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MEASUREMENT OF RADIUS OF CIRCULAR MACHINE PARTS USING MATLAB

K. Shiva Prasad[1], B. Naveen Kumar[2], G. Shiva Prasad[3], Uttej Immadi[4], J. R. Pradyumna[5]
[1]*Assistant professor,ECE Dept,Nalla Malla Reddy Engineering College, Hyderabd,India,500088*
[2,3,4,5]*Student of ECE at Nalla Malla Reddy Engineering College,Hyderabad,India,500088*
[1]shiva13b71d5516@gmail.com,[2]naveenbonthala789@gmail.com,[3]shiva82474@gmail.com,[4]immadiuttej@gmail.com,[5]pradyumna.jr@gmail.com.

Abstract— Extracting the dimensions of objects from an image or frame can be a vital capability for large number of scientific and engineering applications where computer vision is required instead of making physical measurements. This is a basic algorithm for isolating a desired object and measuring its radius. With the help of this project we will be able to write a MATLAB script file to import an image, segment the image in order to isolate the desired object from its background and then use the MATLAB functions that come with the Image Processing Toolbox to determine the object's radius. Through this project, we've formulated a way to measure the radius of a circular object in an image very easily and accurately as well. We use the image processing toolbox and also a few of our own functions to achieve an accurate measurement. Digital Image Processing deals with processing of digital image by means of a digital system. To put it in a simple it can also be called as usage of computer algorithms to get information from the image.

Keywords—computer vision, MATLAB script, segmentation of image, image processing toolbox,)

I. INTRODUCTION

Measuring the radius of an object from a picture is an important parameter in today's age where most of the purchases are made online and having the item delivered to you, not be the exact measurements that the seller claims it to be is the most frustrating thing for the buyer. Through this project, we've formulated a way to create measure radius of a circular object in an image very easily and accurately as well. We use the image processing toolbox and also a few of our own functions to achieve an accurate measurement. Digital Image Processing means processing digital image by means of a digital computer. We can also say that it is a use of computer algorithms, in order to get enhanced image either to extract some useful information. Image processing mainly include the following steps:

1. Importing the image.
2. Analyzing and manipulating the image.
3. Output in which results can be an altered image or a report which is based on analyzing that image.

A. Phases in Image processing

a) Acquisition: Image acquisition step invloves with getting the digital form of the image. The subjects may include motors, nuts, bolts, cylindrical containers, rotors, pipes, cross sections of conductors and many more whose diameter is to be estimated. The main work involves:

i. Scaling:
The captured image may lot of other artifacts along with the required part. Here we need to crop and rescale the image to a considerable resolution (from 400x400 to 2000x2000)

ii. Color conversion:
The calculation of the diameter requires two end points of the circle and difference between in pixels. So to reduce complexity and time for calculation we need convert the all color image to a binary image. RGB to Gray or vice-versa.

b) Image Enhacement: It amongst the simplest and most appealing in areas of Image Processing, it is also used to extract some hidden details from an image and its subjective.

c) Image Restoration: It deals with the processing of an corrupt, noisy image into a clean and clear one with the help of mathematical and probabilistic distribution models. It does not specifically deals with subject in the image but is more of an objetive process .

d) Color Image Processing: It deals with pseudocolor and full color image processing color models are applicable to digital image processing. Image Enhancement and Image Restoration play the key roles in Color Image Processing.

e) Wavelets and Multi-Resolution Processing : It is foundation of representing images in various degrees.

f) Image compression: It involves in developing some functions to perform this operation. It mainly deals with image size or resolution.

g) Morphological Processing: It deals with tools for extracting image components that are useful in the representation & description of shape.

h) Segmentation Procedure: It includes partitioning an image into its constituent parts or objects. The segmentation applicable here is to isolate the object from its environment.

i) Representation&Description: It follows output of segmentation stage, choosing a representation is only the part of solution for transforming raw data into processed data.

j) Object Detection and Recognition: It is a process that assigns a label to an object based on its descriptor.

II. Motivation

The motivation for this project is to establish an automated software tool using MATLAB to measure the parameters of the objects (machine parts, devices, motors, sensors and etc.) through the image of the objects. The requirement of digital solution for measurements at micro scale where human eye cannot reach and in industrial applications where more automated solutions and less human invention are needed to enhance the production processes are can be successfully solved by this software tool.

It can be used in a lot of medical applications to automate the processing of monitoring the patient's vitals. The project can differentiate between the changes in the heart rate and can be easily adjusted to alert the doctor in case of an emergency.

In military applications, identification of the enemy weapon properties through a mere image is of the highest importance and this project can be easily embedded into the system with a few tweaks. In agriculture, to identify the conditions of the crops and to better irrigate them.

The flexibility of MATLAB to reduce complex calculations with the use of matrices is fully utilized in building it. This project is going to be the one of the step towards building a completely automated environment in the industries for making parameter calculations and design process by developing extra additions like measuring areas and volumes of ambiguous planes and shapes.

III. Challenge

The challenge is to create a MATLAB based image processing application which can isolate the required circular machine part from the rest of the image with the help of various segmentation, thresholding and noise removal techniques and then calculate its diameter.

IV. Methodology

A. Import Image

Open the MATLAB software application and in the application section download the *Image Processing ToolBox*. This library provides the necessary functions required to create an image processing tool on MATLAB. Create a new MATLAB script file. The first few lines like *clc,clear all,close all* are just to clear the workspace and the command window. It is important that the Current Folder that you are working out of the folder that contains both the script file and image.

The function *imread* reads an image and converts it into a numerical matrix in its constituent color space. The image used here for demonstration is test_machine.jpg Figure (1), which is a 300x225 pixel image. The *imread* function converts this into a matrix that is 225x300x3 (Rows x Columns x RGB – the color space may change from RGB, CMY'K, Y'UV, YIQ according to the image and also the matrix representation). The final dimension (RGB) corresponds to a red, green and blue intensity levels. The command *imshow* enables us to view the produced image in a new window.

Figure 1. test_machine.jpg

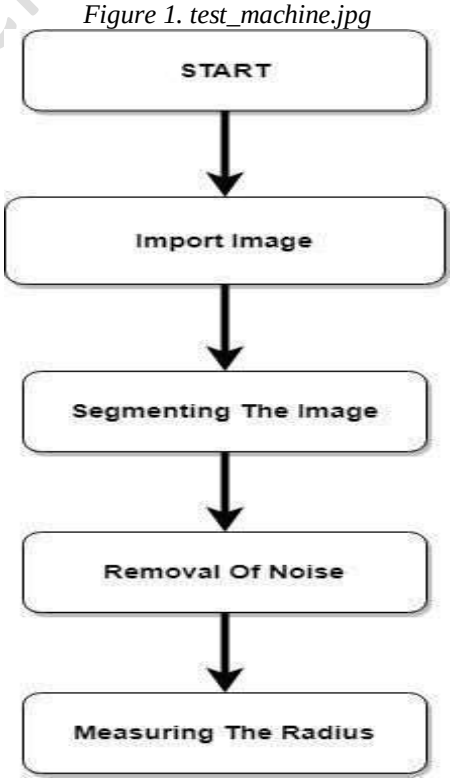

Figure 2. Flow of the Process.

B. Segmentation of Image

The next step is to segment the image into a binary image to differentiate the background from the desired objects. The first task is to break the image into individual intensity images(based on their color

space). This is called Color Based Image Segmentation. You can see from Figure(3) that the red plane for this case is the best choice to use for Image Thresholding because it provides the most contrast between the desired object (foreground) and the background.

This process of selecting the proper image is either done manually or can also be automated with calculation of contrast of all the segmented images. Thus the image with highest contrast is selected for further processing

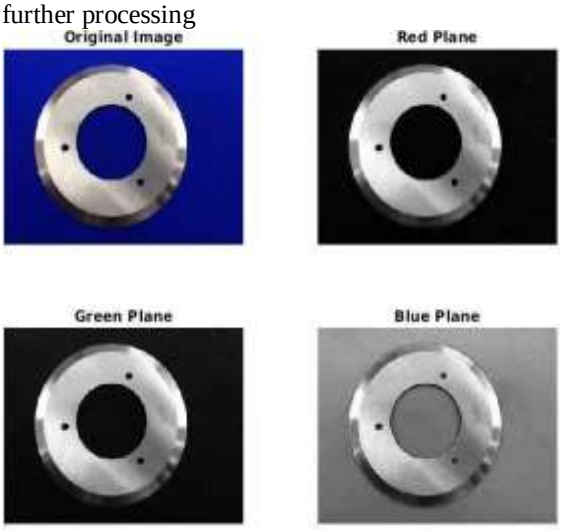

Figure 3. Color space based segmentation.

C. Thresolding of image

Image Thresholding is done to convert the segmented image to a binary image. Here we have written a function *"cvt2bnry"* which takes an intensity image and first turns it into grayscale image and then converts it into a binary image based on the level desired. "*cvt2bnry*" introduces a barrier in the grayscale image and the pixel values less than the barrier are set to '0'(white) and the pixel values above it as '1'(black). Here the threshold value is calculated as the average value of all the pixel individual pixel values of grayscale image. Thus this function is better than *im2bw* which requires the user to manually input the thresholding value, making it more automated, dynamic and less tedious. Figure(4) shows the result of thresholding.

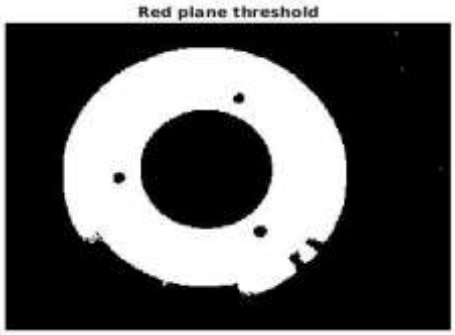

Figure 4. Output of thresholding.

D. Removal of Noise

Noise is the disturbances that prevent us from achieving the final result, in the case - the measurement of radius of the machine part and there is quite a bit of "noise" and we need to clean the image up significantly to improve the accuracy of our diameter measurement. We've written a block of code with the function name "*horivertifill*" which basically fills any of the small blobs which might hinder the measurement process. Here, because we need the outer radius and there's a middle circle, the function is used to fill it. Figure (5) shows the result of "*horivertifill*". Figure 6 shows the result of *imopen* function used to fill in blobs of size less than 7 pixels.

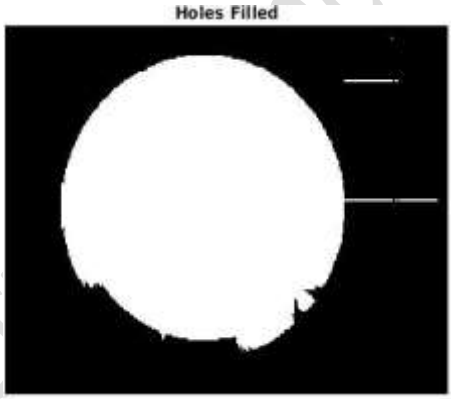

Figure 5. Removed holes.

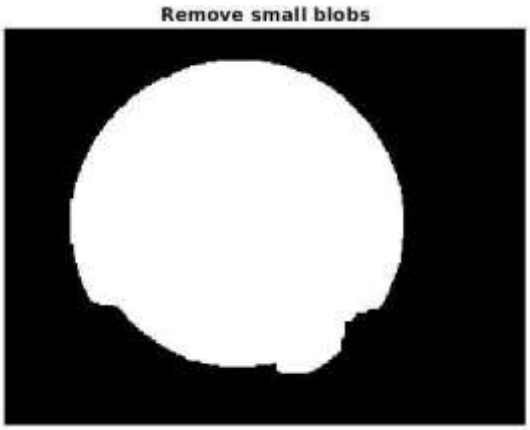

Figure 6. Final output.

E. Measuring the Radius

The image in figure is the result of all image segmentation and cleanup procedures to provide one distinct and cohesive blob, which represents the machine part's outer circle in the original image. Having the original image in a binary form such as this will make it easy for other functions built into MATLAB to quickly analyze the region and a host of different information. The *regionprops* function is the tool that will provide the *MajorAxisLength* of the blob in the image. The produced structure array is then converted into a matrix by using 2 functions - "struct2cell" and "cell2mat". The final result, radius, can be printed on the command window just

by not ending the part of the code with a semicolon. We can see in the figure (7) that with the *imdistline* tool we can manually check the measurements by adjusting the two points of the tool.

V. Results

The diameter along with the radius are now displayed in the Command Window to be approximately 193.4 and 96 pixels across respectively in Figure 8 and 9. This was verified in Figure 7 by using the *imdistline* function which allows the user to manually select the boundaries to measure the pixels that it measures.

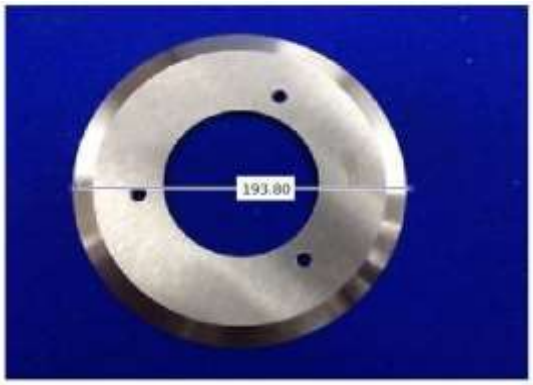

Figure 7. Test image with imdistline to manually check the radius

Figure 8. Showing the diameter and radius of machine part.

VI. Conclusion

As intended in the start, we've successfully measured the required radius of the machine part and also have been able to complete the project. This has been a great experience working with the image processing toolbox and MATLAB which are loaded with a lot of functions to help in a better Acoding of the project. The project is a coalition of many functions working together to make the process easier and faster. Starting from importing the image to ending with the measurement of radius, this project has given us innumerous ways to improve the code to not only make it lighter but also faster.

VII. Acknowledgement

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IMMADI UTTEJ currently pursuing his B.Tech in Electronics and Communication Engineering at Nalla Malla Reddy Engineering College. He also attended an internship program at DRDO. His areas of interest are Image Processing and Machine Learning.

J.R. PRADYUMNA completed his schooling in St Andrews High School and Intermediate in Bhavan's Junior College. Presently pursuing B.tech final year in Nalla Malla Reddy Engineering College. Also an internship holder from DRDO.

B. NAVEEN KUMAR is a final year graduate at Nalla Malla Reddy Engineering College. Attended an internship program at ECIL

G. SHIVA PRASAD completed his Schooling in Jawahar Navodaya Vidyalaya. Currently a final year graduate in ECE department at Nalla Malla Reddy Engineering College. He is interested in Digital Electronics and VLSI.