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Image Recognition System for the Blind Based on Tactile Perception

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Abstract

A tactile perception system is designed in order to help the visually impaired perceive images which used image acquisition module to analog shape, color and luminance information of the object saw by human eyes in the surrounding environment. Through the different control signal, the data processing module controlled tactile produce device and current produce module to produce the current of different region, frequency and intensity to stimulate the body skin of user in certain parts, thus transferring the included shape, color and luminance information of image information to user. The system can help the visually impaired perceive the image information.

`Introduction

For The blind's vision in pouring rain, they have access to information is mainly rely on the touch and hearing for catching image information, it is hard to perceive effectively. How to let the blind access to a certain degree of image information is the problem that the researchers pay attention to. The sense of touch is the most important way to visually impaired access to environmental information. Of tactile stimuli can be formed of rich "Tactile Language" according to certain rules of combination, realized the tactile expression and perception. Medical research shows that the visual cortex of the blind, still retains the visual information analysis function organization, the information interaction is through the parietal cortex of the brain .Although the blind irritants in the treatment of the external space information is not done directly by the visual cortex[1], but completed by hearing and touch. But looking from clinical trials, the blind of the visual cortex can be activated and reused in order to help the blind perceive the world better, which is the feasibility of the basic theoretical basis.

For the purpose of realizing the actual touch of image information, this paper puts forward a kind of system that can automatically collect image information and be converted to electrical stimulation of tactile perception. Based on ARM system design the image information acquisition, RGB information extraction, stimulates the production of electric current and tactile information. The system through the image acquisition module to collect the object shape, color and brightness information, which are stored with the RGB pixel format after recodification and every pixel color and luminance information is converted to a different intensity, frequency and area of the current stimulus signal to make abdominal skin irritation to human body, let the wearer by tactile stimuli perceived image information. Therefore matrix intelligent blind graphics perception process of tactile sensing device is more close to the actual process of human visual perception, it is the substantial advance in the research of image information to the existing visual perception meaning understand, also is a conversion process of a new research subject that the connection between the touch nervous and the optic nervous[2.3.4].

Implementation method

1 The Fundamental Principle

The blind image aided identification system based on tactile perception which is based on the principle that the human of eye visual imaging. We use a CCD video for image acquisition, image edge detection. Through image information encoding and frequency conversion algorithm combining with the principle of abdominal skin conditioning, then we use the array type current stimulate the abdominal skin for the blind. After the blind get professional training, they will be in a characteristic way to perceive the environment of the physical shape, color, brightness, near or far. Auxiliary

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blind people perceive the world and improve the quality of their lives. The research content includes: visual images transformed into auxiliary tactile recognition methods, the research on target recognition algorithm under complicated background, design a kind of RGB pixel colors to touch frequency conversion algorithm, study the human body under the stimulus current tactile neural physiological parameters, visual perception and tactile perception with the information interaction[5].

2 The Approach of Visual Images into Touch Aided Identification

In the study of the system, our aim is to solve the blind identification of visual objects through touch imaging information, therefore we can imitate the human eye visual cognitive process. According to the physiological and psychological characteristics, for the blind in the aspect of visual perception mechanism should focus on how to mimic this convert image information to the blind identifiable tactile information. In this process, we need to research three important links: one is in terms of visual way to collect, how to imitate the human eye optical imaging principle, such as automatic focusing and parallax Angle according to the human eyes fuzzy matching algorithm for 3D vector graphics model; Due to the human body skin resolution and visual resolution is inconsistent, so how to build the two pixel information of the best mapping model, namely: the heavy coding; The third is that the blind tactile identification process is a dynamic tracing process, how to ensure the stability of target imaging and real-time acquisition system will identify the error feedback to see road, to adjust the focus on the goal clarity.

3 The Research Focus on Target Identification Algorithm under Complex Background

Focusing on the target recognition is a unique function of human eyes, imitate human visual perception process, attention to focus on the target selection algorithm as the core, the dynamic adjustment focus on the target imaging area, real-time to acquisition and processing, pay attention closed to the target area pixel for RGB colors and tactile frequency mapping relation model, realize the goal that visual the visual sense of touch information reprogram[6,7]. The system of the whole solution is shown in figure 1.

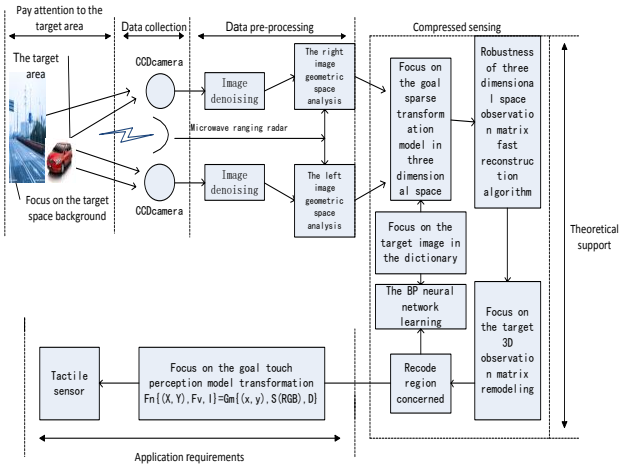

Figure 1. The Whole Solution of the System

In order to strengthen the focus on the target outline and details, use the following method to deal with focus areas:

3.1 Selective Target Image Edge Detection and Search Target Matching Algorithm

Selective image edge detection is mainly refers to the complex image background, according to the interest target in the image like gray scale, texture and color change of discontinuity, we use variety of algorithms to extract the target area of the image information of characteristic value, it can keep the selected target shape, color and brightness information.

3.2 The Coding Algorithm of Tactile Perception

For visual images changing into touch perception coding, the purpose is to convert the image pixels of visualization for the blind touch perceived frequency of contact. The corresponding relation between contact frequency and visual pixel is:

$$F_n\{X,Y,F_v,I\}=G_m\{x,y,S(R,G,B),D\} \qquad (1)$$

among them: F_n was blind skin contact matrix, parameters of X , Y are location coordinates, F_v

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means that the behalf of the color at a frequency, current I represents that point distance (brightness); G_m is a visual image matrix, the parameters of x, y are for the pixel coordinates, $S(R,G,B)$ is on behalf of trichromatic pixel point, D is the visible distance.

Because of the physiological differences between visual and tactile, visual information of pixels and tactile perception information point belongs to nonlinear corresponding relation. So you need to strengthen encoding and weaken coding of view area according to the focus area and not the focus area to ensure that the focus on the target area tactile perception pixel density is higher. About nonlinear scaling factor of the two, we need decide by the tactile dot density. In view of this, you need to choose to focus on the goal of image edge detection and contour the extraction of characteristic value, through experiment, we propose the ascension based wavelet image edge detection algorithm.

3.3 Image 3D Visual Observation Information Compression Reconstruction Algorithm

To build an ideal space observation matrix is as follows:

$$F(x,y,d)+\Sigma\alpha_i\psi_i=\psi\alpha \qquad (2)$$

In this type F is sparse compressible ideal observation space coordinate information, $\psi=\{\psi_1\psi_2\cdots\cdots\psi_N\}$ is a sparse change matrix, α_i is sparse coefficient. Because in CS code measurement model, sparse signal F is not directly measured, but the signal F projection on a set of measurement matrix, then measurement matrix is obtained:

$$y=\psi F(x,y,d) \qquad (3)$$

So that:

$$y=\phi F(x,y,d)=\phi\ \psi\ \alpha \qquad (4)$$

With the noise, spatial structure observation model building is as follows

$$y=F(x,y,d)+\varepsilon(x,y,d)=\psi\alpha+\varepsilon(x,y,d) \qquad (5)$$

So the problem is transformed into the Lagrange multiplier method which is adopted to solve the following optimization problem of the model.

$$F_c(x,y,d)=\min\|(y-\psi\alpha-\varepsilon(x,y,d))\|_2^2+\lambda\|(\alpha)\|_1 \qquad (6)$$

F_c is refactoring coordinate, λ can adjust the balance between the permissible error and sparse[8].

3.4 Three primaries frequency conversion

Central processing unit will make the color and brightness information into different intensity and frequency of current signal, Experimental results show that Eyes within the visible spectrum have different Response sensitivity for different sensitivity of different wavelengths of radiation, (As shown in figure 2). Through the spectrum curve is known that the human eyes are sensitive to yellow and green wavelengths (550 nm). In order to touch this phenomenon with more accurate frequency sensitivity of nonlinear analog, the conversion formula is:

$$F_v=F_b\times B+F_g\times G+F_r\times R \qquad (7)$$

Among them F_b 、 F_g and F_r are frequency conversion coefficient of *R*, *G*, *B*. These coefficients are not linear relationship. But need to be adopted based on the least square method and spectral luminous efficiency curve for approximation, determine the conversion coefficient.

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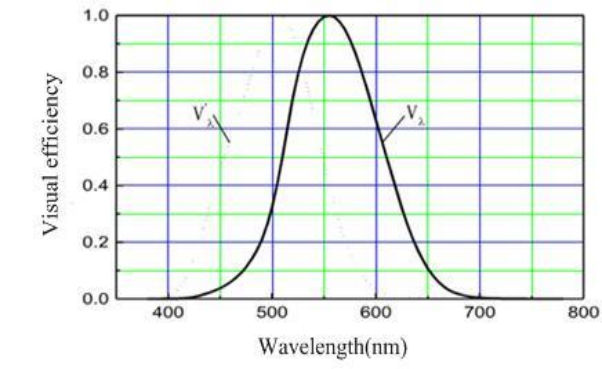

Figure 2. The Relationship between Wavelength And Visual Efficiency

3.5 Abdominal Tactile Sensitivity Tests to Current Stimulation of The Human Body

The key of this project is to determine human abdomen under the effect of different current and flings of threshold current intensity and frequency change.

3.5.1 Signal Generator

The human skin tissue as a load, the system design of the current intensity and frequency signal source can continuous variation within a certain scope, due to differences in human skin tissue, its skin impedance parameter value is uncertainty, in order to produce a constant PWM modulation current value, we use the microcomputer constant current controller, as shown in figure 3 is a PWM constant current control block diagram. Through the circuit current intensity and PWM pulse width modulation control system, it come into being constant current and the stimulation of different frequency pulses. First according to the setting of current intensity, frequency of color, V/I and PWM constant current output a, the protection circuit sends out the signals, then the CPU collect the feedback signal and adjust the output signal to ensure that the changes over human skin impedance.

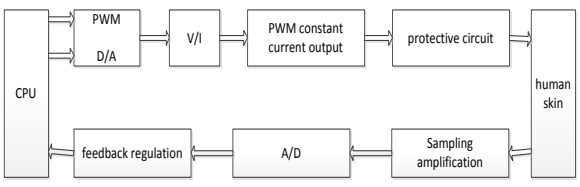

Figure 3. the block diagram of PWM modulating constant current

3.5.2 Signal Extraction

Frequency resolution threshold detection with reference to the current commonly used threshold detection algorithm of nervous system, namely UDTR rules method. To gain effective basic data, we choose three persons to join the test, figure 4 is for the blind touch points frequency resolution test experiment data, designed to test frequency and the body color sense relations of different frequencies. From the test results analysis, test data and the theoretical calculation of the basic difference is that according to the different frequency of the crowd the tactile band overall migration, this does not affect the use effect of the system. Test conditions are set current strength is 2.5 mA, gradually adjust the frequency (from 0 to 1500 Hz continuous stimulation), from the test data analysis, the lower the frequency, the human body for frequency change has the higher sensitivity, conversely lower. When the frequency is greater than 1500 Hz, human abdomen cannot distinguish less than 50 Hz frequency change quantity, this also shows that the sensor's touch frequency band selection in the range of 0-1100 Hz[9].

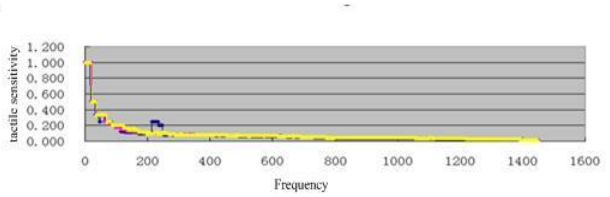

Figure 4. The Experiment Data of Human Abdominal Skin Touch Frequency Change Threshold

Conclusion

In this paper, we design a kind of auxiliary tactile image perception system for the blind, using image acquisition module to simulate human eyes to see objects in the information of shape, color and brightness and processing of the surrounding environment through the analysis of the data processing module, then the data processing module generate touch device and current control module by different control signal. It is resulted that specific parts of the stimulate users' body skin have different frequency and intensity of current, the information containing the image is transmitted to the

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user by the shape, color and brightness information. The system can help the visually impaired sensory image information in a visual way. In the future, we will improve information tactile coding method further, and then to expand the practicability of the system[10].

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