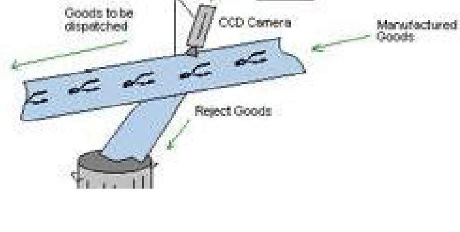
بینایی ماشین (Machine Vision)

از میان همه شاخه‌های هوش مصنوعی، شاید کاربردی‌ترین آن‌ها کامپیوتری و مکانیزه کردن سیستم‌های بینایی باشد. دامنه کاربرد این شاخه از فناوری در حال رشد، بسیار وسیع است و از کاربردهای عادی و معمولی مثل کنترل کیفیت خط تولید و نظارت ویدئویی گرفته تا تکنولوژی‌های جدید مثل اتومبیل‌های بدون راننده را دربرگرفته است. دامنه کاربردهای این تکنولوژی براساس تکنیک‌های مورد استفاده در آن‌ها تغییر می‌کند. دراین مقاله سعی داریم به شما نشان دهیم که سیستم‌های بینایی ماشین چگونه کار می‌کنند و مروری کوتاه بر اهداف، تکنیک‌ها و تکنولوژی‌های موجود داشته باشیم و سعی داریم با نحوه کار بینایی ماشین و پیشرفت آن‌ها که مطابق با سیستم بینایی انسان است، آشنا شویم. در این متن، بررسی خود را با دو مثال انجام می‌دهیم. اولی سیستم کنترل کیفیت خط تولید است که شامل نحوه عکس‌برداری و ذخیره و شیوه تفسیر عکس‌های گرفته شده به‌صورت خودکار است و دیگری به‌عنوان یک مثال پیچیده‌تر، چگونگی بینایی یک ربات را توضیح می‌دهد،ودر آخر نیز به کاربردهای پردازش تصویر در دنیای امروز می پردازیم.

کنترل کیفیت خط تولید



Design and application of industrial machine vision systems

H. Golnabi[a,] , A. Asadpour[b]

[a]Institute of Water and Energy, Sharif University of Technology, Tehran, Iran
[b]Plasma Physics Research Center, Islamic Azad University, Tehran, Iran

Abstract

In this paper, the role and importance of the machine vision systems in the industrial applications are described. First understanding of the vision in terms of a universal concept is explained. System design methodology is discussed and a generic machine vision model is reported. Such a machine includes systems and sub-systems, which of course depend on the type of applications and required tasks. In general, expected functions from a vision machine are the exploitation and imposition of the environmental constraint of a scene, the capturing of the images, analysis of those captured images, recognition of certain objects and features within each image, and the initiation of subsequent actions in order to accept or reject the corresponding objects. After a vision system performs all these stages, the task in hand is almost completed. Here, the sequence and proper functioning of each system and sub-systems in terms of high-quality images is explained. In operation, there is a scene with some constraint, rst step for the machine is the image acquisition, pre-processing of image, segmentation, feature extraction, classi cation, inspection, and nally actuation, which is an interaction with the scene under study. At the end of this report, industrial image vision applications are explained in detail. Such applications include the area of automated visual inspection (AVI), process control, parts identi cation, and important role in the robotic guidance and control. Vision developments in manufacturing that can result in improvements in the reliability, in the product quality, and enabling technology for a new production process are presented. The key points in design and applications of a machine vision system are also presented. Such considerations can be generally classi ed into the six different categories such as the scene constraints, image acquisition, image pre-processing, image processing, machine vision justi cation, and nally the systematic considerations. Each aspect of such processes is described here and the proper condition for an optimal design is reported.

Keywords: Design; Application; Industrial; Vision system; Image

1. Introduction

The introduction of the automation has revolutionized the manufacturing in which complex operations have been broken down into simple step-by-step instruction that can

within that image, and the exploitation and imposition of environmental constraints [1].

Scene constraint is the rst consideration for the machine vision system. The situation of the scene must be recognized by the machine vision designer and accord-

used to get the position of the hole of barrel in the pixel coordinate, after coordinate transform, the actual position is obtained in space coordinates. Finally, Stepping motor is droved by stepping drive system to located the actual position of the hole of barrel and achieve the automatic positioning.

Keywords-machine vision; hough transform; stepping motor

I. INTRODUCTION

Liquid automatic filling technology is widely used in petroleum, chemical, beverage and medical filling process. Automatic filling machinery has become an important symbol of industrial modernization [1-4]. If the hole of barrel is not a center position, filling process is a semi-automatic mode at home and abroad, namely artificial filling. This reduces the production efficiency seriously. The process of filling strong poisonous liquid such as hydrofluoric acid, sodium cyaniding thus becomes extremely dangerous. Worker engaged in this job would be damaged. If the hole of barrel is judged by using machine vision system instead of human eyes, the Production efficiency is improved and the worker engaged in this job would be safe.

II. POSITIONING SYSTEM

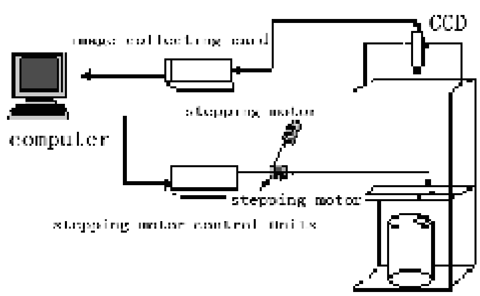


Figure 1. Structure positioning system

images is stored. Position information of circular sprue, including sprue radius, sprue circle space coordinate location, is achieved by image processing procedures. Then this information is transferred to the stepping motor control system. Based on the pulse signals proceeded by computer, the stepping motor control system drives two stepping motors. The two-dimensional positioning rack drived by motor will move above the sprue, realizing automatic positioning.

III. IMAGE PROCESS

A. Image Edge detection

Reusing barrels is inevitable and oil stain cannot be completely cleaned. These lead to the low sprue image quality such as, boundary disconnected and boundary fuzzy. Boundary disconnected is interferential for image process. It is necessary to detect image edge [5]. Edge detection can make more accurate results, namely sprue edge profile is detected, not the wrong edges of goal. Discontinuity spatial characteristic is first detected in edge extraction, and then discontinuity boundary is repaired with complete boundary edge pixels. The gradient along the edges changes gently, changes dramatic in perpendicular to the direction of edge. In this sense, the essence of edge detection algorithm is to utilize appropriate mathematical operator. Mathematical operator process pixels edge, including quantizing the grayscale rate and determining direction.

Common edge detection operators include Roberts operator, Sobel operator, Krisch Prewitt operator, Gauss-Laplace operator. Processing result of every kind of operator is compared. Fig. 2 is the original image, Fig. 3 - Fig. 7 respectively are processed images.

Robert operator is 2×2 operator and makes a better response for low noise image. Krisch operator, Soble operator and Prewitt operator are 3×3 operators and make a better response for gray level gradually changing image with more noise. Prewitt operator is not isotropic [6-8]. In Fig. 6 we can see that the image edge is not totally connected. Considering the

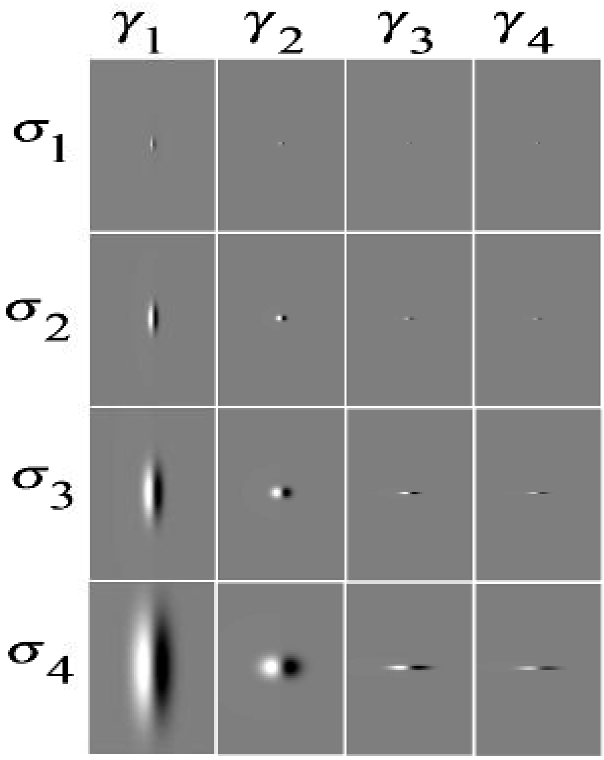
اگر از توان‌های مرتبهٔ دو به بالا در بسط تیلور حول نقطهٔ x=0 تابع $\cos(\frac{2\pi}{\lambda}x+\varphi)$ صرف‌نظر کنیم، رابطه ۵ بدست می‌آید:

$$\cos(\frac{2\pi}{\lambda}x+\varphi)=\cos(\varphi)+\frac{2\pi x}{\lambda}\sin\varphi \qquad (۵)$$

اگر در تابع گابور، بسط تیلور تابع کسینوسی جایگزین شود و رابطهٔ حاصل را هم‌ارز رابطهٔ ۳ قرار دهیم، پارامترهای مدل ساده برای تقریب بهینهٔ معیارهای مطرح شده توسط کنی، به صورت زیر بدست می‌آیند :

$$\lambda = 2\pi\sigma^2 \ , \ \varphi = \frac{\pi}{2} \qquad (۶)$$

یکی دیگر از مشکلات روش‌های قبلی، تحلیل لبه در جهت‌های محدود افقی و عمودی است، مانند روش‌های کنی، مار-هیلدرث، سوبل، لاپلاسین-گوسین. در این روش‌ها لبهٔ سایر جهت‌های دیگر از مقادیر گرادیان افقی و عمودی تصویر تخمین زده می‌شود و معمولاً شامل چهار جهت به صورت دو جهت اصلی و دو جهت فرعی می‌باشند. با توجه به دو بعدی بودن سیگنال تصویر، برای مکان‌یابی هرچه دقیق‌تر لبه‌ها، باید تعداد جهت‌های ترجیحی برای میدان دریافت سلول آشکارساز لبه، متناسب با مقیاس میدان دریافت انتخاب گردد. در این مقاله برای کاهش هزینهٔ محاسباتی، تعداد این جهات به صورت تطبیق شده با عرض میدان دریافت سلول ساده، در رابطهٔ مستقیم در نظر گرفته می‌شود. اگر مقدار γ ثابت نگه داشته شود، با افزایش مقیاس، میدان دریافت هم در جهت طول و هم در جهت عرض رشد می‌کند. رشد عرضی میدان دریافت در مقیاس‌های بزرگتر، باعث ادغام بیشتر اطلاعات روشنایی تصویر در گسترهٔ میدان دریافت می‌شود و در این صورت میانگین‌گیری در بازهٔ بیشتری نسبت به مقیاس‌های کوچکتر در سطح زیر میدان دریافت انجام می‌شود. درنتیجه محاسبهٔ مقدار تغییرات در یک جهت خاص برای آشکار شدن لبه در آن جهت، با دقت کمتری صورت می‌گیرد و مکان‌یابی لبه دچار خطای بیشتری می‌شود. بر اساس این فرض، در این مقاله برای جبران این خطا به صورت تقریبی، از γ به صورت متغیر و متناسب با مقیاس σ به صورت $\gamma = \sigma$ استفاده می‌شود. در این



شکل ۴: تغییر در شکل میدان دریافت به ازای γ و σ مختلف.

شکل ۵: تأثیر مقدار γ در مقیاس بزرگ ($\sigma = 10$). الف) تصویر اصلی.

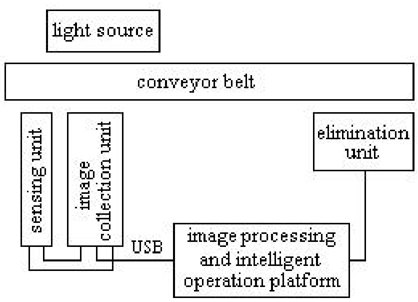


Figure 1. Composition of the detecting system for pharmaceutical bottle-packaging

image collection unit is transmitted to image processing platform through the camera interface. Machine vision software have a processing operation to it and output a result according to the calculation,comparison and judgment to some related parameters. System process is as follows

When a glass packaging bottle transmitted by conveyor belt is passing by the sensor, it output a pulse signal to control the image collection unit and capturing a image,then the image is transmitted to monitoring operating system and haven analysis and operation. After "comparison",a judgment can be concluded: normally, the glass packaging bottle moves on with belt and into the next station; as the problems are discovered, the elimination unit executing commands from monitoring operating system will eliminate "unqualified" bottle, so as to realize the detection and sorting work for bottle packaging products and defective.

III. CONSTRUCTING DETECTION SYSTEM

A. The software platform of detection system

The software platform of test system consists of machine vision software and intelligent operation platform, and its main tasks are to control respectively the every hardware part as well as integrate all parts of hardware. At secondary developments in order to achieve different target detection.

B. The software structure of detection system

The detection and control system for Pharmaceutical Bottle-packaging including the recognition algorithm,user interface and communication three subsystems that respectively complete the inspection identification, mechanical control and communication function. The system software is based on windows platform,takes graphic processing by using HALCON software, and its program is designed by adopting the object-oriented VB language for real-time, coordinated planning process[7]. The structure of detection and control system is as shown in figure 2, divided into seven modules: parameter setting, pretreating, image processing, intelligent judging, eliminating, communicating and user interface.

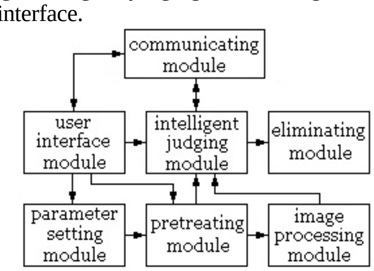


Figure 2. The structure of detection and control system

Parameter setting provides data file setting and storage operation in database; pretreating module completes initialization operation according to the set value; digital image processing module completes digital processing to real-time collecting images; intelligent judging module compares and judges image data; eliminating module completes controlling to works eliminated; communication module completes two-way communication and statistical data report between the epistatic machine and the database; the user interface provides users with convenient operation and statistics show by using graphics mode, and it is

Automatic Extraction of Positive Cells in Pathology images of Meningioma Based on the Maximal Entropy Principle and HSV Color Space

Vahid Anari
Islamic Azad University
Khoramabad Branch
V_anari@yahoo.com

Parvin Mahzouni
Isfehan University of Medical Science
Isfahan, Iran
Mahzouni@med.mui.ac.ir

Rasoul Amirfattahi
Department of Electrical and Computer
Engineering IsfehanUniversityTechnology
Fattahi@ cc.iut.ac.ir

Abstract- This paper describes a computer-aided system for analyzing immunohistochemically stained meningioma cancer cell images. Accurate segmentation of cells in such images plays a critical role in diagnosing diffrent type of meningioma cancer. The methodpresented to automatically extract the positive cells in meninigioma tumor immunohistochemical pathology images based on HSV color space. First, according to distribution rules of positive cells in the HSV color space, it uses the component H, S and V as threshold conditions and leverages the maximal entropy principle to build a model to segment and extract positive cells. Experimental results shows that proposed algorithm can be used by pathologist to detection reliable quantitatively analyze the parameter of tumor cells and over come to disadvantages of the traditional approach.

Keywords: Positive Cell, Color Segmentation, HSV Color Space, Immunohistochemistry, Meningioma, Maximal Entropy Principle, Thresholding.

1. Introduction

Meninniomas are tumors of the meninges arising from arachniod cells. Meningioma where histologically classified

processing techniques to automated cell analysis. Positive cells nuclei segmentation and counting is the key issue in automatic cell image analysis. Pixel based cell segmentation method combining the shape information of the cell nuclei was proposed in[3]. Techniques of active contour[4], neural network[5], mathematical morphology[6], were also used in cell nuclei segmentation. Gray level thresholding thechniques are computationally inexpensive methods for partitioning a digital image into mutually exclusive an exhaustive regions. A survey of various thresholding schemes is represent in[7]. Entropy based thresholding is widely used in image segmentation methods. The variants of Shannon's entropy have been effectively uased for estimation of thresholds in image segmentation[8,9]. The maximum entropy criterion for threshold selection which is first proposed byPun[10,11] is one of the most important threshold selection method. The aim of this method is to separate a histogram into two or more independent classes by means of threshold selected in such a way that the entropy of the classes and hence their information

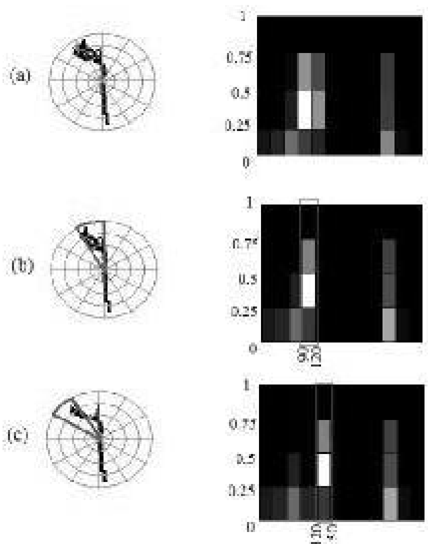


Fig. 4: Feature selection. (a) 'daria_wave1' [11] and accosiated histogram (b) 'move down' action. (c) 'move up' action. Saliant feature is reperesentd with red color.

membership function parameters. Recognition rate is 93.9% for the first layer that uses general features and 98.3% for the second layer with salient features. Fig. 5 shows the comparison of test data and ANFIS output on the testing set. Blue point represents the test data. Axes show the action classes and red star shows ANFIS output. As it is seen there is some error in class No. 7.

We compare our approach with Bobick and Davis [1] that is alternative method and claim to improve their algorithm. They introduced binary motion-energy image (MEI) and motion-history image (MHI) generated from silhouette. Their results are shown in TABLE II .We use skeleton data in one action duration instead of silhouette images. Using skeleton

spatio-temporal feature matching reported in [9]. Besides 'Run', 'Walk' and 'Skip' that are chosen to select features, we see that 'jump' is confused with 'skip' because of both temporal and spatial similarities.

The total training time are 8.53 min on Intel Pentium 2.16 GHz personal computer using Matlab implementation. The training data set. Classification results are shown in Table I for both layers. This shown that the percentage accuracy of diagnosis in this proposed method may be sensitive to skeleton images, hence we extract skeleton with different methods [10, 14-15]. The recognition rate is adapted 98.3%, 97.9%, 96.9%, respectively then skeletonized method has no major effect on it.

TABLE I: Experimental Results for ANFIS.

Optimization method: hybrid, Epoch: 3

Layer	No. of nodes	Training Time (min)	Accuracy of diagnosis	Error
1	7107	5.03	93.9%	0.00039
2	5539	3.5	98.3%	7.04e-6

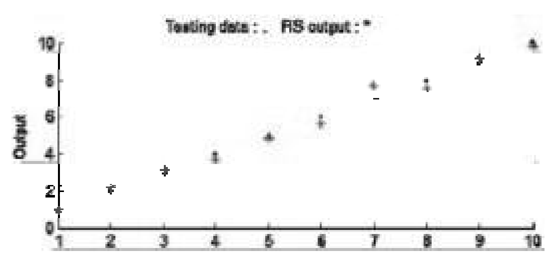


Fig. 5: Comparison of test data and ANFIS output