LOCOBOT

Toolkit for building low cost robot co-workers in assembly lines

Dissemination and Exploitation Report

Grant agreement no.:	**260101**
Thematic priority:	**FoF.NMP.2010-1**
Objective:	**Plug-and-Produce components for adaptive control**
Start date of the project:	**01.08.2010**
Duration:	**36 month**

Actual submission date:	**30.12.2013**
Organisation name of lead beneficiary for this report:	**PROFACTOR GmbH**

Project co-funded by the European Commission within the 7th Framework Programme (2007-2013) Dissemination level		
PU	Public	✓
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

Document Information

Attachment to the final report

Disclaimer

LOCOBOT ("Toolkit for building low cost robot co-workers in assembly lines") is a project funded by the European Communitie's Seventh Framework Programme under Grant Agreement no. 260101. For more information on the project, its partners and contributors please see *http://www.locobot.eu/*.

Copyright Notice

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0 Context Information

0.1 *The LOCOBOT Project*

The European automotive industry and their component manufacturers are facing the biggest shift in their history. The transition from combustion engines to electric drives (e-vehicle) requires production facilities that can initially deal with low and varying production volumes and can quickly be up-scaled to large numbers at need. LOCOBOT provides a solution to this problem by developing a toolkit for building customized low cost robot co-workers for a broad spectrum of scenarios.

This project will go beyond state-of-the-art in three important topics regarding a low-cost tool-kit for constructing robots:

- Plug-and-Produce robotic modules for robot assistants
- Self-optimizing and adaptive mechatronic systems
- Enhanced sensing and human activity interpretation including usability aspects

A group of key players in the automotive industry (Audi) and in automation components (Festo) as well as high-tech SMEs (e.g. FerRobotics) will be supported by a group of excellent researchers to solve the technical and scientific challenges in LOCOBOT.

The results will be demonstrated by setting up 3 typical and highly relevant use cases in a pilot production line of Audi AG:

- **Demonstrator #1 "starter pre-sorting":** LOCOBOT will automate the starter unit commissioning process and pre-sort the various starters into a specific starter rack according to production sequence.
- **Demonstrator #2 "battery delivery":** LOCOBOT will retrieve and pass an appropriate battery just in sequence to the production line into an appropriate battery rack.
- **Demonstrator #3 "battery mounting":** LOCOBOT will help a human to mount a battery into the engine bay.

The project will be set up in 8 work packages covering all aspects of innovation related activities (WP1-5), demonstration (WP6), dissemination & exploitation (WP7) and project management (WP8) in a carefully balanced way:

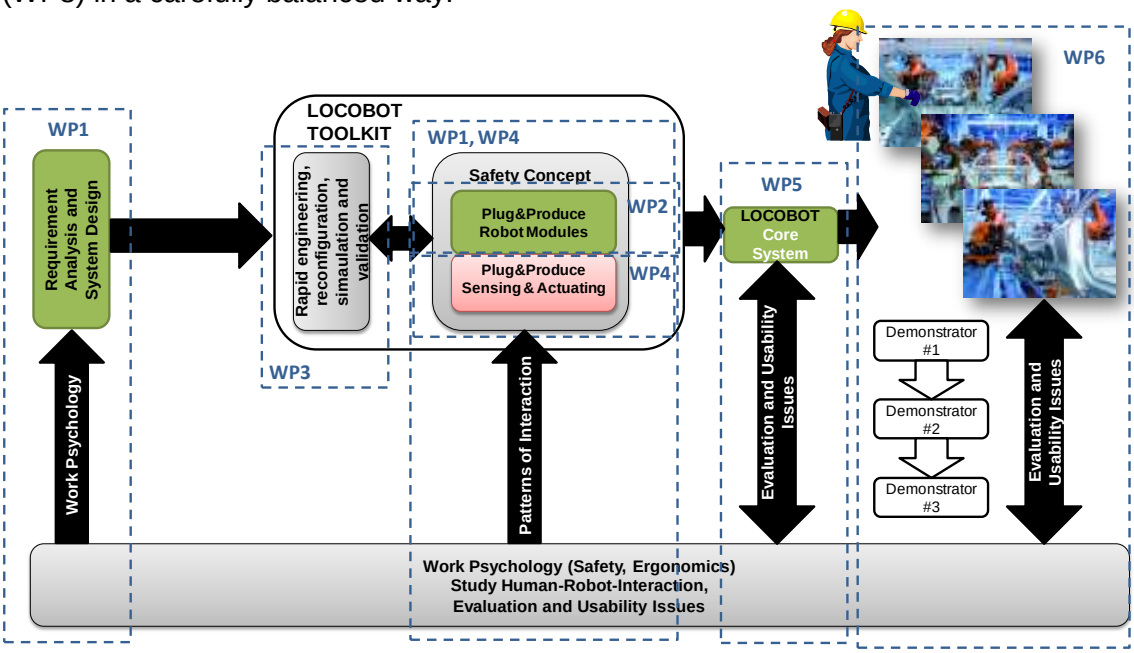

Figure 1: Work package structure of the LOCOBOT project

1 Publishable Summary

LOCOBOT has developed a toolkit for low-cost robots built from a set of plug-and-produce kinematic modules with compliant yet precise actuators and intelligent sensors for man-machine cooperation. The toolkit will provide higher flexibility, adaptivity and scalability, all of which are required to meet the challenges faced by manufacturing in the 21st century. Key players in the automotive industry, along with the manufacturers of automation modules and components, as well as high-tech SMEs, are supported by a group of high-quality researchers in solving the project's technical challenges. Production in the automotive industry is faced with the challenge of high numbers of variants. A robot co-worker will substantially enhance efficiency by cooperating with people and greatly reduce the need for heavy lifting. The need to enter the market early, with reasonably priced vehicles, while increasing production, has to be met by new production technologies such as those developed at LOCOBOT.
LOCOBOT goes far beyond most available systems as it is safe, low-cost and tailor-made, complying with the end-user's need to produce greener, more customised and higher-quality products for their industry. Stemming from its increased flexibility and efficiency, the immediate impact (2-5 years) of LOCOBOT will be about €150 million in savings. This will be 10 times as much in the following years, depending on how the production numbers of the e-vehicle evolve. Three major objectives will be addressed:

- Development of a modular plug and produce robotic assistant platform in which the robot will consist of a set of lightweight, compliant kinematic modules built on a mobile platform.
- Reconfiguration of adaptive control for plug-and-produce components to avoid costly reprogramming and setup procedures for control algorithms and software. Control algorithms need to be adaptive and self-optimising to account for the different kinematic structures, deal with oscillations induced by the mobile platform and achieve precise positioning.
- Intelligent sensing and actuating structures, for which the robot will be equipped with a stereo camera system and audio components to obtain and process audio visual information, so that it can learn to cooperate with human workers.

At a Glance

Call FoF.NMP.2010-1 Plug and Produce components for adaptive control

Start 2010-08-01

Duration 36 month

Costs 5 320 000 €

Funding 3 740 000 € funded by FP7

FP7 Ref. 260101

Type Collaborative project (generic)

Partners:

Website:
www.locobot.eu

1.1 *Dissemination and Exploitation*

Dissemination pillars:

1.) Peer reviewed papers in journals for dissemination of the scientific results.
The results will be published in IEEE or other relevant journals with a high impact factor. A clarification of IPRs before publication is strictly required but it‘s no reason for —non publishing activities. This will be regulated in a separate IPR point of the consortium contract. As described in the chapter —Management of IPR‖ conflicts of patents vs. publication will be solved in the steering committee. The general rule is, that patents have a higher priority than publications.

2.) Papers, talks and presentations of the results in international Conferences, technology monitoring and training of scientific staff.
A conference and publication plan with defined and binding targets for point 1 and 2 will be part of the consortium agreement.

3.) Presentations, talks and visits of international fairs and workshops with industrial focus together with the industrial partners (for example Hannover fair). Project partners will exhibit at trade fairs and present the results of the project. Trade fairs that we plan to attend are on the one hand large automation fairs such as the —Automatica‖ in Munich, and on the other hand local fairs dedicated to the specific areas of the project partners (HMI, - Hannover Trade Fair for Industry (D), MOTEK - Automation Fair in Stuttgart (D), SMART - Automation Fair in Linz (A), FA-KUMA - Trade Fair for Plastics Processing in Friedrichshafen (D)

4.) Active involvement in international Organisations and platforms such as Manufuture (Trendset-ter). Profactor is acvtive as well in Manufuture in Austria and also in Manufuture international (www.manufuture.org). In addition to this Profactor is active in the OSG (Operation support group) of MINAM – Micro- and Nanomanufacturing – which is also a promising field for LOCOBOT applications. Currently PROFACTOR is the chair of the EUREKA umbrella PRO- Factory (www.profactory.eu) and member in several other platforms. Together with the involvement of the partners in there relevant organisations (VDMI/VDMA) a broad basic for dissemination is established and will be used for an exploitation as well of the knowledge and also of different application into the market. It is also used to influence the process bringing adaptive robotic components to a broader industrial use and for creating addition projects with the members of the consortium.

The strategy of exploitation of the LOCOBOT project results is based on 4 pillars

1.) Implementation of the developed prototypes into the **applications of the industrial core partners**, adaption and —industrial usable products‖ starting during the project funded either by own reFP7- Industrial partners act as friendly reference customers.
2.) Market diversifications of markets which are closed to the developed applications, penetration of the car manufacturer market with applications which are not **owned by AUDI.** (Motorcycles, Trucks..)
3.) Market diversifications to markets which are in totally different fields than the developed applications like **solar industry, clean room applications and handling of damageable semi-finished parts.**
4.) Components as a **catalogue product** you can choose from a catalogue (FerRobotics, Festo), turning from the project level to the product level.

Achievements:

Project presentations (wider public) (**PROF**, all)

- Project presentations as well as an overview and also as special presentations for different tasks exists
- Homepage (*www.locobot.eu*) with a lot of public information's exist
- Project was presented at the FoF Workshop in Brussels in Nov 2011 (see. 7.3)
- Locobot was also presented at the European opendoors day in Brussels, 5. May 2013
- 

Scientific publications and conferences (HWU, all)

List of Publications

2012

Publications in peer reviewed Journals

Christian Wögerer, Harald Bauer, Martijn Rooker, Gerhard Ebenhofer, Alberto Rovetta, Neil Robertson, and Andreas Pichler *"LOCOBOT – Low Cost Toolkit for Building Robot Co-workers in Assembly Lines"* In: C.-Y. Su, S. Rakheja, H. Liu (Eds.): International Conference on Intelligent Robotics and Applications ICIRA October 3-5 2012, Part II, LNAI 7507, pp. 449–459, Springer-Verlag Berlin Heidelberg 2012 [*LOCOBOT project presentation - Low cost toolkit for building robot co-workers in assembly lines*]

M. Plasch, A. Pichler, M. Rooker, Simplified Programming of Modular Robotic Systems Based on Workflow Modeling, Austrian Robotics Workshop 2012, Graz, Austria, 3-4 May 2012

Contributed speeches/ papers at international conferences

Characterising Pedestrian Detection on a Heterogeneous Platform, C.Blair, N.M.Robertson, D.Hume, Workshop on Smart Cameras for Robotic Applications, IEEE/RSJ Int. Conf. Intelligent Robotics and Systems (IROS)

GEI+HOG for Action Recognition, T.Whytock, A.Belyaev, N.M.Robertson, 4th UK Computer Vision Student Workshop, British Machine Vision Conference, Surrey, UK, September 2012

Wasit Limprasert, Andrew Wallace, Greg Michaelson *"Accelerated People Tracking Using Texture in a Camera Network"* International Conference on Computer Vision Theory and ApplicationsVISAPP 2012, page 225-234. [*Accelerated people tracking using texture in a camera network*]

P. Barattini, C. Morand and N.M. Robertson *"A proposed gesture set for the control of industrial*

collaborative robots" 21st International Symposium on Robot and Human Interactive Communication, IEEE RO-MAN 2012, Paris, France, September 9-13, 2012, ISBN 978-1-4673-4604-7 [*A Proposed Gesture Set for the Control of Industrial Collaborative*]

Matthias Plasch, Andreas Pichler, Harald Bauer, Martijn Rooker, Gerhard Ebenhofer *"A Plug & Produce Approach to Design Robot Assistants in a Sustainable Manufacturing Environment"*, 22nd International Conference on Flexible Automation and Intelligent Manufacturing (FAIM 2012), Helsinki, Finland, 10-13 June 2012. [*A Plug & Produce Approach to Design Robot Assistants in a Sustainable Manufacturing Environment_FAIM2012*]

Eleonora D'Arca, Neil M. Robertson, James Hopgood *"Person tracking via audio and video fusion"* 9th IET Data Fusion & Target Tracking Conference, London, 16-17 May 2012. [*PERSON TRACKING VIA AUDIO AND VIDEO_IET*]

Stefanie Angerer, Christoph Strassmair, Maren Roettenbacher, Max Staehr *"Give me a hand -The Potential of Mobile Assistive Robots in Automotive Logistics and Assembly Applications"* 5th Annual IEEE International Conference on Technologies for Practical Robot Applications (TePRA), Massachusetts, USA, April 22-23, 2012. [*Give me a hand*]

2011

Contributed speech/ papers at international conferences

Warakorn Gulyanon, Claire Morand, Neil. M. Robertson and Andrew. M. Wallace *"Real-time Active Visual Tracking with Level Sets"*, Proc. 4th International Conference on Imaging for Crime. Detection and Prevention ICDP-11, 3-4 Nov2011. [*Real-time Active Visual Tracking with Level Sets*]

Andreas Pichler[1], Harald Bauer[1], Gerhard Ebenhofer[1], Jens Bunte[2], Maren Röttenbacher[4], Neil Robertson[3], James Hopgood[3], Alberto Rovetta[5], Paolo Ferrara[6], Rüdiger Neumann[7], Paolo Barattini[8], Ricardo Velez[9]*:" LOCOBOT: Toolkit for building low cost robot co-workers in assembly lines*", Project Presentation at the Austrians Robotic Workshop, Hall in Tyrol (Austria), May 23-24 2011. [*Toolkit for low-cost robot co-workers_ARW*] [*LOCOBOT project presentation_1pager*]

Claire Morrand, Neil M. Robertson "Audio-Visual HRI for Robots in Factories" Project Presentation at the European Robotics Forum, Odense (Denmark), 6th March 2011. *[Audio-Visual HRI for Robots in Factories]*

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Profactor GmbH(Austria)[1], Audi AG (Germany)[2] , Joint Research Institute for Signal and Image Processing, Heriot-Watt University & Edinburgh University (United Kingdom)[3] Hochschule Ingolstadt, (Germany)[4], Politecnico di Milano (Italy) [5] , FerRobotics Compliant Robot Technology GmbH (Austria) [6] Festo AG & Co. KG (Germany)[7] Ridgeback sas (Italy) [8],Visual Components Oy (Finland) [9]

2013:

Wasit Limprasert, Andrew Wallace, and Greg Michaelson, Real-time people tracking in a camera network, IEEE J of Emerging Technology, Circuits and Systems(JETCAS)

G. Ebenhofer;A. Zoittl, G. Strasser "Developing Modular Reusable IEC 61499 Control Applications with 4DIAC" (submitted for INDIN 2013)

P. Barattini, C. Strassmair, M. Staehr and M. Roettenbacher, Physical and psychosocial safety and

risk assessment of a mobile robotic industrial co-worker*, ICRA 2013 Karlsruhe

Paolo Barattini and Andrea Corradini, Gesture input and annotation for interactive systems*, ICRA 2013 Karlsruhe

A. Pichler, P. Barattini, C. Morand, I. Almajai, N. Robertson, J. Hopgood, P.Ferrara, M. Bonasso, C. Strassmair, M. Rottenbacher, M. Staehr, R. Neumann, M. Tornari, A. Rovetta, M. Plasch, H. Bauer, C. Woegerer, Tailor made Robot Co Workers based on a Plug&Produce Framework, FAIM 2013, Porto

P. Barattini, C. Morand. , I. Almajai, N. Robertson, J. Hopgood, P.Ferrara, M. Bonasso, C. Strassmair, M. Rottenbacher, M. Staehr, R. Neumann, M. Tornari, A. Rovetta, M. Plasch, H. Bauer, C. Woegerer,A. Pichler, Towards Tailor made Robot Co Workers based on a Plug&Produce Framework, ISAM 2013

Tailor made Robot Co Workers based on a Plug&Produce Framework, Springer Book, WRSM 2013, CCIS 371 proceedings

A.R. Fardana, S. Jain, I. Jovancevic, Y. Suri1, C. Morand and N.M. Robertson, Controlling a Mobile Robot with Natural Commands based on Voice and Gesture

Workshop on Human Robot Interaction (HRI) for Assistance and Industrial Robots. Scientific Knowledge, Standards and Regulatory Framework. How do I design for the real world? Organizers : Gurvinder S. Virk, A. Tapus, F. Bonsignorio,, N. Mirnig, M.Tscheligi, S. Haddadin, M. Vincze, Han Boon Siew, H. Samani, N. Bellotto, A. Corradini, P. Barattini, N. Robertson, C. Morand, A. Rovetta, C. Woegerer, A. Pichler. *http://www.kontor46.eu/kontor46/ICRA_2013_Workshop.html*, ICRA 2013, Karlsruhe

Statistic:

19	Paper in Proceedings of a Conference/Workshop
1	Peer reviewed publication
1	Article/Section in an edited book or book series
0	Thesis/Dissertation
0	University Publication/Scientific Monograph

Communication and dissemination inside the scientific community (**PROF,** all)

- Presentation at the FoF Workshop in Brussels (November 2011)
  - Short Presentation of LOCOBOT
  - Discussion with other related projects
- EFFRA Brochure: Overview of FP7-Funded projects under the first call "Developing Technologies for 'Factories of the Future“ (http://www.effra.eu/attachments/article/123/101209%20EFFRA%20Projects%20brochure%20FINAL-%20ALL.pdf)
- EFFA Website: www. Effra.eu - http://www.effra.eu/research-a-innovation/fof-projects.html
- 2nd Workshop on Impact of the Factories of the Future PPP on 15-16 March 2012 , Brussels – Presentation of LOCOBOT, Contact with other relevant projects of the 1st and 2nd Call of PPP, Impact Workshop
- Workshop on Robot Co-Workers in Manufacturing Environments (Speakers: A. Pichler, P. Ferrara, F. Walhoff, J.Hopgood, C.Morand), EU Robotics Forum 2012, Denmark
- Industrial Technologies Conference 2012, Concert Hall – Aarhus, 19 - 21 June 2012, Locobot booth together with other EU Projects Presentation, Demos

- Workshop "Standards Supporting Energy Efficiency in Manufacturing Processes" - 5th June 2012
- 3rd Workshop on Impact of the Factories of the Future PPP on 11-13 March 2013 , Brussels – Presentation of LOCOBOT, Contact with other relevant projects of the 1st and 2nd Call of PPP, Impact Workshop

http://ec.europa.eu/research/industrial_technologies/meetings-and-workshops_en.html

Other activities:

Participation of Ridgeback in the ISO Working Groups on Assistance and Service Robotics Meeting Milan July 2012, and input contributions to the draft Standards based on LOCOBOT project results (safety, robot control, HRI)

LOCOBOT link added on the website of Robotiquette: *www.robotiquette.eu; http://www.robotiquette.eu/links/*

LOCOBOT Description on the PROFACTOR Homepage: *http://www.profactor.at/nc/projekte/alle-projekte/projekt-detailseite/news/locobot-414.html*

LOCOBOT link added to the Human Robot Interaction article of Wikipedia: *http://en.wikipedia.org/wiki/Human%E2%80%93robot_interaction*

Creating a pictogram label for ISO:

Figure 1: Suggested label for collaborative use according to ISO 10218-2:2009

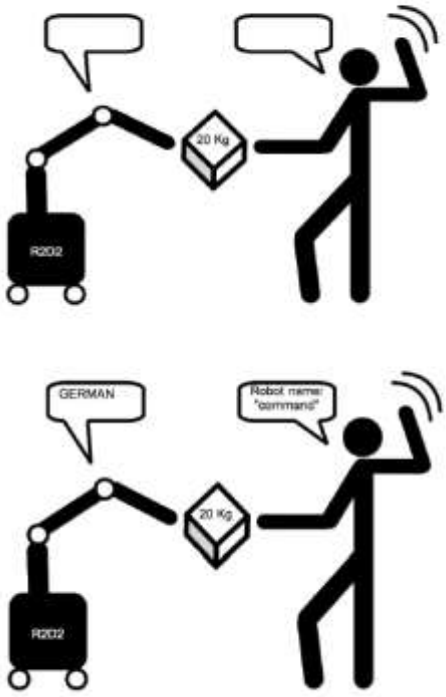

Figure 2: Label for collaborative use developed in the frame of the LOCOBOT FP7 project by partner RBK

Youtube Video: http://youtu.be/i9Faqzy1cxc
PR Video: /PR_Material/ Approvaed/FHI_Dissemination/Locobot2.wmv for FHI_Dissemination Video

Public Videos:

YOUTUBE

- Locobot robot - Politecnico di Milano_ 08.09.2012

http://www.youtube.com/watch?v=F0xEy6qaNoI

- LOCOBOT LOW COST MODULAR ROBOTIC CO-WORKER TOOLBOX starters scenario_15.09.2012

http://www.youtube.com/watch?v=i9Faqzy1cxc

- Locobot robot presentation at Museo della Scienza e della Tecnica "Leonardi da Vinci"_13.10.2012

http://www.youtube.com/watch?v=xJuEenErnuM

EuronewsTV
The video shows some parts of partner project Custompacker first, later the Locobot project

The program is already available in the following languages:

English: http://www.euronews.com/2013/02/18/robots-on-the-factory-floor/
French: http://fr.euronews.com/2013/02/18/des-robots-au-travail/
German: http://de.euronews.com/2013/02/18/roboter-als-arbeiter/

Locobot – Webpage

- 3DCreateToolbox Video

http://www.locobot.eu/2012/09/12/how-to-configure-an-individual-locobot/3dcreatetoolbox/

- model based application programming - LynxMotion Video

http://www.locobot.eu/2012/09/12/model-based-application-programming/lynxmotion/

- locobot notte dei ricercatori

http://www.locobot.eu/2012/11/08/locobot-on-28th-september-in-the-night-of-researchers-at-museum-della-scienza-e-della-tecnologia-in-milan/locobot-notte-dei-ricercatori-2/

Night of the Researchers, an European Event in Museum of Science "Leonardo da Vinci" of Milan on the night of 28th September. **Presentation of LOCOBOT** by Alerto Rovetta

Visit of Prof. Alberto Rovetta in the US presenting Locobot (to Stanford and JPL, California) October 2012

- VISIT TO UNIVERSITY OF STANFORD, CALIFORNIA - PALO ALTO - LABORATORY OF COMPUTER SCIENCE AND SURGERY - PROF. KEN SALISBURY
- VISIT TO ARTIFICIAL INTELLIGENCE LABORATORY OF UNIVERSITY OF STANFORD, CALIFORNIA, PALO ALTO, DAY 5 OCTOBER 2012, DIRECTOR PROF. OUSSAMA KHATIB
- VISIT TO THE JET PROPULSION LABORATORY - NASA - PASADENA CALIFORNIA, OCTOBER 9, 2012, DR. LEON ALKALAI

COMMENTS FOR LOCOBOT PARTNERS AND UTILITIES FOR FUTURE APPLICATIONS

The main topics which have appeared as important and interesting for they present of Locobot design and for the future developments, are many. In Alberto Rovetta´s opinion, after the discussions, the analysis, the presentations and visits to the best Laboratories. Many of them can be underlined-

1. *Importance of the interaction between the robot and the human, in front of safety, gesture control, analysis of faces and of fingers, RFID use and reliability. Details on voice control*
2. *Necessity of a beautiful design of the platform and of the robot, because beauty is a factor which supports the intelligence and the participation. The platforms in USA are very smart. Locobot too is smart and it can be integrated in many systems.*
3. *Software developments connected with the new approaches in neurology and human psychology, where new trends are changing the knowledge's, like neuron mirrors, brain knowledge, and many increasing elements*
4. *Use of many sensors as lidar, infrared, ultrasonic, to perform the best knowledge of the environment*
5. *Concept of robot as a safe and reliable entity, as a possible perfect executor of tasks.*
6. *Ideas of software flexibility to apply in industrial fields, in non-industrial fields, in space robotics, in rehabilitation robotics.*

The proposal of a joint Workshop between the visited Laboratories and Locobot Partners has been propose, to be examined for the future years.

Setup of a Homepage http://www.isorobotics.org/ Evidence Based Robotics and Normative Data for Standardisation

Report about LOCOBOT in FD Mediagroep B.V., statutair gevestigd te Amsterdam. Handelsregister nr. 33292629 De disclaimer van toepassing op e-mail van de FD Mediagroep vindt u op http://fdmg.nl/producten/790832-1205/disclaimer

- Presentation of LOCOBOT during the OPEN DOORS in Brussel, 4.5.2013 ; http://www.locobot.eu/event/open-door-day-2013-at-the-european-commission/; http://ec.europa.eu/belgium/events/euopendoors/index_en.htm

EURONEWS VIDEO:
The program is already available in all the eleven languages on our website:

English: http://www.euronews.com/2013/02/18/robots-on-the-factory-floor/
French: http://fr.euronews.com/2013/02/18/des-robots-au-travail/
German: http://de.euronews.com/2013/02/18/roboter-als-arbeiter/
Italian: http://it.euronews.com/2013/02/18/robot-che-sentono-e-parlano/
Spanish: http://es.euronews.com/2013/02/18/robots-al-trabajo/
Portuguese: http://pt.euronews.com/2013/02/18/quando-o-robot-ajuda-o-trabalhador/
Russian: http://ru.euronews.com/2013/02/18/robots-on-the-factory-floor/
Arabic: http://arabic.euronews.com/2013/02/18/robots-on-the-factory-floor/
Turkish: http://tr.euronews.com/2013/02/18/robotlar-insan-gucune-destek-olabilir-mi/
Persian: http://persian.euronews.com/2013/02/18/robots-on-the-factory-floor/
Ukrainian: http://ua.euronews.com/2013/02/18/robots-on-the-factory-floor/
Greek: http://gr.euronews.com/2013/02/18/robots-on-the-factory-floor/

and it's also being uploaded on the euronews' YouTube channels:

English: http://www.youtube.com/watch?v=LiOVuGo7dPA
French: http://www.youtube.com/watch?v=Yf4oElzNEps
German: http://www.youtube.com/watch?v=6zsuXkhsELk
Italian: http://www.youtube.com/watch?v=oxlCdpSkmFQ
Spanish: http://www.youtube.com/watch?v=dF9tSWA7o50
Portuguese: http://www.youtube.com/watch?v=dZQ6VGQBhbg
Russian: http://www.youtube.com/watch?v=nurOue3VNx0
Arabic: http://www.youtube.com/watch?v=sR1mXUmFG9s
Turkish: http://www.youtube.com/watch?v=G6FDxmLTzV8
Persian: http://www.youtube.com/watch?v=LyF8znDz7fQ
Ukrainian: http://www.youtube.com/watch?v=C6r-gAVYUhE
Greek: http://www.youtube.com/watch?v=psnfOmhVDMw

- Artikel in Upper Austrian News about LOCOBOT

Der Roboterarm des Locobots übernimmt die Last: Er hebt die Autobatterie an. So kann sie der Mitarbeiter ins Fahrzeug einpassen, ohne selbst das Gewicht zu spüren zu bekommen.

Die Helfer der Zukunft

Er ist grau, kalt, hart. Er ist stark, groß, intelligent. Er wirkt einschüchternd, wenn man neben ihm steht. Und dennoch könnte er der beste Freund der Arbeitnehmer werden. Der „Locobot" ist einer jener Helfer, der den Produktionsablauf der Zukunft prägen wird.

Von Elisabeth Eidenberger

Der Locobot ist ein Roboter, genauer gesagt ein Assistenzroboter. Er steht bei der Steyrer Forschungsfirma Profactor im Labor und wird künftig in Produktionsbetrieben Seite an Seite mit den Menschen arbeiten.

Der Locobot – kurz für „low cost robotor" – wird entwickelt für das Problem der „Losgröße 1". „Automatisierung hat sich bisher nur in Unternehmen gerechnet, die in großen Losgrößen produzieren. In Zukunft müssen die Firmen aber flexibler auf Produktwechsel reagieren, weil sie eine größere Variantenvielfalt haben. Dafür braucht es kleinere Roboter wie den Locobot", sagt Andreas Pichler, technischer Geschäftsführer von Profactor.

Die Maschine liefere Kraft, Präzision und Wiederholgenauigkeit, der Mensch sei der Problemlöser. „Es ist sinnvoll, die so beiden Akteuren zu koppeln", sagt er. Ein Beispiel ist der Einbau einer Batterie in ein Auto. „Der Roboter hebt die Batterie und führt sie Richtung Auto. Den verschiedenen Bauschnitten des Einsatzes macht dann der Mensch", erklärt Pichler. Derselbe könnte mit dem Verlegen von Kabeln oder beim Platzieren von Steckern gemacht werden.

In der Zusammenarbeit mit dem Menschen stehe die Sicherheit an oberster Stelle. Der Roboter weicht zum Beispiel zurück, wenn er Widerstand „spürt". Gleichzeitig lässt sich der Roboterarm vom Menschen durch sanften Druck führen.

Mit Assistenzrobotern würden Produktionsbetriebe auch auf den demografischen Wandel reagieren. Laut der Europäischen Kommission werden im Jahr 2020 die Arbeitnehmer in einem Industriebetrieb im Durchschnitt 48 Jahre alt sein. Mit Assistenzrobotern sei es nun möglich, Arbeitsplätze ergonomischer zu gestalten und ältere Menschen länger in Beschäftigung zu halten. „Die Tätigkeit des schweren Tragens übernimmt dann die Maschine", sagt er. Auch für integrative Werkstätten sehen Assistenzroboter ein Thema.

Ebenso wie gerne für Klein- und Mittelbetriebe. „Bisher kosten Roboter in der Industrie bis zu 400.000 Euro", sagt Pichler. Der Locobot soll maximal 70.000 Euro kosten und ist gleichzeitig für mehrere Aufgaben nutzbar.

Der Locobot von oben: Der Greifarm übernimmt das Tragen der Batterie.

Harald Bauer und Andreas Pichler von Profactor arbeiten am „Helfer der Zukunft".

Weg zum „großen Ziel"

Seit zwölf Jahren arbeitet Profactor in der Robotik. „Und es wird sicher noch acht bis zehn Jahre dauern, bis der Locobot tatsächlich in Produktionen im Einsatz ist", sagt er. Es brauche neben der technologischen Entwicklung rechtliche Rahmenbedingungen, Normen und die Akzeptanz der Arbeitnehmer zu Umgang mit dem Roboter.

Ob man auf dem Weg zum „großen Ziel" nicht die Motivation verliere? „Das Schöne ist, dass es auf dem Weg zum Ziel sehr viele Zwischenerfolge gibt. Wir können einzelne Technologien auskoppeln und unmittelbar in anderen Bereichen einsetzen", sagt Pichler. „Die Mitarbeiter freuen darauf und freuen sich, wenn etwas richtig funktioniert. Solche Auskopplungen kann man schwer stoppen, sie passieren", ergänzt Harald Bauer, Teamleiter der Softwareentwicklung.

Profactor gehe bei Innovation daher neue Wege – weg von der Gelehrtenstubenidee der klassischen Forscher hin zu gemeinem Wissen. „Wir haben eine neue Plattformstrategie Profactor Labs. Hier kann man sich unsere Technologien im Internet herunterladen und offenen Gedankenaustausch führen", sagt Bauer. „Hier kommen immer wieder konkrete Ideen, wie man unsere Technologien kommerziell nutzen könnte", sagt er. Ideen, auf die man selbst wohl nicht gekommen wäre. „Es ist unglaublich, wie viele Ecabs weltweit, vor allem in den USA, sich hier einbringen", sagt Bauer.

Der Locobot verrichtet indes im Labor weitere Testaufgaben. Insgesamt sind zehn Partner an dem von der EU geförderten Forschungsprojekt beteiligt. 25 Forscher arbeiten daran. Profactor ist für den Software-Teil zuständig. Wenn der Locobot am Ende gebaut ist, ist nicht klar. „Es ist immer sehr schwer, Verwertungspartner für die gesamte Entwicklung zu finden. Da schauen wir gerade die einzelnen Projektpartner Elektrotex, wenn jemand die Technologien einsetzen will", sagt Pichler.

- Article about LOCOBOT in Upper Austria

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PROFACTOR: Assistenzsysteme

Menschenfreundliche UND wettbewerbsfähige Fabrik

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- **PROFACTOR BLOG:**

Seit zweieinhalb Jahren koordiniert PROFACTOR

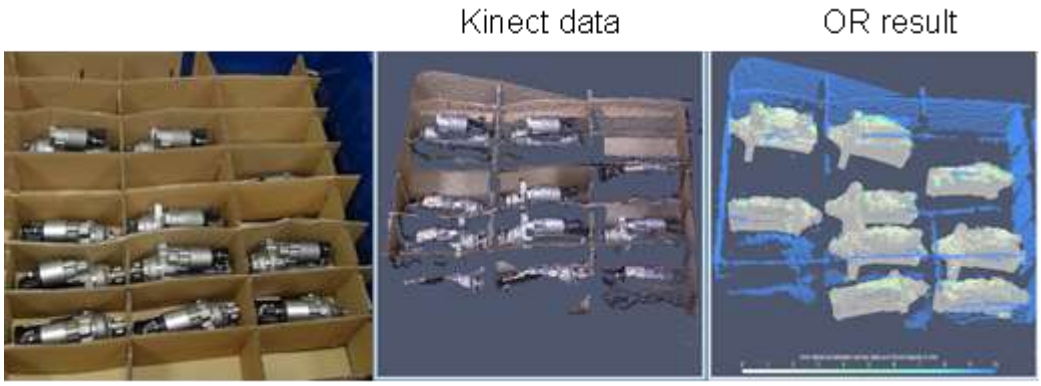
das internationale Forschungsprojekt *Locobot.* Insgesamt zehn *Partner* sind an der Entwicklung des „Low Cost Robot Co-Workers“ beteiligt. Anfang Februar konnten bei einem Endkunden aus der Automobilindustrie, der auch im Projektkonsortium vertreten ist, die Zwischenergebnisse erfolgreich präsentiert werden.

- **PROFACTOR Link: Headline: Did you know that CandelOR is heavily used for Locobot's intelligence ?**

Using the power of *CandelOR*, unknown/unstructured scene data can be replaced by high quality CAD models.
Within Locobot's starter presorting scenario workflow, *CandelOR* detects

- the container positions (which allows to find suitable parking positions for the mobile platform).
- the battery object positions on pallets respectively starter positions within containers (which allows to grasp these objects autonomously).
- the commissioning table position and its next free slot (which allows to deposit the picked starter autonomously).

See below a screenshot illustrating the detection of starter objects.



http://candelor.com/2013/03/01/robots-on-the-factory-floor/

Robotic Interview about LOCOBOT: *http://www.robotspodcast.com/list/*
Possible Channel for Business: *http://www.robotspodcast.com/list/*
IMAGE and PR CD for “Everybody” showing the Advandage of LOCOBOT

Flyer:

Figure 2: Locobot flyer messages and flyer layout

In conclusion the Locobot solution has shown a special advantage in saving “red seconds” at production sites. A “red workplace” means non-ergonomic tasks, lifting heavy loads for a prolonged time. This opens a series of business opportunities, even if the project result is a functional prototype and not a product yet.
The consortium tries to install reference application for bin picking, to show its benefits on a wider public.