Rotary position sensor for wind direction measurement

Introduction

For the autonomous boat to gain maximum propulsion force from wind, the direction of the wind needs to be constantly measured so that the rudder can be adjusted accordingly to form an optimal angle with the wind. As part of a large system, the measuring device needs to be lightweight and programmable. Magnetic rotary sensor chips are the common solution to this question, as they are not only easy to integrate with other components but also have high durability under harsh environmental conditions. This technical review summarizes some common commercial rotary position sensors, explains the mechanism of rotary encoder technology and basic building blocks of the sensor.

Commercial rotation sensor product

There are 2 types of rotary sensor in the market. Absolute encoder measures the exact angle of rotation of the shaft, while incremental encoder measures the motion of the shaft [1]. Because incremental encoder requires additional calculation to convert motion to absolute angle, absolute encoder is more suitable for building autonomous boat. Reliability is the main requirement of the sensor due to the weather condition in the sea. Among absolute encoders, magnetic sensor is the most reliable type. At the top is a magnetic sensor, AS5045, offered by the multinational company ams AG. This sensor has a failure detection mode for magnet placement monitoring and power loss, which is unique among its competitors [2]. Additionally, it is small and accurate. It weighs less than 10 grams and the total length is 10cm [3]. It also uses 12 bits angular resolution to ensure high accuracy measurement and has a coverage range of 360 degree. This sensor is marketed at US$12.53 [4].

Another competing design is EM3242 from AKM Semiconductor, Inc. Like AS5045, EM3242 is a magnetic sensor that can operate under extreme condition. Its temperature tolerance is from -40 to 150 degree Celsius. Its advantage is its small size (SOP6 3.6 X 3.0 mm), which is much smaller than the size of AS5045, but its angular resolution is 2 bits less than AS5045 [5]. It is marketed at US$3.69 [6].

Technology of rotary sensor

An absolute rotary encoder determines its position by using a static reference point. The encoder has 2 concentric disks with offset makers. One disk is fixed and the other can move freely. As the disc turns, the markers along the track of absolute encoders change position on the fixed disc. Each configuration along the disk represents a unique binary code, and by looking at the binary code, the encoder can determine the absolute position of the object. [7]. A Hall array is used to measure the binary code by detecting the position of magnetic poles. Several Hall elements will be used to record the Z field at various positions so that the angle information can be determined by evaluating local gradients [8].

Implementation of rotary sensor

The major building blocks of a rotary sensor include a Hall array, a DSP processing unit, and an SSI interface. The Hall array is used to deliver a voltage representation of the magnetic field. This signal is then passed to a DSP processing unit and converted to angular position information through Sigma-Delta Analog / Digital Conversion and Digital Signal-Processing (DSP) algorithms. This signal can be accessed via a Synchronous Serial Interface (SSI), which is the most common protocol of serial encoders [2].

References

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