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Design and application of rice disease identification system

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Abstract. This paper proposes a kind of design and implementation method for rice lesion identification system, which includes the hardware structure and lesion recognition application software. This system applies DSP as the core, image coding chip of TVP5147, external cameras, together with the application software to identify the rice lesion. The experiments illustrate the system has better performance.

Introduction

Rice is one kind of most important food crops in China, which plays an important role in Chinese national economy. However, the incidence of pests and diseases of rice reduced the yield of crops. Traditionally, abusing pesticides to control pests and diseases brought the environmental degradation and pollution, which cause the indirect losses. It is one the most difficult issues in modern agricultural development. It will cost a lot of manpower and material resources to control the rice diseased due to the areas of rice cultivation and lacking of experts. Therefore, the rice diseases seriously threat Chinese food security and modern agriculture development. The practice shows the pest prevention science is an important measure to ensure that the rice harvest. The premise of scientific control is to correctly diagnose the types and extents of the diseases and pests, and promptly provide to the farmers. It is urgent to develop a rice lesion intelligent recognition system which can easily diagnose the rice crops based on the image of lesion. This paper mainly focuses on the research, design and implementation of the rice lesion recognition system.

General design

The rice lesion recognition technology closely integrates the computer science and biological pathology which uses the inherent physiological characteristics of rice lesion for identification purposes[1-3]. The design schemes are as follows. The camera will detect the rice lesions information and send them to the hardware system. The main controller CPU chip will extract the key features of the lesion information. The main extracted shape features include the area, perimeter, circularity, squareness and so on; the color features includes HIS and the average RGB value of each channel together with the texture information. CPLD will cooperate with SRAM memory to read the saved critical data. The storage sizes of the original images are determined by the specific algorithms and the image sizes. Then the recognition algorithms are used to identify the types of the lesion. The communication interface is used to connect with the peripheral devices to inform the recognition results[4-5].

System hardware design

After the general design of the lesion recognition system determined, we study the system hardware first. The entire system hardware is divided into three parts-image acquisition system, the main control system, and communications system. The hardware circuits are the basis of the rice lesion recognition system and they are the carriers of the functions. The selection of the devices, circuit design and seal modes directly relate with the system efficiency, accuracy, physical security, and anti-attack capability. The structure scheme is shown in Fig. 1.

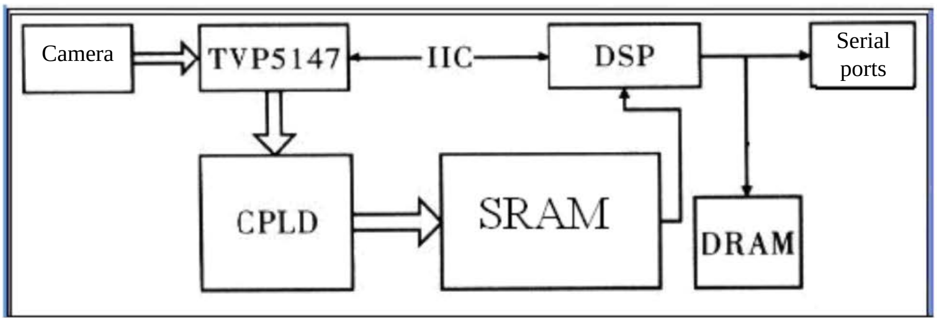

Fig. 1 The scheme of hardware structure

The system selects DSP6713 which is one kind of C6000 series floating-point processors produced by TI. It uses the VLIW architecture with lower equivalent periods of instructions and higher operation time. The lesion image acquisition uses the ordinary camera with PAL output and the image coding chip TVP5147 from TI company which supports a variety of formats and a variety of interface input, and can output YUV format video data. Also it can provide line synchronization signal and vertical sync signals. The data will temporarily be stored in CPLD with SRAM. The system hardware can achieve better performance in functionality and cost control.

TVP5147 and initialization.

TVP5147 is used as video front-end processing chip. When the system is powered on, DSP will initialize TVP5147 which is realized through the I2C bus. The DSP comes with I2C bus controller. The I2C addresses are controlled by the voltages in the pins of I2CA. If the voltages are high, the I2C write address is 0xB8, otherwise it is 0xBB. The system will output 10 bits mixed video data from ports Y [9.. O] after initialized.

CPLD read/write SRAM.

The hardware system selects the memory of DS1265AB which is SRAM memory with fast storage speeds and it can store the data for 10 years without power. DS1265 has 1 MB capacity, 20 address lines, 8 data lines, and WE, OE, CE signal input ends. CPLD selects EPM7128 with lower costs and high counting frequencies. The memory SRAM is connected with the IO pins of CPLD. With timing control, it can achieve the read and write of SRAM. The CPLD programs will make the timing meet the SRAM storage requirements. Two pieces of SRAM are used to store the

SRAM memory connected to the CPLD IO pins, with the timing will be able to achieve the parity field data. The switch of the SRAM is finished by parity field signals FID to control several pieces of 74HC245.

System software design

The software design mainly involves the following four aspects-image preprocessing, image segmentation, feature extraction and image recognition. The camera will take the lesion images as the input. The image processing programs will compress and tailor the original images and then filter with median values. The preprocessed images are used as the input for threshold segment. The features are extracted from the segmented lesion. The main extracted shape features include area, perimeter, circularity, squareness and so on; the color features include HIS and average RGB value of each channel; and the texture features include the lesion texture detail information. Then they are used for recognition processing. There are two processing steps in the system-library processing and comparison process in which the library process is to process the images of the known diseases and archive the processed features in the training library for the comparison basis. The diagnosis results can be obtained after comparison.

The key part of the intelligent recognition is the lesion identification which can be controlled by the optical flow PCA (Principal Component Analysis) and DTW (Dynamic Time Warping). The basic idea is to solve the sum of the absolute values of the pixel gray differences in the interested blocks in the adjacent frames in order to obtain the optical flow. If the size of the R block in frame f is 8×8, it is in the searching block S of the next adjacent frame. The searching block S is obtained by extending the reference block R in which the upper left direction extends 8 pixels and low right direction extends 7 pixels. The optical flow can be obtained by following equation (1).

$$D(u,v)=\sum_{x,y=0}^{7}\left|R(x,y)-S(x+u+8,y+v+8)\right| \quad (1)$$

In the equation, $R(x,y)$ denotes the grey value of the inner point (x,y), $S(x+u+8,y+v+8)$ denotes the grey value of the inner point $S(x+u+8,y+v+8)$ in the searching block, $D(u,v)$ denotes the accumulation of the differences between the reference blocks and the searching blocks. The range of (u,v) is -8～7. The point (u,v) corresponding the minimum $D(u,v)$ lies in the position of next frame. The correlation analysis method is used to calculate the vectors of each moving blocks in f frames.

The basic ideology of DTW algorithm is to find an optimal time warping function which can project the time line j of the lesion pending detection to the time line i of the template lesion. Then local optimization is used to minimize the sum of the weighted distances, which is expressed as

$$D=\min_{C}\frac{\sum_{n=1}^{N}\left[d(a_i(n),a_j(n))W_n\right]}{\sum_{n=1}^{N}W_n} \quad (2)$$

In the equation, C denotes the time warping function with $C=\{c(1),c(2),\cdots,c(N)\}$, N denotes the distance length, $c(n)=(i(n),j(n))$ is the n-th matching points by the $i(n)$ feature vector in A and $j(n)$ feature vector in B. $d(a_i(n),a_j(n))$ describes the distance between i and j which is the defined distance in the equation (2). W_n denotes the weight and it is determined by the local constrain path.

Experiments and analysis

In order to verify the validity of the proposed method, the experiment selects the 1.6GHz technology machines as the hardware environment. The rice lesion image with size of 256 * 256 is picked as the reference and the image of 64*64 is cut as the template. The performance of the proposed method and the traditional method are compared. Each method is tested for 50 times as shown in Table 1.

Table 1 The comparison of the simulation results

Methods	Matching points	Accurate times	Matching time（ms）	Matching accuracy
Traditional method	49.96	38	380	0.76
Proposed method	59.104	47	130	0.94

In Table 1, the average matching accuracy of the proposed method can achieve up to 94% which can meet the matching requirements of the rice lesion detection system. The matching speeds of the proposed method are 3 times of those in the traditional method with only 130ms. It greatly increases the system rapid detection efficiency.

Conclusions

In order to meet the requirements of modern agriculture, more and more crops expert diagnose systems are developed. This paper implements the intelligent diagnosis of the rice lesion, which can basically meet the diagnosis requirements for the common lesion in rice leaves with high diagnostic accuracy. All in all, the developed system can achieve all image processing functions, and its reliability, accuracy and intelligence also makes the system can be used in practice, which is a rice disease expert intelligent diagnosis system with high practical value.

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