ISSN: 0975-8585

Research Journal of Pharmaceutical, Biological and Chemical Sciences

DSP Algorithm for Real-Time Automated Visual Inspection of Aspirin Tablets in Pharmaceutical Blisters.

Karmugilan D, Mohamed Abdullah Alsaad M, and Vijayakumar V*.

Department of Electronics and Communication Engineering, Sathyabama University, Chennai-600119, India

ABSTRACT

The main objective of the proposed work is to detect the various kinds of defects in tablets using automated visual inspection approach. If the defect is in the form of hole or crack, it is possible that the capsule filling will spill out and will have unsafe effects if it reaches the end-user. Detection of defects is necessary to protect the consumer from many hazardous impacts. To do the same we need to regulate our inspection system. As still there are many manufacturing companies which do not use automated inspection system our project will help the company to do so. Detection of defects will not only benefit the consumer but also help the pharmaceutical industry to raise the standard of production. To avoid hazardous mix-ups among various types of tablets produced by the pharmaceutical industry, tablets must be easily and accurately identified by professionals and customers. Now, there is a need of a method, with the help of which, we can understand images and extract information or objects is nothing but " Image Segmentation using Level Set Method" method which fulfill above requirements. In this work, detect the broken aspirin tablets using image processing techniques in an object oriented image processing software. The processing scheme can be adapted for other practical applications from other domains. The algorithm can be implemented in various digital image processing environments and can be a part of a complex automated manufacturing and testing system.

Keywords: DSP, algorithm, aspirin, blisters

Corresponding author

INTRODUCTION

Automated visual inspection (AVI) is one of the most prominent image-processing methods especially for quality control checking in the production line of manufacturing industries, such as for vehicles, mechanical parts and the garment industry. Machine vision systems can perform AVI and slowly applied to the variety of challenges in manufacturing leads to enhancing productivity and quality in the manufacturing process [1-4]. Moreover, machine vision unifies imaging, illumination, material handling technologies to gives noncontact localization, image processing and analysis, manipulation and characterization of moving or stationary objects. In the case of real-time operation, visual inspection should be able to handle with the manufacturing process which also been a difficult and challenging task when the goods are produced at high rates. Interestingly, machine vision systems frequently operate in controlled and constrained environments in which there is some control over image resolution and contrast, illumination, orientation and position of objects about the object to be inspected. Precisely, two various approaches, namely design-rule verification and template matching can be considered to perform automated visual inspection [5]. Most of the published approaches for color image segmentation are mainly depend on various color representation and gray level segmentation. In general, segmentation approach can be classified into the following methods: region-based approach, edge detection approaches, statistical methods and physical reflectance models performed in color feature space [6, 7]. Segmentation can be enhanced with the help of human perception based interpretation models [8] and physical reflectance models [9]. Statistical methods are mainly related to the clustering in some color feature space and threshold histograms [10, 11]. A segmentation algorithm can also be including various methods [12, 13]. The statistical segmentation method is very effective, even though the feature space in sample drawn from an unknown probability distribution have quite a complex structure. Besides, the partial consequence of the adverse effect in spatial color nonuniformity can manipulate as smooth spatial color difference. In feature space this may reflected in more overlapping and dispersed clusters. Cluster shapes are also based on the color space. This can refer to the probability distribution with parameteric models and quite difficult in RGB space [14]. RGB space, complex cluster shapes, call for nonparametric clustering-based segmentation method, like kernel estimation or nearest neighbor method and multivariate histogram [15-17].

Automated real-time visual inspection has played a vital role in the pharmaceutical industry, which gives huge amounts of goods at very high rates. For example, in pharmaceutical blister packing, it is most recommended security standard for inspect the tablets in every blister before it is sealed. Since, tablets are automated, colored visual inspection through the design-rule verification known as color image segmentation. In the present work detection of broken aspirin tablets using image processing techniques in an object oriented image processing software. The processing scheme can be adapted for other practical applications from other domains. The algorithm can be implemented in various digital image processing environments and can be a part of a complex automated manufacturing and testing system.

PROPOSED SYSTEM

Level Set Segmentation

Segmentation is an important technique used in image processing to identify the objects in the image. As we work with data from simulations, observations, and experiments, we are interested in segmentation techniques that can be applied in a robust and efficient way to both image and mesh data. Mesh data is frequently unstructured; this precludes the direct application of techniques that were originally developed for the more structured image data. One solution to this problem is the use of PDE-based techniques such as level sets or implicit active contours [18, 19].

The idea behind active contours, or deformable models, for image segmentation is quite simple. The user specifies an initial guess for the contour, which is then moved by image driven forces to the boundaries of the desired objects. In such models, two types of forces are considered - the internal forces, defined within the curve, are designed to keep the model smooth during the deformation process, while the external forces, which are computed from the underlying image data, are defined to move the model toward an object boundary or other desired feature with in the images. There are two forms of deformable models. In the parametric form, also referred to as snakes, an explicit parametric representation of the curve is used. This form is not only compact, but is robust to both image noise and boundary gaps as it constrains the extracted boundaries to be smooth. However, it can severely restrict the degree of topological adaptability of the model, especially if the deformation involves splitting or merging of parts. In contrast, the implicit deformable models, also called implicit active contours or level sets, are designed to handle topological changes naturally. However, unlike the parametric form, they are not robust to boundary gaps and suffer from several other deficiencies as well [20].

Level Sets are an important category of modern image segmentation techniques are based on partial differential equations (PDE), i.e. progressive evaluation of the differences among neighboring pixels to find object boundaries. Ideally, the algorithm will converge at the boundary of the object where the differences are the highest. The Fiji plugin provides two PDE based methods, the more basic fast marching and the advanced active contour algorithm. Fast marching works similar to a standard flood fill but is more sensitive in the boundary detection. While growing the region it constantly calculates the difference of the current selection to the newly added pixels and either stops if it exceeds a pre-selected gray value difference or if it would exceed a certain pre-selected rate of growth. This algorithm is sensitive to leaking, if the object has a gap in the boundary, the selection may leak to the outside of the object.

Level sets advance a contour like a rubber band until the contour hits an object boundary. The rubber band like nature (= curvature) prevents the contour from leaking if there are gaps in the boundary. The strength of the rubber band and a gray level difference can be pre-selected. The speedy fast marching can be used as input for the slower active contours. If the image is very large, starting with Fast Marching and using the contour from the fast marching to refine the object with Level Sets can significantly speed up the object detection. Our main motivation for investigating level set techniques was to better understand their pros and cons relative to the more traditional image segmentation techniques. The results obtained using level sets to segment a grain of pollen from the background. To obtain the outer boundary of the grain, we started with an initial level set at the boundary of the image. To obtain the structures on the inside of the pollen grain, we started with an initial level set that was a closed curve around a point on the inside. This curve evolved to identify the boundaries of all the spines inside the grain. The contours generated by the level sets are closed contours. This technique not only provides more accurate numerical implementations but also handle topological change very easily.

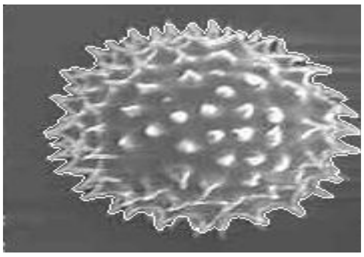

Fig 1. The initial curve was at the boundary of the image

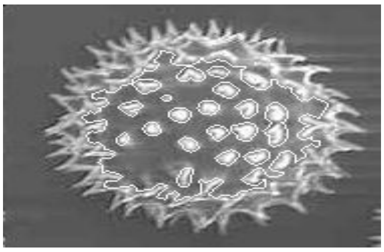

Fig 2. The initial curve was a closed contour around a point on the inside of the pollen grain

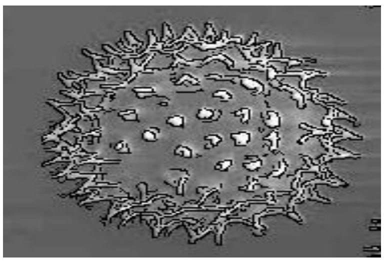

Fig 3. The output of the Canny edge detector

ISSN: 0975-8585

Curves in Levet Set Method

The basic idea is to start with a closed curve in 2D or a surface in 3D and allow the curve to move perpendicular to itself at a prescribed speed. In image processing the level set method is most frequently used as a segmentation tool through propagation of a contour by using the properties of the image. One of the first applications was to detect edges in an image , but in more recent applications textures, shapes, colors etc can be detected. In the level set method, an interface C is represented implicitly as a level set of a function ϕ , called level set function, of higher dimension. The geometric characteristics and the motion of the front are computed with this level set function. The interface is now represented implicitly as the zero-th level set (or contour) of this scalar function.

Over the rest of the image space, this level set function is defined as the signed distance function from the zero-th level set. Specifically, given a closed curve C, the function is zero if the pixel lies on the curve itself, otherwise, it is the signed minimum distance from the pixel to the curve. By convention, the distance is regarded as negative for pixels outside C and positive for pixels inside C. The level set function ϕ of the closed front C is defined as follows, $\phi(x, y) = \pm d((x, y), C)$ (1) Where $d((x, y), C)$ is the distance from point (x, y) to the contour C, and the sign plus or minus are chosen if the point(x, y) is inside or outside of interface C.The interface is now represented implicitly as the zero-th level set (or contour) of this scalar function :

$$C = \{(x, y) / \phi(x, y) = 0\} \qquad (2)$$

Such an implicit representation has numerous advantages over a parametrical approach. The most striking example is topological changes occurring during the propagation, typically when two flames burn together the evolving interfaces merge into one single propagating front.

The function ϕ , which varies with space and time (that is, $\phi = \phi((x, y), t)$ in two dimensions) is then evolved using a partial differential equation (PDE), containing terms that are either hyperbolic or parabolic in nature.

In order to illustrate the origins of this PDE, we next consider the evolution of the function ϕ as it evolves in a direction. The following images show the progress of this function. As can be seen, the corners of the curve are slightly smoothed but except that the zero level set of phi is preserved during the diffusion.

Evolution of a binary function towards a signed distance function under reinitializatial PDE.

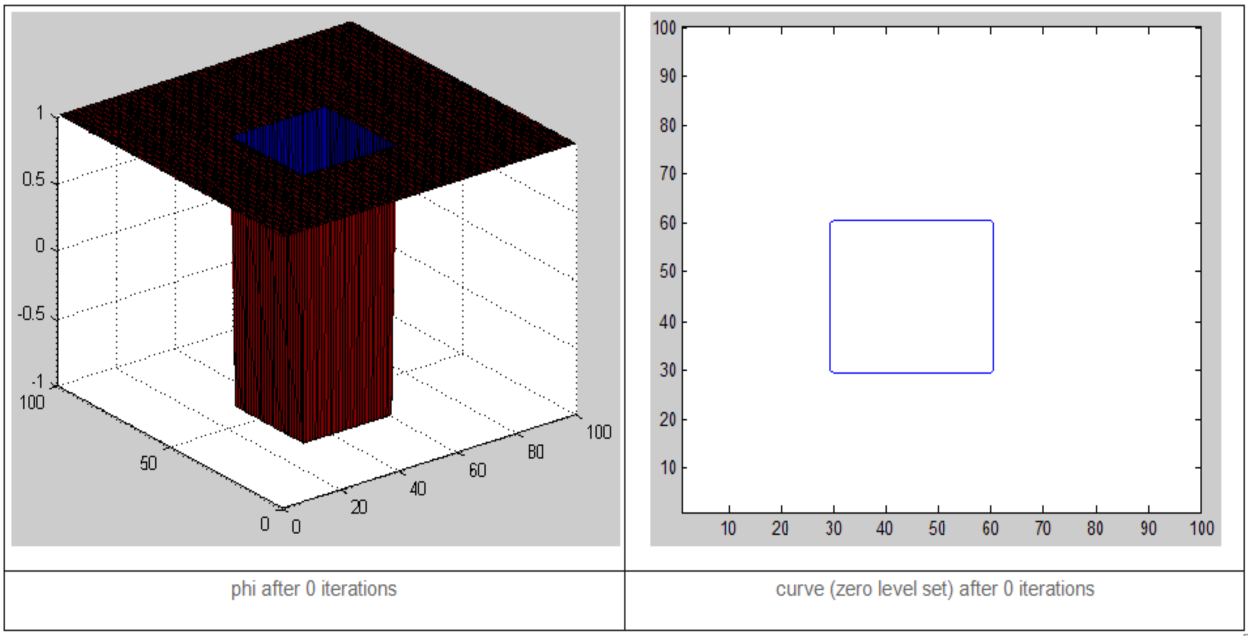

Fig 4. Phi after 0 iterations

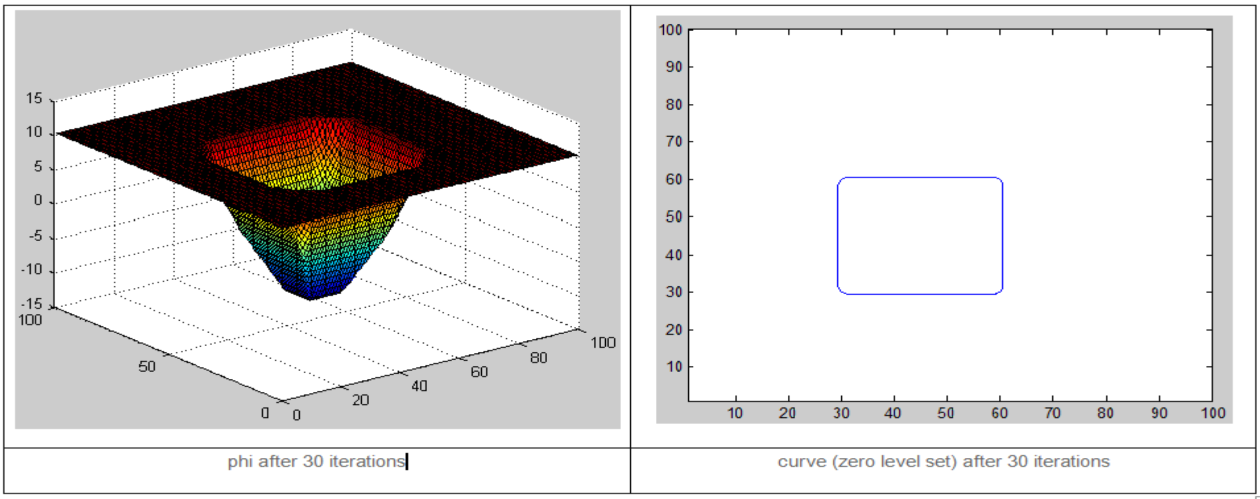

Fig 5. Phi after 30 iterations

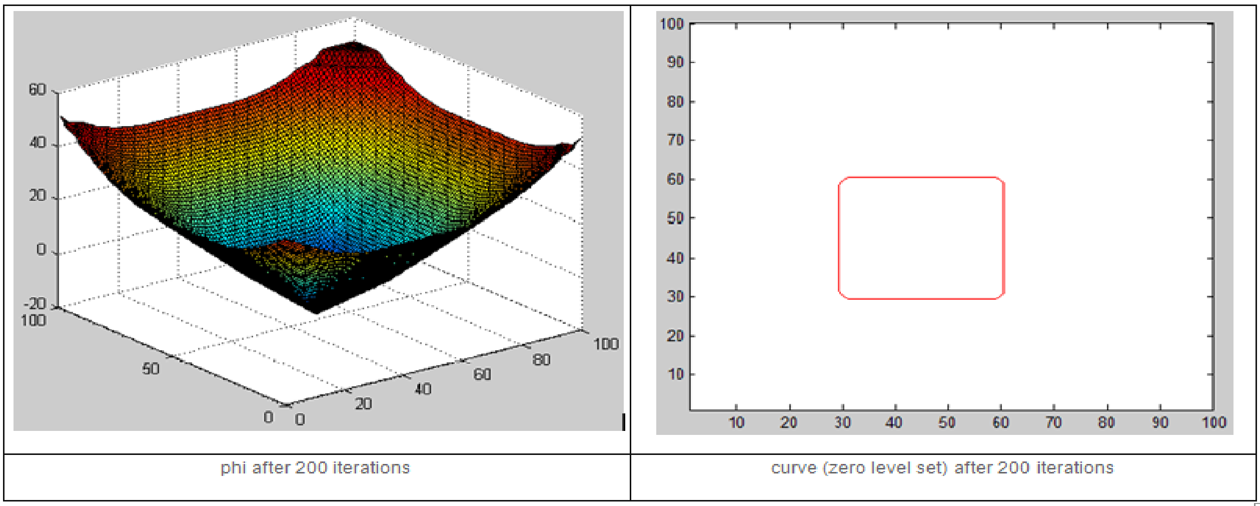

Fig 6. Phi after 200 iterations

Since this process takes longer than necessary and smoothes the curve slightly, we'll use for the rest of this discussion a different way of creating this signed distance function. We will utilize Matlab's function.

COMPUTATION TOOLS

MATLAB

MATLAB is a high-performance language for technical computing. It integrates computation, visualization, and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notation. MATLAB includes built-in mathematical functions fundamental to solving engineering and scientific problems, and an interactive environment ideal for iterative exploration, design, and problem solving. MATLAB is an interactive system whose basic data element is an array that does not require dimensioning. This allows you to solve many technical computing problems, especially those with matrix and vector formulations, in a fraction of the time it would take to write a program in a scalar non interactive language such as C or FORTRAN. Matlab (Matrix laboratory) is an interactive software system for numerical computations and graphics. As the name suggests, Matlab is especially designed for matrix computations: solving systems of linear equations, computing eigenvalues and eigenvectors, factoring matrices, and so forth. In addition, it has a variety of graphical capabilities, and can be extended through programs written in its own programming language. Many such programs come with the system; a number of these extend Mat lab's capabilities to nonlinear problems, such as the solution of initial value problems for ordinary differential equations.

ISSN: 0975-8585

Matlab is designed to solve problems numerically, that is, in finite-solutions, and should not be confused with a symbolic computation system (SCS) such as Mathematical or Maple. It should be understood that this does not make Mat lab better or worse than an SCS; it is a tool designed for different tasks and is therefore not directly comparable.

SIMULINK

Simulink is a software package that enables us to model, simulate, and analyze systems whose outputs change over time. Such systems are often referred to as dynamic systems. The Simulink software can be used to explore the behavior of a wide range of real-world dynamic systems, including electrical circuits, shock absorbers, braking systems, and many other electrical, mechanical, and thermodynamic systems. This section explains how Simulink works. Simulating a dynamic system is a two-step process. First, a user creates a block diagram, using the Simulink model editor, which graphically depicts time-dependent mathematical relationships among the system's inputs, states, and outputs. The user then commands the Simulink software to simulate the system represented by the model from a specified start time to a specified stop time.

SIMULATION RESULTS

Image Acquisition

Image acquisition is done by capturing tablet image using camera as shown in Figure 7.

Fig 7. captured Image by using camera

Gray Scale Conversion

The original image is converted into gray scale image for further processing as shown in Figure 8.

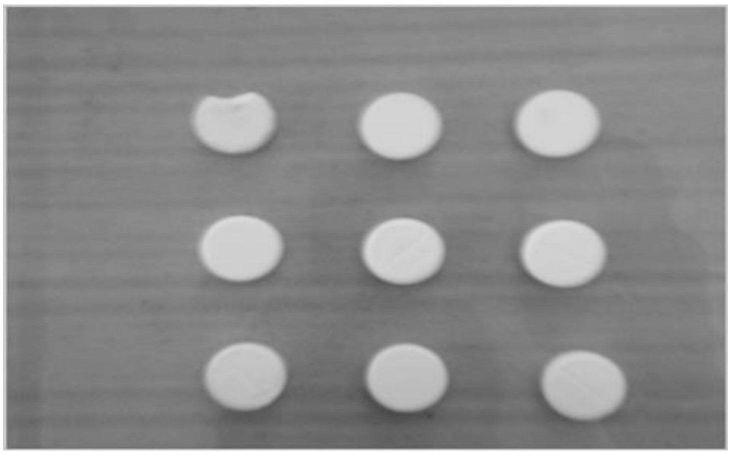

Fig 8. Gray scale conversion

Creation Of An Image With Uniform Background

Create a more uniform background, subtract the background image from the original image and then view the image in Figure 9.

Fig 9. Image with uniform background

Adjustment Of The Contrast In The Processed Image

Contrast adjustment can be done for getting a clear image and it could be easily separable with background for predicting accuracy in image as shown in Figure 10 .

Fig 10. Contrast adjustment in the processed

Image Level Set Segmentation

The object boundaries in an image can be sharply detected in a great accuracy by means of level set segmentation as shown in Figure 11.

ISSN: 0975-8585

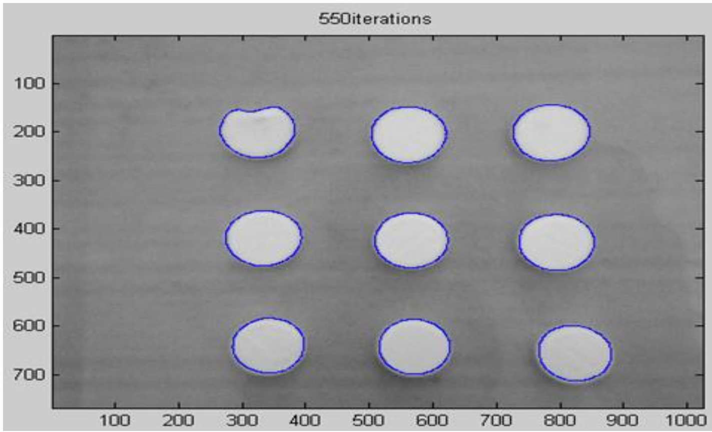

Fig 11. Level Set Segmentation

Create a Binary Conversion of The Image

Creating binary conversion is for getting a clear background and mostly binary images compress well with simple run-length compression schemes as shown in Figure 12.

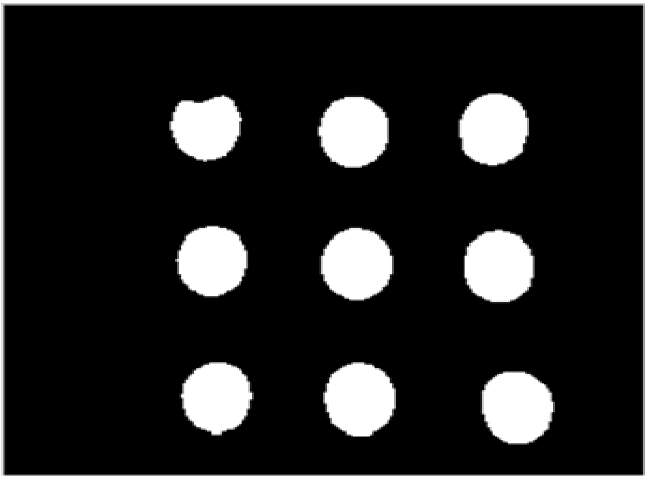

Fig 12. creating binary conversion

Flaw Detection

Prediction of flaw, cracks or any broken areas in order to find the largest and smallest object in an image , maximum and the minimum area calculation can be found respectively as referred in Figure 13. Average area calculation can also be determined.

Fig 13. Flaw detection

Pseudo Colouring

Defective tablet is highlighted by applying Pseudo coloring as shown in Figure 14.

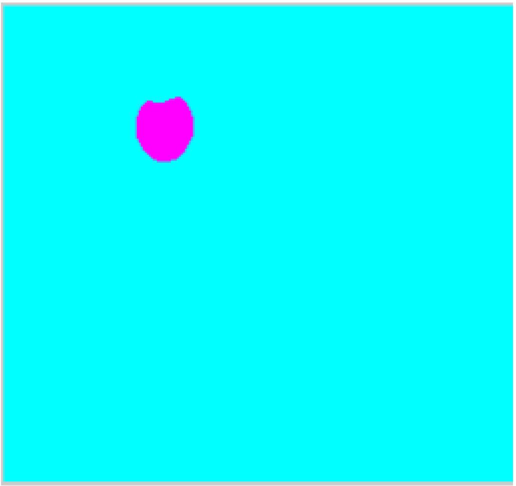

Fig 14. Pseudo Colouring

Table 1 refers the different methods such as pixel based segmentation, edge detection, Region Growing and Level Set Segmentation with corresponding efficiency 60, 64, 71 and 85 % respectively. Among these method, level set segmentation method has secured high efficiency which is most suitable for image processing and automated visual inspection of manufactured goods.

Table 1: Comparison Table

S.NO	METHOD	EFFICIENCY
1	PIXEL BASED SEGMENTATION	60%
2	EDGE DETECTION	64%
3	REGION GROWING	71%
4	LEVEL SET SEGMENTATION	85%

CONCLUSION

A major area of imaging is in automated visual inspection of manufactured goods. A typical image processing task with products like this is to inspect them for missing or wrong parts. Detecting some anomalies is a major theme of industrial inspection that includes a large area of products. The proposed paper presents an application for detection of broken aspirin tablets using image processing techniques in an object oriented image processing software. The processing scheme can be adapted for other practical applications from other domains. The algorithm can be implemented in various digital image processing environments and can be a part of a complex automated manufacturing and testing system.

REFERENCES

[1] Chin R, Computer Vision Graphics and Image Processing, 1988;41:346.
[2] Mohtadi O, Sanz J, International Journal of Robotics and Automation, 1993;8:44–66.
[3] Newman TS, Jain AK, Computer Vision and Image Understanding, 1995;61:231–62.
[4] Thomas ADH, RoddMG, Holt JD, Neill CJ, Real-Time Imaging, 1995;1:139–58.
[5] Lai SH, Fang M, Journal of Electronic Imaging, 2001;10: 359–66.
[6] Cheng HD, Jiang XH, Sun Y, Wang JL, Pattern Recognition, 2001;34: 2259–81.
[7] Pal NR, Pal SK, Pattern Recognition, 1993;26:1277.
[8] Maxwell BA, Shafer SA, Computer Vision and Image Understanding, 2000;77:1–24.
[9] Klinker GJ, Shafer SA, Kanade T, International Journal of Computer Vision, 1990;4:7–38.
[10] Park SH, Yun ID, Lee SU, Pattern Recognition, 1998;31:1061–76.
[11] Ohta Y, Kanade T, Sakai T, Computer Graphics and Image Processing, 1980;13:222–41.

[12] Schettini R, Pattern Recognition Letters, 1993;14:499–506.
[13] Cheng HD, Sun Y, IEEE Transactions on Image Processing, 2000;9:2071–82.
[14] Bergasa L, Duffy N, Lacey G, Mazo M, Image and Vision Computing, 2000;18:951–7.
[15] Fukunaga K, Hostleter LD, IEEE Transactions on Information Theory, 1975;21:32–40.
[16] Cheng Y, IEEE Transactions on Pattern Analysis and Machine Intelligence, 1995;17:790–9.
[17] Comaniciu D, Meer P, Pattern Analysis and Applications, 1999;2: 22–30.
[18] Osher S, Paragios N, Geometric Level Set Methods in Imaging, Vision, and Graphics, Springer-Verlag, New York, 2003.
[19] Sethian J, Level Set Methods and Fast Marching Methods: Evolving Interfaces in Computational Geometry, Fluid Mechanics, Computer Vision, and Materials Science, Cambridge University Press, Cambridge, UK, 2003.
[20] Suri J, Liu L, Singh S, Laxminarayan S, Zeng X, Reden L, IEEE Transactions on Information Technology in Biomedicine, 2002; 6.