AZ "ÖVEGES JÓZSEF" HALLGATÓI és PhD ÖSZTÖNDÍJ

2012-2013-AS TANÉVRE ÉRVÉNYES PROJEKT TÉMÁI

szervezeti egységenként csoportosítva

Advantage Workstation képfeldolgozó és diagnosztikai munkaállomás egység

A legfontosabb termékünk az Advantage Workstation, amely nagyban segíti az orvosokat, hogy az adatok alapján döntéseket hozzanak, és megsokszorozzák az adatfeldolgozás sebességét, kezdve az adatátviteltől egészen az eredmények közléséig. Olyan hardver és szoftveralkalmazásokat készítünk, amelyek megkönnyítik az orvosoknak a modern képalkotó rendszerek (CT, MR stb.) által szolgáltatott hatalmas mennyiségű információ feldolgozását. Többek között háromdimenziós modelleket alkotunk, illetve más speciális orvosi képfeldolgozáson alapuló alkalmazásokkal segítjük a diagnózisok felállítását.
Legfontosabb szoftver területeink:

- 3D rekonstrukció
- Érszűkület, valamint szívkamra analízis
- Radioterápiás tervezés virtuális szimulációval
- Vizsgálatok követése PET-tel: daganatok összehasonlítása a kezelés előtt és után
- Az alkalmazások működéséhez és az adatok kezeléséhez, tárolásához szükséges platform

Title	**User experience measurement in medical applications**
Id	G-AW-1108
Introduction	The measurement of the users effective interaction speed is a real need in medical applications. Nowadays the medical applications are usually running on network environment. The network environment brings in concepts like latency, performance lost which are mainly affecting the user experience. By creating a user interaction database and continuous comparison with it could give us real status of the measured applications. Main phases: • Learn about the existing measurement technics used in GE Healthcare; • Create user interaction criteria database; • Develop a tool for recording image sets, comparing the recorded and the stored image sets.
Goal	Develop a tool which is able to measure the user experience using predefined rules.
Duration	1 year
Required skills	C/C++, Bash Nice to have: PHP + MySQL, image processing Communication level English
Tutors	Arpad Csincsak; +36 23 410 546; arpad.csincsak@ ge.com
Further information	

Title	**Smart connector to encoded volume data**
Id	G-AW-1109
Introduction	Efficient 3D volume rendering and processing engine can be built on a run-length encoded data structure. Access to this engine from 3D volume processing frameworks like ITK, which use a 3D array representation of the volume, usually results in explicit extraction of the encoded data into a full-blown duplicated volume and the advantages of run-length encoded representation are lost. In many cases this is not optimal neither in memory consumption nor in terms of development. To avoid these problems we need an interface that can directly connect a 3D array based framework to the run-length encoded representation. Connector should be optimized on different access patterns (like sequential access or neighbourhood sampling in convolution filters), so that performance on general 3D array based algorithms do not downgrade wherever possible.
Goal	Design a connector that can efficiently access run-length encoded representation from an 3D array based framework. Implement the design to connect ITK to connect one of our existing framework, which use run-length encoded representation. Evaluate the performance of the connector.
Duration	1 year
Required skills	C/C++, willingness to learn and work with a large framework. Experience with ITK is an advantage
Tutors	Balazs Cziria: +36-23-410-015; balazs.cziria@med.ge.com
Further information	

Title	**Dose display on clinical images (DICOM RT format)**
Id	AW – ADVSIM - 2201
Introduction	Review the DICOM/DICOM-RT standard, in particular understand the DICOM-RT formats, develop software component to read and display RT dose and cumulative RT dose, and develop effective tools for analysis. Integrate it into GE Healthcare's AdvantageSim MD virtual simulation application.
Goal	The goal of the project is to • perform scientific literature search on uses of cumulative dose display and analysis in radiation therapy • understand industry-wide utilization and implementation (as possible) of dose- and cumulative dose display and analysis • design the RT dose and cumulative RT dose display software component including quality check tool • develop effective tools for analysis of dose and cumulative dose • understand GEHC oncology product design and structure • Integrate the developed software component into the AdvantageSim MD product
Duration	9-18 months
Required skills	C, C++, Java programming skills
Tutors	Cziria Balázs +36 23 410 015 balazs.cziria@med.ge.com
Further information	

Title	**Point dose calculation for radiation treatment**
Id	AW – ADVSIM -2202
Introduction	AdvantageSim MD is a software product of General Electric's Healthcare business intended for virtual simulation in external radiation therapy planning. This product has been developed for and successfully used by clinicians all over the world.
Goal	The goal of the project: • scientific literature research around palliative and emergency external radiation therapy planning and treatment delivery • understand palliative and emergency radiation oncology workflow and it's use cases and document them • create detailed software requirements specification for point dose calculation including intuitive and easy-to-use user interface design

	• create verification and validation plan
Duration	1,5 years
Required skills	physicist academic knowledge, oncology background
Tutors	Ferenczi Lehel +36 23 410 038 lehel.ferenczi@med.ge.com
Further information	

Title	**Cumulative dose display and analysis**
Id	AW – ADVSIM - 2203
Introduction	AdvantageSim MD is a software product of General Electric's Healthcare business intended for virtual simulation in external radiation therapy planning. This product has been developed for and successfully used by clinicians all over the world.
Goal	The goal of the project is to understand dose and cumulative dose display and offer effective tools for analysis as per below: • Perform scientific literature- and industry-wide search on uses of dose and cumulative dose display and analysis in radiation therapy • As a conclusion from current uses and clinical and industry-wide trends, write-up recommended use cases for dose and cumulative dose display, quality check and analysis • Prepare design specification • Prepare verification and validation document
Duration	1,5 years
Required skills	physicist academic knowledge, oncology background
Tutors	Ferenczi Lehel +36 23 410 038; lehel.ferenczi@med.ge.com
Further information	

Title	**Efficient GPU Implementation of Segmentation and Registration Algorithms**
Id	PhD-AW-1210
Introduction	Segmentation and registration are fundamental operations in medical image processing. The aim of segmentation is to separate the different organs contained in the data, whereas registration is required to merge data sets of different modalities such that each voxel consistently represents the same sample position in both data sets. The resolution of 3D medical data sets increase due to the evolving scanning technologies and improved tomography reconstruction techniques. Because of the large amount of data to be handled, an efficient implementation of recent segmentation and registration algorithms is a challenging task.
Goal	The major goal is to efficiently map the state-of-the-art segmentation and registration algorithms to the conventional graphics hardware. Especially those algorithms are worthwhile to adapt to the recent GPUs that are known as off-line methods because of their computational overhead. For example, level set segmentation techniques and entropy-based registration methods are two representative examples.
Duration	3 years
Required skills	basic knowledge in image processing algorithms, high motivation to learn them
Tutors	Letonai Mátyás +36 23 410 024; matyas.letonai@med.ge.com
Further information	

Title	**Interactive Medical Applications on Distributed Computer Systems**
Id	PhD-AW-PLATF-1401
Introduction	Current applications that are designed to run in distributed environments (clusters, grids) are mainly batch processing or large data storage management applications. Today's mainstream interactive medical applications are in best case simply paralleled applications and they are not able to utilize computational hardware resources distributed over the network.
Goal	The doctoral thesis should discover related literature, and provide a comparative analysis of the currently available distributed medical application systems whether they are batch mode, storage oriented or interactive applications. Based on these results the applicant should define the set of interactive medical application types that are good candidates to be executed in distributed environment. The applicant shall also create the necessary fundamentals of an application framework that can be the basis of a future commercial grade application family of distributed interactive medical applications.
Duration	3 years
Required skills	Parallel programming experience, Fundamentals of distributed computing, Fundamentals of Image Processing Communication level English
Tutors	Palagyi Tamás; +36 23 410 027; tamas.palagyi@med.ge.com
Further information	

Title	**Medical Imaging on Distributed Systems**
Id	PHD-AW-PLATF-1201
Introduction	In medical imaging web based image display is an increasing need. At a radiology department images generated by acquisition systems and their post processed 2D and 3D forms – which usually contain large amount of data - need to be transferred to several locations all around the world without data loss and in a fast and easy way. Main phases: learn about GE Healthcare review workstation architecture, presently used tools, compare of current solution of thin client vs. thick client, examine current trends in medical imaging (cloud computing, interoperability, etc.). Based on the thin client vs. thick client examination results define the data transfer method. Give an overview how web technologies relate to current architecture.
Goal	Create a new architecture for more efficient data processing and flow than the today used one
Duration	3 years
Required skills	Networking Java Nice to have: C++, Image processing, image rendering, Distributed Architecture, enterprise architecture Communication level English
Tutors	Palagyi Tamás; +36 23 410 027; tamas.palagyi@med.ge.com
Further information	

Title	**Web applications in medical imaging**
Id	PHD-AW-PLATF-1202
Introduction	In medical diagnostics and imaging mobility, accessibility and collaboration is an increasing need. At a radiology department images generated by acquisition systems and their post processed 2D and 3D forms – which usually contain large amount of data - need to be presented to radiologists and physicians independently their location and hardware. Our product provides 2D and 3D anatomical reconstructions and measurements to doctors in order to guide diagnosis, radiotherapy, and surgery. Main focus of the thesis is fast, effective image visualization and basic manipulation using web based application technics like HTML5, WebGL and related technologies (CSS3, javaScript, eventually some WHATWG specifications). Another area of investigation is how to provide direct access to the medical data (DICOM) using web services in concordance with the IHE specifications and guidelines.

Goal	Design platform architecture and create guideline and requirement for hosted applications and suggest how to create and us web applications in medical world
Duration	1+8 months
Required skills	Fundamentals of WebGL, HTML, Web services, SOA Communication level English
Tutors	Sótanyi Balázs +36 23 410 044; balazs-zoltan.sotanyi@med.ge.com
Further information	

AW Klinikai alkalmazások egység, szegedi K+F iroda

Az AW szegedi K+F irodájában jövőbeli klinikai alkalmazásokat megalapozó algoritmus-fejlesztés folyik. A legfontosabb kutatási terület a különböző modalitású orvosi képek automatikus szegmentációja.

Title	**Anatomy based multi-modality registration**
Id	PhD-AW-APPS-1402
Introduction	The registration of multi-modality images is a well developing, but still very complicated and challenging area of the science. Multi-modality registration methods are often used in medical imaging as images of a subject are frequently obtained from different scanners. Examples include registration of brain CT/MRI images or whole body PET/CT images for tumor localization, registration of contrast-enhanced CT images against non-contrast-enhanced CT images for segmentation of specific parts of the anatomy, or registration of ultrasound and CT images for prostate localization in radiotherapy.
Goal	In this research project we would like to concentrate to the registration of medical images captured from the same patient but in different times or with different modalities. The goals are to learn the most up to date registration techniques and develop fast and robust registration algorithms, which uses the anatomy information during the optimization (as the deformation and shift of different organs, respiration correction, sub-anatomy registration, etc.).
Duration	3 years
Required skills	MsC in computer science, Image processing experience is an advantage Communication level English
Tutors	Tamas Blaskovics: +36-23-410-362; tamasblaskovics@ge.com
Further information	

Title	**Segmentation of medical 3D images with hierarchical models**
Id	PhD-AW-APPS-1403
Introduction	Due to the widespread of clinical systems, which allow background processing of medical images prior reading, there is an increasing need for fully automated segmentation methods. The complete segmentation of a medical image is still a challenging problem due to the large anatomical variation between patients. The model-based approaches incorporate some anatomical information to segment a body region, but cannot handle a wide range of variations.
Goal	Our goal is to develop a hierarchical body model (or set of some models), which represent all anatomical regions, organs, and organ specific structures (lobes, vessels), and automatically segment an image using this model within clinically acceptable time. The method shall involve automated detection of the presence or absence of important anatomical points and shall be robust enough to handle anatomical differences due to age, sex, or typical pathologies.
Duration	3 years
Required skills	MsC in computer science or biomedical engineering
Tutors	Laszlo Rusko: +36-23-410-173; laszlo.rusko@ge.com
Further information	

Title	**Automated medical image processing**
Id	G-AW-1110
Introduction	Due to the widespread of 3D imaging modalities (CT, MR, PET) the number of cases processed by the radiologists has been significantly increased in the last decade. In order to facilitate medical image processing, various software applications have been recently developed. These applications can be further optimized, if some of their functions are automated. When the number of manual steps is decreased in a clinical workflow, the physician can focus on complex problems, which cannot be solved by the computer. Even a small modification of the workflow can result in big improvement of efficiency, when the workflow is repeated many times by the clinician.
Goal	Our goal is to develop new algorithms to facilitate automated processing of 3D medical images. The topic involves visualization (2D image fusion, 3D rendering), detection (locating characteristic structures, recognizing patterns or abnormality), segmentation (intensity modeling, contouring algorithms, quantification of 3D structures), registration (image to image, model to image), as well as optimization (parallelizing algorithms). The problem to solve is defined based on the actual research needs and the student's interest.
Duration	1 year
Required skills	MsC in computer science, software engineering, biomedical engineering, mathematics
Tutors	Laszlo Rusko: +36-23-410-173; laszlo.rusko@ge.com
Further information	http://www.itk.org/ http://www.vtk.org/

Vascular System egység

Csapatunk a katéteres érsebészetben használatos digitális röntgen rendszert tervez, amely technikai megoldásaival úttörőnek számít a világpiacon. Ez a röntgen rendszer lehetővé teszi az érrendszeri betegségek kíméletes vizsgálatát és gyógyítását. Segítségével főleg szív és agyi keringési problémák gyógyíthatóak nagykockázatú és hosszú lábadozási idővel járó nyílt sebészet nélkül, pusztán a csuklón vagy a combon ejtett apró vágáson keresztül elvégzett katéteres beavatkozással.

A rendszertervezői csapat irányítja az új röntgenek fejlesztését a teljes életciklusban. A rendszertervezők határozzák meg az új termék követelményeit és funkcióit, végzik a

kockázatelemzést és kezelést, irányítják a komponens fejlesztői csapatok munkáját és az elkészült termék gyártásba állítását.

Vascular DiVICS egység

Csapatunk szoftver fejlesztést végez a már említett katéteres érsebészeti digitális röntgen rendszer számára. Egy ilyen komplex rendszer szoftverfejlesztésének minden részletével foglalkozunk: specifikációval, megvalósítással, illetve teszteléssel és validálással. Specialitásunk a GUI fejlesztése, a kórházi információs rendszerekhez való kapcsolódás programozása és az orvos munkáját segítő képfeldolgozáson alapuló alprogramok integrálása. Ezenkívül foglalkozunk a rendszer karbantarthatóságával és általában a programok integrációjával és verifikációjával is.

Napi kapcsolatban állunk a világ más részein dolgozó kollégákkal: a francia, amerikai és indiai fejlesztőkkel, illetve a világ több mint 400 kórházában a készülékeinket felügyelő szervizmérnökökkel.

Title	**The application of Dual Energy imaging in interventional procedures**
Id	PHD-VASC-1404
Introduction	Dual energy imaging is a powerful method providing valuable additional information compared to traditional x-ray images by combining two images acquired with different x-ray spectra. This technique is well established in conventional radiography and is increasingly used in computed tomography, mostly due to its ability to differentiate between different types of tissues and objects, and due to the new means it provides to correct common imaging artifacts.
Goal	The goal of this project is to evaluate the applicability of dual energy techniques in our vascular x-ray systems that are used to diagnose and treat cardiovascular diseases and cancer. The project starts with reviewing existing literature/work, about dual energy methods and the most important challenges faced during interventional procedures. A set of different methods should then be prototyped and evaluated by acquiring phantom images with various x-ray techniques, applying a variety of image combination and presentation methods on them, and assessing the usefulness of the gained additional information for the medical procedures. Finally the research findings should be combined into a proposal for a clinical application.
Duration	3 years
Required skills	Master degree in engineering and/or physics and basics of programming Communication level English
Tutors	Pal Tegzes; +36-23-410-126; Pal.Tegzes@med.ge.com
Further information	

Title	**The impact of image processing on x-ray optimization for medical interventions**
Id	G-VASC-1102
Introduction	Digital x-ray systems use complex optimization procedures for the selection of radiation parameters, and they also apply advanced image processing to enhance the visibility of medically relevant objects and anatomical structures. These two image improvement directions are often treated as separate problems, although they are obviously connected: if for example image processing applies a strong noise reduction with some contrast loss, then x-ray optimization should focus on maintaining a good contrast and make a compromise on noise level – rather than the other way round.
Goal	The goal of the project is to propose an improvement in the x-ray optimization for our cardiovascular x-ray system, taking into account the image processing algorithms that are applied on the acquired images. The student should investigate how the image processing algorithms modify the various

	image quality metrics that impact object visibility, and define a new metric that describes the goodness of the input image for the different algorithms. As a second step the x-ray optimizer should be modified to take the new metric into account. Finally the impact of the technique improvement on the final image quality should be evaluated experimentally.
Duration	1+8 months
Required skills	The project requires some knowledge of x-ray physics and mathematics, as well as experience in programming, preferably Matlab
Tutors	Pal Tegzes: +36-23-410-126; pal.tegzes@med.ge.com
Further information	

Title	**Title Usability related development in medical device engineering**
Id	G-VASC-1106
Introduction	In the design of our X-ray angiography system, just as generally in the medical device engineering field, usability is playing a growing role. Enhancing the usability aspect of the features can reduce X-Ray and contrast material dose on the patient, or even save human lives. Regulatory pressure to design the human computer interaction in a way that is as safe as possible for the patients is also growing.
Goal	The goal of the project is to • perform several usability enhancement projects by analyzing, user testing and prototyping solutions • build a Usability Testing Guidelines Booklet for engineers, applying general Interaction Design theory to the specificities of the medical device engineering field • Develop software UI prototyping tool for graphical UI testing
Duration	1+8 months
Required skills	Theoretical knowledge in Interaction Design / HCI and graphical user interface design capabilities are required. Any programming knowledge is a plus
Tutors	Balint Czupi: +36-23-410-267; Balint.czupi@ge.com
Further information	http://www.gehealthcare.com/usen/xr/cardiovascular/index.html http://www.gehealthcare.com/usen/xr/int/index.html

Önálló labor / Kooperatív képzési program

Title	**Analysis of ECG waveform downscaling and display algorithms**
Id	C-VASC-2200
Introduction	The current medical devices on the market for ECG recording and displaying are using different algorithms. ECG waveform visualization is well developed and researched, but still very complicated and challenging area of the science. Tons of ECG displaying algorithms are developed and introduced on research level but only some of these are used in practice. During an electrophysiology exam the doctors spend hours in front of the monitor for analyzing electrograms. Because of the long procedure time the ECG waveform visualization in good quality is a real need in medical applications. Main phases of the project: • Learn about existing displaying algorithms • Implement a tool for displaying waveform with different algorithms • Make measurements with the selected algorithms
Goal	The goal is to implement and analyze existing (ECG) waveform displaying algorithms, adopt algorithms for ECG displaying. Make quantitative measurements on memory usage, process time, etc. Make qualitative analysis on image quality.
Duration	6 months (cooperative)
Required skills	Experience in C/C++ Nice to have: MFC or Qt SDK knowledge Communication level English
Tutors	Kátai-Pál Gábor; +36 23 410 275; gabor.kataipal@ge.com
Further information	