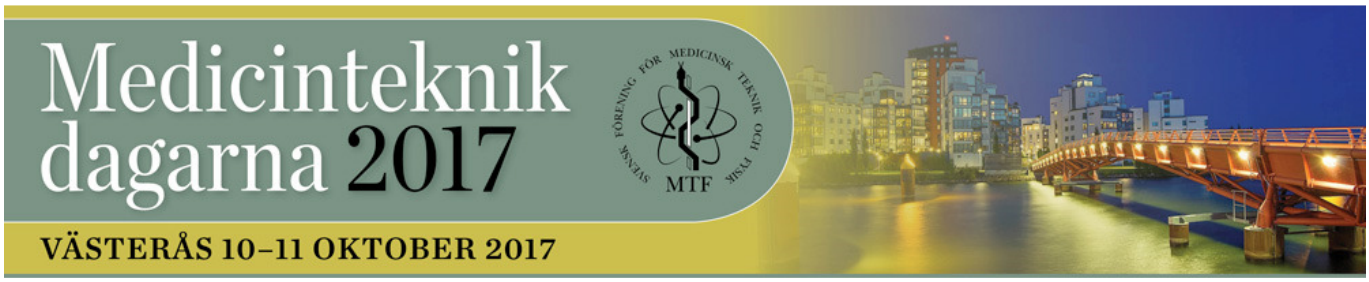

POSTERS

P1. Resolving nanoscale structures in kidneys with light microscopy

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The subtlest element of the kidney such as the filtration slit has historically only been possible to visualized using electron microscopy. Recently we have however shown that the distribution of proteins in the slit diaphragm can be resolved by fluorescence based super-resolution microscopy in combination with optical clearing [1]. Super-resolution microscopy is still a complex technique though, not readily available to all biomedical researchers. Resolving the subtlest structures in the kidney with common light microscopy using more standard fluorescence imaging techniques is thus highly desirable. Recent published studies have shown that biological samples can be isotropically expanded and thus allowing effectively better resolved localization of multiple protein epitopes with conventional microscopy [2]. In this work we show that kidney samples can be optically cleared while expanded sufficiently much to study even the nanoscale-sized filtration slit using confocal fluorescence microscopy.

[1] Unnersjö-Jess et al., Kidney International, **89**, p.243 (2016)
[2] Tillberg et al., Nature Biotechnol. **34**, p.987 (2016); Ku et al., Nature Biotechnol. **34**, p. 973 (2016).

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P2. Quantification of Helical Flow and Aortic Tortuosity using 4D Flow MRI

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Purpose
Due to the complex anatomy of the heart, its valves, and the aorta, the blood flow in the aorta is similarly complex and can exhibit a swirling, or helical flow pattern. Helical flow can be quantified using 4D Flow MRI and previous studies have indicated that flow helicity is related to age and whether the aorta is gothic-shaped, crook-shaped, or cubic-shaped[1,2]. As the shape of the aorta is complex and evolves over time, the aim of this study is to examine the relationship between the shape of the aorta and helical flow.

Methods
4D Flow MRI velocity data covering the whole aorta from aortic valve to the iliac bifurcation was acquired for 10 young (age: 23±2 y. o.) and 12 older (age: 70±3 y. o.) normal male volunteers with no history of cardiovascular disease using a 3T Philips Ingenia scanner.
Aortic tortuosity was computed by separating the aorta into three distinct segments: the ascending aorta, the aortic arch, and the descending aorta. Tortuosity was defined as the ratio between the straight-line distance and the centerline distance of each segment which represents the flow path.

Helicity, or the direction of the helical flow, was computed as the localized normalized helicity (LNH), = $v \cdot \omega / v\omega$ where *v* is the local velocity vector and ω is the vorticity, which is the curl of the velocity. ANOVA was used to assess the difference between the groups. Linear regression was used to assess the relationship between LNH and tortuosity.

Results
The mean ± SD for aortic tortuosity was 0.89±0.04 and 0.86±0.03 for younger and older normal volunteers, respectively. This difference was borderline significant ($p=0.052$). Regional average LNH increased with age and had a significant difference ($p < 0.05$) in all aortic regions except the ascending aorta. LNH was correlated to segmental tortuosity with $R^2 = 0.48$.

Conclusion
This study showed that aortic tortuosity changes with age, and that increased tortuosity is associated with increased flow helicity. This supports the hypothesis that tortuosity of the aorta is an age-related descriptor of the shape of the aorta that is related to the degree of flow helicity.

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P3. Fetal cardiac magnetic resonance imaging using iGRASP: a new clinical frontier

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Introduction: Fetal echocardiography has long been the only means of assessing anatomy and function of the fetal heart, but often has limitations, especially late in pregnancy. Recent developments in fetal cardiac magnetic resonance imaging (CMR) could enable this modality as an adjunct to ultrasound (1,2,3) .

CASE PRESENTATION: A 37-year-old female presented to the fetal cardiac clinic at gestational age 32+6 weeks after a screening ultrasound showed a size discrepancy of the cardiac chambers. Poor acoustic windows and suboptimal fetal position limited visibility of the heart, especially the aortic arch. Fetal echocardiograms at the fetal cardiac clinic showed suspicion of unbalanced atrioventricular (AV) canal, favoring the right ventricle, and possible coarctation. Fetal cardiac MRI was performed at gestational age 37+4 using a 1.5T Siemens Aera with the recently proposed fetal cardiac gating technique tiny golden angle radial sampling combined with iGRASP (iterative Golden-angle RAdial Sparse Parallel) for accelerated acquisition based on parallel imaging and compressed sensing (3). This enabled cine loop acquisitions of the heart in 4-chamber and short-axis projections. Static imaging stacks were also acquired to delineate anatomy. CMR imaging revealed an unbalanced common AV canal to the right with preserved ventricular systolic longitudinal shortening and narrowing of the aortic arch. The CMR findings impacted delivery planning directly. Postnatal echocardiography has confirmed the diagnoses.

Conclusions: This case demonstrates clinical feasibility of high resolution targeted imaging of the fetal heart using CMR. The novel iGRASP technique shows that technological advancements in fetal CMR allow for accurate diagnosis of cardiac malformations. This carries clinical relevance in cases of limited ultrasound visibility and impacts delivery planning.

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2.Roy CW, Seed M, Macgowan CK. Accelerated MRI of the fetal heart using compressed sensing and metric optimized gating. Magn Reson Med. 2016.
3. Haris K, Hedström E, Bidhult S, et al. Self-gated fetal cardiac MRI with tiny golden angle iGRASP: A feasibility study. J Magn Reson Imaging. 2017.

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P4. An online Cloud-ORiented Engine for advanced MRI simulations (coreMRI)

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Introduction
In this study, we present coreMRI, an advanced simulation platform delivered as a web service through an on-demand, scalable cloud-based and GPU-based infrastructure. We hypothesized that such an online MR simulation platform can become an indispensable research tool within the MR community.

Methods
The simulation framework of coreMRI was based on a ground-up-approach design based on the principles already published in the literature[1,2,3]. Amazon Web Services were utilized for the distribution and process of data on GPU-based instances on the cloud. A dynamic web-page was developed to bridge the user with the cloud-based and GPU-based infrastructure and to activate the GPU-resources required for the MR simulations.

To evaluate the performance and scalability of coreMRI, the execution times of two experiments were recorded. In the first case, a Gradient Echo (GE) pulse sequence was applied to the McGill 3-D anatomical model of the brain[4]. The pulse sequence consisted of 810497 discrete time-steps whereas the total number of tissue isochromats was 1887619. In the second case, a simulation-based quantitative-MR experiment[1] was performed. The simulated pulse sequence was a 5(3p)3 MOLLI[5] of 724724 discrete time-steps whereas the spin population consisted of 592200 spins covering a large range of physiological combinations of native T1 and T2 values.

Results
In the first experiment, coreMRI achieved with the 8 GPUs (NVIDIA K80) configuration a speedup of about 63 when compared to a single GPU (NVIDIA GRID K520) configuration whereas in the second experiment coreMRI achieved a speedup of about 12.

Simulation of the entire anatomical model of the human brain, that would take more than an hour on a single-GPU computer, can now be completed within less than 2 minutes. Moreover, the development of the database of simulated MR signals to be used in quantitative-MR can now be completed within clinically acceptable times (34 sec).

Conclusions
coreMRI is an online web-service available to the entire MR community. coreMRI allows its users to exploit the highly tuned computer performance of GPUs on MR simulations with neither upfront investment for purchasing advanced systems nor technical programming expertise. coreMRI is available to the users through the webpage http://www.coreMRI.com.

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P5. Patient-specific modelling of cardiovascular function using 4D Flow MRI

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Lumped-parameter models of the cardiovascular system can improve the understanding of cardiovascular function and treatment planning. To date, most approaches to personalizing lumped-parameter models have required invasive measurements[1,2] or can only estimate a small subset of parameters[3,4]. This work proposes a framework for personalizing a lumped-parameter model of the heart and the systemic circulation using exclusively non-invasive data from clinical cardiovascular MR acquisitions and 4D Flow MRI.

We evaluated the approach in a group of eight healthy subjects representing a spectrum of heart rates and blood pressures. All subjects underwent MRI examinations on a 3T scanner (Philips Ingenia, Philips Healthcare, Best, the Netherlands) to acquire 4D Flow data and 2D cine morphological data. The lumped-parameter model includes three main compartments: the pulmonary venous system, the left side of the heart (including the left atrium, the mitral valve, the left ventricle and the aortic valve) and the systemic arterial system. Parameter estimation requires 4D Flow-derived measurements characterizing the morphology and function of the left ventricle and the aortic valve, as well as volumetric flow waveforms from five predefined locations. These locations correspond to the mitral valve, the aortic valve, the ascending aorta, the aortic arch and the thoracic aorta. The parameters were estimated using imaging-derived measures and nonlinear optimization, by minimizing the error between the 4D Flow waveforms from the five locations and those generated by the model.

After personalization, the model-based results agreed well with the pressure and flow measurements obtained in vivo for each subject, both quantitatively and qualitatively. The model accurately characterized the flow patterns in terms of both wave shape and specific wave features. The predictions of SBP agreed well the measurements (bias= -1.593 mmHg, limits of agreement -9.769 and 6.582 mmHg), while predictions of DBP were, on average, underestimated (bias= -8.448 mmHg, limits of agreement -18.301 and 1.404 mmHg).

The proposed imaging-modelling approach can synthesize medical data into clinically relevant indicators of cardiovascular function and estimate variables, such as the pressure-volume loop, that cannot be obtained non-invasively. Further studies should validate the model on a larger group of subjects, preferably including a comparison with invasive measurements.

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[2] K. Sughimoto, J Thorac Cardiovasc Surg **145**, 1367-1372 (2013).
[3] S. Pant, J Biomech **49** 2162-73 (2016)
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P6. Polymer Microbubbles as Dual Modal Contrast Agent for Ultrasound and Computed Tomography

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Background
Hybrid imaging modalities are new trends in medical imaging. Therefore, dual modal contrast agents are desired.

Method

The plain MBs and MBs loaded with gold nanoparticles are fabricated following the protocol adapted from Paradossi et al.[1]. Gold nanoparticles were added during MBs formation to achieve dual modal contrast agent. 40mg gold nanoparticles with a mean diameter of 1.9nm were dissolved in 250ml water to be used as a reference for CT tests.

The MBs size was determined using Neubauer counting chamber and optical microscope equipped with high-resolution camera.

The acoustic attenuation coefficient of the MBs suspension diluted to three different concentrations was determined using non focused single crystal ultrasound transducer with central frequency 3.5MHz. Attenuation coefficient were obtained at fundamental, 2nd and 3rd harmonic as a function of peak negative pressure varied from 50kPa up to 300kPa.

The attenuation (in HU) of water, gold nanoparticles suspension, plain and gold-loaded MBs was measured by a micro-CT. The micro-CT was operated at a current of 200mA with exposure time of 120s and varied voltage 50kV, 70kV and 90kV. Contrast to noise ratio (CNR) between water and all samples were calculated.

Results
The mean diameter of plain MBs is 3.5 µm. The mean diameter of gold-loaded MBs, determined following the same procedure, decrease to 3.2 µm.

Acoustic tests revealed the constant attenuation coefficient at the peak negative pressure below 100kPa, indicating linear oscillation of MBs. As the pressure increases up to 300kPa, the attenuation coefficient at 2nd and 3rd harmonics increases, indicating the nonlinear behavior of the MBs.

The pilot results of the micro-CT tests demonstrated the highest CNR per voxel equal to 2.57 between water and Gold NP under 90kV. CNR for gold loaded MBs was higher than for the plain MBs and equal to 2.12 and 1.98 respectively. As the applied voltage decreases from 90 to 50 kV the CNR also drops to 1.26 and 1.32 for plain and gold-loaded MBs, respectively.

Conclusion
In this study, we have demonstrated the possibility to develop dual modal contrast agent for ultrasound and CT using polymer shelled MBs loaded with gold nanoparticles.

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P7. Lärandeprocessen för användning av ”fickultraljud” vid diagnostik av hjärtsvikt i primärvården

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Hjärtsvikt är en vanlig orsak till ohälsa och lidande. Bland personer över 65 år som söker i primärvården med andfåddhet vid ansträngning beräknas cirka en sjättedel ha odiagnostiserad hjärtsvikt. För att diagnostisera hjärtsvikt används för närvarande ultraljudskardiografi (UKG) utfört av särskilda biomedicinska analytiker och specialistläkare på sjukhus. För att flytta diagnostiken närmre patienten har man i olika delar av världen börjat använda portabla ultraljudsapparater, s.k. ”Fickultraljud”, inom konceptet ”Point of care ultrasound”. Användning av denna metod har studerats främst inom akutsjukvård och kardiologi. Fickultraljud ger möjlighet att upptäcka en nedsatt vänsterkammarfunktion, något som annars lätt kan förbises vid en konventionell undersökning. Vi vill undersöka om allmänläkare också kan lära sig denna metod. En spridning av kunskapen till primärvården kan medföra snabbare diagnostik och bättre prioritering av patienter för specialistvård. Syftet är att undersöka om läkare utan föregående kunskap i ekokardiografi, efter 20 undersökningar under handledning, kan utföra riktade ultraljudsundersökningar av tillräckligt hög kvalitet för att metoden skall vara användbar för att påvisa eller utesluta hjärtsvikt.

Metod

Deltagarna får en kort utbildning i användande av fickultraljud (Vscan 1.2 GE Healthcare) genom nätbaserade föreläsningar och teoretisk inläsning. Tjugo studiepersoner undersöks under handledning varefter ytterligare 10 studiepersoner undersöks utan handledning. Studiepersonerna rekryteras bland patienter som remitterats från primärvården till Fysiologavdelningen, Östersunds sjukhus, för UKG med frågeställningen hjärtsvikt. Studiepersonerna undersöks av två eller tre allmänläkare (distriktsläkare med specialistkompetens eller under utbildning), under handledning av en ultraljudskunnig biomedicinsk analytiker med handledarkompetens. Vid undersökningen sparas en filmsekvens från 5 olika standardprojektioner, för senare kvalitetsgranskning och för jämförelse med resultat erhållna vid konventionell UKG-undersökning, samma dag. Undersökningarna avidentifieras före kvalitetsgranskning utförd av specialistläkare inom kardiologi. Kategoriindelning: godkänd, inte godkänd undersökning. Bedömning av parametrar talande för eller mot hjärtsvikt redovisas i studieprotokollet, för senare jämförelse med UKG vid Fysiologavdelningen. Studien är godkänd av etikprövningsnämnden i Umeå dnr 2016/337-31 och registrerad vid ClinicalTrials.gov (NTC02939157). Studien ingår i ett projekt finansierat genom anslag från Medtech4Health (dnr. 2016-02514) Fickultraljud för innovativ hjärtsviktsdiagnostik.

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2. A Colli, et al., PloS one. **10,** e0122181 (2015)
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4. NM Saha, et al., Am J Cardiol. **116,** 1224-8 (2015)
5. TM Stokke, et al., J Am Soc Echocardiogr. **27,** 1238-46 (2014)
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P8. Seizure detection with integrated sensor garments

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Background:
The overall goal of the project is to develop a tool for diagnostic of epilepsy, Parkinson's Disease and stroke. This consists of a garment with integrated electronics and sensors together with analysis algorithms. The sensor functionality includes monitoring of heart rate, oxygen level, blood pressure and motion. Sensors are both conventional electronic sensors like optical pulse meter, accelerometers and gyros, together with functionality in textile like passive heart rate electrodes.

Materials and methods:
The garment must be comfortable enough to wear during an extended period, while recording useful data, and robust enough to stand normal use as well as normal machine wash. Also, the possibility to individualize the garment construction, including positioning and adding more sensors, aided by 3D-scanning and 3D-fitting software is investigated.
The garment is based on an undershirt integrated with three sensor units and one central unit. The sensor units are placed on the forearm and chest respectively. All electronics are potted in epoxy and connected via standard jumper wire, and the wire joints are protected by shrink tubing with adhesive.
The analysis algorithms are based on machine learning methods, and several commonly used classification methods are evaluated in the development. The algorithms are supposed to be able to classify CTCS and hyper motor seizures from non-seizures, with high sensitivity and high specificity.

Results and conclusions:
A generic detection algorithm focused on GTCS, based on accelerometer data, using machine learning methods is developed. The performance is improved by complex non-linear classifiers, improving algorithm generalizability and robustness against high frequency non-seizure movements.
The first version of the integrated sensor garment is developed and tested with promising results with respect to measurement of motion and pulse. Next version, is upgraded with respect to fitness and robustness. The final version of the garment will also include sensors for heart rate variability, oximetry and change of blood pressure.
The challenges in the project include both practical aspects, such as washability, and advanced developing methods for analysis algorithms.

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P9. Telemedicinsk bedömning av patienter med misstänkt stroke

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Bakgrund:
Stroke är den tredje vanligaste dödsorsaken i Sverige och den vanligaste orsaken till förvärvad funktionsnedsättning hos vuxna. Akuta behandlingar går ut på att återställa blodflödet i hjärnan, antingen i form av trombolys, propplösande läkemedel, eller på senare tid vid svårare stroke även genom trombektomi, kateterburen mekanisk avlägsnande av blodpropp. Båda metoderna har gott vetenskapligt stöd men effekten med avseende på handikapp och död efter stroke är starkt tidsberoende. Därför står ambulanssjukvården inför stora utmaningar då efterfrågan på prehospitala insatser vad gäller stroke ökar. Den långsiktiga målsättningen med projektet är att ge både ambulanspersonalen och mottagande läkare på akuten ett bättre konsultationsstöd av strokejour vilket gör att fler patienter kan komma till undersökning, CT-skalle med betydande tidsvinster.

Material och metoder:
”Telemedicinsk bedömning av patienter med misstänkt stroke” ingår som delprojekt i *”Innovativ teknik för framtidens akutsjukvård”,* ett av Vinnova delfinansierat projekt inom Utmanings Driven Innovation (UDI) med målsättning att bidra till en effektivare pre-hospital vård. Vi utvecklar möjligheten till länkad bild- och ljudöverföring från patient inifrån ambulans under färd, s k telemedicinsk bedömning, där systemet kompletterar det nuvarande bedömningsverktyget (preHAST, Andsberg et al, 2017 [1]) som används av ambulanspersonalen, med den mer detaljerade NIHSS (National Institute of Health Stroke Scale) som idag används på akutmottagningen inför beslut om trombolys/trombektomi. Då NIHSS verktyget bygger på visuell bedömning är bildkvalitet på rörlig bild en kritisk parameter. Överföringen från ambulans till läkare ska kunna ske med tillräckligt god kvalitet oavsett geografisk plats (lika vård för alla).

Resultat:
Systemet är tänkt att ge stöd för neurologisk distansundersökning för att få en relativ klar bild av symptom och anamnes redan innan patienten kommit till sjukhuset. Utvärderingen av systemet sker i flera steg (prototyp, utvärdering av kliniskt testinstallation med simulerade fall och senare även patienter, samt en retrospektiv klinisk studie) för att belysa såväl teknisk kvalitet som eventuella kliniska effekter av denna teknologi inom den akuta strokevården. En tidig prototyp har visat lovande teknisk kvalitet och vi kommer att presentera den tekniska lösningen samt första resultat från utvärderingen av den framtagna kliniska testinstallationen.

[1] G. Andsberg et al. (2017); PreHospital Ambulance Stroke Test - pilot study of a novel stroke test; *Scand J Trauma Resusc Emerg Med*. **11** ;25(1):37 (doi: 10.1186/s13049-017-0377-x)

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P10. Nordic Telemedicine Center - A competence center for telemedicine

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Background:
Despite the large efforts to develop ICT solutions in the area of healthcare, and the successful trials across the world - Nordic countries in particular, telemedicine is still far from its full potential. The implementation rate is low, which has caused the eHealth paradox; healthcare technology is available but not yet applied enough.
Nordic Telemedicine Center is aiming to highlight the advantage of telemedicine solutions and technologies in everyday life. The goal of this competence centre is to enlighten the citizens about the available technological solutions for their everyday needs, to help the technology providers to reach the relevant target audiences better and to provide learning material and trainings on these technologies for Health care staff, among others. The Nordic Telemedicine Center is an ongoing Project, mainly funded by Botnia Atlantica Interreg, with partners from Västerbotten County Council and Umeå University from Sweden, and Vasa University and EPTEK from Finland. The partners have long-term experience in telemedical solutions in Health care, home-care, assisted living technologies, research, implementation, education and more related to the field.
Method:
An infrastructure comprising two physical rooms (Umeå and Seinäjoki, Finland) will be set up together with a webportal. A key functionality of the structure will be focused on best-practice and good examples for quadruple Helix users.
Results:
The infrastructure is currently being developed and is expected to be released in a first version in early autumn. Piloting activities are also currently being planned to evaluate the services of the center.
Discussion:
The Center's mission is to offer eHealth expertise and services to health and social care professionals, researchers, companies and citizens in the region as well as to support the target groups in testing, adopting and developing new eHealth technologies, and in increasing knowledge and skills related to eHealth. Through the virtual environment, the center aims at increasing cooperation between companies and health care sector in the development and utilization of eHealth services.

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P11. Big Data Analytics in Health Monitoring at Home

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I. INTRODUCTION

This paper proposed a big data analytics approach applied in the projects ESS-H[6] and E-care@home[7] in the context of biomedical and health informatics with the advancement of *information fusion, data abstraction, data mining, knowledge discovery, learning, and reasoning* [1][2].

II. Method and approach

Data are collected through the projects, considering both *the health parameters*, e.g. temperature, bio-impedance, skin conductance, heart sound, blood pressure, pulse, respiration, weight, BMI, BFP, movement, activity, oxygen saturation, blood glucose, heart rate, medication compliance, ECG, EMG, and EEG, and *the environmental parameters* e.g. force/pressure, infrared (IR), light/luminosity, photoelectric, room-temperature, room-humidity, electrical usage, water usage, RFID localization and accelerometers. They are collected as *semi-structured/unstructured, continuous/periodic, digital/paper record, single/multiple patients, once/several-times*, etc. and stored in a central could server [5]. Thus, with the help of embedded system, digital technologies, wireless communication, Internet of Things (IoT) and smart sensors, *massive quantities of data* (so called 'Big Data') with value, volume, velocity, variety, veracity and variability are achieved [2].
The data analysis work in the following three steps. In *Step1*, pre-processing, future extraction and selection are performed based on a combination of statistical, machine learning and signal processing techniques. A novel strategy to fuse the data at feature level and as well as at data level considers a defined fusion mechanism [3]. In *Step2*, a combination of potential sequences in the learning and search procedure is investigated. Data mining and knowledge discovery, using the refined data from the above for rule extraction and knowledge mining, with support for anomaly detection, pattern recognition and regression are also explored here [4]. In *Step3*, adaptation of knowledge representation approaches is achieved by combining different artificial intelligence methods [3] [4]. To provide decision support a hybrid approach is applied utilizing different machine learning algorithms, e.g. case-based reasoning, and clustering [4].

III. CONCLUSIONS

The approach offers several data analytics tasks, e.g. information fusion, anomaly detection, rules and knowledge extraction, clustering, pattern identification, correlation analysis, linear regression, logic regression, decision trees, etc. Thus, the approach assist in decision support, early detection of symptoms, context awareness and patient's health status in a personal environment.

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P12. Telemetrisk traumavärdering av skadeplatsområde

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Bakgrund: Vid stora olyckor med flertalet involverade fordon, individer samt eventuellt ytterligare objekt på skadeplatsområdet kan det vara en utmaning för initial insatsstyrka att förmedla en överblick av skadekaraktärer och omfattning till olika räddningsinsatser, traumateam och akutmottagningar. Med kompletterande information ges möjligheten att omhändertagande av trauma som uppkommit vid skadeplatsområdet att planeras utifrån mer adekvat underlag. Dessutom kan upplevd stressnivå för involverade parter bibehållas på nivå där uppmärksamhet och genomförande av uppgifter inte påverkas negativt. En möjlighet som ger kompletterande information för traumavärdering är att förmedla realtidsbilder över skadeplatsområdet via telemetri. Därvid kan de olika parterna ta del av realtidsvideo och planera respektive räddningsinsats.
Den långsiktiga målsättningen med delprojektet är att ge mottagande traumateam på akutmottagning mer komplett förhandsinformation av skadeplatsområdet vilket lyfter akutpersonalens beredskap att behandla inkommande patienter, samt vid större olyckstillbud att alla involverade akutteam får tillbörlig information.
Material och metoder: ”*Telemetrisk traumavärdering av skadeplatsområde*” ingår i projektet ”*Innovativ teknik för framtidens akutsjukvård*”, ett av Vinnova delfinansierat projekt inom Utmanings Driven Innovation (UDI) med målsättning att bidra till en effektivare pre-hospital vård. Målsättningen med delprojektet är att utvärdera tekniska utmaningar med takmonterad kamera med målsättningen att få överblick av skadeplatsområde. Manövreringen av kamerans bildinformation, riktning fokus etc., sker via telemetri. För denna initiala konceptvärdering är takkameran monterad på ambulansfordon och manövercentralen är placerad på engagerad akutmottagning, således låses ambulanspersonal ej upp för kamerahantering. Redundant telekommunikation och därmed säkrad bildöverföring uppnås med flerkanaligt telekommunikationsmodem i ambulansen. Därtill kontrakteras olika oberoende teleoperatörer, tillika mastägare, för att säkerställa bästa möjliga kommunikationsförhållanden.
Resultat: Utvärderingen av systemet sker i flera steg (prototyp, utvärdering av testinstallation) för att belysa såväl teknisk kvalitet som eventuella kliniska effekter av teknologi. En tidig prototyp har visat lovande teknisk kvalitet och vi kommer att presentera en teknisk lösning.
Slutsats: Om projektet faller väl ut kommer det att innebära utökad tid för planering av traumatema och motsvarande insatser och därmed livsviktig behandling och i förlängningen minsta lidande för patienten.

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P13. Fog computing in clinical health monitoring applications

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Health monitoring is one of the main IoT applications that has motivated various research communities. Advancements in terms of hardware and software by developing various low-power radios and several communication protocols, have enabled various health applications. Some of these applications require high reliability and timeliness since alarm messages are supposed to be delivered to the emergency unit within a predefined time period. Conventional network topologies and system models are unable to provide such guarantees.

Fog computing enables using new services within IoT applications. Fog computing extends the Cloud computing by shifting the computation and storage closer to the user. In the health monitoring system model, we collect and store physiological measurements close to the user, where we can ensure some level of timeliness. In the Fog computing, we are able to employ new networking technologies, which are the main building blocks of future IoT applications. Utilizing these technologies, we can gain more network management, high flexibility, and on-the-fly programming.

In the ESS-H research profile, we have implemented a preliminary wireless infrastructure. Shimmer sensors with classical Bluetooth provide physiological measurements, where we collect readings in a local server. The system permits collecting measurements in a remote server over the Cloud for historical data storage. Thus, users can access data either locally from the Fog server or remotely via the Cloud server. Accessing a Cloud server requires longer response time, where the Fog server is much faster. Therefore, in case of emergency, it is possible to create some rules at the Fog controller to send alarm messages to the emergency unit in order to avoid catastrophic situation.

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P14. Heterogeneous network for health monitoring applications

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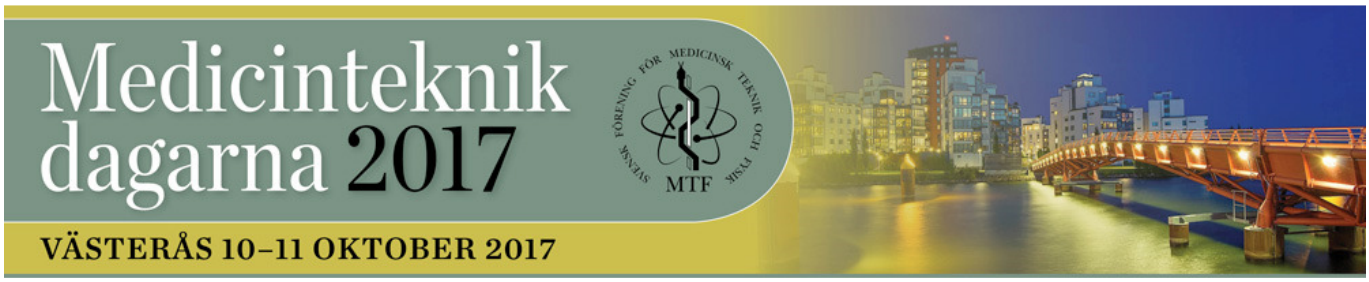
The aging population and the increasing cost of healthcare has motivated implementing and developing remote health monitoring systems. Low-power wireless sensors and small-size physiological sensors have enabled using such systems. However, wireless infrastructure is becoming very much chaotic by emergence of various wireless technologies. Existence of different low-power radios, such as BLE, ZigBee and WiFi, while employing different standards such as IEEE 802.15.1, 802.15.4 and 802.11 would lead to heterogeneous networks.

We are envisioning interoperability solutions in heterogeneous networks by considering the requirements and limitations of health monitoring applications. We target this issue by targeting the hardware and the software implementation by (i) devising a novel network management strategy, and (ii) designing a generic protocol stack.

We propose a cross layer controlling architecture for low-power wireless networks by introducing new layers for software defined networking and software defined radio. The “software defined” feature in this technology would enable the capability of reconfiguration by allowing administrators to easily collecting signals or changing parameters within the packet, and quickly finding a suitable frequency band or path. This eventually leads toward a self-adaptive environment that is able to cope with wireless devices of different types.

We propose a generic protocol stack to provide interoperability between various protocol designs. A conventional generic protocol stack consists of multiple physical, data link, network, and application layers. Based on the requirements, a specific combination of lower layers is selected, while all networks are supposed to have similar upper layer protocol designs. In our proposed protocol stack, we define layers in such a way to provide the common constructs of all protocol stacks, while adaptation layers are supposed to add extra features to provide a reasonable network performance.



P15. Uppsala Centrum för Medicinsk Teknik

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Uppsala har en stolt tradition av forskning inom det medicintekniska området. Det moderna graviditetstestet utvecklades vid Akademiska sjukhuset, och den mikromekaniska sensor som mäter blodtrycket i hjärtats kranskärl och som används rutinmässigt vid hjärtdiagnostisering har sitt ursprung från Ångströmlaboratoriet. Inom bildbehandling/strålningsfysik har mångårig forskning och utveckling givit upphov till Skandionkliniken, Nordens första klinik för protonterapi, vilken möjliggör en effektiv och mer skonsam behandling av cancer än traditionell strålterapi. Svensk medicinteknisk industri är världsledande inom många områden och sysselsätter omkring 20 000 personer och har en omsättning på cirka 60 miljarder kronor per år. En grundläggande förutsättning för dessa historiska framgångar har varit god samverkan mellan hälso- och sjukvård, näringsliv och akademi. För att samla tidigare spridda verksamheter till ett stärkt profilområde har Uppsala universitet tillsammans med Akademiska sjukhuset beslutat om en långsiktig och fakultetsöverskridande satsning på medicinsk teknik - Uppsala Centrum för Medicinsk Teknik - vilket inrättats av Rektor vid Uppsala Universitet i början av 2017. Ett antal strategiska delområden inom medicinsk teknik har identifierats som relevanta för Uppsala och ambitionen är att knyta framstående forskare till centrumet för att initiera och leda forskningsprojekt inom dessa områden. I denna presentation kommer vi beskriva bakgrund, status och vision för Uppsala Centrum för Medicinsk Teknik.

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P16. Food4You: A Personalized System for Adaptive Mealtime Situations for Elderly

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The proposed project 'Food4You' focuses on advanced research and development to support older individuals with more enjoyable mealtime situation. The main goal in this project is to provide an *individual adaptive mealtime situation solution* based on data mining to support elderly people at home care.

Food and mealtime are an essential part of human life that keeps us healthy and happy. Food gives us energy and mealtime is often a social time where family or friends meets and interacts [1]. However, this mealtime can be challenging for elderly for various reasons e.g., decreases of sense of taste or smell, difficulties in chewing and digesting and problem of seeing the food clearly, difficulties in bringing the food to the mouth, forget to eat meal, sitting long time for the meal and also loneliness during the mealtime.

Thus, the domain for mealtime quality improvement is a weak problem domain i.e., no generalized rules to articulate the domain. Therefore, the main challenge here is to provide personalized solution. Observing the situation or learning about individual information could improve the support in this area. However, when one individual caregiver or nurse has to serve for many persons at a time then analysis of individual information and providing the solution is difficult.

Therefore, the project aims to develop individual mealtime “knowledge base” that represents a cluster of individuals within a particular age, health condition, food choices, patterns, environmental situations, etc. and this “knowledge base” helps to find out users' need in this area. Data mining algorithms [2] e.g., clustering is then applied to discover knowledge from the gathered data to assist in providing personalized solution. Here, the vision of the project is to develop a digitized system that supports to make mealtime situation as easy and enjoyable as possible by providing appropriate knowledge to personals/caregivers who are working in this area. This will in turn increase the quality of life for elderly and reduce the cost for the elderly home care.

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P17. Implementation and Calibration of Force Sensing Resistors in Insoles

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Introduction
Many researchers have built pedobarography measurement systems [1]. Pedobarography, the study of forces interacting between the plantar surface of the feet and a supporting surface, can be used in many applications. Examples are analysis of gait and posture in for example orthotics design and monitoring of rehabilitation. Force sensing resistors (FSR) measure approximately the ground reaction force which is the force acting on the foot from the insole. Low sensor height, high linearity and good durability are three important sensor properties. FSRs are down to 0.2mm thick but can be non-linear and they can break easily if implemented wrongly. How can the FSRs be implemented in insoles and calibrated to overcome these sensor type shortcomings?

Implementation
Discrete FSRs are often placed at the heel, inside and outside of the metatarsal pad and the big toe pad. It is vital to protect the boundary of the active sensor area. If the boundary is exposed to too much mechanical strain it will rapidly break down. This is because the upper and lower layers of the sensor get short-circuited. First the sensor will show intermittent maximum values and later stop working at all. One solution is to remove insole material right under the sensor boundary to relieve it from mechanical strain [2].

Calibration
The FSR manufacturers recommend using at least four different loads for the calibration and be aware that static load makes the sensor drift over time. It is important to choose a similar calibration procedure as the application it will be used for, e.g. dynamic calibration if the application is measurement while walking. A load cell should be used for calibrating the FSR. Linear or exponential regression are not recommended. Three or fourth power polynomials have shown to produce acceptable errors [3].

Discussion
FSRs have two less than ideal properties regarding linearity and durability. The lifetime of the sensor can be increased by taking special care of not exposing the active sensor area boundary to mechnical stress. Calibration should be done dynamically if the application is e.g. measurment while walking. Three power, or higher, polynomials are recomended for the regression.

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P18. Detektion av muskelskador med ett mikrovågssystem

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Muskelskador i form av blödningar efter kontusioner och/eller rupturer har de senaste åren blivit allt vanligare liksom överansträngningsskador (overuse) inom många idrotter och utgör ca 30 % av alla skador inom fotbollen och är de vanligaste skadorna inom friidrotten. Hamstringsskador är ett problem som blir allt vanligare inom både elitidrott och motionsidrott. Behovet är stort av ökade möjligheter till enklare och billigare diagnostik och objektiv uppföljning av dessa skador, genom att kunna följa läkningsprocessen tills muskelskadan är helt läkt.

I denna presentation beskrivs vårt arbete med att utveckla ett mikrovågsbaserat system för tidig diagnostik av muskelskador och muskelbristning.

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P19. Continuous monitoring of COPD patients

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According to World Health Organization (WHO), Chronic Obstructive Pulmonary Disease (COPD) is the fourth most frequent cause of death worldwide, and COPD is likely to increase in the future due to higher smoking prevalence and aging populations. Since it is so frequent but also disabling disease, it is associated with high costs for treating and managing the patients. The total costs of COPD in Sweden in 1999 were estimated to SEK 9.1 billion [1].
At the same time it is well known that remote patient monitoring can significantly decrease healthcare costs. The remote monitoring is very much applicable to COPD patients, for which there is evidence that it reduces costs by at least 14% [2]. The COPD patients are normally outpatients before the cases of exacerbation (sudden worsening of their health status), for which they might be hospitalized. More than 70% of COPD-related healthcare costs are consequences of emergency and hospital stays for treatment of exacerbations [3]. On the other hand there is certainly a theoretical possibility to predict exacerbation and hence further reduce costs [4]. There are also studies that investigate the suitability of home care for severe uncomplicated exacerbations.
The home care can be supported by the continuous monitoring of patients' physiological parameters. The most used physiological parameter for monitoring COPD patients in remote settings, is the peripheral O_2 saturation (SaO_2), which is taken at discrete time intervals by patients. We aim at enabling continuous monitoring of all relevant physiological signals for COPD patients, and concentrate more specifically on the electrocardiogram (ECG) acquisition in the remote settings, which is one of the most important physiological signals for COPD patients monitoring, since there is a strong evidence that primary cause of death for COPD patients is cardiac failure [5].
We investigate the usage of novel patch bipolar ECG devices which pose a number of convenient features and can be used to detect arrhythmias and cardiac arrest, but also a reliable respiration rate can be estimated from ECGs produced by them [6], which reduces a need for separate respiratory sensors.

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P20. A remote health monitoring system featuring relational databases

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Remote health monitoring (RHM) through the use of wearable wireless sensors, has drawn a lot of attention from academia and industry in the last decade [1,2]. The aging population, increasing cost of health-care, and lack of human resources in healthcare, are the three key motivators for the development of RHM [3,4]. The RHM systems should reduce health care costs and improve care quality.
How to ensure a reliable and secure data collection from sensor devices to stake holders in RHM systems, is an open research question. The most established data storage technology that can ensure the security and privacy of data is the relational database management systems (RDBMSs). Besides security, RDBMSs provide a number of additional convenient features like querying the data, indexing, backups, replication, but are however in general slower than storing the data directly in a file system. Presented is a RHM system with a RDBMS in its core. The system was developed for the needs of ESS-H research profile [5] at Mälardalen University, Sweden.
We also present a comprehensive system design which covers all the needs for the RHM application. The system is composed of four main components: (I) Shimmer sensors [6], (II) data acquisition layer (LabVIEW or C#.NET program), (III) RDBMS, and (IV) web service and web interface. The system communicates with the Shimmer sensors over Bluetooth and collects measurements in a relational database, either through a C#.NET or a LabVIEW program. The web service and a web interface are both written in PHP and are running on the Apache HTTP Server. The end-user is able to observe either real-time data (i.e. with insignificant delay) or processed historical data on any web browser. The advantage of using the web interface instead of a desktop application is that it makes the presentation layer easily accessible and platform independent.
The RDBMSs provide data security and privacy in addition to other convenient features. Therefore, it is beneficial to incorporate RDBMSs in RHM systems. However, the RDBMSs provide no solution for security and privacy issues in wireless communication which is another research problem.

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P21. Real-time streaming interface for multiple hardware platforms: towards a novel stroke rehabilitation technique

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It is becoming more and more common for physiological measurement systems to incorporate equipment from different sources. This require careful synchronization techniques with high temporal precision in order to interpret and fuse the recorded data. In addition, the potential of using these systems in rehabilitation require an interface for real-time streaming and signal processing to generate direct biofeedback. In this study we have developed a real-time interface in LabVIEW capable of streaming eye-tracker and neurophysiological data. Data is merged and aligned to key-events in a computer game to allow for signal processing, data fusion and feedback generation. We used i) a stereo-camera eye-tracking device using a sampling rate of 120Hz (Aurora, Smart Eye) to record and stream eye movements, gaze, pupil diameter and many more, ii) a 64-channel ElectroEncephaloGram (EEG) device (Brain Products) using a sampling rate of 1000Hz to record electrical potentials on the scalp, and iii) Unity game engine to create program for the subject to perform. The Unity program is synchronized to the EEG-device by placing a photodiode on the computer screen capable of measuring changes in luminosity. The eye-tracking device is synchronized with the EEG-device by the triggering of a mechanical servo creating a trigger mark in the eye-tracking data. Using socket-based communication allows for programs to be distributed on different computers and minimize the risk of bad scheduling. The delay of streaming data is small (~6ms) to allow for real-time biofeedback. The LabVIEW program is built on the Queued Message Handler Template which is a design pattern used to facilitate parallel threading and inter-thread communication, while also providing a responsive user interface.

This system will open up many opportunities in rehabilitation and of particular interest for our work is stroke rehabilitation. Brain-Computer Interface (BCI) with real-time feedback has an enormous potential in stroke treatment and several studies are showing promising results with improved motor recovery. The implemented LabVIEW design in this study allows for additional threads, such as acquisition of EMG or head movement data that will further refine and improve stroke rehabilitation.

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P22. Egentillverkning av bärande konstruktion till MTP-Produkter för mobil intensivvård

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Bakgrund: För att kunna hantera patienter med intensivvårds behov (IVA-patienter) inom ett större geografiskt område har Region Skånes Prehospitala Enhet (RSPE), Samariten och IVA utvecklat ett specialanpassat ambulansfordon som kan transportera IVA-patienter mellan sjukhusen och från olyckstillfälle till sjukhus. För att möta intensivvårdens behov krävdes anpassningar vad gäller utrustning i ambulansen. RSPE har därför haft kontakt med olika leverantörer för att få den utrustning som krävs för att kunna transportera IVA-patienter. Leverantörerna har ofta ett brett utbud av IVA produkter men har svårt för att specialanpassa MTP utrustningen till ambulansbruk då det är både kostsamt och tidskrävande. Tekniska utrustningen som pumpar, respirator och övervakning som är för ambulansbruk godkända MTP-produkter finns att köpa med transportfäste. Dessa fungerar dock ofta inte med en patient bår. Eftersom det inte är lönsamt för leverantörer att ta fram specialanpassade upphängningsanordningar till MTP-produkter har MT Service Skåne samarbetat med RSPE i framtagning av bärande utrustning för en IVA-bår enligt verksamhetens önskemål.
Material och metoder: Arbetet genomfördes under MT Service Skånes kvalitetsledningssystem enligt ISO 13485 och ISO 1789.
På bårens framsida monterades 1st övervakning MP5, 1 st respirator Hamilton och 1 st pump av typ Alaris samt 1 st droppställning.
På bårens baksida monterades 2 st droppställningar, 2 st Alaris pumpar och en defibrillator samt 1 st ytterligare väska. Det var även ett krav att defibrillatorn och väskan skulle gå att ta loss och flyttas på.
För att kunna möta dessa önskemål har MT Service Skåne gjort ritningar i 3D-Cad och genom dessa utvecklat de olika anpassningarna teoretiskt genom beräkningar med FEM simuleringar. Den bärande utrustningen tillverkades sedan när det gällde svetsarbeten av extern leverantör och övriga arbeten inom MT Service Skånes egen verkstad.
Resultat: Arbetet resulterade in en specialanpassad IVA bår som är utrustad med den utrustning som är nödvändig för säker transport av IVA-patienter samt ergonomisk placering av MTP-utrustningen. De bärande konstruktionerna till vissa MTP-produkterna har tagits fram och har en bärighet enligt tillämpliga ISO-standarder. Preliminär feedback från användarna är övervägande positivt.
Slutsats: ISO-certifierad egentillverkning av MTP-utrustning kan vara en väg för att kunna bedriva effektiv och patientsäker mobil intensivvård inom ambulanssjukvården.

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P23. New Progresses on Intelligent Phonocardiography

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Intelligent phonocardiography (IPCG), as an emerging ICT-based approach, has recently received interests from the researchers due to its informative contents, ease of use, and low examination cost. Many researchers attempt to develop appropriate signal processing methods to exploit indicative disease-related features from the signal, and hence to make the approach even more informative. IPCG showed a good performance in screening children with congenital heart disease where the accuracy/sensitivity was estimated to be 87.45%/87.29%, exhibiting an outperformance when compared to a typical paediatric cardiologist who relies on the conventional auscultation [1]. Application of the IPCG has been expanded from the screening purpose to paediatric cardiac assessment in several of our previous studies. Detection of the children with bicuspid aortic valve was an objective of one the studies in which an accuracy of higher than 80% was observed [2]. Finding the sophisticated machine learning methods for detecting murmur type and discriminating between cardiac defects with similar murmurs were the two other achievements within this scope [3][4]. Such the intelligent methods can be integrated in the fashion to serve as a decision support system, using appropriate web-based platform. Although this approach seems to be rather diagnostic in paediatric cases, its applicability for adults and elderly people is becoming more important, using advanced signal processing and machine learning methods. In this perspective, the intelligent phonocardiography provides an efficient tool, not only to screen aortic stenosis [5], but also to assess severity of the underlying stenosis using statistical pattern recognition methods and hybrid models [6][7]. Differentiation between septal and valvular leakage, and between aortic and mitral defects have been investigated based on the IPCG, all confirming capabilities of the approach as a reliable decision support system. In our upcoming studies, the IPCG is employed for screening obstruction in coronary arteries, in conjunction with the other auxiliary signals. Such an approach attributes a unique diagnostic value with the approach for the adult patients. The IPCG could be of special importance in the developing countries and rural place, due to its low-cost and easy-to-use characteristics.

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