Emerging sensor technology

Extreme applications on earth and in outer space are using new encoder technologies that allow robotics and automation engineers greater design freedom.

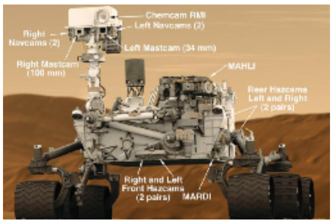
The traditional optical incremental encoder is one among many feedback devices including resolvers, DC tachos, Absolute, virtual absolute and the humble hall sensor. The optical encoder is still the most widely used and can be an adequate and cost effective device providing speed and position feedback in most motion control applications. However, the optical encoder has some inherent limitations in extreme applications that may involve shock and vibration, pressure, vacuum, subsea and oil filling and the most common – size constraints.

Optical Encoder.

Magneto Resistive Encoder.

Two poignant examples of this new technology in use are the MR (magnetoresistive) encoders on the Mars Rover Curiosity and Mile encoders using inductive principals being integrated inside motor bodies.

Magnetoresistive Encoders on Mars.



Curiosity Rover.

For space applications there are many different considerations taken into account that would mean a standard optical encoder may not be suitable. Temperature range causing uneven expansion and contraction, Ball bearing lubrication outgassing or solidifying, plastic parts and adhesives that can be damaged by vacuum and most importantly current consumption.

Magneto resistive encoder technology with extremely low power consumption supplied by maxon motor Switzerland will play a part in the successful excursion of the curiosity rover having been installed into the electromechanic joints. The plan is that the rover shall explore the immense Gale Crater on Mars for signs of life for two years. Despite being equipped with a radionuclide battery, power consumption is critical, especially considering the impressive equipment on board including a gas chromatograph, spectrometer, two meter long robot arm and a neutron source.

The MR encoder features a magnetic disc mounted on the axis with a non-contact apposing pcb also mounted on the axis to reduce the diameter by comparison to a standard magnetic encoder using hall sensors. The magnetic disc raw pulses are then interpolated in to high resolution channels. The MR encoder signals have a very fast rise time and accuracy by comparison to optical or Hall encoder they are also typically much smaller.

Inductive encoders inside motors

Motors are getting smaller and in order to take advantage of this, encoders must also. Smaller motors are also typically faster. An optical encoder cannot cope with the frequency required when highly accurate positioning is required and also high speeds. A maxon 6mm diameter brushless DC motor is capable of accelerating from 0 to 100,000 rpm in just 4ms and for this the only capable encoder technology is the inductive principle. With the inductive principle a high frequency alternating field is transfomatively transmitted and therefore angle dependent. Modulated eddy currents are captured in a conductive target using a structured copper disc. These encoders can be made incredibly small and are now being integrated into the motors body. In particular they are suited for use inside “pancake” or brushless flat motors which are often used in direct drive applications such as robotic joints or

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rotary stages without adding any additional length or diameter to the drive mechanism. The Mile encoder produced by maxon motor is currently the world's smallest rotary inductive encoder.

Compared with optical and reflective encoders the advantages of a high-frequency inductive methods of measurement and the magnetoresistive method, include a high robustness against dust, dirt and oil, a high speed capability, insensitivity against electromagnetic interference in Mile encoders such as PWM controllers and motor magnets.

6mm diameter brushless motor.


Brushless Flat motor with encoder.

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Reference: maxon program 12/13