Sensors in Smart Phone

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Abstract. The technological innovation in electronics makes nowadays mobile phone more than a simple communication tool: it becomes a portable electronic device with integrated functions, such as listening to music, watching movies, taking photos, etc. To achieve these, many kinds of advanced sensor are used. In this paper, several applications of sensor in smart phone are introduced including Image Sensor, Fingerprint Identification Sensor, Photo-electric Sensor, Acceleration Sensor, etc. The trend of the mobile phone, 3I (Intellignet, Interaction and Internet), will have all kinds of sensor more and more popular in mobile phones to change our life**.**

Key words: Communication Terminal, Sensor, Smart Phone, 3I

1 Introduction

The development of technology, as seen in the portable devices, is making people's work and life more convenient. Digital cameras, MP3, MP4, Pocket PC and other small but powerful electronic devices are seen everywhere. Mobile phone, with annual sale of more than 200 million worldwide, is one of the most popular ones and almost indispensable to our lives. Starting from being a simple communication tool, mobile phone started to integrate more basic functions such as text messaging, multimedia, etc. To become more intelligent and smarter, a variety of sensors are adopted in mobile phones.

2 definition and classification of the sensors

2.1 Definition of the sensors

According to National standard GB7665-87, sensors are defined as: "Devices which can feel the information to be measured, and convert the information into usable signal in accordance with some rules. Sensors are usually composed of sensitive components and conversion devices." Sensor is a detection device based on certain rules, which can measure the information and transform the signal to another form to meet the requirement of information transmission, processing, storing, displaying, recording and controlling. It is the primary step for automatic detection and control.

2.2 Classification of Sensors

Sensors can be classified in several ways, by conversion method (based on their basic physical or chemical effect), by usage, by type of output signal, by material, or by manufacturing techniques.

2.2.1 By working theory, it can be classified into physical sensors and chemical sensors.

2.2.2 By usage, it can be classified into positioning sensors, liquid level sensors, power sensors, speed sensors, thermal sensors, acceleration sensors, radiation sensors, vibration sensors, humidity sensors, magnetic sensors, gas sensors, vacuum sensors and biosensors.

2.2.3 By output signal, it can be classified into analog sensors, digital sensors, and switch sensors.

2.2.4 By the materials, they can be further classified by,

2.2.4.1 The category of materials used, into metals, polymers, ceramics and mixtures.

2.2.4.2 The physical properties of materials, into conductors, insulators,

semiconductors and magnetic materials.

2.2.4.3 The crystal structure of the materials, into single crystal, polycrystalline, and amorphous materials.

2.2.5 By the manufacturing process, it can be classified into integrated sensors, thin film sensors, thick film sensors, and ceramic sensors.

3 The application of some typical sensors in smart phones

3.1 Image Sensor

As the photography feature has become standard in many mobile phones, image sensor has been widely used in mobile phones after its application in regular cameras. Taking pictures and shooting videos with mobile phones are part of a lot of people's daily lives. The image processing technology has given the image sensors a broader room for application.

3.1.1 Business card recognition
We use the phone to take a picture of the business card. The image is processed by software to identify the information in it. After some types of processing, the name, age, telephone, company address on the card are automatically inserted into the mobile telephone directory under one entry. This is a typical high-end feature of the business mobile phones.

3.1.2 Facial recognition
The user can take a picture to his/her face, and register it in the phone. Image processing software can identify the user's facial features, and establish the criteria to authenticate the user in the future. With this feature, the user does not need to remember complex password when accessing secured mobile phones. The only thing to do is simply to take a photo for himself/herself, and register it in the phone. In this way, the mobile device is more secured and the usage becomes simple.

3.2 Fingerprint Sensor

As the demand increases for security of personal data on consumer products, and as the fingerprint sensors have achieved substantial improvement in the size, cost and accuracy, and so forth, fingerprint recognition technology has been applied on more and more diverse mobile devices. Many latest high-end business phones have such functions.

Currently there are two solid-state fingerprint sensors in the market, contact sensors (touch sensors), and slip sensors (slide sensors). Contact sensors require the finger to push on the fingerprint sensor area. Slide sensors require your fingers to move at the sensor surface. The sensor will capture a specific set of data, then quickly analyze the data, and certifies the user. The improvement in sensing technology and algorithms, the cost-sensitive market, and the inherent requirements of portability, have made slip sensors more popular.

Fingerprint sensor was firstly used in the mobile phone for identification, which is equivalent to the password identification. Only when the owner of the fingerprint is verified, can he/she be able to use the phone. With the development of semiconductor and software technologies, mobile phones are becoming mobile terminals that can access personal and corporate data at anytime, anywhere. It is critical to ensure the security of user access to prevent unauthorized access. For example, in e-commerce, the fingerprint recognition software can relieve the user from multiple complicated password operations. The process is simpler but the level of security is higher than traditional method. Fingerprint recognition can also be widely used in many other areas. For example, in the future the police can use the mobile phone to obtain the fingerprint, instead of ID card or driver's license, of a suspect in a district of high crime rate. The fingerprint information can be sent to the central database via Internet from the mobile phone. Then the ID of the suspect can be obtained.

3.3 Optical Sensor

The photoelectric sensors in mobile phones are mainly used to smartly regulate the mobile phone by detecting the brightness of the environment, to save energy and make the mobile user-friendly. When the environment is too dark, it can automatically reduce the backlight brightness protect the eyes. When the environment is too bright under the sun, it can automatically increase the screen brightness, so the

display can be clearer. When the mobile phone is placed near the ear during a phone call, it can automatically turn off the screen and backlight, to extend the battery life. The touch screen is disabled at the same time, to prevent unintentional hang up of the call by miss touching on the screen. By using this type sensor, the mobile phone can even be designed to control the ring volume by detecting the light intensity of the environment. When the mobile phone is put in the pockets or purse, the ring tone is loud. When the mobile phone is taken out of the pocket, as the brightness of the environment changes, it can turn down the volume. This feature is very useful. It not only can avoid missing phone call because of weak ring tone, but also can avoid disturbing others. The battery life is also saved.

3.4 Accelerometer Sensor

There are two types of acceleration, static and dynamic. When static accelerometer is tilted to an angle, gravity will produce a vector in the sensing field. By measuring this vector, the tilt angle of the mobile phone can be calculated. So moving the mobile phone back and forth, up and down, can control some functions. The so-called dynamic acceleration can detect the moving speed, collision and so on.

Accelerometer can be used to detect the angle. When we move the phone up and down, the acceleration sensor can send the corresponding information to CPU. And the software can control the menu selection, flipping, image switching and other operations. When the phone is rotated for 90 degrees, it can automatically switch between vertical display and horizontal display. In racing, skiing and other games, accelerometer can even replace the arrow keys, to turn, accelerate, and break the vehicle by tilting the phone at different angles, thus making the game more entertaining.

Acceleration sensor can also be used as odograph, to detect and record the number of steps when walking or running, to calculate the distance. Combining with personal characteristics, such as height, weight and other information, the software can calculate the energy consumption, which can reflect the exercising result. In this way phone can also be used as fitness equipment.

Mobile phones with acceleration sensor can also be used as emergency alarm. When the user experiences a severe crash, or falls, the acceleration sensor can immediately send the related information to the CPU. If the user does not move within a period of time after the accident (such as 1 minute), the software then

determines that the user is injured, and will immediately alarm. If the phone has GPS module, it can also automatically start the GPS, and send the location information to the emergency department. So the victim can get first aid treatment. This will greatly benefit the growing population of senior people.

Acceleration sensor, combination with magnetic sensor, can provide more powerful functions. "Perspective Space" technology is achieved by combining these two types of sensors. They detect the horizontal displacement, as well as vertical displacement, and the directions. When the user is carrying such mobile phone traversing in a building, a lot of information of lateral displacement, vertical displacement and the direction is transmitted to the CPU. With image rendering technology, a perspective of the building can be shown to us. This technology can also be the supplement to GPS navigation. In a special location, such as tunnels and tall buildings, where GPS does not work, acceleration sensor and magnetic sensor can work together to collect multi-directional displacement information and continue the navigation in the absence of GPS signals.

4 Conclusion

With the rapid improvement of the technology, mobile phone is far more than just a simple communication tool. It has become a complex mobile data terminal with a variety of functions. The mobile phone will definitely become 3I (Intelligent, Interaction, Internet). To be intelligent and interaction, the mobile phone should provide a lot of practical functions, and automatically change settings and response to different environment, to achieve the user’s requirement in the simplest way. This requirement gives the sensor a great opportunity to show its functions. It is believed that a variety of sensors will spread in a large area in the mobile phone and eventually change our life.

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