MINIATURE HEXAPODA IN SPINAL SURGERY

Accurate to a Millimeter

High Definition Testing Device
Innovative measurement technology with a precision drive by FAULHABER

Remote-controlled camera cranes
FAULHABER drives ensure inspiring perspectives

New: Microsystems
Three full drive systems now optionally available as a practical starter kit

Sweepstakes
Win with the micro-drive technology by the FAULHABER Group
Dial Gauge Testing in no time at all

With all of the advances in electronics, mechanical measuring devices are indispensable, especially in superior mechanical and plant engineering. In order to always guarantee exact measurements, devices must be tested in certain time intervals, and must possibly be re-calibrated. However, this testing is time consuming, and therefore expensive. A substantial cost savings can be realized with a new fully automated method as opposed to the current testing method which is done by hand using mechanical/optical calibrating devices. In it, computer controlled EC servo motors ensure exact positioning, which saves up to 75% of the work time. In this manner, inexpensive “series tests” of dial gauges and high definition display measuring devices become possible.

Dial gauges and high definition display measuring devices, colloquially often also known as a dial gauge, are precision instruments. As with all mechanical devices, they are also subjected to wear and tear, aging, or are adversely affected by “accidents,” such as hard impacts. It is therefore necessary to test them for their measurement accuracy on regular intervals. This is also stipulated in various standards, as well as the required documentation for this.

With a larger stock of measuring instruments this is an effort and cost factor not to be underestimated. In order to remedy this situation, Feinmess Suhl GmbH has developed the new, fully automated testing device MFP-100.01 BV. Small drive specialist FAULHABER ensures the necessary highly precise mechanical movement process.
Measurement and Documentation
The principle of the dial gauge is based on a plug gauge, which is pushed into a housing against a spring force. This moves an indicator, displaying the measurement value on a scale, proportionally to the path via a gear. The display value may not exceed a certain error, compared with a norm, and must remain approximately equally low across the entire measurement range. Therefore, the clock is normally mounted in a temperate environment for testing purposes and mechanically/optically measured by hand. The tester then records the respective target and actual values, and issues a test badge. This procedure can now be drastically simplified thanks to modern electronics. After the test item has been inserted, the dial gage and high definition display testing device will assume all further work steps. A camera with adjusted lighting records a non-glare image of the gage display. The connected computer analyses this image, and internally determines the zero point, as well as the scale graduations for the test. Now, it actuates an EC servo motor, which supplies the highly precise mechanical adjustment necessary for the measuring sleeve of the testing device. In this way, the entire measurement range can be run through step-by-step in the previously determined steps. The dial gauge display associated with the target specification at the measuring sleeve and is recorded, analyzed, and stored parallel to the measuring process in a database. The complete, individual documentation of the test item is therefore accessible on the screen at any time. If the measurement result is within the scope of the specification, the testing device also issues the necessary test badge at this time. The entire test run requires only a fraction of the currently usual time. In this manner, even larger stocks of measuring devices can be tested in a short amount of time, and documented consistently.

Sensitive Drive
In order to be able to completely replace the precision test pieces of the conventional testing method with an automated process, experience in the area of positioning is required. Generally, dynamic, sensitively controllable EC servo motors are particularly suited for such tasks. They allow for any length of movement path, limited only by the technology of the remaining devices, and offer high performance with compact dimensions. Even very different types of measuring devices can be tested in one and the same testing device without any problems. In this case, an EC Sinus servo motor with an output of about 100 W and an integrated transmitter was selected. In this manner, the testing device computer receives 3000 increments per motor shaft rotation. One increment therefore corresponds to an angle of only 0.12 degrees. This angle is further broken up by a flanged planetary gear at 134:1. The gear output then engages the spindle drive with repeated gear reduction for the sleeve. In this manner, an adequately high transmission amount is reached in order to also safely break up the smallest movement paths of the sleeve. Since with such small paths the mechanical clearance of the gears must also always be taken into consideration, the testing device always moves the plug gauge of the test item from the idle position into the “0”-position in order to eliminate this clearance. From the zero point, the measurement is then started free of any clearance.

In order to relieve the test computer, the EC motor runs with its own internal controller. In this manner, only simple control commands are necessary with regard to the testing device control, the rest is done by the drive itself. This also relieves the quick integration into the device, any special work knowledge is not necessary for this.

Today’s small drives with electronic controls offer high performance in the smallest of spaces. Thanks to the integrated controller and incremental encoder, they are also easily integrated into total systems. Despite of this, they allow both extremely precise positioning, and quick dynamic movements, and if required by the application, even in 4 quadrant operation. If the drive specialist FAULHABER is integrated with his know how at the beginning of the development, remarkably efficient and yet inexpensive drive solutions can often be established.

Compact mechanics with very high resolution – the heart of the testing device

weblinks
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Unknowingly, almost everyone has already seen them, at the latest they were featured as “important margin” during the Soccer World Championship broadcasts: Light construction cranes for movie and television filming. Thanks to their viewing height and maneuverability, in the case of soccer and other types of sports broadcasts, they are located behind the goal, or in other exposed locations, and allow brilliant images of the on-going events of the game. Such cranes for the guidance of a camera must be quickly assembled, easily controlled, and must also be able to reliably support even heavier cameras with a large (tele-) lens. So-called remote heads, remotely controlled camera supports at the tip of the crane, allow the precise alignment of the recording devices. In order to keep the camera’s load capacity at the long lever arm of the boom as large as possible, all components must be of a very light construction. In this regard, small EC motors ensure movement and compact high performance at low mass.
Especially with movie filming, as well as in the everyday television business, quickness and flexibility are key issues. In order to provide the director and camera man improved views, and therefore the viewers with an improved overview, MovieTech AG builds modern light construction cranes under their brand name ABC Products. Depending on the model and customer request, these cranes can be equipped with boom arms from up to 12 m. Yet, the mechanics can be assembled by only one person in 20 minutes. Smaller models fit into a tote bag, and can be transported easily to the filming site, which is a substantial advantage for documentaries. In order to be able to variably utilize the camera at the crane end, one camera support is integrated per quick connection. This remote head then allows the turning and pivoting of the camera, optionally also the zoom and focus functions. In order to be able to perform these movements as easily, reliably and efficiently as possible, the crane specialist works in cooperation with the FAULHABER small motor expert. In this manner, the compact device support for precise camera pivots was created.

Camera Technology makes high Demands

Modern camera technology makes specific demands of light construction cranes. The recording devices achieve a weight of several kilos without any problems. Depending on the job site, additional weight is added by heavy telephoto lenses. This poses two challenges for the crane: First, the boom must be able to naturally support the weight, second, all movements of the camera must obey the operator’s commands fluently and without any delays or bouncing motions with dynamic recording. The crane specialist solved the problem for the larger professional grade devices by means of a special alignment of the controllable crane heads. In this way, the smaller remote head Alex can carry up to 15 kg of load capacity with a dead weight of only 6.8 kg, its larger brother Pelé even up to 30 kg at a net weight of 9 kg.

The total mass of up to 20 kg at the 12 m boom is moved safely and precisely via efficient EC servo motors with a planetary gear. Current events and good recording is “captured” manually only, therefore a camera man controls the pivoting movements during filming by hand via a control console. In order to provide the operator direct feedback of his actions via a screen, the motors must accelerate without delay. However, quick does not necessarily mean with a jerking motion, a soft utilization of force is key, any nodding, or rocking motions of the camera by too hard of an acceleration would result in blurred images. The drive used by the small motor specialist from Schönaich makes allowance for this.

Markus SchärTEL of Movie-Tech remarks: “A large, popularly utilized advantage of the EC motors is that they can accelerate using ramps that are preset and adjusted to the respective camera weight. In this manner, the system’s pivoting tendency is reduced to a minimum”. An optional moisture attenuation additionally calms the camera at the crane boom. In this manner, a silky-smooth start-up, and a slow pivoting that is barely recognizable by the eye, are possible. Even with television filming, sharp images are the result.
Small, powerful, creative
The reason that two EC motors were selected per remote head was for two reasons: The drives are innately sturdy and reliable. With exception of the bearing, there are no expendable parts. In this manner, several thousand maintenance-free operating hours are possible. The motor can be mounted, and forgotten, since no maintenance is required. Thanks to electronic commutation, the drive is very flexible. Whether pivoting direction, rotation speed, torque, or complex “movement programs” of several of these variables, an EC motor reacts quickly and precisely to incoming control signals or specifications.

That is one of the reasons why it is also a very inexpensive drive solution. Thanks to its maintenance-free nature, compact dimensions, and a planetary gear series adjusted specifically to it, it offers a lot of performance for little money. Advantages: The power level is individually adjustable by the user, the user can issue commands to the motors without any delay via the crane controls. The creative specification gained from experience for the ideal positioning of the camera is quickly transmitted by the flexible drive. In this manner, drive and human operator of the remote heads are a perfect match, the crane becomes the extended arm of the camera man.

Modern EC small drives are especially suited for applications constructed as small and compactly as possible or in which special consideration must be given to weight. Thanks to the flexible actuation and the delay-free reaction of the motors, even dynamic application sites are no problem. The quick, sensitive controls avoid distracting start-up rocking motions, which is an advantage that is not to be underestimated as opposed to other drive concepts.

Thanks to a large variety of models and extensive accessories, an optimum drive concept is therefore possible for practically any application.

Motion Manager 3
A powerful software package with comfortable user interface is available for the actuation and configuration of the drive systems with Motion Controllers using the further developed “Motion Manager 3” by FAULHABER.

With the current version of the user software, even the start-up by means of the CAN interface is effortlessly easy without any deeper knowledge of CAN. For this purpose, the commands and configuration dialogs can be either implemented into the desired CAN telegram either directly, or via a respective ASCII interpreter.

Furthermore, the “Motion Manager 3” offers many additional functions, which facilitate the administration and the handling of the network drives in particular.

The software is available for free downloading on the FAULHABER GROUP website.
Micro-Precise Surgery Assistant

The inventor of the SpineAssist system and surgical procedure, Mazor Surgical Technologies, was established in 2001 as a spin-off of the mechanical department of the Israel Institute of Technology. The company’s offices are located in Caesarea, Israel and Norcross, GA, USA (Mazor Surgical Technologies Inc.). Mazor specializes in development of medical robots whereas the precision mechanics manufacturing is outsourced to the Swiss based Faulhaber Group company, MPS Micro Precision Systems AG.

Accuracy in implant placement is very important in spinal surgery since most procedures are performed close to the nerve roots and spinal cord, where every millimetre counts. This, together with other biomechanical considerations makes accuracy and precision of the utmost importance.

Spinal fusion is a surgical intervention that is performed for example to straighten the spine and prevent further deformation due to scoliosis or other disorders; to support a weakened or injured spine, or to reduce or prevent pain from pinched or injured nerves. Although spinal fusion is associated with a high rate of success, implant displacement is disconcertingly high, up to as much as 25% for scoliosis related interventions according to some sources. Misplacement is associated with a heightened risk of neural and vascular complications, as well as injury to the spinal cord membrane.

A miniature, high precision hexapod with 6 DOF is used as guidance assistance for spinal surgery. The bone-mounted system, named SpineAssist, will accurately guide the surgeon for maximized precision when placing implants destined to stabilize spinal (vertebrae) fusions in both open and minimally invasive surgery. A part from the miniature hexapod robot, the system also consists of a preoperative planning software with automatic fluoroscopic and CT image processing and a set of rigid bone fixation clamps and platforms.
Intervention
The intervention using the SpineAssist consists of five steps:
1) preoperative planning based on a CT scan of the patient’s spine;
2) rigid fixation of the SpineAssist platform to the patient’s spine;
3) positioning calibration by matching a fluoroscopic image of the bone mounted platform to the CT-image from the preoperative plan;
4) rigid mounting of the SpineAssist robot to the platform;
5) the robot guide arm is now ready to automatically position itself at the exact location according to the preoperative plan and serve as a guiding tool when the surgeon drills or performs some other intervention on the bone.

The SpineAssist intervention has FDA and CE approval and has, as of today, been clinically used in over 250 cases in hospitals all over the world.

Benefits
Minimally invasive surgery (MIS) is one on the most important trends in the medical device industry. The benefits from a minimally invasive procedure are potentially many: a smaller incision - and smaller scar - reduces the risk of infection and bleeding. Less pain and trauma, as well as decreased length of hospital stay and recovery time are other advantages that incite the medical device industry to constantly develop new instruments supporting MIS.

With the SpineAssist a spinal fusion intervention can be performed with only a couple small incisions compared to open surgery where a large incision potentially causes more muscle damage. The miniature size of the robot with no need for “line of sight” and its high accuracy simplifies the surgical procedure and minimizes the risk for screw misplacement. Since the robot is rigidly attached to the patient there is no need for a tracking coordinate system. The procedure using the SpineAssist only requires a few fluoroscopic images, adding reduced radiation exposure for the surgeon and the patient as an important benefit to the system.

Spine Assist robot
The hexapod robot measures 50 mm (2 in) in diameter and 80 mm (3.15in) in height for a weight of 250 g (0.5 lb) - much like the size of a soda can. The working volume is several cubic centimetres depending on the guide arm used.

The overall system accuracy and repeatability is less than 100 microns and 10 microns respectively. The motion control accuracy is of 10 microns. When you take into account human influence and the CT- and fluoroscopic-image distortion, the system accuracy in placing an implant with respect to the preoperative plan is of less than 1.5 mm.

Six of Faulhaber’s DC brushless smoovy® gear motors with custom drive electronics drive the linear actuators based on a high precision, miniature lead screw design. Accurate and absolute displacement measurement is assured by seven LVDT sensors, one for each actuator and the seventh tracking the performance of the others.

The miniature size of the hexapod involved several design challenges, where one of the most important one probably was finding a miniature drive solution. The smoovy® DC servomotor, measuring only 5 mm in diameter, proved an excellent trade off between miniature size and required torque and speed for the application. The overall thigh tolerances for small dimensions and the precision of the M2.5 custom thread lead screw, as well as precision actuator ball and socket joints are all examples of engineering specifications that make the hexapod a true manufacturing challenge.

Outsourcing partner
The collaboration between Micro Precision Systems AG and Mazor Surgical Technologies was initially limited to the MPS developed smoovy® DC motor but rapidly extended when market demand picked up and Israeli based Mazor needed outsourcing solutions for serial manufacturing of the robot. MPS ensures today manufacturing, precision assembly and quality control of the complete SpineAssist robot.

MPS was founded and joined the Faulhaber Group in 2003. The history of the company however dates back to
Unique applications demand unique solutions – customer specific drive systems by the FAULHABER GROUP. These range from special components especially constructed for an application, or as in the case of the SpineAssist robot, to a system partnership with mutually coordinated development, construction, and automated production of total mechatronic systems.

Utilize the competences of our Customs Solutions Center.

**PROJECT MANAGEMENT.** Competent consultants with many years of application know-how in all industrialized regions worldwide directly at your site. From conception all the way to production.

**TECHNOLOGY.** Highly developed technology platform of a Group of the most renowned companies for drive, precision and micro-systems.

**DESIGN.** Experenced developers and high-performance engineering for a customized, production-optimized product design.

**GLOBAL PRODUCTION.** Harmonized production, quality, and logistic concepts based on the most modern automation and testing technology at international production locations.

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High Performance after the Comma

The miniaturization of complex electronic and mechanical systems holds an enormous innovation potential for numerous industries. As a qualified partner, the FAULHABER Group contributes to realizing the visionary ideas of these industries with a highly developed drive technology, and the competence and experience in manifold application areas.

Currently, the FAULHABER Group offers the worldwide most extensive product range in micro-drive systems. These include, in addition to the world’s smallest brushless FAULHABER DC micro-drives with an outer diameter of just about 1.9 mm, ultra-flat penny motors, ARSAPE step motors, which achieve a resolution of 10 µm per full step with a threaded spindle, and the latest smoovy® DC micro-motor generation in a design with pre-mounted spindle as a micro-linear actuator. The new micro-systems folder will give you an overview of this high-tech product spectrum, including the most important technical data.

Order your free copy today. Order by fax (see last page), or at www.faulhaber-group.com

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Micro-Systems Starter Kit

See the efficiency of these highly developed micro-drive technologies for yourself with the micro-systems starter kit. It contains a full drive system, consisting of optionally either a FAULHABER, a penny, or a smoovy®-motor, as well as the new associated micro-systems control, via which the operating modes of all drives of the starter kit can be easily demonstrated.

You may obtain the micro-systems starter kit at the @xpress48 shop at www.faulhaber-group.com.

Change in Management Team

A long planned change became effective on January 1, 2007 in the management team of the Dr. Fritz Faulhaber GmbH & Co. KG company.

Mr. Ulrich Beckord, Manager of the Technical Department, who has successfully worked for the company with great dedication for more than 19 years, commenced his well-deserved retirement.

Dr. Thomas Bertolini, B.S-Eng. Electrical Engineering (Doctorate at the Chair of Drive Technology in Kaiserslautern), working as a technical supervisor at FAULHABER in Schönaich since January 1, 2005, is now taking on the management duties of the Technical Department.

We would like to take this opportunity to thank Mr. Beckord once again for his accomplishments in the company, and to wish Dr. Bertolini much success in his new position.
Forward-Looking Investment

TIPPING-OUT CEREMONY AT FAULHABER NEW CONSTRUCTION IN SCHÖNAICH

As a leading member of the internationally operating group of companies, FAULHABER, at the Schönaich location, now again creates room for 70 additional employees in production after an expansion construction in 2002, the reorganization of the logistic area and the organization of an international customer and distribution center.

Moved into the industrial area in 1991, completed an expansion construction in 2002, FAULHABER in Schönaich has again reached the capacity limits of its production plant.

In October 2006 already, ground-breaking was therefore performed for another expansion construction, and its completion of the structural work and of the roof truss was celebrated on March 9, 2007, with a traditional topping-out ceremony.

On about 9,000 square meters of the 4-story new construction, room has been created for the production of existing customer-specific drive solutions, and for a new production line, which is to be completed for up to about four million drive units per year. Furthermore, an international distribution and customer service center is being set up, in which customers are greeted and attended to, and in which distribution employees from around the world can be trained. Presumably in October of this year, after about one year of construction, the first machines are to be set up in the finished building. With this currently largest investment in the company’s history, FAULHABER emphasizes the know how and quality at the Schönaich location, and its healthy growth as the leading provider of drive, precision, and micro-systems.

www.faulhaber-group.com
Win with the Micro-Drive Technology of the FAULHABER Group

Please answer the following 4 questions:

1) The outer diameter of the world’s smallest brushless FAULHABER DC micro-drive measures just:
   - [ ] 4.6 mm
   - [ ] 2.3 mm
   - [ ] 1.9 mm

2) The characteristic design of the penny motors is:
   - [ ] ultra-flat
   - [ ] mega-tall
   - [ ] extremely short

3) Ideally suited for micro-precise positioning tasks are ARSAPE step motors with threaded spindles with resolutions per full step of:
   - [ ] 24 µm
   - [ ] 10 µm
   - [ ] 32 µm

4) The latest smoovy® DC micro-motors are also available in a model as:
   - [ ] micro-linear actuator
   - [ ] drive with hollow shaft
   - [ ] step motor

More Information? Yes, please!

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