Design and Application of Sitting Posture Perception based on FSR Sensor in Wheelchair

Lu Zhang, Xiaoting Li and Liting Du

College of electrical and information engineering, Quzhou University, Quzhou, China

Abstract

Modern society has a number of long-term abnormal sitting posture of the disabled. At the same time, the population aging era coming in China, with most of the elderly weak action, such as auxiliary equipment more and more like the wheelchair into the disabled and the elderly people's life and action inconvenience. Abnormal sitting posture not only for the disabled, the elderly and other groups of people with impaired mobility have a negative impact on health, but also often lead them to fall from the wheelchair. This paper is to sense when appreciating the pressure distribution of sitting by the pressure sensor, thus infer the tilt direction and tilt of the body, achieve the recognition of different posture, to preventing and alarming effect on the occurrence of falls. The design of intelligent sensing system of our system is to monitor the use of the disabled and wheelchair whenever and wherever possible the state, and improve the abnormal state recognition and emergency rescue, and improve their quality of life. This article mainly introduces the posture perception module, which can adjust the posture of the disabled with a predictable and timely reminder.

Keywords

Disabled Person; Wheelchair; Sitting Posture Perception; FSR Sensor.

1. Introduction

By the second China national sample survey on disability data speculation calculation shows that the current sum total of disabled persons in all categories in China has reached 82 million 960 thousand, of which there are 24 million 120 thousand disabled people, the two accounted for 6.4% of the total population and 1.85%. Coupled with the elderly, the total number of people with mobile disabilities has exceeded the total population of 15% mark. "The wisdom of the city" strategy, is provided to solve this kind of health care and medical aid and social information service and a powerful opportunity, and the wheelchair is an important tool for disabled people, becoming more reflected in the daily lives of people with disabilities in the more important. This system has designed a set of intelligent wheelchair around perception and transmission system, realizes the real-time user sitting in a wheelchair, determine the physiological information, wheelchair location information perception, and the data transmission in a wireless manner whenever and wherever possible to upload. This system is based on in a wheelchair for the elderly and disabled people sitting, if the system can timely perception of posture, and a rating on sitting on the degree of risk, it falls in dangerous situations will have predictable effects, can timely remind the user to adjust the sitting posture, and guarantee the quality of life for the disabled.

2. Hardware design of sitting posture perception

Sitting posture perception can be using technology attitude, there are many methods of common attitude, access from the signal classification, the posture sensing technology is divided into two categories: video image technology based on contact or wearable sensor device based on. For the video image technology is human motion capture through the camera images, the image processing algorithm, determine whether it exists image features fall, the high cost of installation is not convenient, and there are some security issues of personal privacy, the image quality is easily affected by the surrounding environment. Another is the use of pressure sensors or acceleration sensors to obtain the characteristic signal in various sitting state, realize the posture perception through the

support vector machine theory, pattern recognition, threshold judgment algorithm. In this system is designed a sensor using pressure sensors to achieve posture perception module.

2.1 ensor selection

FSR（Force Sensitive Resistor）is a famous company called Interlink Electronics production of a small size, light weight, high precision, high sensitivity, ultra-thin resistance type pressure sensor. The sensor will be applied in the area of sensor film (PVDF film) the pressure changes into the change of resistance, so as to obtain the pressure information, pressure increases, the output resistance value is small, which allows the pressure range of 10g-10kg, as shown in Figure 1 for the FSR sensor output resistance varies with pressure the curve.

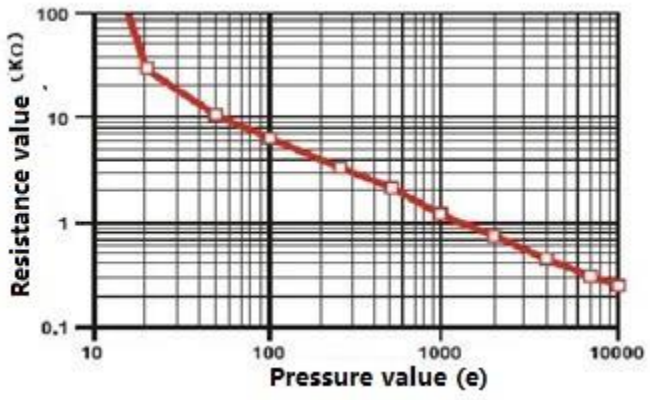

Fig. 1 Curves of output resistance value of FSR sensor with pressure

FSR sensors with a variety of models and different sizes, such as round, square, bar. The system selected FSR406, FSR406 physical map and its size as shown in figure. The outer edge of this type is the side of 43.7mm square, the sensing area is 38.1mm*38.1mm, thickness of 0.46mm, with the adhesive on the back, just can be torn off in parts of the detected paste. FSR406 measurement accuracy of ±5% to ±25%, resolution of up to ±0.5%, response time of 1ms~2ms. As shown in figure 2.

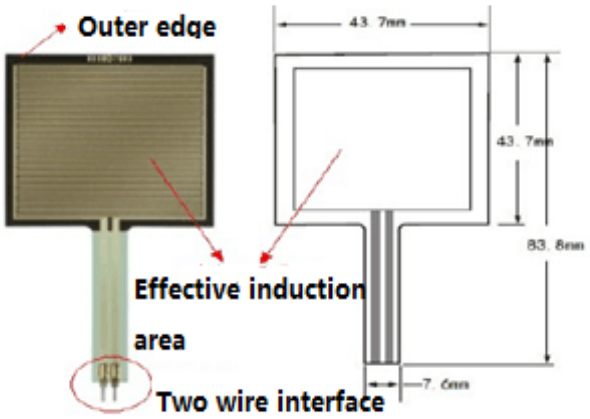

Figure. 2 FSR406 physical map and its size

2.2 Hardware structure of posture perception module

The hardware of the posture sensing module consists of four parts: FSR406 sensor, ATmega328P chip and its peripheral circuit composed of the main control unit, wireless transmission module, power part. Figure 3 shows the hardware structure of the posture perception module.

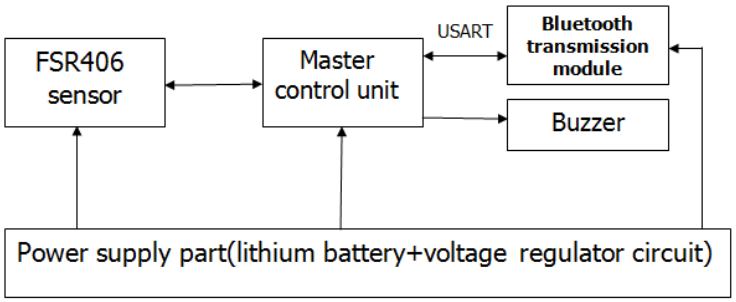

Figure. 3 Hardware structure of posture perception module

The power part adopts a 5V lithium battery unit, ATmega328P chip and FSR406 sensors are working in the 5V main control module, can be directly powered by lithium battery and wireless transmission module in 3.3V, it is necessary to design a voltage stabilizing circuit. The module chose the positive voltage linear regulator PAM3101 chip, PAM3101 chip with low quiescent current and low voltage leakage characteristics, making it an ideal choice for use in lithium battery power supply scheme, the SOT-23 package, in the design of PCB saves a lot of space, but also to make it portable and can be widely used in the design wearable electronics scheme, voltage regulator circuit principle diagram is shown in Figure 4 PAM3101 chip.

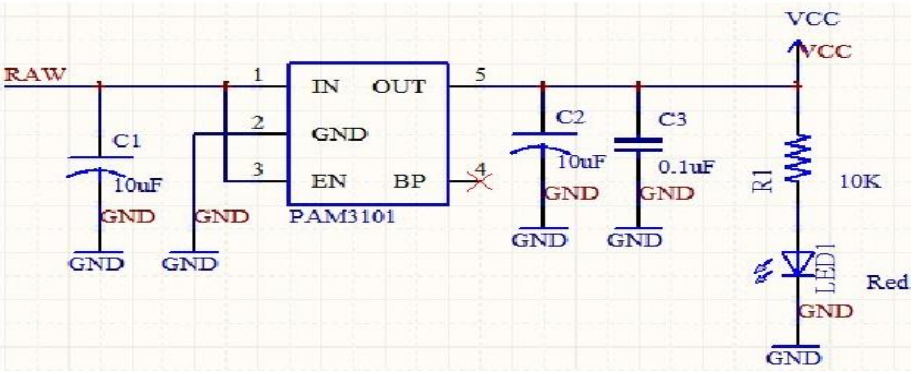

Figure .4 PAM3101 chip regulator circuit schematic

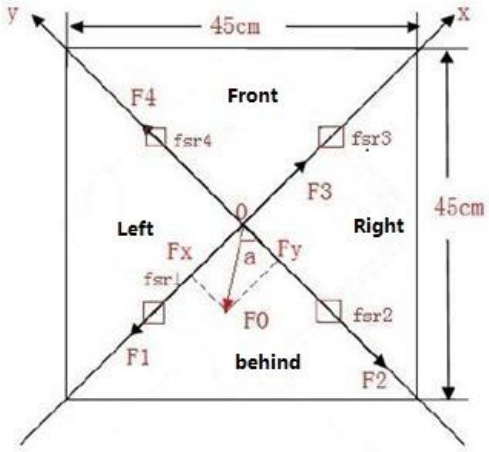

Fig. 5 Schematic diagram of sitting judgment model

2.3 Adjustment of sitting posture

In order to determine the upper body tilted about the direction of the model, the square diagonal seat where the axis were recorded as X axis and Y axis, if the pressure center is located in the first quadrant represents the upper part of the body's center of gravity forward, when the pressure center in the second quadrant is shown on the left side of body center of gravity, when the pressure in the center of the third quadrant when it said human upper body center of gravity back when the pressure center is in the fourth quadrant when it said human upper body center right and center of pressure when standing in the center said the upper body upright body. The location of the center of pressure is through four pressure sensors, the pressure value to judge, according to the sensor placement, the

stress were recorded as F1, F2, F3, F4, their direction is in the opposite direction of X axis, Y axis direction and X axis is the direction, Y direction, the resultant force is denoted as F0 $\overrightarrow{F_0} = \overrightarrow{F_1} + \overrightarrow{F_2} + \overrightarrow{F_3} + \overrightarrow{F_4}$, The sitting posture judgment model is shown in figure 5.

The upper part of the body tilt degree can be judged according to the |F |, the larger the greater the degree of tilt said; according to the above definition, the deflection angle of projection in the horizontal direction of the a can be through the angle between the vector F and Y positive axis are calculated.

2.4 Processing of FSR sensor data

Vector $\vec{F}_0$ in the microcontroller program in the calculation method, because the model in four directions of pressure perpendicular to each other .So it brings great convenience to its calculation, and suitable for computing on the microcontroller. The specific solution process is as follows:

To solve the degree of tilt$|\overrightarrow{F_0}|$.

Resultant force in the X axis direction: $F_x = F_1 - F_3$;

Resultant force in the Y axis direction: $F_y = F_2 - F_4$;

$|\overrightarrow{F_0}| = \sqrt{{F_x}^2 + {F_y}^2}$.

Solving horizontal projection angle of human body a namely tilt direction angle.

If $F_x > 0$, $F_y > 0$,$a = \tan^{-1}\frac{|F_x|}{|F_y|}$;

If $F_x > 0$, $F_y < 0$,$a = л - \tan^{-1}\frac{|F_x|}{|F_y|}$;

If $F_x < 0$, $F_y > 0$,$a = \tan^{-1}\frac{|F_x|}{|F_y|}$;

If $F_x < 0$, $F_y < 0$,$a = л - \tan^{-1}\frac{|F_x|}{|F_y|}$;

3. Summary

Sitting posture directly affects the safety of wheelchair users such as disabled and elderly. In this system, the object is wheelchair users, this kind of mobility inconvenience crowd in wheelchair posture perception. Combined with this demand, coupled with the seat as a closely related to sitting and commonly used daily necessities, based on this, proposed a pressure sensor through the pressure distribution and then determine the method of sitting posture. The other way it compared to users of the shackles of the smaller, choose the pressure cushion form to determine the body's posture, and this method uses accelerometers to carry the equipment more convenient, more comfortable, more users on the daily life of small interference.

References

[1] Xibo Wu, Zaigao Yang. Smart city concept and future urban development [J]. Urban development research, 2010 (011): 56-60.
[2] Zhongchao Du, Yongmin Zhang. Current situation and thinking of smart city construction in China [J]. Chinese information circle, 2011 (002): 28-32.
[3] Lei Wu, Design and implementation of intelligent perception system for the disabled in Intelligent Community [J]. 2014.05
[4] Kui Yuan. Research status and trend of intelligent wheelchair [J]. China medical device information, 2009, 15(1): 6-33.
[5] Honghong Ren, Pulin Yu. Research Progress on intervention of falls in the elderly [J]. Chinese Journal of geriatric medicine, 2011, 30(10):883-886.
[6] Kuitao Ding . On the aging of population in China [J]. Journal of Hunan Institute of socialism, 2013 (4): 77-78.