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Animal Identification Using Footprints

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ABSTRACT— Here we propose animal identification system that employs image processing techniques. Firstly, the collected footprint images are pre-processed. Images are converted into gray-scale and boundaries of image are determined using canny algorithm. Further, footprint images are segmented. Gabour filter are used to extract features of segmented image. After feature extraction, features are reduced based on unsupervised model, we have used Principle Component Analysis (PCA) to reduce dimensionality features. Then reduced feature vectors are inputted into the classification model. Probabilistic Neural Network (PNN) is used for classification and identifying the animal class. Footprint datasets of 120 images are collected consisting of 10 different animal categories of variable training sets. Proposed system provides 93% of accuracy in detecting animal class.

Keywords— Gabour filter, canny edge detector, PCA based dimensionality reduction and Pnn.

I. INTRODUCTION

Many researches has been carried out for identification of footprints which used manual footprint identification, this technique requires minimum three human expertise or officials for identification, which is complex in time and cost, not every footprint left by the animal is accurate. So the footprint identification system is used which adopts image processing techniques which overcomes shortcomings of manual process.

The system automatically identifies the footprints, based on images collected using camera or web cam. Since there is no human intervention accuracy in determining the animal class is more compared to manual identification. Main motive is to identify the animal class and determining how many would exists in certain area, protecting the animal if endangeoured, then preventing the social and environment causes from the animal. Several features associated with animal footprint are used to detect animal. Efficient classification can be based on footprint dataset collected and algorithm being used. Identification system consists of four major stages; pre-processing, segmentation, feature extraction and classifier design. Input image is normally in rgb format which needs to be converted to gray-scale, this reduces the amount of information to be used and processed. In.[8]. Various pre-processing methods are given (gray-scaling, canny edge detector, etc).

II. LITERATURE REVIEW

In Yuan et.al.[1]. Tracks of the rats are identified. Because of similarities between tracks, identification process becomes tedious. In-order to eradicate these difficulties, segmentation of footprint is required, segmentation involve dividing each footprint into hoofs, pads and full print .The aim to remove unnecessary human pre-processing, time efficiency, and increase accuracy for footprint recognition. Footprints are composed of set of segments which can be grouped based on size, shape and orientation since there may be similarities between each segment. Features of each segments must be extracted, Gabour filter is used for feature extraction. In [6] this paper shows algorithms for automatic footprint segmentation and feature extraction.

In Manohar et.al.[2]. This paper proposed a Gabour filter response, for extracting texture features and preserves texture features of an image in frequencies. Selective scale and orientation filter is applied on input image to acquire texture features. And Segmentation requires separating the image from the background for efficient classification. Next step is extracting templates of the footprints. In [1].template matching process along with template updating is specified.

In Qi et.al.[3]. This paper proposes an algorithm for multi-scale and rotated image template matching along with seven hu-momemts along with rotation invariance features is determined. Degree of moments is very important. In Ming-kuei Hu [4]. Two-degree moment invariants are given for geometrical

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figures. Complete systems of moment invariants under orientation are derived. Dimensionality of the data or feature vector must be reduced, in-order to reduce overfittting PCA based dimensionality reduction process is given. [5]. [2] specifies calculation of covariance-matrix and computation of eigen-values and eigen-vector for this covariance-matrix. A probabilistic neural network for used for plant classification [7]. Pnn is trained with 1800 leaves with accuracy of greater than 90%. Working of PNN model is given here.

III. METHODOLOGIES AND TECHNIQUES

The image processing techniques have been established to optimize the footprints, input image is converted into greyscale, Edge detection on the image. All the images in the dataset are read, processed, and feature extracted, raw data is loaded for classification of input image. Detailed process is given below:-

A. pre-processing

Animal footprint images are converted into gray-scale [13]. Gray-scale image is a image consists of binary contents in the form of 0 and 1 pixels of the initial rgb image. Gray-scale image consists of image pixel is a single sample representing only small amount of light, it carries only intensity information between (0 to 1). The converted grayscale for further processing, it should be further reduced in information which includes edge detection. Here we observe the "Canny edge detection algorithm" is one of the optimal algorithm among the edge detection algorithm. Three main criteria's of canny edge detection are as follows:

Low error rate: it is important that edge occurring in the image should not be missed and there should be no response for non-edge.

Good localization: distance between edge pixels as found by the detector and actual edge is to be minimum.

Single response: to have one response to single edge. Algorithm has five steps:-

Step1: computing Horizontal (GX) and vertical (GY) gradient of each pixel.

Step2: using above information the magnitude (G) and direction (of each pixel in the image is calculated).

Step 3: in this step all non-maxima's is made zero that is suppressing the non-maxima, thus this step is called Non-maximal suppression.

Step4: high and low thresholds are measured using histogram of the gradient magnitude image

Step5: To get the proper edge map hypothesis thresholding is employed which will link between weak and strong edges. Thus pixel strength and orientation is computed. In-order to detect edges it consider two threshold as high and low. Addition adaptive thresholding block and block classification are added to handle weak edges.

B. Feature extraction.

Here we choose Gabor filters for the purpose of feature extraction. Gabor filters effectively preserves the texture characteristics of an image pattern in frequency domain. By applying the selective scale and orientation gabor filter on an image where, the texture analysis is accomplished [9]. Initially the image are segmented before extracting desired feature below figure shows steps involved in gabor feature extraction.

Fig 1: process of extracting Gabour features.

Gabour filter is a sinusoidal computed by sinusoidal given by below equation:

$$G(X, Y, theta, f) = e^{([\frac{-1}{2}\{(\frac{x^1}{sx^1})^2 + (\frac{y^1}{sy^1})^2\}])} * \cos(2 * pi * f * x^1) \text{ ---------- (1)}$$

Where,

$x^1 = x * \cos\cos(theta) + y * \sin\sin(theta)$ and

$y^1 = y * \cos\cos(theta) - x * \sin(theta)$

Sx & Sy = Variances along x and y-axes respectively.
f = The frequency of the sinusoidal function.
theta = The orientation of Gabor filter.

The texture features such as Contrast, Uniformity, Energy and Correlation are extracted from the responses of Gabor filter at different orientations and scales [9].

$$\text{Contrast} = \sum_{i=0}^{L-1}\sum_{j=0}^{L-1}(i-j)^2 P(i,j) \quad \text{------(2)}$$

$$\text{Uniformity (U)} = \sum_{i=0}^{L-1} p^2(z_i) \quad \text{--- (3)}$$

$$\text{Energy} = \sum_{i=0}^{L-1}\sum_{j=0}^{L-1}(P(i,j))^2 \quad \text{------- (4)}$$

$$\text{Correlation} = \sum_{i=0}^{L-1}\sum_{j=0}^{L-1}\frac{[(i\,j)P(i,j)]-\mu_i\mu_j}{\sigma_i\sigma_j} \quad \text{---- (5)}$$

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In order to solve changes of rotation for the scene image in template matching, ring projection[14] of template image was proposed, ring projection of template and scene image are selected as matching feature. Various rotational invariant features of the image is extracted, then template moment of the image is extracted. We divide the images to 3 segments then 8 templates have been used to consider orientation factor of the image and angle of its use. Second order moments are determined and this moments are used with classification.

C. Dimensionality reduction.

Dimensionality reduction is the process reducing the image data to be processed in-order to reduce amount of overfittting of training image sample. We use principle component for dimensionality reduction [5].

1) Principle component analysis(PCA)

It is one of the multivariate statistical technique for reducing dimensionality [10]. It can easily handle large quantity of data but also avoid the computational intense calculations. Here data is transformed into another feature vector for preserving high dimensionality data or reduce overfittting of data. Let n*d be the size of the feature matrix F, where n is the total number of samples and d be the total number of features. The aim is to reduce the dimensions from d to k such that k<< d, we compute the d-dimensional mean vector and the co-variance matrix of F. Later the eigenvectors and eigenvalues are computed from the co-variance matrix. Sort the obtained eigenvalues in descending order and choose the k eigenvectors corresponding to k largest eigenvalues selected are called principal components. The important stage in PCA is to select the number of principal components k such that the selected principal components should be good enough to represent the data so that accuracy of the classification increases.

D. Classification

After processing and feature extraction we have to determine the animal class by comparing the input image with trained data, trained data consists of 80 percent samples, probabilistic neural network is used for footprint classification.

1) Probabilistic neural network:

Pnn is the type of feed forward neural network evolved from radial basis function network [12]. It theoretical basis is the Bayesian minimum risk criteria. A probabilistic neural network (PNN) has 3 layers of nodes. The figure below displays the architecture for a PNN that recognizes K = 2 classes, but it can be extended to any number K of classes. The input layer (on the left) contains N nodes: one for each of the N input features of a feature vector. These are fan-out nodes that branch at each feature input node to all nodes in the hidden (or middle) layer so that each hidden node receives the complete input feature vector x. The hidden nodes are collected into groups: one group for each of the K classes as shown in the figure. Each hidden node in the group for Class k corresponds to a Gaussian function centered on its associated feature vector in the k class. All of the Gaussians in a class group feed their functional values to the same output layer node for that class, so there are K output nodes.

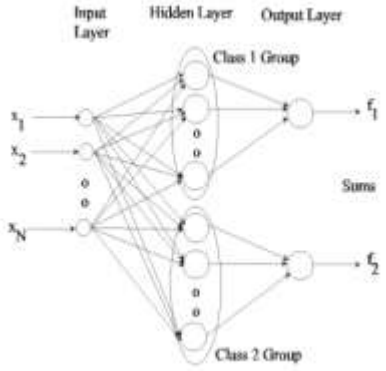

Fig 2: Pnn architecture

The output layer performs summation of all features the sum is scaled to so the probability volume under the sum function is unity so that the sum forms a probability density function. Here we temporarily use special notation for clarity.

The complete methodology and how the process is carried out is shown below in the figure:

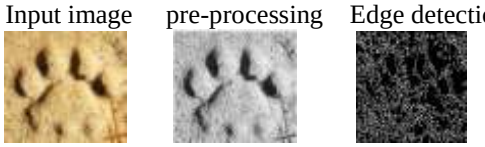

Fig 3: system working model

Detailed steps of the system is shown in the below block diagram

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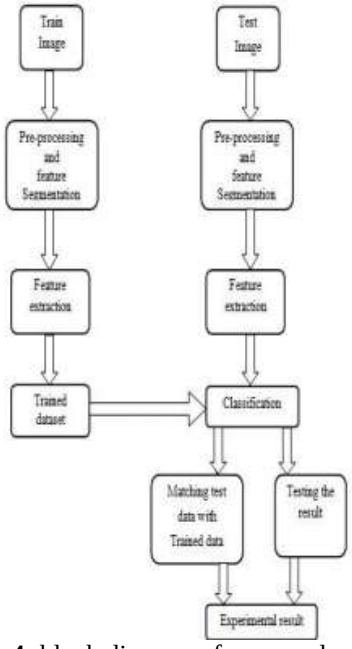

Fig 4: block diagram of proposed work

IV. RESULTS

There is no standard datasets of the footprints available. And the challenges are, the footprints might be smugged or partially visible. So we have created our own dataset. Some images are captured through camera that are available in and around our surroundings and remaining imges are collected through world wide web(WWW). We have created the dataset of 10 different class of animals with maximum of 20 images in each class, so we have collected around 120 footprint images. Fig 4 shows the datasets we have collecting comprising of various class of animals.

Fig 5: sample dataset

Below figure Fig 5 shows the result of our project.

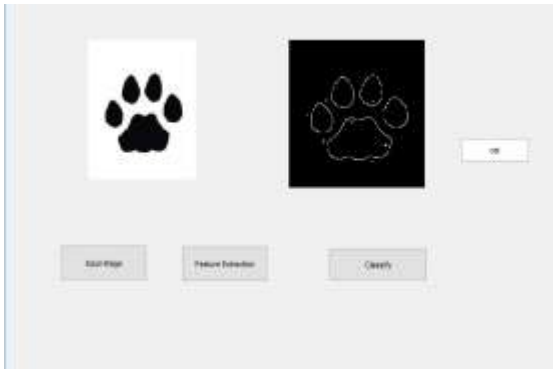

Fig 6: result of the proposed system.

Here we implement our project using matlab tool. Mat-lab is a high-performance language for technical computing. It integrates computation, visualization, and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notations. Mat-lab stands for matrix-laboratory. The accuracy of classification of Pnn model is given below in the bar graph, horizontal axis indicates the accuracy of classification ad vertical axis determines the number of samples, as the number of samples for classification increases the accuracy of classification increases.

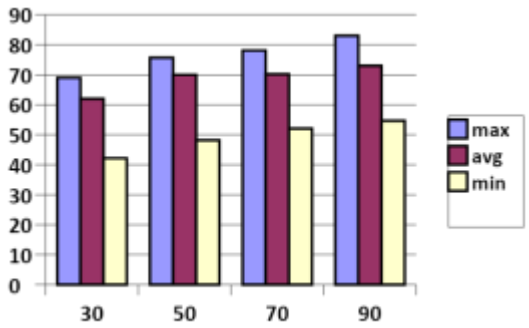

Fig 7: Pnn classification on number of samples

V. CONCLUSION

The system classifies animal footprints. The footprint images are inputted initially, the preprocessing is performed on this inputted image. Pre-processing includes Gray-scaling, resizing the image. The image features are extracted using Gabour filter along with images segmentation. Various image moments are calculated and feature of each moment is determined. Probabilistic neural network is used for image classification, principle component analysis (PCA) is used for reducing image dimensions. Thus the system boasted 100% accuracy rate for initial classification. The system finally got 93% accuracy for classification.

Future work of the system involves collecting comprehensive datasets, and further performing future experiments and tests results can be obtained.

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