HCTL Open International Journal of Technology Innovations and Research (IJTIR)
http://ijtir.hctl.org
Volume 15, May 2015
e-ISSN: 2321-1814, ISBN (Print): 978-1-62951-974-6

Identification of Tigers through their Pugmark using Pattern Recognition

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Abstract

The protection of wildlife and forests is a major responsibility of human being. Forest's officials use to keep track of all movements by each tiger. They used radio collars to track the tiger. But all tigers are not collared. Because collaring a tiger is a tough job. Another method is to track tiger is through their pugmarks. Forest people can identify the tiger by identify their pugmarks. This paper is presenting method for identifying tiger through their pugmarks using image processing techniques. The pugmarks for 6 different tigers were collected from the forest. The images of pugmarks were analyzed and database of identified parameters have been created. The identification is based on matching of parameters stored in database. The recognition rate of algorithm is 93%.

Keywords

Image processing, pugmark detection, neural network, machine learning.

Introduction

The status of the Tiger, its prey and habitats has caused grave concern among conservationists because they play a potentially vital role as the large mammalian predator in our ecosystem. The tiger is considered an icon for conservation in all the ecosystems where it occurs. Due to its endangered and flagship status, accurate and reliable population estimates are critical for implementation and assessment of conservation measures and management practices. Here arise the requirement of monitoring individual tiger in their natural habitat and create their profile for better surveillance. All this could be monitored if we could identify them individually. After identification proper observations can be made about behaviour of each tiger. Forest officials are using radio collars [1] to locate the tigers. These radio collars are heavy (about 3-4 kgs) and it disturbs the normal behaviour of tigers. Collaring the tiger is also a very tough task. Sometimes tigers attack on forest officials during collaring process. This process is very time consuming and not good for tigers also.

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The other method of locating the tiger is pugmarks identification. Forest guard can identify pugmarks of several tigers by inspecting visually. But they are not accurate. This paper proposed an algorithm for identification of tigers through their pugmarks. It will help forest guards to locate tigers. The algorithm is based on image processing technique. The image processing algorithm is developed on FPGA processor.

There are various literatures available for image processing techniques and FPGA implementation of algorithm. Few of them are as follows:
Sandeep Sharma et al. [2] have proposed a technique to identify tigers through their pugmarks. Author has identified parameters for the training of system. Parameter matching technique has been used for classification. Author has taken pugmarks which is 0.5 to 1cm deep in soil. The efficiency of technique was 92 percent.

Gopinath Mahale, et al. [3] has implemented scalable modular hardware solution for real-time Face Recognition (FR) on large databases. Author has used Weighted Modular Principle Component Analysis (WMPCA) and Radial Basis Function Neural Network (RBFNN) for implementation on hardware. Author used a novel format to store large database on off-chip memory so that it does not effect on performance of algorithm. Virtex-6 LX550T FPGA is used for implementation and testing. The speed of processor is 450 recognitions per second on image of size 128 X 128 with 450 classes.

Bai Limin, et. al. [4] described different algorithms for face recognition and analyses. The database contains variety of pose, shelter, illumination, and expressions of various faces. The algorithms were tested for different applications. After analysis author concluded that efficiency of LBP algorithm is better than other algorithms.

Ramu Endluri et. al. [5] has developed FPGA based embedded platform using TSK 3000a processor for real time face recognition. Author has implemented PCA algorithm on FPGA processor. The model consists of a camera which can capture image and process through embedded processor to recognize image of a person. Author has tested the model in real time with a webcam attached to hardware. Due to the limitation of memory only two images were stored in database for testing.

Qasim Al-Shebani et. al. [6] presented existing hardware implementation for face recognition. The authors described different face recognition algorithm and importance of hardware developed on FPGA processor. Author has suggested hybrid feature extraction technique to improve accuracy of face recognition system. Author has developed door access control system using FPGA device.
Manzoor Ahmad Lone et. al. [7] has developed face recognition algorithm based on multi-algorithmic approach. Author used four different algorithms Principal Component Analysis (PCA), Discrete Cosine Transform (DCT), Template Matching using Correlation (Corr) and Partitioned Iterative Function System (PIFS) for classification of image. Author has found the recognition rate of PCA-DCT technique is better than by individual PCA and DCT techniques and recognition rate by PCA-DCT-Corr technique is better than the PCA-DCT technique.
Janarbek Matai et. al. [8], presented a complete real-time face recognition system consisting of a face detection, a recognition and a downsampling module using an FPGA. Author has developed a system which captures video input from a camera, detects the locations of the face(s) using the

Viola-Jones algorithm, subsequently recognizes each face using the Eigenface algorithm, and outputs the results to a display and it operates at 45 frames per second on a Virtex-5 FPGA.
The above literatures provide various ways to solve the problem. The implementation process of algorithm is described in different sections. Section II describes about pugmarks, section III describes the process flow of algorithm, section IV presents the feature extraction technique, section V describe results of testing and section VI concludes the paper.

Pugmarks of Tiger

Figure 1: Pugmarks of tiger

Pugmark is the foot impression of animals. Figure 1 shows foot impression of tigers. The impression is on soil and 3-4 cm deep. Forest guards use to make pugmark impression pads using wet soil. It is difficult to extract pugmark impression and removal of noise. The process of image processing and feature extraction is defined in next sections.

Methodology

Figure 2 shows different stages and methods which are used for image processing.

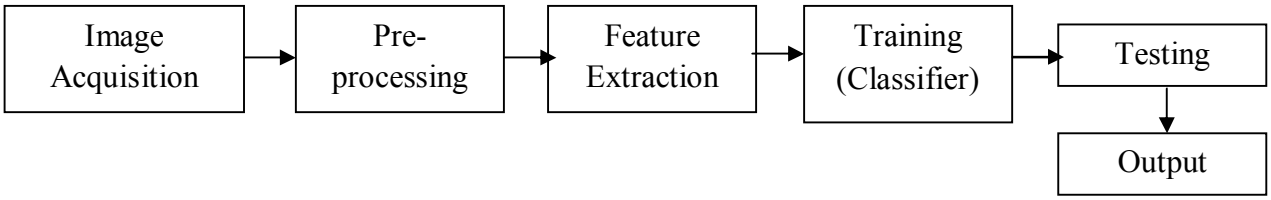

Figure 2: Flow diagram for image processing

Image Acquisition

The image acquisition is done using a digital camera and it is loaded and saved using MIL software. MIL works with images captured from any type of colour or monochrome source. MIL

supports the saving and loading of images. It supports file formats such as TIF (TIFF), JPG (JPEG), BMP (bitmap), as well as raw format. Here the input image got is an RGB image.

Pre-processing

Figure 3 shows the pre-processing of image. It includes resizing of image, de-noising, conversion of RGB to gray scale & then binary image, and at last morphing of image.

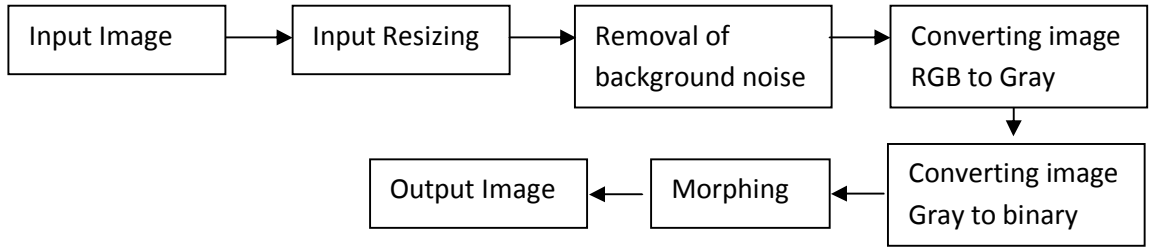

Figure 3: Flow diagram for pre-processing of image

A. Image Enhancement

Image enhancement is basically improving the interpretability or perception of information in images for human viewers and providing better input for other automated image processing techniques.

B. Background Subtraction

Background subtraction is a process of extracting foreground objects in a particular scene. A foreground object can be described as an object of attention which helps in reducing the amount of data to be processed.

C. Gray Image

Gray scale images have the only color which is a shade of only gray in between. Monochromatic is another name of gray image, denoting the presence of only one (mono) colour (chrome). To convert any colour to a gray scale representation of its luminance, we must obtain the values of its red, green, and blue (RGB) primaries in linear intensity encoding, by gamma expansion. A grayscale image usually requires that each pixel be stored as a value between 0 – 255 (byte), where the value represents the shade of gray of the pixel. The number of gray levels typically is an integer power of 2 (L=2K).

D. Binary Image

A Binary Image is a digital image where the image has two assigned pixel values. Typically the two colors used for a binary image are black and white. The gray image of tomatoes is converted to binary image this means that each pixel is stored as a single bit (0 or 1).

E. Morphing

Morphing is an image processing technique used for the metamorphosis from one image to another. The idea is to get a sequence of intermediate images which when put together with the original images would represent the change from one image to the other. The simplest method of transforming one image into another is to cross-dissolve between them.

Feature Extraction

There are 14 parameters were identified for recognition of tiger thorough their pugmarks. The features identified for pugmark is as follows:

1. Area of toe 3 (AT3)
2. Length of minor axis of toe 3 (MiT3)
3. Distance between toe 2 and toe 3 (DT2T3)
4. Length of minor axis of toe 2 (LT'2)
5. Distance between main pad top to toe base-line (H)
6. Angle between toe 2 and toe 3 (T2T3)
7. Heel to lead toe length (HLTL)
8. Width of the pugmark (Wpg)
9. Length of the pugmark (Lpg)
10. Pad area
11. Area of toe 1
12. Area of toe 2
13. Area of toe 3
14. Area of toe 4

System is trained with 6 pugmarks of 6 different tigers. Parameters were extracted for 6 pugmarks of 6 different tiger's pugmark and stored as master database. The parameters of pugmarks are as follows:

Parameter	T1p1	T1p2	T1p3	T2p1	T2p2	T2p3
AT3	8300	6309	4508	5605	6098	8288
DT2T3	120.1480	115.5307	118.8433	93.7177	107.6493	119.5789
H	76.4562	66.7887	40.5770	63.2304	46.4947	61.6521
HLTL	267.2171	298.2918	242.7694	343.2273	253.8523	258.6987
Lpg	395	404	263	471	377	402
MiT3	76.5609	68.0085	73.3004	52.2771	56.2681	74.5459
T2T3	120.1480	115.5307	118.8433	93.7177	107.6493	119.5789
Wpg	373	325	359	213	291	347
Pad area	31203	46864	34797	28893	27457	39735
Area toe 1	5705	6943	3343	4894	4416	5954
Area toe 2	7678	6309	4508	5605	6098	8288
Area toe 3	8300	6912	4530	5716	4917	5240
Area toe 4	7258	5498	3537	5869	3118	4517
LT2	67.854	68.4453	67.4156	58.6929	54.9006	61.4259

Table 1: Parameter extracted for Tiger T1 and T2

Parameter	T3p1	T3p2	T3p3	T3p4	T3p5	T3p6
AT3	6818	6111	3746	2415	2835	7703
DT2T3	99.2887	63.4684	66.4859	63.0390	71.1197	141.4499
H	80.1660	53.0278	64.0109	38.8870	74.5648	72.6329
HLTL	267.6191	218.0505	252.3886	198.4036	213.6376	304.967
LT2	53.7526	41.1873	41.5993	31.8248	32.7256	79.3487
Lpg	390	354	376	295	338	469
MiT3	67.9881	49.2961	39.6492	30.2829	30.4755	63.6857
T2T3	99.2887	63.4684	66.4859	63.0390	71.1197	141.4499
Wpg	356	195	196	135	166	328
Area Pad	38242	17641	20273	14146	15372	39138
Area toe1	8101	4033	2848	1383	2339	6890
Area toe2	6818	6111	3746	2415	2835	7703
Area toe3	5566	4625	4218	2129	2949	10818
Area toe4	4986	3143	3613	1678	2510	5498

Table 2: Parameter extracted for Tiger T3, T4 and T5

Parameter	T4p1_1	T4p1_2	T4p2	T4p3	T4p4
AT3	3411	5235	1527	1454	742
DT2T3	69.2852	59.7764	49.8820	72.1244	40.1626
H	41.5155	43.7385	41.9364	61.6750	27.2466
HLTL	228.1074	265.7066	174.9426	270.1851	148.0135
LT2	28.9976	33.4682	33.6194	34.6436	27.3058
Lpg	321	387	227	348	199
MiT3	45.5503	49.3823	27.7293	27.4762	21.1539
T2T3	69.2852	59.7764	49.8820	72.1244	40.1626
Wpg	198	162	135	207	119
Area pad	17072	18842	8964	21490	6199
Area toe1	4223	3407	1202	1936	1402
Area toe2	3411	5235	1527	1464	742
Area toe3	2097	3517	1454	2103	1105
Area toe4	2206	2526	1005	2048	665

Table 2: Parameter extracted for Tiger T4

Pseudo code of algorithm:

- Convert RGB image to binary image
- Boundary detection of pugmark in image
- Feature extraction of pugmarks
    - Area of toe 3
    - Length of minor axis of toe 3
    - Distance between toe 2 and toe 3
    - Length of minor axis of toe 2
    - Distance between main pad top to toe base-line
    - Angle between toe 2 and toe 3
    - Heel to lead toe length
    - Width of the pugmark

Length of the pugmark
Pad area
Area of toe 1
Area of toe 2
Area of toe 3
Area of toe 4

- Creation of feature vector of all features
- Calculate the Gaussian distance from all the feature vectors in training set using a sample feature vector
- The feature vector with the minimum distance will be recognized as pugmark of particular tiger

Results

The algorithm has been tested on 60 pugmark images of 6 tigers. The recognition rate of algorithm is 94.3 %. The algorithm is not able to classify those pugmarks which foot print is not clear on soil.

Conclusion

The paper is focused on identification of tigers by recognizing their pugmarks. The pugmarks were collected from the forest and zoo. The pattern of each pugmark is analyzed by image processing. 14 features were extracted from each of pugmark image and stored in master database. The detection of algorithm is based on Euclidean distance between the master database and the parameters of testing image. The result of recognition is 94.3%. The future perspective is to make an independent hardware which can be used in forest.

Acknowledgement

We would like to thank to officials of Chhatbir zoo, Chandigarh, Panna forest reserve MP, and Wildlife Institute of India, Dehradun to provide support for experimentation and data collection.

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