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## Integrated Pattern Matching Algorithm for Quality Testing Of Sheet-Metal Using Digital Image Processing

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**Abstract:** The quality testing and assurance has over the last decades increasingly gained importance and is one of the most important tasks in all areas of industrial production. Today industries produce more than thousand products at a time, testing of each and every product manually becomes difficult which ultimately decreases the speed, accuracy and leads to humans error. Thus manual inspection needs to be replaced by automated visual inspection. As it is the key factor behind all the industrial application of digital image processing. Automated visual inspection uses digital camera that captures image which is coming out of product line. The captured image is then fed to computer for further processing. The typical image processing task is to find the faulty piece by comparing the user requirements and manufactured product image. Digital image processing is mainly used in industry to find faulty materials and missing parts of the product. Digital Image Processing is a technique for analyzing and manipulation of the digital images using computers. This System will employ verification of measurements of all the pieces that are coming out poof product line. Based on the error rate modification in the design can be pursued. Edge detection is one of the most commonly used operations in image processing and pattern recognition, the reason for this is that edges form the outline of an object

**Keywords**— Edge detection, Template matching, Digital image processing.

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### 1. INTRODUCTION

Today there is no field which doesn't use digital image processing. As digital image processing pays an important role in manipulation and analyzing digital images using computers. Automated visual inspection is a key factor behind digital image processing. Automated visual inspection is used to capture the image as soon as it comes from production line, after manufacturing. This captured image is send to the system for image processing. The typical image processing technique finds the faulty piece by comparing the ideal object given by user and manufactured product image.

Quality testing and assurance management are growing in importance in industrial development and production.

The decentralized production of components by supplier means that tight specification has to be met to ensure problem free assembly in final production, resulting in a high quality final product. Test engineers strive to catch defects before the product is released but they always creep in and they often reappear, even with the best manual testing process. Automated product testing is the best way to increase the effectiveness, efficiency and coverage of your product testing

Many industries perform quality testing of product manually by human workers where human observes the shape and size of the product coming out of the product line. But actually only a few pieces are taken and verified for dimension and orientation of shapes. In this way performing a test manually is tedious process and prone to some of human errors which ultimately reduces the quality of product. So our system is going to quality testing using digital image processing techniques. Image of every product is taken and the dimension and orientation of the shapes cut are calculated with actual dimension in drawing. This increases the speed and accuracy and avoids human errors which are common in quality testing.

### 2. LITERATURE SURVEY

Currently, the raw sheet metal parts are only randomly tested using conventional measurement methods, e.g. form gauge, hap tic test by special experts, abrasive stripping of the parts and observation of the scratch marks, or highlighting the surface with special oil that allows observing the reflection lines due to oil film's specularly. All these methods are time consuming and based on human observations, entailing subjectivity, lack of repeatability, and are quantitative in nature. Coordinate measurement machines (CMM) can, however, produce accurate, quantitative results, but due to the mechanical contact with the flexible part, the results are biased and the measurement process can take ten minutes in case of many points, not to mention the

need for special environmental conditions .Laser-triangulation techniques have an advantage in measurement speed over CMMs, though measurement of a surface still needs several scanning steps. Fringe projection method can simultaneously capture millions of surface points of light coloured, homogeneous, texture less, diffuse-reflecting objects, but glossy, metallic surfaces need to be treated by a special chalk spray prior the measurement to reduce gloss; otherwise it generates noisy or no measurement data at all . Deflectometry is a white light, whole-field method, which is appropriate for the form measurement of specular, highly reflecting objects, e.g. mirrors, lenses, or varnished carbody parts.

### 2.1. Detection of surface defects on sheet metal parts using one-shot deflectometry in the infrared range

Deflectometry method is actually an advanced, computer-aided version of the human observation process of specular objects which we described previously. The method was first proposed by Ritter and Hahn [5] as an advanced version of the reflection moiré method. A reference pattern, usually consisting of several parallel stripes, is captured by a camera as being reflected from the test surface. Often, instead of the stripe pattern a cosine intensity patten is used, in order to increase the resolution. The pattern in the camera images is distorted due to the 3D geometry of the test object (see Figure 2.1). Irregularities in the specimen's geometry deflect the reflected light beams by a twofold angle difference (see Figure 2.1), which makes this method very sensible to local slope changes of the surface. Since most surface defects like dents, bumps, and waviness have small height differences, distributed over a relatively large area, they are slope irregularities, and the Deflectometry method is ideal for their detection.

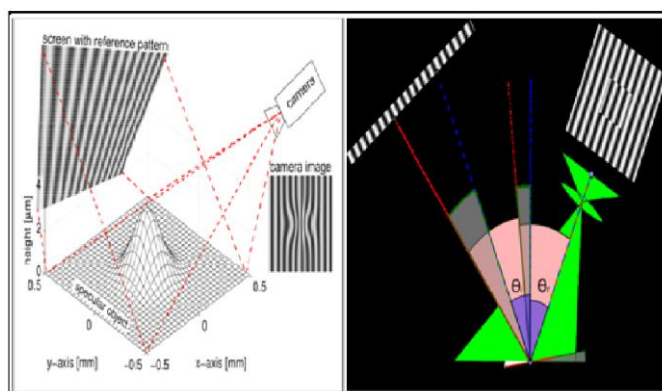


Figure 1. Deflectometry method-3D illustration object geometry is exaggerated in z direction for the illustration, b. 2D model.

### 2.2 ERICHSEN cupping test

The quality control and assurance has over the last decades increasingly gained importance and is one of the most important tasks in all areas of industrial production. For almost 100 years a test method to determine the level of quality of sheet metal exists. Abraham M. Erickson is considered the inventor of the cupping test and he patented this test method in the early 20th Century. Meanwhile, the cupping test is adopted by the International Standards Organization (ISO) and therefore valid worldwide in all industrial applications

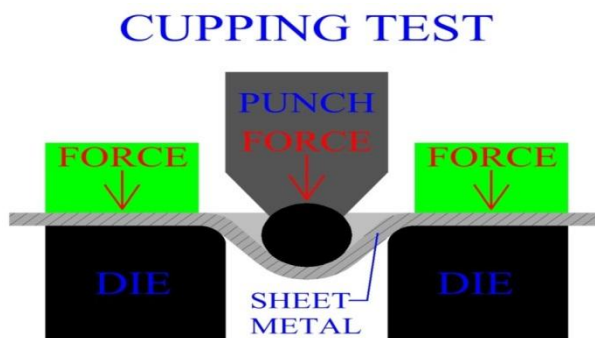


Figure 2: Cupping test

### 2.3. ERICHSEN Deep drawing test

Another coup of MrErichsen was the development of a special tool for deep-drawing cup test in 1932. Without this testing procedure the series production of hollow bodies made of sheet metal would hardly be possible up to the present day. Feature of the method: to punch out round disks from sheet metal strip and then use it to shape it with a drawing die to a cup. The deep-drawing cup test is a method of testing sheet metal by which a circular plate (blank) is stamped from a strip of sheet metal and then formed into a cup using a drawing die and a drawing punch. The greatest possible ratio between the blank and the drawing punch diameter, which just permits the faultless production of a cup.

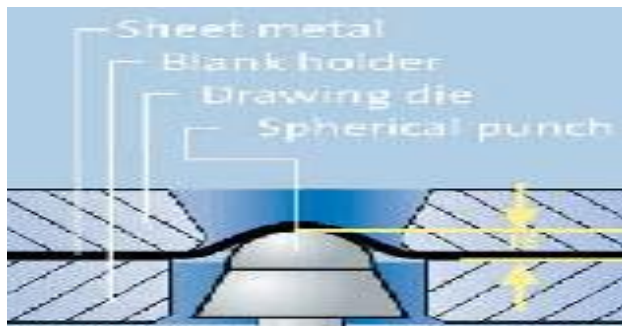


Figure 3: Deep drawing tests

### 2.4. Optical 3D measuring techniques and inspection software or quality control of sheet metal components

Previously, sheet metal parts could be inspected by tactile measuring machines in only a few locations due to time limitations. In contrast, optical 3D measuring techniques acquire the entire component surface geometry using a high-resolution point cloud (Fig. 2.4).

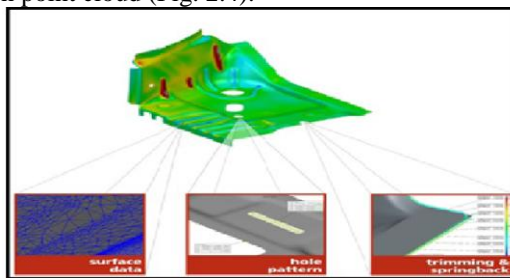


Figure 4: Full surface optical 3D measuring technique, acquisition of the entire component geometry (STL mesh), the whole pattern, (holes, slits, etc.), and the borders (trim and spring back)

## 3. QUALITY VERIFICATION AND TESTING

Digital image processing is used to verify and test the various products individually at a time as soon as they come from production line. This image processing technique is preceded by various methods and algorithms for scanning of images. Firstly camera captures the image of each and every product that comes on conveyer belt. This captured image is then fed to computer system for further processing. That is this captured image is scanned and actually it is captured in the form of black and white image. This black and white image is converted to binary format; this binary image is stored as an ideal image and compared with other images. Edge detection algorithm is used to compare the edges, shapes and dimensions etc. In this way at the end the objects whose object gets compared is found to be correct object otherwise faulty. Digital Image Processing helps to save time as the process to carry out quality testing becomes fully automated and results in increased productivity. It gives accurate results as industries carry out manufacturing on large scale. It also reduces human efforts.

#### **4. COLOR RECOGNITION**

The captured image is a RGB image which needs to be converted into binary form. A grayscale digital image is an image in which the value of each pixel is a single sample, that is, it carries only intensity information. Images of this sort, also known as black-and-white, are composed exclusively of shades of gray, varying from black at the weakest intensity to white at the strongest[1]. First we need to convert the grayscale image to a binary image. The output image replaces all pixels in the input image with luminance greater than level with the value 1 (white) and replaces all other pixels with the value 0 (black). If the input image is not a grayscale image, convert the input image to grayscale, and then convert this grayscale image to binary by thresholding.

Image conversion:

While (true)

{

Captured frame will get stored into integer pointer frame.

It is shown in "video".

Convert invoked image into binary form using,

```
CvInvoke.cvCvtColor(frame,frame,EmguCV.CvEnum.COLOR_CONVERSION.CV_BGR2RGB);
```

Specify threshold value for conversion of image.

```
CvInvoke.cvShowImage("Video", frame);
```

```
//shows rgb image in video.
```

```
CvInvoke.cvShowImage("Binary", thresh);
```

```
//shows binary image with thresh in Binary. break;
```

```
}
```

```
//On key press application window will disappear.
```

This is the code used for making binary conversion of image in frame. Frame is in the integer pointer . MVSCALAR used for scaling the image to appropriate size.

```
CvInvoke.cvShowImage ("video", frame) //it shows real rgb video captured by camera.
```

```
CvInvoke.cvShowImage ("Binary", thresh) //shows binary conversion of frame in video.
```

#### **5. EDGE DETECTION**

Edge detection is one of the most commonly used operations in image processing and pattern recognition, the reason for this is that edges form the outline of an object. An edge is the boundary between an object and the background, and indicates the boundary between overlapping objects. This means that if the edges in an image can be identified accurately, all of the objects can be located and basic properties such as area, perimeter, and shape can be measured. Since computer vision involves the identification and classification of objects in an image, edge detection is an essential tool. Efficient and accurate edge detection will lead to increase the performance of subsequent image processing techniques, including image segmentation, object-based image coding, and image retrieval. A Color image edge detection algorithm is proposed in this paper. Average maximum Color difference value is used to predict the optimum threshold value for a Color image and thinning technique is applied to extract proper edges. The proposed method is applied over large database of Color images both synthetic and real life images and performance of the algorithm is evident from the results and is comparable with other edge detection algorithms.

#### **6. TEMPLATE MATCHING**

Template matching is a technique in digital image processing for finding small parts of an image which match a template image. It can be used in manufacturing as a part of quality control. The binary image is given as an input for template matching process. This image is compared pixel by pixel with the template image of an ideal product to verify the actual shape and dimension. Matches are estimated based on the intensity values of both image and template. If the templates match accurately then product will be considered as a non-faulty piece.

In template matching, we are selecting an ideal image and a captured image which are need for comparison. We are comparing height and width of image, using loop and checking for maximum matching of pixels in both images. If images are not same increment counts two for unlatching pixels. In this we are using

threshold value as 700 for matching pixels. If count is less than that then it is considered as correct image else incorrect. We can set threshold count as per need.

Template Matching:

Get the height and width of captured image,

Values will be stored in i and j.

Get the maximum matching pixel of both images using `img1_ref = img1.GetPixel (i, j).ToString ();` `img2_ref = img2.GetPixel (i, j).`

`To String ();`

Maintain count for maximum amount of pixel matching,

If (`count2 < 700`)

```
{  
Correct image;
```

```
} else
```

```
{  
Incorrect image;
```

```
}
```

## 7. IMPLEMENTATION OF SYSTEM

The fig.5.1 portrays steps handled in this project. Digital image processing techniques are employed to verify almost all the punched sheet metals that are coming out of product line. This is pursued by taking image of each and every sheet metal as soon as the designs are pressed. The captured image is fed to computer and it is pre-processed (Gonzales and Woods, 2008). Pre-processing is the process of suppressing noise and enhancing the quality of the digital image. Then coloured image is converted to black and white image and is subjected to edge detection

Edge detection (Gonzales and Woods, 2008) is the process of identifying sharp discontinuities in an image. Discontinuities are the abrupt changes in the pixel variations which characterize boundaries of different shapes in an image. By comparing efficiency of different filters, Robert filter (Gonzales and Woods, 2008), is suited well for this application. By applying this, clean and sharp edge of image can be obtained. Since the punched designs create hole in sheet metal, edge detection is necessary for the extraction of edges of all shapes in a single image

After edge detection each and every binary image of object is compared and the images which matches with each other are considered as correct object otherwise it is considered as faulty object

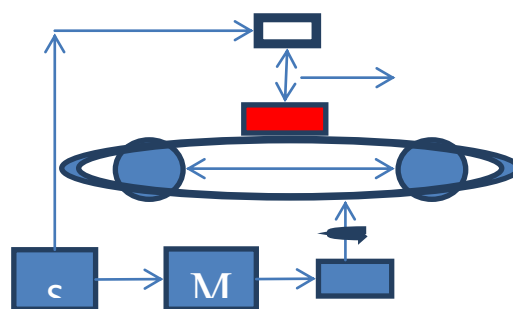


Figure 5: Block Diagram

## 8. RESULTS

After partial implementation of the proposed study we have carried out image conversion that is from RGB to Binary, of our products which we are going to use for this project.

Following are the images taken after the partial implementation. These images show the RGB form of the product along with their Binary form.



**Figure 6:**Actual product used for quality control with their binary image

## 9. CONCLUSION

Digital image processing is majorly used in automated visual inspection of manufactured goods. Detecting anomalies is the major task of this system. As in manual testing few products are tested with some tools and other are tested depending on them accordingly. But in this automated system of ours we can test thousands of products at a time and individually through image scanning and processing. This proposed system can also be extended to any irregular shapes of products in future scope. And we can also extend our system for testing roughness and other properties of materials in future. After testing our system through various conditions we come to a conclusion that proper light conditions are needed to scan images and light condition varies accordingly.

The proposed system can be used to test different images. It produces stable and fairly good results. Consistent acceptable outputs over different kinds of real life images have proved robustness of the presented scheme. Thus, the proposed method of testing may be handy for any computer vision task where extraction of edge maps is required for a large set of images for feature extraction or for any other work. Our next venture will be comparing those algorithms with the proposed one and analyse the performance on the basis of parameters like computing time, execution complexity and accuracy of the system output in presence of noise.

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