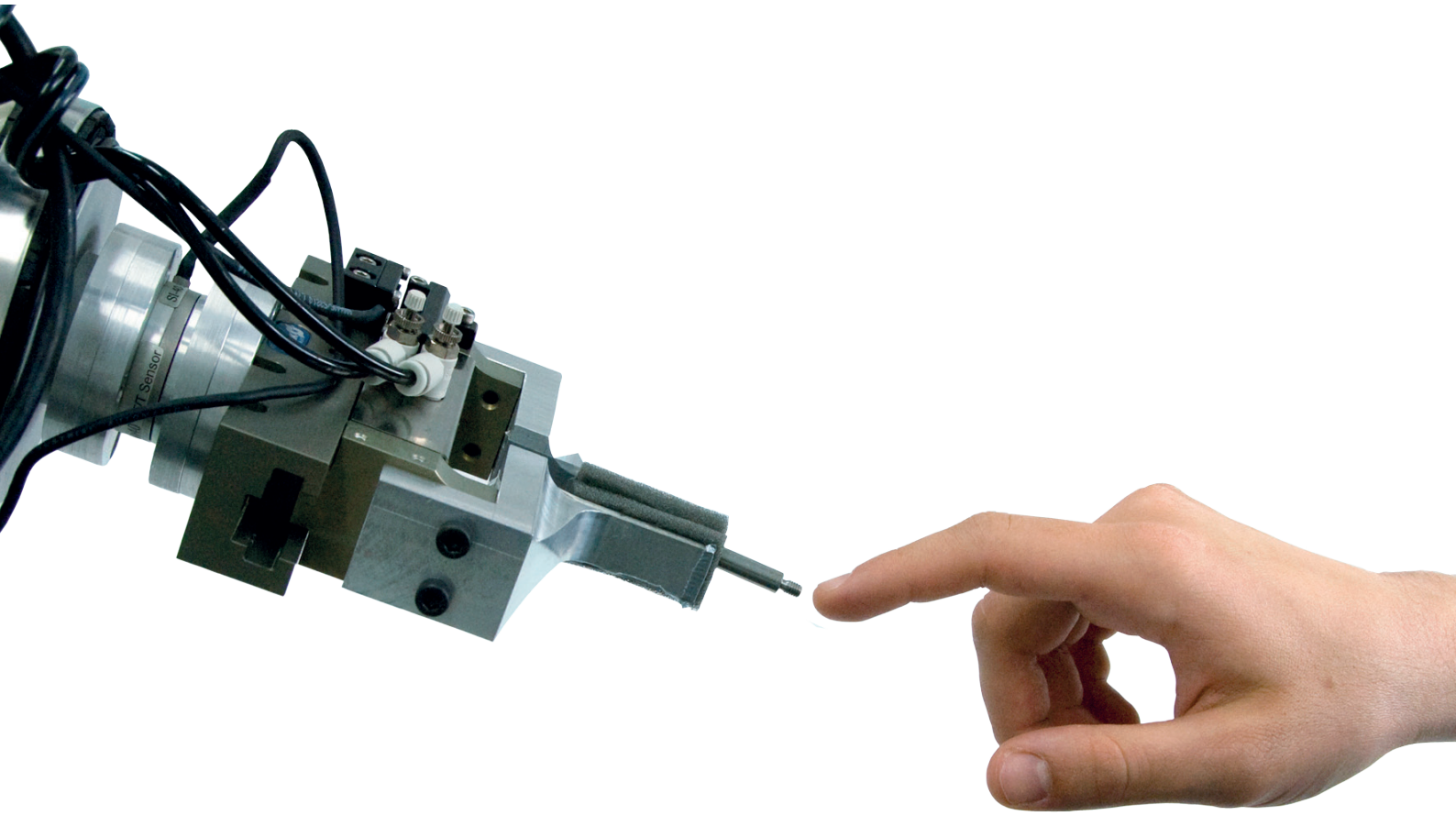
ECHORD

European Clearing House for Open Robotics Development

Overview of the experiments



ECHORD

Technische Universität München

Università di Napoli Federico II

Universidade de Coimbra

SEVENTH FRAMEWORK PROGRAMME

Introduction

The European funded ECHORD project "European Clearing House for Open Robotics Development" began in May 2009 with the ambitious goal of bringing together Europe's robotics manufacturers with the excellent European research institutions. This has been hugely successful! ECHORD now comprises 53 universities and more than 80 industrial partners – the latter as partners within the experiments as well as suppliers of equipment.

This was achieved by joint projects or "experiments" based on scenarios and research foci relevant to both the robot manufacturers and research institutions. Lasting only 12 and 18 months, these experiments can be of different types: some are geared towards joint enabling technology development (develop new robots, components, network, etc. based on bi-directional exchange of knowledge), others towards application development (use of robots and components in new areas and scenarios) and yet other towards feasibility demonstration (show that prototypes can actually be deployed in classical industrial settings). Obviously, there have been and will continue to be many long-term effects and benefits to the industry as a whole (developing new technology, unifying a fragmented community etc), but also more unexpected successes like the fact that, the ECHORD team managed to actively motivate hardware suppliers to display their offer in the European showcase of robotics (Produktkatalog), which now displays nearly 300 items.

The unique, never before tried structure of ECHORD can be seen as a basis for further EU projects – tapping untold potential and application possibilities. The impact that the project has already had is immense and will continue to shape the robotics community in the future. We have gathered experience, developed structures and systems and best practice standards for a novel type of project that can be utilized for a myriad of areas.

It is with great pride that we present this brochure, which provides an overview of all of the 51 experiments that have been selected for funding from 243 submitted proposals, and which demonstrates the wealth of research conducted under the umbrella of ECHORD.

This full range of industry-academia collaborations and the resulting knowledge transfer will provide European industry as a whole with tangible and measurable results by accelerating the development of new enabling technologies and by the deployment of robotics technology into new applications. With ECHORD as the driving force, the European robotics industry can achieve a significant cutting-edge advantage in an increasingly competitive world market.

Prof. Dr.-Ing. habil. Alois Knoll
ECHORD Coordinator

Prof. Dr.-Ing. habil. Alois Knoll

ECHORD Coordinator

Professor of Computer Science

Head of the Chair of Robotics and Embedded Systems

Computer Science Department of the Technische Universität München

Statements from ECHORD Partners

"ECHORD provides the unique opportunity to transfer advanced robotics technologies to new industrial applications even for companies with a limited R&D or hardware budget. Due to the focused approach and the targeted schedules of the single experiments, ECHORD allows the agile development and evaluation of new automation solutions."
Fraunhofer IPA

"Telerobot is confident that ECHORD will help the European industrial robotics in creating and discovering new applications and markets."
Telerobot OEM S.R.L.

"The main reason for our participation in ECHORD is the cooperation between scientific research institutions and industries in the exciting field of robotics."
Università Campus Bio-Medico di Roma
Universidad Miguel Hernandez de Elche

"We welcome ECHORD as a new type of funded research and we greatly appreciate its unique approach. […] The approach to fund real applications is an excellent method for creating new expertise and knowledge. SCHUNK is therefore pleased to be a member of the ECHORD community."
SCHUNK GmbH & Co. KG

"The ability to help the industry to make a major leap forward regarding human-robot interaction in this important application field is very motivating."
Universität Bayreuth

"The ECHORD experiment offers AEA the possibility to achieve [its] goals through a collaboration with an important research institute and to develop hardware and software components necessary to build a complete and functional solution."
AEA S.R.L.

"What has been highly appreciated by PERCRO in the ECHORD approach are the very lean administrative procedures established for management of the whole project lifecycle that dramatically simplified the proposition and the selection-for-funding phases, as well as the monitoring of the results and the accounting of the project expenses."
Scuola Superiore di Studi Universitari e di Perfezionamento Sant'Anna

"We are participating in the ECHORD project for the purpose of solving a complex problem. […] For facing this kind of challenge, it is necessary to cooperate with a company producing AGV systems and ECHORD has provided the perfect framework for setting up this kind of collaboration."
Università degli Studi di Modena and Reggio Emilia

"The main reason for participating in ECHORD is because of its innovative and application oriented approach."
Università di Pisa

"The participation in ECHORD allows us to get a different perspective on our research, namely to become more application-oriented."
Università degli Studi di Siena

"[…] the minimal organisational effort required for application and the expected minimal administrative burden of participation contributed to our decision to apply for participation."
Tyker Technology

Table of Contents

Industrial Companies Involved

A3R S.R.L.
ABB AB
Adept Technology France S.A.R.L.
Aldebaran Robotics S.A.
APIA XXI S.A.
Asociación Centro de Tecnologías de Interacción Visual y Comunicaciones Vicomtech
Atelier Kai Dräger
Bachmann Engineering AG
Blackbird Robotersysteme GmbH
BlueBotics S.A.
CMO
Cognitive Robots S.L.
Comau S.p.A.
Convergent Information Technologies GmbH
Cyberbotics S.À.R.L.
Deutsches Zentrum für Luft- und Raumfahrt (DLR)
EGICON S.R.L.
EICAS Automazione S.p.A.
Elettric80 S.p.A.
Elumotion Ltd.
FARO Europe GmbH & Co. KG
FerRobotics Compliant Robot Technology GmbH
Festo AG & Co. KG
Festo Didactic GmbH & Co. KG
Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e.V.
Fundacion Tecnalia Research & Innovation
GPS Gesellschaft für Produktionssysteme GmbH
Graal Tech
Grundfos DK A/S
Güdel AG
Humanware S.R.L.
Iberobotics
IdMind - Engenharia de Sistemas, Lda
Igus GmbH
ImagingLab S.R.L.
INGENIA-CAT S.L.
Intelligent Machines Stockholm AB
Intermodalics
Kineo CAM
KUKA Roboter GmbH
Lagal Shoes S.L.
Loccioni AEA S.R.L.
Locomotec UG
Magellium
MAJAtronic GmbH
M-BOT Solutions S.L.
Mediavoice S.R.L.
Merlin Systems Corp. Ltd.
Metoda Enginnering S.R.L.
MetraLabs GmbH
Metronom Automation GmbH
MoviRobotics S.L.
MRK-Systeme GmbH
M-Tecks EAC S.A.R.L.
Nav on Time
Neobotix
OC Robotics
Pi4_Robotics GmbH
Pilatus Aircraft Ltd.
Precisis AG
Qfix Robotics GmbH
Reis GmbH & Co. KG
Rekno S.R.L.
Robosoft S.L.
Robotnik Automation, S.L.L.
Robox S.P.A.
Scape Technologies A/S
Schunk GmbH & Co. KG
SenseFly LLC
Servicios de Tecnología, Ingeniería e Informática, S.L.
Shadow Robot Company Ltd.
Skybotix AG
Staubli Faverges SCA
Tecnalia France
Telerobot OCEM S.R.L.
Tyker Technology
ViSSee S.A.G.L.
Vocally
Wany Robotics
WEDA Poolcleaner Sweden AB

Academic Partners

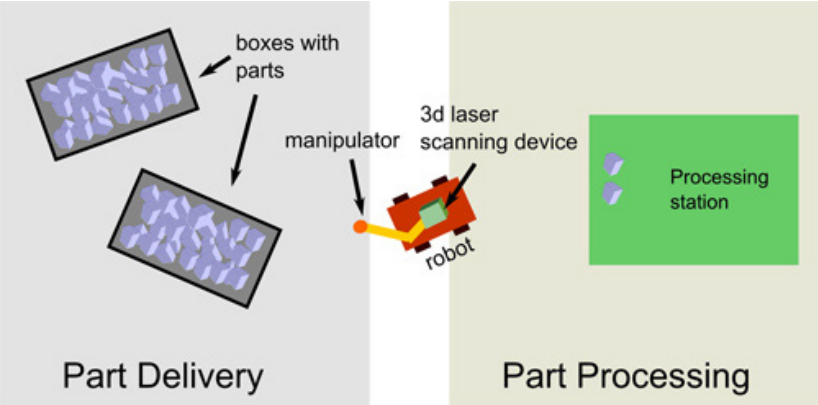
Aalborg Universitet
Applied Plant Research (PPO)
Blekinge Teknsika Högskola
Centre National de la Recherche Scientifique
Consiglio Nazionale delle Ricerche
Deutsches Forschungszentrum für Künstliche Intelligenz GmbH
Eidgenössische Technische Hochschule Zürich
Fondazione Istituto Italiano di Tecnologia
Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e.V.
Health Protection Agency
Hochschule Bonn-Rhein-Sieg
Hospital Universitario Vall d'Hebron
Innovent e.V.
Institut Français de Mécanique Avancée
Instituto de Desenvolvimento de Novas Technologias
Instituto Politécnico de Castelo Branco
Instituto Superior Técnico
Johannes-Kepler-Universität Linz
Karlsruher Institut für Technologie
Katholieke Universiteit Leuven
King's College London
Kungliga Tekniska Högskolan
Laboratoire d'Informatique et de Robotique et de Microélectronique de Montpellier
Lunds Universitet
Otto-von-Guericke-Universität Magdeburg
Politecnico di Milano
Politecnico di Torino
Rheinische Friedrich-Wilhelms-Universitaet Bonn
Scuola Universitaria Professionale della Svizzera Italiana
Scuola Superiore di Studi Universitari e di Perfezionamento Sant'Anna
Simon Listens e.V.
Syddansk Universitet
Technische Universität Berlin
Università di Verona
Universidad Miguel Hernández de Elche
Universidad Politécnica de Madrid
Università Campus Bio-Medico di Roma
Università degli Studi di Modena e Reggio Emilia
Universitá degli Studi di Roma La Sapienza
Università degli Studi di Siena
Università di Pisa
Universität Bayreuth
Universität Bielefeld
Universität Hamburg
Universität Heidelberg
Universität Innsbruck
Universitat Politècnica de Catalunya
Université de Nice
University of Bristol
University of the West of England
Wageningen University
Zürcher Hochschule für Angewandte Wissenschaften

Application Areas

- Domestic
- Industrial
- Agriculture
- Inspection / Monitoring
- Medical / Healthcare

ActReMa

Active recognition and manipulation of simple parts exploiting 3D information



In the ActReMa experiment a bin-picking task for machine feeding will be investigated. This is an industrially relevant application which today still requires human labor.
A mobile robot equipped with a 3D laser scanning sensor and two flexible arms has to take out parts from a transport box. Initially, the parts are known to the robot, but they are piled randomly in the box. After approaching the box, the robot makes a 3D scan of the parts and recognizes the upper layer of parts based on the detection and fitting of shape primitives to the measured point cloud. Next, the robot determines accessible parts and plans collision-free arm motions for grasping. It selects the most suitable grasp, picks the part, and delivers it to a processing station.
In the second phase of this experiment, the robot will learn new part models from brief presentations and will handle occlusions by planning its scan poses for active exploration of the box.
Finally, the developed technology will be transferred to a real-world industrial application.

Rheinische Friedrich-Wilhelms-Universität Bonn
Germany

Metronom Automation GmbH
Germany

http://echord.info/wikis/website/actrema

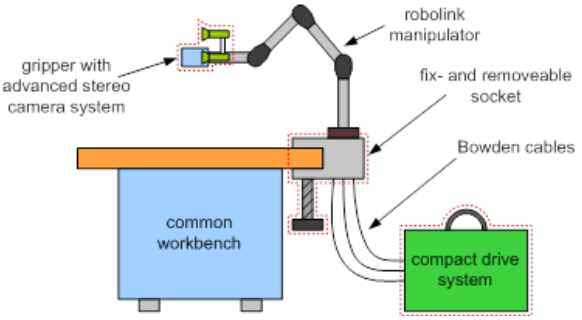
Started 1/02/2011

universitätbonn

METRONOM automation

ALEXA

An advanced light-weight robot arm for flexible and mobile applications in hyper-flexible cells



Fraunhofer IFF
Germany

http://echord.info/wikis/website/alexa

Started 1/04/2011

The ALEXA experiment will test the capabilities of a new lightweight manipulator, which was made using the innovative and low-cost robolink construction kit from igus®. The robolink joints are cable-driven and connected with lightweight, carbon fiber-reinforced plastic links. Fraunhofer IFF will develop a 5-DOF robolink manipulator for use as an assistant in flexible cells. In contrast to common industrial manipulators, its compact drive system comprised of SCHUNK rotary units can easily be detached for enhanced portability.

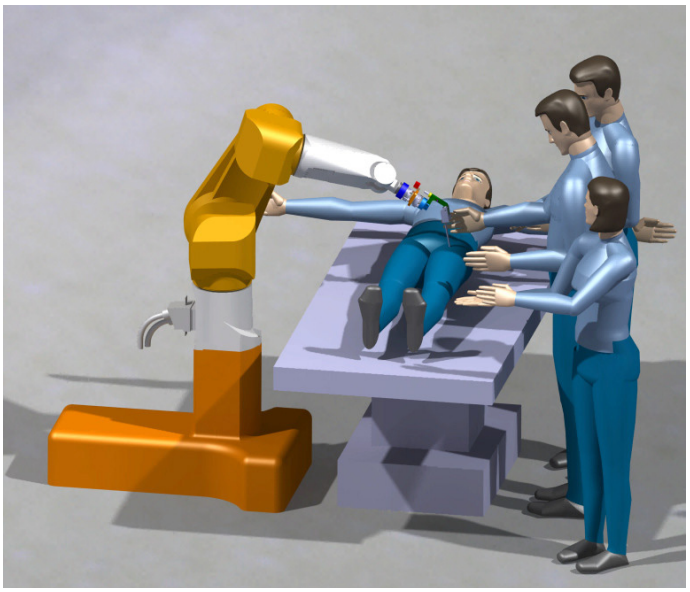
The main focus of the ALEXA experiment will be on the use of portable robot manipulators in hyper-flexible cells, as demonstrated in a common pick-and-place scenario. Three cameras and Visual Servo Control technology will be used to control the positioning of the manipulator so that it can grip objects. The advanced control system will also allow for quick and simple on-site, situational programming.

In particular, the portability, simple situational programming, and high adaptability will be tested in the ALEXA experiment. The fulfillment of this criterion is essential for robolink manipulators to be used as an easily-transportable automation tool for small and medium-sized enterprises and achieving them will mark an important milestone in developing low-cost robot manipulators with high portability.

Fraunhofer
IFF

AssRob Tool Instrumentor

Semi-autonomous surgical tool Instrumentor for robot co-workers in hip-surgery



The main innovation of the AssRob Tool Instrumentor experiment is to create a semi-autonomous two-arm assistant bone lever holding robot system and to demonstrate that it can take over the tiring lever holding and handing over task from a human assistant.
Specific challenges have been identified that have to be met in order to allow the successful deployment of such an assistant robot system in the operation theatre. These are, for example, the guarantied safety of patient and medical staff during robot interaction, semiautonomous cooperation with the surgeon, the capability of holding two surgical instruments at a time, detecting and approaching the surgical instruments and the capability of applying the required forces. All this must be designed in a way that will not alter the commonly known operation work flow to be implemented into routine surgery easily.
One major challenge that remains to be solved in the frame of this proposal is the manual adduction of the two-arm robot towards the bone levers handed over by the surgeon. This currently forces the surgeon to use both his hands, one for holding the lever and one for force controlled manual adduction of the robot arm, resulting in a delay and change of the work flow. The goal is to show the capability of the robot to autonomously recognize the bone lever in space and then approach it close enough, just like a human assistant does, to enable the surgeon to couple already in situ placed bone levers and retractors to it.

Ruprecht-Karls-Universität Heidelberg
Germany

Precicis AG
Germany

Started 1/02/2012

RUPRECHT-KARLS-
UNIVERSITÄT
HEIDELBERG

Precisis AG
Stereotaxy / Radiosurgery

ASTROMOBILE

Assistive smart robotic platform for indoor environments: Mobility and interaction

Scuola Superiore Sant'Anna
Italy

Simon Listens
Austria

http://echord.info/wikis/website/astromobile

Started 1/10/2010

This project aims to develop and demonstrate that a smart robotic mobile platform for indoor environments with an embodied bi-directional interface can be conceived to improve services useful for humans. Its applications range could include industrial environments, security, rehabilitation, and much more. In particular, this project wishes to address the use of such a platform in a domestic environment, covering possible applications, such as a personal robot for non-self-sufficient people, for telework, or for security. The ASTROMOBILE robot-assistant cooperates with users in the indoor environment to help them in daily life or working activities. Therefore, natural speech recognition control could be very helpful.

Speech recognition software is not just a database of speech samples and frequency of voting, but is also a phonetic dictionary, and a vocabulary and grammar definition. With the development of the open source speech-recognition software Simon a very powerful tool was created - one that could make verbal control of computer applications and electronic equipment possible. The application package "basic autonomy", including easy use of the internet and the telephone and the control of multimedia applications, can be easily adapted.

The implementation of this project could result in creating a control mechanism that could significantly change all other developments in this area in Europe, in particular because of the language independent programming of Simon.

Scuola Superiore Sant'Anna
di Studi Universitari e di Perfezionamento

simon listens
non-profit organisation for research and apprenticeship

BABIR

A better audition for a better interaction with humanoid

A robot has to offer an efficient and intuitive interaction with the user in order to be considered as an efficient co-worker in an industrial environment, or as a real companion in a domestic environment. Speaking to the robot and listening to its feedback are the natural interaction way required by potential users.
Speech recognition is a rather mature technology for some dedicated applications, as for example telecommunication or answering machines. In these applications, the user speaks in a dedicated microphone and the speech analysis process gives satisfactory results. In other fields, speech recognition is still disappointing: the surrounding noise and the bad quality of signal acquisition do not allow a robust recognition. The vocal interface is generally given up for the benefit of keyboards or tactile screens.
In this project a robust vocal interface between human and robot will be developed. It will be implemented on Nao, a small humanoid robot. Experiments will be performed in a domestic environment.

Aldebaran Robotics S.A
France

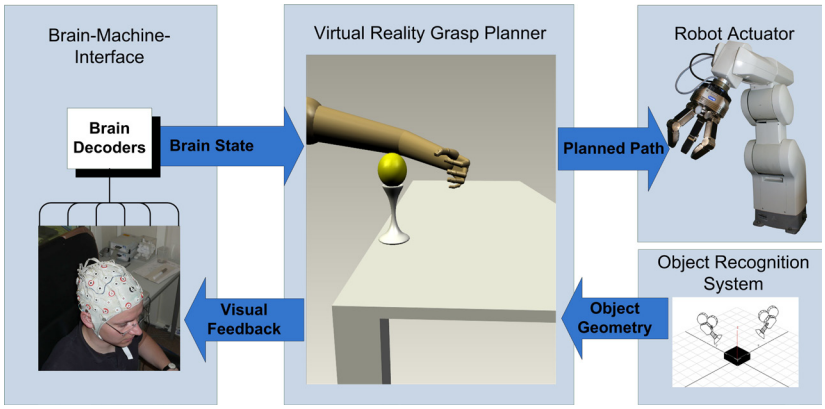
Vocally
France

http://echord.info/wikis/website/babir

Started 1/02/2011

BRACOG

Brain-controlled grasping



Fraunhofer IFF
Germany

Otto-von-Guericke-Universität Magdeburg
Germany

http://echord.info/wikis/website/bracog

Started 1/02/2011

Every year, strokes and traumatic injuries cause severe motor handicaps in more than 15 million people worldwide (Atlas of Heart Disease and Stroke, WHO, 2004). As a result, many of these patients will be dependent on other people's help for the rest of their lives for performing everyday tasks.

To provide those patients with some level of physical independence, this research project aims at developing a robotic arm they can use to grasp and manipulate common objects, controlled by voluntarily changing their brain activity. For the future, this research on brain controlled grasping (BRACOG) aims to enable patients with severe upper limb motor handicaps to perform essential motor tasks, such as eating and drinking autonomously. The prosthesis being developed will provide them with some independence and relief from the need of other people's help. A demonstrator will be developed, which is expected to be the first robot controlled by thoughts that is able to grasp an unknown object.

In the early project stage, for safety reasons, the experiment will be entirely executed in Virtual Reality. Thus, before the real robot used, all processes will have been simulated and evaluated in an immersive 3D visualization.

Fraunhofer IFF

OTTO VON GUERICKE UNIVERSITÄT MAGDEBURG

C-KOMPAï

Providing cognitive capabilities to the KOMPAÏ robot with the addition of a cognitive brain

The CBRAIN (Cognitive Brain for Service Robotics, developed by C-ROBOTS) is a portable and modular system that can be potentially installed in any vehicle to transform it into an autonomous vehicle with an intelligent behaviour and cognitive capabilities. C-KOMPAÏ's objectives are to demonstrate the potential of the C-BRAIN system for its application to robotics, and to further progress in the development and application of advanced cognitive capabilities to robotics, particularly in the areas of navigation, map building, path planning and human-robot interaction.

This will be tackled through the development of a highly autonomous service robot, with a double functionality: Assistance robot for elderly people and floor scrubber in the household.

The starting point of the experiment will be the KOMPAï robot, a modular system for interaction with people. The experiment will incorporate to the KOMPAÏ robot and the CBRAIN system, including the following functionalities and capabilities: High level perception and representation of the environment, robust and reliable autonomous discovering of the environment and map building functionality, cognitive navigation, intelligent problem solving.

Cognitive Robots S.L.
Spain

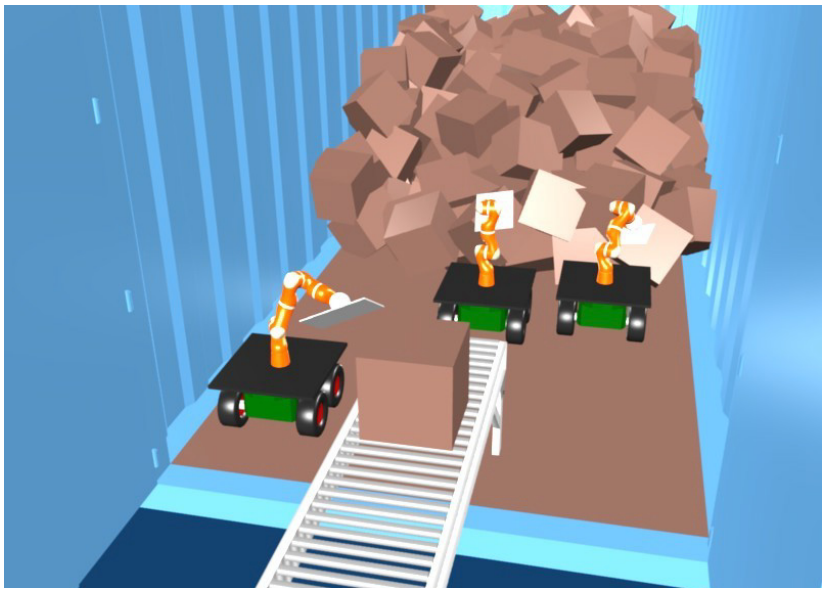
Robosoft S.A.
France

http://echord.info/wikis/website/c-kompai

Started 1/02/2011

ContainerBot

Stochastic impact-triggered mobile manipulation for fast cycle time unloading of variable-sized boxes from unordered piles



Katholieke Universiteit Leuven
Belgium

Intermodalics BVBA
Belgium

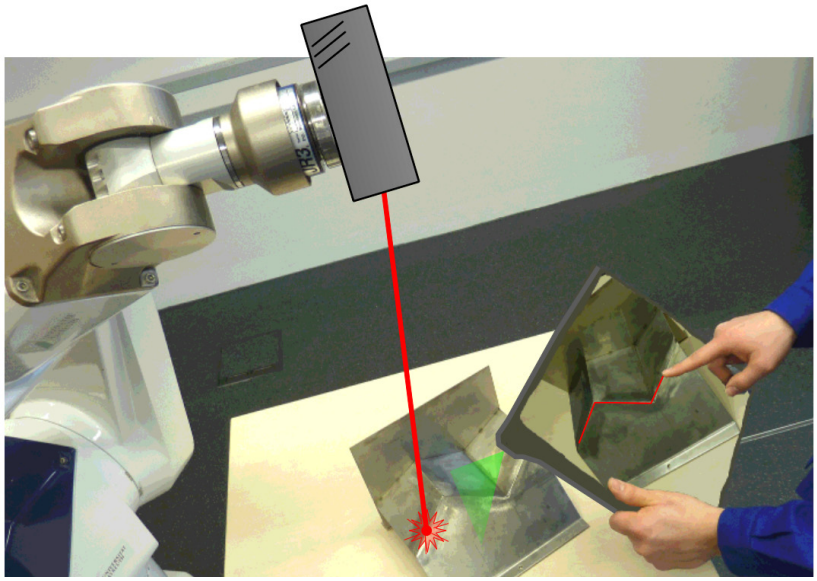
http://echord.info/wikis/website/containerbot

Started 1/02/2011

This experiment develops a solution to unload a container that is filled with a load of boxes that have shifted during transport from a structured matrix into an unstructured „pile" (hence, traditional fork lift unloading can not be applied).
The larger goal is to integrate robotics hardware (mobile platforms and robot arms) and control and coordination software, in order to reach a solution that has the same performance and quality as the human solution. There will be one or more mobile platforms per container, each carrying two or more KUKA Light-Weight Robot arms to „pick" the boxes at the front of the mobile platform, and to deliver them to a conveyor belt or storage trailer behind the mobile platform. The navigation capabilities of the platform can bring it in front of where the pile starts. Then the arms move in towards the pile and start picking the boxes.
One expected result of the project lies in the online coordination of the integrated system with multiple cooperating arms and mobile platform(s). This coordination has to deal with the high cycle times, and be very configurable and customizable, in order to support a variety of application scenarios and environments.

COWBOI

Cooperative welding employing robot intelligence



In the COWBOI experiment, an integrated approach for a small lot-size human-robot cooperative welding systems will be developed, implemented and evaluated. The system will enable welding of small lot sizes with manual efforts reduced to a mere interactive, intuitive, fast and highly accurate task specification by the user. This is accomplished in an efficient way, leveraging the system beyond existing cooperative and fully automatic welding systems by combining existing trusted technologies and new promising approaches.
One of the major aspects is the broad visual communication interface between the human and the robot system enabling fast task communication.
Another key aspect is the increase in robot autonomy, compared to existing approaches, in both task suggestions and autonomous task-based movement planning. This relieves the human co-worker from specifying the exact robot movement, a tedious and error-prone task when complex geometries are involved.
An additional demand for robot system autonomy is optimizing the exploitation of the redundant degrees of freedom of the actuator, because this cannot be accomplished satisfactory through a human operator.

Universität Bayreuth
Germany

Blackbird Robotersysteme GmbH
Germany

http://echord.info/wikis/website/cowboi

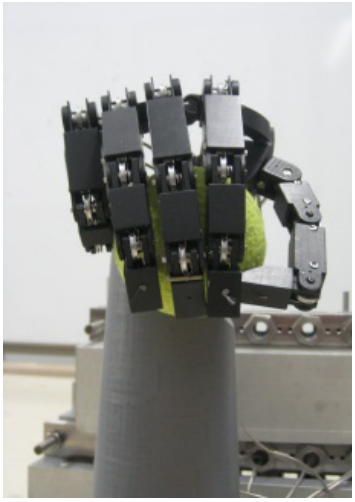
Started 1/10/2010

UNIVERSITÄT BAYREUTH

BLACKBIRD ROBOTERSYSTEME

DexDeb

Application of dexterous hands for deboning operation



King's College London
United Kingdom

Institut Français de Mécanique Avancée
France

Shadow Robot Company Ltd.
United Kingdom

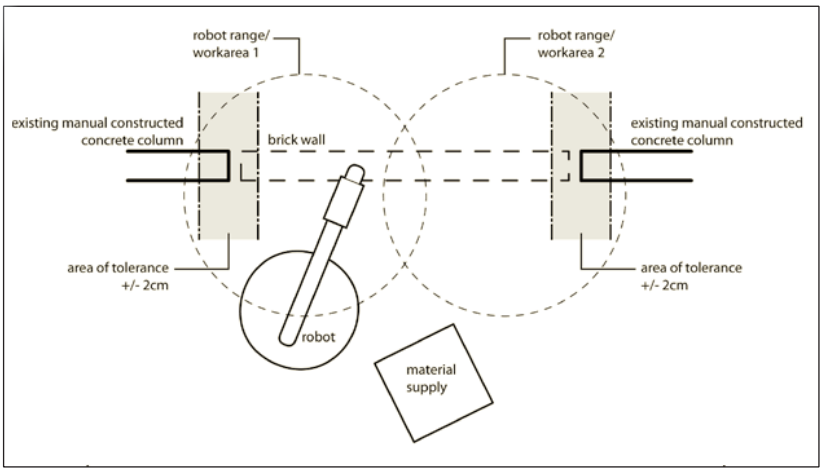
http://echord.info/wikis/website/dexdeb

Started 1/02/2011

The DEXDEB experiment carries out an application study of using dexterous robot hands for de-boning operations - a task that is laborious and dangerous for human operators. This pioneering study aims to establish a hyper-flexible work cell for the cutting, de-boning and muscle extraction operation in the meat-packing industry. The proposal goes beyond the classic grasping and handling: DEXDEB proposes using robotic hands in de-boning operations, particularly for replacing the very dangerous and laborious use of a human operator's left hand.

dimRob

Robotics on construction site - dimensional tolerance handling



The dimRob experiment aims to examine and demonstrate strategies for handling imprecision and tolerances in construction work. These deviations and tolerances are unique, because they are at the construction site, where the product (i.e. the building) is considerably larger than the fabrication tool.
DimRob mainly addresses the cognitive factory scenario. At a construction site, the robot is no longer operating in a controlled environment and is therefore in need of cognitive skills: perception of assembly objects (location of material and material tolerances), as well as context conditions (site tolerances and positioning/ relocation) is required. Furthermore, as manual labor and robotic manufactured elements are combined on a construction site, the robotic system should be fault-tolerant and adapt autonomously to changing conditions.
The core contribution of the dimRob experiment is the implementation of industrial robots at construction sites, thus advancing the use of new technologies in the building industry and opening up new market possibilities for the robot industry.

Eidgenössische Technische Hochschule Zürich
Switzerland

Bachmann Engineering AG
Switzerland

http://echord.info/wikis/website/dimrob

Started 1/02/2011

ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

EASYPRO

Accurate manual guided robot programming

Fundación Tekniner
Spain

Consiglio Nazionale Delle Ricerche
Italy

Comau S.p.A.
Italy

http://echord.info/wikis/website/easypro

Started 1/02/2011

While static robot programs may be sufficient for high volume part manufacturers, they are not adequate in one-off or small-batch manufacturing. The result is that industrial robots are hardly ever used for small- batch and one-off manufacturing. The objective of this experiment is to facilitate robot programming by combining hand guided end-effector rough movement planning and 3D visual servoing based accurate trajectory following.

To integrate a breakthrough programming approach combining a 'universal' Manual Guidance Device (MGD) for a fast, intuitive but rough tool path programming, will be integrated with a 3D visual servoing approach to adjust the obtained trajectories and to allow accurate end-effector positioning by automatic on-line correction of Tool Central Point (TCP) path. The user decides the distance between the end-effector and the part on top of which the application has to process, the orientation with respect the part, the type of correction and any other parameter relevant for the process.

In EASYPRO this new approach will be tested and validated in a real production scenario by integrating it in a Laser Cladding process, an innovative method of depositing a material on top of other. Robots are used to this aim, but their use requires programming the trajectory manually. This hard, time-consuming task will be dramatically optimized by using the EASYPRO approach.

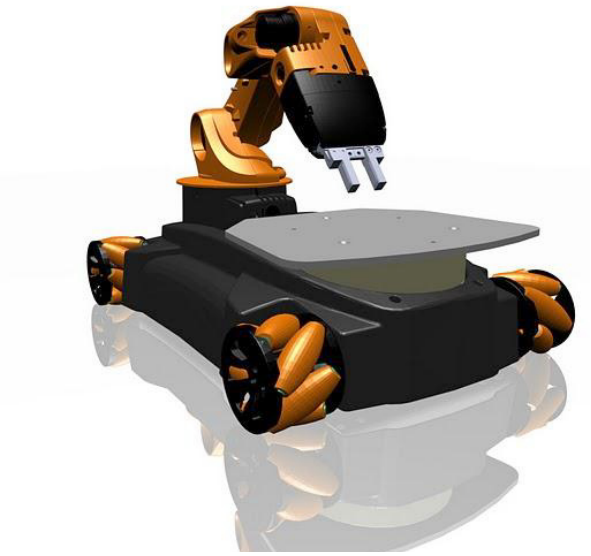
Tekniker
ik4 research alliance

Consiglio Nazionale delle Ricerche

COMAU ROBOTICS

EduFill

Filling the educational gap in service robotics



This project's goal is to foster the use of advanced (mobile) manipulation techniques in small and mid-size enterprises, in production and home service settings. In the last couple of years, research has made significant advances in mobile manipulation, however little has been applied to industrial and service applications so far. This gap between research results and application is due to a lack of ready-to-use software components to build advanced robotic applications and to a lack of engineers educated to master advanced (mobile) manipulation. The project will bridge the gap, by providing industry with a software toolbox of modular components implementing basic robotic functionalities for mobile manipulation and an education framework with course modules covering the theory and application of mobile manipulation. As a by-product of this effort, simple sensing capabilities, comprehensive of hardware interfaces and software drivers, will be adapted to the mobile manipulator chosen for this project, to let instructors and students also practice with sensor-based navigation and manipulation. The open source toolbox and course material will be developed along three showcases: (a) handing over an object between two (moving) mobile manipulators, (b) a cooperative assembly example and (c) a fetch and carry task, of which two will serve as demonstrators.

Hochschule Bonn-Rhein-Sieg
Germany

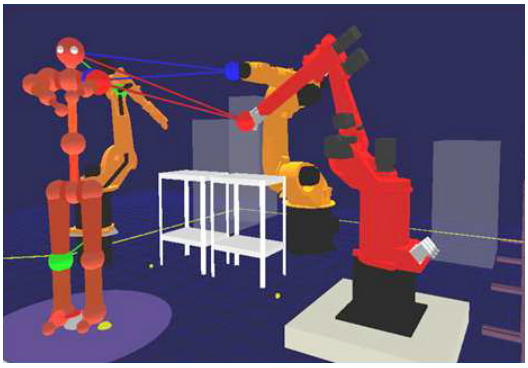
Universitá di Verona
Italy

Started 1/02/2012

Hochschule
Bonn-Rhein-Sieg

ERICA

Evaluating human-robot interaction and cooperation based on analysis of 3D image sequences



Karlsruher Institut für Technologie
Germany

Reis Robotics
Germany

KUKA Laboratories GmbH
Germany

Started 1/11/2011

The ERICA experiment has the goal to achieve safe human-robot-cooperation and to advance a system which is based on real time estimation of significant parameters of human body kinematics. The knowledge about parts of the human kinematics is a key issue for cognitive vision based systems, which deal with real cooperation between man and machine. This knowledge is also used to guarantee safety for the human co-worker by estimating the risk of a situation and adapting the robot's behaviour accordingly.

The experimental evaluation is based on different scenarios, covering categories like classical work tasks, synchronous robot control by the co-worker and gesture recognition for interaction as well as scene understanding for cooperation. Together with Reis Robotics and KUKA the experiments will be carried out and guided by their experience in industrial robotic applications.

Execell

Experimental evaluation of advanced sensor-based supervision and work cell integration strategies

Robots currently used in industrial applications are located behind fences in order to prevent contact between humans and robots and to ensure safety. Increasingly, however, there is a need for a new class of service and assistance robot applications that will allow for a common workspace for robots and humans. The next generation of hyper-flexible cells combines the cognitive advantages of humans with the speed, accuracy, and strength of robots to allow for a new variety of tasks to be efficiently carried out. This, in turn, calls for a new generation of networked robots with tightly integrated sensor systems which allow for closer interaction between humans and robots. Therefore, Execell's goal is to develop and experimentally demonstrate safe interaction between humans and robots of various types and sizes.

The Execell work cell will be equipped with a 2½D sensor system developed at the Fraunhofer IFF, which reliably detects humans and other objects in three dimensions under a variety of conditions. An algorithm for dynamic, online planning and monitoring of safety volumes will be used, in order to fully realize the potential of the experiment. This algorithm will take the motion of the KUKA LWR into account when defining the safety volumes, and will detect situations in which the robot needs to react with a lower velocity or to stop completely. The algorithm has been recently developed and demonstrated at the Fraunhofer IFF using the mobile robot.

Fraunhofer IFF
Germany

KUKA Laboratories GmbH
Germany

http://echord.info/wikis/website/execell

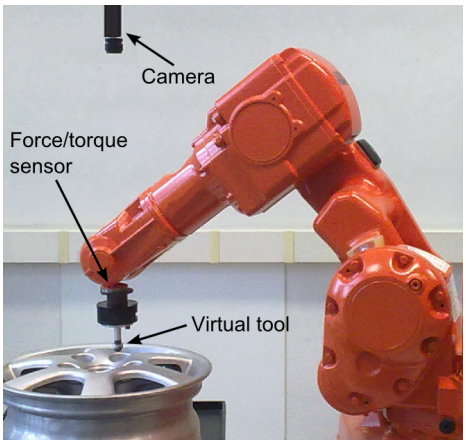
Started 1/02/2011

Fraunhofer IFF

KUKA

FIDELIO

Fixtureless deburring of wheels by human demonstration



Politecnico di Milano
Italy

Comau S.p.A.
Italy

http://echord.info/wikis/website/fidelio

Started 1/02/2011

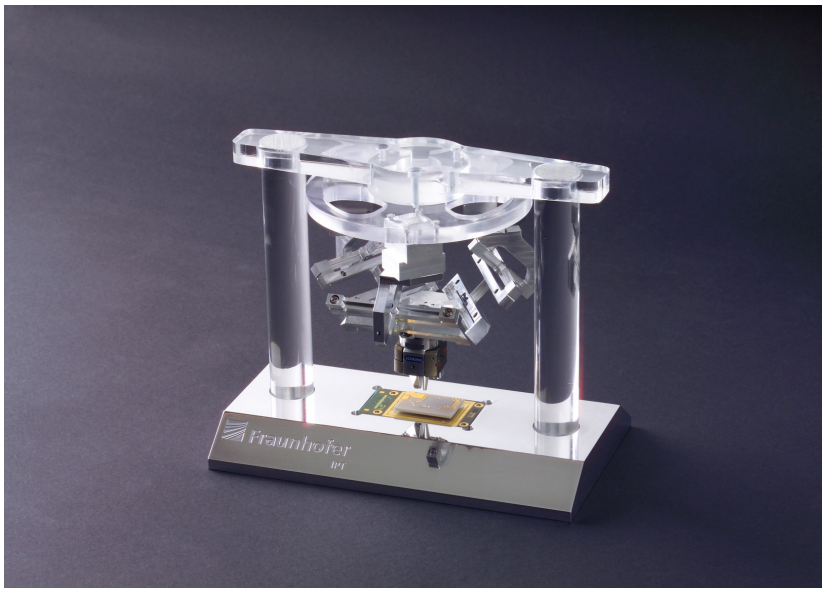
Modern industrial robots are complex and powerful machines, able to execute a variety of different tasks with high speed and accuracy. Nevertheless, they still have a low degree of autonomy and adaptability, and need the presence of a human operator to learn new tasks or tune existing ones.

Robotic researchers have been focusing on the Learning From Observation paradigm, developing prototypic robotic systems able to observe and learn from human operations: the information coming from a variety of observations is analysed and transformed into an abstract representation of the task. By using such information, and exploiting the abstraction capabilities of a suitable cognitive system, the robot is able to autonomously generate a program to reproduce the task, even in an environment which is different from the one observed during the learning phase.

The FIDELIO project wants to investigate the feasibility of this innovative approach in an industrial application scenario, exemplified by a fixtureless wheel deburring task. A robotised cell will be set up, composed of a six degree-of-freedom industrial manipulator and a workstation where aluminium wheels are placed for deburring.

Flexprass

Flexible precision assembly with mobile robots



The integration of human workers and their creativity with mechanical precision allows the efficient production of high-tech products in small lot sizes. In the Flexprass experiment the partners SCHUNK and Fraunhofer IPT combine human-friendly modular industrial desktop robotics with high-precision equipment. This will make it possible to setup a flexible precision assembly system for highly demanding products such as laser-systems. Programming efforts and planning activities can be reduced to a minimum in this human-robot co-worker scenario because the complexity of manipulation can be handled by the experience of the human worker. Compared to conventional scenarios, where plain manual assembly plays a major role, this approach offers improved working conditions, reducing the cognitive efforts of the human worker. Yet, it makes the overall process sustainably more efficient and even improves product quality.

Fraunhofer IPT
Germany

Schunk GmbH & Co. KG
Germany

http://echord.info/wikis/website/flexprass

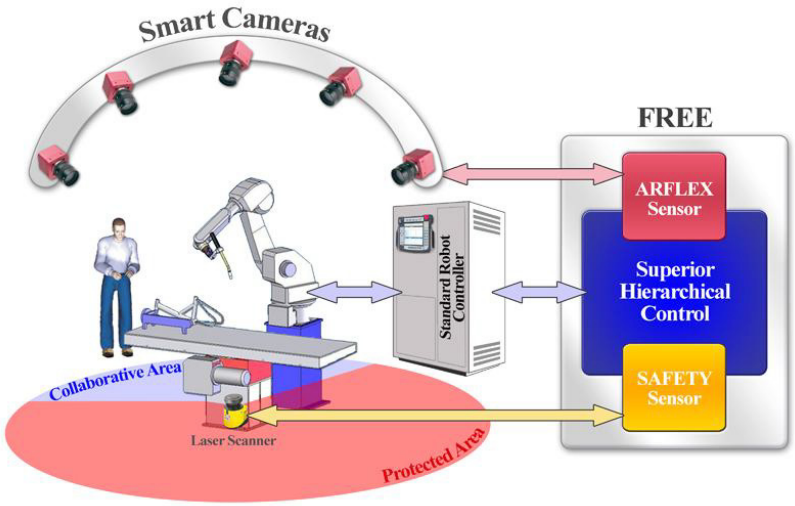
Started 1/02/2011

Fraunhofer IPT

SCHUNK®

FREE

Flexible and safe interactive human-robot environment for small batch exacting applications



EICAS Automazione S.p.A.
Italy

Politecnico di Torino
Italy

Started 1/02/2012

The FREE experiment addresses the sector of small batch production where manual work is still the main manufacturing option since the introduction of automated systems is costly and lacks the necessary flexibility.

FREE aims at contributing to change this situation by offering to SMEs affordable robotics solutions: safe, accurate, low-cost and plug & play, moving towards the concept of a flexible and safe interactive human-robot environment, achievable by combining robot equipments with the most advanced safety and control technologies (control theory, sensory devices, electronic embedded systems and ICT). The FREE basic idea is the introduction of a further control loop operating at a level hierarchically superior with respect to the standard robot controller. Such a control loop, denoted as "Superior Hierarchical Control", is interfaced with the human operator and equipped with its own sensors that provide contact-less robust measurements of body pose (including the robot tool pose) and of human operator position within the robot working area. The system must work with low cost commercial sensors.

The achievement of the main S&T objectives, namely "enhanced human-robot interfacing and safety", "robot flexibility", "improvement of the robot tool position and attitude accuracy", will be measured in any key aspect (flexibility, safe human-robot interactions, high accuracy, low-cost, plug & play) through an experiment, reproducing the assembly process of metal sheets.

EICAS Automazione S.p.A

GISA

Little helper plus: Gesture based instruction of safe mobile robot arm

The GISA experiment aims to provide information about the consequences and effects of using mobile robot arms in manufacturing.
Mobile robot arms with the ability to cooperate with humans provide significantly new possibilities to manufacturing industries. Contrary to traditional immobile and pre-programmed production robots, mobile robot arms can provide assistance in different locations, are able to provide highly flexible logistic possibilities, and can improve productivity by providing assistance in dangerous or straining situations.
Research within the field of mobile arms has been going on for more than 20 years and has been the focus of many research groups around the world. Good research is ongoing, and many interesting and relevant new technologies are constantly being developed. However, in spite of the large amount of research and interest in the area, there are only very few examples of applications of mobile robot arms in real manufacturing environments. Hence, real insight about the consequences and effects of applying mobile robot arms in manufacturing is limited.
GISA aims to provide such knowledge by implementing a mobile robot arm into the manufacturing environment at Grundfos A/S.

Aalborg Universitet
Denmark

Grundfos A/S
Denmark

http://echord.info/wikis/website/gisa

Started 1/02/2011

GOP

Generating optimal paths for industrial and humanoid robots in complex environments

Rupprecht-Karls-Universität Heidelberg
Germany

Centre National de
la Recherche Scientifique
France

http://echord.info/wikis/website/gop

Started 1/02/2011

The generation of the best possible path that does not violate any constraints imposed by the environment is a ubiquitous task in both industrial and humanoid robotics. Currently there is no algorithmic approach available that allows to address this problem for very complex dynamic robot systems in cluttered changing environments in real time. Instead there are two established but still quite separated research areas that both address a part of the problem, namely path planning and numerical optimal control. Path planning is mainly interested in the determination of a feasible path in very complex environments based on geometric and kinematic models. Numerical optimal control techniques are capable to generate optimal trajectories for robot manipulators or humanoid robots taking into account the dynamics; however the treatment of a huge number of environmental constraints giving rise to many local minima makes the problems very hard, if not impossible, to solve.

This project aims at combining state of the art development of these two domains and to create the algorithmic foundations to tackle real time optimal control problems in cluttered environments.

RUPRECHT-KARLS-
UNIVERSITÄT
HEIDELBERG

LAAS-CNRS

GRASPY

Stereo vision for grasping by humanoid robot

The personal robotics market will be a major industry in the 21st century. In order to integrate robots in our everyday life, the quality of interaction between a human and a domestic robot has to be improved. This is the aim of the GRASPY project. Compared to computers or other smart objects in the domestic environment, a robot is able to manipulate objects. One of its most important tasks will be to grasp an object and to hold it out to the person or to grasp an object that is being held by the user. In this project, the consortium will develop a stereovision head for the humanoid robot NAO. Based on this stereovision system, a functionality allowing the robot to grasp objects autonomously from the user's hand will be developed.
The innovations addressed in the GRASPY project are the development of an embedded stereovision system for a small humanoid robot, the detection of the fingers on the object to avoid collisions, and the detection of exactly the correct moment to release the object when it is being grasped by the user.

Aldebaran Robotics S.A.
France

Deutsches Forschungszentrum
für Künstliche Intelligenz GmbH
Germany

http://echord.info/wikis/website/graspy

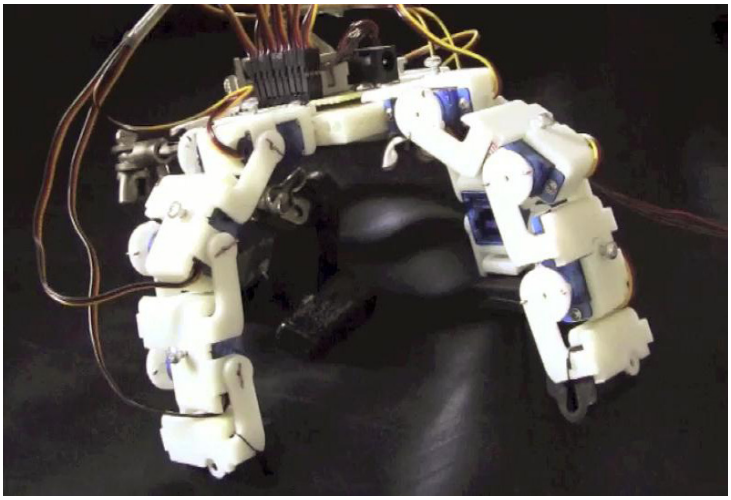
Started 1/10/2010

ALDEBARAN Robotics

Deutsches Forschungszentrum für Künstliche Intelligenz GmbH

HANDS.DVI

A device-independent programming and control framework for robotic hands



Università degli Studi di Siena
Italy

Unisersità di Pisa
Italy

Fondazione Istituto Italiano di Tecnologia
Italy

http://echord.info/wikis/website/hands-dvi

Started 1/10/2010

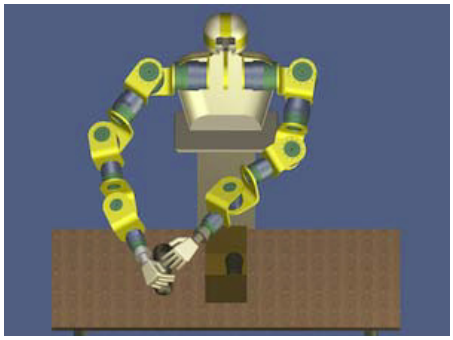
The scientific goal of Hands.DVI is the development of a common framework for programming robotic hands independently from their kinematics, mechanical construction, and sensor equipment complexity.

The human hand is a redundant structure, with many degrees of freedom with respect to the dimension of the controlled workspace. The hand's sensor motor transformations pose constraints on d.o.f., so that the number of effective d.o.f. is much lower than the number of joints. The reduced set of parameters which is effectively used by humans to control the hands is known in literature as the set of synergies.

In this project, a kinematic model of an anthropomorphic robotic hand embodying synergies will be developed. A suitable mapping function of the control action from the paradigmatic hand domain to the articulated hand co-domain will be designed. Control will be device independent, leading to a sort of standardization between control strategies among robotic hands with dissimilar structures. The developed control framework will be applied on an experimental set up consisting of three robotic hands with dissimilar kinematics, grasping an object instrumented with force sensors. The experiment's results will encourage the diffusion of robotic hands in advanced industrial environments, such as hyper flexible cells. Furthermore, the design of robotic control systems that "think" like human hands will ultimately promote human-robot interaction and cooperation.

HERMES

Hyper-flexible bimanual robot manipulation and packing of deformable parts in footwear industry



The footwear industry accounts for some of the shortest production runs to be found in manufacturing (eight pairs of shoes is the average order size). Automation is required more and more in order to ensure competiveness in this growing market. The introduction of intelligent robotic technologies can contribute to overcoming the complexity in the automation of the production processes.
The HERMES experiment will demonstrate the potential of applying robotic technologies to the packaging process of high added value shoe production. Important key technologies for bi-manual manipulation, specifically in terms of detection and manipulation of non-rigid parts will be developed and transferred to potential system integrators for future commercialization.

Universidad Miguel Hernández de Elche
Spain

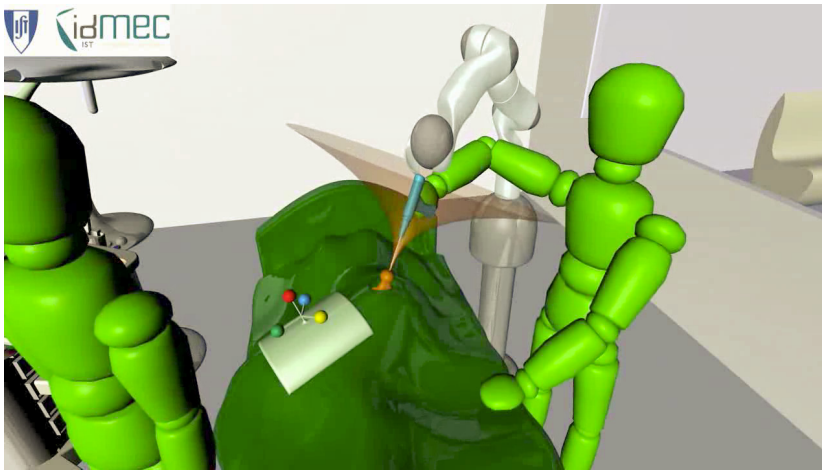
Fraunhofer IPA
Germany

LAGAL Shoes S.L.
Spain

Started 1/02/2012

HipRob

Robot-assisted and ultrasound-guided navigation for hip resurfacing arthroplasty



Instituto Superior Técnico
Portugal

Instituto Politécnico de Castelo Branco
Portugal

Started 1/02/2012

The objective of this collaborative experiment is to integrate a robotic system that will aid orthopaedic surgeons in performing Hip Resurfacing prosthesis surgery with consistent high accuracy and precision. A co-manipulation robotic solution for hip resurfacing surgery based on variable impedance control for physical surgeon-robot interaction will be developed, as well as an ultrasound image sensor for non-invasive real-time bone tracking. This innovative co-manipulation setting to the medical gesture combines the higher geometric accuracy and precision of the robot manipulator with the higher sensibility and decision making capability of the surgeon when applying force.

The most critical step during HR is the placement of the central guide wire in the femoral head and neck. This wire is crucial for the success of the surgery since it decides upon the alignment of the femoral component and whether any impingement of the acetabular component with the femoral neck occurs or not. Traditionally, this wire is introduced using a mechanical guiding device that requires a lot of talent and/or training on behalf of the surgeon, or using optical navigation systems eliminating the mechanical guiding device. These systems, while helping to improve accuracy, do not prevent the surgeon from failing to follow the surgical plan accurately. The proposed solution overcomes these limitations, providing force feedback to the surgeon while guiding him in the right direction.

INSTITUTO SUPERIOR TÉCNICO

Instituto Politécnico de Castelo Branco

HUBRINA

Human-robot co-working in agricultural master-slave systems

In this experiment, a master-slave robot control for agricultural activities will be developed and its feasibility demonstrated. The human takes over the non-robotized tasks of safety prevention and feedback on the quality of work performed by the robot. The HUBRINA experiment proposes to advance the research to master-slave systems in agriculture beyond just the level of simulation and prove the feasibility of a fully automated master-slave system. This fits into the ECHORD research focus 'human robot co-worker' in that a robot co-worker interacts with a human towards achieving a common goal. The research foci of ECHORD that relate to this experiment are human-robot interfacing and safety and cooperation. Tractor manufacturer CLAAS supports the research by supplying a tractor for the experiment.

Tyker Technology
The Netherlands

Wageningen University
The Netherlands

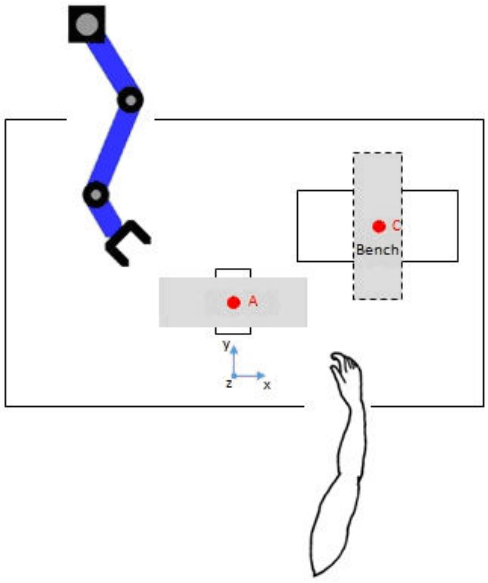
Applied Plant Research (PPO)
The Netherlands

http://echord.info/wikis/website/hubrina

Started 1/10/2010

HUROBIN

Human-robot object interaction



Scuola Superiore Sant'Anna
Italy

Humanware S.R.L.
Italy

http://echord.info/wikis/website/hurobin

Started 1/02/2011

At the moment, safety in manufacturing automatic cells is achieved using safety devices such as light curtains, scanners, mats, etc. This does not allow the worker to enter in the cell, in fact preventing the worker from co-operating with the manipulator. The HUROBIN experiment aims at developing a safe scenario for the human-robot cooperative manipulation, including both sensor redundancy and the implementation of a robust control strategy

HUROBIN investigates a scenario in which the human operator and the robot agent handle the same object: the robot is supposed to bear the load while the human leads the movement of the object in a co-operative pick and place task.

The focus lies on human robot co-operation, interfacing and consequently the safety for the human operator. Accordingly, the human forearm movements will be measured by means of a tracker in order to ensure a whole safe operation. Furthermore, the tracker and a dataglove operated by the human will lead the robot in a sort of master-slave tele-operation.

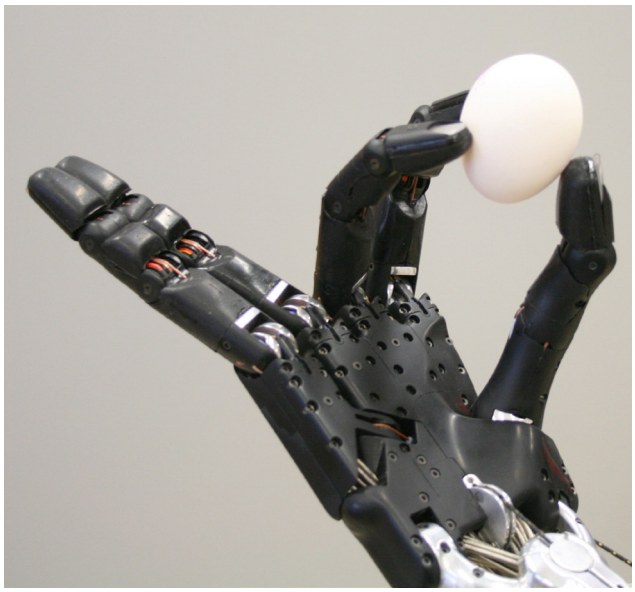
The robot has distributed position sensors and a torque/force sensor. During the object handling the robot sensors will be selectively ignored or deactivated (simulating a failure), while the tracker sensor will guarantee the sensor redundancy. The final achievement will be the implementation of a robust control mixed with sensor redundancy, overcoming the sensor failure, in a sort of tree fault analysis for a human-robot co-operation.

Scuola Superiore Sant'Anna
di Studi Universitari e di Perfezionamento

Humanware

HYFLAM

A hyper-flexible work cell for biochemical laboratory automation



In this experiment a hyper-flexible cell will be built, featuring a dexterous robot hand which performs a set of complex manipulation operations arising in a bacteriological or chemical laboratory. Working with some of the deadliest microorganisms on the planet in a laboratory setting is a highly-skilled job where accidents can be catastrophic.

The aim of HYFLAM is to experimentally demonstrate that robotic technology can provide intelligent manipulation through autonomous and tele-operated techniques in the mentioned environment.

The objective of the research experiment is to bring hyper-flexible work cells for laboratories a step closer towards the commercial market. At the moment the work that is planned to be carried out with a robot manipulator can only be accomplished by a human either using glove-boxes or working directly in the isolated area wearing a protection suit. So one benefit of the investigated solution is that it enhances the safety of laboratories by reducing the risk of people getting in contact with hazardous material. The efficiency of semi-automated labs can also be increased by the use of robot systems, as complex manipulation operations can be carried out autonomously.

The experiments will cover an extensive set of operations that will permit robot systems to be used productively in a laboratory environment.

Universität Hamburg
Germany

The Shadow Robot Company Ltd.
United Kingdom

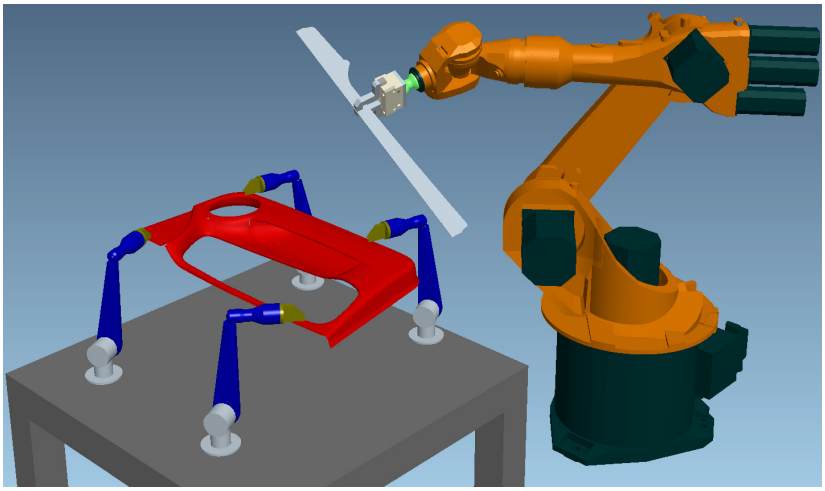
Health Protection Agency
United Kingdom

http://echord.info/wikis/website/hyflam

Started 1/02/2011

HYROPA

Hyper-flexible robot cells using reconfigurable passive kinematics



Fraunhofer IFF
Germany

http://echord.info/wikis/website/hyropa

Started 1/06/2011

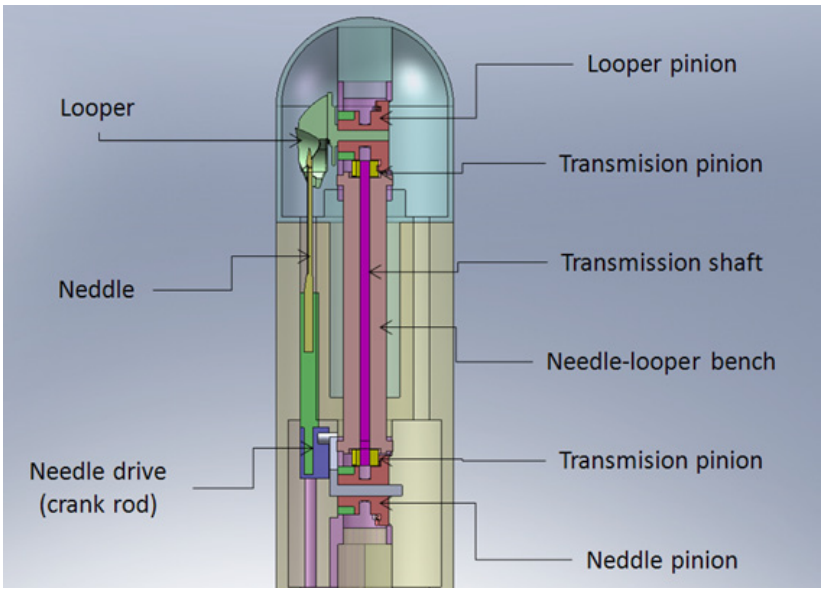
In the HYROPA experiment, the use of reconfigurable passive articulated arms will be examined, in order to enable the support of different work tasks in standard industrial robot cells. Passive kinematics can expand the level of flexibility of existing robot cells, where they can be adapted to different components and individual work pieces. Accordingly, passive kinematics is used to hold and easily manipulate work pieces in the workspace of an industrial robot. The passive kinematics for this purpose can be locked in almost any position by clamping the individual joints. Reconfiguration of the passive kinematics will be done by the industrial robot. Thus, an automated change-over is possible without manual intervention.

The HYROPA experiment addresses the ECHORD research focus "robot hands and complex manipulation", within the scenario "hyper-flexible cells", as the technology allows an automatic adaption to a variety of given tasks from the industrial repertoire. The major advantages of using reconfigurable passive kinematics are the lower complexity and lower costs in the construction and operation of robot cells, while at the same time offering good adaptability to small production volumes.

Fraunhofer
IFF

INSEWING

Development of a robotic manipulator of human tubular tissues for suture and support in anastomosis surgery interventions



The aim of the INSEWING project is to develop a surgical robotic manipulator device, focused on the improvement of surgical interventions with anastomosis. These interventions consist basically of a cross-cutting of tubular tissue (usually the intestine), removing a piece of it, and re-uniting the remaining ends. This is a common procedure in the treatment of colon cancer which has a high rate of occurrence in the population of the western hemisphere.

It is expected that this innovative new surgical device technology will significantly contribute to the increase of life expectancy in the population. The success of the study, development, and implementation of the new sewing robot will have a very positive social impact – not only for patients, but also for the national Health Departments. The goal is to achieve better results for the patient, compared to techniques used today, in stopping the progression of the disease and in the quality of life after the intervention. The patient will not have all the common post-procedural complications of traditional anastomosis interventions. This not only results in speedier recovery of the patients, but also in lower costs for the Health Department.

Universitat Politècnica de Catalunya
Spain

Hospital Universitario Vall d'Hebron
Spain

http://echord.info/wikis/website/insewing

Started 1/10/2010

UNIVERSITAT POLITÈCNICA DE CATALUNYA

Vall d'Hebron Hospital

InterAID

Interactive mobile manipulators for advanced industrial diagnostics

Loccioni AEA S.R.L.
Italy

Fraunhofer IPA
Germany

http://echord.info/wikis/website/interaid

Started 1/10/2010

The main goal of InterAID is to demonstrate the feasibility of applying mobile robots with manipulation capabilities to advanced diagnosis and quality control in industrial environments.

The application environment will be the reliability lab of a white goods factory producing washing machines. InterAID targets the repetitive tasks of taking measurements of the products in order to guarantee standardized and consistent quality control. In particular, the mobile robot should be able to find its way around the reliability lab and approach the single machines autonomously. When the robot is in front of a washing machine, it has to push buttons and to turn knobs in order to power on the machine or change programs. It has to move its special sensors as close as possible to the machine in order to check that it is operating correctly. Since some of the required tasks, e.g. putting clothes into the washing machines, cannot be automated, the collision free operation and cooperation of such robots with human operators is essential for their future commercialization.

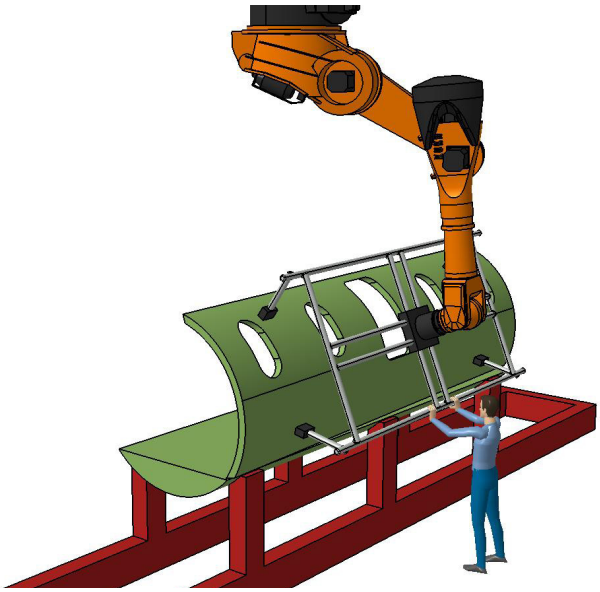
The goal is the design and the assembly of a mobile manipulation robot which is able to solve these tasks. It will be equipped with a 7 DOF robotic arm and gripper as well as several 3-D sensors. Advanced processing routines will allow the robot to detect obstacles such as humans blocking its path, will be able to adapt mobile platform and arm movements accordingly and thus ensure its successful, collision-free operation among human operators.

LOCCIONI

Fraunhofer IPA

JILAS

Jig-less airplane assembly in low volume production by enhanced human robot interaction



JILAS focuses on "human-robot interfacing and safety". The core of the JILAS experiment is to realize a scenario where a human worker and an industrial robot assemble airplane components in a classic human-robot-coworker cooperation. Therefore, an industrial robot with state of the art safety technology and the ability to perform force controlled movements will be used. Additionally, the robot has the capability to be hand guided by grasping and moving the gripped work piece. With the help of this robot, the human worker can pick up a component and move it toward the final assembly position. With the help of an external, absolute measurement system, the worker records the current component position in order to enable the main controller to calculate the exact path the robot must take to reach the final position of the gripped component. Then, at the human worker's command, the robot moves the component, perhaps force controlled or at least force supervised, to its final position.

Zürcher Hochschule für Angwandte Wissenschaften
Switzerland

MRK-Systeme GmbH
Germany

http://echord.info/wikis/website/jilas

Started 1/10/2010

KANMAN

Kanban integrated, magnetic orientated modular mobile manipulator

MetraLabs GmbH
Germany

Innovent e. V.
Germany

Schunk GmbH & Co KG
Germany

http://echord.info/wikis/website/kanman

Started 1/10/2010

The Kanban system is a widely used production control method for just-in-time (JIT) production. It is often compared to supermarkets, where customers take only what they need, and the stock is refilled automatically.

The KANMAN experiment will develop an application in which a robotic co-worker supports a Kanban production process by taking care of the flow of materials. While the Kanban process is controlled by crates containing the production materials, these crates will be transported by a mobile service robot platform with a manipulator. First of all, in order to be able to fulfil this task in a joint workspace with humans, the safety of the system needs to be guaranteed. Within the KANMAN experiment, several new concepts for a general solution will be developed, evaluated, and the most promising one will be implemented.

KANMAN contains a second research challenge: a magnetic approach for mobile navigation and manipulation. KANMAN will use the ambient magnetic field to localise itself – especially in environments with big open spaces and a constantly changing environment.

KOMPEYE

Enhancing the visual perception capabilities of Kompaï robot using parallel processing

In recent years important advances in the field of computer vision have been achieved, allowing humans to interact with machines in a more natural way. Such advances include the detection of human figures, heads, faces, and facial expressions, even with moving cameras, along with gesture detection and recognition. The gap between all these perceptive technologies and their effective implementation into autonomous service robots aimed at looking after people is to be narrowed by the KOMPEYE experiment.

In a combined and complementary way, computer vision techniques for markerless, view-independent human figure, head and face detection, face emotion recognition, gesture spotting and recognition approaches, will be applied for an advanced autonomous robot cognitive visual perception. Thanks to the results of this experiment, service robots will be able to look after humans, detecting if they are in trouble and acting consequently. The experiment will be guided and evaluated through four demonstrators in an indoor environment.

The main developments in the experiment will be focused on integrating in an optimal way a different set of advanced computer vision algorithms which at the end will allow the robot at the end detect people in trouble using only its own cameras.

Robosoft S.A.
France

Asociación Centro de Technologías de Interacción Visual y Comunicaciones
Vicomtech
Spain

Started 1/02/2012

LearnBiP

Grasp learning in industrial bin-picking

Syddansk Universitet
Denmark

Universität Innsbruck
Austria

Scape Technologies A/S
Denmark

http://echord.info/wikis/website/learnbip

Started 1/02/2011

The LearnBiP experiment aims to utilize the huge amount of data generated in industrial bin picking for the introduction of grasp learning. Additionally, it evaluates the potential of the SCHUNK dexterous hand, SDH-2, for its application in industrial bin picking.

The first aim will be achieved by using a novel concept of grasp densities. The second aim will be achieved in a two-stage process, in which the SDH-2 hand is thoroughly evaluated in a bin-picking context in a controlled lab environment before it is applied to the industrial system.

It is anticipated that the LearnBiP experiment will generate the first example of applying grasp learning in industrial robotics, as well as using dexterous hands in industrial production.

MAAT

Multimodal interfaces to improve therapeutic outcomes in robot-assisted rehabilitation

The MAAT project aims at developing a new robotic system for the administration of highly sophisticated therapy for stroke patients in order to maximize patient motivation and involvement in the therapy and to continuously assess the progress of the recovery from a functional and neurological viewpoint, with special attention on the issue of safety in human-robot interaction. The uniqueness of the MAAT approach is to include the patient in the loop: multi-modal physiological data (such as motion, muscle activity, skin conductance etc.) and an immersive virtual reality system will be exploited to adaptively and dynamically change the complexity of the therapy in accordance with specific patient requirements and ability.

For the experimental validation, two prototypes of robotic platforms with multimodal sensing capabilities will be developed. Two different commercial robot manipulators will be used as the key components of the MAAT platforms: modularity, dexterity, flexibility and adaptability of these systems will allow the execution of a wide variety of therapeutic exercises that will significantly extend the current state-of-the-art, paving the way for a new generation of rehab robotics products.

The close collaboration with qualified medical experts in the areas of neurology and medicine and rehabilitation at the University Campus Bio-medico in Italy and at other clinical centers in Spain, will be of great benefit for preliminary clinical validation of the MAAT systems on post-stroke patients.

Università Campus Bio-Medico di Roma
Italy

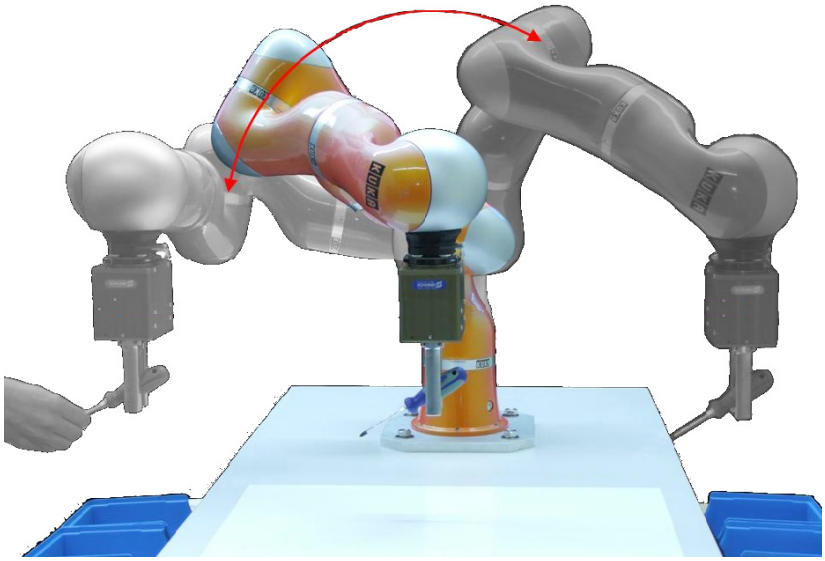
Universidad Miguel Hernández de Elche
Spain

http://echord.info/wikis/website/maat

Started 1/10/2010

MoFTaG

Model-free flexible trajectory generation



Universität Bielefeld
Germany

Started 1/11/2011

In co-worker scenarios, flexibility by allowing for changes in kinematic configuration, e.g. through application of new tools or new degrees of freedom in re-configurable robots, is highly desirable. The redundancy resolution for optimizing complex task behaviour and online trajectory adaptation for obstacle avoidance and safety will be crucial for a widespread application of such systems. Current technology requires costly and tedious reprogramming by experts for each of these tasks. To facilitate and speed up this inefficient process, MoFTaG proposes to use a model-free learning method that only requires a non-expert user to record a limited number of data-points in task-relevant areas of the workspace. This can be done by kinesthetic teaching to interactively learn inverse kinematics including task-specific redundancy resolution and trajectory generation between several parts of the workspace. The learning itself is perfomed fully automatically and allows for generalization to new tasks.

Universität Bielefeld

MONROE

Hyper-modular open networked robot systems with excellent performance

Robots so far suffer from several trade-offs:

- Stiff robots are heavy (in terms of moving mass), and therefore slow and/or too expensive.
- Parallel robots providing stiffness and high forces have a small and closed workspace.
- Precise robots are very expensive, slow, and/or cannot stand process forces.
- Modular robots have low performance due to lack of mechatronic optimization.

The first two of these items were successfully tackled in SMErobot (FP6; smerobot.org) by means of the Tau PKM structure.

The basis for MONROE are ideas which overcome all of the tradeoffs above. However, convincing demonstrations are needed before customers are willing to buy the concept. For software and networking loosely coupled networked devices will be combined, which should communicate via asynchronous messages that are both self-describing and possible to be compiled into real-time communication with multi-kHz control over standard Ethernet.

An integrated demonstration is outside reach for robot manufacturers from a business point of view, and hence the crucial need for this ECHORD experiment.

Lunds Universitet
Sweden

Güdel AG
Switzerland

Fraunhofer IPA
Germany

http://echord.info/wikis/website/monroe

Started 1/02/2011

MUCE

Modular underwater cleaning equipment

Intelligent Machines Stockholm AB
Sweden

Kungliga Tekniska Högskolan
Sweden

WEDA Poolcleaner AB
Sweden

Started 1/11/2011

The aim of this experiment is to develop the next generation autonomous pool cleaner that is lighter, cheaper and more flexible and modular than today's products. It should be able to navigate in non-rectangular pools, with an interface that allows the user to configure and operate the machine with little training. MUCE will use an integrated systems approach to get better performance at the same time as e.g. cost and weight are reduced.

Objectives of the experiment are to

i) develop a solution for robust, accurate and cost effective underwater positioning and navigation in non-rectangular pools combined with an appropriate navigation strategy that allows the machine to provide coverage.

ii) develop a flexible mechanical design that supports many different models of different sizes and levels of functionality.

iii) develop an easy to use user interface, including installation and operation functionality.

iv) facilitate knowledge transfer between academia and industry.

INTELLIGENT MACHINES

KTH VETENSKAP OCH KONST

WEDA

ODEUO

Inner oscillation detection and evaluation of unknown test objects

The OUDEO experiment aims to take what is a relatively simple job for humans, ie. the detection of spare or lose parts by shaking, and to make it a manipulation task solvable by mechanics.
OUDEO investigates the sensorless detection and evaluation of inner oscillations of unknown test objects mounted on a compliant test bench. The principle of the sensorless analysis is that test objects are not totally rigid in reality. This means one or more parts of the test objects are oscillating with different eigenfrequencies compared to the rigid reference. By comparing eigenfrequencies with the test object to the rigid model, oscillating parts are detectable.
The aim of this experiment is to demonstrate the functionality of a 6 DOF compliant hexapod to generate frequency sweeps in all degrees of freedom. These sweeps are used as a "sensorless" detection instrument to get quick and reasonable results, which is of general use for the detection of vibrations in unknown objects.

Johannes Kepler Universität Linz
Austria

FerRobotics Compliant Robot Technology GmbH
Austria

http://echord.info/wikis/website/odeuo

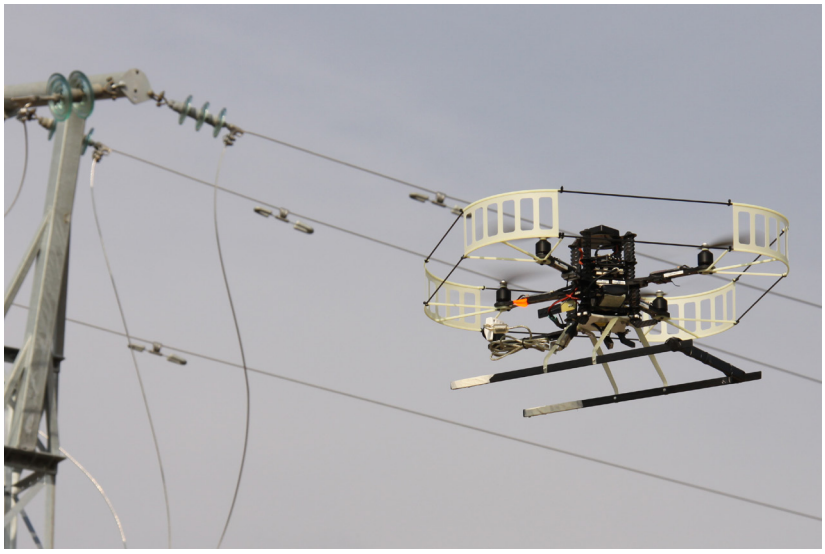
Started 1/02/2011

JOHANNES KEPLER UNIVERSITY LINZ | JKU

FER ROBOTICS
Compliant Robot Technology GmbH

OMNIWORKS

Omnidirectional vision for human-UAV co-working



Universidad Politécnica de Madrid
Spain

Skybotix AG
Switzerland

APIA XXI S.A.
Spain

Started 1/02/2012

Inspection of industrial plants has become a primordial industrial policy in order to warranty quality and reliability. However, inspection is a costly and time consuming process that often involves a reduction, or a total stop of the production process. Thus remote and non-invasive inspection is a key feature for the daily industrial process. Currently some applications are available in the market, but they are costly and difficult to operate by a non-high-skilled person.

The aim of OMNIKWORKS is to exploit the growing interest and convenience of use of small scale UAV by developing a series of self enclosed specialized and complementary modules and applications suitable for a large variety of commercial UAV currently on the market. Another primary objective is that all the developed systems will be easy-to-manage by a non-skilled person.

Each one of these modules and applications will be focused on exploiting the information given by cameras in order to automate different processes involved in the operation of the UAV, including e.g. mosaic maps, visual navigation based on maps, video stabilization, image tracking and servoing, 3D pose estimation, and autonomous landing.

This modular scheme will allow a generic UAV to be easily adjusted for different kind inspection operations, considerably reducing the equipment, system, and inspection costs.

PRADA

Parallel robot with adaptive dynamic accuracy

In the PRADA project control techniques will be implemented on an industrial parallel manipulator so that robot builders, integrators and users can envision using such robots in applications or industrial sectors which are nowadays beyond the capabilities of existing solutions.
In a scientific point-of-view, PRADA aims at reaching beyond today's performances for high-speed parallel robots in terms of dynamic accuracy along complex paths and adaptability to changes in operational conditions. This will be done thanks to a joint development effort of up to three enabling technologies specifically adapted to industrial parallel robots: adaptive dynamic control, sensor based control and actuation redundancy.
In order to offer the high rate-of-work coming with parallel robots to SME's and new sectors, it is necessary to provide performance that can be robust to payload change, and motions with kinematic & dynamic accuracy.
Expected advances are: Firstly, to apply advanced control techniques (dynamic control) on industrial parallel robots, controlled by existing industrial control systems. Secondly, to establish calibration models and strategies enhancing the robot kinematic accuracy while being simple enough to be implemented in a cost effective control system. And thirdly, to asses experimentally if an idea still in its early age of development , "actuation redundancy for parallel robots", could be a tool to enhance dynamic accuracy in a realistic way.

Tecnalia France
France

Fundación Tecnalia Research & Innovation
Spain

Laboratoire d'Informatique et de Robotique et de Mircoélectronique de Montpellier
France

Adept Technology France S.A.R.L.
France

Started 1/11/2011

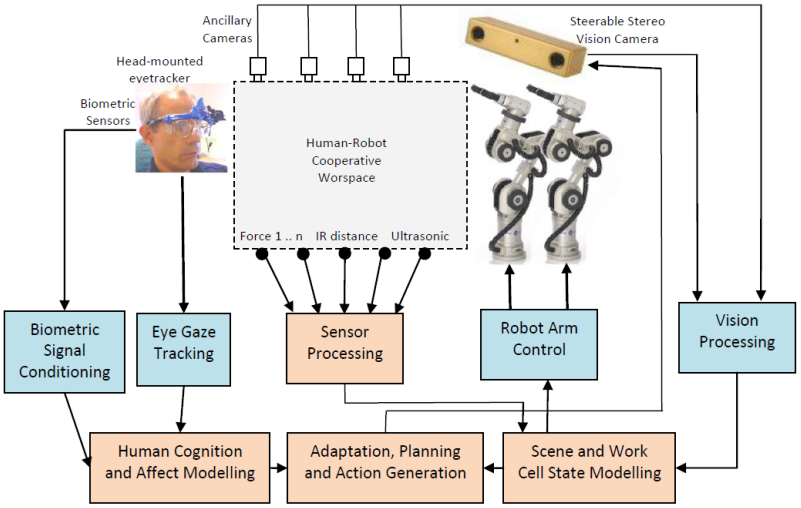
tecnalia

Laboratoire d'Informatique de Robotique et de Microélectronique de Montpellier
LIRMM

adept

PsyIntEC

Psychophysiological interaction and empathic cognition for human-robot cooperative work



Blekinge Tekniska Högskola
Sweden

Started 1/02/2012

PsyIntEC is a feasibility demonstration project targeting safe ergonomic and empathetic adaptation by a robotic system to the needs and characteristics of a human co-worker in a joint human-robot work cell. Inputs to the robot control system will include psychophysiological (i.e. biometric) data from the human co-worker, which will provide the basis for affective and cognitive modelling of the human by the robot as a basis for behavioural adaptation.

Objectives include the development of:

i) A collaborative human-robot work cell as the technology platform for the experiment, including a vision system for the robot, two articulated robot arms, an eye gaze tracking system, and biometric interfaces for the human co-worker (including EEG, GSR and EMG).

ii) A human cognition and affect model with real-time automated state updates based upon data inputs from biometric interfaces.

iii) Robot decision and adaptive task performance models integrating the cognition and affect model, to accomplish empathetic and supportive action generation to achieve reference tasks.

iiii) A rigorous experimental design and evaluation framework that can be used to validate the demonstrator.

BLEKINGE TEKNISKA HÖGSKOLA

REMAV

Remote eye for micro aerial vehicles

The main goal of REMAV is to demonstrate the possibility to precisely and safely operate Micro Aerial Vehicles (small autonomous helicopters) in a dynamically changing environment consisting of fixed obstacles, humans and other MAVs. In order to achieve this goal, an extremely precise position and speed control is required.
On a MAV, a new specifically adapted miniature optical-flow based speed sensor for measuring both position and speed of the vehicle with an unprecedented level of accuracy and precision will be integrated.
The speed sensor will complement and integrate the other classical MAV sub-systems (e.g. the navigation system and the collision-avoidance system), improving the navigation capabilities of the vehicle. The final goal is to achieve a quick and safe collision avoiding movement.
Human-MAV dynamic collaboration will be checked in a typical scenario. The definition of a realistic test scenario is one of the experiment tasks. Real-world scenarios can be taken as starting point and include for instance factories (e.g. for mass-customization), logistics storages and large shops, where MAVs could perform many kind of activities, e.g. carrying small payloads.

Scuola Universitaria Professionale della Svizzera Italiana
Switzerland

ViSSee S.A.G.L.
Switzerland

Skybotix AG
Switzerland

Started 1/02/2012

SUPSI ViSSee Skybotix TECHNOLOGIES

RIVERWATCH

Cooperating robots for monitoring of riverine environments

Instituto de Desenvolvimento de Novas Technologias
Portugal

Started 1/02/2012

RIVERWATCH aims at the development of an autonomous multi-robot system for ecological monitoring of riverine environments. The multi-robot system will be composed of an autonomous surface vehicle (ASV) with an unmanned aerial vehicle (UAV) piggybacked on it. The UAV overcomes the limitations imposed from observing the environment from the low vantage point provided by the ASV. Conversely, the ASV being equipped with a solar panel is able to perform energy harvesting for itself and for the UAV, which is a key factor for a long-lasting operation.

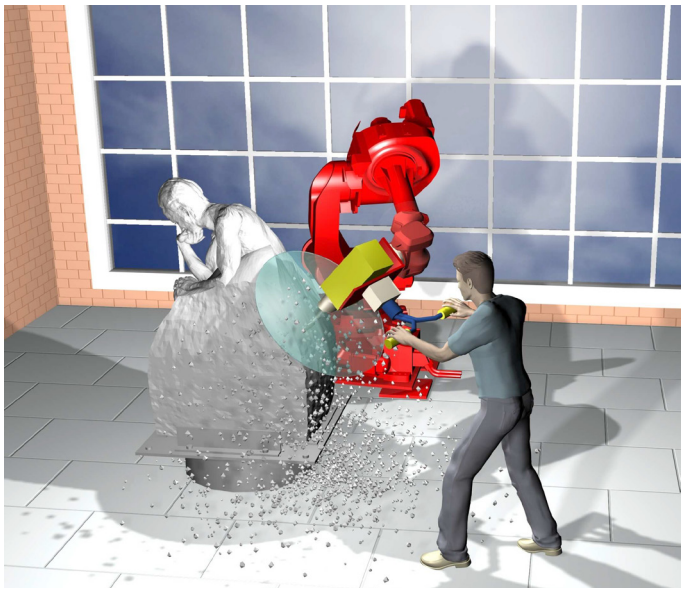
The project will exploit this symbiotic partnership by covering perception, navigation, coordination, and technological integration aspects. A particular aspect to be taken into account is the interaction of robots to take the best of the complementary visual perspectives they have of the environment. The goal is to use an aerial perspective to promote on-water safe navigation. In the application scenario, the robotic team, moving downriver, assesses a series of environmental variables. In case a pollution indicator is triggered the aerial platform is asked to perform a local survey. This information is passed on to a remote control centre, where a human operator is monitoring and configuring the mission.

RIVERWATCH is expected to impact on scientific (novel perception, navigation, and coordination algorithms), technological (novel autonomous multi-robot integrated platform), and application (novel environmental application scenario) dimensions.

UNINOVA
INSTITUTO DE DESENVOLVIMENTO DE NOVAS TECNOLOGIAS

RODIN

Robust control of human-robot-environment dynamic interaction for natural stone carving



The aim of the RODIN experiment is to prove experimentally the feasibility of concepts that extend industrial robot usage as an intelligent power tools carrier and as an active assistant supporting dynamic physical human-robot-environment interaction during the complex and demanding artistic work of hard natural stone carving. This novel promising concept will enormously increase efficiency and productivity of artistic stone processing, reduce hazards, improve ergonomics as well as health and safety of the worker.
The RODIN experimental investigation will considerably contribute to the gathering of the knowledge and experience concerning robot stability, safety and reachable performance during cooperative operation in high demanding stone carving and similar manufacturing contact tasks with very hard environment.

Technische Universität Berlin
Germany

Atelier Kai Dräger
Germany

Started 1/02/2012

SPEAKY

SPEAKY for robots

Universitá degli Studi di Roma La Sapienza
Italy

Mediavoice S.R.L.
Italy

Started 1/11/2011

SPEAKY for Robots (S4R) aims at fostering the definition and deployment of voice user interfaces (VUIs) in robotic applications where human-robot interaction is required. S4R promotes speech technologies transfer towards manufacturing processes, to provide semi-automatic speech-based interface development for robotic platforms. This in turn will boost up the robot presence in manifold activities, by supporting a natural interaction with humans.

S4R's specific goal is a novel Robotic Voice Development Kit (RVDK). A RVDK is conceived as an interactive environment aiding designers to define the voice interface according to the desired application requirements. In order to design and implement the RVDK, state of the art solutions about lexical vocabularies and knowledge representation to capture the semantics of the domain, and natural language processing technologies will be integrated.

S4R targets two possible application domains: Home services, where a user controls a humanoid robot through a voice user interface, and outdoor robotic surveillance, where the user is controlling the action of a wheeled robot capable of navigating in rough terrain.

SprayBot

A robotic spray booth for the automatic painting of bodyworks

SPRAYBOT's objective is to demonstrate that an integrated mobile robotic system is able to carry out the painting phase of bodyworks as a human operator does inside an already existing spray booth, improving the quality of the service with a reasonable investment. The project foresees the acquisition of a modular mobile manipulator and the integration with a viewing system to recognize shapes. The spray booth becomes a flexible work cell where components of different shapes, kinds and quantities are introduced. They will be finished with a painting quality similar to the original one.
The navigation algorithm in partially structured environments will be studied and implemented on the mobile manipulator, processing the information coming from the onboard sensors and from a pervasive network of sensors installed inside the painting booth. Then the manipulation algorithms for the execution of the varnishing phase will be studied and implemented. The operator will have to monitor the robot operations and to supervise that they are accomplished in a safe manner. In order to increase the automation level of the cell the most diffused vision algorithms in the industrial field will be studied and shape recognition algorithms will be implemented. The robot will search in a spare parts database and will notify the operator outside the booth about the colour gradation and varnish composition of the part to be processed. The operator will compose the mixture and load the spraying device onboard the robot, using common manual tintometers.

CMO
Italy

Scuola Superiore Sant'Anna
Italy

http://echord.info/wikis/website/spraybot

Started 1/02/2011

CMO
oleodynamic - hydropneumatic equipments

Scuola Superiore Sant'Anna
di Studi Universitari e di Perfezionamento

TACTIP

Tactile fingertip for robots

University of the West of England
United Kingdom

Elumotion Ltd.
United Kingdom

University of Bristol
United Kingdom

http://echord.info/wikis/website/tactip

Started 1/02/2011

The TACTIP project addresses a number of robotics issues: the need for improved tactile sensors for robot manipulators and the creation of tactile probes for many applications. Tactile probes will need to function over a range of materials with different deformation properties. In particular, robots dealing cooperatively with humans and especially, robots required to touch humans (e.g. assistive care robots, co-operative assembly robots) need improved tactile sensors.

The TACTIP project is a biologically inspired tactile robot fingertip that reflects on the nerve structure found in a human fingertip, in particular the Dermal Papillae. Movement of developed artificial papillae is monitored using an image camera. The image data is then interpreted into contextual contact data such as shape and direction of an edge or raised bump. The initial prototype is just over twice the size of a human fingertip.

The experiment addresses issues of performance benchmarking, 'miniaturisation' and integration of the probe into a robot hand, developing feature extraction and robot actuator control based on tight sensori-motor loops (e.g. find a more dense 'lump' in a deformable material). The final demonstrator will show these advanced capabilities in a series of demonstrations ranging from feature following (e.g. small ridge) to the reading of Braille characters.

TESBE

Technologies for efficient and safe body extenders

Body Extenders are an emerging class of advanced robots that can be worn by human operators to dramatically increase physical performance.
The overall goal of the TESBE experiment is to make viable use of such wearable devices in practical application scenarios, like the prompt removal of debris for the rescue of victims of natural and man-made disasters.
TESBE is one of the ECHORD experiments contributing to the human-interaction research focus. The robotic community sees this as a high priority topic to be addressed in order to allow the future introduction of a new generation of service robots to our societies that can successfully collaborate with humans.
The scientific and technological contributions expected by the TESBE experiment results are, firstly, the definition of new control strategies and techniques that could improve the response of the device to the operators' motion intention while at the same time guaranteeing safety in the various operating conditions. Secondly, a new gripper concept will be introduced that could allow to stably grasp diverse typologies of objects, with very different shapes, dimensions and consistency.

Scuola Superiore Sant'Anna
Italy

Telerobot OCEM S.R.L.
Italy

http://echord.info/wikis/website/tesbe

Started 1/10/2010

Scuola Superiore Sant'Anna
di Studi Universitari e di Perfezionamento

telerobot

TRAFCON

Traffic control of AGVs in automatic warehouses

Università degli Studi di Modena e Reggio Emilia
Italy

Elletric80 S.p.A.
Italy

http://echord.info/wikis/website/trafcon

Started 1/10/2010

Since their introduction in the 1950s, Automated Guided Vehicles (AGVs) have been being used more and more in manufacturing and logistics. One of their most successful applications has been in automatic warehouses where huge quantities of goods need to be moved continuously.

Due to increasing time pressure for the delivery, the number of AGVs circulating in a warehouse is constantly increasing. AGVs often share their workspace with human guided forklifts that are still needed for some specific tasks.

Thus, the problem of regulating and controlling AGV traffic is central in the AGV market, in order to insure both a high delivery rate and safety for the human guided vehicles. This problem is currently being solved using traffic rules that need to be manually tuned for each warehouse, making the installation time long and expensive.

TRAFCON falls under the ECHORD hyper-flexible cell scenario and the mobile manipulators and cooperation research focus. In this experiment, an academic institution, the University of Modena Reggio Emilia, and a global provider of AGV systems, Elettric80, are working together in order to develop and test on a real system a new traffic manager for AGVs. Modern control techniques are being used to improve the efficiency and flexibility of the fleet, making the installation time shorter and the cost of the system lower.

UNIVERSITÀ DEGLI STUDI
DI MODENA E REGGIO EMILIA

ELETTRIC80

TUAV

Tele-operation of unmanned aerial vehicles

This project focuses on applications in which an aerial robot interacts actively with its surrounding environment and/or human operators. The tele-operated UAV scenario involves a VTOL vehicle which is remotely piloted by a human operator in order to approach a target infrastructure (i.e. obstacle), such as bridges, to inspect faults by means of one or several embarked cameras. Quite often, visual evaluation of the distance between the vehicle and the obstacle is difficult and hardly accurate. As a consequence, even experienced pilots may fail to safely pilot the vehicle without collision with the obstacle. Moreover, complex aerodynamic effects induced by strong and unpredictable wind gusts, and/or by interactions between the vehicle and the target complicate the matter even more.
A force feedback joystick will be incorporated in the control interface in order to provide human operators with the sensation of approaching obstacles (including direction to obstacles, the closeness of obstacles), permitting very precise UAV maneuvers.

Université de Nice Sophia Antipolis
France

Skybotix AG
Switzerland

http://echord.info/wikis/website/tuav

Started 1/02/2012

Outlook: The Structured Dialogue

Structured dialogue, in general, refers to dialogue practices developed in order to facilitate and maximize efficiency in dialogues focused on problem definition and action tasks toward problem resolution. For ECHORD it means achieving improved industry-academia cooperation, finding out what industry really needs, increased knowledge transfer and knowledge of future trends in robotics.

Currently, the European robotics industry is faced with multiple challenges, including tough competition outside Europe. In order to become competitive and consequently ensure economic prosperity, long-term collaborations between industry-academia will be the deciding factor in who will succeed. That is why it is of major importance that ECHORD extracts and exploits our high quality experiment results, and this can be ultimately achieved via structured dialogue. This way we will obtain scientific state of the art, upcoming trends of robotics, as well as emerging future applications.

This very valuable information will be obtained via a diverse range of information gathering techniques, such as target group interviews, Delphi studies, conferences, workshops, extensive literature research, and visits within and outside ECHORD. Finally, in order to completely round out the European perspective, we are taking a very close look at what is going on outside Europe. This will be done via a North American and Asian Lab Tour, in which experts from Europe and the ECHORD consortium leaders visit major labs and see what the state of the art actually is, and discuss in person with the experts there. The information generated by the structured dialogue is then analyzed with respect to scientific, technological, economical and societal aspects, using key questions as guideline.

The data collected will be organized for specific target groups and distributed accordingly. This can include advertising opportunities for tailor-made technology transfer and exchange. In addition to this, the structured dialogue also envisages involving all stakeholders in the exchange of ideas and findings with the end-users. Cooperation with associations like EUnited, VDI/VDMA and RIA will be sought as well, completing the goals as foreseen by ECHORD at its inception to connect the community and increase knowledge flow.

Publishing Information

European Clearing House for Open Robotics Development

Technische Universität München (TUM)

Department of Informatics VI
Robotics and Embedded Systems

Boltzmannstr. 3
85748 Garching bei München, Germany

echord@in.tum.de
www.echord.info

Application icons: glyphish.com
Picture on page 21: youbot-store.com
Picture on page 52: imageafter.com

Version 3.1
February 2011

The ECHORD Consortium acknowledges support by the European Comission under FP7 contract 231143.

ECHORD
European Clearing House for Open Robotics Development

Technische Universität München (TUM)

Department of Informatics VI
Robotics and Embedded Systems

Boltzmannstr. 3
85748 Garching bei München, Germany

echord@in.tum.de

---

www.echord.info