Self-supervised Preparation for Supervised Pose Prediction

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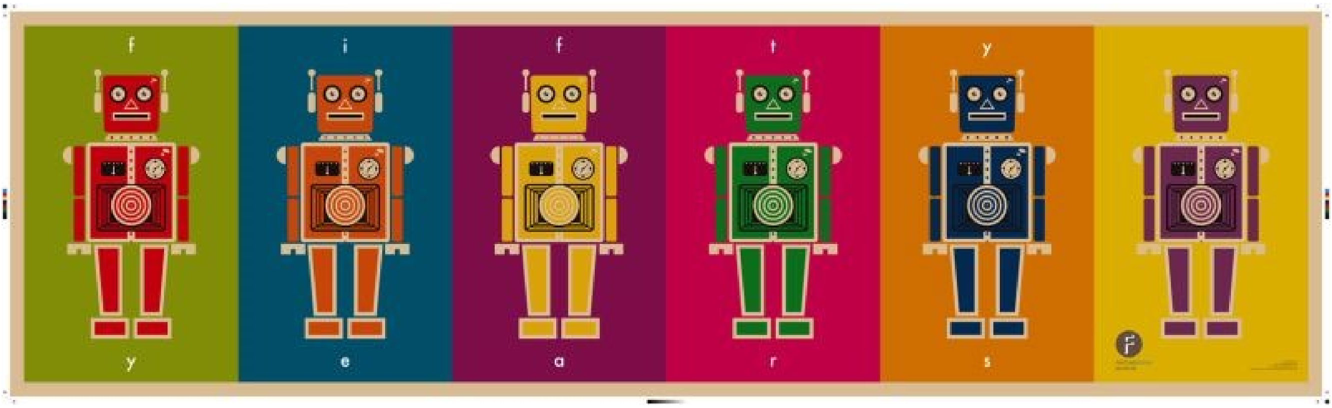

7th Aalborg U Robotics Workshop

December 3rd, 2018

NOVI, Niels Jernes Vej 10, 9220 Aalborg, Auditorium

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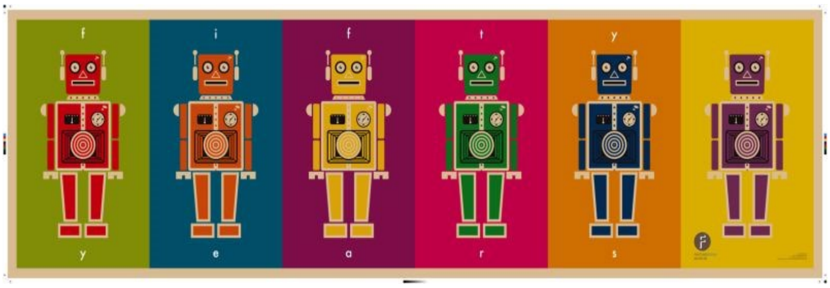


Seventh Aalborg U Robotics workshop

December 3rd, 2018

NOVI, Niels Jernes Vej 10,
9220 Aalborg, Auditorium

Program at a glance

08.00 – 08.30	Registration and Coffee
08.30 - 08.35	Welcome – Ole Madsen
08.35 - 09.20	Keynote #1 • Robots as part of the Industry 4.0 ecosystem *by Prof. Ulrich Berger, Brandenburg University of Technology Cottbus, Germany*
09.20 - 10.00	Technical Session #1 • Introducing the new HRI lab at TECH *Matthias Rehm* • Capturing the Complexity of Human-Robot Interaction *Elizabeth Jochum* • Developing robots 'in the wild' *Antonia Krummheuer, Matthias Rehm, Kasper Rodil*
10.00 - 10.20	Coffee break
10.20 - 12.00	Technical Session #2 • The walk-to-run transition puzzle: An example of a specific locomotion topic of relevance within both human motor control and robotics *Ernst Albin Hansen* • A novel system for semi-autonomous prosthesis control *Strahinja Dosen* • Semi-autonomous Control of an Assistive Robotic Manipulator using Computer Vision *Stefan H. Bengtson, Thomas Bak, Thomas B. Moeslund* • Tongue-based control interface for a robotic exoskeleton as an assistive device for individuals with tetraplegia *Mostafa Mohammadi, Hendrik Knoche, Lotte N.S. Andreasen Struijk* • How do robots read expressions? Effective data collection techniques for robotics to identify the facial expressions of traumatic brain injured patients *Chaudhary Muhammad Aqdus Ilyas, Viktor Schmuck, Matthias Rehm, Kamal Nasrollahi, Thomas B. Moeslund* • Conceptual Design of Upper-body Exoskeleton for Tetraplegia Patients *Muhammad Ahsan Gull*

	• Design of an integrated joint unit with high torque density for exoskeleton actuation *Dinh-Son Vu, Shaoping Bai* • A novel approach of human-machine interaction by forcemyography *Muhammad Raza Ul Islam, Shaoping Bai*
12.00 – 13.00	Lunch break
13.00 – 13.30	Keynote #2 • Flexible industrial robotics *by Prof. Nestor Arana Arexolaleiba, Mondragon Unibertsitatea, Spain*
13.30 – 14.45	Technical session #3 • Self-supervised Preparation for Supervised Pose Prediction *Mark P. Philipsen, Thomas B. Moeslund* • Universal Industrial Interface – Mobile *Andreea Ciontos, Ioan-Matei Sarivan, Casper Schou* • Little Helper 7: Dual-Arm Cobot *Jens Filtenborg Buhl, Rune Grønhøj, Jan Kjær Jørgensen, Guilerme Mateus Martins, Daniela Rodriguez Pinto, Jacob Krunderup Sørensen, Simon Bøgh, Dimitris Chrysostomou* • Kugle – Robot Digital Signage *Karl Damkjær Hansen, Rasmus Pedersen, Søren Tranberg Hansen, Malte Rørmose Damgaard, Thomas Kølbæk Jespersen, Nicolaj Vinkel Christensen, Thomas Bak* • An obstacle specific danger anticipation-based approach to avoiding static and dynamic obstacles while navigating in an indoor environment *Viktor Schmuck, David Meredith* • RObot-Supported Inclusive Education (ROSIE) *Eva Brooks, Lykke Brogaard Bertel*
14.45 – 15.05	Coffee break
15.05 – 15.35	Keynote #3 • Development of Robot Programming System through the use of Augmented Reality for Assembly Tasks *by Dr. Wenchao Zou, Brandenburg University of Technology Cottbus, Germany*
15.35 – 16.10	Technical session #4 • Creative Robotics in Architecture – Robotic Brick Stacking *Mads Brath Jensen, Isak Worre Foged, Anke Pasold, Michael Hansson* • Multimodal control of assistive robotic arms for severely disabled individuals *Ásgerður Arna Pálsdóttir* • Automated Sewer Inspection Robot *Joakim Bruslund Haurum, Chris Holmberg Bahnsen, Thomas B. Moeslund*
16.10 – 16.15	Farewell

Robot Ecosystems in Times of Industry 4.0

Keynote speaker:

Prof. Dr.-Ing. Ulrich Berger, Brandenburg University of Technology Cottbus-Senftenberg

Abstract:

The presentation provides a survey of the state of the art in industrial robotics technologies and introduces the term Robot Ecosystems. Robot Ecosystems serve in a new way to create novel robotic production units as e.g. stations, cells, islands or clusters. The prominent building blocks of these systems consist of selected theories, technologies and experiments in order to collate the right first time approach. Industry 4.0 affects all of these building blocks and the interdependencies are highlighted.

The presentation reveals distinct case studies dealing with high variant manufacturing, ad-hoc factory set ups and the use of artificial intelligence (AI) systems in robotics. The findings of the latter application are, that even though the vision capabilities convolutional neural networks can give machines are already respectable, they still need well prepared training data that is costly and time-consuming to produce. The effort to test and improve a system in order to automatically synthesize training images are described. This existing system renders computer aided design models into scenes and out of that produces realistic images and corresponding labels. Two new models, Single Shot Detector and RetinaNet are re-trained under the use of distractors and then tested against each other. The better performing RetinaNet is then tested and validated for performance under training with a variety of datasets from different domains in order to observe the models strength and weakness under domain shifts. These domains are real photographs, rendered models and images of objects cut and pasted into different backgrounds. The results show that the model trained with a mixture of all domains performs best.

Eventually, the case studies approve, that Robotic Ecosystems can support configuration, planning and programming tasks in order to realize cost effective and flexible production systems with high quality.

Introducing the new HRI lab at TECH

Author:
Matthias Rehm

Abstract:
In the future, robots are envisioned to work side by side with humans in dynamic environments both in production contexts but also more and more in societal context like health care, education, or commerce. This will require robots to become socially accepted, to become able to analyze human intentions in meaningful ways, and to become proactive. We have defined three major research themes that the work in the lab will be centered around:

- Design for social acceptance: While robot development is usually driven by technical constraints, to ensure social acceptance a new approach is necessary to take the user perspective into account during the design and development phase.
- Long-term interaction: In societal context, robots will build up relations to users and need to be equipped with methods for open ended, long term, emerging interactions (e.g. applying methods of interactive storytelling and emergent narratives; modeling personality and affective interactions; developing methods for intention recognition and learning).
- Human robot collaboration: When robots and humans work side by side, a particular challenge is the complex multimodal interplay of asymmetric communication capabilities. This creates a need for multilevel coordination for successful interactions on several levels like communicative, physical, social, and task level.

Capturing the Complexity of Human-Robot Interaction

Author:

Elizabeth Jochum

Abstract:

The continuous effort to embed robots in human environments requires nuanced understanding of the complex nature of social interaction and contexts for use. This is true even for robots designed for use in more functional or service-oriented tasks. This presentation presents several in-the-wild studies and experiments carried out in public settings, conducted by researchers from AAU and the University of Canberra (UC), using a variety of robot platforms (Baxter, UR10, and upper body exo-skeletons). We present three case studies, and mixed-methods approaches for studying the intricate aspects of human-robot interaction. Qualitative methods (such as video analysis and multimodal interaction analysis) help capture nuances of interaction and clarify important aspects of HRI that are not always represented by quantitative methods and self-reporting. Working in the wild requires a shift in how we approach HRI research and benchmarks, and creates new opportunities for studying how real people interact with real robots on meaningful tasks.

Developing robots 'in the wild'

Authors:

Antonia Krummheuer, Matthias Rehm, Kasper Rodil

Abstract:

Social robotics in health care settings are criticized for the technology-driven approach, the bias to build robots based on stereotypes of the target group, and for evaluating the interaction with the robot in laboratory situations. The fundamental aim to build social robotics seems to have turned a blind eye on the social structures of the targeted field of application and its target groups. The current talk suggests an alternative approach that focuses on building (social) robots based on local practices of the targeted application field using ethnography and participatory workshops for co-creating and implementing robots 'in the wild'. We will illustrate and discuss this approach using examples from the interdisciplinary and exploratory project "Build Your Own Robot". In this project, we develop and implement individual reminder and guiding robots for and with people with acquired brain injury.

The walk-to-run transition puzzle: An example of a specific locomotion topic of relevance within both human motor control and robotics

Author:

Ernst Albin Hansen

Abstract:

Man-machine interaction may increase with respect to extent and importance in the future. For this to succeed, it appears essential to unite research efforts within human physiology (including motor control and biomechanics) and robotics. Locomotion is an activity that could be cooperated on. The walk-to-run transition could constitute an example of a more specific topic. Reasons for this include that the mechanism(s) underlying the walk-to-run transition remains under clarification and that development of e.g. exoskeletons and neuroprostheses to an extent must take into account natural human motor control. Recently, we studied human walk-to-run transition focusing on stride frequency rather than velocity at the transition, which is more common. We found agreement between two different methods (a calculation-based and a novel prediction-based) for determination of the transition stride frequency. There was practically no mean difference (i.e. −0.3 strides min−1) between the two transition stride frequencies and a significant correlation (R2=0.316) between them. Theories on central pattern generator-mediated behavioral attractors in the form of stride frequencies during unrestricted walking and running were considered for interpretation of our findings. A combination of the theories and our findings supports that stride frequency could play a particularly noticeable role for the walk-to-run transition in humans.

A novel system for semi-autonomous prosthesis control

Author:
Strahinja Dosen

Abstract:
Myoelectric prostheses can be used to restore motor functions lost due to an amputation. These devices are controlled by recording the electrical activity of user muscles to estimate motor intention and command the prosthesis accordingly. However, modern prosthesis are advanced robotic system with many controllable degrees of freedom, and therefore the manual control can be difficult and cognitively taxing. One approach to address this problem is to make the prosthesis "smarter" so that it can accomplish certain functions autonomously. In this lecture, a novel system for semi-autonomous prosthesis control will be presented. The prosthesis is equipped with an advanced interface for perception, estimation of user intention, and autonomous control. Computer vision is combined with sensor fusion to continuously build a comprehensive model of the scene, including potential target objects as well as the pose of the prosthesis. Using this information, the prosthesis controller estimates the likely point of interaction with the environment, and preshapes the prosthesis DoFs in order to successfully grasp the target object. Importantly, the user can take over the control at any time by utilizing a multichannel myoelectric interface based on pattern recognition. The developed automatic control system improves functional performance and decreases the user effort.

Semi-autonomous Control of an Assistive Robotic Manipulator using Computer Vision

Authors:
Stefan H. Bengtson, Thomas Bak, Thomas B. Moeslund

Abstract:
Assistive robotic manipulators (ARMs), such as exoskeletons and robotic arms, are becoming increasingly more available with several options already being commercially available. These manipulators have a huge potential for empowering persons with limited or no motor control by enabling them to complete common everyday tasks with little or no help. The limited motor control of these users could however impact their ability to efficiently control an ARM.

The main idea in this work is to equip an ARM with intelligence such that it can be controlled in a semi-autonomous manner and hence making it easier to use. The intelligence will consist of the ability to perceive and interpret the environment around the user using computer vision. The system will rely on affordance detection in order to predict the intention of the user. This prediction is then applied in a blending-like scheme to realize a semi-autonomous control.

It is expected that the semi-autonomous control will make it easier to use the ARM for object manipulation tasks as opposed to a system without semiautonomous control. The ease of use is evaluated as a reduction in both the time and the number of interactions required to complete a task.

Tongue-based control interface for a robotic exoskeleton as an assistive device for individuals with tetraplegia

Authors:

Mostafa Mohammadi, Hendrik Knoche, Lotte N.S. Andreasen Struijk

Abstract:

Tetraplegia is a devastating condition of paralysis neck down affecting many people around the world. An upper limb exoskeleton (Exo) can help the people with tetraplegia to perform some of the activities of daily life and make them more self-reliant. These people have few remained sensory and motor functions and there are few options to provide them with a controller for interfacing an exo-skeleton with several degrees of freedom. An inductive tongue computer interface that was recently developed as an interface for electronic devices for disabled people will be used for controlling the Exo arm.

The main objective of this PhD is to develop a tongue-based control interface for a full hand/arm exoskeleton. A holistic approach to the design of the control system will lead to development of an efficient interface, an intelligent control, and a user-accepted device. A user board will involve in the design procedure and a dynamic feedback from them will ensure the user acceptance. The control system should provide all the required control inputs for controlling the Exo and enable the user to fully drive it. Finally, the user should be able to perform some of the main activities of daily living by the system.

How do robots read expressions? Effective data collection techniques for robotics to identify the facial expressions of traumatic brain injured patients

Authors:

Chaudhary Muhammad Aqdus Ilyas, Viktor Schmuck, Matthias Rehm, Kamal Nasrollahi, Thomas B. Moeslund

Abstract:

We presented the investigation of data collection procedures associated with robots when placed to operate with Traumatic Brain Injured (TBI) patients for rehabilitation purposes through facial expression and mood analysis. Rehabilitation after a traumatic brain injury is very crucial due to the nature of such injury and the variation in recovery time. It is advantageous to analyze emotional signals in a contactless manner due to the non-supportive behavior of patients, limited muscle movements and a resulting increase in negative emotional expressions when working with contact-based analysis. This work aims at the development of a framework where robots can recognize TBI patients' emotions through facial expressions to perform rehabilitation tasks by performing physical, cognitive and interactive activities. The result of this study shows that with customized data collection strategies, the proposed framework can identify facial expressions connected to emotions more accurately, which can be utilized for enhancing recovery, treatment and social interaction in a robotic context.

Conceptual Design of Upper-body Exoskeleton for Tetraplegia Patients

Author:

Muhammad Ahsan Gull

Abstract:

Patients suffering from chronic neuro-muscular disease and disabilities face difficulties in locomotion and manipulation. Severe neuro-muscular dysfunctions caused by tetraplegia and other spinal cord injuries significantly decreases the patient's autonomy, which imposes additional financial costs for the society. The use of wearable exoskeletons to support the activities of daily living offers a new paradigm for tetraplegics.

The kinematics of an exoskeleton are expected to comply with the upper limb of human anatomy. However, the natural mobility and the achievable range of motion, especially about the shoulder and wrist joint, remains the principal challenge in developing upper limb exoskeleton. Several studies have modeled the shoulder joint as three degrees of freedom ball socket joint. Thus, it is quite difficult to model a compact mechanism that can support three degrees of freedom shoulder movements. Similarly, several exoskeletons have been developed to support wrist movements based on the assumption that the wrist movements are generated about a fixed center of rotation.

This presentation highlights the main challenges involved in the mechanical design of upper-body exoskeletons. A concept of exoskeleton to accommodate variable center of rotation for shoulder and wrist joints will be presented and discussed.

Design of an integrated joint unit with high torque density for exoskeleton actuation

Authors:
Dinh-Son Vu, Shaoping Bai

Abstract:
Exoskeletons are devices aligned with an operator's limbs to support the execution of physical tasks. These devices can be classified according to different purposes, such as for rehabilitation, where a patient learns to execute a movement through repetitions, or for assistance/human augmentation, where the workload of an operator or the fatigue relative to activities of daily living of disabled people is alleviated.

Whereas passive upper-limb exoskeletons grow in popularity in the industrial domain, particularly to support overhead tasks, active solutions remain less attractive because of additional elements, such as the battery, the controller board, and the actuator itself to be carried during the task execution. In addition, tasks that involve significant torques, such as assisting the sit-to-stand motion for wheelchair users, increase the torque requirement of the actuator, which impact on its weight and dimensions. These additional masses may thus increase the fatigue of the user instead of providing the desired assistance.

This presentation focuses on the design of a compact actuator solution to address partially the aforementioned issue. An overview of the actuation technology for exoskeleton contextualize the development of the presented actuator. Preliminary test results highlight its torque density and its application for assisting simple tasks, i.e. the biceps curl and triceps extension.

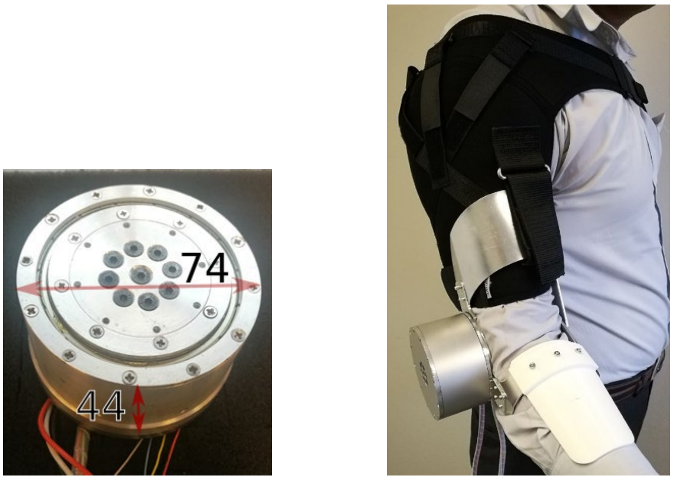


Figure: Version 2.1 of the integrated joint unit and elbow exoskeleton prototype

Version	V1.0	V2.1	Reduction (%)
H: protrusion D: Diameter	H: 62.5 D: 115	H: 44 D: 74	H: -29.6% D: -45.6%
Weight (Kg)	1 Kg	0.6 Kg	-40%

A novel approach of human-machine interaction by force-myography

Authors:
Muhammad Raza Ul Islam, Shaoping Bai

Abstract:
Human-machine interface (HMI) is comprised of sensors and algorithms that allows the interaction between human and machines, where the interaction can be sensed through either physical or cognitive interface. In context of cognitive interaction, besides EEG and EMG, forcemyography (FMG) has gained the interest due to its reliable performance.

In FMG, muscle activity is measured in terms of force applied by the muscle. During muscle contraction/relaxation muscle stiffness varies, which results in varying normal force. This normal force can be read through force sensing resistors (FSR). By virtue of machine learning upper and lower limb muscle activities i.e. gestures, motion type, joint angles and human effort, can be classified.

In this presentation some experiments using FMG as a reliable interface to control robotic devices are presented. These include control of assistance level in upper body exoskeleton, upper arm onset-motion detection to control elbow exoskeleton and teleoperation control of elbow exoskeleton. In addition, forearm gesture classification to control Lego NXT mobile robot is also presented. The method has shown promising results, which implies that FMG can provide a reliable HMI.

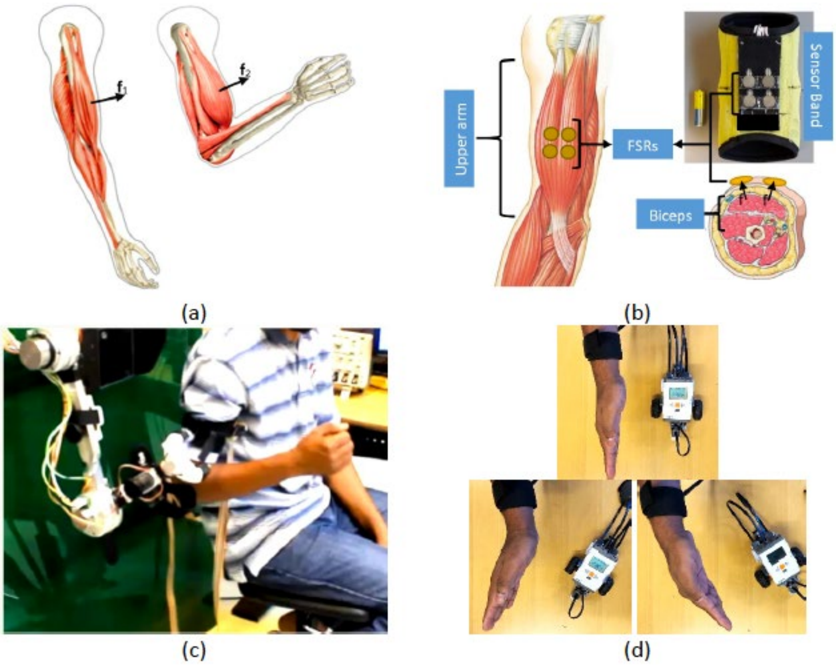


Figure: (a) The normal force caused by muscle contraction, (b) The sensor band placed on upper arm, used for estimating muscle effort, (c) teleoperation control of exoskeleton by placing the sensor band on upper arm and estimating the elbow joint angle and (d) Controlling Lego NXT direction using hand gestures

Flexible industrial robotics

Keynote Speaker:
Prof. Nestor Arana Arexolaleiba, Mondragon Unibertsitatea, Spain

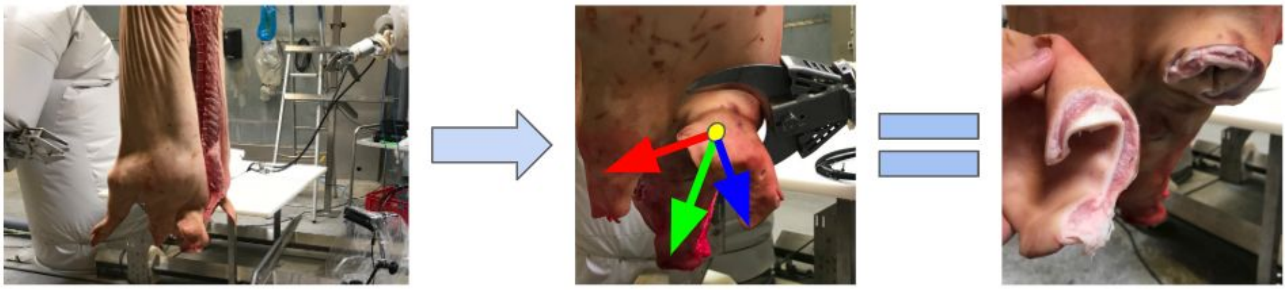
Abstract:
Market demands are changing every day, while the product quality standards are high and the production cost must be competitive. In the case of the automotive industry, for example, each car that goes through the production line has been already sold and belong to a customer that has requested a personalized product. Automatic quality control systems are usually in charge of controlling the quality of each produced part. Nowadays, the challenge is to construct an inspection system that is able to identify defects in such a changing context. The robots in addition to the accurate machine vision sensors can help to increase the demanded flexibility.

Self-supervised Preparation for Supervised Pose Prediction

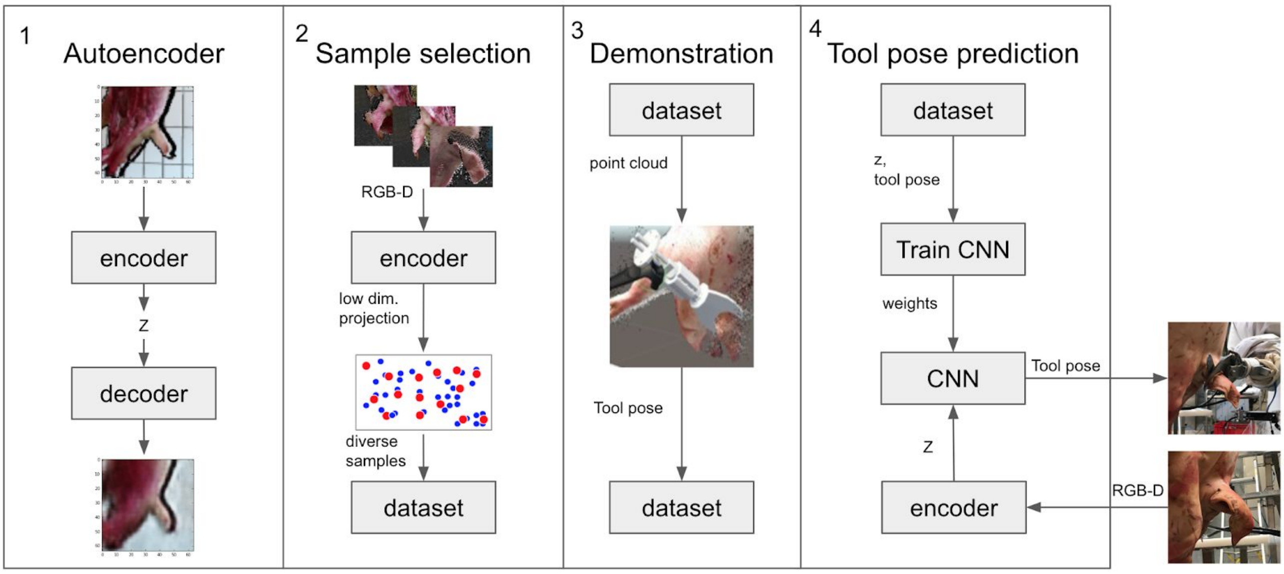
Authors:
Mark P. Philipsen, Thomas B. Moeslund

Abstract:

Many processes in modern slaughterhouses have yet to be automated. One of these is removing ears from pig's heads. Butchers put a lot of strain on their musculoskeletal system by repeating the required set of motions thousands of times a day. The ear is one of the most valuable parts of the pig and must be accurately cut off to retain as much value as possible.



Here we present ongoing work on a vision based robot controller that is able to accurately cut off pig's ears with the natural variation, in orientation, shape, size and appearance, that entails. We employ an autoencoder in order to get a low dimensional representation of the vision data. This lets us select a diverse set of samples for annotation and limits the need for using a large neural network for predicting tool pose. Demonstration of correct tool pose is intuitively done in virtual reality. This work is part of a greater effort towards automating and collecting four such tasks in a robot cell.



Universal Industrial Interface – Mobile

Authors:

Andreea Ciontos, Ioan-Matei Sarivan, Casper Schou

Abstract:

A smartphone connected to Internet of Things (IoT) becomes an interface for controlling and monitoring various devices as well. Even though IoT has its place in industrial environments through the emerging Industry 4.0, the smartphone ceases to be used as the main interface, and instead bulky, old fashioned equipment that needs training for operators is in use.

This paper presents a framework allowing ordinary smartphones to be used for controlling and programming industrial and collaborative robotic manipulators. In the spirit of Industry 4.0, the framework is cross-vendor compatible in terms of manipulators and grippers. The framework is mainly intended to be used in highly flexible industrial setups. The framework consists of Uii Desktop , an application running on a Raspberry PI connected to the physical robot cell; and Uii Mobile , an app for Android smartphones that provides an add-on interface for controlling and monitoring the robot-cell. A usability assessment was conducted by having subjects with background varying from no technical experience to robotics experts program a task using Uii. The user experience was measured on the System Usability Scale (SUS). On the SUS, the Uii framework scored 75.38/100 points which is considered an above average system.

Little Helper 7: Dual-Arm Cobot

Authors:

Jens Filtenborg Buhl, Rune Grønhøj, Jan Kjær Jørgensen, Guilerme Mateus Martins, Daniela Rodriguez Pinto, Jacob Krunderup Sørensen, Simon Bøgh, Dimitris Chrysostomou

Abstract:

The Little Helper platform has been under development by AAU for the past decade, running a total of six main iterations. In the prior development it was concluded that some tasks required the implementation of a dual-arm robotic collaborative platform. Therefore, we aim to integrate a dual-arm platform, with computer vision in order to sense and perceive the environment, and apply it into an Industry 4.0 context. This project in specific explores the design and implementation of different functions in a dual-arm collaborative robot. For this, a proof of concept use case is currently being performed, where the dual-arm collaborative robot should manipulate a bottle in the environment. More specifically opening it, by removing the bottle cap, followed by serving it to an end user. This use case is performed in order to show the future potential of the new Little Helper 7 platform, and to give an idea of what industrial tasks might be possible.

Kugle – Robot Digital Signage

Authors:

Karl Damkjær Hansen, Rasmus Pedersen, Søren Tranberg Hansen, Malte Rørmose Damgaard, Thomas Kølbæk Jespersen, Nicolaj Vinkel Christensen, Thomas Bak

Abstract:

The aim of the “Robot Digital Signage” project is threefold. To build a social robot platform, to develop a programming interface for app developers to program robots, and to develop a cloud solution for mapping and navigation for robot fleets. Here we describe only the robot platform. The robot platform that is being developed is specifically designed to serve people in public spaces with information and wayfinding. The specific case being studied, is the implementation of such robots in airports. This case imposes some constraints on the design of the robot. A suiting match for the constraints is a ballbot; a robot balancing on a ball. The ballbot has several advantages. The base is narrow relative to its height, enabling it to navigate tight situations like crowded areas. It can move in both forwards, backwards, sideways and turn on the spot, which is useful in human-robot-interactions. Its motions are more fluent than most social robots because of it balancing on a ball. It is able to traverse relatively large obstacles because of its large ball diameter of 25 cm. However, it has one main disadvantage; that it always needs to keep its balance.

An obstacle specific danger anticipation-based approach to avoiding static and dynamic obstacles while navigating in an indoor environment

Authors:

Viktor Schmuck, David Meredith

Abstract:

Autonomous navigation in complex, cluttered buildings is still a challenging task if robots should not only be able to navigate to their destination, but also avoid obstacles in order to ensure safety while doing so. Such robots could be deployed in hospitals, airports or shopping centres to serve as guidance robots and platforms capable of human--robot interaction. Based on previous work, there have been several approaches regarding the required sensors, data collection, and model creation aimed for enabling safe avoidance of unmapped obstacles in an environment. We further investigated the recognition and anticipation of collisions in order to determine when avoidance manoeuvres have to be applied. To do so, we proposed and compared two sensor-fusion and neural network based solutions, with models trained on datasets consisting of all, and only static or dynamic obstacle involving collision samples. The measured accuracies confirmed that the separately trained, ensemble averaged models had better recognition performance, although were slower at calculation than the models trained without taking the obstacle types into account

RObot-Supported Inclusive Education (ROSIE)

Authors:
Eva Brooks, Lykke Brogaard Bertel

Abstract:
This presentation focuses on the development of a project focusing on developing robot-supported and inclusive learning designs focusing on the transitions between preschool and primary school. The presence of educational robots in classrooms is getting stronger and has shown to have powerful inclusive and playful qualities as well as facilitating interest in Science, Technology, Engineering, Art and Math (STEAM). The question is whether it is possible to make use of these advantages to improve the challenging educational transfers in children's early years (5-8 years of age). Based on a state-of-the-art review, we suggest that it is necessary to (1) engage with children, teachers and pedagogic professionals in focused interactions to mobilize their tacit knowledge when developing robot-supported learning designs, (2) understand how novel robot technology can be integrated in these practices, and (3) assess how the practices change by introducing this technology. Thus, we would like to discuss the relevance and applicability of the following questions:

- How can robot-supported inclusive learning design guidelines for development of efficient transitions between preschool and school be designed in collaboration with practitioners?
- How can programmable, educational robots mediate imagination, collaboration and communication skills, and facilitate a play-based approach?
- How can an assessment procedure combining qualitative and biometric data be designed?

Development of Robot Programming System through the use of Augmented Reality for Assembly Tasks

Keynote speaker:

Dr. Wenchao Zou, Brandenburg University of Technology Cottbus, Germany

Abstract:

A higher flexibility is always required for the automation of production, especially for small-batch assembly. The use of robots is one of the ways to adapt the production line for changes in products or processes. However, this aim cannot be comprehensively fulfilled by conventional robot programming systems. This is because of the complexity in setup and operation of these systems as well as high demands on the qualification of the personnel handling the systems. To overcome this bottleneck, a concept for intuitive and simple robot programming was developed to provide the non-expert personnel with efficient and easy robot programming without requirements on prior knowledge of robotic systems.

The developed robot programming concept is based on an intuitive approach by creating assembly tasks through demonstration instead of conventional programming approaches. The demonstration is conducted in virtual environment without requiring the physical robotic system. The user interface is designed for performing virtual assembly planning wherein the gestures are used for input and augmented reality for feedback so that the assembly tasks can be created or reproduced easily. The demonstration environment is created by using the geometric models of the parts and their assembly data. This data is generated in the phase of product development and exported from the CAD software as an exchange file. Reading this exchange file transfers the assembly data to the demonstration environment. The human demonstrations of the assembly tasks are then performed and the assembly tasks are segmented into subtasks. The subtasks invoke the robot actions from an action library, which contains the actions as templates for general description of the robot motions to perform the assembly tasks. In this way, the robot programs are generated automatically after the demonstration. The robot actions are parametrized by combining the user's motion capture and the transformations of the assembly constraints so that the inaccuracy of the motion capture system can be compensated. To ensure safety, the generated robot programs are initially simulated for validation and the validated programs can be transferred to the robot controller for execution.

The developed programming concept was implemented on a demonstrator, which was set up to realize the assembly tasks. The design of the demonstrator showed that it is possible for the user to program a robot alone for assembly tasks by manipulating the virtual components manually. The developed approach leads to an increased flexibility and a reduction of effort and complexity in robot programming.

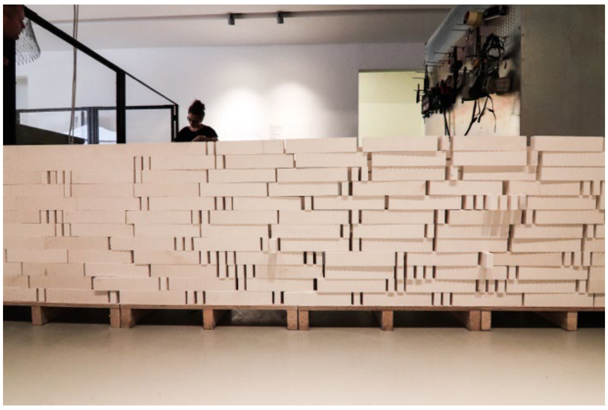
Creative Robotics in Architecture – Robotic Brick Stacking

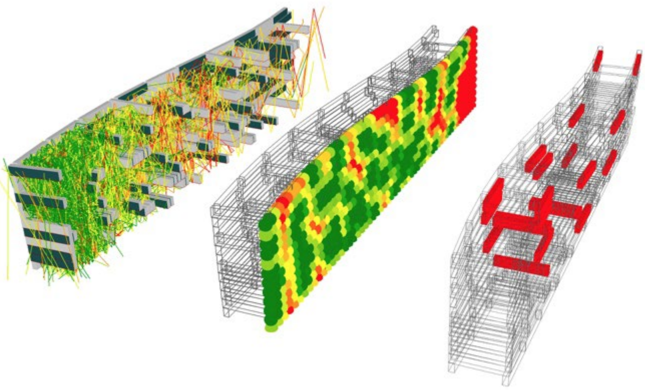
Authors:
Mads Brath Jensen, Isak Worre Foged, Anke Pasold, Michael Hansson

Abstract:
Current software developments allow architects to work with both multi-performative design explorations, including simulations and analysis of ex. acoustic, thermal and structural properties, and robotic fabrication in the same visual programming environment. This means that architects can visually explore the shape and form of a design object and in the same software environment simulate the movements needed for a robotic arm to fabricate the designed object; thereby ensuring that fabrication of the object is feasible.

In our current research project, we seek to construct and explore a multi-performative computational framework that integrates parametric design, acoustic simulation, and robotic fabrication of brick assemblies. The projects' contribution to the field of architecture will be the development of a computational design framework capable of generating intelligent/informed brick assemblies; thereby facilitating a higher level of acoustic, fabrication, and material specificity within the design and construction of architectural structures.

The research project was explored through the fabrication of a 1:1 demonstrator – a 3.2-meter-long brick wall made of limestone bricks – build and showcased during the Istanbul Design Biennale 2018.





Multimodal control of assistive robotic arms for severely disabled individuals

Author:
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Abstract:
Amyotrophic lateral sclerosis (ALS) is a motor-neuron disease which gradually progresses, resulting in paralysis of all voluntary muscles. Since this disease causes tetraplegia, the need for assistance is high. Assistive robotic manipulators (ARM) have been developed to assist disabled individuals with activities of daily living, reducing the need for care and giving more independence to the users. There are multiple modalities for tetraplegic individuals to use a computer or a robot. However, an intuitive direct control interface for a 7 DoF wheelchair mounted ARM (WMARM) is currently lacking, as well as a control scheme where an individual with a disability that progresses (like ALS) can change modality easily.

The objectives of this PhD study will be to develop a control scheme for an electrically powered WMARM, which allows for gradual combination with control signals from muscle and brain to allow for a shift of control modalities as a disabling disease such as ALS propagates. Further, the objective is that the control scheme should allow for remote control of the wheelchair and the ARM so that a user in e.g. bed can use the system to fetch e.g. beverages from the refrigerator by the use of the tongue.

Automated Sewer Inspection Robot

Authors:

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Abstract:

Each year 10 billion DKK are spent on maintaining and adding to the Danish waste-water infrastructure. Each pipe is expected to be functional for approximately 75 years, but are rarely kept in use for longer than 55 years. This is due to inefficient surveying processes, which result in pipes rarely, if at all, being checked, and therefore preemptively replaced. If the lifetime of the pipes can be improved by 10%, it is expected that up to 170 million DKK can be saved each year. The Automated Sewer Inspection Robot (ASIR) project, is a focused on creating a continuous and autonomous surveying tool, a robot "living" in the sewers. Using a yet to be specified set of sensors, the robot will automatically detect and classify structural and surface abnormalities in the pipes, as well as autonomously navigate and map its designated section of the sewer system. The robot will have to be able to navigate and sense its surroundings in pipes as small as 20 cm in diameter. By being able to survey and analyze the same pipes in a much shorter time span, it will be possible to better prioritize the maintenance of the waste-water infrastructure.