IJCSE International Journal of Computer Sciences and Engineering Open Access
Research Paper Vol.-7, Issue-5, May 2019 E-ISSN: 2347-2693

Machine Learning Approach for Signature Recognition by HARRIS and SURF Features Detector

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DOI: https://doi.org/10.26438/ijcse/v7i5.7380 | Available online at: www.ijcseonline.org

Accepted: 11/May/2019, Published: 31/May/2019

***Abstract*-**In today's' world forgery of signature is very widely increased. There are many sophisticated scientific techniques to identify a correct signature. As signatures are widely accepted bio-metric for authentication and identification of a person because every person has a distinct signature with its specific behavioural property, so it is very much necessary to prove the authenticity of signature itself.A huge increase in forgery cases relative to signatures induced a need of Signature recognition system.However human signatures can be handled as an image and recognized using computer vision and neural network techniques. In this paper we have taken a set of trained images and stored their features in a database and to test an unknown image we compare the features and calculating the matching factors. We have considered 70 % as threshold for human signature recognition. Regarding creation of recognizer we gave considered HARRIS and SUFR Features.
efficient "Signature Verification System".

Keywords—*Image Processing, Pattern Recxognition,Feature Selection,HARRIS,SURF*

I. Introduction

'Signature Recognition' is a technique to recognize any hand written signature efficiently on computer with input is either an old optical image or currently provided through touch input, mouse or pen. Biometrics can be categorized as behavioural and physiological. Handwritten signature belongs to behavioural biometric[1].It is a field of research in pattern recognition, artificial intelligence and machine vision. Though academic research in the field continues, the focus on character recognition has shifted to implementation of proven techniques. Signature recognition is a scheme which enables a computer to learn, understand, improvise and interpret the written or printed character in theirown language, but present correspondingly as specified by the user. Signatures Recognition uses the image processing technique to identify any signature features printed or hand written. A lot of work has been done in this field. But a continuous improvisation of this techniques is being done based on the fact that algorithm must have higher accuracy of recognition, higher persistency in number of times of correct prediction and increased execution time.

The idea is to device efficient algorithms which get input in digital image format. After that it processes the image for better comparison. Thenafter the processed image is compared with already available set of training images. The last step gives a prediction of the signature matching in percentage accuracy. In most of the places the verification is done manually either by a person who is familiar to the signature or by matching it against a few signature templates handwritten signature verification can be classified into offline signature recognition system and online signature recognition system. Between the two, online signature recognition systems are more reliable because of its higher efficiency in terms of accuracy and time than offline.

The objective of this research paper is to identify handwritten Signature recognition by the Harris algorithm and Surf algorithm. We have to construct suitable neural network and train it properly. The program should be able to extract the characters one by one and map the target output for training purpose. After automatic processing of the image, the training dataset has to be used to train "classification engine" for recognition purpose.

II. BACKGROUND STUDY

A. Image Processing

A digital image is a 2-D array of real numbers.2-D image is divided into N-rows and M-columns. The intersection of this row and columns is called pixels. Depending on whether the image resolution is fixed, it may be of vector or raster type. By itself, the term "digital image" usually refers to raster images or bitmapped images[7],[8].

Digital image processing is the use of computer algorithms to perform image processing on digital images. As a subcategory or field of digital signal processing, digital image processing has many advantages over analog image processing. It allows a much wider range of algorithms to be applied to the input data and can avoid problems such as the build-up of noise and signal distortion during processing. Since images are defined over two dimensions (perhaps more) digital image processing may be modeled in the form of multidimensional systems[9][10].

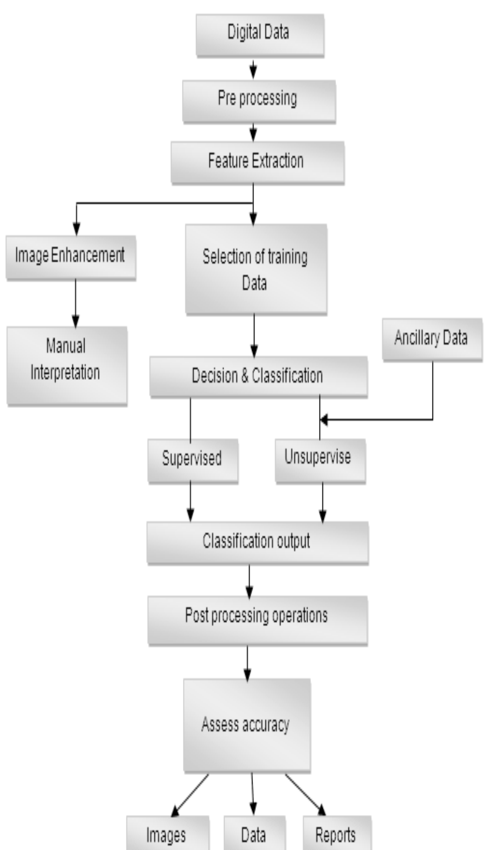


Figure 1. Steps in Digital Image Processing

Image enhancement techniques have been widely used in many applications of image processing where the subjective quality of images is important for human interpretation. Contrast is an important factor in any subjective evaluation of image quality. Contrast is created by the difference in luminance reflected from two adjacent surfaces. In other words, contrast is the difference in visual properties that makes an object distinguishable from other objects and the background. In visual perception, contrast is determined by the difference in the color and brightness of the object with other objects. Our visual system is more sensitive to contrast than absolute luminance; therefore, we can perceive the world similarly regardless of the considerable changes in illumination conditions. Many algorithms for accomplishing contrast enhancement have been developed and applied to problems in image processing.

B. Feature extraction

Feature extraction is a method of extracting of features of characters from the sample image. Feature extraction for compact representation of image data in computer vision. Feature extraction is a type of dimensionality reduction that efficiently represents interesting parts of an image as a compact feature vector. This approach is useful when image sizes are large and a reduced feature representation is required to quickly complete tasks such as image matching and retrieval. Feature detection, feature extraction, and matching are often combined to solve common computer vision problems such as object detection and recognition, content-based image retrieval, face detection and recognition, and texture classification[14],[15],[16].

In machine learning, pattern recognition and in image processing, feature extraction starts from an initial set of measured data and builds derived values (features) intended to be informative and non-redundant, facilitating the subsequent learning and generalization steps, and in some cases leading to better human interpretations. Feature extraction is related to dimensionality reduction[16][17].

The selected features are expected to contain the relevant information from the input data, so that the desired task can be performed by using this reduced representation instead of the complete initial data.

There are basically two types of feature extraction:

- Statistical feature extraction
- Structural feature extraction

In Statistical feature extraction the extracted feature vector is the combination of all the features extracted from each character. The associated feature in feature vector of this type of extraction is due to the relative positions of features in character image matrix.Statistical features are not affected too much by noise or distortions as compared to structural features. A number of techniques are used for statistical feature extraction; some of these are: zoning, projection histograms, crossings and distances, n-tuples. In the proposed paper Zoning, Number of endpoints, End point existence in zone, Zone with zero foreground pixel value, Number of horizontal line and Number of vertical line are extracted from character.

a) Zoning: Zoning based feature extraction is one of the most popular methods. The character image is divided into predefined number of zones and a feature is computed from each of these zones. The character image is divided into several overlapping or non-overlapping zones. A character is usually divided into zones of predefined size. These predefined sizes are typically of the order 2×2, 3×3, 4×4 etc.
b) Number of Endpoints: Endpoint defines starting and ending point of a character.
c) Number of Vertical: Lines Vertical Line feature describes that character contains vertical line. In English language vertical lines are always connected with some other part of the character and are not independent.
d) End Point Existence in Zone: After finding numbers of endpoints, check in which zone endpoint exists.
e) Number of Horizontal Line : Horizontal Line feature describes that character contains horizontal line. In English language horizontal lines are always connected with some other part of the character and are not independent.
f) Zone with Zero Foreground Pixel Value: For this feature, thresholding (black and white) image is used. Image is divided into 9 zones and Count the number of foreground (black) pixels in each zone and find out the zone with zero foreground pixel value.

In Structural feature extraction techniques which extracts morphological features of a character from image matrix. It takes into account the edges, curvature, regions, etc. This method extracts the features of the way character are written on image matrix.The different methods used for feature extraction are Piecewise linear regression, Curve-fitting, Chain code, etc.

C. Artificial Neural Network

An early phase of NeuralNetwork wasdeveloped by Warren McCulloch and Walter Pitts in 1943 which was a computational model based on Mathematics and algorithm. This model paved the way for research which was focused on the application of Neural Networks in Artificial Intelligence.
Artificial neural network is basically a mesh of large number of interconnected cells. The arrangement of cells is such that each cell receives an input and drives an output for subsequent cells. Each cell has a pre-defined

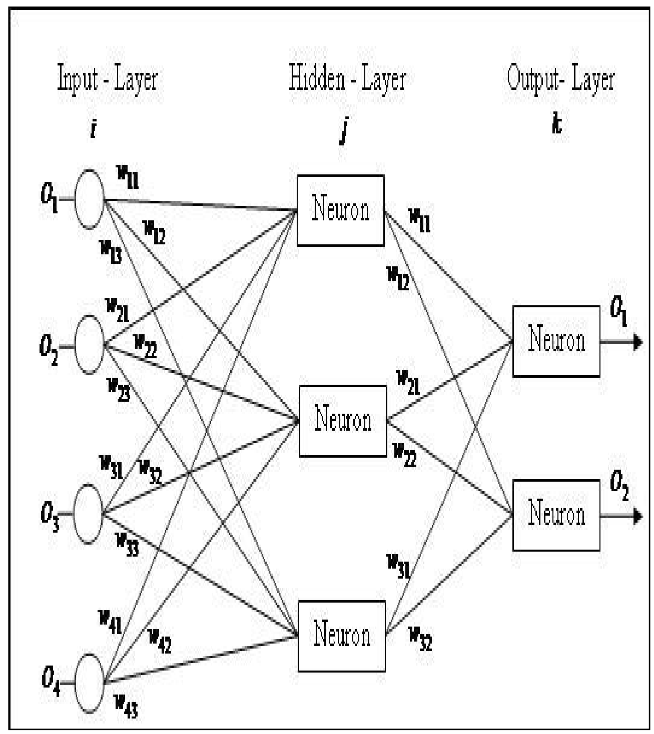


Figure2: Artificial Neural Network

The diagram above is a block diagram that depicts the structure and work flow of a created Artificial Neural Network[4],[15].The neurons are interconnected with each other in a serial manner. The network consists of a number of hidden layers depending upon the resolution of comparison of inputs with the dataset. The goal of the neural network is to solve problems in the same way that a human would, although several neural network categories are more abstract. New brain research often stimulates new patterns in neural networks. One new approach is use of connections which span further to connect processing layers rather than adjacent neurons. Other research being explored with the different types of signal over time that axons propagate, such as deep learning, interpolates greater complexity than a set of boolean variables being simply on or off.

Historically, the use of neural network models marked a directional shift in the late 1980s from high-level (symbolic) artificial intelligence, characterized by expert systems with knowledge embodied in *if-then* rules, to low-level (sub-symbolic) machine learning, characterized by knowledge embodied in the parameters of a cognitive model with some dynamical system.

III. METHODOLOGY

The computation is performed in following manner:

- Pre-processing of the image
- Add noise in a image and remove this noise.
- Feature extraction
- Detect the corner and
- Calculate matching factor.

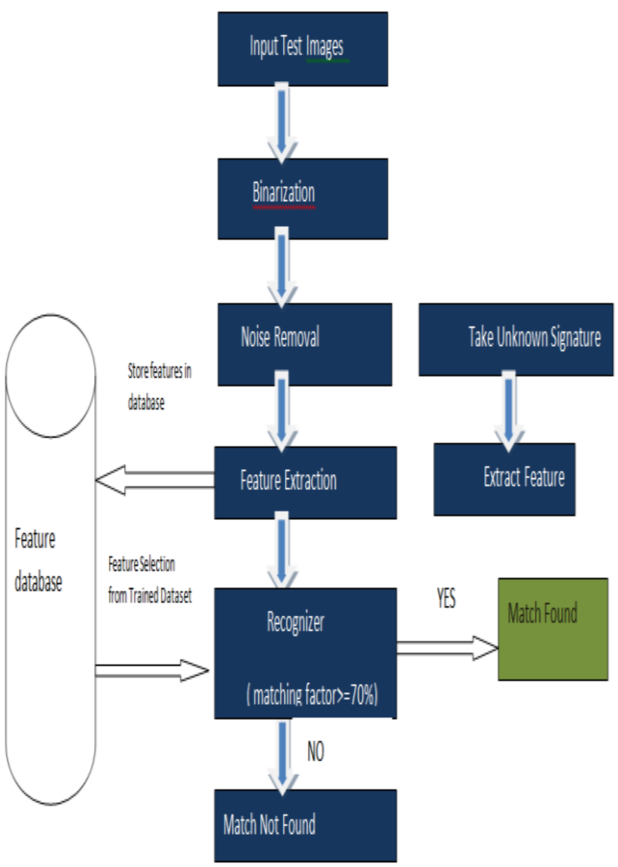


Figure 4. Steps in Signature Recognition

A. *Pre-processing of the image*

Grey-scaling of an image is a process by which an RGB image is converted into a black and white image. This process is important for Binarization as after grey-scaling of the image, only shades of grey remains in the image, binarization of such image is efficient.

Figure 3: RGB to Grey tone Conversion and Binarization

Binarization of an image converts it into an image which only have pure black and pure white pixel values in it. Basically during binarization of a grey-scale image, pixelswith intensity lower than half of the full intensity value gets a zero value converting them into black ones. And the remaining pixels get a full intensity value converting it into white pixels.

B. *Adding Noise and Removing NoiseGaussian Noise:*

Gaussian noise is statistical noise having a probability density function (PDF) equal to that of the normal distribution, which is also known as theGaussian distribution. In other words, the values that the noise can take on are Gaussian-distributed. A Special case is white Gaussian noise, in which the values at any pair of times are identically distributed and statistically independent (and hence uncorrelated).In communicationchannel testing and modeling, Gaussian noise is used as additive white noise to generate additive white noise[13][14].

Principal sources of Gaussian noise in digital images arise during acquisition e.g. sensor noise caused by poor illumination and/or high temperature, and/or transmission e.g. electronic circuit noise. In digital image processing Gaussian noise can be reduced using a spatial filter, though when smoothing an image, an undesirable outcome may result in the blurring of fine-scaled image edges and details because they also correspond to blocked high frequencies. Conventional spatial filtering techniques for noise removal includemedian filtering.

In selecting a noise reduction algorithm, one must weigh several factors:

- the available computer power and time available: a digital camera must apply noise reduction in a fraction of a second using a tiny onboard CPU, while a desktop computer has much more power and time
- whether sacrificing some real detail is acceptable if it allows more noise to be removed (how aggressively to decide whether variations in the image are noise or not)
- the characteristics of the noise and the detail in the image, to better make those decisions

C. Feature extraction and Corner detection

a) Harris Corner Detection

The Harris Corner Detector is a mathematical operator that finds features (what are features?) in an image. It is simple to compute, and is fast enough to work on computers. Also, it is popular because it is rotation, scale and illumination variation independent. Corner detection is an approach used within computer vision systems to extract certain kinds of features and infer the contents of an image. Corner detection is frequently used in motion detection, image registration, video tracking, image mosaicing, panorama stitching, 3D modelling and object recognition. Corner detection overlaps with the topic of interest point detection[2][5].The Harris Corner Detector is a mathematical operator that finds features in an image. It is simple to compute, and is fast enough to work on computers.

$$E(u,v) = \sum_{x,y} w(x,y)[I(x+u,y+v) - I(x,y)]^2 \quad (1)$$

- E is the difference between the original and the moved window.
- u is the window's displacement in the x direction
- v is the window's displacement in the y direction
- w(x, y) is the window at position (x, y). This acts like a mask. Ensuring that only the desired window is used.
- I is the intensity of the image at a position (x, y)
- I(x+u, y+v) is the intensity of the moved window
- I(x, y) is the intensity of the original

We've looking for windows that produce a large E value. To do that, we need to high values of the terms inside the square brackets.

Figure 5: Corner Detected Image Matching points of Image

b) Surf Feature Extraction:

In computer vision, speeded up robust features (SURF) is a patented local feature detectorand descriptor. It can be used for tasks such as object recognition, image registration, classification or 3D reconstruction. It is partly inspired by the Scale-Invariant Feature Transform (SIFT) descriptor. SURF was first presented by Herbert Bay, et al., at the 2006 European Conference on Computer Vision. An application of the algorithm is patented in the United States.

The SURF algorithm is divided into main two steps: firstly, interest points are detected. Secondly, interest point description is performed. Both of these steps depend on a scale space representation [6].

SURF excludes the step of creating different images in its processing. It uses Hessian matrix that expresses the local changes in area of each point in x and y direction as shown in equation 2.

$$H(p,\sigma) = \begin{bmatrix} L_{xx}(p,\sigma) & L_{xy}(p,\sigma) \\ L_{xy}(p,\sigma) & L_{yy}(p,\sigma) \end{bmatrix} \quad (2)$$

Where, $L_{xx}(p, \sigma)$ is second derivative of the Gaussian as displayed in equation 3

$$L_{xx}(p,\sigma) = I(p) * \frac{\partial^2 g(\sigma)}{\partial x^2} \quad (3)$$

A variable sized filter is used as **σ** to form a scale space image. Afterwards, based on the sum of Haar wavelet responses, construct a square window entered around the interest point.SURF descriptors have been used to locate and recognize objects, people or faces, to reconstruct 3D scenes, to track objects and to extract points of interest.

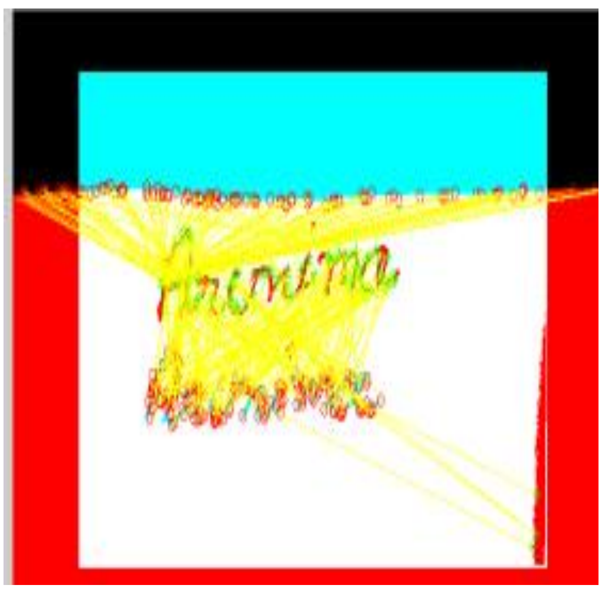


Figure 6:SURF detected image Matching points of Image

IV. RECOGNITION

Matching for factors is a convenient method for minimizing confounding in case-control studies, but it does not allow inferences about the effects of the matching factors unless case ascertainment is virtually complete and the distribution of the matching factors in the source population is known. When this is so, the effect of a particular factor can be estimated by comparing the population distribution of that factor with what is observed in the case series.

After feature extraction we calculate Matching Factor to compare between two images. The final step is the verification/matching method. This is done by calculating the Euclidean distance between the descriptors. For every key point in the descriptor in the original image, two closed neighbours are computed and the distance will be taken to match between them and find similarity. The matching of each two signatures is applied based on the number of key points in each one.The recognition phase consists of two parts, training and testing. Training contains different module or processes to which all images of our signature are given as input to get desired training data.In testing, used for verifying an input signatures.

V. RESULTS AND DISCUSSION

In this paper we accept a new signature then extract its features. As explained in previous section images in our database belonging to 50 people are used for both training and testing. Since 3(out of 5) input vectors for each image were used for training purposes. Under normal (correct) operation of the back propagation neural network, only one output is expected to take a value of "1" indicating the recognition of a signature represented by that articular output. The other output values must remain zero.

TABLE 1: HARRIS Corner Detection with matching factor

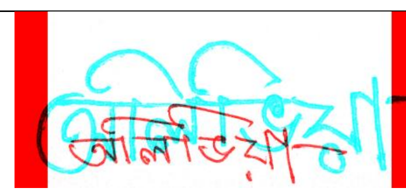
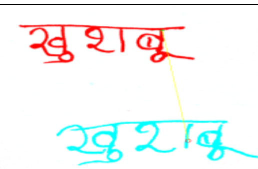
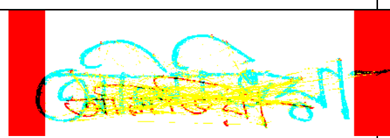
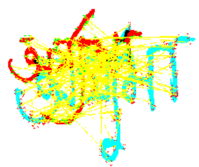
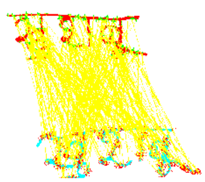
Sample type	HARRIS Corner Detection	Matching Factor
Sample 1		85.88%
Sample 2		80.78%
Sample 3		76.58%

TABLE 2: HARRIS Corner Detection with matching factor

Sample type	SURF Corner Detection	Matching Factor
Sample 1		80.55%
Sample 2		75.45%
Sample 3		70.78%

The back propagation neural network program recognized all of the 5 signatures correctly. This result translates into a 70%-86% recognition rate. We also tested the system with 5 random signatures. Signature recognized whenever matching factor is above or equal to70%.

VI. Conclusion and Future Scope

Classification of characters and learning of image processing techniques is done focused on envisaging methods that can efficiently extract feature vectors from each individual character. The method we came up with gave efficient and effective both for feature extraction as well as recognition. We have considered some genuine image and check its originality to prevent any forgery.

The result which was got was correct up to more than 90% of the cases, but it would be improved at the end. This work was basically focused on offline methods that can efficiently extract feature vectors from each individual signature. This method can also be used in huge number of datasets where multi layered ANN can be used to get better results.

Acknowledgment

We express our sincere gratitude to **Dr.Dharmpal Singh**, HOD of the Department of Computer Science and Engineering of JIS College of Engineering and all the respected faculty members of Department of CSE for giving the scope of successfully carrying out the research work. Finally, I take this opportunity to thank to **Dr. Malay R Dave**, Principal of JIS College of Engineering and for giving us the scope of carrying out the research work.

References

[1] A Bansal, B Gupta, G Khandelwal,SChakraverty *"Offline Signature Verification Using CriticalRegion Matching"* International Journal of Signal Processing,Image Processing and Pattern Vol. 2, No. 1, 2009

[2]A. Masoodand M. Sarfraz. "Corner detection by sliding rectangles along planar curves" ,Computers & Graphics, Vol. 31, pp.440-448, 2007. [3] A K Das, A Massand ,S Patil *"A novel proxysignature scheme based on user hierarchical access controlpolicy"* Journal of king Saud University-Computer and InformationSciences, 2013

[4] A Pansare and S Bhatia *"Handwritten Signature Verification Using Neural Network"* International Journal of Applied Information Systems (IJAIS), Vol. 1, No. 2, 2012

[5] S. Harpreet, "Robust Video Watermarking Algorithm Using K_Harries Feature Point Detection", International Journal of Soft Computing and Engineering (IJSCE), ISSN: 2231-2307, Volume-5 Issue-4, September 2015..

[6]S Garhawal and NShukla *"SURF Based Design andImplementation for Handwritten Signature Verification"*International Journal of Advanced esearch in Computer Scienceand Software ngineering (IJARCSSE), Vol. 3, Issue 8, 2013

[7].D.Mitra,R.Barik,S.Roy,S.Bhattacharyya"ASurvey on Image Segmentation and Image Registration" ,ACEEE-CPS, International Conference on Computing,Communication& Manufacturing, ISBN: 978-0-9940194-0-0,Pages 61-69

[8]D.Mitra,R.Barik,S.Roy,S.Bhattacharyya"Cumulative Measurement of Image Entropy on Different Mathematical Morphological Operation",ACEEE-CPS, International Conference on Computing,Communication& Manufacturing, ISBN: 978-0-9940194-0-0,Pages 35-39

[9] D Mitra, KG Verma "Information Processing using Multilevel Masking to Image Segmentation " , International Journal of Computer Applications , pp 1-6.

[10] S Gupta , K G Verma, D Mitra "Identification Of Mass Of Tissue Growth In Brain Region Under The Framework Of Image Segmentation(http://dx.doi.org/10.21172/1.84.28)" , International Journal of Latest Trends in Engineering and Technology .pp 179-186, Volume 8 Issue 4 - July 2017

[11] P Metri, AKaur *"Handwritten Signature Verification using Instance Based Learning*" ,International Journal of Computer Trends and Technology- March to April Issue 2011,Pune,India

[12]D Bhattacharyya, and T Kim "Design of Artificial Neural Network for Handwritten Signature Recognition"

International Journal Of Computers And Communications Issue 3, Volume 4, 2010

[13] Gonzalez, Woods "Digital Image Processing"

[14] Sanjay Sharma "Fundamental Of Digital Image Processing"

[15]Stuart Russel& Peter Norvig "Artificial Intelligence: A Modern Approach", Pearson, 2009

[16]kevin P. Murphy "Machine Learning: A probabilistic perspective"

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