



## Research Article

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**Authors:** Hüseyin CEYLAN  , Ömer ÇOKAKLI 

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## COLOR SEPARATION WITH COMPUTER VISION

Hüseyin CEYLAN<sup>\*b</sup>, Ömer ÇOKAKLI<sup>2b</sup>

<sup>1</sup> Kırıkkale University, Kırıkkale Vocational School, Kırıkkale, Turkey.

<sup>2</sup> Ermes BTK, Product Engineer, Konya, Turkey.

\*Corresponding Author: [huseyinceylan@kkk.edu.tr](mailto:huseyinceylan@kkk.edu.tr)

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**ABSTRACT:** From the first day of existence human beings have been carrying out various production activities to meet their basic needs. Today, the majority of products are produced within factories. The identification, differentiation or classification of these products plays an extremely important role in factory operation and efficiency. Human factors and mechanical systems in factories cause a waste of time, defects or faulty separation of products. According to these requirements and problems, the methods used in factories have necessarily become more functional. Various cases such as whether the products produced in the factories comply with the required standards or their classification are determined according to varying parameters. One of these parameters is the color of the product (or the color of some part on the product). In this study, different product images will be browsed through the Matlab environment with a camera and this image will see colors (Red, Green, Blue) in Matlab environmental visual planning techniques and its separation is the main purpose of the study.

**Keywords:** Computer Vision, Color Detection, Product Separation, Image Processing

### 1. INTRODUCTION

Human beings have been led to research and develop faster methods of supply in order to meet the consumption of the rapidly increasing world population and the increasing demand accordingly. Today, the identification, differentiation, or classification of all products, from the heaviest to the lightest one, is carried out economically and quickly thanks to the color detection field. Thanks to modern technology, color separation systems are preferred in many sectors, where industrial automation systems are used, such as food, agriculture, automotive, chemistry, cosmetics. With the increasing demand of human beings, new demands like the identification, control, counting and sorting of products produced in factories have arisen. Due to these demands, color detection systems have now become more functional.

Color separation systems in the automation industry provide an alternative option for processes such as identification, sorting or control of different products. Color recognition systems allow easy identification, sorting or control of products according to their own colors, other labels, packages or texts. Especially in the packaging industry, color control on products is used extensively. Besides, it provides a significant advantage in the sifting of products that are out of the standard due to the detection of packages and bottles.

In this study, firstly, color detection studies carried out previously will be mentioned. Theoretical information about computer vision, image processing and color detection will be given. Products separating process in Matlab environment according to their colors will be explained in a detailed way. As a result, the designed interface will be tested and the results will be announced.

Gürcan, in his study titled - "Computer Vision in Industrial Automation", has designed an economical, modern and real-time vision system that can meet the industrial automation needs by using camera and computer image processing techniques [1].

Öztürk, in his study titled - "Detecting eggshell defects on white eggs with image processing techniques", used computer vision techniques in the quality classification of eggs [2].

Arslan, in his study titled - "Real-Time Forest Fire Smoke Detection in Motion Camera", used computer vision techniques in detecting the presence of possible smoke in the images obtained from a moving camera that can monitor a wide area of 3600 [3].

Çelik, in his study titled - "Mouse Design Using Image Processing for Disabled", discussed the issue of developing a mouse that can be controlled with the help of a camera [4].

Senthilkumar, in his study titled - "Traffic Analysis and Control Using Image Processing", used the computer vision method to develop a highly efficient work as an alternative to existing solutions to manage traffic congestion and accidents especially in big cities [5].

Ebraheem, in his study titled - "Using Digital Image Processing to Make an Intelligent Gate", has brought a new perspective to the field of home security by using image processing techniques preferred in many sectors (medical, social life,... etc.) [6].

Bayrakdar in his study titled – “An accelerated approach for facial expression analysis on video files”, an approach is proposed for the accelerated facial expression analysis of video files[7].

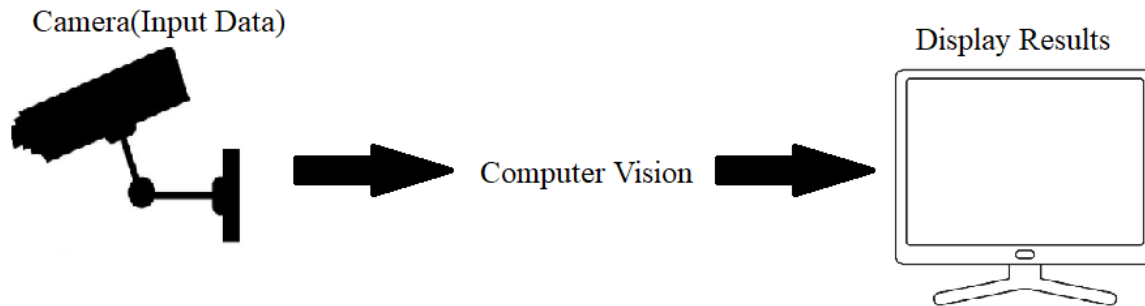
The main purpose of this study is products separation according to their colors (Red, Green, Blue) delicately and without using human power. Firstly, the products images in different colors (red, green and blue) will be obtained by the camera and then they will be separated according to their color using computer vision techniques.

## **2. COMPUTER VISION**

According to the study conducted by Chang Shu [8], computer vision (CV) is a field of study that offers assistive techniques for interpretation and understanding of images with useful information extracted from the contents of digital images such as images and videos, by computer modeling the perception way with eyes of living beings. According to the studies by Szeliski [9] and Adrien [10], the algorithms used in this field studies are divided into three groups: those that improve the noise or missing data in the image, learn the image in real time, and those that allow the use of limited resources such as power and memory. Existing research has been carried out on studies in grouped titles to make algorithms more robust and efficient [11]. Computer Vision has taken its place in various mathematical methods such as statistics, optimization and differential equations, and its use in the fields of robotics, graphics and security has started to increase gradually [8].

The first fruits of computer vision are based on the 1970s. In the beginning, only very simple shapes such as writings could be perceived. Processing lines by labeling or showing the shape with a circuit were a few of them. In the following 1980s, objects began to be defined by looking at their shapes and boundaries and decisions were made based on these defined objects. These algorithms were based on methods such as corner detection, shading, and physically based modeling. In the 1990s, not only one image but many images from different angles were processed. More familiar methods such as face recognition, factorization-based structure from motion, image segmentation were started to be used. In the 2000s, three-dimensional modeling has been one of the most interesting subjects of today [11].

Operation order in the computer vision field consists of image acquisition, image processing, feature extraction, preparation, recognition, interpretation, and understanding stages [11]. The operation order is shown in Figure 1. The subject of image processing will be explained in 2.1 in a detailed way.



**Figure 1.** Computer vision processing steps

The image source is determined via image acquisition process, which is the first step of the cycle in Figure 1. The image source contents can be taken by optical intervention or digital photography. Image sources' contents can be images or videos as well. Thus, the image acquisition phase is completed by executing the image capture process. After the image acquisition stage, the converting process of the images into digital data starts, which is the second step in Figure 1. Various tools are used in this process. The digital data obtained through those tools are evaluated with digital methods such as various signal processing methods and statistics, allowing them to produce measurable throughput, analyze and interpret them. Computer graphics are obtained from the image data which becomes digital data by using computer vision techniques and image processing methods with the image processing stage shown in Figure 1. This stage is the last step of the Computer Vision process, which plays a role in the decision-making process by making the actual analysis of the data. In the other steps, low-level information and image data are calculation process is carried out. In this step, high-level algorithms are applied on the calculated data. Feature extraction methods that provide high-level information extraction from the image such as color and shape, classification of information extracted from the image, and algorithms including image recognition processes that enable objects recognition are applied to the image at this step. The obtained image data becomes ready for the application of machine learning methods.

## 2.1. Image Processing

Image processing is one of the forms of signal processing in which an "image" is used as the input signal. It is a method of obtaining a new image by changing the features and appearance by processing images that have been transformed into a digital image in different ways due to various needs [12]. Image processing is one of the forms of signal processing in which an "image" is used as the input signal; and it is a method of obtaining a new image as a result of processing images transformed into a digital image in different ways within the framework of various needs and purposes, changing their features and appearance [12].

Image processing stages vary depending on the purpose for which the image will be processed. However, the basic stages in image processing can be sorted as noise removal and image editing (image enhancement, image sharpening, etc.), color editing (brightening, sharpness adjustment, color conversion), edge detection, corner detection, segmentation (dividing the image into objects or areas), image recognition, detection by classification (creating a concept related to seeing with the help of image analysis of recognized objects) [12-15]. These levels are also an image processing method.

Today, the application scope of image processing is more in comparison with past and this diversity is increasing day by day.

Fundamentally, image processing is used in almost all fields, as well as in medicine and biology (detection of bone fractures, tumor detection, biomedical imaging, etc.), astronomy (satellite images, etc.), industrial applications and engineering (film industry, TV, material testing, remote sensing, inspection of moving surfaces, robotics, , textile and food industries process and product inspection, barcode reading, document processing, etc.), security, defense and law (fingerprint recognition, plate recognition system, iris, face recognition, symbol recognition, hand gesture and sign recognition, paper money recognition. Picture or image recognition, target identification, GPR-mine scanning, night vision, smart rocket systems, etc.), sports (finding the speed of the athlete, detecting whether the ball crosses the goal line, etc.), banking, commerce, art, geography (forecasting via air and satellite images, etc.), biology, physics (spectrometers, electron microscope images), game programming (computer vision, 3-D modeling, etc.), space science (satellite, microwave radar images, etc.) r images etc.) [14-19].

The methods used for image processing can be developed optionally. Applications may require combined use of various methods, inclusion of some criteria, and transaction speeds increase. Image processing contains a lot of methods like Fourier transform, which is used for different purposes, Histogram equalization, Median (Medium) filters, Gabor filter method, wavelet transform method, Topological Independent Component Analysis (TICA), etc.

Perihanoğlu [21,24] divided image processing methods into 3 groups. They are point processing techniques, image enhancement methods and morphological processes.

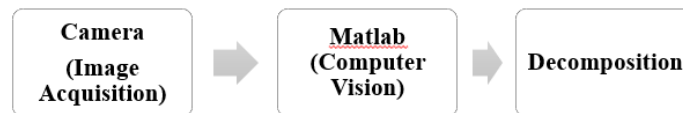
Karakoç [22,25] divided image processing methods into seven groups. They are:

- ✓ Image transforms (Fast Fourier Transform, Hadamard Transform, Cosine Transform),
- ✓ Image enhancement (Spatial Enhancement, Frequency Enhancement),
- ✓ Image restoration (Distortion Models, Block-Circulant Matrices, Inverse Filtering),

- ✓ Image segmentation (Discontinuity-Capturing [Point capture, line capture, edge detection], Threshold/Field Detection),
- ✓ Image compression (Lossy Compression, Error-Free Compression),
- ✓ Image presentation (Border Recognition, Area Recognition) and
- ✓ Image interpretation (Decision-Theory Methods, Structural Methods).

### 3. METHOD AND EXPERIMENT

The products separating process according to their colors by using computer vision techniques is shown in the block diagram in Figure 2.



**Figure 2.** By using a block diagram

Products images of different colors were exported to Matlab environment via camera. The camera has 6 layers of high quality CMOS optical 5-Glass lenses, 2.0 megapixels and a picture resolution of 2304x1728 pixels [23]. The camera that has been used is shown in Figure 3, the sample image obtained from that camera is given in Figure 4.

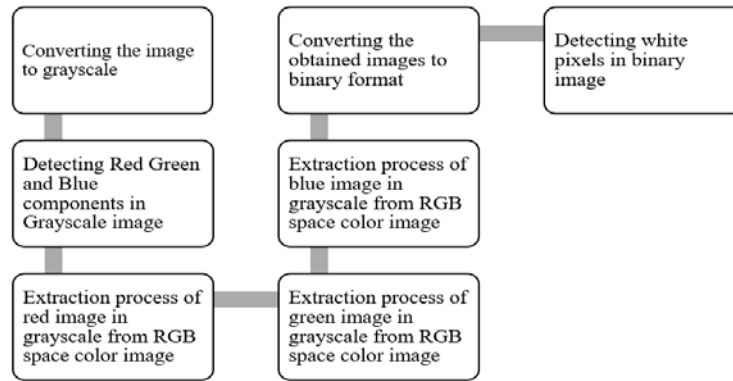


**Figure 3.** Camera used in image acquisition



**Figure 4.** Image obtained from the camera

After camera acquisition of products in different colors, the computer vision stage in Matlab environment starts. At this stage, the conversion process in an image to a gray scale, pixel determining of the red, green and blue (RGB) combination in the gray scale image, applying the extraction process to the image from the red, green and blue color space forms respectively, converting the obtained images to binary and counting the white pixels were carried out. Products color determination is done after the counting process. Flow chart of computer vision stage applied in Matlab environment is shown in Figure 5.



**Figure 5.** Flow chart of the computer vision process applied to images in Matlab environment.

The flow chart in Figure 5 has been randomly applied to three products of different colors. These products are shown in Figure 6.

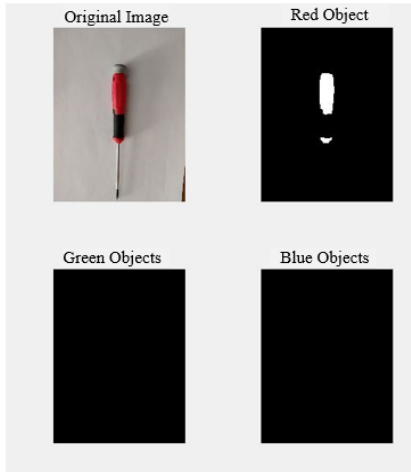


**Figure 6.** Products that Computer Vision process is applied.

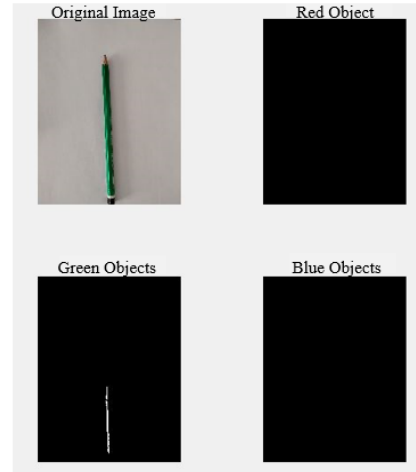
#### 4. DISCUSSION AND SUGGESTIONS

To test the algorithm, images of 3 different products were exported to the Matlab environment via camera as shown in Figure 6. These products are a screwdriver (red color), a pencil (green color) and a key ring (blue color). These images were separately subjected to the flow diagram given in chapter 3, figure 5. The products have been converted from RGB color space to gray scale. The red, green and blue pixels of the gray scale products have been detected. The gray scale image has been extracted from the RGB space color image. The white pixel areas in the new images were detected. These detected regions have enabled the products to be distinguished according to their colors.

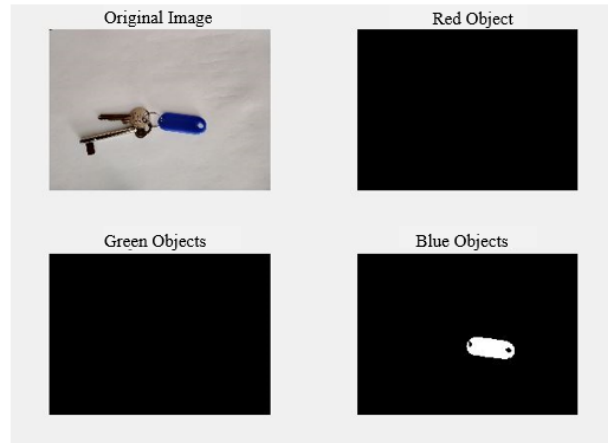
Color classification of the products in three different colors has been completed successfully and the study has achieved its goal. The obtained results are shown in Figures 7, 8 and 9.



**Figure 7.** Red product color separation result



**Figure 8.** Green product color separation result



**Figure 9.** Blue product color separation result

In order to develop this system, this can be integrated in factories, where belt conveyors are used for production, calibration can be made for other colors and the color recognition scale can be increased or the work carried out in the quality control sector can be used. Other programming languages such as PYTHON, C# can be used instead of the Matlab interface. STM, Little Panda, Beaglebone, NVIDIA etc. development cards can be used in industrial applications of computer vision.

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