Factory-in-a-day

Newsletter #3

Dear friends of Factory-in-a-day,

Last May we had our first review meeting with our project officer in Brussels. We are pleased to report that the overall feedback was very positive. We are on a good track and even though there is always room for improvement we are making good progress. Some of the results will be explained in more detail over the next pages. One of the results of Factory-in-a-day that have been noted by the EU, is the fact that we have tried to bring our ideas to market right from the start. So far, three start-ups are either up and running or in the founding process. The most advanced one is Delft Robotics, a company that develops custom comprehensive solutions of robotic systems with 3D vision. We will update you on further progress of the new companies in the upcoming newsletters and keep our fingers crossed for a successful start of the other start-up companies.
Best regards,

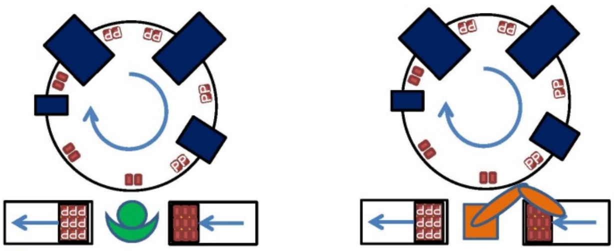
Prof. Martijn Wisse, Coordinator

Update on Philips‘ shaver use case

The Philips case is the most advanced case in our project.The idea is to automate a step in the production of shavers. In this case, instead of a human worker doing the work manually, a robot has to put shaver parts – the casing – in trays which will then be placed in a tampon printing machine (see picture 1).
In several workshops the team has looked into different aspects on how to robotize this task in a way that it is also attractive from a business point-of-view. The question regarding the performance is of great interest to the project as it proves that the idea of Factory-in-a-day is realistic.
In the last months, the team carried out integration tests. This had a positive effect on the performance. The biggest improvement in the operations phase was on the Input Tolerance Requirement (ITR). The system is more tolerant on the exact placement of parts. This is an important feature for future cases. In order to reach this ITR improvement the vision components had to be developed.

New vision components

With these new vision components the position of trays and parts are not fixed, but detected by using 2D and 3D camera techniques. This allows for shorter installation time and lower costs, since no input device is needed to precisely orientate the parts for the robot to grasp. It also provides more flexibility for variations in the parts and the trays. For instance, if another type of a part in a different type of tray needs to be handled, no hardware



Picture 1: On the right: human worker doing task, on the left the robot.

changes are needed (except for the gripper). Only the models for the vision modules need to be updated. This means the system can more easily be re-used in a different case with similar tasks.
Although the performance in this test case with the shaver handling was positive, it remains to be seen how generic these components can be used and how easily they can be implemented in future cases. With respect to the future success of Factory-in-a-day, this topic is important. Simply because of the fact that if reliability and speed are not improved for future cases, it will be difficult to install systems at customer sites.

Performance checks

The need for this development is very well visible in the chart comparing the different stages of the project with two workshops testing the feasibility – we call them Robothons.

To follow the progress in the project, we compare this shaver case demonstrator with a similar one built in June 2014 as well as an existing industrial robot system.
The overall comparison shows that the Factory-in-a-day approach is successful in the sense that the installation time/ effort is indeed only a fraction of that of standard industrial robot systems.
On the other hand, the automation level and the production rate – the number of approved parts that leave the system - are so far not competitive with standard industrial robot systems. On the automation level, the output of standard systems is 27 times higher than that of the Factory-in-a-day robot. At first sight these numbers seem to be discouraging, but with the progress of the project and the fact that we are still in an early phase, we are still convinced that our project goals are doable, although they are challenging.

Next steps need to focus on developments of fast plug-and-play generic components to improve both the installation time and the overall reliability of the system. These are essential requirements to successfully carry on with the project.

Metric	Existing industrial robot system	Tampon print case June 2014	Tampon print case March 2015
Installation effort	8750 [hrs]	200 [hrs]	120 [hrs]
Reuse value	25%	65%	71%
Installation time	40 [weeks]	30 [days]	2 [days]
Uptime	91%	67%	67%
Production rate	12,0 [parts/min]	1,8 [parts/min]	1,6 [parts/min]
Operator load	0,1 FTE	0,33 FTE	0,33 FTE
Automation level	130 [parts/min/operator]	5,5 [parts/min/operator]	4,8 [parts/min/operator]

Comparison of KPIs for different test cases of Factory-in-a-day

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Spotlight on: Materialise

One of the industrial partners in Factory-in-a-day is the company Materialise. The company is specialized in additive manufacturing, more commonly known as 3D-printing. In 2014, Materialise made an IPO (Initial public offer) at NASDAQ.

In the context of our project, Materialise is designing and producing grippers and carriers for the test cases. The most advanced one is the shaver production case by Philips. Here, the robot has to put shaver parts in a special tray and then put the tray in a tampon printing machine. One question was here what kind of gripper is the most efficient one to do that?

Together with the partners, Materialise developed a 3D-printed gripper customized for the tasks of the robot. This means that the grippers are especially made for being able to carry out two gripping functions at once: housing the parts of the shavers as well as picking up the whole tray and placing it. This is the most efficient way of handling this task as the robot otherwise has to “change hands”, which is time consuming.

The gripper is made of laser sintered PA, laser sintered TPU and carbon tubing. The advantage is that the gripper was tailored towards the two specific tasks it had to carry out, making it a very complex part. The advantage of using 3D-printing is that this extra complexity comes at no extra production-cost or time.

The complexity does have a price in the design phase: it takes (expensive) engineering time. The goal is to develop design tools that facilitate the designing and iterating the design of a gripper faster.

Despite the flexibility of 3D-printing, the design was made modular. This reduces the price and time required for modifications (e.g. when the type of shaver changes).

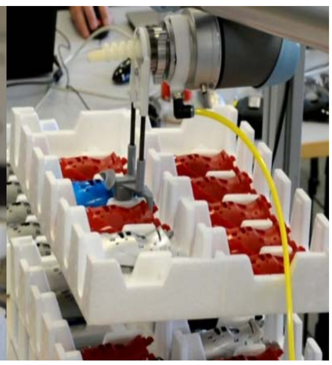
In the process of developing the 'tray gripper‘, two iterations were necessary. The improvement was needed on the general stiffness, size of the 'feet' and some extra clearance was needed in order to allow the trays to be picked.

Several iterations were made of the gripper using a simple (low-cost) Makerbot desktop 3D printer. This is easy for quick try-outs and in a real-case scenario, can be taken along on-site.

The final design

These iterations were done mainly to improve reliability and increase the tolerance on the positioning of the gripper while picking up parts. Furthermore, the design of the jigs also turned out to be very reliable. The jig allowed the parts to be located with a very large tolerance on the release position, thus providing enough flexibility for the robot to function. All in all, the final gripper design proved to be very reliable.

Picking up the shaver parts …



and with the same gripper also the tray. © Materialise

The Philips case has helped to keep the focus on the time-critical factors of the design. This started already at the first meeting. The goal is now to find a completely different case study. This will then help to estimate the “completeness” of the developed design toolbox. Furthermore, our goal is also to look for a gripper that can handle a variety of products rather than just one very specific object.

ROS Industrial: Why is ROS so useful for Factory-in-a-day?

ROS Industrial is a flexible framework for writing robot software and is also widely used in our project. Here are some short explanation why we choose to do so. In comparison to ROS, ROS Industrial focuses on code quality and reliability. It contains libraries, tools and drivers for industrial hardware. More information on: http://rosindustrial.org/

“ROS has a distributed and modular design and thus allows to mix and match robotic tools and functionalities from a large body of existing work. Furthermore, the components talk to each other using interfaces that have become a de facto standard.
This nicely illustrates the parallel with the 'Plug & Work Robots‘-aspect of our project. ROS is an open source core, based on permissive licensing, and also friendly towards commercial and proprietary deployments. It helps to offset the elevated costs of implementing a basic robotics software infrastructure.
This also reflects the core idea of Factory-in-a-day to offer flexible and affordable robots.
Another important aspect is - as there are many existing tools for agile and effective application development - that the system is consistent with the short deployment time goals of Factory-in-a-day.”
Dr. Adolfo Rodriguez Tsouroukdissian, Senior Researcher at PAL Robotics

“ROS is used in the core of the project Factory-in-a-day. We aim to increase the speed of development and installation of industrial robots for SMEs. Therefore, it is important to create intelligent, flexibel robots within a minimum amount of time. ROS makes this possible for us.“ (statemen taken from video on http://rosindustrial.org/contributors/)

Prof. Martijn Wisse was recently appointed the Scientific Coordinator of the ROS-Industrial Consortium Europe.

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Short news and Events

Factory-in-a-day has been presented here in the past months:

- European Robotics Forum in Vienna, March 2015
- Hannover Messe, April 2015
- GreenTech Innovation Summit in Amsterdam, June 2015
- IROS – IEEE/RSJ International Conference on Intelligent Robots and Systems in Hamburg/Germany September 2015

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Robot TOM with robotic skin at the European Robotics Forum 2015.

Booth at IROS 2015.

We are sorry to announce that our partner Unicam has decided to step out of the consortium. Their contributions will be covered by other partners.

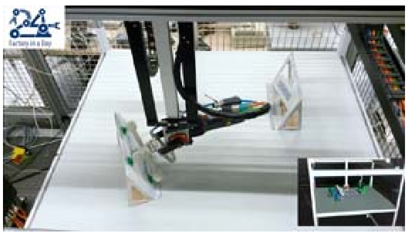
Prof. Wisse © TU Delft

Coordinator appointed professor for Biorobotics

We are proud to annouce that our coordinator, Martijn Wisse, has been appointed the first professor of Biorobotics in the Netherlands. The professorship is located at TU Delft's Faculty of Mechanical, Maritime and Materials Engineering (3mE). His appointment will strengthen TU Delft's research and education on nature-inspired robot designs and cooperation between humans and robots.

New video

We have a new video on our YouTube channel on "Autonomous motion planning: Flexible handling of large plates" and demonstrates the work of our partner Siemens, on how a robot can find a collision-free, accessible path in a work space in order to handle a specific work piece.



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