Sensing changes over time

Non-contact operation is something of a holy grail for most engineers. It offers the possibility of a system without wear, maintenance, side loads, system losses or friction. 'Wirelessness' is the buzz word of the moment, but the concept has a long and significant history, as **Tony Ingham** of Sensor Technology recounts

For today's bright young engineers just out of college and ready to change the world, the word 'wireless' is about as cutting edge as it gets. For those of us a little longer in the tooth, however, hearing our parents say wireless was only marginally less embarrassing than hearing them swear. It was such an old fashioned word, 'Dancette record player' was so much groovier!

I suppose we can trace the root of the word back to a certain Mr Marconi. The concept really showed its mettle during the Second World War, when troops were able to send and collect live information from around the battlefield and when Mr Churchill was able to talk to Mr Roosevelt without sailing across the Atlantic.

Now, non-contact sensors offer tremendous opportunities in many, many fields of endeavour. The TorqSense transducer from Sensor Technology is a fine example of the idea – a sensor that can monitor the torque in a rotating shaft without actually touching it. There is no need for flying leads, slip rings or other paraphernalia. Installation can be done in next to no time, the system is robust and data collection is straightforward. The consequential cost savings over more complex systems are often highly significant.

The foundation of the technology, however, goes back further than Marconi to a Victorian gentleman scientist called Lord Rayleigh. Not troubled with the need to earn his daily crust, he delighted in scientific research for its own sake. Rayleigh discovered a phenomenon called Surface Acoustic Waves (SAW) or Rayleigh Waves, which basically are discontinuities in an object's natural resonance frequency at the surface of the object when it is moving relatively fast.

Like all the best scientific discoveries, people had all sorts of whacky ideas for using SAW waves – most of which proved thoroughly impractical. However, they were soon recognised as playing a part in earthquakes and the movement of lava and magma, and serious work has been done with them by volcanologists over several decades.

Now, SAW waves are really coming into their own in cell phones, mobile communications and wireless sensors.

Capabilities

Sensor Technology has been developing non contact sensors for the best part of 30 years. Since 1990, the main thrust has been with the TorqSense transducer. Prior to that, the focus was on optical systems. The principle was based on the idea of measuring the amount of light passing through two adjacent gratings whose relative alignment was proportional to the torque applied.


Tony Ingham

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Like mobile phones, the fundamentals of TorqSense and the optical systems are still the same today, but the capabilities are through the roof compared to the original product.

TorqSense developed out of research and development for specialist automotive sensors. Its early industrial applications tended to be in lab-based projects, perhaps because researchers are freer to adopt new ideas than production engineers who have to be very focused on reliability through proven technologies.

An early project using the pre-TorqSense optical system was the characterisation of stepper motor drives. Back in the late 1970s and early 1980s, stepper motors were a new technology and something of a marvel. Small and light and with a naturally digital output, they were seen as ideal for applications such as computer peripherals and business machines, instrumentation and smaller robots. Larger ones were being adopted for machine tools, special purpose industrial position systems, and as process valve actuators.

TorqSense had been refined and further developed over the years, so that it is applicable to more and more situations

Back then there were many makes of stepper to choose from, each of which had to be married to a drive circuit. There was a black art to selecting the right motor and drive combination to achieve optimised performance for any given application. By the mid 1980s, the engineering fraternity was sufficiently confident with the concept of stepper motors that it was willing to use them on ultra high integrity systems – provided the performance was guaranteed.

To do this, various combinations of drive and motor were run under various conditions and the performance of each was plotted in detail. This data was then used for compiling performance curves which designers could use for identifying ideal combinations.

This necessitated building a test rig that could accommodate a wide range of motors and drives and which would be quick and easy to set up for each now combination. Each system would be run against a brake and the motor's output measured.

The thought of constantly resetting a conventional torque transducer with its fiddly slip rings and complex wiring was not appealing, so an alternative solution was sought. Sensor Technology's optical transducer offered the possibility of setting up the test rig with each new motor in a matter of minutes rather than hours.

That stepper mapping work was far from glamourous and didn't win any awards, fame or fortune for the engineers involved. But it laid the foundation for the rapid take-up of stepper technology and helped give the UK a competitive edge in the field.

Developments

Through the 1990s steppers gave way increasingly to servo motors, and this time TorqSense was at the heart of the operations.

Work was carried out at several UK universities, backed by drive and control companies of world class stature, to develop and refine servo motors from the expensive exotica of the aerospace sector to the backbone of modern manufacturing and production. Many of the researchers were using test rigs and dynamometers featuring TorqSense non-contact transducers.

The ease of set up of TorqSense is still a driving force for drives researchers, but one of the greatest changes since the 1980s is the ubiquitousness of the PC. Not surprisingly, TorqSense now sports all the necessary ports to interface directly with PC systems, and has its own suite of software for analysing data and presenting it in easy to appreciate formats.

Drives research still continues today. Manchester University, for instance, is still pushing the boundaries with its dedicated Power Conversion Laboratory. Imperial, Oxford and Cambridge, Glasgow's SPEED lab, Birmingham's Controls and Drives Group, and Sheffield's specialist teams, are recognised as world leaders in their fields.

Just like servomotors, TorqSense has been refined and further developed over the years so that it is applicable to more and more situations. It is no longer confined to the laboratory, but is to be found in process plants, machine tools, robots and special purpose machines. Most of its applications are vital but mundane, but it does have its occasional moment of glory: positioning astronomical telescopes to pinpoint accuracy for viewing distant planets; in stage sets for the West End theatres and blockbuster films; in developing the latest high performance electric vehicles; research into earthquakes, volcanoes and tsunamis etc.

A non-contact torque sensor does not have the mass market appeal of the latest multifunctional mobile communications device, but in its way it is doing almost as much to reshape the world.

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TorqSense is useful for research into earthquakes, volcanoes etc.