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RESEARCH PAPER

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CLASSIFICATION OF COLOR CODED RESISTOR BASED ON POWER RATING

Shubhangi Katti
Department of Electronics Science
Fergusson College
Pune, India

Nitin Kulkarni
Department of Electronics Science
Fergusson College
Pune, India

Abstract: Colour coded Resistors are used to build electronic circuits. Power Ratings of a colour coded resistor depend upon its size. This paper describes the application of Machine Vision for classification of used colour coded Resistors based on their power handling capability. Colour coded Resistors have been classified into four different categories viz., one fourth Watt, half Watt, one Watt and two Watt. Physical dimensions of colour coded Resistors have been considered as an important feature that provides the information about their power handling capability. Image Segmentation technique has been applied to isolate the Resistors from each other followed by blob detection method for differentiating geometrical features such as an area, perimeter, diameter, length and compactness of each Resistor to predict the power rating .Propose method could be further used for classification of Colour coded Resistor into two different categories viz. reusable and damaged(lead broken) Resistor. Proposed method could be also used for classification of different types of Resistor based on the material used for fabrication useful during recycling process.

Keywords: **Resistors**; Power Rating; segmentation; blob detection; classification; Machine Vision; Reuse

I. INTRODUCTION

Resistors are the common components used in electronic circuits[1]. Two types of resistors are used to mount on PCB, through hole and SMD [2]. Though SMD components are being used in Industries, through hole components are still in use for designing and building electronic circuits. Through hole components are used in aerospace, Military automobile and educational institutions for training purpose[3]. As resistors and other electronic components are inexpensive, they are thrown away after the use. Through Hole resistors are divided into different categories such as fixed resistors and variable resistors. Fixed resistors include color coded resistors and printed resistors. Printed resistors have the value and power rating printed on the surface of the resistors[4]. A lot of research therefore has been done and being done for employing different techniques to find out the value of the color coded resistors[5] while optical character recognition systems have been designed and are being designed for identification and classification of printed resistors[6]. For identification and classification of color coded resistors color band separation and color detection algorithms have been used[7]. Power rating is an important feature that has to be taken into consideration while selecting appropriate Resistor values along with the power rating value for particular application.

In this paper we have described the application of Machine Vision for classification of used color coded Resistors based on their power rating viz., 1/4Watt, ½ Watt, 1 Watt and 2Watt for reuse to reduce E waste.

II. LTERATURE REVIEW

In modern era of technology Machine vision finds application in almost every field viz., quality control, Industrial Process Control, Medical diagnosis, Surveillance, robotics, remote sensing, optical character recognition, voice recognition, forensic, biometry, agriculture, traffic control, automotive, air traffic control etc. [8]. Machine vision systems are being used in recycling electronic waste for separating E Waste based on the material. The majority of the works have focused on the WEEE recycling either as a whole or fraction wise i.e. PCB and Polymer part. Works on electronic component reuse and recycle has not been reported so far. Hence, this is a new area of focus for the technologists and practitioners [9]. Resistors are divided into two different groups viz. color coded Resistors and printed Resistors. Printed Resistors have printed information on the surface that is used for selecting appropriate component for building a specific circuit. Resistors are available in different size, shape and color. For classification of the color coded Resistors with different power ratings blob detection is the most suitable technique. The difference in power rating of color coded Resistor is related to the surface area of the Resistor. Vision systems are employed in PCB manufacturing Industries for guiding the robotic system for automated placement and soldering of electronic components [10]. Vision systems are employed in electronics and semiconductor Industries for quality improvement of the components during manufacturing process to accept the components that meet the standards laid by those Industries and to reject the faulty components. In resistor manufacturing industries vision systems are used for painting the color bands on the surface of the resistors, for verification of dimension and color codes, to detect the surface defect etc.[11]
Manufacturing Industries are encouraged to reuse the electronic components which were rejected from production processes. Rejected components can be recycled as used as spare parts or as a substitution part in new products [12]. Recovery of electronic components from the Printed Circuit Board of nonfunctioning consumer products for secondary use is also encourages in USA and Europe [13]. In order to perform quality testing of recovered components, Automated Vision Systems are employed in Electronic component manufacturing Industries. [10] Automatic machine vision system has been proposed for quality assured disassembly of

electronic components for reuse. [8]. Machine Vision systems have been employed for PCB detect detection viz., missing components, misalignment, wrong orientation of IC chips, wrong parts, and poor solder joints.[11]The electronic component positioning is an important research content of machine vision in completely automatic SMM. The new high-speed algorithm of the center and rotate angle was proposed by Jun Wang to locate the electronic component. [12]

III. RELATED WORK

Vision based classification of electronic components involve different image processing stages depending on the required output of the classification system. Recognition of used electronic components is based on the features viz. Color, size, shape, number of terminals and, position of the terminals related to the surface of the electronic components. These key features are used for classification of electronic components into different class's viz., Resistors, Capacitors, and Inductors etc. while information about number of terminals and their orientation help the Machine Vision system to detect the fault in the components. Faulty components are rejected and components with no defect are accepted. [14] RGB image is converted to Gray scale Image for Preprocessing. Preprocessing is necessary for noise removal and for increasing the contrast ratio have been discussed by. Color detection algorithms have been used for detecting the color of the color band. Preprocessing image is segmented by using canny edge detection method. [15] Region based features viz. Solidity, Rectangularity, Minimum Bounding Box, Aspect Ratio have been used for size and shape parameters based classification of electronic components[16].

IV. METHODOLOGY

Proposed system consists of hardware and software. The hardware consists of imaging device and a Computer. Imaging device has been interfaced to a PC using USB port. Image of four different colour coded Resistors has been captured by camera and is saved into the computer memory. Software consists of MATLAB 2014a which has been used for processing the image and to provide the results. Image Processing and Computer Vision Toolboxes are used for Image processing and Image Analysis.

Image of four color coded Resistors with power rating of ¼, ½,1and 2Watt has been captured by using Mobile phone camera. Captured RGB image was then shared with the computer that has MATLAB software installed on it. RGB image was converted into gray scale Image. Gray scale image was further converted to Binary image by using simple segmentation method i.e. thresholding.

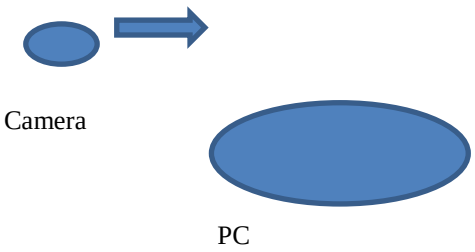

Figure 1 Hardware setup

Four resistors in the image were isolated from each other by using minimum bounding box. Region properties were measured using built in MATLAB function regionprops. Twenty four different features were evaluated from the blob measurement. These features were Area, Perimeter, Major Axis length, Minor Axis length, Diameter, width, height, Total Area, Total Perimeter, Area Ratio, Perimeter Ratio, Perimeter Length Ratio, Narrow factor, form factor, rectangularity, circularity, compactness, roundness, Elongation, solidity, circularity, Eccentricity, Perimeter Length Ratio, and Perimeter Diameter Ratio. Some of these features show the value increasing with power rating, some features show the value decreasing with increasing power ratings, while some features show constant value for all four resistors.

Algorithm

1. Convert RGB image to Gray Scale Image
2. Evaluate threshold from Gray Scale Image
3. Segment the Image using threshold value
4. Isolate all four Resistors using Minimum Bounding Rectangle
5. Carry out Blob measurements for each of the isolated Resistor
6. Extract blob features and derived features in the form of a table
7. Sort the feature area in ascending order
8. Find out the index for area in increasing order
9. Classify Resistors according to the area
10. Minimum area Resistor is 1/4watt Resistor, Maximum area Resistor is 2W Resistor
11. Display the Original Image of four Resistors with minimum bounding boxes
12. Display the images of four Resistors Separately with their power rating
13. End

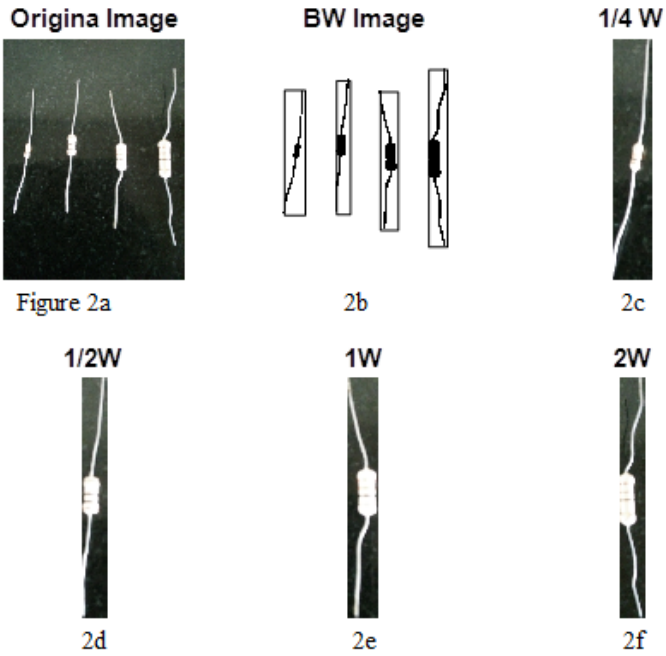

Figure2a Original Image with four Resistors,

2b Binary Image showing four isolated resistors with minimum bounding rectangles

2c 1/4th Watt Resistor Original Image

2d ½ Watt Resistor Original Image

2e 1 Watt Resistor Original Image

2f 2 Watt Resistor Original Image

Features extracted known as shape descriptors from isolated resistors using region properties are defined as

Area: Area is defined as total number of pixels of each Resistor in the Image.

Perimeter: Perimeter is defined as the number of pixels on the boundary of each Resistor in the Image.

Length: It is the Length of the minimum bounding rectangle of each Resistor in the Image.

Equivalent Diameter: Diameter of a circle with same area calculated by using formula sqrt(4*Area//pi)

Compactness: Compactness is defined as the Ratio of square of the perimeter to Area

V. RESULT AND DISCUSSION

Classification of four different Resistors in the Image has been carried out with the help of segmentation and blob detection technique. Segmentation has been used to isolate each of the Resistor from other Resistors. Blob detection method has been used to extract geometric shape descriptors viz. Area, Perimeter, Diameter, Length and Compactness. The features Area, Perimeter, Diameter, length, compactness increase with increase in power ratings of the resistors for through hole resistors as shown in figure 3,4,5,6,7 respectively.

Proposed method accurately predicts the power rating of the resistor that increases with increase in the dimensions of resistor. Proposed method could be used as a part of Machine vision system for classification of color coded Resistors along with color code identification system. It could be also used for classification of different types of Resistors viz. fixed and variable Resistors such as printed Resistors, preset, trimmer, Potentiometer, LDR etc. based on their size and shape. This would help to automatically sort the resistors for reuse or for recycling based on the material used for fabrication. It could be also used to guide the pick and place robotic arm in PCB manufacturing process.

Same concept can be applied to SMD resistors i.e. power ratings of SMD resistors can be also evaluated from the dimensions of SMD Resistors

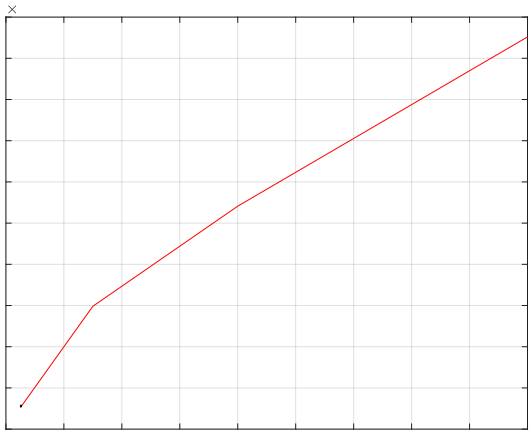

Figure 3 Graph of Area Vs Power

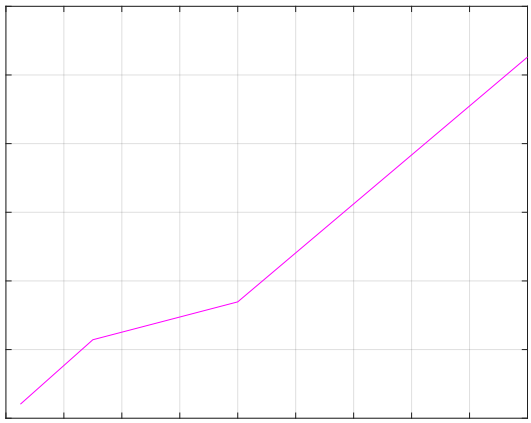

Figure 4 Perimeter versus Power Rating.

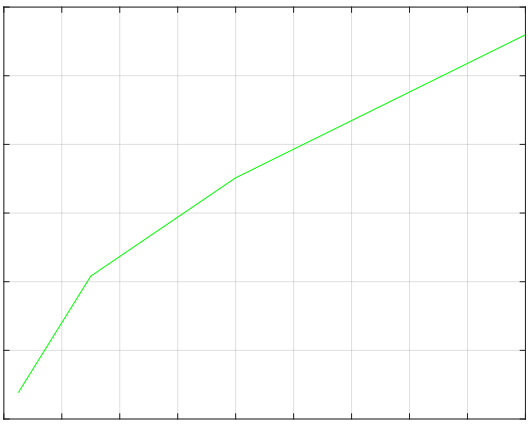

Figure 5 Diameter versus Power Rating

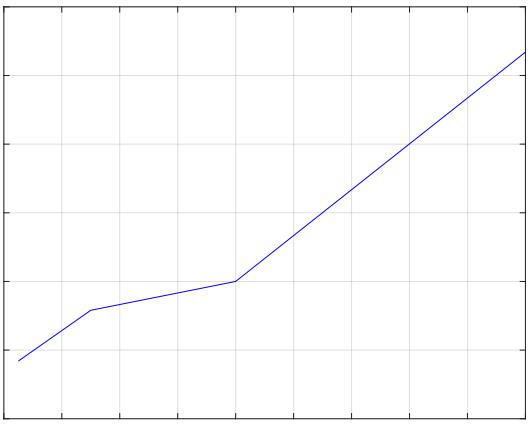

Figure 6 Length Versus Power Rating

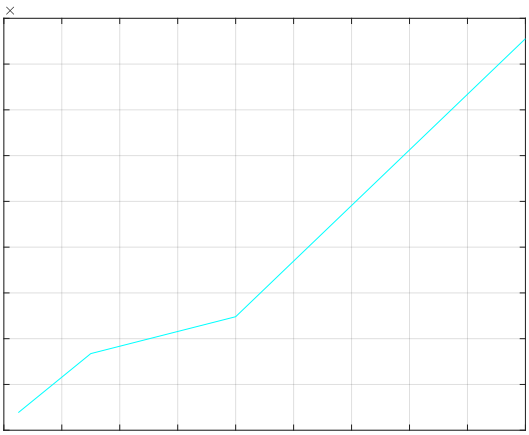

Figure 7 Compactness versus Power Rating

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