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Anomaly detection in pharmaceutical pills using image processing

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ABSTRACT

There are various kinds of Technologies available in the market for categorizing and packaging in the production line. Our project here discusses various image processing techniques and their shortcomings in the process. Our aim is to categorize the defective tablets based on their color shape missing tablets, color changes due to oxidation. The images of the tablet strip is captured using camera. The features are extracted for a defect-less tablet strip. Input image is compared with the reference image present in the database, the amount of features that can be compared with the pre- loaded reference image is compared for a threshold value and is discarded if found to be less by separating them and rest are allowed to pass for packaging.

Keywords: *Template Matching, Feature Descriptors, Feature Matching*

1. INTRODUCTION

The quantity of pharmaceutical drugs produced by any company is enormous and they play an important role in the human life. Therefore the quality assurance of the medical drugs plays an important role. There may be defects such as missing pills, damaged pills, different pills, defect in packaging, at times pills may be oxidized due to exposure to external environment; consumption of such pills may not only have detrimental effects on the lives of the humans but also analogously harm the reputation and the profit margin of the company.

This invoked the need of stringent and standardized procedures for quality inspection. In some companies, manual inspection may be employed which is tedious and error prone and there might be chances of overlooking and several times it depends on the mood of the employee. Various processes such as binary matching, the process of and'ing the image, template matching and feature detection and matching are discussed in this project along with their shortcomings inclusive of their implementation examples for reference.

Therefore, implementation of image processing based on machine vision can act as a suitable replacement for the existing system. This system involves capturing and storage of an error free template of the tablet strip in the database as a reference image and template. The images of the tablet sheets from the conveyor belt are captured at regular intervals and the captured image is used for feature extraction & comparison with the reference template & then alert is generated and the defective tablet sheets are separated from the conveyor belt.

Development of a low cost, highly effective and high accuracy rate method to ensure quality maintenance is of prime importance. Image processing provides a promising and effective way of error detection when compared to traditional human implementation techniques which are both time consuming and error prone. The use of image processing also provides provision for remote monitoring and actuation. It can also lead to automation and reduction in the workforce along with the provision of being scalable, the new products or the new variants can be added to the sample reference images which can later be used to compare the incoming images using the process of image detection and feature extraction and comparison.

2. LITERATURE SURVEY

- X-ray inspection equipment is widely used to detect missing materials and defective goods in opaque containers. Its application has been expanded to the pharmaceutical industry to detect the presence of drug tablets in Aluminum foil press-through packaging. However, the effect of X-rays on the pharmaceutical quality of drug tablets is not well known [1]. Here aim was to characterize the parameters for identifying defective tablets from the manufacturing line using image processing techniques. [1] Here capsules are differentiated based on colors.
- X-ray imaging is one of the oldest forms of imaging techniques that has been used for imaging in medical, astronomical, industrial and various other areas. The basic principle in x-ray imaging lies in the vacuum tube attached with

the cathode and the anode. The cathode is heated which causes the release of free electrons and these electrons moving at high speeds tend to move towards the cathode. Any substance which can obstruct this flow of electrons can form a pattern and result in the formation of an image on the cathode film. This film can be replaced by a digital screen or having it presented on films for further analysis. In this particular implementation, we focus on real time scenario as analysis and processing of an image after capturing it is a time consuming and complex scenario. It fails in meeting the external time constraints.

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3. METHODOLOGY

- Morphology Operation technique(MO)
- Template Matching(TM)
- Mathematical manipulation(MM)
- Euler's Method(EM)

3.1 Morphological Operation

Morphological operations are affecting the form, structure or shape of an object. Applied on binary images. They are used in pre or post processing or for getting a representation or description of the shape of objects/regions.

Morphology has following types:

- Dilation
- Erosion
- Opening
- Closing

3.2 Templete Matching

This is a technique used in classifying objects. Template matching techniques compare portions of images against one another.

Sample image is used to recognize similar objects in source image. Templates are used to identify printed characters, numbers, and other small, simple objects.

3.3 Mathematical Manupulation

MM is used to find the defect in tablets.MM calculates the mathematical values. No. of tablets are calculated which helps to determine the correct figure in a tablet strip. They can simply discard the strip containing less or greater no. of tablets.

3.4 Euler's Method

Tablet which is having any hole is detected by using Euler's number of binary image. Euler's number is used to detect the holes in an object; we used this function in tablets having holes. Euler's number is the number of objects minus the number of holes. Eu=N-H, Where Eu, N and H are Euler's number, number of objects, number of holes respectively

4. PROPOSED DESIGN

4.1 Method Implemented

Human has the ability to effortlessly recognize all objects in real world; but when it comes to machine it is unable to recognize objects by itself. Recognition algorithms are implemented on machines [4]. There are several challenges in identification of an object such as there could be change in scale, object could be bigger or smaller as that in template, or there would be cluttered scene like other objects hiding the path of the object that we are trying to detect. To solve this problem we cannot use standard image processing approach like template matching. We need to apply some algorithm that is more robust and sophisticated. The approach we are using is Feature Detection, Extraction and Matching [4] should be implemented for object detection and recognition.

Computer Vision is one of the most advanced techniques that can be implemented as it can used to detect the required template using the idea of object feature detection. Object detection and classification is a core part of Computer Vision (CV). In autonomous systems, image detection is one of the features that can make autonomous systems smart. Generally, a system that can identify any object through CV can be considered as a smart system [2]. Since images in general made of pixel values, the features such as point, line and edge can be detected by the pixel values. They are determined by monitoring the sequence of the pixels involved in the formation of the image.

The point can be determined by a sudden rise or fall in the pixel value on both the sides. In the same way, a line can be determined by a sequence having same or similar set of values along the set of pixel values. On the same grounds, an edge is determined by a sudden abrupt increase in the pixel value.

It uses the process of feature detection and extraction for recognizing an image. Features are nothing but the edges, corners and center points of the various segments of the image. These features are extracted and stored in an array of points. In the first scenario, the template image is fed to the system and features are extracted which are then stored in an array of points containing the pixel points in the image.

Whenever the image from which the object is to be recognized is passed, the same procedure of feature extraction is considered and the array of the feature points of the pixels are stored. An effective way of calculating the percentage of features matched brings about a way to match and detect the object of interest from the surroundings. This feature is more reliable than other methods as it reduces the risk of image resizing and to increase its implementation efficiency, it can even be used for the purpose of live monitoring using a camera module and interfacing it with a controller for localization.

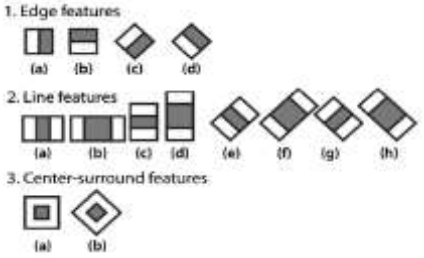


Fig 1: Figure showing various features that can be detected from an image.

4.2 Main Component of Feature Detection and Matching

- **Detection**: Identify the Interest Point
- **Description**: The local appearance around each feature point is described in some way that is (ideally) invariant under changes in illumination, translation, scale, and in-plane rotation. We typically end up with a descriptor vector for each feature point.
- **Matching**: Descriptors are compared across the images, to identify similar features. For two images we may get a set of pairs (*Xi, Yi*) ↔ (*Xi`, Yi`*), where (*Xi, Yi*) is a feature in one image and (*Xi`, Yi`*) its matching feature in the other image.

4.3 Interest Point

Interest point or Feature Point is the point which is expressive in texture. Interest point is the point at which the direction of the boundary of the object changes abruptly or intersection point between two or more edge segments. The highlighted pints on the below image shows the detected key feature points in the outdoor building.

Properties of Interest Point

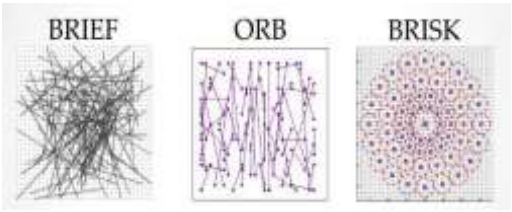
- It has a well-defined *position* in image space or well localized.
- It is *stable* under local and global perturbations in the image domain as illumination/brightness variations, such that the interest points can be reliably computed with a high degree of *repeatability*.
- Should provide efficient detection.

Possible Approaches

- Based on the brightness of an image (Usually by image derivative).
- Based on Boundary extraction (Usually by Edge detection and Curvature analysis).

4.4 Feature Descriptor

A feature descriptor is an algorithm which takes an image and outputs feature descriptors/feature vectors. Feature descriptors encode interesting information into a series of numbers and act as a sort of numerical "fingerprint" that can be used to differentiate one feature from another.



Ideally, this information would be invariant under image transformation, so we can find the feature again even if the image is transformed in some way. After detecting interest point we go on to compute a descriptor for every one of them. Descriptors can be categorized into two classes:

- **Local Descriptor:** It is a compact representation of a point's local neighborhood. Local descriptors try to resemble shape and appearance only in a local neighborhood around a point and thus are very suitable for representing it in terms of matching.
- **Global Descriptor**: A global descriptor describes the whole image. They are generally not very robust as a change in part of the image may cause it to fail as it will affect the resulting descriptor.

5. ALGORITHMS

- Brute-Force Matcher
- FLANN(Fast Library for Approximate Nearest Neighbors) Matcher

5.1 Algorithm for Feature Detection & Matching

- Find a set of distinctive key points
- Define a region around each key point
- Extract and normalize the region content
- Compute a local descriptor from the normalized region
- Match local descriptors

5.2 Application of Feature Detection &Matching

- Automate object tracking
- Point matching for computing disparity
- Stereo calibration (Estimation of the fundamental matrix)
- Motion-based segmentation

5.3 Recognition

- 3D object reconstruction
- Robot navigation
- Image retrieval and indexing

6. STEPS INVOLVED

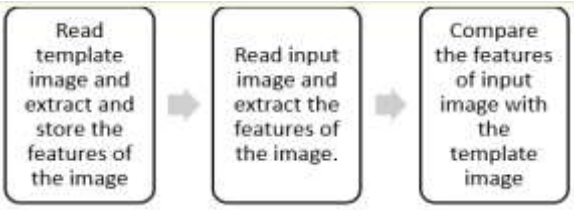
6.1 Feature Extraction

First step is to read all images and then convert them to 'Gray-Scale' as Computer Vision's most algorithms especially "feature detection algorithms" work more effectively on gray scale images. To detect features we use a command '*detectSURFFeatures*' that finds all possible SURF points in the images [4]. The top 25 features are detected and later visualized in the program. The same process is carried out with the input image from the live feed.

6.2 Feature Matching

The Extracted features from both the images are then matched. In the live feed image, the object or the region of interest is separated from the background and the extracted features from the template image are matched with the live feed image.

7. FLOW CHART



8. RESULTS

Fig 1- representing non defective strip of tablets

As it can be seen in the above image (fig 1) the features of both the images are matched by using the computer vision. The number of features matching are shown.

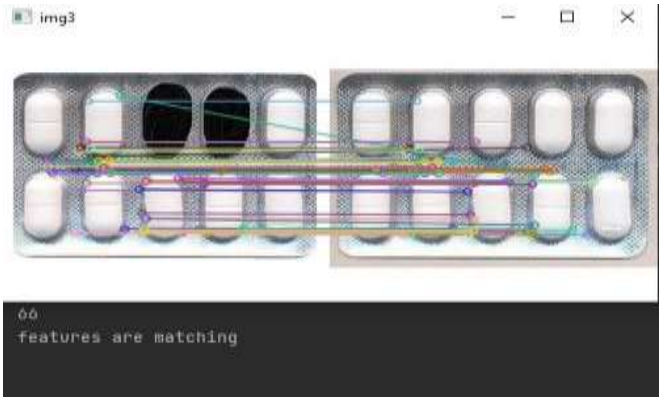


Fig 2- representing defective strip of tablets

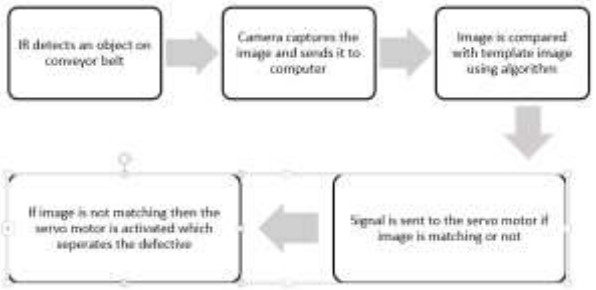
In the above image (fig 2) the features matching are less this is because that the comparison image is defective which reduces the number of features matching with the template image.

9. HARDWARE IMPLEMENTED

Primarily the manufactured products arrive on a conveyor belt to the quality verification stage.

Once it arrives at the verification stage it passes under the camera sensor (connected to the raspberry pi board), the camera sensor records the product and the recorded data is fed to the python program in real time. The information in the recorded data is compared with the stored database. Comparison is done frame by frame and the criteria for comparison is number of features matching between the real time video frames and the stored database.

If the number of features matching is below the desired threshold then a signal is sent to the servo motor through the raspberry pi, when signal is received the servo motor actuates and separates the defective product from the main conveyor belt line. The servo motor can also be programmed to separate the products based on the number of features matching(Ex: for a product that has just 10 percent of features matching it can be completely discarded and the product with 50 percent of features matching can be separated on a different place so that it can be sent for further inspection.



10. CONCLUSION

As discussed above, the 'and' process and the template matching process are not very accurate as they depend mostly upon the sequence of occurrence of the bits or pixels. Hence, the feature matching technique is of prime importance which circumnavigates the drawbacks of the above two processes. It offers more agility robustness and can be used for wider range of objects of interest. It is more application specific and the process can be remotely monitored with lesser complexities. This process is also helpful in implementing multiple scanning of pills and helps in increasing its implementation range.

For the further development of this project following improvements can be made:

- When a tablet has been rejected the reason for the rejection such as shape defect, color defect etc can be highlighted on the screen when it is due for further inspection.
- Since we are doing only top angle inspection using a single camera this can be upgraded by inspecting even the labels of the tablet strip by inspecting the bottom side of the strip.

11. REFERENCES

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