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Fish Classification Algorithm using Single Value Decomposition

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ABSTRACT: Automatic fish classification system plays a very useful role in the process of separating fishes into species for human consumption,ornamentation and other usages. Manual classificationof fishes into different types is difficult and boring. This work proposes a fast and accurate system capable of classifying fish images into distinct classes based on their physical form. The system comprises image-processing, feature extraction and classification method. Fishfeature vector is obtained from Single Value Decomposition (SVD) product extracted from fish block images. Training and testing of the proposed fish classification system are done using Artificial Neural Network (ANN). Experimental test was carried out to determine the species of query fish images. Thirty-six fish images were tested, 94% correct classification result is recorded.

KEYWORDS: Fish, Single Value Decomposition, Feature vector, Artificial Neural Network.

I. INTRODUCTION

Fishes are aquatic gill bearing vertebrate which lack limbs with digits. They can be found in abundance in nearly every habitable water body.Also they can be cultivated in ponds for commercial purpose;they have either bony or cartilaginous skeletal structure. They possess appendages known as fins which are used to control motion in water; among distinctive fins are dorsal, caudal, anal, pectoral and pelvic fin. Fishes have always been an important source of income and food for mankind. In Nigeria; there are many indigenous fish species of ornamental value, such fishes like trunkfish, marble catfish, butterflyfish andAfricanpike serve assources of income.

One of the challenges facing fishing activities in many developing countries is difficulty of manually ascertaining different species of fish for most valuable purpose. There are several metric featurethat are still in use to classify fishes into different species such as manual counting of number dorsal, anal, caudal, pectoral and ventral fin rays and spines and getting length fish parts using measuring board[1][2].

This work seeks toprovide fastalgorithm responsible for encoding of fish image contents for classificationusing image processing and machine vision techniques.Automatic classification of object of interest into different group is an important research area that involves application of artificial intelligence techniques such as Neural Network (NN), which makes the process of data classification possible fornon-linear separable features.There are several other techniques which can be employed to implement such systems such as K-Nearest Neighbour (KNN), Hidden Markov Model(HMM) and Support Vector Machine (SVM)[3][4].

Automatic fish classification systems are essential for a wide range of applications which includemanagement of fisheries resources,aquaculture development, conservation offish species and ornamental fish trade.

II. RELATED WORK

Development of a fish classification system has been undertaken previously with varying levels of accuracy. The main differences between the various approaches are the features extracted and the algorithms implemented for classification.A fish classification system that is based on colour texture measurements is proposed in [5]. The system uses the Grey Level Co-occurrence Matrix (GLCM) method for the extraction of feature and ANN is used for fish classification. In [6], fish classification method based on global geometric feature was developed. The system involved

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decision trees andANNto classify fishes into poisonous and non-poisonous cluster. The system appropriately recognized fish imagesand analysed their individual impact whereas in [7],fish recognition system is proposedwhich made use of Support Vector Machine (SVM) and fish shape features. The systemmade use offeatures extracted from length of fins as a means to improve the accuracy of existing methods. The method developed in [8] involved the creation of an automatic classification system that recognizes fishes, plants and butterfly species. It involved the extraction of geometric, morphological and texture features from images and it made use of Artificial Neural Network (ANN) for pattern recognition.In [9] fish recognition systemis proposed,thesystem depends on feature extracted from fish shape, size and colour.And the features extracted were used to train Artificial Neural Network (ANN) for fish recognition.

In this work, feature vector is extracted from fish body pattern using Single Value Decomposition (SVD). The featureand ANN are used to develop the proposed fish classification algorithm. This method is better compared to previousmethodsbecause extracted featureis independent on fish colour, shape and size;these physicalcharacteristics are not stable due to variation in age and season across different fish species.

III. FISH IMAGING AND PRE-PROCESSING

This work made use of eighteenindigenousfish samples obtained fromEbuteRiver in Epe local government area of Lagos state, Nigeria. Fish imaging was carried out by placing the individual fish sample on a clear white plane and photographing five times using a cannon power A14000 HD digital camera. Figure 1 showsimage of most commonly found fishes in Nigeria waters. The fishes are named as shown in Table 1.

Table 1. Names of acquired fish samples

No.	English name	Scientific name
a.	African pike	Hepsetusodoe
b.	Bichir	Polypterusbichir
c.	Butter fish	Schilbemystus
d.	Climbing perch	Ctenopomakingsleyae
e.	Mackerel	Scomberomorustritor
f.	Mormyrups	Hyperopisusbebe
h.	Tilapia	Tilapia spp
g.	Silver catfish	Chrysichthysnigridigitaus
i.	Sardine	Sardinapilchardus
j.	African carp	Labeopseidocoubie
k.	moonfish	Citharinuscitharus
l.	Marble catfish	Marcuseniusihuysi
m	Flatfish	Symphuruspusillus
n.	Glass catfish	Physailiapellucida
o.	Elephant nose trunk fish	Gnathonemuspetersii
p.	Reed fish	Calamoichthyscalabaricus
q.	Silver moony	Monodactylussebae
r.	Crayfish	CambaridaeCamburus

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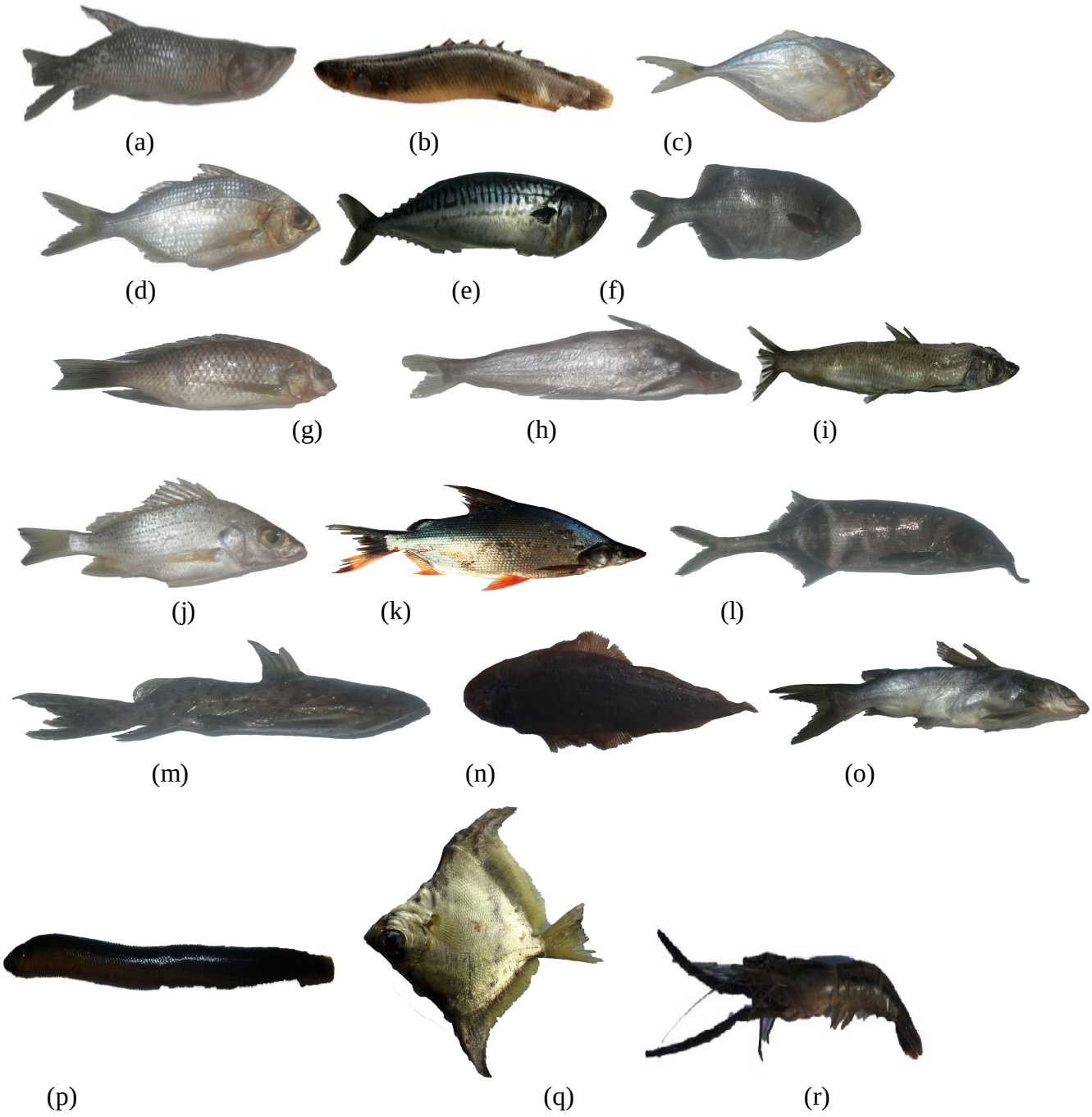

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Fig.2 Colour fish image sample

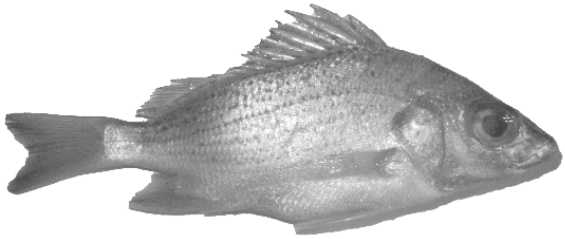

Fig. 3 Grey-level fish image sample

Colourfish images are converted to grey-level images using (1). Example of a colour fish image and corresponding grey-level image are shown in figure2 and figure 3 respectively.

$$I = 0.2989*R + 0.5870*G + 0.1140*B \quad (1)$$

Where: I is the intensity of the resultant grey-level image, R is red component of the colour image, G is green component of the colour image and B is blue component of the colour image.

IV. FEATURE EXTRACTION METHOD

The extraction of discriminate fishfeature is a very important process ofobtaining reliable classification system. Fish body pattern vary from one species to another. Some fishes have scaled body that vary in size and structure with different types of fins whereas some fishes have naked body with absent of typical fins. In this workSingular Value Decomposition (SVD) is applied to fish block images to capture the type of body parts pattern exhibited by different fish species.

SVD is avery useful tool in linear algebra;it has applications ranging from data compression to data extraction [10]. Singular Value Decomposition involves the factorization of any $m * n$ matrix into USV^T where U and V are orthogonal matrices and S is a diagonal matrix comprising of singular values of the original matrixA as given in (2).

$$A = USV^T \quad (2)$$

Robust feature is extracted from fish image by using Single Value Decomposition component. The image is divided into fifteen image blocks by a moving overlapping window,thereafter feature values are extracted from every area occupied by the window as it moves from head to tail region. These feature values are combined to form feature vector. The feature extraction steps are stated as follows:

Step 1: Resize fish image to specific dimension.

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Step2: Set the size of moving window.
Step3: Set the number of overlapping pixels.
Step4: Slide window over grey-level fish image from head to tail to divide image into fifteen blocks. Example of fish block image is shown in figure 4.
Step5: Perform Single Value Decomposition on each block image.
Step6: Extract predominate feature element from S matrix of each block.
Step7: Combine feature elements from the entire fifteen image blocks to form a feature vector. Example of feature vector extracted from some fish samples is as shown in table2.

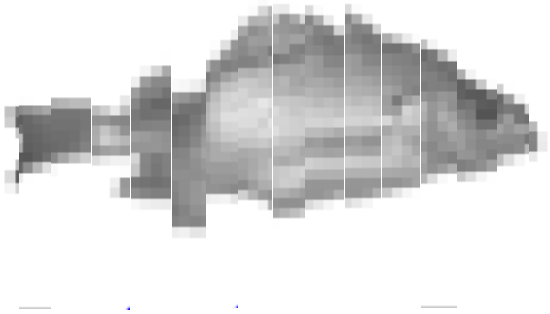

Fig.4 Fish block images

Table2. Feature vectors for some of the fish samples.

No.	Name	Feature Vector
1.	African carp	[215,128,56,119,137,73,160,112,67,116,100,126,157,149,152]
2.	Butter fish	[11,88,145,87,43,120,147,143,104,72,96,114,176,226,9]
3.	Climbing perch	[9.23,66,223,182,92,146,198,65,122,89,130,116,132,219,50]
4.	Marble catfish	[1.22,144,246,62,69,248,150,97,45,47,68,104,199,295,4.77]
5.	Mackerel	[502,449,205,300,311,262,155,115,98,134,223, 247,266,335,485]
6.	Silver catfish	145,130,67,70,76,59,81,27,119,132,156, 209, 8.33, 2.28
7.	moonfish	[168,308,190,212,278,151,404,256,298,219,215,281,319,285,319]
8.	Tilapia	[3.37,3.78,286, 49,155,123,103,87,60,75,123,187,256,9.22,8.33]
9.	Reed fish	[317,149,29,87,93,70,27,61,34,41,33,83,56, 157,384]
10.	Crayfish	[0.85,400,345,119,152,88,97,255,303,334,406,263,81,7.61,4.01]

V. FISH CLASSIFICATION USING ARTIFICIAL NEURAL NETWORK

Artificial Neural Network (ANN)emulates operation of biological neural system such as the human brain. It consists of interconnected neurons based on specific network architecture. One of the most useful ANN for building pattern recognition systemis Feed Forward Neural Network (FFNN) called Back Propagation Neural Network. The network consistsof input layer, output layer and one or more hidden layers.The number of node in the hidden layer depends on the nature of the problem.The network is trained by passinginput data to the input layer and it flows forward to the output via hidden layer and thenthe error signal differences of thetarget from actual output is propagated backwardthereby adjusting the weight values of the interconnected network.Once minimum error value is reached, network parameters are stored to create knowledge base for the testing process.

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VI. EXPERIMENTAL RESULT

In this work, aFeed Forward Neural Network (FFNN) called pattern recognition network wascreated, supplied with input and target data, thenetwork was trained and used to classify fishes into different classes based on target data. Input data matrix consists of eighteen column feature vectors extracted fromthe fish samples. The target matrix consists of vectors which haveelements equal to one at a position that represent a classand is equal to zero in all other positions. The number of node in the output layer is equal to the number of classes of fishes in thedatabase.During testing the feature vector of fish to be classified is fedinto the network, output is produced based on parameters already stored in the trained network and class result is provided. Reasonable classificationresult of 94% is achieved.

VII. CONCLUSION

Fish classification method based on Artificial Neural Network (ANN) has been developed. Feature is extracted from fish body pattern using Single Value Decomposition (SVD). Feature vector is formed from fish image blocks and passed as input data to ANN algorithm to classify fishes into different species. The result from experiment conducted has showneffectiveness of the proposed method. This type of system will enhance effective management of fish resources for different purposes based on species.

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