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Intelligent Steering Key Components Report, 2023

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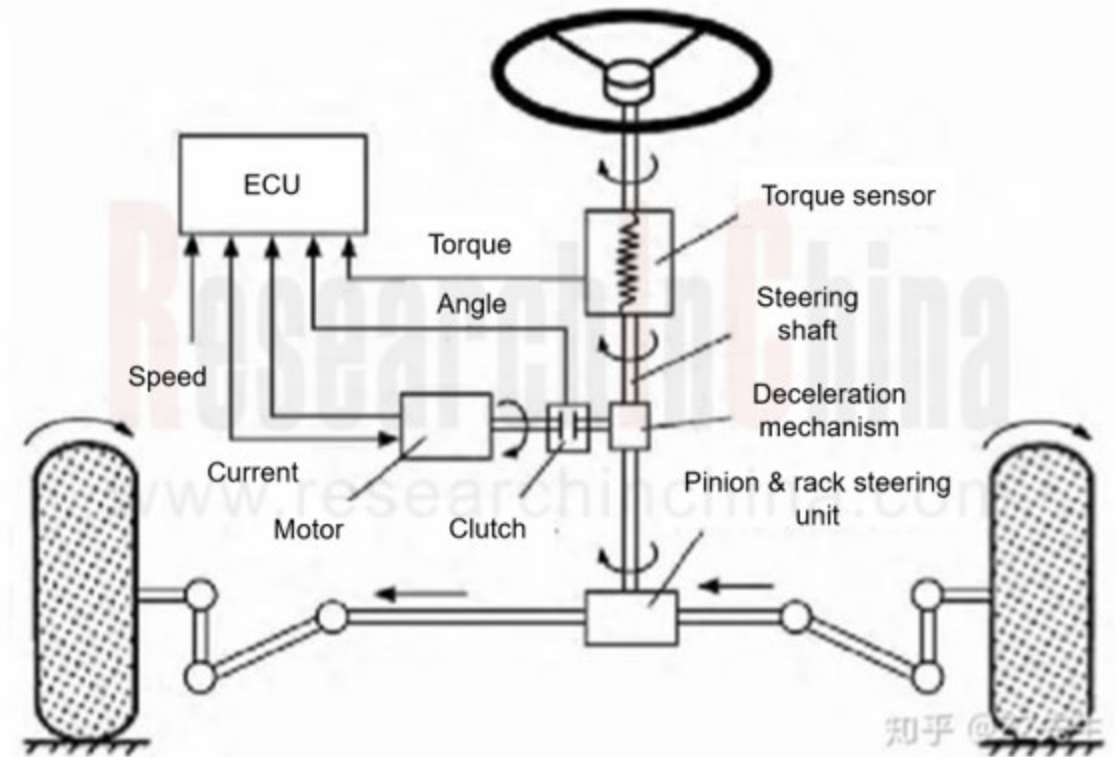
Research on intelligent steering key components: four development trends of intelligent steering

The automotive chassis consists of four major systems: transmission system, steering system, driving system and braking system, covering five major parts: drive, gearshift, brake, suspension and steering. Wherein, the steering system passes through the development process from mechanical steering to hydraulic power steering to electric power steering. Nowadays, as intelligent driving technology advances, intelligent steering, namely, electric power steering as an important part of intelligent chassis, is becoming widespread, and steer-by-wire that develops from electric power steering is also being applied.

Based on conventional mechanical steering systems, electric power steering system adds sensor, electronic control unit (ECU) and power steering mechanism, and generates power by controlling the electric motor to achieve steering, which is completely free from the hydraulic power method. The key components of this system are torque sensor, motor and ECU, of which:

?The torque sensor is used to measure the magnitude and direction of the torque applied to the steering wheel by the driver, and to convert the torque into an electrical signal sent to the ECU.
?The electric motor converts the electric energy provided by the battery or generator into mechanical energy, outputs the appropriate torque to the mechanical steering mechanism, and together with the steering gear offers the steering torque to the steering wheels.
?Based on the signals from the speed and torque sensors, the ECU determines the direction of rotation of the motor and the magnitude of current of the booster, so that the motor can provide power steering effects according to vehicle speeds.

Intelligent Steering Structure



Steer-by-wire will gradually replace electric power steering, and brushed motors will shift to brushless motor

Trend 1: steer-by-wire will gradually replace electric power steering

The main difference between steer-by-wire (SBW) and electric power steering (EPS) is that SBW removes the mechanical connection between the steering wheel and vehicle wheels and uses sensors to obtain the steering wheel angle data, and then the ECU converts the data into specific driving force data, so that the electric motor can drive the steering gear to turn the wheels. The EPS, on the other hand, uses an electric motor to assist the driver in steering.

SBW outperforms EPS in response sensitivity and expansibility of intelligent driving functions. SBW not only has all the advantages of conventional mechanical steering systems, but also can optimize angular transmission characteristics, which is difficult for a mechanical system. By virtue of these benefits, SBW systems have become a development trend in the automotive industry.

Trend 2: the gradual shift from brushed motors to brushless motor

Brushless motors generate no electric sparks while running, its most direct difference from brushed motors, which minimizes the interference of electric sparks to remote control on radio equipment. Secondly, without brush, brushless motors enable much less friction, smooth operation, far lower noise and higher operational stability when they run. Thirdly, having no brushes means the wear of brushless motors is concentrated on the bearings. From a mechanical prospective, brushless motors are almost maintenance-free, only needing some dust removal maintenance when necessary. In the long run, brushless motors will thus gradually replace brushed motors.

Comparison between Brushed Motor and Brushless Motor

Characteristics	Brushless motor	Brushed motor
Commutation	Electronic commutation based on Hall position sensor	Brush commutation
Maintenance	Less maintenance required	Regular maintenance required
Lifetime	Long	Short
Speed/Torque	Flat - works properly at all speeds under load rated conditions	Medium flat - higher speeds increase brush friction and reduce useful torque.
Efficiency	High - no pressure drop across the brushes	Medium
Output power/volume	High - reduced size due to excellent heat dissipation features. The BLDC motor dissipates heat better because the windings are placed on the stator which is attached to the motor housing.	Medium/low - the heat generated by the armature is dissipated into the air gap, which raises the temperature in the air gap and limits the output power/volume specification.
Rotor inertia	Small, improved dynamic response due to the permanent magnets on the rotor.	Large dynamic characteristics of rotor inertia.
Manufacturing cost	Higher manufacturing costs due to the permanent magnets	Low
Control	Complex and expensive	Simple and cheap
Control requirement	To keep the motor running, a controller is always required. This controller can also be used to control the speed.	The controller is not required for fixed speeds; it is only required when the speed needs to be changed.

Source: ResearchInChina

The transition from sliding variable resistance sensor to non-contact sensor, with 32-bit MCUs replacing 8-bit/16-bit MCUs

Trend 3: the transition from sliding variable resistance sensor to non-contact sensor

Sliding variable resistance sensors are a relatively conventional type of sensor. Despite high maturity, this sensor technology also has problems of unstable performance and short service life caused by wear and ageing of the sliding contact surfaces. In contrast, non-contact sensors offer following benefits:

1. Longer service life for insusceptibility to wear and ageing;
2. Higher levels of accuracy and stability;
3. Available in harsh environments, e.g., high temperature and high pressure;
4. Small size, light weight, easy to install and maintain.

Hence non-contact sensors are expected to replace sliding variable resistance sensors and dominate the market in the future.

Trend 4: 32-bit MCUs are replacing 8-bit/16-bit MCUs.

8-bit, 16-bit and 32-bit products prevail in the automotive MCU market. 8-bit MCUs are mainly used for controlling basic functions such as seat, air conditioner, fan, window, and door control module. 16-bit MCUs are generally applied to lower body covering power and transmission systems like engine, e-brake and suspension system. 32-bit MCUs customized for vehicle intelligence are often seen in automotive power system, intelligent cockpit and body control.

In addition, steering system control units are almost monopolized by foreign manufactures such as JTEKT, NSK Ltd, ZF TRW, Nexteer and Sono Koyo Steering, and they are capturing bigger market shares by way of establishing joint ventures and partnerships. For example, the four companies, Aisin, ADVICS, JTEKT and Denso, have respectively combined their competitive hardware such as sensors, steering and brakes with integrated ECUs and established integrated ECU software development companies.

Comparison between Sliding Sensor and Non-contact Sensor

	Sliding Sensor	Contactless Sensor
Advantages	<ul style="list-style-type: none">• Simple structure• Low manufacturing cost	<ul style="list-style-type: none">• More stable: compared to sliding resistance sensors, contactless sensors are not affected by external environmental factors, such as dust and moisture.• High accuracy: contactless sensors use a digital signal output, allowing for higher accuracy and more precise data collection.• Long lifetime• High temperature resistant• Corrosion resistant• More functions possible: contactless sensors enable more functions such as automatic steering, automatic parking, lane keeping assistance, collision avoidance, etc. These functions can further improve the driving safety of the vehicle.
Disadvantages	<ul style="list-style-type: none">• Easy to wear and tear• Easy to contact poor• Long-term use will produce errors and reduce accuracy	<ul style="list-style-type: none">• High cost: complex manufacturing techniques and high-end materials making them more expensive.• Large volume

Source: ResearchInChina

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