Micron gear head article in Technische Rundschau
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Planetary gearheads key to advances in medical applications

Micron gearheads are used widely across a huge range of engineering sectors in order to provide efficient, accurate and reliable gear reduction.

Since the development of the true planetary gearhead by Micron, however, interest has spread into the medical devices sector. So much so that they are now regular features in many medical appliances, including blood pumps, infusion pumps, dental equipment, lifting equipment, light barriers, lung machines and kidney dialysis machines. They are also crucial to the successful operation of scanners and patient tables.

Micron planetary gearheads use a sophisticated gear arrangement in which 3 planet gears rotate about a pinion or or sun gear. The planet gears orbit within an internal gear that is normally cut into the inner circumference of the gearhead. This construction is rigid, increasing the torsional rigidity of the gearhead as a whole.

The planet gears all share the load attached to the output shaft, an arrangement that gives a planetary gearhead a higher load capacity than a spur gearhead for a given size of gearbox. Because it is possible to have a number of gears within a confined space, very high ratios are possible. So ratios up to 100:1 are typical and Micron offers up to 500:1 in their standard right angle product offering.

Interest by the medical devices industry began to grow after engineers at Micron optimised the gearheads by attaching planet gears with a mobile ‘swing link’. This innovation enables the planet gears to pivot, adjusting so that they mesh more effectively with both the sun and ring gears, whilst sharing the load dynamically between them. The result is a 25% increase in torque capacity compared to fixed planet configurations. In addition, reductions in vibration reduce the noise produced.

Frictional losses caused by tight meshing with the ring gear are also reduced because the swing link improves tooth contact by balancing the load, enabling a 3-11% increase in efficiency. Meanwhile, torque ripple can be reduced by as much as 20% over a fixed planetary gearhead, making the gearboxes suitable for both low and medium speeds.

Micron now markets six true planetary gearheads for applications that require a high torque-to-volume ratio, high torsional stiffness and low backlash:

*XTRUE – the smoothest operating gearhead on the market, ideal for all duty cycles.
*NemaTRUE – an economical solution for all applications.
*DuraTRUE – a high precision solution.
*ValueTRUE – a new, low-cost, high-performance addition to the range.
*UltraTRUE – for situations demanding higher torque capacities, precision and stiffness.
*EverTrue – a continuous duty version, lubricated for life.

In medical scanning equipment, one of the biggest successes of Micron's planetary gearheads is with scanners and patient tables.

The use of scanners is becoming increasingly important in medical diagnostics and treatment. Digital technology has made imaging more precise, allowing both dynamic and static images to be collected and processed. Such images can now be transmitted via internet if necessary, giving experts access to the information regardless of where the patient happens to be.

For this to happen, scanners and patient tables require smooth, precise and coordinated movement of a patient relative to imaging emitters and detectors. An additional challenge comes from the high level of safety needed, something that puts extreme pressure on the performance and reliability of such carefully coordinated systems. Patient weight is also an engineering challenge: the current generation of scanning and patient tables is designed for a patient weight of 250kg. The next generation will have to cope with 350 kg.

Of all scanning systems, including Computed Tomography (CT), Magnetic Resonance (MR) and Positron Emission Tomography (PET), it is Cardio Vascular (CV) that presents the largest requirement for coordinated, synchronised movements.

CV scanners can have 6-7 axes of movement, the patient table another 4-5. So for full 360° scans, it is necessary to coordinate all these axes simultaneously. Since all hardware must be enclosed within scanner and table covers, space is also a limiting factor.

Although axis movements are basically slow because of current maximum patient weight, safety factors and the mass of the machinery, servomotor size is limited due to space constraints so faster small servomotors must be used. For this reason some type of gearing system must be used to both reduce motor speed and increase output torque. On top of these requirements is the necessity for high-efficiency engineering, in order to prevent significant heat build-up and gain as much useful motive power as possible from small-size servomotors. Backlash must also be considered. This happens when an axis is reversed, for example when the scanner or table goes from a forward to a backwards movement. Any gaps or roughness during this change of axis generates backlash which disturbs image quality.

The design of Micron planetary gearheads provides the highest possible torque output, doing so with high efficiency, low noise and minimum backlash. That way servomotor size can be reduced, keeping the overall size of scanning CV and patient tables to a minimum. This has the added benefit of allowing medical staff to be very close to a patient during set-up of a scanning procedure.

Standard configurations of CV patient tables have four axes of movement:
*Height axis - the up/down movement which is accomplished using a ball screw linear actuator driven by a servomotor via a Thomson Micron planetary gearhead.

*Tilt axis - the movement of a table from the horizontal position to either the patient legs-down or head-down position. This is used for dynamic scanning of arterial conditions such as blockages. Tilt axis movement relies on a similar linear actuator to that used to control height axis.

*Lateral axis - when standing next to a table on which a patient is lying in a horizontal position, this is an in-and-out movement. It is achieved via a rack and pinion gearing system with the rack-gear-pinion mounted directly on a Micron planetary gearhead output-shaft, and the gearhead being driven by a servomotor.

*Longitudinal axis - when standing next to a table on which a patient is lying in a horizontal position, this is the left-to-right/right-to-left movement of the table. The drive mechanism here is similar to lateral movement, using rack and pinion, Micron planetary gearhead and a servomotor.

Two types of Micron planetary gearheads are generally employed in such applications:

*For high performance, low backlash applications, Micron's UltraTRUE and ValueTRUE helical crowned True Planetary product lines are used. In this design, the output shaft is an integral component (machined out of solid stainless steel rather than fabricated out of components), which offers high degree of safety, especially in the height and tilt axes.

*For high performance, lower cost applications, the Micron XTRUE series is used where movements are in horizontal plane, such as the lateral and longitudinal axes. There is still the need for low backlash here, but requirements are less stringent with regards to the height and tilt axes.