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Robotics & Automation Report, 22nd issue 2010

The Robotics & Automation Report, 22nd issue 2010, offers the following articles:

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Man/Machine Interaction
Bionic Handling Assistant is Inherently Yielding

The Bionic Handling Assistant should also be able to “play a man’s part” in workshops and in industrial environments. Photo: Festo

Inspired by the elephant’s trunk, Festo is going new ways in non-dangerous man/machine cooperation with the Bionic Handling Assistant. The freely movable “third hand” system is said to have eliminated all dangers, even during direct contact between man and machine.

The Bionic Handling Assistant by Festo is a light, freely movable “third hand” system which presents no dangers of any kind, even during direct contact between man and machine. In the event of a collision – whether intended or unplanned – the naturally yielding characteristics of the system come into play: the assistant is made of plastic, for example, and not of metal. Furthermore, compressed air and control technology guarantee that the assistant yields.

“In principle, it is very dangerous to work close to machines with dynamic functions. Our aim was to create a handling system with inherent yielding properties – that is, allowing persons to work with this system at any time with zero risk,” said Markus Fischer, Corporate Design at Festo.

Handling assistant also suitable for use in production

Brilliant as the technical innovation may be, it is ultimately its economic application and value to society that underline importance for the future of the Bionic Handling Assistant. The built-in yielding distinguishes the system from competing products and opens up many areas in which persons require non-dangerous machine support: in industry, for example, as a handling system supporting assembly in the production process, in car workshops, in rehabilitation, as an aid for the handicapped, in pedagogical institutions or even in a household setting, or in areas which go beyond the classical application fields for Festo, such as production technology and (special) machine construction.

In this project, the elephant’s trunk provided the model. With more than 40000 individual muscle fibres, the trunk can move freely in any direction. This fascinated the engineers at Festo and inspired them to create a handling system which goes far beyond anything previously available in industrial automation. The freedom of movement even goes as far as allowing the Bionic Handling Assistant to extend from 70 cm to 1.10 m, which its natural counterpart cannot do.

“Here we are entering a new generation of assistance systems, for which the fields of application are currently being defined and tested by various research bodies and academic institutes,” said Dr. Peter Post, director of research and programme strategy at Festo.

Trunk flexible all the way to the tip

Eleven degrees of freedom provide the Bionic Handling Assistant with a specific advantage in mobility compared to conventional handling systems. In any direction required, its operating range extends to a radius of over one metre. Coupled with its light weight of less than 2 kg and the yielding properties already mentioned, use of the Bionic Handling Assistant introduces a new dimension into "third arm function". In addition, the laser-sintered three-finger grippers are completely harmless for man, producing a new definition of give and take.

If one now looks at the price, which is many times lower than that of comparable (service) robots, totally new applications open up. "Due to the generative production process, we can copy a structure from nature almost one-to-one. On the other hand, the combination of pneumatic drive technology and generative production technology in this project create the pre-conditions for the production price," explains Andrzej Grzesiak of the Fraunhofer IPA.

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Robotics
Cable Carriers make Robots Mobile in Laser Measurement Technology

The 3D cable carrier system Robotrax was honoured with the iF Design product award. Photo: Kabelschlepp

Inline laser measuring installations measure up to 100 geometrical features of a workpiece in only 60 seconds. The positioning of the sensors is achieved by mobile linear axes or bent-arm robots. For 3D robot movements in particular, Kabelschlepp has developed special cable carriers.

By using laser measurement technology with non-contact laser triangulation sensors, it has been possible at Claas Fertigungstechnik to achieve 100 percent inline measurement of geometries of test objects in industrial production.

Robot laser measurement installations test welding component groups

These installations are distinguished by speed, robustness and their adaptability to varying environmental conditions. Compared to conventional contact measurement procedures, re-tooling times are substantially reduced. Robot laser measurement installations prove useful in, for example, inline geometry tests on welding component groups or in structural components.

So that the robot can measure at top speeds while retaining the flexibility of the system, the corresponding freedom of movement for the mobile machine must be guaranteed. Claas have therefore fitted the robot with Robotrax: this system, designed as an open system cable carrier in special plastic, was conceived by the Siegen-based firm specially for three-dimensional processes such as pivoting and rotational motion of industrial robots and handling systems.

3D Line: mechanical life supply for bent-arm robots

The fundamental construction of the cable carrier system consists of single chain links, made of special plastic for especially long service life. Fitted with ball-shaped snap fasteners on both sides, the links can be pressed together to form a cable carrier of the required length for the bent-arm robot or other applications. Regardless of the direction: integrated stops prevent the bending radius being exceeded. The cables carried are thus protected in all positions.

The interior space is subdivided into three equal-sized chambers. This guarantees separation and secure cable carrying, even with cables of extremely different diameters. As the surrounding ring on each chamber can be opened, the system can be loaded simply by pressing the cables into the carrier.
This saves work, time-expending threading, and also tools for loading the carrier. Even the loading of ready-to-fit confectioned cables with push connections is possible, thanks to the opening ring. Mounting points can be adapted as best suits the movement patterns of the robot.

Fixing and extending of the cable carrier is performed with fast-clamping spring clips which are fixed by two screws. They fit any link in the chain, enabling optimum adaption to the movement patterns of the robot. A comprehensive range of application-specific accessories rounds off the programme.

A soul of steel

In fast movements of the bent-arm robot during high-speed workpiece measurement, high accelerations occur, with correspondingly high forces pulling on the cable carrier. In order to pass these on, the Robotrax chain links have a bore in the middle, through which a steel rope is passed and fixed on both sides with a clamping piece.

Instead of the cables and pipes, the steel rope takes over the function of transferring the forces. Accelerations of up to 10 g and more can therefore be realised; a torsion of the longitudinal axis of up to ±380°/m is possible. An active withdrawal mechanism allows defined motion patterns and results in an up to 4 times longer service life for the cable carrier.

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Sensor Technology
Project starts on Assistance Systems for Production and Medicine-linked Applications

L. to r.: Dr. Hubert Steigerwald (Sensorik Bayern), Christian Zielger (Erlangen-Nuremberg University), Harmut Assel (Lutheran Social Services, Neuendettelsau), Dr. Reinhart Schwaiberger (Passau University), Florian Leutert (Würzburg University) and Dr. Eberhard Kroth (Reis Robotics) are delighted with the declarations of support handed over by Peter Kartmann (l., LGA Innovation Advisory Centre, North Bavaria). Photo: Cluster Sensorik

The Strategic Partnership for Sensorics (SPS), as a Bavarian cluster platform for the field of sensorics, has started, with the project AsProMed (Assistance Systems for Production and Medicine-linked Applications) a further large-scale project with a budget of about two mln. Euros.

The cluster Sensorics has thus underlined its competence in the field of cluster services at project level. As part of its responsibility for the whole area of innovation support in the state LGA innovation advisory centre for North Bavaria, Peter Kartmann handed over officially in Obernburg, on the occasion of a kick-off event at the lead-taking firm Reis, which is also the initiator of this large-scale project, the support declarations to the project participants.

The demographic developments in Europe make it quite clear that in the next years and decades the proportion of older people will increase, while the proportion of young people will be retrograde. As a consequence of this, the number of persons available for production tasks will fall. Resultingly, the average age of personnel involved in the production process will rise.

Robot-based assistance systems to enable re-integration into the working world

The aim of the AsProMed-Project, involving more than the one cluster – the clusters Mechatronics and Medical Technology are also participating –, is therefore to construct an assistance system that enables persons currently active in working life to retain their good health in daily work with the help of robot-supported measures.

Furthermore, it is to offer an opportunity of re-integration into working life for those who were previously excluded as a result of work-related bodily incapacity. In addition, the assistance system should also give the handicapped a means of taking on demanding tasks which would be unthinkable without such support.

Cluster projects strengthen the culture of cooperation

Sensorics Cluster CEO Dr. Hubert Steigerwald emphasised the immense strengthening of the culture of cooperation, as a result of such large-scale cluster projects, amongst the firms and scientific institutions taking part. Stimulating this culture of cooperation, as well as selecting and subsequently successfully coordinating research and development projects, is one of the core tasks of the Sensorics cluster management, whose competence is focused on this field.

Partially autonomous camera guiding for minimally invasive surgery

At the moment, as one example amongst many, the cluster team centred on Dr. Steigerwald is providing scientific support for the cooperative project TeKaMic, in which partially autonomous camera guidance for minimally invasive surgery is being developed. This scientific support by Sensorics Bavaria is seen by the participating project partners as consultation with competent specialists. Parallel to this, the cluster team supports the lead-taking project manager in all matters of coordination, enabling the generation and securing of value for cooperating partners involved as well as for the project itself.

The following members and animating figures of the Sensorics cluster Bavaria are involved in the project AsProMed, which is supported within the framework of the support programme “Flagship Project Medical Technology” of the cluster project fund of the Bavarian Ministry of Industry:

- Reis Machine Factory (Reis Robotics)
- Passau University, Chair for Embedded Systems
- Erlangen University, Chair for Production Automation and Production Systematics
- Würzburg University, Chair for Robotics and Telematics
- Sensorics Bavaria
- Lutheran Social Services, Neuendettelsau

The aims of the project are advanced by exemplary consultations with the Innovation Advisory Centre North Bavaria, who not only offer support regarding the difficult problems of relevant state legislative framework, but have also made valuable contributions to the project through advice based on profound specialist knowledge.

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Inspection Systems
Image Processing Module Inspects the Entire Surface of Cylindrical Objekts

Finding a serialised 2D code on a cylindrical container, then reading and verifying it – and all this independent of the orientation of the bottle: the inspection module SV360 can do this. Photo: Seidenader

Finding a serialised 2D code on a cylindrical container, then reading and verifying it – and all this independent of the orientation of the bottle: this challenge is mastered by a new inspection module from Seidenader Vision GmbH.

This manufacturer of optical inspection systems for the pharmaceutical industry, based in Markt Schwaben, has developed a new module for inspecting the entire surface of cylindrical objects, the SV360.
Today, many pharmaceutical products are packed in cylindrical, translucent plastic bottles. Due to legal requirements calling for the presence of a label or seal of authenticity and for inspection of the serialised code on the label, it is becoming necessary to inspect the entire surface of the bottle after attaching the labels.

Complete traceability on all packing levels must exist

Imminent global regulations and business initiatives to secure the delivery chain and protect the consumer from fake medicines are pushing the packaging industry into applying serialised 2D codes to products sold in bottles, if these bottles are the smallest retail unit.
Traceability of these serialised containers in bundles or in boxes, so that data for complete traceability of the product on all packaging levels is available in aggregate form, presents a special challenge for the packing line.

Bottles are tested uninterruptedly

With the new SV360 inspection solution, these bottles are examined without interruption due to recording a 360° view of the lying bottle on the conveyor belt. The inspection module can be integrated at any point on the conveyor belt, usually at the feed-in from the bundling or boxing station, and has a throughput of up to 400 containers per minute.
The module SV360 is equipped with six cameras which are positioned at successive intervals of 60°; it finds, reads and inspects the 2D code when the bottle passes through the inspection module by recording six individual images of the bottle.

The image processing system Seidenader SVIM analyses either each individual one of these overlapping images or makes a composite image from all six individual images. The code is read, verified and documented in a data bank for the next aggregate level.

Aggregate handling for packing lines

Integrated into the Seidenader Track and Trace concept for packing lines, the SV360 module is seen by Seidenader as the answer to the requirements for aggregate handling equipment and thus for uninterrupted product tracing. T&T Solutions combines data bank management and encoding systems with code reading and verification technology and also with product handling systems.

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Dexmart Project
Robot Hand must Grip Powerfully and yet Carefully

The fingers of the hand of the robot are being moved by twisted cords. Photo: University of Saarland / University of Bologna

If robots are to help people, they need hands which are powerful, but which can also grip carefully. At a workshop in Saarbrücken, international partners of the Dexmart project discuss their results.

International scientists have developed quite various solutions for their robots with the help of different technologies such as electric motors and artificial muscles. At a workshop in Saarbrücken they present different robots and discuss how the technology could be further improved. This is part of the Dexmart Project supported by the European Union, involving eight universities and research institutes in Germany, France, Italy and Great Britains.

If possible not larger than a human arm

If things go as envisaged by the scientists of the department of process automation (LPA) at Saarland University, robot hand will in future unite the strength of a body-builder with the finger-tip sensitivity of a surgeon.

The research group is working on the development of a drive which is intended to give robot hands this wide spectrum of human characteristics. In a simple and space-saving way, this artificial muscle, as in the ancient Roman catapults, is said to transmit enormous forces. The necessary technology should as far as possible disappear within the robot arm so that this will not differ significantly from the human arm.

“Via strings, which are twisted by small, rapidly rotating electric motors, we can now produce very large forces in the smallest of spaces,” the Saarbrücken engineer Thomas Würtz explains.

Robot hands are in future to resemble human hands

This is only one example for new paths in robot research which are to be opened up as a result of the Dexmart Project. The European Research Association, for example, is pursuing the development of robot hands which should have the same extreme flexibility of use as human hands.

Artificial Intelligence for Drives and Sensorics

“They should be able to feel objects, then grasp and lift them and put them down again carefully in another place,” explains Chris May, project supervisor at the department of process automation, “robots should thus be given certain characteristics so that they can support persons as personal assistants at home, in the operating theatre or in industrial applications. For this, not only are new drive technologies required, but also new solutions for sensor technology and for robots’ artificial intelligence.”

Anthropomorphic robot arm with adjustable yielding properties

In this field a research group from the German Aerospace Centre (DLR) are demonstrating an electromechanically driven anthropomorphic robot arm with adjustable yielding properties. Here all electric motors are packed into the robot in such a way that they can reflect very extensively the dynamics, robustness and mobility of the human arm.
A research team from the Karlsruhe Institute of Technology (KIT) has developed artificial muscles which, with a technology based on fluids, are capable of being moved extremely elastically.

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Assembly Technology
Screw Joint Analysis Provides Security regarding Correct Torque Parameters

In screw joint analysis everything revolves around these questions: What is the ideal torque for the operation? What rotational speed should one choose? What kind of screwdriving tool fulfils the task best? Photo: Deprag Schulz

If rejects are produced during screwdriving, a search for the causes starts. Help is provided by screw joint analysis, in which everything revolves around the following questions: What is the ideal torque for the operation? What rotational speed should one choose? What kind of screwdriving tool fulfils the task best?

Almost everyone has used one once – lipstick which gives cracked lips their suppleness back again. A soothing balsam extracted at a turn from the practical rotating case: apply and go. It sounds so simple, but can cause real headaches in industrial manufacture.

What if difficulties occur during assembly of the plastic components of this healing stick? What if rejects occur time and again at the works when screwing the housing for the lip salve together? The fault search on site can last weeks, even months. In this case, a detailed screw joint analysis by a screw specialist would be worthwhile.

Fault-tracing at the screw joint analysis laboratory

Applications technician Rudolf Schmidbauer is holding three plastic parts in his hand in the screw joint analysis laboratory. The housing, the piston and the rotating spindle for the lipstick. During assembly, the piston is first of all introduced into the housing. The second step is the one at which problems always occur. This step is the one that Deprag Schulz GmbH u. Co., assembly automation specialists based in Amberg, are now going to put under the magnifying glass as part of the screw joint analysis ordered by the customer.

The spindle is screwed into the existing threaded bore in the piston until the snap connector for the housing closes. At the same time, the piston is led to the lowest position in the housing. The next working step in the factory would be to fill the assembled plastic housing with care salve and to close it with the intended cover.
In the Deprag screw joint analysis, however, everything revolves around these questions: What is the ideal torque for the operation? What rotational speed should one choose? What kind of screwdriving tool fulfils the task best?

Rudolf Schmidbauer explains: “In order to find out how a component should ideally be screwdriven, I have to destroy it. I must deliberately screw it tight with an exaggerated torque until screws or other components break down. This is the only way to find out the overload torque.”

Laboratory screwdriver packed full of measurement electronics

The various screwdrivers by this Bavarian manufacturer used for laboratory experiments are equipped with suitable measurement electronics and are thus capable of representing the screwdriving process graphically on a screen. On the basis of the curve displayed, the screwdriver specialist can evaluate the screw joint precisely. The test is now repeated between ten and twenty times, always with original parts. At the end of the test series, an exact analysis leads to a recommendation for the manufacturer regarding which screwdriving parameters and tool are most suited to the task in question.

But what causes problems in screw joints? In the technological world, screw joints are the only reversible joining process for components in assembly. After screwdriving, they behave like one single part which withstands the highest strain.

The role of the screw in this is to press the components together so firmly that no external force can dislodge them. The force developed here is called the pre-load force. The screw assembly process must keep to the following tolerances: on the one hand, the pre-load strength achieved must be sufficient to hold the parts together, while, at the same time, screw and component must not be damaged by overloading.

The torque generally remains proportional to pre-load force

Yet direct methods of measuring the pre-load force achieved are not appropriate for series production. Indirect measurements during screwdriven assembly are therefore typical in this sector. The torque is consequently considered the determining process parameter during screwdriving, for it remains generally proportional to the pre-load force. The rotational angle is also taken into account in calculating the pre-load force actually achieved.

The driving home of a screw results in friction which depends not only on the geometry of the screw but also on the component material. The friction changes the relationship between torque and achieved pre-load force: it is one of the great unknowns in selecting the torque parameters. The technician in the laboratory can evaluate this by repeatedly loosening the driven screw and then turning it tight again. By comparing the torque curves for the first and second drivings, he can recognise possible friction losses.

Applications technician Schmidbauer also searches for signs of settling in the screwdriving process. If, for example, a seal is fixed to a pump with four screws, pre-load force is lost, even if the torque might lead you to expect a one hundred percent pre-load force, due to the “settling” of the silicon. The result in practice: the pump leaks.
In the case of a “soft screw joint” of this kind, the technician in the test laboratory first of all raises the calculated torque. “Signs of settling can show up during the screwdriving process itself, after some hours, or only after several days,” explains Rudolf Schmidbauer.

Overload torques deform screws or the components to be joined

After a certain time has elapsed, he tightens the screw again. The “further turning torque” reveals information about signs of settling and their effect on the pre-load force. “In such a case, it can happen that we recommend carrying out the screwdriving in two stages,” the screwdriving expert explains.

A further example is screwdriving in the assembly of refridgerator housings. Two metal sheets are to be screwed together, although the holes are not perfectly aligned. Initially, much force is required to bring the sheets precisely on top of each other; towards the end of the screwdriving process, when the holes are lined up perfectly, a lower torque is sufficient for the final tightening.
During screwdriving with constant torques, this task would lead unintentionally to a destructive overload torque, deforming screws or the parts to be joined. Here again, screw joint analysis gets to the root of the problem and lays down process-secure parameters and sequences.

Screws which form their own thread during the screwdriving process are subject to similar laws. During the screwdriving process, the screw joint requires a high torque, but another set of parameters is needed after the head makes contact. If this is not taken into account during screwdriving, the task will fail, components and/or screws will be destroyed, and the desired pre-load force not achieved.

Screw joint analysis calculates here the optimum torque sequence. For example: during assembly of a plastic light switch, two self-tapping screws are used. First of all, the Sensomat compressed air screwdriver proceeds with full torque, but, only shortly before the screw head makes contact, the switch-off coupling is activated and the intelligent screwdriver switches off at exactly the torque planned.

Analyse screwdriving tasks even in the design phase

Deprag sales manager Jürgen Hierold: “We can recommend to our customers not only the optimum torque sequence, but also the appropriate tool.”
Another case taken from practice. Rudolf Schmidbauer: “While one section of our customers only come to us after screwdriving problems have occurred, other customers are already testing their product design in advance with our help.”

A plastic housing is to be mounted in a car as an instrument panel. The construction consists of a rear wall, printed circuit board, front frame and display. The components are to be connected with eight screws. The focus of interest for the customer: what torque do I need for a process-secure assembly of these components? In addition, he wants to investigate the functional security of his construction. Once mounted in the car, the instrument panel must not rattle.

Although screws and material are the same, the results vary

In the Deprag test laboratory, there are now boxes full of components for the plastic housing. For the analysis in the screwdriving laboratory, not less than about ten to twenty destructive tests of the components are needed to investigate the right torque sequence. Rudolf Schmidbauer numbers and marks on one component the screw joints to be investigated, and photographs the plastic housing for the screw joint analysis documentation to be handed over to the customer later. He then chooses a suitable screwdriver, in this case a hand-guided compressed-air screwdriver. The screws used must likewise be originals. These are plastic self-tapping screws, 3.5 x 14 TXP 15.

Each screw joint is recorded and evaluated graphically. Rudolf Schmidbauer makes an unusual discovery during the series of tests: although the same screws and materials are used, the results vary.
The four outer screws, which fix the front frame onto the rear wall after insertion of the printed circuit board, reach torques between 1.10 and 1.38 Nm. The other four screws, which hold the display, need less, namely 0.96 to 1.16 Nm, in order to achieve the optimum pre-load force. If both applications are carried out with one screwdriver, it is recommended as an alternative that 1.10 Nm are applied to both screw joints. For the customer a valuable discovery – he can now take this into account in planning production.

Prevent later problems in assembly by screw joint analysis

Sales manager Jürgen Hierold summarises: “Screw joint analysis makes economic sense as a solution when problems arise during assembly with screw joints. Furthermore, it identifies, for a relatively small expenditure of time and capital, the best possible choice of screwdriving parameters and the appropriate screwdriving tools.”

With a large number of completed screw joint analyses (1000 plus), Deprag Schulz GmbH u. Co. has a rich store of experience at its disposal, in which almost every kind of screw joint problem can be found. In addition, approaches to individual solutions can be extrapolated from these.

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