometric data, etc.); analyze problems that arise during acquisition; design suitable algorithms for digital processing in real time. Another possibility is to generate biological signals for verification of medical equipment. For the needs of high performance processing, parallel processing system with gate arrays FPGAs may be used. For these reasons, the specialized workspace was created for practical training and educating students.

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CoXaM – PREOPERATIVE PLANNING SOFTWARE

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This paper presents current applications of computer technology in the field of surgery and pre-operative planning of total hip implantation. At the present time orthopaedic surgeons use transparent template radiographs as part of pre-operative planning in order to gauge the suitability and correct size of an implant. The newly developed CoXaM software offers a simple solution of the problems by using the digital x-ray images and handmade transparent plastic templates. Radiographs historically have not been standardized according to magnification. Depending upon the size of a patient, a film will either magnify a bone and joint (of large patients with more soft tissue) or minimise (in the case of thin patients). An orthopedic surgeon must estimate at what degree, plus or minus magnification to select an implant that is the correct size. The "CoXaM" software was developed in Visual Studio 2005 (Microsoft) in the Visual C++ programming language at the Department of Biomedical Engineering, Automation and Measurement at the Faculty of Mechanical Engineering, Technical University of Kosice. The software was designed for pre-operative planning and helps to determine on the X-ray image a length dimensions, a center of rotation, an angle values. It enables the digitalization of plastic templates from several producers, which will assess the suitability of the type of implant. Selected orthopedical departments used a demonstration version of the CoXaM software. The respondents learnt the basic work knowledge with the software. Learning how to use the software takes from 30 to 60 minutes from results from the questionnaires. Preoperative planning for the skilled user takes from 10 to 15 minutes for each case. The pre-operative planning process is fast, precise, and cost-efficient, and it provides a permanent, archived record of the templating process. The new proposed methodology provides the opportunity for comfortable, user-friendly and dimensionally accurate computer programming surgical operation.

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DIMENSIONAL VERIFICATION OF CALIBRATING ELEMENT ON X-RAY IMAGE

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The article is focused on confirmation or refutation of relevance of measurement of dimensional elements of digital X-ray images with calibration designed by CoXaM software. Imaging methods are an important branch of contemporary medicine. The estimate is that about 70 % of all diagnoses are made on the basis of imaging methods examination. The aim of this paper is analysis of dimensional distortion of calibrating elements in X-ray images in connection to position of calibrating element from anatomical region, which is focused on central X-ray and changes of range X-ray emitter – object – scanning cassette. System CoXaM is intended for pre-operation planning and post-operation check up of hip joint surgeries. Chosen number of calibrating elements of equal dimensions is arranged on scanning cassette (dimensions for AP projection of hip joint). Images are made by vertical central projection from the distance of 1 m, while the central ray is directed at calibrating element placed in the centre of cassette. The image will be evaluated in CoXaM software using the functions calibrating circle and circle or measurement of length dimensions. Dimensions of central calibrating element will be set by user, other dimensions will be measured by software in proportion to element set by the user. The evaluation of the same image will be done by one user 30 times and 1 times by 10 users. The results of measurements will be statistically evaluated with focus on significant abnormality and arithmetic diameter.

This research has been supported by the research project 1/0715/10 VEGA - Optimization of technological processes in prosthetics and orthotics with utilization of the infrared thermographic diagnostics.

NORMOCAPNIC HIGH-FREQUENCY OSCILLATORY HYPERVENTILATION INCREASES OXYGENATION IN PIGS

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Background: High-frequency oscillatory ventilation (HFOV), contrary to conventional ventilation, enables a safe increase of tidal volume, which is usually similar to anatomical dead space volume, without endangering alveoli by volumotrauma. Introduction of normocapnic high-frequency oscillatory hyperventilation (HFO-HV) might provide a safe increase of alveolar oxygen concentration while controlled CO_2 supplementation assures normocapnia. The aim of this study is to specify the effect of normocapnic HFO-HV upon oxygen gain under experimental conditions. Design: Experimental animal study. Settings: Institute of experimental medicine. Methods: Laboratory pigs (n=9) were investigated under total intravenous anaesthesia in three phases. Phase 1: Initial volume controlled HFOV period—ventilatory frequency f=300 min^{-1}, relative inspiratory time T_i/T=50 %, mean airway pressure MAP (CDP)=0.8 kPa, tidal volume V_T=1.9±0.3 ml kg^{-1} generated by a volume controlled oscillatory ventilator designed for this study and verified by a special measuring system. Normocapnia ($PaCO_2$=41.1±2.6 Torr, PaO_2=84.4±11.9 Torr) was achieved by iterative change of V_T. Phase 2: Hyperventilation—V_T was increased by (46±12) % compared to normocapnic V_T during phase 1. Phase 3: Normocapnic hyperventilation was achieved by supplementation of CO_2, i.e. iterative changing CO_2 fraction in the inspiratory gas in order to reestablish normocapnia. Samples for arterial blood gases analysis were taken 15 minutes after each change of V_T or CO_2 admixture. Results: A significant increase of PaO_2 (28.1±3.9 Torr, $p<0.001$) and decrease of $PaCO_2$ (–15.4±2.3 Torr, $p<0.001$) were reached by the increase of V_T in phase 2. Subsequently, the statistically significant increase of PaO_2 (28.5±5.5 Torr, $p<0.001$) against phase 1 was preserved in phase 3

while normocapnia was reestablished by CO_2 admixture into the inspiratory arm of the ventilatory system. Conclusion: Concept of high frequency normocapnic hyperventilation offers a low tidal volume strategy significantly improving oxygenation.

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DESIGN OF THE MATHEMATICAL MODEL OF THE HUMAN RESPIRATORY SYSTEM WITH RESPECT TO THE ASYMMETRY OF THE BRONCHIAL TREE

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The study deals with design and implementation of the mathematical model of the human respiratory system. The aim of the study is to design the mathematical model of the respiratory system with respect to its anatomical structure including the asymmetry of the bronchial tree. Bronchial tree has a very complex and asymmetrical structure with a lot of branching and it is difficult to describe the structure mathematically. The model of the respiratory system presented in this article is based on the morphological data of the respiratory system described by Horsfield respecting asymmetrical properties of the bronchial tree. Electro-acoustic analogy is applied to implement the model. The model can be used to study the effect of changes in pulmonary mechanics upon the intrapulmonary conditions during different types of ventilatory techniques such as conventional ventilation and high-frequency ventilation. It is possible to simulate use of wide spectra of ventilatory regimens and to study the effect of pulmonary diseases on the efficiency of artificial lung ventilation. Respiratory system is non-homogeneous and the non-homogeneity is emphasized in cases when the lung suffers by different type of diseases such as asthma, chronic pulmonary disease etc. The model respects the heterogeneous structure of the respiratory system and it can be used to study the effect of pulmonary diseases upon the efficiency of treatment by artificial lung ventilation. New aspects about intrapulmonary conditions can be found using described model. It can contribute to better understanding of effects that are observed during use of artificial lung ventilation in the clinical practice.

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HARVESTING OF BONE MARROW CELLS AND THEIR POTENTIAL ROLES IN OPEN WOUND HEALING IN A RAT MODEL

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Wound healing is a complex process of the replacement of dead or damaged tissue by two basic processes, repair and regeneration, where adult stem cells play remarkable role. The aim of present study was to develop a simple and reproducible method of harvesting of rat bone marrow cells for their further cultivation leading to generation of cells improving open wound healing. Six adult male Sprague-Dawley rats were anesthetized and subjected to doubletrephination of both thigh bones and the bone marrow was flushed out by saline and aspirated to a syringe with saline and heparin. In addition, dermal fibroblasts were isolated from small skin biopsy. The harvested cells were cultured in different media such as StemSpan SFEM (with or without growth factors), DMEM/F12, and α-MEM. Phenotype of cells was analyzed by either flow cytometry or immunocytochemistry using selected primary antibodies: anti-CD45, anti-CD90, anti-CD146, anti-nestin, anti-vimentin, anti-cytokeratin, anti-sox-2, anti-oct-4, anti-nanog, anti-fibronectin, and anti-α-smooth muscle actin (SMA). Cells expressed markers of poorly differentiated cells during the first few days of cultivation, later their expression decreased to minimum. Bone marrow cells cultured in α-MEM showed morphologic picture of mesenchymal stem-like cells. After long-term cultivation cells cultured in this medium spontaneously differentiated into myofibroblast-like cells (expressing vimentin and α-SMA) and produced extracellular matrix rich on fibronectin. In contrast, dermal fibroblasts did no express α-SMA after similar number of passages. From this point of view bone marrow cells, cultured at presented methodology, might be able to improve new tissue formation and wound contraction and, thus might play important role in open wound healing.

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CHONDROITINASE ABC INFLUENCES THE PHENOTYPE OF NEURAL PROGENITOR CELLS ISOLATED FROM INJURED ADULT RAT SPINAL CORD

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Neural progenitor cells (NPC) are self-renewing, multipotent cells differentiating into neurons, astrocytes, oligodendrocytes and play an important role in the neuroregenerative processes following spinal cord injury (SCI). Chondroitin sulfate proteoglycans (CSPG) are enriched in the extracellular matrix in the CNS and they are upregulated at the injury site. Degradation of CSPG using enzyme chondroitinase ABC-ChABC might impact the NPC phenotype development at the lesion site. In present study we performed *in vitro* model demonstrating the differentiation potential of NPC isolated from adult rat spinal cord after SCI, treated with ChABC. Animals were divided into 3 groups: i) rats after SCI with intrathecal application (IT) of ChABC (10 U/ml) (SCI+ChABC), ii) rats after SCI with IT application of saline (SCI+saline) and iii) naive rats. The IT delivery of ChABC or saline was performed at day 1 and 2 after SCI. At the fifth day after SCI, NPC were isolated from spinal cord, cultivated in proliferation medium and arisen neurospheres were passaged and differentiated. Using immunocytochemistry by applying specific antibodies, the population of astrocytes-GFAP, oligodendrocytes-RIP and neurons-NSE were analyzed. The positive cells were counted as a percentage of total DAPI+ nuclei in 10 random fields. The number of differentiated cells were correlated in SCI+saline vs. SCI+ChABC: astrocytes 11.10 % vs. 21.23 %, oligodendrocytes 26.45 % vs. 34.81 % and neurons 21.59 % vs. 24.57 %. In naive rats we observed following values: astrocytes 15.1 %, oligodendrocytes 37.38 % and neurons 28.47 %. These findings indicate, that the impact of SCI resulted in a decrease of all NPC phenotypes. On the contrary, the ChABC treatment caused an opposite effect, increase of surviving neurons and oligodendroglial cells, reaching almost control values, but with significant acceleration of astrocytes.

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SPONTANEOUS BREATHING OF HELIOX USING A SEMI-CLOSED CIRCUIT REDUCES EXPENSIVENESS OF VENTILATION WHILE PRESERVING THE POSITIVE HELIOX EFFECTS: A BENCH STUDY

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The use of helium-oxygen mixture (heliox) for ventilation has an advantage in patient with obstruction of the airways. The physical properties of helium enable an easier gas flow through the airways allowing the patient an easier breathing compared to ventilation with air. Heliox breathing reduces airway resistance and work of breathing in patients with airflow limitation. A limiting factor for using heliox in clinical practice is a high cost of helium. At present, heliox is applied by an open circuit. Disadvantage of this method is a high consumption of helium. The aim of the study is to design and test a semi-closed circuit for heliox application in order to minimize consumption of helium and, therefore, reduce the expensiveness of spontaneous breathing with heliox. During a pilot study, designed semi-closed circuit was tested in combination with spontaneous breathing in healthy volunteers. Effort to breathe was assessed by the end-tidal fractions of O_2 a CO_2 as an indicator of change in work of breathing. Results of heliox ventilation were compared with those obtained with standard air ventilation. The reduction in work of breathing during inhalation of heliox was confirmed by increased of the mean value of O_2 fraction by more than 25 % and significantly reduced fraction of CO_2 in expired gases, referred to as end-tidal CO_2. We conclude that use of a semi-closed circuit offers a potential benefit of heliox in patients with obstructive bronchopulmonary diseases at a lower cost than during heliox application using an open circuit.

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THREE-DIMENSIONAL STEREOSCOPIC VISUALISATION OF HEART ELECTRICAL VECTOR PROGRESS FOR EDUCATIONAL PURPOSES

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A human heart electrophysiology is a difficult topic and requires a complex approach in education and training of young doctors, physiologists and biomedical engineers. The aim of this work is to design and realize a simple and comprehensible educational system. The entire system should include measuring of heart biopotentials on the surface of body; it's processing and three-dimensional (3D) stereoscopic visualization of the heart electrical vector progress. System is realized as an ordinary PC peripheral device – measuring unit and necessary processing and visualization software. The measuring unit consists of multiple inputs and allows taking bipolar leads, or monopolar leads with Wilson terminal and augmented voltage. USB standardized connection allows using the device with different types of PCs. The measured data output consists of three columns of numbers that represents measured voltage coordinates in the X, Y and Z axes. Measured data are processed in Matlab® numerical computing environment. The projecting scene is pre-paired in Matlab as well. Final 3D scene – spatiocardiogram – is generated using a connection of Matlab and VRML file format. The advantage of the system is that it is open and allows combining classical bipolar, monopolar and augmented standardized ECG leads or its combination, or orthogonal leads use as well. Passive or active 3D stereoscopic projection is possible, due to VRML standard based visualization system. Electrical heart vector progress projection can be stopped and rotated for different planes of view and a complex study of its shape and characteristics is guaranteed. Further, the device allows demonstrating the differences in ECG signal recorded using bipolar, monopolar, and monopolar augmented leads from the given electrode. A complex educational system for measuring, processing and 3D stereoscopic visualization of the heart electrical vector progress was designed, realized and described. It's possible to modify and reconfigure for demonstration and educational purposes.

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PROPOSAL OF AN EXPERIMENTAL APPARATUS FOR KINETICS STUDIES OF DRUGS INCORPORATION INTO BILAYER LIPID MEMBRANES

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The main goal of the present work is a construction of experimental setup for a detection of drug molecules incorporation into bilayer lipid membrane (BLM). Photo-sensitizers (pts) used in photodynamic therapy (PDT) mainly hypericin (Hyp) have been in focus of our interest. PDT is based on application of pts, which are selectively accumulated in cancerous cells. After light irradiation these molecules trigger a sequence of photo-chemical reactions finally leading to cell death. One of the key issues of PDT is the targeted drug transport into the tumor tissue. From this point of view the characterization of Hyp incorporation into planar BLM has got a great importance. Bilayer lipid membranes (BLMs) are formed by painting Diphytanoyl-phosphatidylcholine dissolved in n-decane onto a 0.5 mm diameter hole connecting two chambers of a Teflon cell. The chambers are filled with electrolyte: 170 mM KCl and 10 mM HEPES at pH 7.4. The formation of the BLM is followed by observing the interference pattern of the membrane in reflected light under a microscope. The presence of the membrane is detected by measuring the membrane resistance using Ag/AgCl electrodes. After forming the BLM Hyp dissolved in DMSO is added into one of the chambers equipped with a magnetic stirrer. In aqueous environment Hyp forms non-fluorescence aggregates and on the other hand Hyp is dissolved in the membrane in its monomeric form, which shows fluorescence. This fact has been used in the construction of our experimental apparatus. The Hyp monomers incorporated into the BLM are detected by time-resolved measurement of the Hyp auto-fluorescence signal using 532 nm laser irradiation. The signal is measured by a photomultiplier tube operated in photon counting mode. By using of this apparatus we have obtained a typical increase of the fluorescence signal of Hyp incorporated into the BLM in dependence of time. The measured data were fitted with an exponential curve having characteristic time constant of 70 s.

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NEW AND EMERGING RISKS – OLDER STAFF IN EMPLOYMENT

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Work injury statistics prove that employees over the age of 40 belong to the category of people who are most involved in serious work injuries. Psycho-physiological changes of the human body as results of ageing seem to be the likely causes of these injuries. This study focuses on one particular psycho-physiological factor, which is the eyesight. Statistics, in the form of a questionnaire, involving a group of respondents between the ages of 23-61, were carried out to reveal the state of the eyesight and how its changes caused by ageing are perceived. 52 respondents from Košice Region were involved in the questionnaire survey focusing on perception of the impact of working environment on the eyesight. Questions referring to the age, sex, profession, state of eyesight and perception of the effect of working environment on the eyesight were answered by the respondents in an anonymous questionnaire. They also expressed their views regarding the measures that have to be taken to modify the working environment for the employees over the age of 50. Respondents were divided into different categories by their age. The conclusions resulting from the questionnaire are the following. The categories of people between the ages of 20-30 and 30-40 state that they have a good eyesight. Categories of elder people indicate that their sight got worse and they use dioptres at a high rate. This is applicable to 79 % of respondents between the

ages of 40-50. A serious eyesight damage has been detected, by the questionnaire, within the category of respondents who are over 40. In categories between the ages of 50-60 and those who are 60 and over sixty, all the respondents state they use dioptres. These results can be biased because of the number of respondents having been involved and the work they do. 94 % of the people questioned say that a good eyesight is essential for the operations they perform.

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AUTOMATED INTRA–ABDOMINAL PRESSURE SENSING SYSTEM VERIFICATION

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Intra-abdominal pressure (IAP) is the steady-state pressure concealed within the abdominal cavity. It is directly affected by solid organ volume, presence of diseases or other space occupying lesions and conditions that limit expansion of the abdominal wall. Abdominal compartment syndrome (ACS) is the natural progression of pressure-induced end-organ changes. According to recent literature, frequency of ACS in trauma ICU admissions is anywhere from 5-15 % and is 1 % of general trauma admissions. A variety of direct and indirect measuring methods for intermittent IAP measurement have been suggested, but only a several of them utilize the electronic data processing. The measurement via bladder is today the most used measurement method. This paper describes the verification of measuring system for intra–abdominal pressure measurement. The measuring system is a basic part of proposal device for automated measurement of IAP. The testing device for pressure sensor verification is composed from abdomen model and sensing system. The model is created from 250 ml saline bag (as bladder) placed on the bottom of 35 l container. The container allows create pressure by the water column up to 25 mmHg. The pressure in the saline bag is measured with pressure transducer and level gauges. The measurement was approached as follows. The pressure in the "abdomen" was increased from 0 to 25 mmHg with 5 mmHg increment and when reaching 25 mmHg decreasing to the 0 with 5 mmHg decrement. The value of pressure was measured after each increment / decrement. This measurement has character of pilot measurement for acquiring the basic parameters of sensor and other elements. The recalculated pressure values don't have outliers and the standard deviation for particular levels is from 0.032 mmHg to 0.069 mmHg. The sensor stability in the short time testing is suitable. For the better results is necessary eliminate mistakes in measurement methodic and improve the data processing.

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THE ROLE OF THERMOGRAPHY IN THE DIAGNOSTICS OF CARPAL TUNNEL SYNDROME

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Presented paper deals with infrared thermography (IRT) used for the diagnostics of Carpal Tunnel Syndrome (CTS). More studies on medical thermography in the relation with CTS diagnostics were published. Jesensek Papez B. *et al.* in 2008 and 2009 improved outcome with classification success rates near to or over 80 % in dorsal segments of hand. The background of this study is the skin physiological temperature distribution difference on the dorsal hands and pathophysiological temperature distribution on hands with CTS and non-invasiveness and painlessness of IRT. For presented study, the database of 268 thermal images of the dorsal side of 120 healthy (n=120) and 14 pathological hands (n=14) with clinically diagnosed CTS of 8 patients were examined. Pre-surgical thermograms of the hands with CTS of each subject were taken and stored by using IRT (Thermocamera Fluke Ti55/20, FLUKE, USA). The new methodology of measurement and evaluation process of thermograms (SmartView 2.1, FLUKE, USA) was assessed. We observed the temperature distribution of the whole hand and the partial temperatures of the center point of carpals (D1), the center point of metacarpals (D2) and the finger tips of the third finger from proximal phalanges (D3), the intermediate phalanges (D4) to the distal phalanges (D5) and the Median Nerve Index (MI=(D1-D5)) were calculated. Results obtained from measurements of the five defined points on the dorsal side of hands showed, that the temperature of CTS hands is characterized by a higher temperature in the phalanges unlike the wrist (MI<0, 71.1 %), while the temperature is the lowest on distal phalanges (D5) of healthy hands (MI≥0, 85.8 %). The results showed that the skin temperatures of median nerve distribution area on dorsal hands were significantly different between CTS and the control group. The sensitivity of IRT in diagnostic process of CTS is 0.714. Results will be confirmed by further screening of statistically significant group of patients.

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PERSPECTIVE TREATMENT OF KNEE JOINT OSTEOARTHRITIS WITH AUTOLOGOUS PLATELET RICH PLASMA

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Autologous platelet rich plasma (PRP) is a rich source of bioactive proteins, including growth factors that modulate the healing process. PRP therapy offers a promising solution to accelerate and support healing of tendon injuries and osteoarthritis naturally without subjecting the patient to significant risk. The current study was designed to find out a simple, low-cost method for PRP preparation and explore this novel approach to treat degenerative lesions of articular cartilage of the knee. The manual protocol consisted of the anticoagulated whole blood collection (30 ml) and three-step aseptic centrifugation procedure, which was precisely suited to platelet separation from whole blood and their sequestration in high concentration without lysis or damaging the platelets. The total time needed to prepare platelet concentrate was one hour. PRP unit of 3 ml was used for the intra-articular injection. On average 4.5-fold increase in platelet concentration was found in PRP compared with that of whole blood (average baseline whole blood, $150\pm30 \times 10^3$ platelets / μl; platelet concentrate, $680\pm132 \times 10^3$ platelets / μl). The clinical trial assessing the safety and efficacy of the application of PRP tracked 60 participants with medium degree of articular degeneration, with 30 receiving a series of three PRP injections, 30 getting injections of hyaluronic acid. No severe adverse events were observed, and statistically significant improvements in all scores were recorded. The preliminary results confirmed suitability of developed manual procedure for the preparation of PRP and suggest that this method may be safely used for the treatment of joint destruction in knee osteoarthritis, by aiding the regeneration of tissue which otherwise has low healing potential.

NOVEL IMAGING MARKERS OF SPERM LOCATION AND SPATIAL GEOMETRY ARE CORRELATED WITH IMPROVED VIABILITY OF EARLY HUMAN EMBRYOS

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In human assisted reproduction, reliable signs of embryonic wellness are still controversial, and accurate criteria for embryo assessment after

in vitro fertilization (IVF) are on high demand. The aim of our study was to define novel spatiotemporal morphologic markers in early embryos, which would be suitable for easy scoring with human vision as well as with computer image analysis, while serving as solid predictive markers of embryonic developmental potential. Methodologically, pronuclear and cleaving embryos (stages E1 to E5) from clinical IVF program were subjected to automated time-lapse imaging over 5 days. Subsequent morphometric analysis (human force and digital tools) was used to define striking phenotypic features suitable for computational scoring. Three of our newly defined markers have shown a strong correlation with the embryonic developmental competence: i) the timing of the three interphases occurring after the two-cell stage, ii) the position of the pronuclear apposition axis, and iii) the angle of the first cleavage plane relative to the polar body location. Namely, synchronous and early timing of blastomere cleavages correlated with the ability to develop to fully expanded blastocysts. Furthermore, 91 % of zygotes cleaving towards the first polar body region were developmentally competent, in contrast to only 4 % of normal embryos found among the zygotes with the first cleavage plane deviating away from polar bodies. And finally, most of the normal embryos were originated from zygotes having the cleavage plane in line with the axis of pronuclear apposition. In conclusion, our novel imaging markers correlate strongly with the embryonic developmental competence and can be refined for fully automated high-throughput usage in clinical trials.

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THE EFFECT OF STRESS ON NMR IMAGE CONTRAST AT LOW FIELD NMR EXAMINED IN THE HUMAN HAND

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The clinical examinations of human body surface are very difficult even with modern diagnostic tools like nuclear magnetic resonance (NMR). A lot of outer factors may influence the results of such measurement, for instance the mental comfort of the patient; especially, the stress level. In our experiment we investigated the effect of stress on the NMR image contrast to determine its possible influence on diagnostic examinations. We used an opened system with specially designed accessories to minimize the possible artifacts. Hand was selected as an examined body part because of high concentration of sweat glands on the palm. Stress was represented by its outer effect (sweating), which was simulated by a hand soaking in an artificial sweat bath. Images before and after this procedure were evaluated with a special focus on superficial and inner regions. The measured average signal intensity of the superficial skin regions increased significantly from 1305.14 pre-stress to 1539.91 post-stress. While the signal intensity of inner muscle region remained relatively stable (from 1091.91 pre-stress to 1112.66 post-stress), thus the general image contrast was changed. Our results suggest that the relationship between stress and the NMR image contrast should be taken into account when evaluating superficial (e.g. skin) NMR data.

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SYSTEM FOR EFFECTIVE INFORMATIONAL SUPPORT OF THE CARDIAC PACING TEAM

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Innovation in medicine is an essential contribution to the care of the health of the mankind worldwide. Our innovation lies in improving the efficiency of the work of health care personnel, specifically in the operating room at the cardio stimulation department of the hospital in Ostrava (Městská nemocnice Ostrava). Solution of this innovation is designed by using the workflow automation. Automation is carried out by creating a system which replaces the sequence of operations performed by human personnel. System – the software enables a transmission of real-time data from the vital signs monitor DASHx000 (where x is the product range 1, 2, ..., 5). The system allows data acquisition from the implant control system the ICS3000 using one of the media (USB flash drive, CD). Data from both devices are processed and then used in filling the forms which are ready in the programming environment. User – the doctor then can work with that data in a user friendly interface. This also allows the creation of a database of patients with their measured data and other information such as the statistics and the surgery relating data. So the current obsolete system for managing patients and their data will be replaced by the new software. The new system is being developed using C# programming language and the .NET environment. It is necessary to create a software driver that implements a communication protocol. This is probably the most important element of the system, since the interconnection between the DASH and the PC is the main goal of this project. Currently, the software allowing connection to vital signs monitor DASHx000 is created. So the basic software driver has been developed. The ECG signal is the most important parameter for monitoring. ECG data can be loaded, displayed and stored in a file. Data can later be retrieved from this file and user can choose different channels to display. Thanks to a functional interconnection between the PC and the DASH there can be made many useful tasks and applications. For example there is a plan to create simple application that can be used in ambulance car to store important vital signs during patient transfer. In case that the patient is pacemaker dependent, can another software application evaluate the length of the RR interval which is time between two pulses from the pacemaker. Extending of this interval means that the battery is discharging. So the software can be used to determine the status of the battery. These applications can be easily implemented in many healthcare facilities. Therefore it makes sense that these innovative features are being developed and supported.