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Modeling glucose dynamics for regulating blood glucose levels in diabetes

**Assignment:** BME-B/M and EE-B/M assignment and internships

**Assignment description**
Many patients with diabetes experience troubles in keeping their blood glucose value at the desired level. Automatization of the glucose control will relieve patients of their burden. Inreda Diabetic has developed an artificial pancreas (AP) system. The Inreda AP is a bi-hormonal closed-loop system, that regulates blood glucose levels without meal announcements being required. The device has been clinically validated and is approved for treatment of in type 1 diabetes mellitus patients. Further development of the Inreda AP is still ongoing. A simulation model of the glucose regulation in a type 1 diabetes patient is important to optimize the controller in the closed-loop system.

Inreda has started the development of a bi-hormonal mathematical model of the glucose dynamics in patients with type 1 diabetes mellitus. The model consists of three physiological compartments that simulate the glucose, insulin and glucagon processes in the body. Parameter estimations using system identification methods have shown that interpatient and diurnal variations of the parameter values are required for a realistic model of glucose dynamics. Meal intake has not yet been considered in these estimations. Further research is necessary to determine how parameter variations and meal intake can be applied in the model of glucose dynamics. Model-based prediction of glucose concentrations can be important for AP control, but needs to be further developed and evaluated against glucose measurements. Important research questions concern the optimal model structure for best prediction performance and how parameters of the model can best be identified.

The assignment is to explore how the current model of glucose dynamics can be improved such that it can be applied for optimization of the controller in the Inreda AP.

**Contact:**
Gijs Westen (gijs.westen@inredadiabetic.nl), Marijke Vosman (marijke.vosman@inredadiabetic.nl), Bert-Jan van Beijnum (b.j.f.vanbeijnum@utwente.nl)
Peter Veltink (p.h.veltink@utwente.nl), Hans Zwart (h.j.zwart@utwente.nl)
Personalized cAnceR TreatmeNt and caRe (PARTNR)

**Assignment:** Bachelor, Master, Internship

**Educational program:** BME, TM, HS, PSY, CREATE

**Daily supervisor:** Kim Wijlens, MSc or ir. Lian Beenhakker

**Project description**

Due to improved treatment and early diagnosis of breast cancer, there are more survivors. However, this also means that more patients are struggling from late effects from treatment. One of these late effects is cancer-related fatigue (CRF), which is defined by the American National Comprehensive Cancer Network as “a distressing, persistent, subjective sense of physical, emotional and/or cognitive tiredness or exhaustion related to cancer or cancer treatment that is not proportional to recent activity and interferes with usual functioning.”

In the Personalized cAnceR TreatmeNt and caRe (PARTNR) project, we aim to help breast cancer patients suffering from CRF. We will holistically assess patients, considering all aspects that can cause/influence the fatigue and predict who might be at risk of developing CRF. Using multimodal data, we will advise an intervention to reduce the fatigue which is based on the holistically assessed patient information about CRF and personal preferences patients might have for types of intervention. In the end, we will combine all information from patients into an intelligent self-learning platform that patients can use to keep track of and improve their fatigue.

If you would like to work on the PARTNR project during your internship or thesis, please contact either Kim Wijlens (k.a.e.wijlens@utwente.nl) or Lian Beenhakker (l.beenhakker@utwente.nl). Supervisors will depend on the chosen assignment.

**PARTNR Team:**
Prof. dr. Miriam Hutten (BSS), prof. dr. Sabine Siesling (HTSR), dr. Christina Bode (PGT), dr. Annemieke Witteveen (BSS)
**Pain scales in monitoring physical function recovery of patients with hip fractures**

**Student assignment:** Bachelor/Master project (ca. 30 credits, ca. 21 weeks)

**Educational program:** Health Sciences, Biomedische Technologie, Technology and Liberal Arts and Sciences, or other relevant direction

**Daily supervisor:** Dr. Ying Wang

**Project background:**
The worldwide incidence of hip fractures is expected to be 21.3 million by 2050 considering the impact of secular trends. Elderly patients with hip fracture may have an increased dependency on mobility aids and a decreased quality of life because of long-term functional impairment after surgeries. A quick functional recovery after surgeries is essential to increase patients’ quality of life. Monitoring the recovery can help optimize and personalize interventions, such as physical therapy, to increase the recovery speed. Currently, most studies have used the gait analysis, such as the number of steps, to monitor the recovery level. Post-operative pain can affect the gait performance and hamper rehabilitation. However, few studies have investigated the relationship between pain scales and physical function recovery.

**What you can expect from us:**
We aim to investigate the effect of post-operative pain on the physical function recovery of patients with hip fractures. In this project, you can expect to obtain the knowledge about:

- Data management: collect and re-organize archived data from hospital databases.
- Design questionnaires about post-operative pain in patients.
- Collect questionnaire data within clinical practice.
- Statistical analysis to investigate the relationship between pain scales and physical function recovery.
- Build a model to predict the recovery level using pain scales (for Master students).
- A potential scientific publication can be expected based on the project outcomes.

**What we expect from you:**
- We are looking for open-minded students who have a background in Health Sciences, Biomedische Technologie, Technology and Liberal Arts and Sciences, or other relevant direction.
- Students should be strong in using statistical software, such as SPSS, and R.
- Students should have strong communication and collaboration skills for a good contact (in Dutch) with clinicians and patients.
- Programming skill in Matlab/Python is optimal.

**Information and application:**
Please send your application to Ying Wang (ying.wang@utwente.nl), and include:

- A curriculum vitae including your name and contact (max 2 A4 pages).
- A personal motivation letter (max 1 A4 page).
- Lists of courses and grades of your BSc (and MSc) degrees.
Activity recognition using multimodal signal analysis (BSS-ZGT)

**Student assignment:** Master graduation project (40-45 credits, 28-32 weeks)

**Educational program:** Electrical Engineering, Biomedical Engineering, or other relevant direction

**Daily supervisor:** Dr. Ying Wang

**Project background:**
Continuous wearable sensing technologies have been widely applied in the vital sign monitoring of in-hospital patients for timely and personalized intervention. These advanced techniques can help decrease patients’ mortality rate and release the burden of national health care systems. However, the accuracy of the vital sign monitoring can be affected by different physical activities of patients, such as lying on the bed, getting off from the bed, sitting, walking, dressing, and going to the toilet. Recognizing these activities can assist us to adjust the vital-sign monitoring strategies and therefore guarantee the accuracy.

**What you can expect from us:**
We aim to develop an algorithm to recognize physical activities using different modal physiological signals, such as accelerometer and electrocardiography (ECG) signals. In this project, you can expect to obtain the knowledge about:

- Design a polit experiment for healthy subjects to simulate the physical activities of in-hospital patients.
- Collect physiological signals from healthy subjects to learn about the potential effects of real-life factors on the quality of signals.
- Develop an algorithm to detect physical activities:
  - Preprocess different modal signals.
  - Extract features from the signals.
  - Apply machine learning techniques to classify the physical activities.
- Test the developed algorithm on data collected from in-hospital patients: you can visit the hospital to observe the patients’ daily activities to inspire and improve your algorithms.
- A potential scientific publication can be expected based on the project outcomes.

**What we expect from you:**
- We are looking for talented and open-minded students who have a background in electrical engineering, biomedical engineering, or other relevant direction.
- Students should have strong interest in signal processing, analysis, and machine learning.
- Students should have strong programming skills in Matlab/Python.
- Experience in physiological signal analysis and/or clinical research is optimal.

**Information and application:**
Please send your application to Ying Wang (ying.wang@utwente.nl), and include:
- A curriculum vitae including your name and contact (max 2 A4 pages).
- A personal motivation letter (max 1 A4 page).
- Lists of courses and grades of your BSc and MSc degrees.
**Identification of movements and postures in daily life using a wearable sensor setup for implementation in a bi-hormonal artificial pancreas system**

**Assignment:** Bachelor (10 weeks, 15 EC)

For: students who are interested in data gathering and signal analysis in a very applied manner

Contact: Ben Sawaryn (b.sawaryn@utwente.nl)

**Background**

The artificial pancreas (AP), developed by Inreda Diabetics B.V., fully regulates blood glucose levels of type 1 diabetes mellitus patients by administration of insulin and glucagon using a closed loop regulator ([Error! Reference source not found.](#)). The mainframe and transmitters contain tri-axial accelerometers which measure physical activity to adjust the administration algorithm. As the AP is a fully transportable system, it operates on batteries which last approximately 3 weeks. Therefore, the software is carefully crafted to prevent it using too much electricity. This means the physical activity sensing algorithm should be as simple and computationally frugal as possible.

In the current design of the AP, physical activity is sensed by thresholding using a 1D activity parameter (mean maximum amplitude) of these tri-axial accelerometers on the AP. Because performing physical activity influences blood glucose levels, the AP control system allows for changing insulin and glucagon administration levels at different activity magnitudes. However, the current physical activity sensing method can be improved as the currently implemented method of data processing entails heavily down-sampled 1D data, which will lead to a loss of information.

Therefore, an experiment was performed where subjects performed sequences of postures and movements to train and test a new computationally frugal classification algorithm. Even though the results are promising, the experiment was performed in a controlled lab environment which does not naturally translate to recognition of postures and movement when performing actual daily life activities for a prolonged period.

**Goal and research activities**

The goal of this assignment is to gather longitudinal (24 hours for several days) human activity data using a wearable sensor setup which in turn are to be used for analysis of posture and movement recognition.

During this assignment you will also have the opportunity to be involved with employees of Inreda Diabetics B.V. (Goor, the Netherlands).
An Enriched Stimulation Protocol to the NDT-EP Method for Improved Observation of Nociceptive Evoked Potentials

**Teachers:** Niels Jansen [n.jansen@utwente.nl](mailto:n.jansen@utwente.nl), Jan R. Buitenweg, [j.r.buitenweg@utwente.nl](mailto:j.r.buitenweg@utwente.nl)

**Educational Programme:** BSc - BMT, TG

**Background:** Chronic pain often is results from disturbed processes in the central nervous system. Once chronic pain is established, treatment is relatively ineffective, with – at best – one patient in three or four achieving 50% pain intensity reduction. Early detection and therapeutic action would mean better treatment outcome and less clinical efforts per patient, but appropriate diagnostic tools are lacking.

An increased sensitivity to noxious stimuli is widely recognized as a key factor in chronic pain development. Noxious stimuli are processed by neural mechanisms at several stages in the ascending pathway from periphery to brain, into a conscious pain experience. As a response to injury or disease, maladaptive changes in this pathway may result in an increased pain sensitivity. Clinical observation of the specific malfunctioning of peripheral and central components of this pathway is limited at present, but would permit a better understanding and early selection of interventions for treatment or prevention of chronic pain.

Recently, we developed a new method for observing the properties of nociceptive processing utilizing subjective detection of electrocutaneous stimuli in combination with objective neurophysiological brain responses. In this method, nociceptive afferents are activated by temporally defined current stimuli with varying number of pulses and varying inter pulse intervals. As these different temporal stimulus properties result in different excitation of nociceptive processing mechanisms of the ascending system, subsequent processing of stimulus-response pairs (SRPs) into estimated nociceptive detection thresholds (NDTs) and Evoked brain Potentials (EPs) of multiple stimulus types may provide information about the properties of these mechanisms.

The EPs comprises mainly of two elements: (1) activity related to the processing of the nociceptive stimulus and (2) task-related activity. At present, the majority of the activity seems to be related to the task. For an improved characterization of the nociceptive processing, we would like to better evaluate the activity related to the processing of the nociceptive stimulus. By providing an enriched stimulation protocol to the participant, we might be able to reduce the extent of task-related activity. This could allow us to better evaluate the activity related to nociceptive processing. Thus far, we have however not experimentally evaluated this protocol. In this study, we want to evaluate whether this enriched stimulation protocol is feasible and useful.

**Assignment** – Prepare and execute experiments at the University of Twente to evaluate the effect of the enriched stimulation protocol on the EP's.

**Components** – (1) Perform a literature study. (2) Implement and conduct human subject experiment. (4) Analyze the data and (5) report and (6) present the results.
Motoneuron adaptations to exoskeleton training

**Student assignment:** Master assignment (28-32 weeks, 40-45 ECs)
**Contact:** Dr. Yavuz US.
**email:** s.u.yavuz@utwente.nl

**Background:** Lower limb rehabilitation exoskeletons support and assist patients in locomotion after neurological injuries. Identifying the mechanisms underlying neural adaptations to exoskeleton training is key to design optimal strategies for assistance. Previous studies\(^1,2\) indicate reduced muscle activation (EMG) after short-term exoskeleton training. However, the specific mechanisms for this adaptation remain unclear.

High-density surface EMG (HD-EMG) is a non-invasive technique to measure neural activity from multi-channel grids on the muscle. Blind source separation (BSS) techniques, such as Convolution Kernel Compensation (CKC)\(^3\), enable exploiting the high resolution capability of HD-EMG to open a window into constituent motor neuron spike trains. By these means, we aim at investigating the neural mechanisms that govern locomotor adaptations to short-term exoskeleton training.

**Goal:** The main goal of this assignment is to develop and validate methodologies for identifying motoneuron adaptations to short-term exoskeleton training.

**Keywords:** HD-EMG, motor neuron, decomposition, blind source separation, exoskeleton training

**Main Activities:**
- Literature study on motor neuron properties (recruitment threshold, variability, discharge rate and synchronicity, stretch reflex, H-reflex and exoskeleton training).
- Development of a methodology to identify physiological changes between before and after-training trials (in time or frequency domain).
- Statistical analysis to compare results.
- Scientific report about the findings.

**References:**
MiniSoccerbal 2.0

Supervisors: Robbert van Middelaar, Jasper Reenalda, Peter Veltink

Student assignments: Bachelor and Master assignment

Educational programme: BMT/BME, EE, CreaTe, iTech, CS

Topics
Develop a prototype soccer ball; data gathering & validation; building an application

Project summary
This project focuses on extending and improving the already existing MiniSoccerbal (www.MiniSoccerbal.com) of the Twentsche Voetbal School. This MiniSoccerbal is a small ball (size 2) that is connected to a cord. With this cord, a player can control the ball in his/her nearest space. The end of the cord is always connected to the player, therefore the ball will never leave the area around the player.

The MiniSoccerbal is already used by a lot of youngsters (7-13 y/o) in (professional) football clubs. They use this ball to improve skills, technique, and coordination. The use of this ball has positive effects: a lot of contact with the ball, improved hand-eye coordination, ball feeling in both legs, and an enhanced cognitive skill. Youngsters can already use over 100 training exercises with the MiniSoccerbal.

Currently, relevant parameters are not measured to analyse the performance. To extend beyond its current capability, the MiniSoccerbal needs to be improved and should measure useful data, allow users to view the data, and interact with the data and other people using an interactive application.

Summarised, this project consists of three parts:

1. Prototype of MiniSoccerbal 2.0
   The MiniSoccerbal 2.0 needs to be instrumented with sensors that would allow users to collect and measure relevant data. A prototype needs to be developed and manufactured to test and validate the functions of MiniSoccerbal 2.0 (see step 2).

2. Evaluation and processing measurement data
   The data received from the sensors need to be processed and evaluated into understandable and relevant results. Algorithms must be derived and developed to fulfil the need for automatic processing, communicate with an application, and validate the test results. Testing is possible together with Twentsche Voetbal School or FC Twente/Heracles.

3. Application building
   The processed data should be visible in an application, where the inferences from the data can be shown and users can socially interact with others.

Email contact: r.p.vanmiddelaar@utwente.nl
Supervised learning framework for real-time HD-EMG decomposition

**Student assignment:** BSS master assignment (28-32 weeks, 40-45 ECs)

**Contact person:** Dr. Utku S. Yavuz, Biomedical Signals and Systems research group, Email: s.u.yavuz@utwente.nl

**Background:** High-density surface EMG (HD-EMG) is a non-invasive technique to measure neural activity from multi-channel grids on the muscle. Blind source separation (BSS) techniques, such as Convolution Kernel Compensation (CKC), exploit the high resolution capability of HD-EMG to open a window into constituent motor neuron spike trains. However, although these techniques offer an accurate decomposition, they are often suboptimal in dynamic or noisy conditions, and most of them only work offline. For this assignment, we aim at developing a supervised learning framework to decompose HD-EMG signals, based on the output of CKC decomposition.

**Goal:** To develop a supervised decomposition technique to extract motor neuron spike trains from HD-EMG recordings.

**Keywords:** HD-EMG, motor unit, decomposition, BSS, deep learning, machine learning

**Main Activities:**
- Literature study on state-of-the-art techniques for HD-EMG decomposition.
- Developing a supervised decomposition framework using HD-EMG data and decomposed spike trains recorded from isometric plantar- and dorsi-flexion trials.
- Statistical analysis to compare several quality and efficiency metrics (accuracy, computational time, rates of agreement, ...) between the proposed supervised framework against CKC decomposition.

**References:**
**Validatie van biosensoren in gezonde vrijwilligers**

**Research Question:** Wat is de accuraatheid en betrouwbaarheid van de Everion biosensor en de Fitbit Charge 3 in gezonde vrijwilligers?

**Department:** Chirurgie Universitair Medisch Centrum Groningen  
**Language:** Dutch/English  
**Educational programme:** BME

**Description project content and methods:**

Bij de chirurgie loopt een groot project waarbij telemonitoring toepassingen worden gevalideerd en geïmplementeerd voor patiënten die grote operaties ondergaan. Het gebruik van telemonitoring, als onderdeel van eHealth, komt tegemoet aan de tendens naar personalized medicine en is geassocieerd met betere klinische uitkomsten en kosteneffectiviteit van zorg in verschillende takken van de gezondheidszorg, met name in chronische ziekten. Het inzichtelijk maken van het welzijn van een patiënt zorgt ervoor dat eerder of beter omgegaan kan worden met veranderingen in gezondheid. De verwachting is dat telemonitoring ook in de perioperatieve periode, van toegevoegde waarde kan zijn. Telemonitoring zou kunnen bijdragen aan de optimalisatie en individualisatie van het perioperatieve (herstel)proces en daarbij te vroeg ontslag, onnodig lange ziekenhuisopnames of ongeplande heropnames kunnen reduceren.

Op dit moment zijn draadloze biosensoren beschikbaar om fysieke parameters te monitoren. De Everion biosensor van Biovotion (Biovotion AG, Zürich, Switzerland) is een CE-gecertificeerde sensor die op de bovenarm wordt gedragen (zie afbeelding) en vitale parameters en activiteit meet met een frequentie van 1Hz, waaronder: hartslag, hartslag variabiliteit, oxygenatie, huid temperatuur, ademhalingsfrequentie, aantal stappen en type activiteit. Hartritme is al een gevalideerde parameter. Bekend is dat de hoeveelheid postoperatieve dagelijkste stappen en fysieke activiteit van een patiënt tijdens ziekenhuisopname geassocieerd is respectievelijk het risico op heropname binnen 30 dagen na de operatie en de lengte van de ziekenhuisopname. Om deze informatie te implementeren in de perioperatieve zorg van hoog-risicopatiënten, moeten in kaart worden gebracht wat de betrouwbaarheid van verschillende sensoren is wat betreft het meten van vitale parameters, het aantal stappen en activiteit (en de gevoeligheid van vitale parameters voor activiteit). Daarom gaan we een validatiestudie doen bij gezonde vrijwilligers.

De studenten zullen telemonitoring devices valideren door het uitwerken van strategieën om looppatronen te simuleren, mee ontwikkelen van protocol en meetopstelling en uitvoeren van tests bij gezonde vrijwilligers. In dit project hebben studenten de mogelijkheid om zelf metingen uit te voeren en kennis te maken met de faciliteiten van het eHealth house (Techmed Centre, Universiteit Twente) en de nieuwste ontwikkelingen op het gebied van telemonitoring.

**Supervisors:**

dr.ir. M. Tabak, associate professor vakgroep Biomedische Signalen en Systemen, UTwente  
dr. R.C.L. Schuurmann, post-doc multi-modality medical imaging group, UTwente  
prof. dr. J.P.P.M. de Vries, vaatchirurg UMCG  
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**Functional electro-tactile stimulation to augment the postural control: development of rehabilitation technology fall**

**Contact person:** Utku Yavuz  
**Student assignments:** MSc project assignment  
**Educational programme:** BME, TM, EE, Create

**Project Summary:**  
The dramatic increase in average life expectancy during the 20th century is one of society’s greatest achievements. In many countries, the oldest age (people aged 85 or older) are now the fastest growing proportion of the total population (the 85-and-over population is projected to increase 351% between 2010 and 2050). As people grow older they are increasingly at risk of falling with resultant injuries. One out of three persons older than 65 and 50% of those older than 80, fall at least once per year (Todd & Skelton, World Health Organization, 2004) based on various reasons. In some cases, fall may be indication of a chronic neurological disorders affecting postural stability and gait (such as Parkinson disease). Therefore, understanding neural mechanism underlying the postural control has utmost importance to develop accurate intervention.

It is well established that the sensory information conveyed from muscle and joint proprioceptors play an important role in the control of posture and gait in humans. In a recent study, we showed that cutaneous mechanoreceptive inflow from the neck is also integrated into the control of posture. More importantly, we showed that the electro-tactile stimulation of cutaneous afferents at neck region, with a subtle (140% of perception threshold) stimulation current intensity, led to a drift towards forward (leaning forward) in the center of pressure (Nunzio et.al., Experimental Brain Research 2018). Within the proposed study, we aim to investigate the integration of cutaneous receptors located at the foot sole and determining the pattern and strength of stimulation current that leads an efficient effect on body-orientation (posture). The findings are relevant for the exploitation of electro-tactile stimulation for rehabilitation interventions where induced body-orientation is desired.

**Assignment:**  
In this study you will use biomedical equipment to record the electrical activity produced by muscles contraction (electromyography - EMG) and to acquire the oscillations of the human body through force platforms during quite upright stance condition. You will then administer a series of electro-tactile stimulation and analyze the postural effects induced by such stimuli. The acquired data will be analyzed with standardized and validated algorithms to study the physiological basis of these postural effects. This will lead to the development of new rehabilitation protocols and devices to enhance postural control in elderly population and neurological patients. You will learn:

- neurophysiology of postural control  
- recording muscle electrical signals and the movement of center of foot pressure using professional biomedical equipment  
- developing acquisition systems with stimulation units  
- statistically analyze the acquired data

**Contact:**  
The student will work at the laboratory of the Department of Biomedical Systems and Signals, faculty of EEMCS, University of Twente, under the supervision of S. U. Yavuz, PhD. email: s.u.yavuz@utwente.nl, tel:+31534898158
Sensing and analyzing (sports) biomechanics with (inertial) sensors

Possible project supervisors:

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Robbert van Middelaar  R.P.vanmiddelaar@utwente.nl
Marit Zandbergen  M.Zandbergen@rrd.nl
Jasper Reenalda  J.Reenalda@rrd.nl
Jaap Buurke  J.Buurke@rrd.nl
Peter Veltink  P.H.Veltink@utwente.nl

Educational programmes: EE and BMT

Topic: Sensing and analyzing (sports) biomechanics with (inertial)sensors

Project summaries:

Multiple PhD student are involved in research related to (sports) biomechanics and (inertial) sensors. Below you can find a short description of the different topics. If you have interest in a Bachelor of Master project related to one of these topics, please contact the PhD student mentioned by the project.

Luca Marotta: Detecting physical fatigue in sport and work related tasks using wearable sensors. Developing and validating algorithms to detect and predict clinical outcomes, with a strong interest in machine learning.

Bouke Scheltinga: Model physiological and biomechanical training load over time using workload data. Ideally with a minimal sensor setup, which can consist of inertial sensors and physiological sensors.

Robbert van Middelaar: Development of new algorithms and tools to monitor an athlete (runner, rower, volleyball etc.) in the sports-specific setting to improve their performance or to prevent them from injuries; detect changes in their movement or posture and give feedback via an interactive system".

Project is related to 'Sports, Data & Interaction Team', meaning there is close collaboration with projects from Human Media Interaction and Mathematics.

Marit Zandbergen: Develop sensing and analysis methods to assess essential metrics that relate to specific risks of injuries in runners. For this purpose, we use a minimal set of three 3D inertial sensors on the sacrum and both lower legs.
Pediatric asthma monitoring (BSS-RRD)

**Teachers:** Monique Tabak, Mattienne van der Kamp

**Student assignments:** BSc and MSc project assignments

**Educational programme:** BMT, TG, EE, TCS, CT, CS, ATLAS

**Contact:** m.tabak@utwente.nl

**Topic:** eHealth in the pediatric asthma care: From smart monitoring to implementing a new care standard for personalized health.

**Project Summary:**
This project focuses on innovative, personalized eHealth for pediatric asthma patients. Currently, pediatric asthma care heavily relies on information acquired during scheduled visits when children usually are asymptomatic. Relevant (symptomatic) information can therefore be missed due to for example recall bias, hampering the treatment of the child. Smart monitoring (e.g. sensing, ESM, video) allows regular monitoring of asthma control at home and helps to identify worsening of asthma control (e.g. prediction modelling, decision-support). This enables the pediatrician to anticipate timely for personalized treatment and self-management of the child and parents, potentially resulting in less symptoms and a better quality of life.

**The challenges of this project lie in:**
- finding the right combination of monitoring tools and devices for the right physiological parameters (i.e. spirometry, smart inhalers, activity, EMG, etc),
- developing a child friendly and attractive monitoring platform,
- creating evidence-based clinical decision support algorithms,
- increasing self-management of asthmatic children and parents (with i.e. automated feedback),
- and implementing eHealth in the current clinical practice in a clear and efficient way.

During the course of this project, we as Medisch Spectrum Twente, University of Twente and Roessingh Research and Development devoted ourselves to many of the above mentioned challenges and are working hard to progress towards extending, personalizing and validating eHealth strategies in pediatric asthma care. So that it benefits both the caregivers and the care providers.
Oncologie (BSS-ZGT)

**Educational programme:** BMT, TG, HS.

*a) Optimizing health outcome in (neo)adjuvant treatment for breast cancer patients.*

**Background information:**
In the Netherlands 1 out 7 women will develop breast cancer, in 2017 17,423 new cases were diagnosed. A substantial part of these women are treated with (neo) adjuvant systemic therapy, hormonal- and/or chemotherapy. In case of (neo)adjuvant chemotherapy this is accompanied by significant loss in physical condition and by a substantial weight gain. In part these women experience chronic fatigue afterwards, loss of concentration and difficulty in regaining normal activity at work and at home. Our understanding is that if preventive measures are taken the loss in physical condition and weight gain can be (partially) prevented. Previous exercise and nutritional habits combined with lifestyle are important factors in maintaining, as good as possible, weight and physical fitness. The majority of women with breast cancer have some overweight and they do not engage in enough physical activity. Tailoring for which patient and at what moment intervention is needed is difficult at this moment by lack of tools and practical guidelines. Recently a personalized and technology supported coaching system to support the patient’ selfmanagement is developed for diabetes patients. A comparable system can be used for oncology patients treated with chemotherapy.

**Supervisors:** Dr. Laverman – g.d.laverman@utwente.nl, Prof. dr. M. Vollenbroek m.m.r.hutten@utwente.nl, Dr. Oving.

*b) Impact of (Neo)Adjuvant Chemotherapy on Long-Term Performance and Employment of Early-Stage Breast Cancer Survivors in our region.*

**Background information:** Many women with early-stage breast cancer are working at the time of diagnosis and survive without recurrence. The short-term impact of chemotherapy on employment (<1 year) has been demonstrated, but the long-term impact merits further research. Even less is known about long-term impact of cancer treatments on social functioning, physical activity or sports, managing family live and maintaining relationships. Recently a database was made of all our breast cancer patients. This database can be used for further research.

**Supervisors:** Prof. dr. M. Vollenbroek - m.m.r.hutten@utwente.nl, Dr. Irma Oving, Dr. Ester Siemerink
Up&Go na een heupfractuur (BSS-ZGT)

**Opleidingen:** TG, BMT, HS, bewegingswetenschappen of andere relevantie opleidingen binnen het domein van de gezondheidszorg.

In Nederland worden jaarlijks ongeveer 17.000 ouderen opgenomen in het ziekenhuis vanwege een heupfractuur, waarvan ongeveer 300 in Ziekenhuisgroep Twente (ZGT). Bij een groot deel van deze kwetsbare patiëntengroep is er na de heupfractuur kans op onherstelbaar functieverlies, met als gevolg dat zij bijvoorbeeld niet meer thuis kunnen wonen en/of blijvend afhankelijk zijn van anderen. Ook overlijdt ongeveer 1/3 van de patiënten binnen een jaar na de heupfractuur.

In 2008 werd in het ZGT het Centrum voor Geriatrische Traumatologie (CvGT) opgericht door de traumachirurgen om de zorg voor ouderen met een heupfractuur te optimaliseren en hierdoor het herstel van patiënten met een heupfractuur te verbeteren. Echter, het CvGT is vooral gericht op de behandeling van patiënten tijdens ziekenhuisopname. Na ziekenhuisopname gaat nog ongeveer de helft van de patiënten tijdelijk revalideren op een geriatrische revalidatieafdeling in een verpleeghuis. Om de zorg voor ouderen met een heupfractuur nog verder te optimaliseren is daarom in 2017 het “Up&Go na een heupfractuur” project opgericht. Dit project richt zich niet alleen op het herstel van patiënten in het ziekenhuis, maar het richt zich ook op het herstel van patiënten tijdens revalidatie in het verpleeghuis. Binnen het “Up&Go na een heupfractuur” project heeft ZGT samen met de omliggende verpleeghuizen een gezamenlijk transmurale zorgpad ontwikkeld met als doel snelle revalidatie en functioneel herstel te bevorderen. Op standaard momenten wordt inzicht verkregen in het herstel van de patiënt door middel van klinimetrische testen. Daarnaast worden er technologische toepassingen ingezet om het herstel van ouderen na een heupfractuur continue te kunnen monitoren tijdens ziekenhuisopname en tijdens opname in het verpleeghuis.

**Doel**
Het doel van het onderzoek is om met behulp van het transmurale zorgpad en de inzet van technologische toepassingen meer inzicht te krijgen in het functionele herstel van ouderen na een heupfractuur. Met behulp van deze inzichten zal er gekeken worden waar de zorg nog verder geoptimaliseerd kan worden om het herstel van ouderen te bevorderen. Uiteindelijk is het doel om met deze inzichten de revalidatie te kunnen voorspellen en feedbacksystemen te maken zodat er tijdig kan worden bijgestuurd in de revalidatie.

**Niveau**
Bachelor/Master.

**Methodes**
- Literatuurstudie
- Uitvoeren van metingen bij patiënten
- Kwantitatieve data-analyse
- Interviews met patiënten

**Begeleiders**
**Extern supervisors:** Dr. J.H. Hegeman / Dr. E.C. Folbert
Afdeling: Geriatrische traumatologie, ZGT Almelo

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**DIAMETER (Diabetes) (BSS-ZGT)**

**Educational programme:** BMT, TG, HMI, ATLAS

**Achtergrond en probleem**
Diabetes Mellitus Type 2 (T2DM) is een chronische ziekte waarbij het risico op complicaties is verhoogd door ontregelde glucosewaarden. Deze patiënten hebben hulp nodig om meer grip te krijgen op de diabetes. Een belangrijke factor dat winst kan opleveren bij T2DM is een gezondere leefstijl, echter ontbreekt de tijd in de gezondheidszorg om patiënten hier optimaal in te kunnen begeleiden. Uit vooronderzoek is gebleken dat patiënten niet voldoen aan de norm gezonde voeding en gezond bewegen en de kennis over de voordelen van een gezonde leefstijl ontbreekt. Daarom is het ZGT in samenwerking met de Universiteit Twente bezig om een gepersonaliseerde diabetes coach, in de vorm van een mobiele app, te ontwikkelen die de diabetespatiënt helpt de glucosewaarde op peil te houden. De coach, de Diameter, maakt gebruik van continue monitoring van glucosewaarden, lichamelijk bewegen, hartslag, voeding en medicatie op basis waarvan een individueel voorspellend model voor glucoseregulatie wordt ontwikkeld. Dit model dient o.a. als input voor de coaching module die gebaseerd op theorieën van gedragsverandering en motivatie theorieën de patiënt ondersteunt in het maken en volhouden van verantwoorde keuzes. De verwachting is dat patiënten hiervan voordelen zullen merken op de korte termijn (groter gevoel van welbevinden) en lange termijn (verminderde kans op complicaties).

**Doel**
Het doel van het onderzoek is het ontwikkelen van de mobiele applicatie die diabetes patiënten kan ondersteunen. De ontwikkeling van de app bestaat uit meerdere subonderdelen. De verschillende app versies moeten bijvoorbeeld getest worden op usability, de coachingsmodule moet (verder) ontwikkeld worden en verschillende onderdelen van de app, zoals ziektebeleving en mogelijkheid tot een community, moeten nog vormgegeven worden.

**Niveau:** Bachelor/master

**Begeleiders**

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Modeling and analyzing tremor related phenomena of Parkinson’s disease

Teachers: Ciska Heida
Student assignments: BSc and MSc project assignments
Educational program: BMT/BME, TG/TM, EE
Topics: Modeling and signal analysis

Introduction
Parkinson’s disease (PD) is a long-term degenerative disorder of the central nervous system that affects the motor system. The cardinal symptoms are (rest) tremor, rigidity (muscle stiffness), and akinesia/bradykinesia (lack or slowness of movement, resp.). These symptoms result from the loss of cells in the substantia nigra, a region of the midbrain that produces dopamine, an essential neurotransmitter for relaying neuronal information that plan and control voluntary movements.

A number of phenomena occur in Parkinson’s disease (PD) that are related to tremor, which have not yet been combined into a single conceptual and/or computational model, but probably all involve basal ganglia and cerebellar circuitry:

- (Rest) Tremor in PD is hypothesized to involve the basal ganglia as well as the cerebellum with the basal ganglia switching tremor on and off, and the cerebellar circuit modulating tremor amplitude (known as the dimmer-switch hypothesis).
- Rest tremor is reduced/suppressed by voluntary movements.
- Rest tremor disappears during sleep.
- Rest tremor may respond to Levodopa medication, but this is not necessarily the case in all patients. Furthermore, while in a single patient rigidity and slowness of movement may respond well to Levodopa, tremor may not, which may suggest that tremor is not a direct effect of the dopaminergic deficiency.
- Rest tremor responds to deep brain stimulation (DBS) in the STN and Vim.

Assignments
- Development of a computational model of the neuronal networks involved in central motor control and couple a number of the phenomena related to tremor at the neuronal circuit level.
- Analyzing experimental data containing movement registrations performed by PD patients during different (movement) tasks that can be used to validate computational models of the mechanisms and neuronal circuits involved in tremor under different behavioural conditions.

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Pride&Prejudice – technology to support healthy eating

**Teachers:** Roelof de Vries (BSS), Juliet Haarman (HMI)

**Student assignments:** BSc and MSc project assignments

**Educational programme:** BMT, TG, HMI, CS, ATLAS, EE

**Topics:** Data gathering and processing of physiological signals; sensor integration; modelling and machine learning of eating events; design of food intake monitoring interventions; design of behavior change interventions; engagement with and compliance to interventions, design of intervention context

**Project Summary:**
Your eating behavior affects your health. We all know it by now. Not just the type of food you consume, certainly also the quantity of the food, the timing of food intake throughout the day, and the speed with which a meal is eaten are important. The Global Burden of Disease study showed that a suboptimal diet is the second-leading risk factor for disability-adjusted life years and deaths worldwide. This number could drastically decrease when attention is payed to a balanced diet, fitted to the needs of each individual. Many studies have proven that a change in eating behavior can be used as an effective way of gaining control of disease related symptoms, ranging from diabetes, heart and valve disease, to Crohn’s disease.

Logically, gaining insight into the current eating behavior of a subject is a first step in accomplishing better health. Professionals still use conventional methods, such as the use of logbooks, for this. They ask the user to manually report on their eating behavior throughout the day. Memory and logging bias are not uncommon factors associated with this method. Often, users simply forget to write down what and when they have been eating. Also, the presence of unknown ingredients in the food, difficulties in estimating portion size or social discomfort while logging the food affect the reliability of this method. One way to lower the chance for bias, is to use technology that automatically detects events of food intake. Providing the user with a time-based logbook where all the identified eating events are noted as timestamps, might make it easier to recall what they have been eaten during a day. Auditive sensors in the ear, strain gauges on the jaw or RIP sensors that monitor the breathing signal of the subject are examples of technologies that are used to identify swallowing sounds and/or chewing movements – indicating that the user is eating. Many of these technologies are not tested outside of a standardized, laboratory environment yet and therefore their practical validity is often unknown – and should be investigated.

A different approach to lower the logging bias is to use technology that is less tedious in use, compared to the conventional manual logging method. Designing new interventions that engage the user in their reporting task and increase compliance might be a suitable approach for this. Combining different sensors or devices (placed on the body, in a room or in cooking gear) might be one way to do it, and adding a gaming element to the intervention might be another. Other elements to consider adjusting are the context of the communication: who (what is the relationship with the sender) - says what (what is the content of the message) - in which channel (how is this message communicated)- to whom (who is the receiver of the message) – when (what is the timing of the message) – where (what is the location of the receiver) – how (what is the style of the message) - and with what effect (how does the messages come across)?

Lastly, interventions can also be designed to try to influence eating behavior directly: behavior change interventions. Think of interventions that directly inform the user of their unhealthy diet choices (feedback on shopping list), or that indirectly influence the user (smaller portions). To increase engagement and compliance with the interventions, similar approaches can also be taken as explained above, such as adding gaming elements or changing the context of the communication.

A variety of assignments is available within the scope of this broad project. Assignments can be made suitable to your specific backgrounds and interests. Please feel free to contact us to hear about the possibilities.

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**E-manager Chronic Diseases**

**Teachers:** Miriam Vollenbroek, Wendy d’Hollosy, Anouk Middelweerd, Annemieke Konijnendijk en Eclaire Hietbrink

**Student assignments:** BSc and MSc project assignments

**Educational programme:** HS, TG, CS, HMI/Create, BME

**Topics:** tailoring and personalization, technology supported lifestyle coaching, experimental designs, mHealth, machine learning, human computer interfaces

**Project Summary:**
Over 5.3 million people in the Netherlands have a chronic disease. The importance of a healthy lifestyle in chronic disease management has been increasingly recognized in recent years. There is a growing body of evidence that lifestyle interventions contribute to a reduction in disease burden and to an improvement in the Quality of Life (QoL) in people with chronic diseases. eHealth technologies show promising results regarding lifestyle coaching. Compared to regular face-to-face lifestyle coaching, eHealth interventions have several advantages as eHealth is less effort-, time- and cost intensive and enables more continuous support in chronic disease management in daily life.

For this reason, this project focuses on the development, implementation and evaluation of the E-manager Chronic Diseases for people with type 2 diabetes mellitus, asthma, chronic obstructive pulmonary disease (COPD) and heart failure. In the E-Manager project, a digital coaching platform, the E-Supporter, is being developed for people with chronic diseases who want to improve their lifestyle. The E-Supporter motivates and helps patients in everyday life to pursue lifestyle goals by providing tailored e-coaching that ties in with the patients’ behavioural state, character and abilities. The coaching content that is developed will be integrated into existing apps. For example, the current content of the E-Supporter for people with type 2 diabetes mellitus is built into the “Diameter” app and the “MiGuide” app.

**Assignments:**
The E-Supporter has not yet been fully developed and evaluated, which is why bachelor and master assignments are available focusing on different topics:
- Developing and evaluating more tailored coaching content for physical activity and/or nutrition;
- Broadening of the existing coaching content to other chronic conditions (e.g., COPD) or lifestyle domains (e.g., smoking);
- Developing a rule based decision support system to automate the provision of tailored lifestyle coaching;
- Using data science techniques to tailor the coaching strategies to an individual patient.

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