Indian Institute of Information Technology, Kalyani

Nadia – 741235

Project Title:

Detection of Integrated Circuits (ICs) on a Printed Circuit Board (PCB) using Open Computer Vision (OpenCV).

Team:

1. Ankit Tiwari
2. Nikhil Kumar Jha

Introduction:

Nowadays, PCB manufacturing is getting more and more important for the electronics industry such as mobile phones, tablets, washing machines and prototyping boards. Hence, it is very important to have machine vision inspection of the PCB to improve the quality of the PCBs. As we know, in manufacturing industry, there are errors such as defects, misalignment and orientation error. Hence we need automated inspection to analysed for the errors. Of course, automated inspection system is better than human inspection in which subjectivity, fatigue, slowness and high cost is involved. The technology is moving very fast and hence a fast and efficient inspection system is required to make sure 100% quality PCBs are produced.

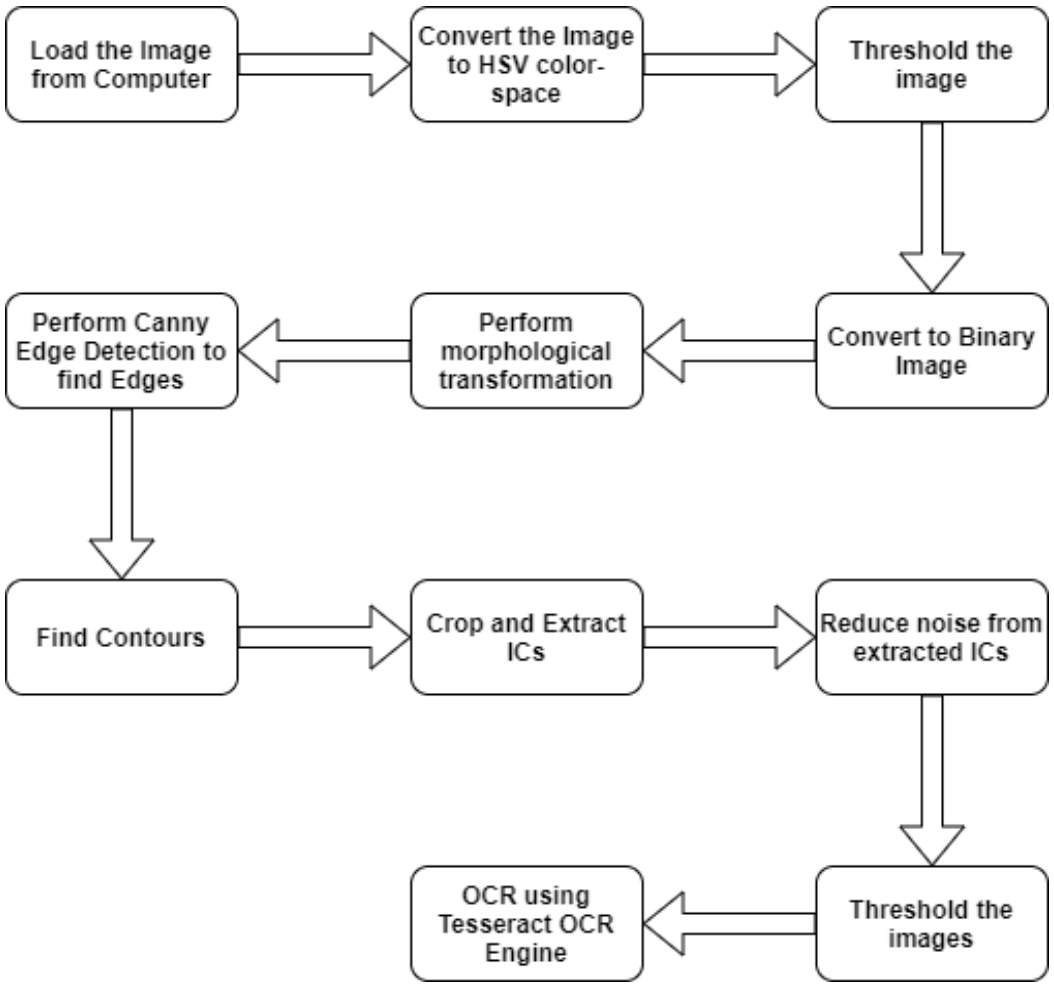
Objective:

A Printed Circuit Board (PCB) is a circuit board consists of electronics components such as Integrated Circuits, resistors, capacitors etc. mounted on the surface.

Our project aims to develop an automated system that can locate and identify Integrated Circuits from a Printed Circuit Board. We apply the computer vision and image processing techniques to locate and isolate Integrated Circuits from the PCB and then apply the Optical Character Recognition (OCR) to identify the IC. Our focus is to build a system that can identify ICs from PCB images of different resolution taken in various lighting conditions.

Methodology:

I. Flow Chart



II. ALGORITHM DESCRIPTION

There are two main parts of our algorithm: Localizing each IC on the PCB, extracting and saving it. Then we use Tesseract OCR engine to read the labels of each detected IC.

A. PREPROCESSING

Before we apply any algorithms to our image we have to process it to obtain proper image. To save processing time we will resize the image maintaining the aspect ratio. After that remove noise from the image using Gaussian Blur.

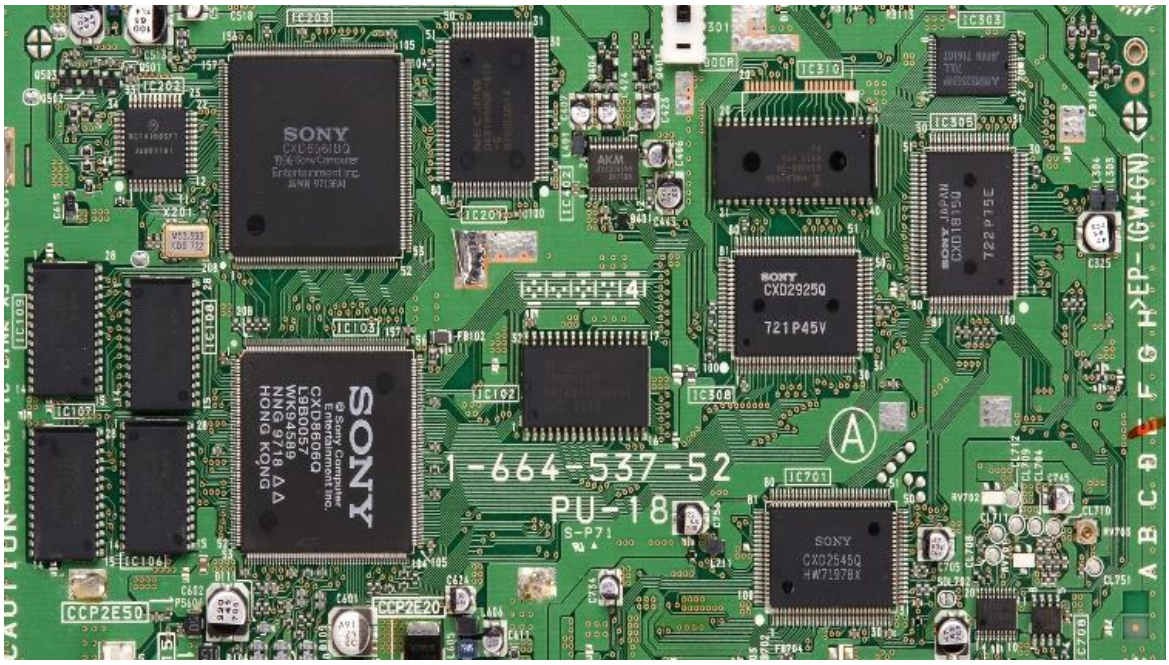


Fig. 1. An example PCB image

B. SEGMENTATION

First we convert the RGB image to HSV (Hue, Saturation, Value) colour space. The H channel creates a mask for all the integrated circuits on the board. We then threshold the image to get a binary image However, it is not perfect.

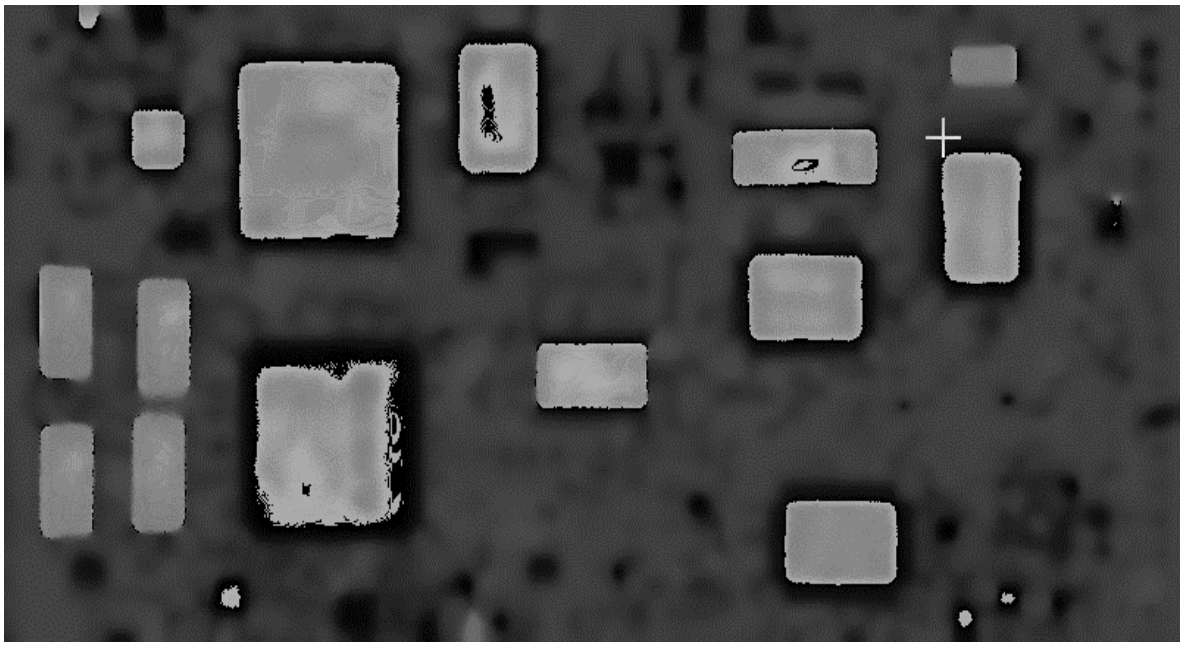


Fig. 2 H Channel

Fig. 3 Threshold image of H channel

C. MORPHOLOGICAL OPERATIONS

As we can see the thresholding is not perfect so we performed morphological operations (first dilate and then erode the dilated image) on the threshold image.

Fig. 4. Threshold image after morphological operations

D. EXTRACTION

To extract the integrated circuits from PCB we first have to find edges of the ICs. We used Canny Edge Detection algorithm to find edges. After that we found contours for those edges. These contours also included small areas on PCB that were not IC so, we had to exclude them. We excluded every contour which had less area than the mean area of contours. We found bounding rectangle for remaining contours and cropped that from the original image. This gave us all the integrated circuits on the PCB.

Fig. 5. Example of extracted IC

E. OPTICAL CHARACTER RECOGNITION (OCR)

Once the ICs were saved on the disk, we identified the ICs by reading their labels using OCR. For OCR, we used Tesseract OCR engine. If we pass the ICs directly to Tesseract OCR engine it will fail to read the labels so we pre-processed the image by smoothing and thresholding it. We used Otsu's algorithm to threshold the image. We also eroded the image to make edges clear.

Fig. 6. IC after thresholding and eroding

We then passed this image to Tesseract OCR engine and got the labels in text format.

For figure 6 we got the following output:

SONY
CXDZ9250

721P45V

Here, we can see that output of OCR is not perfect but the accuracy level is satisfactory.

LIMITATIONS:

- It can only detect and identify ICs in well-lit images.
- Smaller ICs are not detected.
- The accuracy of OCR is very low.

Fig.7. Example of IC which was not perfectly identified due to bad lighting

For the IC in figure 7 we got no output from the OCR.

FURTHER ENHANCEMENT:

Since, we were able to identify ICs from images of PCB. So, we tried to implement the same in real time using a camera. We parsed the video in real time and applied the same algorithm (applied to images) to each frame of the video. It worked as expected with little less accuracy as compared to still images.

CONCLUSION

Although, we are getting good accuracy for this particular image but for images taken in dim lighting or images that contain very small ICs or other circuit elements the result is not good. Our algorithm works when we apply it on a high resolution well lit printed circuit board image.

FUTURE SCOPE

This project can be further improved by upgrading detection algorithm to suit a variety of lighting conditions. Also, a better OCR engine/Machine Learning can be applied for better character recognition of ICs.

BIBLIOGRAPHY:

- Gonzalez R. C., Woods R. E. - Digital Image Processing
- Practical Python and OpenCV
- PyImageSearch