Research and Design of Intelligent Safety Helmet Based on Sensor Technology

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Abstract

Traditional helmet only has simple protection function. After fully researching the functions of photosensitive sensor, magnetic sensor and acceleration sensor, we design an intelligent safety helmet based on sensor technology. According to the working principle of sensor, intelligent helmet can automatically detect environmental light. When the light is not good, it automatically lights up a conspicuous reminder lamp, and adds turning and braking lights on the helmet. When the vehicle turns or brakes, the corresponding turning lights or brake lights can be automatically turned on to remind the surrounding vehicles or pedestrians to avoid. It can effectively reduce traffic accidents and improve the safety of riding.

Keywords

1. Introduction

In recent years, people often ride bicycles, motorcycles and electric bicycles on their daily trips. Left turn, right turn and brake are often used in riding. Because motorcycles, electric bicycles and bicycles do not have a warning light or the warning light is not visible enough, when the light is bad or when the driving state is changed (such as sudden braking, turning, etc.), pedestrians or other vehicles are too late to avoid, causing traffic accidents. Therefore, we try to design an intelligent safety helmet for cyclists. How can a intelligent helmet become a "live" intelligent helmet? How can intelligent helmet improve cycling safety?

In recent years, with the development of sensor technology, objects have senses such as touch, taste and smell, which make them gradually become alive. In order to obtain information from the outside world, people must resort to sensory organs. It is not enough to study natural phenomena and laws and their functions in production activities solely by people's own sensory organs. In order to adapt to this situation, sensors are needed. Therefore, it can be said that the sensor is the extension of the human five senses, also known as the electric five senses. With the advent of the new technological revolution, the world began to enter the information age. In the process of utilizing information, the first problem to be solved is to obtain accurate and reliable information, and sensors are the main ways and means to obtain information in the field of nature and production.

So we make full use of various sensor functions, using photosensitive sensors can automatically detect environmental light. When the light is bad, it can automatically light up the striking reminder lamp. Magnetic sensors are used to detect vehicle turning, and it can automatically light the corresponding turning light. Acceleration sensors are used to detect vehicle speed changes, complete braking or vehicle deceleration operations, and turn on the brake light to remind the surrounding vehicles or pedestrians to avoid, thus effectively reducing traffic accidents and improving the safety of cycling. On the premise of guaranteeing the safety of the traditional helmet, the intelligent embedding of the sensor technology can bring convenience to people.

2. The theoretical basis of intelligent helmet design

In order to obtain information from the outside world, people must resort to sensory organs. It is not enough to study natural phenomena and laws solely by people's own sensory organs. In order to adapt to this situation, sensors are needed. The design of intelligent helmet mainly uses the function of sensor.

2.1 Sensor Introduction

Sensor (English name: transducer/sensor) is a kind of detection device, which can sense the measured information, and can transform the sensed information into electrical signals or other required forms of information output according to certain rules to meet the requirements of information transmission, processing, storage, display, recording and control. The national standard GB7665-87 defines sensors as "devices that can sense the measured information and convert it into usable signals according to certain rules (mathematical function rules). They are usually composed of sensitive elements and conversion elements".

The characteristics of sensors include miniaturization, digitalization, intellectualization, multi-function, systematization and networking. It is the first step to realize automatic detection and control. With the existence and development of sensors, objects have senses such as touch, taste and smell, which make them live slowly. Generally, according to its basic sensing function, it can be divided into ten categories: thermal sensor, photosensitive element, gas sensor, force sensor, magnetic sensor, humidity sensor, sound sensor, radiation sensor, color sensor and taste sensor.

Composition of sensors

Sensors generally consist of four parts: sensitive elements, conversion elements, conversion circuit and auxiliary power supply, as shown in Figure 1.
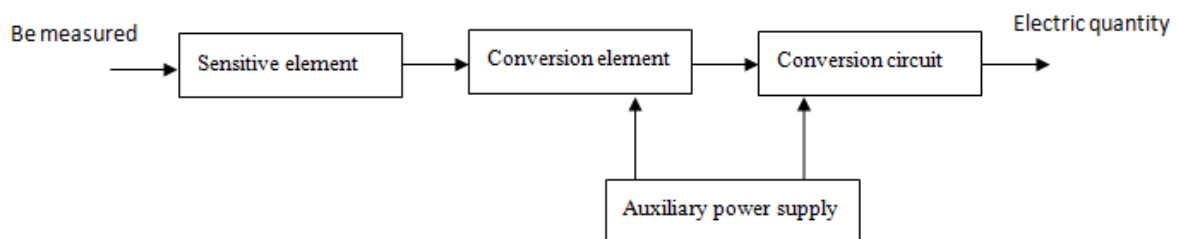

Fig. 1 Composition of sensors

Sensors can sensitively sense some physical, chemical and biological information and output physical quantity signals; converters convert the physical quantity signals output by sensitive elements into electrical signals; converters are responsible for amplifying and modulating the electrical signals output by converters; conversion element and Change circuit are generally need auxiliary power supply. Classification of Sensors: Physics class is based on physical effects such as force, heat, light, electricity, magnetism and sound. Chemistry class is based on the principle of chemical reaction. Biology class is based on molecular recognition functions such as enzymes, antibodies, and hormones.

Three types of sensors are used in the design of intelligent helmet: photosensitive sensor, magnetic sensor and acceleration sensor. The three types of sensors are highlighted in the following.

1. Photosensitive Sensors

Photosensitive sensor is one of the most common sensors[1]. There are many kinds of photosensitive sensors, such as photoelectric tube, photomultiplier tube, photosensitive resistor, photosensitive triode, solar cell, infrared sensor, ultraviolet sensor, optical fiber photoelectric sensor, color sensor, CCD and CMOS image sensor[2]. Its sensitive wavelength is near the visible wavelength, including infrared wavelength and ultraviolet wavelength. Optical sensors are not only limited to the detection of light, but also can be used as detection elements to form other sensors to detect many non-electric quantities, as long as these non-electric quantities are converted into changes in optical signals.

Optical sensor is one of the most productive and widely used sensors. It plays a very important role in automatic control and non-electric measurement technology. The simplest photosensitive sensor is a photosensitive resistor, which generates an electric current when the photon impacts the junction. We mainly use photosensitive sensors to automatically perceive light. When the light is insufficient, the helmet can automatically turn on the prompt lamp.

2. Acceleration Sensors

Acceleration sensor is a sensor that can sense acceleration and convert it into an output signal[3]. Usually it consists of mass block, damper, elastic element, sensitive element and adjustable circuit. In the process of acceleration, the sensor obtains the acceleration value by measuring the inertia force on the mass block and using Newton's second law[4]. According to the different sensor's sensing elements, common accelerometers include capacitive, inductance, strain, piezoresistive, piezoelectric and so on.

The accelerometer is integrated into the intelligent safety helmet. It can measure the acceleration values of X, Y and Z separately. The value of X direction represents horizontal movement. The value of Y direction represents vertical movement. The value of Z direction represents vertical direction of space.

3.Magnetic Sensors

The magnetic sensor is a device that converts the change of magnetic properties of sensitive elements caused by external factors such as magnetic field, current, stress and strain, temperature and light into electrical signals to detect the corresponding physical quantities in this way[5]. Magnetic sensors are divided into three categories: compass, magnetic field sensor and position sensor[6]. Compass: The earth produces magnetic fields. If you can measure the magnetic field on the earth's surface, you can make a compass. The magnetic sensor determines the direction by measuring the magnetic flux. When the magnetic sensor tilts, the geomagnetic flux through the magnetic sensor will change, so that the direction will be erroneous. Therefore, if the electronic compass does not have tilt correction, it needs to be placed horizontally by the user. The inclination of electronic compass can be compensated by using the principle that the accelerometer can measure the inclination angle.

The magnetic sensor used in intelligent helmet is the compass type. Through the geomagnetic field sensor, we can roughly judge the current direction of the cyclist's movement. Combined with the analysis of acceleration sensor and historical data, we can judge whether the cyclist has the action of turning.

2.2 MCU (Microcontroller Unit)

The essence of microcontroller unit is a single-chip microcomputer which integrates the main parts of microcomputers into on a single chip[7]. The microcontroller was born in the mid-1970s. After more than 20 years of development, its cost is getting lower and lower, and its performance is getting stronger and stronger. This makes its application everywhere and in all fields. For example, motor control, bar code reader/scanner, consumer electronics, game equipment, telephone, industrial control and automation, white household appliances (washing machine, microwave oven) and so on.

The microcontroller is integrated in the intelligent helmet. It is the control center of the whole helmet. It collects data from various sensors, analyses data and controls various LED lights through the program. It is the "brain" of the intelligent helmet.

3. Design scheme of Intelligent Helmet

The traditional riding helmet only protects people's head, and can't signal the riders and drivers behind it. In this paper, an intelligent safety helmet is designed to automatically light the warning lamp and improve the safety of riders by using sensor function which can automatically sense light changes, vehicle turning or speed changes, braking and other operations.

3.1 Hardware Design Scheme

This design uses photosensitive sensor as light acquisition equipment, magnetic sensor is used to detect vehicle turning. Acceleration sensor is used to detect vehicle speed change, mainly to detect brake or vehicle deceleration. The microcontroller unit is the control center of the whole helmet. It collects and analyses data from various sensors and controls various indicator lights. The helmet was developed using a 5 V DC power supply. When the helmet is manufactured later, the power supply will be integrated on the helmet. The hardware design is shown in Figure 2.
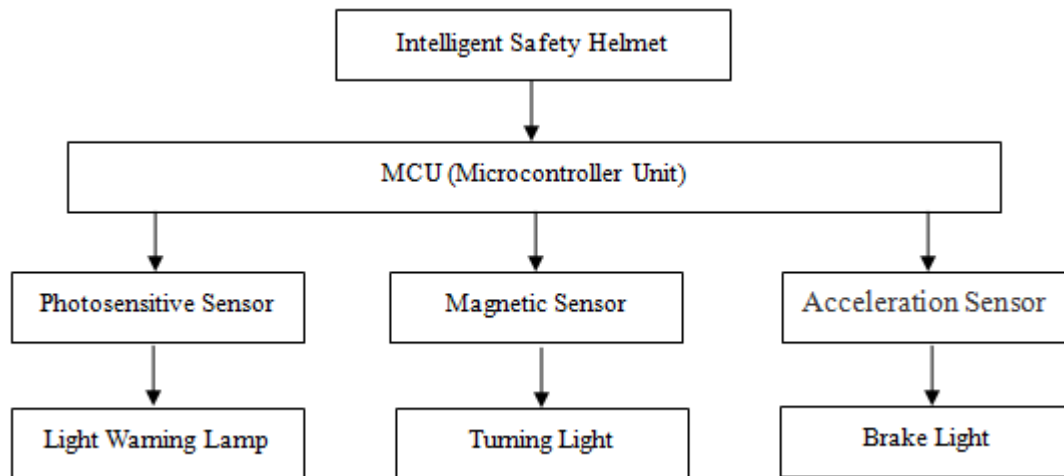

Fig. 2 Hardware Construction

3.2 Software Design Scheme

The realization and design method of intelligent safety helmet are studied and analyzed. The key research is how to realize the following functions of intelligent safety helmet.

1. Auto-sensing light. When the light dims, the LED lamp on the helmet can automatically light up to improve the identification of riders.

2. Auto-detection of vehicle turning, automatic flashing of turning light, reminding passers-by and vehicles to avoid.

3. Auto-sensing the braking action of the vehicle and lighting the brake lamp to remind the vehicle behind it to slow down and avoid.

How did we design this intelligent helmet? Through research and analysis, it is found that the design function of safety helmet can be completed by using sensor control program. We decide to use the following materials and equipment to design and develop the intelligent safety helmet.

1. Photosensitive sensor: Photosensitive sensor can help us to collect the light from environment, to judge the brightness of the current environment, to decide whether to turn on the LED light.

2. Acceleration sensor: Acceleration sensor can detect acceleration in three different directions. Through certain design and processing, we can judge the current movement state of riders by the data it collects, such as whether braking or not.

3. Magnetic sensor: Geomagnetic field sensor is the compact version of the guide. Through the geomagnetic field sensor, we can roughly judge the current direction of the rider's movement. Combined with the analysis of acceleration sensor and historical data, we can judge whether the rider has the action of turning.

4. Microcontroller unit: Microcontroller unit is the control center of the whole helmet, collects data from various sensors, then analyses and controls all kinds of LED lights at the same time.

Sensors, LED lights, microcontroller unit and other materials are needed in design. Among them, photosensitive sensors can automatically detect light, geomagnetic field sensors are used to detect vehicle turning, and acceleration sensors are used to detect vehicle speed changes, mainly to detect brakes or vehicle deceleration. The microcontroller is the control center of the whole helmet. It

collects and analyses data from various sensors and controls various prompt lights. Then assemble them together, collect and analyze sensor data through program, control LED lights, and finally complete the design of intelligent safety helmet.

4. Test results

According to the above scheme, we design and develop an intelligent safety helmet. The test results are as follows: when the environment light is not good, the overhead light automatically lights up to remind others. The left or right turn lights can be flashed in the turn direction when turning. Four lights are all on at the bottom of the helmet when the rider brakes. As is shown in figure 3.In this way, through the relevant warning lights on the safety helmet, to remind the surrounding vehicles and pedestrians to pay attention to rider and his driving conditions, timely avoidance, reduce the occurrence of traffic accidents.
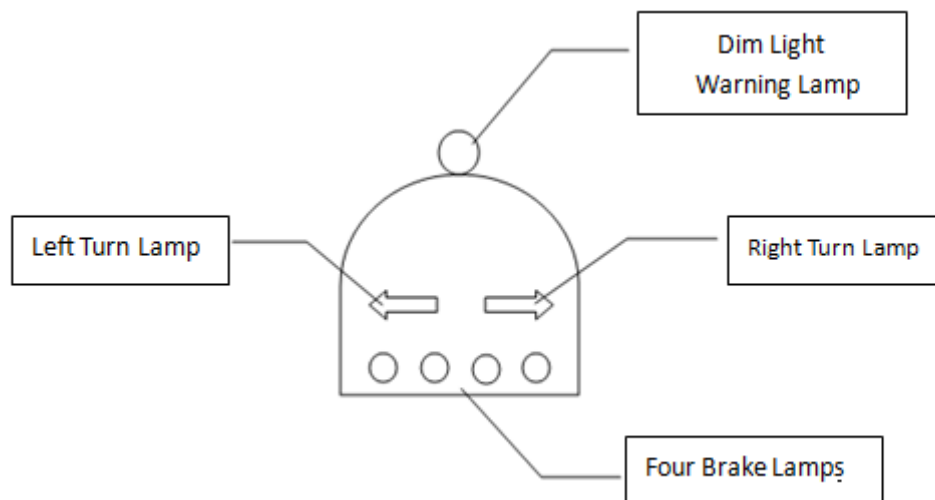

Fig. 3 Several kinds of indicator lamps

5. Conclusion

Sensor is the extension of human five senses, also known as electric five senses. We make full use of the functions of three kinds of sensors, research and design this new intelligent safety helmet. The integrated microcontroller unit can collect and analyze the data of three kinds of sensors, real-time and effective control of all kinds of LED lights in the helmet, while ensuring the safety function of the traditional helmet to protect the head, improve the identification of rider as much as possible. It can not only make people clearly see the rider, but also predict his driving route in time according to the turning lights and brake lights on the helmet, which can effectively reduce traffic accidents and improve the safety of riding. This intelligent helmet is suitable for all kinds of riding tools, including bicycles, electric bicycles, motorcycles and so on.

Acknowledgements

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