Microdrives give humanoid service robots human traits

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There are various processes available for automated soldering or welding. Whether soldering, induction brazing or laser welding – the weld filler metal is often delivered by wire. However, this is exactly where the difficulty lies. The system must always deliver a reproducible length of filler metal to the correct destination, but without jolting or bending the wire in the process.

A new automatic wire feeder driven by a controlled micromotor is now providing a reliable solution to this problem.

Stepper motors regulate adaptive soldering and welding wire feed

Spot on

Compact wire feed module for soldering and welding processes
Soldering and welding are ancient techniques for joining metals that are also ideally suited to modern, automated fabrication processes. To achieve reproducible results, it is important to adhere to all parameters, particularly temperature and quantity of filler meta. Dusslingen-based company EUTECT GmbH has taken up this challenge and has developed an adjustable, customizable soldering and welding wire feeder.

An automatic status message about the amount of weld filler used allows for optimum dosing and provides a record of operating data. EUTECT’s soldering experts have been working with the Schönaich-based microdrive specialist FAULHABER to realize a wire feed system that is both flexible and accurate. The result is a compact, adaptive wire feed unit that is nevertheless highly responsive to individual requirements.

**Exploiting process principles.** On the one hand, there is not just one solution for the majority of technical tasks; on the other, the saying “why make something complicated when simple will do” is not fortuitous. In the area of automation in particular, less can definitely mean more. The developers of the sensitive wire feed proceeded from this basic idea. As the process principle is to deliver all filler metals to the workpiece in wire form, the new module has been designed to use a wide range of filler metals. What sounds simple in terms of the basic premise, however, requires a great deal of know-how when it comes to the details of the automation process.

Very different parameters such as wire thickness, wire stability and workpiece geometry have to be considered for the initial settings. This is why the wire feeder module incorporates various sensors that accurately identify the current wire position. This allows the system to deliver thin, soft soldering wire or relatively rigid steel wires for laser welding as required. The sophisticated sensor system teaches itself the joining process. However, without drives that accurately execute the control instructions, even the best data logging and evaluation system is to no effect. This is where compact microdrives come into play.

The wire is carried to the desired position via small stepper motors with a defined increment. The delivery rate results from the number of step pulses per unit time. In addition, an optical encoder signals the actual rotation to the controller. The encoder is positioned at the stepper motor drive wheel, where it detects slip and variations and thus measures the actual wire length being delivered.

The large number of gear ratios offered by FAULHABER compact stepper motors means that the optimum gear ratio can be selected for each process requirement. The gear and stepper motor combination, designed to customer specification and currently offering gear ratios of between 14:1 and 134:1, allowed the developers to work with the action-reaction principle for the first time. In this case, an intelligent monitoring device measures the reaction force occurring when the wire contacts the soldering point. The high-precision 22 mm stepper motors in combination with the encoder enable highly accurate control of the feed. The resulting wire feeding capabilities have already set new benchmarks for quality and reproducibility in various soldering and welding processes. The filler wire therefore functions like a virtually non-wearing mechanical sensing device directly at the site of the weld or solder. This also means that unavoidable variations in the positioning or geometry of the workpieces can be reliably identified concurrently with the joining process at that location.

**The right movement for the job in hand.** The application calls for a simple motor with adjustable delivery rate and compression force. When comparing various drive systems in this respect, the two-phase stepper motor emerges as the best option. With 24 steps per revolution and a defined step width, it is easy to control. At the same time, it offers the option of a defined torque of almost 40 Nm if required. The compressive force of the weld filler material can therefore be maintained continuously in a wide range, while delivery rates can be easily varied, at a motor speed of more than 10,000 rpm or more than 4,000 steps per second. To guarantee the necessary precision, a plug-on optical encoder is additionally mounted to the drive control wheel. The encoders are capable of generating 100 to 500 pulses per revolution of the wheel shaft with or without zero reference pulse, or up to 1,024 pulses in high resolution. A reduction gear used in the application further improves the resolution at the drive roller that ultimately moves the welding wire.
There is a clear trend towards making components as small and compact as possible, even in mechatronic components. It saves both raw materials and costs! Even the production of these components has potential for savings. A new compact 5-axe CNC machine is now making the production of complex small components easier. Despite its small size, the use of brushless microdrives means the system can offer all the properties which were previously the domain of larger systems.

Efficiency is the relationship between cost and benefit. Using large CNC centres for the production of small components is often less than ideal. It is, as the saying goes ‘using a sledgehammer to crack a nut’. This is where Wegera Oy from Oulunsalo in Finland comes in. Its compact 5-axe CNC system Kolibri represents a practical alternative for small-scale production. In order to ensure the necessary precision within small dimensions, the developers have been working together with microdrive experts FAULHABER in Schönaich near Stuttgart.

**Small but mighty.** Many large machine tools are too big for the production of small components. However, a production system which is adapted to the requirements allows optimum performance at the same time as manageable investment and maintenance costs, with no compromises on product quality. In developing Kolibri, the Finnish machining specialists
started with the main requirements and extended their CNC system with modular upgradable options. The result was an application-specific scaleable machine which is suitable both for standalone operation and for integration into a production line. There are two different sizes of Kolibri machine tools. The smaller one is called Kolibri 500 and the bigger one Kolibri 750. Despite its compact proportions - at 500 or 750 x 740 x 910 (W x H x D) it is around one third the size of a standard desk - a real all-rounder. The sealed system design allows environmentally-friendly mist lubrication. The relevant control software can be loaded either via cable or wirelessly via Ethernet. If necessary, the device can be fitted with a remote controller via an internet connection.

The five-axle machining centre can be upgraded to six axles and has a speed-controlled spindle. There are also three and four-axle versions for less exacting requirements. All machines have a machining area of X = 265/470 mm, Y = 420 mm and Z = 160 mm. The A axle can be inclined by +/- 120°. The C axle can be rotated around n x 360°. The machine can be equipped with automatic tool changer with space for 22 tools. If the machine is equipped with the automatic tool changer, it will utilize 1.8 kW/50,000 rpm high speed spindle from Alfred Jäger. The spindle uses HSK-E25 chuck. The established brushless microdrives are used on the fourth and fifth axle, where space is more critical. The patented quick changeable module of fourth and fifth axle includes two servo motors (200W) and motion controllers. A third microdrive with built-in gears is used to move the magazine for changing the tools. All motor functions are controlled using motion controllers so the actual CNC controller is relieved of the motor functions.

**Compact performance.** Brushless DC servodrives have a particularly impressive service life and excellent dynamics. For physical reasons, they can be overloaded with values well over the rated performance for brief periods, which also improves acceleration and braking. As the design of microdrives means that they can only achieve their high volume performance at high speeds, the necessary speed is brought up to an application level by means of diameter-compliant gear offsets, where required. This increases both the torque and the resolution on the drive shaft if an encoder is fitted to the motor shaft. Output performance of over 200 W and more than 190 mN from a motor diameter of just 40 mm are now possible at a speed level of around 16,000 rpm. Where lower levels of performance are required, 35 mm motors may also be used. They can output a good 90 W (50 mNm) at the shaft and can also be adapted to the speed required using gears. The transformation range for robust, lifetime-lubricated planet offset gears with steel gear wheels ranges from 3.71 to 1526:1 or from 4.8 to 2548:1 for 40 mm gears.

**Motor management.** The gears are all controlled by means of optimised motion controllers. This means the ideal transformation of the control commands can be achieved for each version of the drive. The 4-quadrant PWM controller works at 95 % efficiency and takes the "management" of motor controlling away from the PLC or system controller. At the same time, there is the option of sending independent speed profiles to the motor as well as speed control, positioning mode and various safety functions. Data is loaded through an RS232 interface. The incremental and absolute encoders can also be analysed based on motor type in the same way as hall sensor signals. There is a comprehensive ASCII command set for simple programming. The "FAULHABER Motion Manager" makes programming easier by providing a clear graphical interface and represents an easy point of entry into the world of microdrive controls.
The ultimate
in convenience

Modern locking systems are not just designed for security and convenience but also have to consider the increasing role played by automation in building management. This is why purely manually operated lock cylinders no longer meet the necessary requirements in all cases. Particularly in areas where security is a sensitive issue, there are increasing demands for time-controlled locking and unlocking, automatic opening for authorized individuals or for functions controlled via the facility services control room. In addition, the doorknob has to have a compact design to ensure a universal fit with a wide range of door hardware.
Modern building control technology and integrated facility security systems increasingly call for electronically controlled lock cylinders. In many cases, however, there will also be a need to retain the existing manual operation. For applications that have to combine these two functions in one lock, EVVA has developed the new, compact EMZY motorized cylinder. The compact doorknob design is suitable for a wide range of doors and door fittings. EVVA’s security experts have been working with Schönäich-based microdrive specialist FAULHABER for the purpose of developing an electromechanical structure that is as compact as possible. A microdrive with high power density and compact planetary gearhead is the perfect solution when it comes to combining the benefits of electronic control and a rugged mechanical lock system.

**Motorized doorknob in a modular system.** For locking systems, ease of use and security aspects are important selection criteria. Automated door locks offer a wide range of functions, allowing the creation of a customized security concept. Integrated electronics, for example, allow installation of a time-controlled or pulse-triggered door latch. This setting can be integrated into a building security management system. As a result, areas with more stringent security requirements, such as laboratories, archives, R&D departments or restricted areas in general, can be rapidly equipped with access controls. However, even minor requirements, e.g. for the exterior doors of company premises to be accessible only at certain times, can also be met in this way. To ensure a consistent approach with regard to the overall security concept, it is important that the system is capable of being installed on any standard door if possible. In this respect, the security experts from Vienna were able to further reduce the size of their previous lock system. This means that the electromechanical lock cylinder now also fits modern glass doors with tubular frames. To achieve this, the entire unit had to be reduced to achieve a backset size of no more than 35 mm (distance from center of door handle or keyhole to outside edge). As an additional innovation, the developers integrated a push-button for local operation. This dispenses with complicated wiring and installation of a separate door button. Naturally, automatic locking and unlocking triggered by motion sensors or access control are also possible.

While many things are technically possible, they also have to be cost-effective. In this case, the new design allows for parts previously manufactured to customer specification, such as gearhead and drive shaft with special flange, to be replaced by standardized components. This simplifies logistics operations and saves costs. Despite the inexpensive design, the new system still meets the company’s own high safety standards. For example, the motorized cylinder easily handles the guaranteed service life of 125,000 to 130,000 operating cycles at a torque of around one Nm per locking process. In addition, of course long-term influences, such as wear of the door closer, installation outdoors or in corrosive atmospheres such as indoor swimming pools, electroplating workshops or production facilities, have also been taken into account. Even an extended downtime without the lock activated does not impair its functioning.

**Small, powerful yet undemanding.** The exacting requirement to combine power, efficiency and reliability in a small package is ideally met by compact bell-type armature motor, with gearhead, supplied by FAULHABER subsidiary MINIMOTOR SA. The coreless rotor with skew-wound coil saves weight, and while smaller than conventional rotors, it offers comparable performance. Thanks to the rotor’s low weight, the drive is very dynamic in the ramp-up phase, which shortens the closing times. As the drive is only in operation for a short time for the closing process, the wear on the commutator is not significant. On the contrary, the mechanical commutation allows reliable start-up even at the lowest voltages and functions. Of course, this process calls for specialist expertise. A special alloy for the commutators, and select brush materials, ensures that even under adverse ambient conditions, the contact resistance is extremely low and thus service life remains high. This is also the only modification necessary on FAULHABER’s standard motor. The mechanical structure, bearing and surface coating are identical to those used in the standard range.

As microdrives obtain their power from the rotational speed (output = rpm times torque), the motor’s output speed has to be reduced to a value suited to the application by means of a planetary gearhead with matching diameter. At the same time, this increases the torque at the drive shaft. This means that any lock with a euro profile cylinder can be opened in less than a second. Even for the gearing, all standard design components were capable of meeting the stringent requirements of the security application in question. This also applies to the lifetime lubrication by select lubricants specially developed for high-efficiency microdrives. As a result, the overall efficiency of motor and associated gearing can be reliably maintained at the necessary high level over many years or hundreds of thousands of closing operations.

Further information
ELRA Antriebstechnik, Austria
www.elra.at
EVVA Sicherheitstechnologie GmbH, Vienna
www.evva.com

Compact dimensions allow installation of the unit in almost any commercially available door and hardware.
Micro annular gear pumps with DC microdrives for precision volume dosing over long periods.

Precision dosing

Nowadays, modern electronics and high-precision mechanics allow the miniaturization of many items for everyday use and industrial applications. Micro annular gear pumps for fluid delivery are an excellent example. Their simple, no-valve design allows them to come in a compact size with a virtually non-pulsating, easily adjustable flow. Electronically commutated DC microdrives are particularly suitable for driving this kind of fluid machinery. Compact in size, they offer high power density and a large speed range with excellent dynamics, enabling high-precision control of flow rates from the smallest volumes to a constant maximum throughput.
The smaller a device can be built, the easier it is to transport, install or integrate into existing systems. In addition, precision production processes for metal, ceramic or plastic components allow for closer fits and narrower gaps. This then has a very beneficial spinoff on the efficiency of small and miniaturized fluid machinery such as displacement pumps. German manufacturer HNP Mikrosysteme GmbH is exploiting these new possibilities with its compact, hermetically sealed micro annular gear pump for continuous dosing – even suitable for corrosive media. To achieve a drive with dimensions and output ideally tailored to the pump delivery characteristics, HNP pump specialists worked with Schünaich-based drive expert FAULHABER. The result was a compact pump/drive delivery unit suitable for a large number of applications, including the more exotic.

Accurate and high-performance pumping. There is a wide range of applications requiring the targeted dosing of small volumes of liquid. High-tech solutions are called for if the application also requires a long service life and a seal-less pump design. Typical areas of application are the transfer of crystallizing, air-sensitive or outgassing media, fuel cell technology, the delivery of urea solution (AdBlue) to remove NOx from diesel engine exhaust gas, or dialysis and analysis technologies. The hermetically sealed pump head is driven by means of a powerful rare earth magnetic coupling, which prevents leaks on the drive end. In combination with the materials available, such as nickel-based carbides, stainless steels, ceramics based on aluminum, zirconium oxide or silicon carbide, and plastics such as PTFE, PEEK and FKM, the pumps can be adapted to various media, including corrosive substances. The pump, only 22 mm in diameter and 69 mm long, and weighing around 100 g, is designed for 24 V operating voltage and can transfer 4.8 to 72 ml/min at up to 5 bar delivery pressure. Thanks to the annular gear design, the pumpable viscosity range is between 0.3 and 100 mPas, with a pulsation of around 6% and a differential pressure range of 0 to 5 bar. The no-valve annular gear principle guarantees minimal shear forces during pumping.

Compact microdrives. The pump is driven by an electronically commutated DC motor with integrated speed controller. The brushless design enhances the service life and reliability of the drive. Motor-adapted variable speed control is guaranteed by a speed controller that has the same diameter as the motor and is mounted to the rear of the motor. This means that the user can easily adjust the speed via an analog input with 0 – 10 V. A digital input determines the direction of rotation. For additional monitoring functions, the digital frequency output provides a 15-mA output signal with six pulses per revolution.

The drive supply voltage is 12 or 24 V DC, while the 22 mm motors achieve around 9 W and feature a torque of up to 59.9 Nm. Supply voltage to the speed controller is 5 to 28 V DC via a separate flat ribbon cable. The motor efficiency of around 68%, as well as the more than 95% efficiency of the control electronics, allow for long operating times even in battery-backed mobile devices. The rugged stainless steel enclosure and wide temperature range of –40°C to +85°C enable the device to also be used outdoors, e.g. for environmental measurements. The short-term overload capability of the microdrives supports such applications, as this allows increased pump breakaway torques, e.g. after overnight temperature drops, and the resulting higher fluid viscosity, to be mastered with ease.

Further information
FAULHABER, Germany
www.faulhaber.com
HNP Mikrosysteme GmbH, Parchim, Germany
www.hnp-mikrosysteme.de
Microdrives give humanoid service robots human traits

The face of the future

Since time immemorial, people have dreamed of creating artificial human beings. Nowadays, modern technology is capable of realizing this dream in the form of the humanoid robot. Even if there is still a considerable amount of development work necessary, every project has to take those first steps. As an initial stage in this process, a humanoid service robot that works autonomously already offers a wide range of benefits. Apart from the interaction of the many components used, the main challenge is the power supply and the space required for the various parts. Microdrives represent an ideal solution for resolving these two key issues. Their considerable power density, combined with high efficiency and minimal space requirement, improves the power-to-weight ratio and allows the robot to operate for long periods without having to recharge batteries.
The more human-like a robot should be, the more sophisticated the mechatronic engineering input necessary. Particularly in sectors requiring “human social behaviors”, e.g. for service functions or providing information in places such as museums, airports or hospitals, sophisticated technology for robot construction is a must. For many years, the Barcelona-based company Pal Robotics S.L. has been working on the construction of humanoid robots for special applications. Non-verbal communication, i.e. body language, also plays an important role in increasing the acceptance of humanoid robots. In order to accommodate as many functions as possible in the predefined robot body, the robotics experts have been working with Schönaich-based microdrive specialist FAULHABER. The outcome has been a robot model that most definitely exhibits human traits and is capable of emphasizing certain statements by means of “body language”.

**Service robots for practical applications.** Humanoid robots intended to perform everyday functions have to satisfy certain conditions. The developers wanted to integrate capabilities such as information output, minor transport tasks and service functions into the new REEM robots. This resulted in a robot height of 1.65 m, so that it can communicate with humans at eye level. It was also important that the robot should not be excessively heavy, although there was a need for a low centre of gravity and space to house the necessary batteries. The current robot model weighs around 90 kg, sufficient for one set of batteries allowing eight hours of autonomous operation. In addition to its unladen weight, this service robot can also carry up to 30 kg effective load on its lower loading platform. Each arm can move up to 3 kg independently. In this case, wheels located in the base of the robot ensure effective locomotion. On the one hand, this ensures minimal power consumption and quiet running, while on the other the design provides sufficient mobility for the planned application of up to 4 km/h.

As well as a touch screen for the various programmable applications, the REEM is also equipped with microphone, stereo camera, laser and ultrasound sensors, accelerometers and gyroscopes. These devices enable the robot to identify its current position in the room, move around autonomously in its area of work and avoid sudden obstacles or people walking across its path.

Two DC microdrives in the robot’s neck and waist provide the necessary expressiveness. Thanks to their compact dimensions, the drives can be readily used even in these two “constricted” areas. The small actuators can move head and torso independently of one another and allow them to assume different postures. This enables the robot to imitate human traits using body language suited to the respective situation.

**Microdrives offer flexibility.** Microdrives do not just replicate larger motors. Because of the physics involved they often offer better dynamics, higher output or greater efficiency than you would expect as a result of a mere reduction in size. In practice, this means that very high short-term overload capabilities are possible without affecting service life. This proves particularly advantageous when it comes to executing the less frequent but temporary actions necessary to mimic specific gestures. As well as these features typical of all micromotors, the various models come with further benefits depending on the application in hand. Stepper motors offer accurate positioning without additional encoders thanks to a defined step width per control pulse. Brushless drives run even at minimal supply voltages and are thus ideal for autonomous, battery-backed systems that are designed not to fail immediately in the event of a voltage drop. Electronically commutated DC motors represent the best option for long service life and maximum dynamics. Intelligent motion controllers can control the drive in four-quadrant operation and reduce the load on the robot controller.
By means of different gear motor combinations, all miniature devices can be set to an application-specific speed or the required output torque. The fact that micromotors have for a long time already been in use in “robotized” aids such as motor-powered hand and leg prostheses shows that they meet the most stringent requirements not just for human robotics. The range of applications for modern microdrives is very varied, with a wide range of designs available depending on application. In itself, however, this does not yet guarantee universal use under all circumstances. This is where the system concept comes into play. It is the extensive range of accessories, from control modules such as motion controllers, encoders, bus connections, various gear heads and ultimately the adapted, flexible control electronics that make microdrives the ideal mechanical “muscle” in robot manufacture.
FAULHABER trainee awarded development bursary

IHK bursary opens up a world of opportunity

Since 1980 the Chamber of Industry and Commerce (IHK) for the Stuttgart region has fostered young talent with foreign travel bursaries from its ‘Anniversary Foundation’. Every year four outstanding trainees are awarded a bursary of 6,000 euros each to fund a two- to six-month period abroad to further their careers. The basic criteria for the award of the coveted talent prize are outstanding examination results. In their final chamber-certified occupational examination, candidates must score at least 92 points, which equates to a grade of 1.4 (grading scale: 1 = A, 6 = F). Additional factors taken into consideration are foreign language skills, motivation, personality profile, and the evaluation received from the trainee’s workplace.

Among this year’s prizewinners is Natalia Walz from Renningen, who was enrolled in a vocational training program with Dr. Fritz Faulhaber GmbH & Co. KG in Schönaich and completed her qualification as an Industrial Clerk in winter 2010/2011. She has been employed there as a purchasing administrator ever since, and would now like to use the IHK bursary to relocate temporarily to one of the Faulhaber Group’s international companies. “What is especially important to me is to learn about different cultures and to broaden my language skills,” says the 24-year-old prizewinner. As a high-tech company with global operations, FAULHABER places a very high priority on the initial and continuing education and training of its staff.

Among the more than 557 employees at the Schönaich site, there are around 26 commercial and technical apprentices, sandwich-course students and graduate trainees receiving the ideal preparation for their future careers, thanks to the company’s specialized and personalized development programs.

FAULHABER now on Facebook

Over 800 million people are now on Facebook. Are you? Then why not pay a visit to the FAULHABER Facebook page. We hope you will also ‘Like’ us, so that you never miss the latest company news, even between issues of the customer magazine.
New Reference Book

Vibrations and Sounds of Electric Microdrives

There are specifications for large electric machines and drives that dictate how the noises and vibrations they produce should be measured and assessed. On its own, a microdrive is considered to be ultra-silent due to its small dimensions, while its vibrations are generally not seen as troublesome. Such drives are therefore generally first noticed within the context of the device to which they are attached or installed in and often only then subjectively assessed. Many engineers and technicians regularly have to deal with acoustical issues stemming from the electrical microdrives installed in the products they have developed. The new FAULHABER reference book “Schwingungen und Geräusche elektrischer Kleinantriebe” (“Vibrations and Sounds of Electric Microdrives”) should provide assistance in efficiently and effectively approaching vibration- and acoustics-related issues. Furthermore, it should provide a common basis for discussing sound-related issues and act as a foundation for constructive communication between customers and suppliers. The book is based on practical industrial experience and is therefore better classified as a practical handbook than an instructional textbook.

New Micromotor with Graphite Commutation

FAULHABER DC-Micromotors Series 3272 … CR

In launching Series 3272… CR, FAULHABER has set a new standard within the category of DC-Micromotors with graphite commutation. Its exceptional performance is down to the next-generation ironless stator coil, which is integral to the overall design.

- Dynamic continuous torque of 120 mNm, with extremely flat slope of the n/M curve
- Compact dimensions with a diameter of 32 mm and a length of 72 mm
- Robust and durable construction with proven graphite commutation
- Modular design allows combination with a three-channel encoder and a matching range of gearheads
The New Motion Controller Platform v2.5

Motion Controller Series MC ... 3003 and 3006

With the new Motion Controller Platform v2.5, FAULHABER is offering a cross-motor range of Motion Controllers that now includes drives with absolute encoders. At the same time, users will benefit from greater flexibility and enhanced ease-of-application. Brushless DC-Servomotors with absolute encoders can now not only be commutated more effectively due to the high resolution of the encoder, they can also be very precisely controlled even at very low revolutions. Absolute angle information is already available upon powering on, which is an important feature for many positioning applications.

Another new feature: the ability to switch operational modes for the Motion Controller MCBL. It can now be freely selected and reconfigured from brushless 2 pole drives to brushless 4 pole drives using the Motion Manager Software 4.6. With the help of the motor assistant, it’s simply a matter of selecting the connected motor and thus the corresponding parameters. The new tuning assistant helps in manually optimizing the control parameters. Another feature of particular note is the ability to set configurations using a USB adapter, as the required drivers are already included in the current Motion Manager Software version 4.6. On the hardware side, new features include an expanded operational temperature range that now accommodates temperatures as low as –40°C and the standardized terminal assignment for brushless drives that enables a simple switch from revolution control mode to position control mode.
50 years of MICROMO

FAULHABER drive systems in the USA

From sales office to full-service partner for medical technology, aerospace, robotics and a host of other sectors: for the last five decades, the FAULHABER subsidiary MICROMO has carried on the success story of the FAULHABER brand in the U.S. market. Founded in 1961 by Ella Buehler as a sales office in Cleveland, Ohio, MICROMO started out as a distributor of FAULHABER drive systems to customers from the North American medical technology and aviation industries. At the end of the 1960s the company's headquarters moved to St. Petersburg in Florida and MICROMO rapidly advanced to become one of the leading suppliers of high-end microdrives for numerous sectors and applications. Healthy growth brought another move in the early 1990s to the firm’s current premises in Clearwater, Florida.

Today MICROMO is one of the most renowned full-service partners for standard drive components, modified drive systems, and complete customer-specific drive solutions for leading companies in the United States.

Hagar the Horrible