2015

TechToolBox

Research Project Presentations
in Patient@Home

patient@home

TechToolBox

Patient at Home is the largest welfare technological Research and Development project (FoU) in Denmark with a budget of 190 mill dkr. Patient@Home is a SPIR-platform (Strategic Platforms for Innovation and Research) financed by the government agency of Research and Innovation (FI) and the Region of Southern Denmark. More than 40 partners including private companies, public partners, and GTS's are actively participating and contributing in this large program.

The TechToolBox is a collection of ways to gather and distribute the research knowledge to partners out of the platform. The distribution methods include demos and writings about the research projects. This booklet is the first compilation of research project descriptions from Patient@Home.

Enjoy the reading and please do not hesitate to contact us for further information.

Kind regards,
Lars Vincents Jørgensen, March 2015
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The purpose of Patient@Home is to:

- Reduce the pressure on the public health sector
- Reduce the number of hospitalizations
- Reduce the duration of each hospitalization
- Development of new safe treatments

"... initial studies show that using playware for balance training can save money and create a higher quality of life for the elderly."

Methodology for design and development of playware products

Background

I have a master's degree in Digital Design and Communication from IT-University of Copenhagen (ITU), and a bachelor's degree in Information Science from Aarhus University. Doing my studies and my work, at Center for Playware I have had a focus on play, welfare technology, and user-involvement and how technology can be used in the welfare area.

The PhD project focus

The main scientific objectives for the PhD project is to develop a methodology for design and development of playware products and for evidence studies of (playware) care technology, which is supposed to support the citizen in non-institutionalized contexts, e.g. in the private home.

The PhD project will investigate how playware can become a mediator that utilizes play force by bringing users into a play dynamics during which the user performs specific actions of interest for planned physical and/or cognitive rehabilitation. This will be achieved by seeking a deep understanding of play as a scientific concept, and of how people are motivated and moved into a play state. The generated knowledge from

the investigation is of importance for the development of future playware technology in general.

Further, the project will investigate how to construct playware technology that can transfer knowledge of rehabilitation and health care from institution to private home, i.e. from fixed, controlled settings to free, unsupervised settings. The PhD project will conduct evidence studies of playware products in both institutionalized and non-institutionalized setting with the aim to generate sufficient data to develop a deeper understanding of similarities and differences between these settings.

The project will use an interdisciplinary methodology. HCI, anthropology, and sociology will form the basis for the collection of data, where also humanistic disciplines and playware research will be central. User studies will be conducted both on basis of qualitative methods to build an understanding of the field of playware and care technology, and on quantitative methods to test the effects of playware products.

The preliminary results show that the use of playware technology in the area of balance training can generate significant improvements for the users (see http://bit.ly/W5ObtW for paper on this and below).

A corner stone in the project is doing quantitative testing of playware technology with a focus on the welfare area, to investigate if this will create the effects pilot studies have shown. From this we can further investigate the benefits of the technology on a society level, where initial studies show that using playware for balance training can save money and create a higher quality of life for the elderly.

TABLE RESULTS OF PRE-TEST AND POST-TEST OF THE NINE SESSIONS OF TRAINING WITH MODULAR INTERACTIVE TILES

Test	*Pre-test (σ)*	*Post-test (σ)*	*Average improvement (percent)*	*Significance level*	*Level improvements*
CS	9.9 (2.6)	11.3 (3.1)	14	$P<0.002$	7
TUG	11.0 s (6.1)	9.4 s (4.9)	15	$P<0.001$	6
6MWT	247.6 m (82.0)	303.0 m (106.3)	22.4	$P<0.001$	7

6MWT, 6-Minute Walk Test; CS, Chair-Stand Test; TUG, Timed Up & Go Test.

> "This project focuses on developing a tool for quantifying deficits in neck posture and motion parameters."

Development, testing and validation of technologies to be used for exercise therapy in people with cervical radiculopathy

Background

Neck pain is a very common disorder. Up to half of all adults will have experienced neck pain within the last 14 days. Among the most bothersome types of neck pain is cervical radiculopathy (CR). There are several different treatment approaches for CR including different types of training, use of a hard collar, manual therapy and surgery. There is no evidence to support the superiority of one method over another. One reason for this could be that we lack the tools necessary for choosing and monitoring a given intervention. This project focuses on developing a tool for quantifying deficits in neck posture and motion parameters.

Hypothesis

A measurement system (dorsaVi) that uses a gyrometer, an accelerometer and a magnetic compass processed in mathematical algorithms will have the capacity to quantify neck position and movements.

Neck position and movement parameters will be different in patients with CR compared with patients with mechanical neck pain and with healthy individuals.

Neck position and movement parameters can be used for monitoring progress of a non-operative intervention.

Methods

The first step is a systematic literature review that will answer:

1. Which motion parameters have been tested in previous studies?
2. Have previous studies found a difference in movement parameters between healthy individuals and patients with different types of neck pain?

In parallel, we will develop a test protocol to be built into algorithms of the sensor system. The system will be validated, comparing the sensor system with an infrared tracing system (Vicon).

The final test procedure will be used in a case-case-control study, comparing CR patients with mechanical neck pain with healthy individuals. To test response to treatment, a group of patients with CR participating in a randomised controlled trial will be tested at the start of intervention, at 3 and at 12 months follow-up.

Results

The test protocol has been written into the software of the sensor system and the system is ready to be validated.

Potential impact on society

This test system has the potential to identify posture and motion parameters that can: 1) help clinicians in choosing intervention type, 2) Monitor progress of the intervention, 3) Help correct exercise, and 4) identify harmful motion patterns.

”This new intervention may assist in improving the patient’s ability to understand and participate in their rehabilitation process.”

Technology assisted intervention at home for patients with radiating neck pain: a randomized controlled trial

Background

It is known that neck pain with radiating symptoms into the arm, also known as cervical radiculopathy (CR), is both unpleasant and debilitating. Treatment-approaches range from conservative treatment to surgeries. Little is however known about effects of these interventions. Systematic reviews conclude that there is no evidence of superiority of any of these treatments. It is suggested that individualized and supervised exercise programs might improve the outcome. Information and communication technology (ICT) has successfully been implemented for a range of medical conditions (Heart failure and COPD). It may also be a way to improve delivery and effect of interventions for cervical radiculopathy. In the acute phase, these patients are generally marked with severe pain, which may limit their opportunity to travel to a healthcare provider. Because of this ICT may be beneficial for patients with CR. ICT can be individualized to meet the current needs of the patients and provide on-going monitoring and guidance.

Hypothesis

Patients in a ICT assisted pain management and exercise programme (Patient@Home) will have as good or better outcome as with standard conservative care (Spine Centre) in terms of pain reduction and pain self-efficacy after 3 months intervention and this will be sustained for 12 month after intervention was initiated.

Method

A single site randomised two-arm trial. Study population of 150 patients with CR. Setting: The Spine Centre, Southern Region of Denmark.
Standard care: Usual care at the spine Centre according to their guidelines.
Intervention: Pain management strategies and exercises similar to standard care but with the use of information and communication technology (ICT) in form of SMS-tracking system, apps for smartphone or tablets, video platforms and other feedback systems.

Results

Primary outcomes: Change in pain intensity in arm and neck and pain self-efficacy at 3 and 12 months
Secondary outcomes: Change in disability at 3 and 12 months
Other outcomes: Changes in sick leave and trial related physical tests at 3 and 12 months

Possible impact on the society

This new intervention may assist in improving the patient's ability to understand and participate in their rehabilitation process. Therefore, also make it possible to develop treatment approaches based on patients' preferences and needs and in that way assist the clinician in delivering a more tailored treatment approach. The results from this project may therefore provide basis for developing more sophisticated technologies that can improved the treatment outcomes for not only patients with CR, but for other groups with musculoskeletal problems.

Robot rehabilitation of upper extremities with stroke patients

Background

Regaining physical competences after an injury, disease or operation is desirable for both patients and societies a whole. This is true both seen from economic, welfare and quality-of-life perspectives. Getting back on-track fast requires effective and efficient means of rehabilitation. Previous research has shown, that the amount of rehabilitative training i.e. the amount of repetitions done for each specific exercise has a direct influence on how well you will recover. Robots are per se good at doing repetitions and consequentially researchers have been looking at how to make suitable rehabilitative robotic devices. With the right set of sensors and behaviours robots also allow us to closely monitor the patients' training, and adapt their behaviour on the fly and e.g. match the load simulated by the robot to the strength of the patients at different positions of a given exercise.

With this project we focus on robot rehabilitation of stroke patients with an industrial robot (UR5) from the company, Universal Robots, noticing that this robot has been developed to work in close collaboration with humans as well as designed to be durable and flexible at a low cost.

Thesis

Our main thesis in this project is, that an industrial robot provides the needed amount of flexibility at the right cost to be used as rehabilitation partner of the upper extremities with stroke patients.

Some of the underpinning research questions involved in this thesis are:

- How do we make rehabilitation robots trustable / trustworthy?
- How do we make use and configuration easy and natural for both therapist and patient?
- How do we make people train more effectively using motivational feedback?

Methods

We take a user-centred perspective on developing the right robot behaviour and patient/therapist interface. This

means that we involve both therapists and patients in finding out what the robot needs to be able to do in order to help the patients in the best way possible. Here, we are both looking at usability and user experience with regards to issues such as efficiency, learnability, safety, trust, motivation etc. as well as concrete rehabilitation exercises where the robot may be superior to existing ways of doing exercises. On the therapist side, we also investigate how we can make them "programmers" of this advanced technology, so that they will be able to set up individualised exercises for the patients without having to involve technical staff. This we do though a study of contextual programming languages as well as involving the therapists in the development.

The studies involved are illustrated in the matrix below, which also presents our other rehabilitation technologies. We use these as a comparison to identify the potential benefits of using an industrial robot.

Results

We expect the project to provide us with a better understanding of both the technologies, usability and user experiences needed in order to be able to conduct rehabilitation with industrial robots. Also, the project will provide examples of functional rehabilitation exercises that are practically feasible to execute with an industrial robot. Besides this, the project is expected to provide us with insight in how we make the programming of the robot accessible to therapists. Finally, we expect this project to illuminate us on how the interaction between human and robot might be realised through e.g. physical movement.

Potential impact on society

We hope this project will provide us with enough insight to be able to start conducting empirical measurements on the effect of robot rehabilitation in e.g. municipal training centres. Such studies may lead to improved rehabilitation of patients through intensifying their training using robots as training partners. This again will lead to more people being self-sufficient after rehabilitation and for some this will also mean that they will be able to return to their jobs.

	UR5	RTL	ROBOTRAINER & OTHER TECHN.
TRUST / SECURITY			
INTERFACE			
MOTIVATION			
TECHNOLOGY			
DIAGNOSIS			

"Visual analysis of facial area (...) is a potential candidate to improve the monitoring and diagnosis process."

Computer-Vision Methods for Automatic In-Home Medical Diagnosis and Monitoring

Background

Demographic changes due to the aging of population demand the development of technologies for independent elderly living at private homes. Besides, researchers and medical practitioners have long sought the ability to continuously and automatically monitor patients beyond the confines of doctor's office. Thus, computer-vision based in-home diagnostic and monitoring systems get considerable attention in research and development of health technologies in order to setup a proactive and preventive healthcare model.

Thesis

Human facial image/video can convey information regarding to expression, mental condition, physiological parameters such as heart-rate and respiratory rate, and diseases symptoms. Thus, this PhD project aims to contribute to the development of facial image based diagnostic and monitoring systems for in-home patient or elderly by employing computer-vision methods.

Method

Development of facial image based diagnostic and monitoring systems

using computer vision methods imply a number of challenges to be addressed. Major challenges include setting up an appropriate sensor or network of sensors for facial data acquisition, pre-processing of facial image data, selecting the area of interest as a subset of captured data, extraction of appropriate features from the data, and employing effective machine learning methods to automatically detect clinically important factors from the captured data. In this project, we put emphasis on face extraction from video using a quality assessment, facial skin color analysis, face alignment and facial feature tracking in video frames, expression and emotion recognition, and finally, developing clinically relevant systems using relevant facial information.

At present, we are working with facial images in videos coming from the surveillance cameras. Before any other processing, in such systems, facial images first need to be detected. From a computer vision point of view, not all of these facial images are usable. Therefore, a face quality assessment technique is applied. The result is a set of facial images that are of better quality compared to the rest of the images in the sequence. These images are grouped into so called, facial logs. These facial logs are then used for different purposes, for example, for correcting positions of facial landmarks which are of great importance in many computer vision applications. For example, in the context of patient@ home project, they have been used for contactless measurement of heartbeats from patient. The developed method is working at the moment in constrained conditions.

Results

The contribution of the project is expected to be an automatic, low-cost, non-intrusive system for facial image based medical diagnosis and monitoring of patients.

Possible impact on the society

Visual analysis of facial area in a “patient at home” scenario is a potential candidate to improve the monitoring and diagnosis process. Thus, the proposed research is expected to provide a highly accurate solution to the problem of diagnosis and monitoring at private homes in the “patient at home” scenario.

”Treatment of edema may reduce the number of amputations and improve healing of wounds.”

Foot Edema Simulation and Monitoring Using Dielectric Electro-Active Polymer

Background

Edema of the lower extremities, nerve damage and circulatory dysfunction, are common symptoms in diabetes and other chronic diseases. These symptoms must be addressed early in the disease process before permanent nerve damages occur. Foot edema is often associated with diabetic foot ulcers (DFUs). The Danish Health and Medicines Authority published a report indicating a need for special attention to this complicated condition. World-wide, every minute two individuals with diabetes have a major amputation performed, and almost 85% of amputations among diabetics are preceded by a foot ulcer. A prospective study of 314 patients with DFUs found that peripheral edema is more common in patients who required amputation or died than in patients with primary wound healing. Treatment of edema may reduce the number of amputations and improve healing of wounds. To provide a better understanding of such symptoms and to avoid unnecessary nerve damages, we aim at developing and testing a wearable edema monitoring system.

Methods

Dielectric electro-active polymer (DEAP) stretch sensors are employed for continuous monitoring of edema. Considering the procedure of the clinical study on new sensor systems is normally complicated and time consuming, we developed a mechanical edema simulation system for preclinical testing of new sensors and new techniques. A distensible foot model based on an artificial foot is made to simulate edema. A peristaltic pump with the flow rate ranging from 80µl/min to 120 ml/min is used to drive the fluid and control the edema volume. A manometer is employed to monitor the in-foot pressure, which is another parameter to increase the accuracy.

Results

This study has addressed a new method for continuously monitoring edema based on the state of the art DEAP stretch sensors. Prototypes for both foot edema simulation and monitoring have been established and tested. The results of the experiments show a good validity of the DEAP stretch sensor-based measurement system. The measurement data changes instantly according to the change of foot volume. The DEAP sensor is a thin film with very low self-strength. It has very limited pressure on the foot model, which ensures the limited influence on the measurement in terms of validity. In terms of repeatability, the results show that the sensing values follow the same pattern during pump-in/pump-out phase, but shifts on both amplitude and phase are observed. The edema simulation system provides an efficient solution for preclinical testing of new sensors and new techniques. It also provides the possibility of repeatability testing of sensors, which is not feasible in a clinical setting. In addition, it is considered important to achieve knowledge on the pressure at the lower leg and foot in individuals treated with compression bandages and having different levels of activity, which is very important in the clinical situation. The presented method could be used to register the pressure at the lower leg and foot continuously in mobile individuals as well.

Potential impact on society

This study is focusing on the clinical usability and feasibility of the wearable edema measurement, which provides an efficient method for testing new sensors or techniques, especially in preclinical studies. The output has significant potential to avoid nerve damages and unnecessary amputations, but it requires further clinical studies.

”Hospital at home (...) might be a potential alternative to typical hospital care. ”

Acutely ill geriatric patients: Feasibility of a Hospital at Home supported by technology

Background

The proportion of elder people in the population is rapidly growing. The elder population has significantly higher risk of health problems. Increased use of hospital service is predicted in the future. Especially the number of medically ill elder patient is growing. The trend in health care moves towards fewer and bigger hospitals. The consequence is that many patients will have a longer distance to hospitals with fewer beds. Accessibility will be a challenge, with possible costs for patients and society.

Ensuring high-quality and efficient emergency care for the growing number of elder will require development of alternative management strategies in relation to traditional hospitalization for acute illness.
Hospital at home (HH), established shortly after admission and supported by technology, might be a potential alternative to typical hospital care.

Aim of the study

The aim with this study is to investigate the possibility, effect and patient perspective on home-hospitalisation. We will measure the effect on physical decline, incidence of infection and acute confusion state. Mortality and readmission at 3 month past discharge. Qualitative study's on patients and caregiver perspective is also planned, as well is an economical and organisational evaluation

Method

The study design used is "randomized controlled feasibility study." Participants are acutely ill patients admitted to FAM aged ≥ 65 years and allocated to the department of geriatric medicine OUH. No later than 24 hours after admission patients will be randomized to either hospital at home or normal admission to department of geriatric medicine. In home the patients are assessed by geriatric doctor and nurse daily. Staff from the municipality cares for them 24 hours a day. On demand patients will be attended by physiotherapist Telemedicine for safety, passive surveillance and communication will be used. If needed transition to the department of geriatric medicine is possible at any time.

Results

No results are available yet. Study start is expected January 2015.

Possible impact on the society

Hopefully, the study will contribute to the knowledge of home hospitalization of geriatric patients. The knowledge will be on the safety, the medical effect, the patients and caregiver perspectives, and the economic and organizationally aspects. The study has the potential to make an impact on future decisions on home hospitalization and the use of telemedicine.

"The future vision is that a handheld 3D photo-optical camera can be used in telemedical care of ulcer patients..."

Application of innovatiove technologies in skin ulcer treatment: 3D photooptical scanning for volume measurements

Background

Diabetic foot ulcers and venous leg ulcers constitute an increasing health problem in Denmark concurrent with an ageing population and an increase in diabetes prevalence. Diabetic foot ulcers belong to the most serious and costly complications. Several studies have found that the size and depth of the ulcer is one of the major etiologic factors for delayed healing.

Wound measurement is important in the monitoring of the wound healing process, and to evaluate treatment strategy. For the last decade different three-dimensional techniques for measuring ulcers have been proposed in order to measure ulcer volume. None of the technologies have been widely used due to low accuracy, high costs and complexity in the use for clinicians.

This project focuses on the development of technology to be used in diagnosing, monitoring and treatment of diabetic foot ulcers and venous leg ulcers. A 3D photo-optical camera has been developed which is able to measure ulcer area and volume.

Hypothesis

The intra- and inter-observer variability in ulcer area and volume measurements using the 3D camera are equal to other measurement methods. Volumetric measurements of diabetic foot ulcers and venous leg ulcers are useful in predicting ulcer healing.

Methods

In first substudy a validation of the 3D camera is performed. Ulcer area and volume are measured repeatedly on 48 patients with diabetic foot ulcer. The second substudy is a large prospective cohort study in which newly admitted patients with a diabetic foot ulcer or venous leg ulcer are included at the first visit at the University Centre for Wound Healing, Odense University Hospital. Ulcer area and volume are measured by the 3D camera with frequent intervals, and the patients are followed for one year or until complete ulcer healing, amputation or death. Patient anthropometrics and ulcer data are collected during the study and correlated to the ulcer healing.

Perspective

The project seeks to clarify whether 3D photos of ulcers will provide precise measures in order to illuminate the background for delayed ulcer healing, and thereby to create a platform for more evidence-based treatment algorithm. The future vision is that a handheld 3D photo-optical camera can be used in telemedical care of ulcer patients in the primary sector as well as the specialized units at centres for ulcer treatment. Furthermore this camera provides a platform to evaluate the effect of different treatment strategies more accurately. In future studies this would help to qualify ulcer treatment, which is an area without substantial evidence for specific treatments being more effective than others.

"... the overall goal is to improve patient diagnoses/ treatments, predict and unlock the patterns of disease risk factors, speed diagnostics, and reduce costs."

Big Data Management in the Danish Healthcare Sector

Background

Odense University Hospital (OUH) use various it systems and data sources in its daily operation including clinical logistics systems, electronic health records, etc. These systems create Petabytes of raw and valuable information about patients.

These data sources are not fully integrated and most of these huge amounts of data are only used to some extent by medical staff in the patient's diagnostics and healthcare process due the lack of proper tools and techniques.

Osteoporosis is a widespread disease. About 25% of women and 5% of all men in Denmark experience a hip fracture in their lifetime. Approximately 10,000 hip fractures occur per year, approximately 300,000 bed days per year are used due to hip fractures, and approximately 30% of patients with hip fractures become dependent on others. This results in hospital costs of approximately 1 billion DKK per year.

Problems to solve

The objective of this project is to: (1) develop new tools, algorithms, and techniques to solve problems related to big data management, e.g., collection, integration, analysis, and visualization of patient data at OUH's facilities; (2) identify good cases

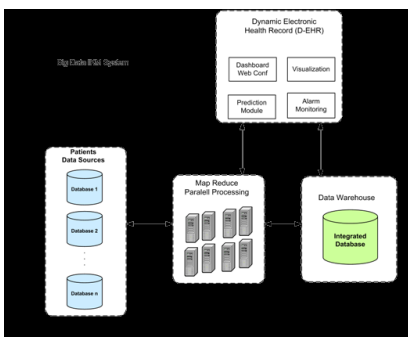
where new applications could make a difference such as osteoporosis diagnosis, treatment, and prevention. Thus, the overall goal is to improve patient diagnoses/treatments, predict and unlock the patterns of disease risk factors, speed diagnostics, and reduce costs.

Research Questions

Big data management in the healthcare sector is a broad theme that this project will explore. In this context there are a number of questions which this study pretends to answer considering the OUH's infrastructure as following:

1 What are the most valuable data sources to be used in this project?
2 How to integrate these data sources?
3 Which methods should be used to transform the unstructured data from these data sources to structured?
4 What are the best data mining algorithms to extract information from the processed databases?
5 What are the best algorithms and statistics models to visualize the data?
6 What is the best way to use a big data management tool for predictive intelligence and decision support?
7 What are the best components configurations (hardware, software, algorithms) for the proposed big data management system?
8 What are the osteoporosis cases where this system can be used?
9 What are the concrete effects of the system utilization in the osteoporosis diagnosis, treatment, and prevention?

Big data management system



"With an arm assistive device the arm's weight is supported and the patient does not need to produce much force to move it."

Passive orthosis for upper extremity assistance

Brachial plexus injuries (BPI) typically caused by traumas, birth complications, inflammation processes and even tumours, result in total or partial paralysis of upper limbs due to the lesion of some neural pathways such as the cervical C5-C8 and thoracic T1 nerve roots. Among adult traumatic BPI, motorcycle accidents represent the overwhelming majority cause mainly involving males below the age of 30. The degree of paralysis is typically individual.

Patients with BPI can be assisted in daily activities by means of either active (actuated mechanisms) or passive (gravity-balancing mechanisms) arm assistive devices. Designs of both types of devices can be found in literature and most of these solutions are already being commercialized. The concept behind passive arm assistive devices is to assist the patient with counteracting the external loads (e.g. the gravitational force) using only passive elements such as springs and hence does not require actuators or complex control algorithms. With an

arm assistive device the arm's weight is supported and the patient does not need to produce much force to move it. This means that the device allows the arm to "float" in the air.

Simulation, for example using the AnyBody Modeling System (AMS) (AnyBody Technology A/S, Aalborg, Denmark), can be used to create a patient-specific biomechanical model by disabling paralyzed muscles in the model. By combining this with a model of an orthosis, the interactions and mechanics between the two can be analyzed and optimized. Considering the aim to exploit the patient's residual muscle forces, an optimization method computes the best orthosis design parameters so that the required maximum force produced by the remaining muscles is reduced while performing the desired daily activities.

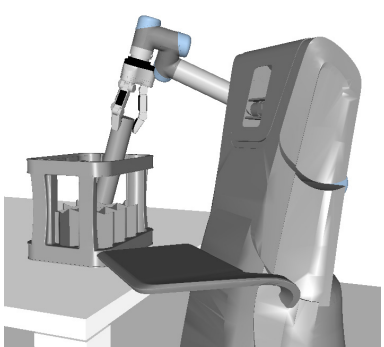
This project is part of a larger project, Patient@home, which targets development of technological solutions to improve independence of patients with physical impairments. The specific goal of this PhD project is to understand the underlying properties of passive orthoses to assist BPI patients and aims at light-weight, wearable and inconspicuous designs to restore function of the upper limb. 3D-printable technologies are nowadays gaining momentum in the global market, comprising companies which develop both orthopedic and prosthetic devices, in such a way that these kind of technologies can play a crucial role in manufacturing low-cost and custom-made orthoses accessible all patients in a near future.

Simulation of Manipulation Actions using the Care-o-bot

”The main focus of the project is reliable manipulation of objects using the robot arm with a manipulator attached to it.”

One of the challenges that faces Denmark and other western countries, is the expected future demographic development. There will be more and more elderly people and fewer young, which will put pressure on welfare systems like hospitals and elder-care. One way to solve these problems is the use of technology to assist people in their own homes. This makes it possible for elderly to stay in their own home for a longer time before going to a retirement home, and makes it possible to reduce the length of stays at the hospital. For both of these purposes the Care-o-bot can be used. The Care-o-bot is a mobile robot with a tray and a robot arm, which is developed specically with the care industry in mind. One use of the robot is the support of a person in the home, such that the person will be able to take care of itself. This will decrease expenses in the public welfare system, allow higher throughput at the hospitals, and hopefully increase the quality of life for the patients as well as making the patients feel more safe in their own home. Developing the tools required for the Care-o-bot to be able to reliably perform tasks in the home is the main purpose of this project. Figure 1a shows the robot and the robot arm. The main focus of the project is reliable manipulation of objects using the robot arm with a manipulator attached to it.

(a) The physical robot.



(b) Insertion of a bottle into a crate

Simulation has become an increasingly used tool for designing robotic systems. It allows fast development, testing and optimization of algorithms and manipulators. Figure 1b shows a virtual model of the Care-o-bot, where it is used to insert a bottle into a crate. This virtual model will be used to develop strategies for insertion and optimization of parameters, that will make these strategies robust to uncertainties. Dynamic simulation is vital in this case, as the interaction forces might cause the crate to slide across the surface, or the bottle to slide out of the hand. Sensor simulation and modelling of noise makes it possible to develop algorithms that are robust to uncertainties, and makes it possible to develop robotic solutions that can solve complex tasks reliably. Optimization will make it possible to find ideal strategies and parameters that makes sure the bottle and crate does not slide too much, and maximize the chance of success. Where robots have earlier been used for automation in large-scale production, there is now a general need for robots that can be used in changing production environments and in service robotics. To make such robots easy to reprogram and use, simulation is an important tool to incorporate intelligence that allows the robot to reason about the optimum strategies for solving specific tasks. The purpose of the project is to develop the low-level simulation tools required to make simulation of manipulation actions possible, and to use these tools to find optimum strategies for manipulation tasks for the Care-o-bot.

Simulation in robotics is often based on physics engines developed for computer games and animation. These engines are often developed with speed in mind, at the expense of the physical accurateness. For instance they often allow contacts to be slightly soft, they model friction with crude approximations, and has diculties when it comes to simulation of sti springs. These are all problems if tight tting assembly should be simulated accurately, as it will cause objects to penetrate slightly during simulation, and sti springs will often be used to model compliant manipulators. The complexity of the dynamics problem often increase drastically as the number of contacts increases. In the case of assembly simulation the number of objects and contacts will however be limited, which will make more complex algorithms feasible.

Finally the traditional gaming engines are not concerned with producing correct interaction forces, as long as the found interaction forces produce the correct motion. The interaction forces are central to development of robust manipulation strategies in robotics, hence the interaction forces should be stable and robust even when the forces are distributed across multiple contacts in redundant congurations.

A new physics engine that targets these issues has been implemented. Qualitative tests show that the new simulator respects the friction model set by the user, and allows using truly hard contacts, even when solving for redundant congurations. Springs can be used to model compliance during manipulation actions, and the simulator gives stable simulated force/torque sensor readings that is suitable for development and optimization of control strategies for assembly. The simulator is implemented as a very open framework, allowing the user to implement custom solvers, models and integrators. Hence it provides a very open framework that is very suitable for research. A framework for performing virtual assembly experiments has been developed, and is currently used for optimization of the strategy for insertion of the bottle in the crate. Furthermore it is used to optimize parameters for similar strategies used in industrial contexts.

Realistic dynamic simulation of manipulation actions is an important tool for development of more intelligent robots that are reliable and easy to program. In many robot applications within both industry and service robotics, it is desirable to use generic manipulators that can solve a wide variety of tasks. These robots must work in complex and changing environments, and it is vital for the robots to be able to use simulation to do optimizations and reasoning on how to perform the tasks it is supposed to do. The simulations will typically provide the robot with much more information than what is possible or feasible to record in the real world, making optimizations better and faster. The tools developed in the project will in general contribute to making more intelligent robots that are easier to program for the end user.

"The main focus for the system is to make telehealth solutions more user-centered"

Supporting Integrated Healthcare Solutions for the Patient in Home Setting

Background

"Welfare technology enables patients and citizens to be treated and monitored in their own home to a greater extent than was previously possible. The ongoing tends towards acute and/or outpatient treatment at the hospital followed by treatment at home has resulted in a decreasing need for hospital bed capacity" – Patient@Home: Innovative Welfare Technology for the 21st Century

In addition to the new technologies, methods, applications etc. needed to enable the vision stated above, an ICT infrastructure that can support the new initiatives is a central component in the Patient@Home platform. A few of the most important requirements to the infrastructure are:

- Make it simple to integrate new applications to the platform.
- Include tools to secure semantic interoperability between applications.
- Provide confidence of being robust and trustworthy.
- Be aligned with state-of-the-art EU

initiatives in telehealth and relevant standards.

In the telehealth domain healthcare services will be provided to the patients in their own homes, and hence the system should adapt its behavior to its user (the patient). Through paradigms and techniques such as context awareness, artificial intelligence, and user modeling the infrastructure will be researched and prototyped in accordance with the requirements stated.

Methods

At this point it hasn't been decided whether the infrastructure will be tested through simulation or in a living lab setting.

Results

A literature review has shown that multiple scholars have previously worked with user modeling in the telehealth domain prior to this project. So far we have designed an ontology with knowledge about: Activity Coverage, User profiling, and Health tracking. The distinguishing feature of the ontology compared to the existing ones is its focus on personal preferences and use of existing ontologies such as ICF and ICD.
The future work will be focused on the implementation of the multi-agent system using the ontology, and begin experimenting.

Potential impact on society

The outcome of this PhD project is a software infrastructure implemented as a multi-agent system using an ontology that supports semantic interoperability between the agents in the system.

The main focus for the system is to make telehealth solutions more user-centered, through the use of knowledge about personal preferences, physical capabilities, and activity recognition. The vision with this user-centeredness is making the Patient@Home platform adapt its behavior to the user and not vice versa.

Additionally, for the healthcare professionals, the intelligence in the platform will hopefully provide them with additional information (context information) about the healthcare data they are interpreting.

"A decrease in the deterioration rate of admitted patients will not only save money in the healthcare sector, but also increase the quality of life for patients at risk"

Identifying patients at risk and patients in need

Background

With the recent reorganization of Danish Emergency Departments into Joint Emergency Departments (JED), the Regions of Denmark has sought to streamline and improve the admission and treatment of acutely sick citizens. The JEDs accommodate short term admissions of up to 48 hours in a department which covers multiple medical and surgical specialties. This range presents both logistic and cognitive challenges to the JED clinicians, and research show that up to 20% of non-critical patients deteriorate within the first 24 hours of admissions. Deterioration can have serious consequences for patients as this not only increases the risk of transfer to the Intensive Care Unit or Medical Emergency Team calls, but also a higher mortality rate after discharge. Despite an increase in standardization of working procedures, and the availability of advanced patient monitoring equipment, several of these deteriorations are not caught in time.

The purpose of this Ph.D. project is to investigate the circumstances surrounding usage of present

patient monitoring equipment and working procedures for identifying deterioration of patients. And to utilize these observations to construct prototypes of improved clinical decision support systems. A fundamental part of this work is modelling of patient trajectories and examination of novel ways to present the state of patients.

Thesis

Our thesis is that a staged approach with an increasing degree of individualization of patient monitoring, can reduce false alarms and improve patient safety by earlier detection of adverse events.

Method

This project follows an action based research paradigm, through which we collaborate with the JED at Odense University Hospital in taking steps towards an improved situation. Qualitative data is collected via field studies, interviews, and workshop participations. Quantitative data from patient monitors are collected, stored and processed in order to perform outcome based analysis and prediction using machine learning and time series analysis techniques.

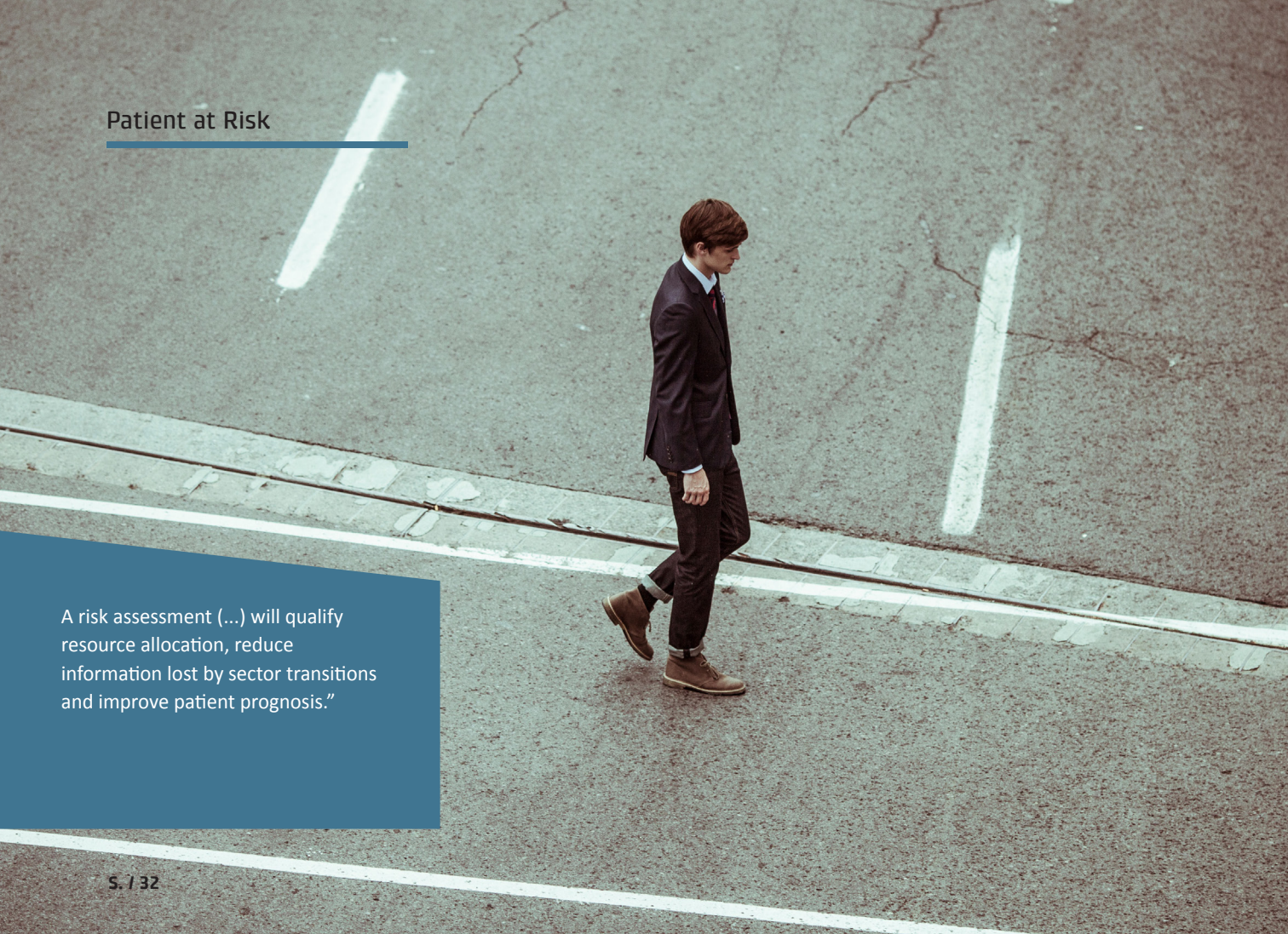
Results

Preliminary results highlight shortcomings of current patient monitoring platforms, and draw out the importance of embedding spatial and temporal aspects into patient monitoring; spatial aspects include dealing with distributed workflows, and temporal aspects addresses the fact that monitoring and alarm generation is unevenly distributed in time.

Possible impact on the society

A decrease in the deterioration rate of admitted patients will not only save money in the healthcare sector, but also increase the quality of life for patients at risk, and hopefully reduce the workload on clinicians.

Patient at Risk



A risk assessment (...) will qualify resource allocation, reduce information lost by sector transitions and improve patient prognosis.”

Background

A sick patient is assessed by health profesionals based on basis of knowledge and experience when a summoned ambulance arrives. Appropriate emergency treatment is initiated, and continuesly carried out during transportation to the Emergency Department (ED). When the patient arrives at the ED, relevant information about the patient and the clinical development during transportation are passed on to the receiving medical staff. The clinical condition of the patient is again evaluated and according to severity the patient is categorized and triaged and will then receive medical attention and treatment in the rate deemed necessary. The physicians in the ED use a broad set of tools to gather further information and data about the patient, the clinical condition and to support diagnosis and decision-making. Prehospital vital values; systolic blood pressure, heart rate, respiratory rate, Glascow coma scale score and peripheral oxygen saturation can identify patients at risk of critical deterioation during hospitalization. The specificity of this approach is low which results in a significant number of patients falsely categorized as high risk patients and 20% of patients who have normal values at arrival to the ED will experience deterioation within the next 24 hours.

3 - 6 % of all in-hospital deaths are unexpected and studies show that early awareness of the development in the clinical condition might prevent adverse outcomes as transfer to intensive units or death. For several years attempts has been made to develop the perfect tool for health professionals, to identify patients at risk of deterioration inhospital. A systematic review from 2007 of these "track and tricker" warning systems, showed lack of evidence, reliability, validity and risk of false security.

Aim

1) Identification and quantification of riskfactors associated with 7 day mortality or serious adverse deterioation among adult (>18) patients who enters the Emergency Department – FAM at Odense University Hospital (OUH).

2) Evaluation of patientcases with unexpected serious adverse events during hospitalization in FAM and investigation of the importance of recognizing patterns in how we monitor the vital parameters of these patients.

Methods

3 populationbased observational

cohortstudies based on the patient's path from ambulance pick-up to the first 24 hours of hospitalization. Period of inclusion 1/ 4 2012 til 30/9 2014. Data from electronic patient journals and logistic systems in the ED linked with populationbased registers.

Results

In total, 18572 first time ambulance contacts were identified in the period of inclusion. Overall seven-day mortality was 4,3% (95%CI 4,0-4,6). Univariate analysis showed increasing age, charlson comorbidity index>=2, vital parameters outside normal reference range and summoned mobile emergency care units to be associated with seven-day mortality.

In the study of patterns of monitor-use, 884 triaged patients and a total of 628.839 vital sign measurements were registered. Overall the number of generated monitor alarms were higher when triage-specific thresholds were used for each patient than when the generic alarm thresholds were used (10509/7613), an increase of 35%. The frequency of alarm events generated in the most severe triage category T1/red were higher when triage-based alarm thresholds were used. 70 alarms opposed to 22. 1433 opposed to 450 in the T2/orange category and 4032 to 4261 in the T3/yellow category. In the two less urgent triage categories; T4/green and T5/blue, the number of generated alarms were distributed opposite with most generated alarm events with individualized thresholds; 5661/1844 and 144/12, respectively.

Potential impact on society

A risk assessment taking the clinical development into account, from ambulance pickup to arrival at the ED and in the hours after arrival, will qualify resource allocation, reduce information lost by sector transitions and improve patient prognosis due to the increased attention on patients at risk of adverse outcomes. The vital values and dynamic development of these from first encounter with the patient at ambulance pick-up, during transport to the ED and while hospitalized can support decisionmaking, optimize treatment, level of observation and follow-up in the hospital.

Socially Assistive Robots

> ”By automating these tasks, the therapists, nurses, and doctors in the healthcare sector may focus on treatment that requires a human touch.”

Background

As we age most of us will experience a decline in both our physical and cognitive capacities. This may lead to a dwindling will to participate in social and physical activities resulting in lower quality of life. Patients with brain damages may experience similar problems. Ergo therapists help patients train what is known as activities of daily life, so that the patient can regain or sustain his independence.

Robots may alleviate some of the work of ergo therapists, for example helping the patient perform repetitive tasks. Thus freeing up time for the ergo therapist to help in more complex training. The robot may function as an instructor, keeping track of the training schedule, but it may also function as a workout buddy, encouraging and motivating the patient.

Method

A prototype robot will be constructed and subjected to clinical trials. Several different modes of operation will be examined to assess their efficacy.

Possible impact on the society

Robots can automate tasks that previously required humans. By automating these tasks, the therapists, nurses, and doctors in the healthcare sector may focus on treatment that requires a human touch. This will lead to more human contact for the patient, and a more comprehensive treatment.

Karl Damkjær Hansen

Caring robots: The role of advanced technology within professional healthcare

Background and thesis

Driven by falling fertility rates, a sustained increase in longevity and increasing rates of people living with chronic diseases and disabilities, many countries are now embracing the idea of using robotic technology to overcome the challenges of the ageing society and the decreasing number of the workforce population. Such technology is expected to assist caring practices and help people to manage their own care better

> "... the essential question of this project is how social issues and assumptions about care, elderly and disabled people are addressed in the design and development of technology"

especially in the elderly - and disability care sector where an increasing number of people will need support in daily tasks and care in the future.

The main purpose of this project is to explore how new forms of assistive robotic technologies make the transition out of the laboratory and enter the lives of elderly and disabled people.

This project is based on anthropological fieldwork in Japan that leads the world in the development of technology marketed specifically to solve healthcare issues on a global scale and in Denmark that increasingly implements so-called 'technology based care' in the healthcare system.

By shedding light on both developers and users of technology, the essential question of this project is how social issues and assumptions about care, elderly and disabled people are addressed in the design and development of technology, and how technology influences on notions and practices of care among caregivers, elderly and disabled people in Danish accommodation facilities.

Methods

Qualitative interviews, group interviews and participant observation among developers of the telenoid robot in Japan and among caregivers, elderly and disabled people who are using the robot in a nursing home and in an activity center in Denmark.

Potential impact on society

This project may contribute with insights into further developments of assistive technologies for the healthcare system and into the social dimensions of the implementation of technology in the daily life of elderly people and people with disabilities.

Få seneste nyt om resultater, arbejde og arrangementer i Patient@home på **www.patientathome.dk**