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Algorithm of Time Optimization on Brands Recognition for Automatic Sorting System

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Abstract: In order to improve the speed of brands recognition of cigarette carton automatic sorting for tobacco logistics tobacconist, the effect factor such as speed of camera frame capturing, the communication speed between camera with computer and imaging quality were analyzed. Furthermore, In order to increase the efficiency of the complexity indexing algorithm, five operators of color recognition, complexity recognition, brands recognition, color of brands recognition, length measure recognition and contour extraction algorithm were optimized. The proposed method not only decreased the calculate times of multi-recognition algorithm, but also optimized the data structure of the recognition automatic sorting system. The experiment results demonstrated that the average time of proposed system was very low; it was obtained less than 50 millisecond average per-frame. The proposed method could satisfy the tobacconist application requirements on the automatic sorting of tobacco recognition and proved that this model is meaningful and useful to the same trade. This method provides references for the LVQ neural network.

Key words: Brands recognition, cigarette carton, complexity indexing calculation algorithm, optimization arithmetic operator, quick automatic sorting system

INTRODUCTION

Now days, There are various research results to solve the problems such as color recognition, boundary detection, enhance contrast, spatiotemporal detection, ship detection and so on. For the tobacco logistics tobacconist, the cigarette carton automatic sorting is the only way to sorting the cigarette. How to get higher speed on sorting cigarette is the challenge problem. We research the application market of sorting cigarette and find only some of them used the RFID technologies (Sourdis *et al*., 2008; Zhong *et al*., 2011; Zhang *et al*., 2008). And some of them used the boundary detection based on the camera image online (Tan *et al*., 2008; Park *et al*., 2008; Zhou *et al*., 2010; Stitt *et al*., 2003). For color recognition is focused very earlier, Weinberg (1966) reported a simple and efficient algorithm for determining isomorphism of planar triply connected graphs. Ten years latter, the concept of the picture-building system with data definition and data manipulation facilities was intended to help standardize and simplify the programming of interactive graphics applications (Williams and Giddings, 1976). The authors shown how the arithmetic mean and the median can be constructed by minimizing appropriate penalties and they discussed which of them coincide with the Cartesian product of the standard mean and the median (Beliakov *et al*., 2012). Osowski *et al*. (2004) presented the neuro-fuzzy Takagi-Sugeno-Kang network for the recognition and classification of flavor. In recent years, more and more researchers interested on the theories and practices of image process and recognize.

Color recognition is one of the most important characteristic for image processing. Minotto *et al*. (2013) showed us a color-based visual voice activity detection algorithm for the audio and video. Celik and Tjahjadi (2012) proposed propose an adaptive image equalization algorithm that automatically enhances the contrast in an input image. A fog degraded image contrast enhancement method based on Bilinear Interpolation Dynamic Histogram Equalization is proposed in Xu and Liu (2010). The original image was transformed by discrete stationary wavelet transform and then a non-linear operator was used to enhance details at three high frequency sub-bands in wavelet domain (Chen and He, 2008). A near-infrared image enhancement algorithm based on fuzzy contrast was raised in CUI *et al*. (2011). Huang *et al*. (2013) proposed an efficient method to modify histograms and enhance contrast in digital images. Some researchers focused on the iris recognition, such as a perturbation-enhanced feature correlation filter which

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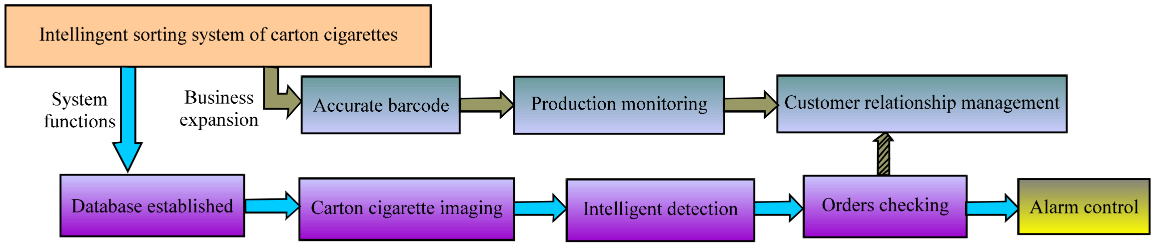

Fig. 1: Main functions of the proposed system

was developed based on quad-phase minimum average correlation energy filter for robust iris matching (Zhang *et al*., 2012) and the quality assurance of texture and matching performance-equal error rate and false rejection rate (Gong *et al*., 2013). Contour extraction and approach for operational ship detection from space-borne optical images based on shape and texture features. Enhanced is an important technique for image processing. Zhu *et al*. (2010) proposed a novel hierarchical complete Song *et al*. (2012) proposed a novel method for the extraction of chin contour from a human face image with lighting and/or facial expression changes which was based on an improved local binary pattern operator. Chen and Su (2011) proposed a sketch environment for young children using computer vision and augmented reality.

For our application requirement, the length measure recognition algorithm is another important technique for image processing. Alexe *et al*. (2012) presented a generic abjectness measure, quantifying how likely it is for an image window to contain an object of any class and Dr. Lu *et al*. (2012) took a mathematical approach with closed-form expressions. Depend on our application of automatic sorting system, we need to combine color recognition, brands recognition, length measure and contour extraction, and need to research how to increase the recognize speed. Only by these way, the system performance could be satisfied the customer requirements.

SYSTEM SUMMARY

Sorting line of carton cigarettes is an important step on the distribution system. In general, brand and specifications of cigarette is used to automatic identification each cigarette brand for cigarette sorting line on the conveyor belt. The number of specifications needed can be checked various orders of cigarette correct or not by this way. The application system through computer processing is complete automated inspection work, and to reduce the human operator checks the error, simple labor intensity, improve sorting quality. The main functions of the proposed system are shown in Fig. 1.

From Fig. 1, we can find that the main factors affecting cigarette sorting system includes four aspects, that is the frame rate of the camera speed, the communication speed from cam era to computer, the image quality and the efficiency of multiple identify algorithms for carton cigarettes. In order to solve the above four aspects, the logic of carton cigarette recognition, the data structure of the identification algorithm, identifying timing logic, the recognition time analysis, the establishment of the recognition result data structure, the data forming program and data processing programs are the main seven ways to solve the challenges. Our research interesting focus on how to optimize the algorithm based on combination of the carton cigarette online imaging system, data structure, identify the statistical system and control synchronization system.

THE OPTIMIZATION ELEMENTS - RECOGNITION OPERATOR

Because of the packaging are various forms for different of carton cigarettes, we only discuss the standard packaging that is hard pack and soft pack two. A wide variety of large strip packaging design, logo design industry is ever-changing. For example, the color may contain all the basic colors. A brand of cigarettes may designed and extremely close to making cigarette specifications of the identification process and the various ways. Some can be seen to be able to distinguish colors, some see trademarks or trademarks of differences, and some rely on dimensions distinction. Gao *et al*. (2010) discussed the description principle of traditional complexity from the perspective of composition theory, and introduced it to the domain of image complexity.

The Local Binary Pattern and Local Ternary Patterns Operators: Depend on the Local Binary Pattern operator (LBP) in 1996 as a means of summarizing local gray-level structure (Ojala *et al*., 1996). The operator takes a local neighborhood around each pixel, thresholds the pixels of the neighborhood at the value of the central pixel and uses the resulting binaryvalued image patch as a local image descriptor. It was originally defined for 33 neighborhoods, giving 8 bit codes based on the 8 pixels around the central one. Formally, the LBP operator takes the form as follow:

$$LBP(x_c, y_c) = \sum_{n=0}^{7} 2^n s(i_n - i_c) \quad (1)$$

The extends LBP to 3-valued codes, Local Ternary Patterns (LTP), in which gray-levels in a zone of width±t around i_c are quantized to zero, ones above this are quantized to +1 and ones below it to -1, i.e., the indicator s (u) is replaced by a 3-valued function:

$$s'(u, i_c, t) = \begin{cases} 1, u \geq i_c + t \\ 0, |u - i_c| < t \\ -1, u \leq i_c - t \end{cases} \quad (2)$$

and the binary LBP code is replaced by a ternary LTP code. Here t is a user-specified threshold (so LTP codes more resistant to noise but no longer strictly invariant to gray-level transformations).

Local Steering Kernel (2-D LSK): Depend on the Local steering kernel (2-D LSK) in 2009 as the key idea behind local steering kernels is to robustly obtain the local structure of images by analyzing the radiometric (pixel value) differences based on estimated gradients, and use this structure information to determine the shape and size of a canonical kernel. The local steering kernel is modeled as Seo and Milanfar (2009):

$$K(x_1 - x_i) = \frac{\sqrt{\det(C_1)}}{h^2} \exp\left(\frac{(x_1 - x_i)^T C_1 (x_1 - x_i)}{-2h^2}\right), C_1 \in \Re^{2\times2} \quad (3)$$

where I∈{1, ..., P}, P is the number of pixels in a local window; h is a global smoothing parameter (This parameter is set to 1 and fixed for the all experiments). The matrix C_1 is a covariance matrix estimated from a collection of spatial gradient vectors within the local analysis window around a position:

$$x_1 = [x_1, x_2]_1^T$$

More specifically, the covariance matrix C_1 can be first naively estimated as $J_1^T J_1$ with:

$$J_1 = \begin{bmatrix} z_{x_1}(x_1) & z_{x_2}(x_1) & z_{x_3}(x_1) \\ \cdots & \cdots & \cdots \\ z_{x_1}(x_p) & z_{x_2}(x_p) & z_{x_3}(x_p) \end{bmatrix} \quad (4)$$

where, $z_{x_1}(x_1), z_{x_2}(x_1)$ and $z_{x_3}(x_1)$ are the first derivatives along x_1-; x_2- and x_3- axes.

Optimization recognition operators: In order to cope with the understanding of the present study complex degree indexing algorithm, we understand of the complexity of the as follows. The complexity is within a certain range in order to distinguish an image of the texture characteristics of the image proposed concept. After extensive analysis, we chose the five kinds of identification method and design optimization operators. Depend on the equation Eq. 1 to4 and according the lots of practice test, we give the five optimized recognition operators show as follow:

- Color recognition operator. Operator is defined as the C operator which discrete the color of the image data identification and other specifications distinction:

$$C = \begin{bmatrix} 0 & 1 & 0 \\ 1 & 7 & 1 \\ 0 & 1 & 0 \end{bmatrix} \quad (5)$$

- Complexity recognition operator. Complexity and other specifications by the appearance of the image content difference. Operator is defined as the F operator:

$$C = \begin{bmatrix} 5 & 0 & 0 \\ 0 & 5 & 0 \\ 0 & 0 & 5 \end{bmatrix} \quad (6)$$

- Brands recognition operator. Identify by brand name and trademark graphics. Operator defined as P operator

$$C = \begin{bmatrix} 5 & 0 & 0 \\ 0 & 5 & 0 \\ 0 & 0 & 5 \end{bmatrix} \quad (7)$$

- Color recognition operator of Brands. Identified by the name of brand or graphics on the identified color, operator is defined as the MC operator.

$$MC = \begin{bmatrix} 0 & 1 & 0 \\ 1 & 5 & 1 \\ 0 & 1 & 0 \end{bmatrix} \quad (8)$$

- Recognition operator of Length measurement. Carton cigarette identify the appearance of length size measurements compared. Operator is defined as L operator:

$$P = \begin{bmatrix} -1 & 3 & -1 \\ -1 & 3 & -1 \\ -1 & 3 & -1 \end{bmatrix} \quad (9)$$

In addition, contour extraction operator used to determine the calculated range of other algorithms that extract carton cigarettes shape.

THE RESULTS ANALYSES OF EXPERIMENTAL AND PRACTICES

The times analysis on recognition:

- Shortest time recognition. By an operator to determine carton cigarette recognition, P operator is required the longest time about 5 milliseconds, the minimum is the C or F operator is needed about 3 milliseconds, so the fastest recognition time of contour is 3 milliseconds plus 8 milliseconds that is MS equal 8 milliseconds (t_{min} (MS) = 8)
- Longest time recognition. All the online recognition does not recognized and output the judgment error. For example, we assumed there are 30 specifications carton cigarettes (n) need to recognize. We know the contour recognition (t_{con}) time equal to 3 milliseconds, the first calculate time of C operator (t_C) is 3 milliseconds and F operator (t_F) is 3 milliseconds too, and each matching times (t_m) are 6 milliseconds, the first calculate time of L operator (t_L) is 5 milliseconds, so the total times (t_1) are 20 milliseconds. The calculate time of P operator is always 5 milliseconds. The second calculate time of C, F or L operator is 1 millisecond, and calculated for each of the specifications of a surface veto average operator in C, F operator, P operator is used a half times, so calculate time for each surface average ($\overline{t}_{as}$) is about 5 milliseconds

The longest time recognition of overflow (t_{ro}) for one specifications carton cigarette is:

$$t_1 = t_{con} + t_C + t_F + t_m + t_L = \\ 3ms + 3ms + 3ms + 6ms + 5ms = 20ms \quad (10)$$

$$t_{ro}(MS) = \overline{t}_{as} \times n_{surface} \times n + t_1 = \\ 5ms \times 2 \times 30 + 20ms = 320ms \quad (11)$$

If we assume the maximum average speed equal 8 carton cigarettes, that the passing time of each carton cigarette is 125 milliseconds. We can get the time of waiting for processed image of the queue backlog is 320/125 = 2.56 sheets.

Fig. 2: Nine brand specifications of carton cigarettes

We do all possible experimentation depend on the field order for all kinds of specifications to get the statistical results, and get the largest lead specifications queue dislocation 6 specifications, so the maximum recognition time (t_{max}) is 5 m sec×2×5 = 50 m sec. Added the basic computing time of C, F and K operator (each 3 milliseconds), we can calculate the longest time recognition online for one specifications carton cigarette is:

$$t_{max}(SS) = t_{max} + t_C + t_F + t_K = 50ms + 9ms = 59ms \quad (11)$$

The times of MS and SS are two import qualifications on the proposed system of carton cigarettes recognition. Data Structure Establishment of the Recognition Results:

- Read and parsed of the order data. Extraction of the date of the pipeline to the production specifications of all specifications carton cigarette queue formed in accordance with the order specifications. Five kinds of identification data of each specification is fill in the corresponding queue. Ten specifications of carton cigarettes are taken for example the operator to optimize the processing

Figure 2 shows the nine brand specifications of carton cigarettes there are Nanjing (Hare-red), Nanjing (Hare-yellow), Liqun (Hare-gray), Chunghua (Hare-red), HUANGHELOU (Hare-yellow), Hongtashan (Hare-red), SEQUOIA (Soft-red), SUYAN (Soft-fuchsine) and YUXI (Soft-pink), respectively.

- Recognition results of specifications interweavement. Table 1 shows the experimental results of once time for the nine brand specifications interweavement. it also shows the result of the

Table 1: Experimental results of once time for the nine brand specifications interweavement

Brand Specification	C	F	P	MC	L
Obverse of Nanjing (Hare-red)	0	1	1	0	1
Reverse of Nanjing (Hare-red)	0	1	0	0	1
Obverse of Nanjing (Hare-yellow)	0	1	0	0	1
Reverse of Nanjing (Hare-yellow)	0	1	0	0	1
Obverse of Liqun (Hare-gray)	1	1	0	0	1
Reverse of Liqun (Hare-gray)	0	1	0	0	1
Obverse of Chunghua (Hare-red)	1	1	0	0	1
Reverse of Chunghua (Hare-red)	1	1	0	0	1
Obverse of HUANGHELOU (Hare-yellow)	0	1	0	0	1
Reverse of HUANGHELOU (Hare-yellow)	0	1	0	0	1
Obverse of Hongtashan (Hare-red)	0	1	0	0	1
Reverse of Hongtashan (Hare-red)	0	1	0	0	1
Obverse of SEQUOIA (Soft-red)	0	1	0	0	1
Reverse of SEQUOIA (Soft-red)	0	1	0	0	1
Obverse of SUYAN (Soft-fuchsine)	1	1	0	0	0
Reverse of SUYAN (Soft-fuchsine)	1	1	0	0	0
Obverse of YUXI (Soft-pink)	0	1	0	0	1
Reverse of YUXI (Soft-pink)	0	1	0	0	1

identification operation is the use of image recognition data and other specifications of the database specifications carton cigarettes. As the same method we can generate a total of twenty tables like the above results

We use the AND calculation for each column and can get the results as:

$$\sum_{i=0}^{n} C[i] = 1, \sum_{i=0}^{n} F[i] = 1, \sum_{i=0}^{n} P[i] = 1, \sum_{i=0}^{n} MC[i] = 1, \sum_{i=0}^{n} L[i] = 1$$

That means:

- Computing the result of the first column C results is:

$$\sum_{i=0}^{n} C[i] = 1$$

  Then we can say that there are the color data is the same as the first reverse of the specifications carton cigarettes, however, only use of the color algorithms can not identify the reverse of this specification carton cigarette
- The results of the second column F operator equal:

$$\sum_{i=0}^{n} F[i] = 1$$

  Then it said the complexity of other specifications carton cigarette of the data is the same as the reverse of the first specification carton cigarettes, however, only use of the complexity algorithm to identify the specifications can not be completely positive carton cigarette too

Table 2: Positive final optimization operator results of Nanjing (Hard-Red)

Results	C	F	P	MC	L
Recognition result	0	1	1	0	1
Perform symbol	C1A	F1A	P1A	MC1A	L1A
Optimization result	0	1	0	0	1

- The results of the third column P operator equal:

$$\sum_{i=0}^{n} P[i] = 1$$

  Then it said brands of other specifications carton cigarette is the same as the reverse of the first specification, that is only use of the brands matching algorithm can not be completely sure that the reverse of this specification carton cigarette as well
- Results of the fourth column of the MC operator equal:

$$\sum_{i=0}^{n} MC[i] = 1$$

  Then it means that no other specifications is the same as the color data of the first reverse of the specifications carton cigarettes, that means use of complexity algorithm can identify this specification positive carton cigarette
- Results of the fifth column L operator equal:

$$\sum_{i=0}^{n} L[i] = 1$$

  Then it means there are other length data is the same as the first reverse of the specifications carton cigarette, which only using the length of the algorithm can not fully identify the reverse of this specification carton cigarette

Perform symbol of survival: Take the first row of Nanjing (Hard-Red) as an example to explain how to produce the perform symbol on line, and we illustrate the structure of the logical relationship between the operator first. The operator perform symbol all as zero, and mark this operator perform symbol as 1.

Product of Nanjing(Hard-Red) positive final optimization operator result show as in Table 2.

The outcoming: The perform symbol of original 1 is equal to zero (1 execution breaks this operator need to perform, and 0 means that the operator does not need to perform). The simplified five operators perform symbol is 00110. Therefore, identifies a simplified implementation of the identification data on the structure of the recognition specifications the simplified execution result, as optimization recognition operator results, it greatly improves the recognition speed. According to analyze of

Table 3: Experiment results based on the proposed optimization recognition operator

Operator	C	F	P	MC	L
Original No.	20	20	20	20	20
Now No.	10	0	10	4	0
Original total times (m sec)	20	20	100	20	20
Now total times (m sec)	10	0	50	4	0

the results above, calculated in accordance with each operator separate statistics on the number of results as shown in Table 3.

CONCLUSION

Through a large number of experiments, the average online 35 to 40 brands, the optimized efficiency can be improved about 5 times. The recognition efficiency compared data before and after the above given optimized through the analysis and calculation of the 9 brands is 3 times. The complexity of this research is based on the depth of the study of the object, the proposed the concept of the operators and pretreatments, it not only increased in the item of recognition speed, stability, error rate achieved not had the best indicators of the industry, but also supposed a novel ideas put forward for the development of visual products and systems, and more concepts for the interesting researchers and developers.

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