The Detection of Electrical and Electronics Components using K nearest Neighbor (KNN) classification Algorithm

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Abstract - *The goal of Electrical and Electronic detection is to locate components like resistor, transistor, capacitor and diodes. This project has a simple electronic component detection procedure which has three major steps; firstly the objects are being recognized based on its physical appearances via length, Breadth, number of legs of the Electrical and Electronics components, secondly by finding roundness of objects and finally matching by correlation. Our procedure is based on object recognition technique (knowledge-based approach). In this paper, we used MATLAB codes and algorithms to detect electric components by quantitative analysis method, for finding roundness of objects and matching by correlation.*

***Key Words*:** **Transistors, capacitors, Diodes, resistor, correlation, Patter vectors.**

1. INTRODUCTION

The term pattern or object means something that is set as an idea to be imitated. For example, in our childhood a shape 'A' is shown to us and we are asked to imitate that. So the shape is the ideal one. On the other hand, if what we produce or draw obeying that instruction is close to that shape, our teacher identifies that as 'A'. This identification is called recognition and the shapes we draw (that is object we made) may be termed as patterns. Thus, the pattern recognition means identification of the real object. Recognition should, therefore, be preceded by the development of the concept of the ideal or model or prototype. This process is called Learning. Under this notion learning is of two types: supervised learning if appropriate label is attached to each of these examples; and unsupervised learning if no labeling is available.

There is another kind of recognition process which deals with abstract items such as an idea, theory, a solution to a problem, a philosophical question etc. this may be termed as conceptual recognition. It is obvious that objects of same class possess similar features and those which belong to different classes possess different features. Therefore, the set of features that distinguishes objects of different classes and is common to objects of the same classes is the key for classification and recognition. Identifying such a minimal feature set is an important step in the process of recognition. The process is called feature selection. Another major step is designing the decision process. The decision procedure should be optimum in a sense that the classification error must be low. Decision methodology adopts one of two major approaches: mathematical and heuristic. Mathematical approaches are based on the given set of models and decision rules are devised satisfying optimal criteria of classification. On the other hand when no such model is available decision rules are designed using human intuition and experience for a specific problem. The mathematical approaches includes deterministic, statistical, fuzzy set theoretic and syntactic recognition; while heuristic methods include graph matching, tree searching etc. Central idea to the theme of recognition is the concept of learning from sample patterns. We call objects as patterns. Approaches to computerized pattern recognition may be divided into two principle areas: decision-theoretic and structural. The first category deals with patterns described using quantitative descriptors, such as length, area, texture etc. The second category deals with patterns best represented by symbolic information, such as strings under structural recognition techniques.

1.1 Digital Image Processing

A. Digital Image

A digital image [m,n] described in a 2D discrete space is derived from an analog image a(x,y) in a 2D continuous space through a sampling process that is frequently referred to as digitization. For now we will look at some basic definitions associated with the digital image. The effect of digitization is shown in Figure-1.

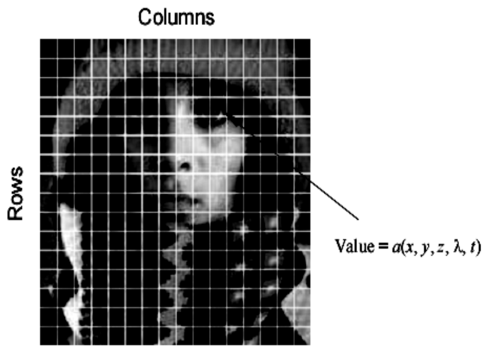


Figure -1: Represents Digitization of a continuous Image. The pixel co-ordinates [m=10, n=3].

The 2D continuous image a(x,y) is divided into N row and M columns. The intersection of a row and a column is termed a pixel. The value assigned to the integer coordinates [m,n] with {m=0,1,2,...,M−1}and{n=0,1,2,...,N-1} is a [m,n]. Intact, in most cases a(x,y)-Which we might consider to be the physical signal that Impinges on the face of 2D sensor- is actually a function of many variables including depth (z), color(l) and time (t).

B. Pattern and pattern classes

A pattern is an arrangement of descriptors that are useful when working with region boundaries. A pattern class is a family of patterns that share a set of common properties. Pattern classes are denoted by $\omega_1, \omega_2 \dots \omega_W$, where W is the number of classes. Pattern recognition by Machine involves techniques for assigning patterns to their respective classes- automatically and with a little human intervention as possible.

2. EXISTING METHODS

2.1 Object Recognition Techniques

Pattern recognition aims to categorize data (patterns) based on either *a priori* facts or on statistical information extracted from the patterns. The patterns to be classified are generally collections of measurements or observations, defining points in an appropriate multidimensional space. A stimulating problem in pattern recognition yet to be solved is the relationship between the problem to be solved (data to be classified) and the performance of various pattern recognition algorithms (classifiers). Holographic associative memory is another type of pattern matching scheme where a target small patterns can be searched from a large set of learned patterns based on cognitive meta-weight.

2.2 Decision-Theoretic methods

Decision theoretic approaches to recognition are based on the use of decision or discriminant functions. Let **x**=(x_1, $x_2 \dots x_n$) T represents an n dimensional pattern vector. For W pattern classes $\omega_1, \omega_2 \dots \omega_W$, the basic problem in decision-theoretic pattern recognition is to find W decision functions $d_1(x)$, $d_2(x) \dots d_W(x)$ with the property that, if a pattern x belongs to the class ω_i,then

di(x)>dj(x) j=1,2,3…., W=i ≠j

In other words, an unknown pattern x is said to belong to the i^{th} pattern class if, upon substitution of x into all decision functions, di(x) yields the largest numerical value. Ties are resolved arbitrarily.

2.3 Forming Pattern Vectors

Pattern vectors can be formed from quantitative descriptors. For example, suppose that we describe a boundary by using Fourier descriptors. The value of the i^{th} descriptor becomes the value of xi, the i^{th} component of a pattern vector. In addition, we could append other components to pattern vector. Another approach used quite frequently when dealing with (registered) multispectral images is to stack the images and then form vectors from corresponding pixels in the images. The images are stacked by using function cat:

S = cat (3, f1, f2,…,fn)

Where S is the stack and f1,f2…fn are the images from which the stack is formed. The vectors then are generated by using function imstack2vectors.

3. SYSTEM ARCHITECTURE

3.1 Working: KNN Classification Accuracy

- Say we have N feature vectors
- Say we know the true class label for each feature vector
- We can measure how accurate a classifier is by how many feature vectors it classifies correctly
- Accuracy = percentage of feature vectors correctly classified
- Training accuracy = accuracy on training data
- Test accuracy = accuracy on new data not used in training

3.2 Training Data and Test Data

- Training data: Labeled data used to build a classifier.
- Test data: New data, not used in the training process, to evaluate how well a classifier does on new data.

3.3 k-Nearest Neighbor Search and Radius Search

Given a set X of n points and a distance function, k-nearest neighbor (kNN) search lets you find the k closest points in X to a query point or set of points Y. The kNN search technique and kNN-based algorithms are widely used as benchmark learning rules. The relative simplicity of the kNN search technique makes it easy to compare the results from other classification techniques to kNN results. The technique has been used in various areas such as:

a) Bioinformatics
b) Image processing and data compression
c) Document retrieval
d) Computer vision
e) Multimedia database
f) Marketing data analysis

kNN search also uses the exhaustive search method if your search object is an exhaustive searcher object. The exhaustive search method finds the distance from each query point to every point in X, ranks them in ascending order, and returns the k points with the smallest distances.

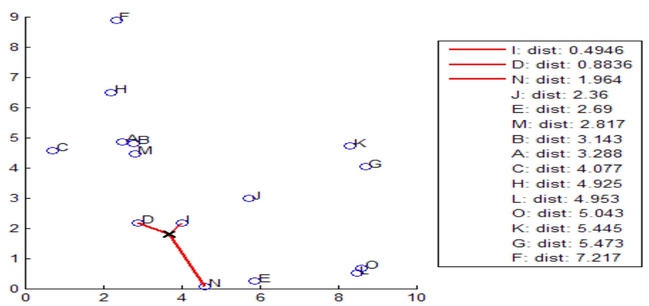


Figure-2: This diagram shows k= 3 nearest neighbor.

3.4 METHODOLOGY

- Quantitative Approach
- By finding Roundness of Objects
- Matching by Correlation

A. Quantitative Approach

In this approach, the objects are being recognized based on its physical appearances via length, breadth, number of legs of the electrical & electronics components.

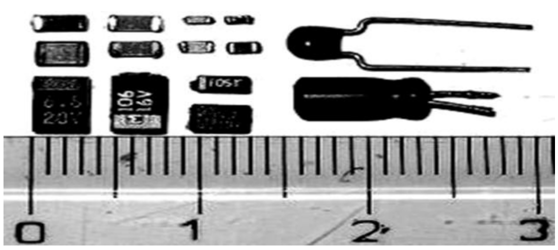


Figure-3: Electronic Components.

Algorithm:

Step1: First of all, read input image which is an RGB image.

Step2: Then, convert the RGB image into Binary image to make the processing operation easier.

Step3: Find the centric of the image so that we can find a point which should be inside the image.

Step4: Find the length of the image. For finding the length, we keep y constant and move along x-direction. In 1st case we increase x position till we find boundary and count the number of pixels. Similarly in second case, this is done by decreasing x position.

Step5: Find the breadth of the object. As in step (IV) in the same manner we find the breadth of the image by increasing and decreasing y position keeping x constant.

Step6: Find the number of legs of the image. For finding number of legs, we move towards boundary and upon finding it, our count is increased by a predetermined position by taking that point we move perpendicular to it. A leg can be indicated by changing of pixel from white to black and then the counter count the number of legs.

Step7: Finally we decide what kind of object it may be depending on the length breadth ratio and the number of legs of the objects.

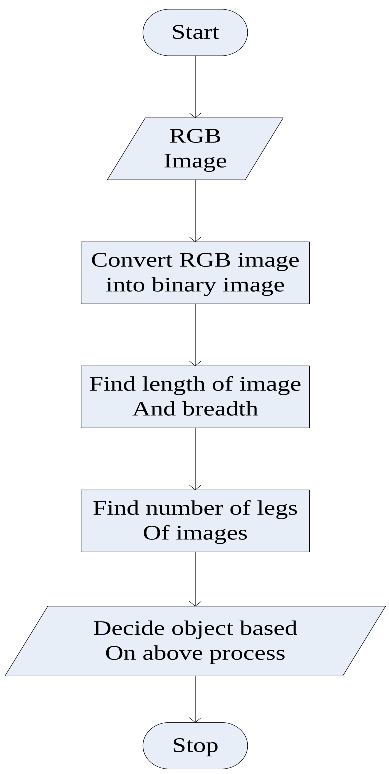


Figure-4: Flowchart of Quantitative approach

B. By finding Roundness of Objects

In this method, the objects are being recognized based on its roundness.

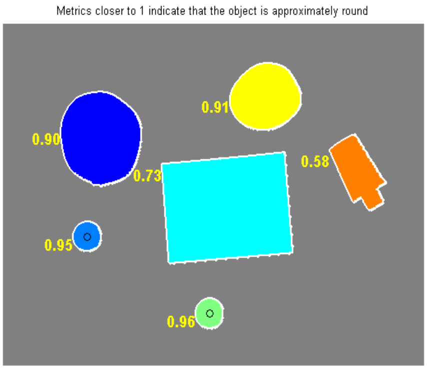


Figure-5: Roundness of Objects.

Algorithm:

Step1: First of all we need to create a database of standard objects or images with which we are going to compare the input images.

Step2: Then, read the input object which is to be compared with the standard one in the database.

Step3: We use 'bwboundaries' function as present in MATLAB Image processing toolbox to find the boundary of the objects.

Step4: Find area & perimeter of the object.

Step5: We compute the roundness using the following formula.

Step6: Calculate metric = 4*pi*area/perimeter^2

Step7: Compare the roundness of the selected object with the standard image in the database

Step8: Then, finally we make decision about the object.

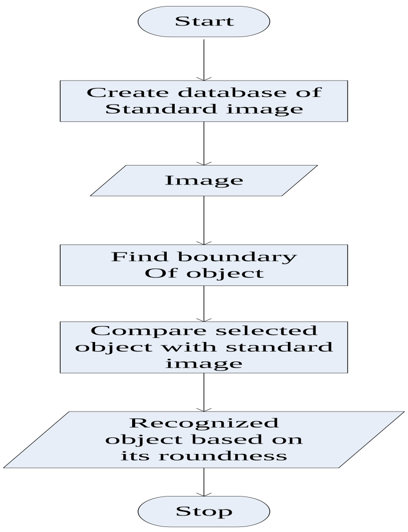


Figure-6: Flowchart of by finding roundness of object.

C. Matching by Correlation

We tried to correlate the input image with the standard image in the database.

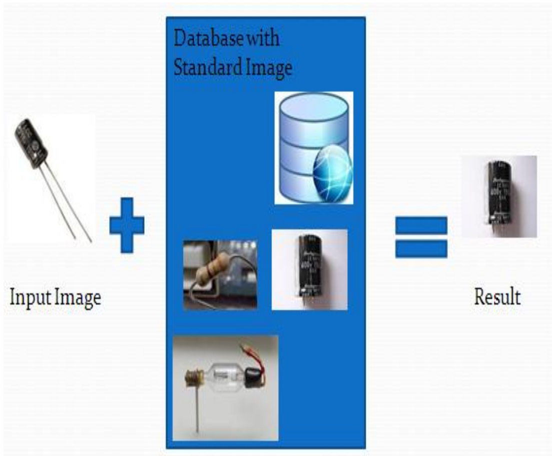


Fig-7: Correlation equivalent.

Algorithm:

Step1: First of all create database of standard images.

Step2: Read input image.

Step3: Correlate each input image with database images.

Step4: Choose a threshold value.

Step5: Determine no of pixels greater & less than threshold value.

Step6: Decision based on maximum correlation.

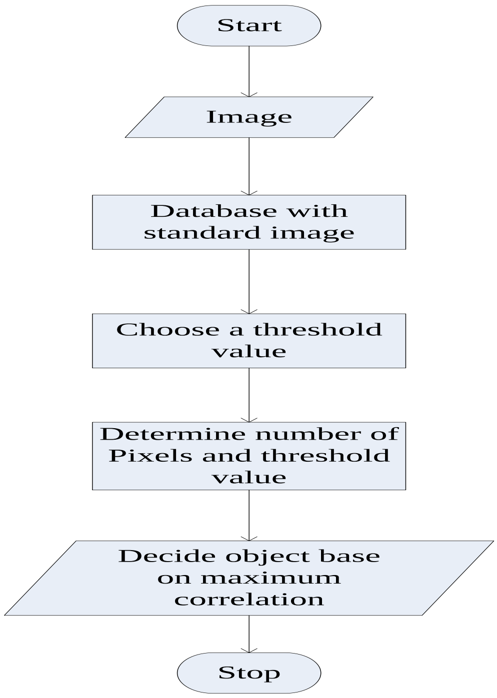


Figure-8: Flowchart of Matching by correlation.

D. Hardware Design

1. Capacitors

A **capacitor** is an electrical device that can store energy in the electric field between a pair of closely-spaced conductors (called'plates'). When voltage is applied to the capacitor, electric charges of equal magnitude, but opposite polarity, build up on each plate. Capacitors are used in electrical circuits as energy-storage devices. They can also be used to differentiate between high- frequency and low-frequency signals and this makes them useful in electronic filters. Capacitors are occasionally referred to as **condensers**.

Figure-9: Capacitor 1000micro farad.

2. Diodes

In electronics, a **diode** is a component that restricts the direction of flow of charge carriers. Essentially, it allows an electric current to flow in one direction, but blocks it in the opposite direction. Thus, the diode can be thought of as an electronic version of a check valve. Circuits that require current flow in only one direction will typically include one or more diodes in the circuit design.

Early diodes included "cat'swhisker" crystals and vacuum tube devices (called *thermionic valves* in British English Dialect). Today the most common diodes are made from semiconductor materials such as silicon or germanium.

Figure-10: Diodes component.

3. Resistor

A **resistor** is a two-terminal electrical or electronic component that resists an electric current by producing a voltage drop between its terminals in accordance with Ohm's law: V=IR. The *electrical resistance* is equal to the voltage drop across the resistor divided by the current. Resistors are used as part of electrical networks and electronic circuits.

Figure-11: Resistor component.

4. Transistors

A **transistor** is a semiconductor device, commonly used as an amplifier. The transistor is the fundamental building block of the circuitry that governs the operation of computers, cellular phones, and all other modern electronics .Because of its fast response and accuracy, the transistor may be used in a wide variety of digital and analog functions, including amplification, switching, voltage regulation, signal modulation, and oscillators. Transistors may be packaged individually or as part of an integrated circuit chip, which may hold thousands of transistors in a very small area.

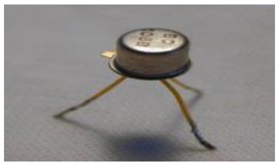
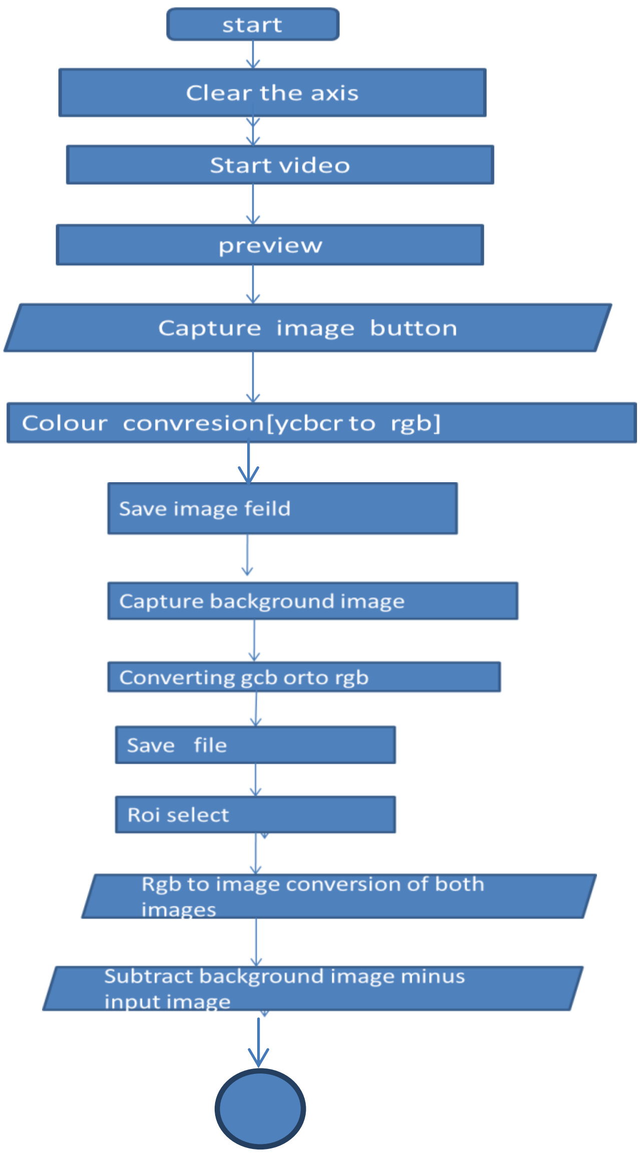


Figure-11: NPN Transistor component.



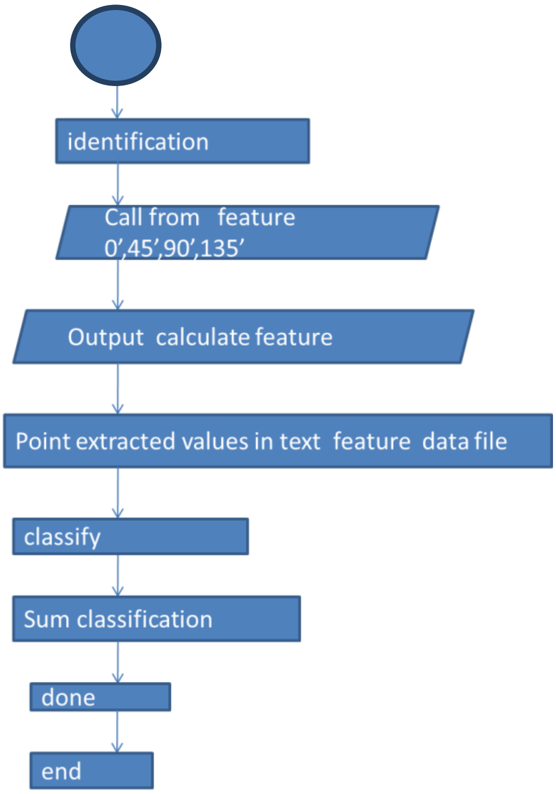


Figure-12: Flowchart of procedure for detection of components.

4. RESULTS AND DISCUSSION

We have presented a new approach to shape matching. Our project in object recognition began a transition from processes whose outputs are images to processes whose outputs are attributes about those images. Although our step is introductory in nature and the thesis is fundamental to understanding the state of the art in object recognition. A key characteristic of our approach is the estimation of shape similarity and correspondences based on quantitative approach by analyzing the physical appearance of the objects (via length, breadth, length-breadth ratio, no of legs etc) and matching using correlation method.

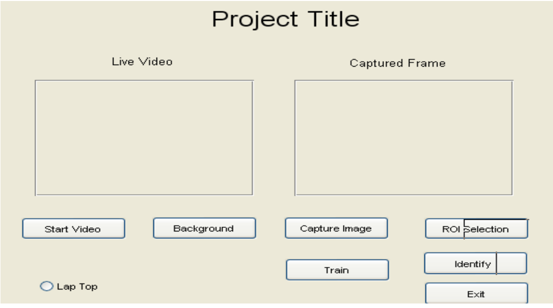


Figure-13: GUI of project title.

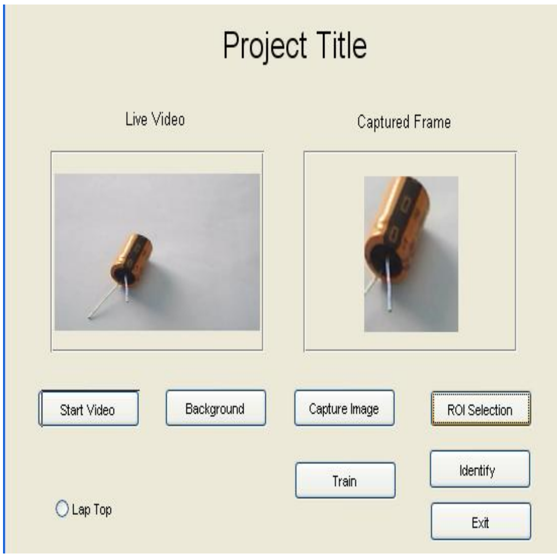


Figure-14: During the region of selection.

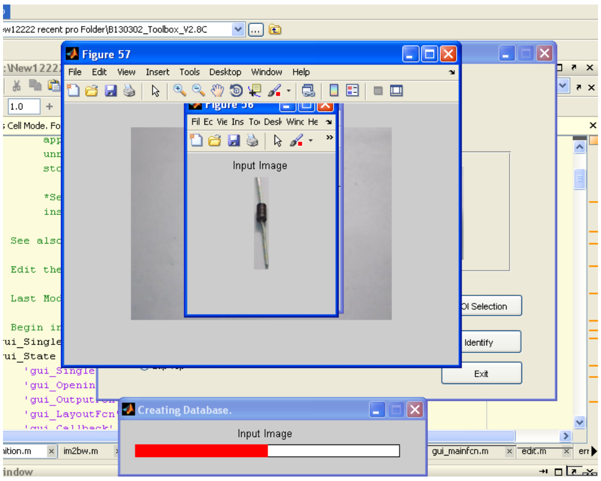


Figure-15: During the train of the database.

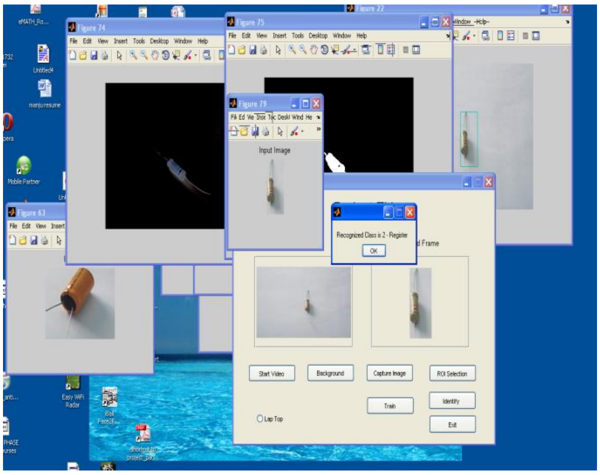


Figure-16: During the identification of components i.e register.

5. CONCLUSIONS

Specifically our next step would be the development of image analysis methods whose proper development requires concepts from machine intelligence. As we know that machine intelligence and some areas in digital image processing depend on image analysis and computer vision. Solutions of image analysis problems today are characterized by heuristic approaches. While these approaches are indeed varied, most of them share a significant base of techniques.

6. FUTURE WORK

In our experiments, we have converted an RGB image to Binary image so that the processing can be made easy as its matrix deals with binary values. If we combine region-based and contour-based segmentation techniques for object recognition at a level, where both pathways interpret the image data on the level of complete regions and contour groups. With this combination and a top-down strategy including a region memory handling different time scales the object recognition process is significantly improved in situations where projections of 3D surfaces are merged due to homogeneous on extensions of pixel values.

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