



AKADEMIA GÓRNICZO-HUTNICZA IM. STANISŁAWA STASZICA W KRAKOWIE

Wydział Elektrotechniki, Automatyki, Informatyki i Inżynierii Biomedycznej

**KATEDRA BIOCYBERNETYKI I INŻYNIERII BIOMEDYCZNEJ**  
**Department of Biocybernetics and Biomedical Engineering**

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## Proposals of PhD topics 2018

(interested candidates are asked to contact the Department Head, prof. P. Augustyniak [august@agh.edu.pl](mailto:august@agh.edu.pl))

### **Usage of intelligent electrical energy meter to pursuit of behavior in assisted living.**

The research aims at building of an intelligent electrical energy meter, tuning it for accurate recognition of typical household equipment and exploring the possible use for detection and assessment of behavioral patterns. Application in volunteers' homes and scenario-based research is necessary for validation of the methods proposed.

### **Synchronous pulse and scanpath measurement from UHD video sequences of multiple faces.**

The research consists in proposing an efficient method of multiple face detection, videoplethysmographic pulse detection and scanpath recording. The proposed method should be validated with recorded scenes, then implemented and validated with real time images of computer users. Additional study of continuous VPG signal recording from a mobile human by a multicamera system will be welcome.

### **Evaluation of personal driving style based on emotional and environmental sensors.**

The research aims at applying non-intrusive emotion recognition sensors and environmental (vehicle-related) sensors of speed, acceleration and distance and study their possible usage for evaluation of personal driving style. Implementation in a real vehicle and experiments in artificial and real driving condition are welcome. With permission, tests under induced emotional states are possible. Another extension of the study includes real-time style recognition and classification and influencing the driver to eliminate risk factors.

### **Detection of heart beats from irregularly sampled or missing samples electrocardiograms.**

Aim of the research is to propose and evaluate an efficient method to detect the heart beats from missing samples electrocardiograms. The performance and the loss of performance due to missing samples percentage have to be evaluated accordingly to the international standards. For irregularly sampled ECGs the evaluation has to be done for various sampling modulation patterns to reveal the optimal reliability-to-bitrate ratio.

### **Adaptive fusion of cardiac, motion and environmental data streams into a standard digital electrocardiogram.**

The aim of the research is to adapt the regular ECG storage structures and data transmission equipment to accommodate additional motion and environmental data streams. Proposal and numerical validation of the method with recorded data is expected before building and validating the hardware prototype. Evaluation with volunteers and true-to-life scenario-based experiment is necessary for validation of the solutions proposed.

### **An autonomous associative vision system of a robot forming knowledge about the environment using motivated learning and artificial intelligence methods.**

Aim: This work aims in the creation of an innovative robot vision system (e.g. for an accessible Parallax Arduino platform using the Intel RealSense vision sensor) based on associative methods, associative semantic memories, machine learning, artificial intelligence methods, and motivated learning. It should enable autonomous and automatic knowledge creation about the environment based on recognizable symbols and symbol grounding with the possibility of moving around and setting goals based on defined or natural robot's needs. The scope of work also includes the creation and implementation of algorithms related to reading data from various robot sensors, controlling its motors and booms, grounding symbol, recognition, clustering and image classification, creating time-space association relationships between objects, semantic memories, machine learning and cognitive system creation.

### **Associative graph databases equipped with quick mechanisms of inference and data access.**

This work aims to use the associative data structures (i.e. AGDS, MAGDS, DASNG, APNN, AANG) and to develop an innovative associative database system based on effective data access algorithms (e.g. using AVB-trees) to create a universal associative database engine similar to SQL together with extensions for data mining. The scope of work also includes the creation and implementation of algorithms for automatic transformation of relational and non-relational databases to the form of associative graph databases (AGDB) and the performance comparison of operations with other databases.

### **The use of artificial intelligence methods and associative graphical parallel data processing to control the quality of data obtained in the large elementary particle accelerator ALICE in CERN.**

The work aims to use artificial intelligence methods and associative graphical data structures (i.e. AGDS, MAGDS, DASNG, APNN, AANG) for fast (in real time) data processing in terms of testing the quality of data obtained from ALICE detectors (over 3Gb / s). The scope of work includes creating associative graph data structures enabling aggregated and associated data representation, quick access to them and further processing and reasoning on their basis. It is also planned to use various associative methods and artificial intelligence for clustering and classifying data. The advantage of the work is the ability to process real data and access to specialized equipment, including parallel processing, as well as software and hardware structures as well as data from the ALICE experiment at CERN. Expected trips to CERN in Switzerland, and even stay and work at CERN during the PhD.

### **Use of neural networks in selected problems of medical diagnostics**

Medical diagnosis is key decision in every medical procedure. This decision must be made by a doctor (human) because it involves personal responsibility. But his decision process can be aided by means of numerous computer methods, belonging to artificial intelligence. One of the best methods is such applications are neural networks. This tool can be especially

effective in analysis of symptoms and in decision making processes, because its learning possibilities. The scope of PhD thesis will be based on practical use of popular Statistica Neural Network program (fabricated by StatSoft) and on medical records (the stories of specific patients' diseases and therapies) taken from the hospital archives. The main goal of the research is related to assessment of the effectiveness of different types neural networks in medical diagnostics.

### **Analysis of acoustic and phonetic changes taking place in the speech signal of patients as a result of the occurrence and development of selected types of diseases**

Many types of diseases cause characteristic changes in patient speech signal. Some of them can change speech phonation and vocalization (e.g. laryngological diseases), some can change speech articulation (e.g. dental prosthesis or jaw surgery), some other can disrupt pronunciation control (e.g. neurodegenerative diseases). In every case speech signal is the easiest symptom of the ongoing disease and can be very useful for early diagnosis and for monitoring of results of the therapy. Main goal of proposed PhD dissertation is finding the acoustic and phonetic parameters signaling diseases symptoms and elaborating computer methods for extraction of such parameters from the raw signal.

### **Application of augmented and virtual reality techniques in supporting the therapeutic process**

Augmented and virtual reality become more and more popular in many areas and in many applications. Nevertheless application of such multimedia ICT technologies in medicine is until now very limited. Main goal of proposed PhD thesis is testing of usefulness of augmented and virtual reality in supporting the therapeutic process – especially in surgery. Mounting real image of patient organs with images taken from some medical imaging devices surgeon can better localize pathological changes in considered organ and can better perform the operation. Qualitative and quantitative assessments of the results of augmented and virtual reality medical applications will be most valuable result of proposed PhD thesis.

**further topic suggestions are welcome !**