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A Quality Control System for White Circle Pull Using Image Analysis

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Abstract: People affected by many diseases at some point in their lives and this affects the productivity of the individual in society and the lives of the entire person and most of these diseases can be cured by medicines. in pharmaceutical industries, every product has its own unique appearance. Especially in tablets, the shape, size and embossed figure should not be varied from tablet to tablet. However, in the actual situation we find number of defect incorporated in tablet inadequate fines to granules ratio inadequate moisture content, improper mixing of the powder, poor formulation and poor machine settings can be some of the reasons for those visual defects such as missing pill, broken pill or fault in cover of tablet pill also production of medicines and pharmaceutical factories producing expanded, so, it is difficult to control the quality of the tablet, there could be damage like break pill bead is bad medicine consumption risk. A novel approach to system for detecting damage to medication bar automatically because it's hard to search manually if the tablet are damaged or not. Analyzing images play a key role in the design of the system and ensure improved image using histogram equalization, circle detection and analysis circle detector to find out if there are missing or broken bead board is the tablet is damaged. The findings outcome from this study have shown that: highlight the methods, based on circle detection for selecting the best region and analysis it the system give performance 97.33% for detecting damage in the tablet.

Key words: No fill detection, breakage, broken tablets, image analysis, circle detection, equalization

INTRODUCTION

A pill also known as medicine is a real estate used to diagnose, treat or prevent disease, also diseases need proper medication. Some, of these pills are used by some people on a regular. In pharmaceutical industries, pills, i.e., tablets and capsules are produced on a wide scale every day. These pills may not be produced carefully i.e., probability some pills that are in damaged form when produced. These damaged pills are not suitable to be used because it causes skin problems infections, etc. It could also happen that the pill is missing in a blister (Ramya *et al*., 2013; Dhiman and Gupta, 2014). So, suitable inspections of these pharmaceuticals are required but mainly it is not possible to inspect manually such a wide scale production. For the inspection of such a wide range production, automated tools required. With the help of these tools, the inspection is finished in a short time period. It can get together the inspection with the production (Deepti, 2015).

Image analysis is a processing of an image into thing different from an image output some information representing an attribute or a decision. Image analysis aims to measure the features of the objects such as their sizes, their orientations and their overlapping also, image analysis used to replace human vision is now widespread in dustrial manufacture (Chen, 2005). Image enhancement is significant to get better the image value, so that, image, processed is enhanced than the original image for a certain application or set of objectives also image enhancement is an important area of image analysis (Wafi *et al*., 2016). The processed image result is more compatible than the original image for a set application. A known technique for contrast enhancement of images is Histogram Equalization (HE). The most part of method is used because of its simplicity and even better performed on the output images (Anju and Rupinder, 2015). Histogram equalization is a very common technique for enhancing the images. Suppose, we have an image which is predominantly dark. Then its histogram would be skewed towards the lower end of the gray scale and all the image detail is compressed into the dark end of the histogram. If it could stretch out the gray levels at the dark end to produce a more uniformly distributed histogram, then the image would become much clearer (Russ, 1992) It is highly used for medical imaging and as pre-processing applications, many of techniques image enhancement processed consists of a set that seek to progress the visual appearance of an image. The main reason of image enhancement is for elucidation the detail that is unknown and enhancement is considered one of the most important images processing technology which

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is basis to get better the visual form of the image incarnation in upcoming automated image processing such as image analysis, detection, segmentation and recognition (Deepti, 2015). Edge detection is a type of image segmentation techniques which determines the presence of an edge or line in an image and outlines them in an appropriate way (Huang *et al*., 2017). The main purpose of edge detection is to simplify the image data in order to minimize the amount of data to be processed (Gonzalez and Woods, 2002). Generally, an edge is defined as the boundary pixels that connect two separate regions with changing image amplitude attributes such as different constant luminance and tristimulus values in an image (Gonzalez and Woods, 2002; Huang *et al*., 2017; Pratt, 1991). In many computer vision applications, edge detection is main and first step in technique such face recognition, image compression and recognition edge based target, etc., also edge detection is the process of locating a sharp discontinuities in an image. These discontinuities are abrupt changes in the density of pixels that describe the boundaries of objects in the scene. They obtained information on the edge of the pixel stringent by checking the brightness of the pixels in the neighborhood of that pixel. If all of the pixels in the neighborhood, we have nearly the same brightness, then perhaps there is the edge at that point. In any way and if some neighbors brighter than the other, then there is probably an advantage at this point (Wang and Bai, 2003; Dinh *et al*., 2009). Edge detection is a sensitive process, particularly for detecting image regions with quick changes. The accuracy of that process is much bigger for the overall performance of high level processing systems. Edges are the boundaries between the area of an image that helps in segmentation and object identification. Edges are the local change in the intensity of an image. The edges of an image are detected by edge find also called edge operators. Some edge detectors work intensely, i.e., recognizes more edges than other (Ramya *et al*., 2013). In this study will use circle detection to detect pill to detect if miss pills or broken, the circle is oe of the most common shapes in our daily life and indeed the universe. Planets, the movement of the planets, natural cycles and natural shapes-there are circles absolutely everywhere. The circle is one of the most complex shapes and indeed the most difficult for man to create, yet nature manages to do it perfectly. The centers of the flowers, eyes and many more things are circular and we see them in our everyday life. Detection of circles is very important for us (Sharma and Sharma, 2012).

Ircle detection and analysis: Circular shape is one of the most commonly seen primitive shapes. Circle detection has been extensively studied in the past decades due to its broad object targeting applications from industrial manufacturing (Zhifeng, 2011; Thomas and Mili, 2007; Lundstrom and Verikas, 2010; Fujiwara *et al*., 1998) scientific research (Peckinpaugh and Holyer, 1994) to biomedical study (Chiang *et al*., 2010; Zhang *et al*., 2011; Kimme *et al*., 1975).

Also, the problem of detecting circular features holds paramount importance for image analysis in industrial applications such as automatic inspection of manufactured products and components, aided vectorization of drawings, target detection, etc. (Fontoura and Roberto, 2000).

Hough transform and its many variation approaches are successfully developed to find circles as well. Hough Transform (HT) is initially introduced in the form as a patent (Hough, 1965) and then further expanded into a general method to detect shapes from binary images (Duda and Hart, 1972; Hart, 2009).

The Circle Hough Transform (CHT) is widely used to detect circle shape on the images which has been proven, robust to noisy images, also, it efficient the technique to find circles in imperfect image inputs. Each edge in image is transformed into 3D Hough space. The first two dimensions in hough space corresponds to the coordinates of circle center. The third dimension is its radius. The voting scheme in Hough space influences the accuracy of circle detection. The voting of right peaks represents the real circles (Deepti, 2015).

Circle Hough transform has been proven to be the best and most popular deterministic method on circular shape detection problems by its unique feature projection and accumulating operations.

Literature review: Many researchers have established many studies and researches in detecting damage in pill system.

Ramya *et al*. (2013) proposed some ideas to identify the damaged tablets after production. This involves a series of steps involving image enhancement, segmentation, thresholding, filtration, pixel calculation, subtraction, elimination of noise and region based statistic to identify the broken tablets. In the case of capsules, a feature extraction technique is proposed to find the defective blister (Ramya *et al*., 2013).

Dhiman and Gupta (2014) suggested an approach for automatic analysis of broken pharmaceutical drugs. This approach is used to check for the defects in tablets and based on canny edge detection and RC-algorithm. It gives the percentage of matching different pharmaceutical drug blister. The image of the blister without any damage is taken as template image which undergoes pre-processing, step same as the input image. Input image compared with template image and display the result of two matching different blisters (Ramya *et al*., 2013).

Huvaida (2017) Proposed two methods for detecting the broken in tablets that is by morphology operation and template matching in a morphological process, the rate of each pixel in the output image is based on a comparison of the corresponding pixel in the input image with its neighbors. By selection the size and shape of the neighborhood, this construct a morphological operation that is sensitive to specific shapes in the input image. The template matching finds the best match of a template within an input image. And computes match metric values by shifting a template over an area of benefit or the full image and then finds the best match location. Template matching is better than morphology operation because template matching no need to preprocessing (Huvaida, 2017).

Ritesh *et al.* (2015) proposed some ideas to identify the damaged tablets after production. A morphological operation is applied to detect the defects. Image segmentation is applied and the input image is filtered to eliminate the noises thereby making the input image that is fitting for further processing. The image is deducted by inscribing rectangles with morphological operation. Then the image is deducted from the original gray image that identifies the broken tablets. Pseudo coloring is applied and the pixel of the broken tablet is computed. The input image undergoes pre-processing. Objects are retrieved based on the region based properties. Detected corners are compared with the stored image. If the detected feature points match in the stored image and the test image capsule is accepted otherwise rejected.

Deepti (2015) suggested an idea to inspect damaged tablets and missing capsules. A novel method is introduced, i.e., detection of damaged and missing pharmaceutical drugs with Centre of Mass (COM) edge detection method. This method introduces the concept of finding edges of tablets by knowing their centre. The missing capsules in the blister also audited by centre of mass edge detection method (Deepti, 2015).

Shilpa and Arun (2016) proposed technology detect edges to extract the properties of the picture and see if the image defects or distortion and use multiple devices to detect edges such as Sobel edge detector, Prewitt edge detector, Canny edge detector, edge detection by the center of mass. The result was Sobel gave a simple detection of edges and he reveals the edges were more computationally efficient than Canny, either Prewitt was sensitive to noise and adapts only with silent images. As for Canny detect edges efficiently, especially, if high noise and can reveal even the weak edges and the center of mass gave a quick calculations and less time to detect edges (Shilpa and Arun, 2016).

Karmugilan *et al.* (2016) propose to 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. 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 (Karmugilan *et al*., 2016).

Pillai *et al.* (2017) proposed the algorithm for counting the drug blisters packed in boxes using image processing. The series of process involves image enhancement, thresholding, segmentation, filtering, subtraction and region based statistic to inspect the boxes of drug blisters in conveyer line. The algorithm used for image processing is efficiently established and suitably adjustable for various cases. The method chosen in the process to implement the image processing is morphology operation (Pillai *et al*., 2017).

Huvaida (2017) proposed different methods in digital image processing technique to find the defects in tablets. Four methods are used in order to detect the defect in tablet strip: morphology opening, template matching, mathematical manipulation, euler's number. MO detects the broken tablet in tablet strip, TM, MM detects broken as well as a missing tablet in tablet strip and EF detects hole in tablet strip (Huvaida, 2017).

MATERIALS AND METHODS

In this study, the image databases of pills that have been adopted in this study are obtained by taking image by camera Nicon 90. The database contains about 300 color images for tablet of pill, images are captured in the JPEG format, 100 images for fill pill tablet, 100 images for empty pill tablet and 100 images for broken pill with maximum resolution size 481×160 pixels. MATLAB Software was used to perform image processing and image analysis. An algorithm for finding broke or missing tablet.

Read image; "Image": Image is read using imread.

Convert to grayscale: 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.

The industrial and other noises are filtered from the gray scale image which makes the image fit for further processing.

Enhance contrast: Enhance contrast by applying histogram equalization to the grayscale image, enhancement is the change of an image to check impact

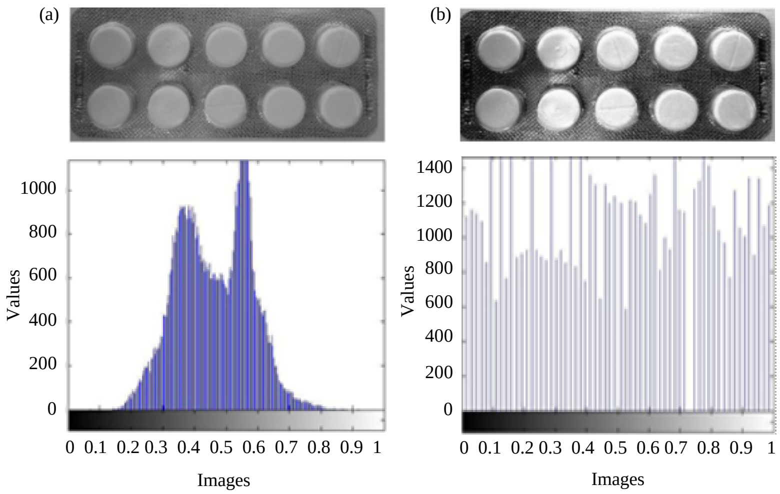


Fig. 1: Histogram equalizatio: a) Histogram original image and b) Histogram after histogram equalization on the image

on the viewer. Generally, enhancement alters the original digital values to get out set features of an image and highlight the clear characteristics of an image. Figure 1 shows the change of image histogram after applying histogram equalization notice the contrast is better.

Define minimum and maximum radius search values: We assume that the pill is circular. Thus, we define the minimum and the maximum possible values of the radius of circles, the pill passes when the following conditions satisfied:

$$R_{min} \leq R \leq R_{max}$$

Where:

R_{max} = Maximum radius of better pill
R_{min} = Minimum radius of better pill

Apply circular detector: A circle detection filter searched for all circles in the image having a radius between minimum and maximum defined values one of the most common methods for circle detection is called Circular Hough Transform (CHT).

CHT has an accumulator and each edge point votes for all circle parameters (origin and radius) which passes through that edge point. After voting, the accumulator will have peaks where a lot of edges voted for a specific circle parameter. These peaks correspond to the circles in the image.

A circle detection filter searched for all circles in the image having a radius between minimum and maximum defined values, used imfindcircles to finds circular objects using a two-stage method with an internal detection threshold that determines its sensitivity. Radius range which is a range of radii to be detected by the algorithm.

Sensitivity factor, a scalar between 0 and 1 when sensitivity is increased, more circular objects with weak and partially obscured circles will be detected. it is possible that at the default sensitivity level all the circles are lower than the internal threshold which is why we don't see any detections. By default, "Sensitivity" which is a number between [0-1] is set to 0.85. So, let's try increase 'Sensitivity' to say 0.92. Consider bright boundaries for circle detection and consider dark boundaries for circle detection. The algorithm 1 for detect and calculate number of circular boundaries in image.

Algorithm 1; Detect and calculate number of circular boundaries in an image:

Input: Image
Circle sensitivity
minimum radius search
maximum radius search
Output: Centers of detected circles
Radius of detected circles

1. Detect two centers and two radii by apply imfindcircles
2. Collect the detected centers and radii for two circles pill circle and cover circle
3. Remove duplicate circles to occure at circle right(pill circle) and remove false circle(cover plastic circle)
   3.1 if (size(Radii, 2)>0):
   Get duplicate radii
   3.2 if (abs(Radii(i)-Radii(j))/size(Image, 2)<0.02)
   3.3 Radii(j) = nan(real or complex number)
   3.4 Get duplicate centers:
   Calculate the distance between the two centers

$$D = \sqrt{(x2-x1)^2+(y2-y1)^2}$$

   3.5 if (d/size(Image, 2)<0.1)
   3.6 (x1, y1) is nan (real or complex number)
4. Remove center and radii whose carry nan value this represents duplicate circles
5. Collect the final calculated circles

Analyze detected circles: The analysis circle work at this step; From the detected circles, we create a binary image where the circles are displayed in white and the background is displayed in black. The created image is saved in a variable named "PillsMap". We label each separated component in "PillsMap". Thus, every circle in the image that is not connected to another circle is given a unique label. Background is labeled as "0" and the separate circles will be labeled with values starting "1". Draw circle that carries the right radius and center the algorithm 2; Draw circle onto an image given its center and radius. Calculates maximum number of labels. This will refer to the number of detected circles. For every detected circle we will calculate its mean value of intensity. For any detected circle, if the mean intensity is found to be <0.75* maximum value of mean intensity, then it is considered as a broken pill algorithm 3: analyze detected pills. Print number of detected circles; Print number of broken circles, Fig. 2 shows the architecture of proposed system those explain above.

Algorithm 2; Raw circle onto an image given its center and radius:

Input: Image
Image center
Image radius
Output: Pills map
1. Transform RGB image into double precision
2. Make very pixel in this image black color by setting the image to 0
3. Define the center of the circle and set the pixel corresponding to the coordinates of the center to white color: 255
4. Measures the distance between every black pixel and the nearest white pixel, for each pixel in binary image, the distance transform assigns a number that is the distance between that pixel and the nearest nonzero pixel of binary image
5. Set all black pixels whose distance to white center pixel is smaller that image radius to white 1. Thus, we obtain a white disk

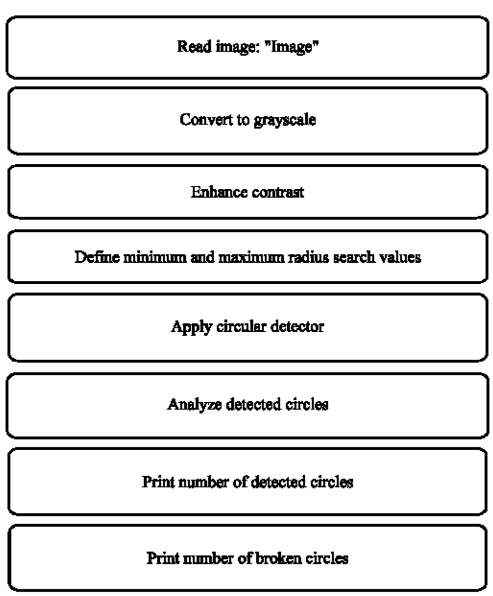


Fig. 2: Architecture of proposed system

Algorithm 3; Analyze detected pills:

Input: Image
Centers of detected circles
Radius of detected circles
Output: Max label
Percentage

1. Get pills
2. Identify ang give label to each pill in the image. We will label each connected component of the objects in the image, Use 4 as connectivity parameter
3. Get the number of labels = number of detected circles
4. Create "PillsMean" array. It will contain mean intensity of each detected pill
5. for i=1 to MaxLabel
   5.1 Get pills label to compare: (pills label ? i) then = 0
6. Compute pill mean for pills label to used to compare pills mean with max pills mean to ensure if the pill broken or not

RESULTS AND DISCUSSION

The proposed method is implemented with different strips of pills blisters. Pill localization is based on a filter that searches for circular object, minimum and maximum radius are defined and optimized for database, image is transformed to grayscale and its contrast is enhanced, detected pill are then labeled, the number of labels identifies the number of pills. The circular detector method calculates the centers and radii of each pill and. It draws circles on the pill whose radius match with radius pill stander and does not draw circles on the image where the pill not matching. Figure 3 shows a tablet strip with all pills existent. On this enhanced image circle are detected with a radius match with radius suppose, also, it draws circles on the image where pills existent also by computes the number of pill equal 10 and check the mean intensity is found within range 0.75* maximum value of mean intensity, then it is considered as not broken pill and consider the tablet is safety.

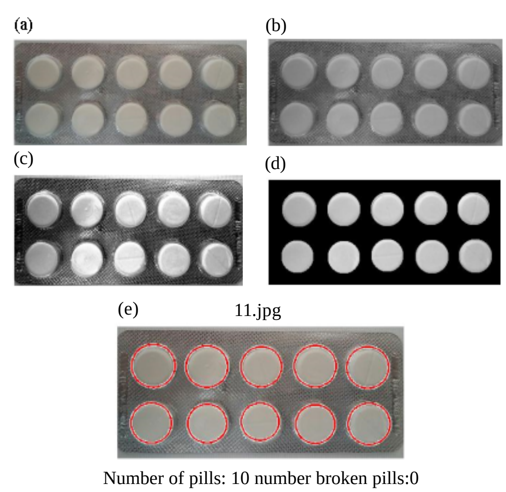
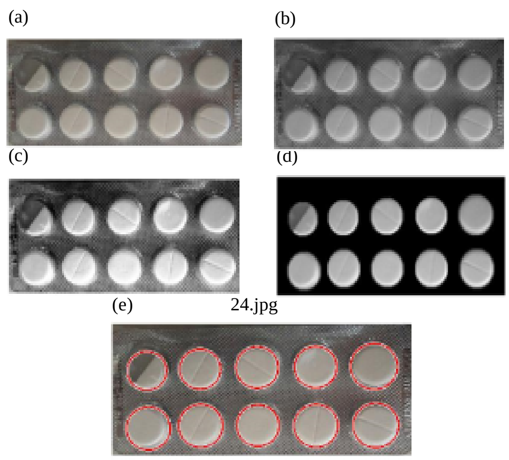


Fig. 3: a) Original image; b) Image after convert to grayscale image; c) Image after histogram equalization; d) Image with pills map overlay and e) Eventual image of the fill tablet

Table 1: State of image tablet

Image. No	Mean (pill 1)	Mean (pill 2)	Mean (pill 3)	Mean (pill 4)	Mean (pill 5)	Mean (pill 6)	Mean (pill 7)	Mean (pill 8)	Mean (pill 9)	Mean (pill 10)	Max mean (pill *75%)	No. pi	State
1	166.97248700	145.574446000	160.961925000	166.147463000	162.605689000	165.251303000	160.85340900	160.132603000	154.418129000	153.6323850	125.229365200	10	Safety
2	139.73086500	146.288402000	167.393873000	160.616630000	163.887300000	167.385016000	161.44822300	160.324622200	156.785626700	155.2258205	125.545404700	10	Safety
3	145.47080440	140.238163040	159.230034300	167.300218810	164.178848509	167.429587420	161.69316010	162.072647702	155.301872370	152.4868169	125.572190500	10	Safety
4	142.92854413	148.925164110	161.719474830	169.303719900	165.264770240	167.940256040	158.68972105	163.124132290	155.757737800	154.0832993	126.977789000	10	Safety
5	138.20553887	146.571991240	157.980512030	166.073499380	163.189529996	167.862968230	158.70080244	161.325563620	155.225066800	155.8275711	125.897226173	10	Safety
6	159.63660680	168.967137940	164.347098610	172.440726230	169.492037562	177.918742340	159.22855108	171.766301969	141.653419940	-	133.439056750	9	Damage
7	147.52652189	133.616736720	161.100391590	166.348490630	160.506585973	155.020008160	161.93236530	150.277256022	152.360982556	-	124.473633930	9	Damage
8	147.80384478	132.077963680	160.475258090	165.964845240	164.007758268	153.453190670	161.68742835	150.332788893	152.355642577	-	124.473633930	9	Damage
9	147.20954287	132.696333210	161.715322888	164.197936568	163.584728460	155.692119232	161.93771494	150.704369130	151.982556069	-	123.148452420	9	Damage
10	147.54004983	129.898565231	160.094695621	166.329384791	163.422239200	154.578195180	161.83568972	149.799918334	152.174083303	-	124.747038590	9	Damage
11	109.61830200	140.764998000	149.841039000	142.264106000	142.619690000	156.992990000	166.56285000	160.563676000	158.512948000	133.26022100	124.922143600	10	Damage
12	108.83309600	140.766144400	140.498030000	149.003821000	140.970190000	155.864020000	165.14209000	160.628008000	163.691249000	136.31033000	123.856574100	10	Damage
13	156.06152080	119.433281800	165.548387000	150.668708900	158.602188100	169.844638900	158.47733760	167.818293800	139.079031600	160.00961190	125.863720300	10	Damage
14	146.01684870	116.149922720	147.978555790	160.469171000	153.228884020	162.785995600	152.25928950	155.594936700	140.688035900	146.13183034	116.696202520	10	Damage
15	112.32029060	151.994748350	143.798956850	157.255614500	150.250765860	162.679649890	151.57452021	161.161050320	130.014347680	153.94077187	122.009737400	10	Damage



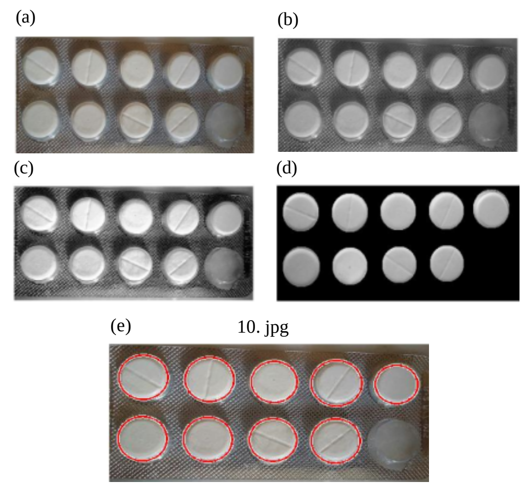
Number of pills: 10 number broken pills: 1

Fig. 4: a) Original image; b) Image after convert to grayscale image; c) Image after histogram equalization; d) Image with pills map overlay and e) Eventual image of the broken tablet

Figure 4 shows the image of the tablet strip in which one pill is broken detect by match the radius of pill with radius sported and the mean intensity is found to be <0.75* maximum value of mean intensity therefore, consider the pill broken and the tablet is damage.

Figure 5 shows the image of the tablet strip in which one tablet is missing and It draws the circles on the image where all pills present except the absent pill position, the absent pill conclusion it from the number of pills in tablet that 9 not 10, therefore, consider the tablet is damaged.

Table 1 shows the state of pill of tablet if broken or not by compare the mean pill with max pill means*75% if lease it consider the pill broken and the tablet damage also if numbers of pill lease 10 consider the tablet damage.



Number of pills: 9 number broken pills: 0

Fig. 5: a) Original image; b) Image after convert to grayscale image; c) Image after histogram equalization; d) Image with pills map overlay and e) Eventual image of the missing tablet.

CONCLUSION

Pharmaceutical pill is very important of human life, these are used to treat disease. The fault effects present in a pharmaceutical pill can be unsafe for consumers as well as produce opinion. So, it is necessary to detect and classify them. So, the inspection of these pills should be finished, the manufacturing of tablets requires a quality nspection system that not only keeps up with the high production throughput but also performs accurately and reliably. We used image-processing tools to detect these pill defects. This helps with the automation of detection of irregular. Dealing with side of defects related to shape, size of the pharmaceutical drugs. The proposed method circle detection and analysis it easily and efficiently detects broken and missing tablets, the system can be implemented in part of complex automated manufacturing and testing system with a highly cost effective solution that fit quality undertaking much desired by the patron in this competitive market.

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