MACHINE VISION BASED LOCAL FISH RECOGNITION

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This Report Presented in Partial Fulfillment of the Requirements for the Degree of Bachelor of Science in Electronics and Telecommunication Engineering

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APPROVAL

This Project titled **"Machine Vision Based Local Fish Recognition**", submitted by Tasnem Ahmed Joye, Israt Sharmin, Nuzhat Farzana Islam, Israt Jahan to the Department of Computer Science and Engineering, Daffodil International University has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of B.Sc. in Computer Science and Engineering and approved as to its style and contents. The presentation has been held on 9 December 2018.

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DECLARATION

We hereby declare that, this project has been done by us under the supervision of **Md. Tarek Habib, Assistant Professor, Department of CSE** Daffodil International University. We also declare that neither this project nor any part of this project has been submitted elsewhere for award of any degree or diploma.

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ABSTRACT

Every single country has its own tradition which help to identify its self differently in front of the whole universe. Like others our county has some abundance too. River dimensional, this country is the state of sweet water fishes. Because of natural climate this is the only birth place of those local fishes and available here. Which fish are local? Where they belong? When they can be found? So many questions are related with them as we hardly know our local fishes. Branch of them can identify easily, but most of are lost in the absence of saving. Without knowing, we cannot save those fishes from being extinct.

A lot of work has been done in the field of research on recognition which has been came in front of us. There is minimum work on fish, and if we focus on the word local, still any research has not been done on Bangladeshi local fish. This is why it make us more interested to work on this section. With the help of this research some local fish can be recognize by capturing image. For research, we collect data from local fish market and then with the help of machine learning the rest of work has been done.

We use some feature extraction like Color Analysis, Texture Analysis, Segmentation and three type of classifiers for training our data. After classification various experimental test have done which can determine whether it's enough hard to recognize our local fishes. This work of research is related with Machine- vision, in that case image processing is used to recognize our local fishes. Machine Vision is the one kind of technology and methods which is used to provide imaging-based automatic inspection and also analysis for such applications like automatic inspection, process control, and robot guidance, usually in industry.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

According to 2018 the current population of Bangladesh is 166,891,852. The population of our country is huge. Many people of our country couldn't buy their necessary food items upon which they live. Because it is a densely-populated, low lying country. Among many food fish is very necessary for our health. There are about 32,000 species of fishes in whole world and one third of the species live in fresh water. In Bangladesh there are 401 species of fishes. Fish contains high-protein, low fat food that gives a range of health benefits. Fish oils are also important for our health. Especially for children, eating small fishes are good for our eyes. But unfortunately for flood and river erosion our livelihoods become a threat. Rivers are emergent to our life, nature, subsistence and culture. If rivers doesn't subsist then we will lost our local fishes. Though we have already lost many local fishes for river erosion, water pollution. That's why in today's era maximum of us doesn't have knowledge about our local fishes. There are lots of local fishes in our country. Some of their names are given below-

- Artamim, Anju, Arwari
- Baim, Botika, Bou mach, Bele
- Chapila, Kholshe, Pabda, Punti
- Meni, Bilchuri, Murari,Darkina

In the past, Bangladeshi people were almost dependent on land-based proteins. But because of a riverine country, we concentrate on our local fishes to reduce the pressure of land-based foods. Many local fishes of our country become cancellous. Our present generation and next generation will have no idea about these fishes. Our project is dealing with the local fish's existence. From this project we can recognize local fishes by their name, color and textures. We studied on its theoretical concepts and after that we will developing this site in future works. We study various types of papers on this affair. After study we decided that our work procedures will go by using machine vision which is under machine learning.

When we look at an image where some people are in the picture, if any known person in there, we can easily recognize him or her. We can also tell some phenomenon about

the person. But if same thing happens with computer just like if computer sees the same picture it can't tell anything either we do it with machine vision or computer vision. So in short machine vision means if computer or machine has sight. Machine Vision plays an important role by achieving best quality in manufactured things, reducing costs and ensuring a high level of customer satisfaction. Cameras and image processing software help machine vision for better inspections. That's why, we are going to use machine vision for recognizing local fishes. In our research, first of all we capture enough pictures of a local fish with both sides and various angles. Then machine can be learned by the pictures and easily get a concept of a fish those pictures are given before for learning and after completing our research if anybody captures pictures using any resolution of same fishes that we work upon through our research, machine vision can easily recognize them as local fish. In our research, we use six classes of fishes such as Pabada, Meni, Puti, Bele, Boumach, Kholse which cannot be found in other country. And we do our machine learning procedure getting idea from image processing and machine learning based thesis paper.

1.2 Motivation

We are a part of a country which is in rich with different category of fishes, but hardly can recognize them. If we can make this work easier to identify, then it will be an interesting work intend of suffering. And our local fishes will be no longer extinct.

Birth place of fishes can make difference. Sea fishes that we get from ocean and local fishes which we get from pond, river etc. It is important to identify them that going to be helped by this work.

Sometime, people went to the market and get confused to see the fish between local and cultivated fish. Cultivated fish which replacing the local fish, get easily, are different in taste and sometimes harmful for human body too. So, the purpose of this paper is to recognize the local fish by a majority people. Another motivation, we get to do this work is to get rid of deceiver. Usually in fish market people may know the name of local fish but hardly know how its look like. Those cultivated fish which are replacing the local fish are become difficult to specify for a short fish knowledge-based person. And here is the point where the fraud sellers take the advantages. They sell cultivated fish saying local fish, and people believe on their words as they don't have any option

to check it. So, we believe that this research project is going to help to solve these kinds of confusion.

As we live in an age where works are going on with the help of electronic device, or mechanical device that operate electrically, make every work easy and clear. But we found absence of this automated system in fish market. And if any kind of system can find out this issue it will be easier to recognize. Final one is that proper law do not maintain on this place where problems are occurred. Lacking of monitoring, mobile curt attempts and wrong use of power make an undisciplined situation. So if we aware of by us about recognizing fish, we can handle those situation. And we are also interested in image processing and machine vision. That's why we are interested to do such work which is research-based work.

1.3 Rationale of the Study

There are lots of work based on sea and tropical fish topic. But there was no work flourished on local fish. We mainly work on this fishes because local fishes are connected with our culture. This fishes produced only in our land. We have to save them from extinction. Nowadays not only children but also adults don't want to eat fish. They have no interest on fish for buying them from market because of high price and not enough knowledge about health. That's why the children of nowadays suffer from lacking of protein and other multivitamins. Many people have no knowledge about fishes. When they go to fish market, they are cheated by fish seller for no knowledge about fish names or their textures. Many fishes looks similar to each other. But every fish has own taste and different type of vitamins.

In this project we can recognize the fishes by their size, color and texture. By using machine vision we can recognize the fishes.

1.4 Research Questions

There are some phenomenon that help to bring some questions those are related to our work. From these questions we can improve our research and anybody can get clear concept.

- Can we only detect local fish? Or can we detect sea fish as well?
- Is there only white background which we will use for taking pictures of fishes? Can we change background?
- Can we detect if there are more than one fish?
- When taking pictures, if there are any small amount of water or dirt, those will not be detected. But if there are any type of objects that will be a little bit bigger such as human fingers, insects can we eliminate them completely?
- If we take pictures of fishes at various angles, will those pictures be detected perfectly?
- If the dimension of image are different then how can it will be recognized?

1.5 Expected Output

Expected outcome of our research based project is to recognize local fish. Here we have to generate an efficient process or algorithm that will boost our project as like when anyone takes a picture of a local fish over white background and upload it following the process, then this procedure can easily recognize the fish if its local otherwise the fish will not be identified. Even the fish will be visualized if resolution of camera is either enough good or not so bad.

1.6 Report Layout

The report will be described as follows:

Chapter 1 provides substance of our research based project. Firstly we introduce all about our project as well in this chapter. Afterwards there is a content that is based on what motivated us to do this project. Hereafter why this study is helpful for us that will be described in rationale of study very well. Then some content name as research questions and expected output are also written in the last part of this chapter 1.

Chapter 2 involves the discussions of what types of works done in this field before. Moreover this second chapter provides the summary of those related works and the problems that were the limitations of these area. And lastly it explains the challenges that could not be overcome.

Chapter 3 represents theoretical description of this research project. This chapter expands the procedure that will encourage using statistical method. And very last it explains data collection processes and instrumental objects that grant us by taking raw pictures of fishes. In this chapter, we will discuss our procedure for this work and also give some figure. Hereafter implementation requirements will be required in third chapter.

Chapter 4 utters experimental outcomes and discuss the results properly. In this forth chapter we attach some experimental tables and pictures that display the procedure and how we finalize our project.

Chapter 5 is based on conclusions of our research. Finally this chapter includes our final work limitations and challenges. And if anyone wants to research elaborately in this field this research is a big scope for them to assist.

CHAPTER 2

BACKGROUND

2.1 Introduction

Here we discuss about the preceding works which have already done by some researchers in this field. Along with we will also discuss about those limitations of these works and finally we included scope of our research as well as the challenges of it in this section.

2.2 Related Works

The IUCN Bangladesh (2000) has made a list of fishes which are threatened to be vanished from Bangladesh. Many local fishes defunct in our country. It is a matter of woe that very few works has performed at fish sector. But as far as we know that still now no work has completed about local fishes which are deeply connected with our country.

There are adequate works for fruit recognition by their many characteristics. Recently many work has been done on this. Like on their Color and Texture [5], Grading system [6], Color Characterization [7], Classification [8], Detection of Defective Apple [9] and many works done by using Machine Vision.

Apart from this some works of food done by using Machine Vision Applications in recognition and aquatic food [10,12], Deep Convolutional network with pre-training and fine-tuning [11].Some works related to our research work which are given below with a short description.

From the paper [1], we get some information about machine vision and neural network. As, Machine vision system actually measures a number of features of fish. Here this thing seen by a camera to a conveyor belt. Widths and heights of fishes are counted here at various location. For the image processing, they used three VME-bus which printed circuit boards from DATACUBE. For developing the software, the system was connected to a workstation. This was the platform which they used to generate and train the neural network. After training this network, only 60% of the fishes of different species were classified correctly. Nearly 98% was classified correctly. As per the report [1], the confusion matrix is shown in table2.1.

Table 2.1: Confusion Matrix for Neural Network

Result of classification by the network

Species Classified by the network as

	Sole	plaice	Whiting	Dab	Cod	Lemon sole	Error(%)
Solo	50	0	0	0	0	0	0
Place	0	47	0	1	0	0	2
Whiting	0	0	41	0	2	0	5
Dab	0	0	0	46	0	0	0
Cod	0	0	1	0	15	0	6
Lemon sole	1	0	0	0	0	47	2

From the paper [4], we get some information about Classify by color, texture, SVM. This paper gave a new method for classifying species of fish based on color and texture features and using a multi-class support vector machine. Images of the fish, 1024*768 size were captured, in different ponds at daytime. All the fishes were lying on the horizontal ground and with body length. The camera was set to automatic exposure and focus mode. Automatic cropping programs were used to crop the original fish images, to obtain same pixel size images. Here fish texture images were converted from RGB space to HSV space, and six HSV color features were extracted as well. Gray scale histogram based texture, and the other was gray level co-occurrence matrices based texture used. GH stored the statistical attribute of histogram brightness of the image which they used in their work. GLCM stored the probability of co-occurrence between two gray levels. The main advantage of wavelets is that they have a varying window size, being wide for low frequencies and narrow for high frequencies, thus leading to an optimal time-frequency resolution in all the frequency ranges so they used it as feature extraction. Entropy and energy are widely used features for texture analysis. Gray scale, RGB, HSV color, wavelet, decompose R,G,B by Wavelet , decompose H,S,V by Wavelet were used for feature vector. Two types of OAO based MSVMs were constructed and compared to serve for the classification of fish species directed acyclic graph MSVM and voting based MSVM, nonlinear SVM software LIBSVM. Here, in fig. 2.1, shows DAGMSVM for fish classification taken from [4].

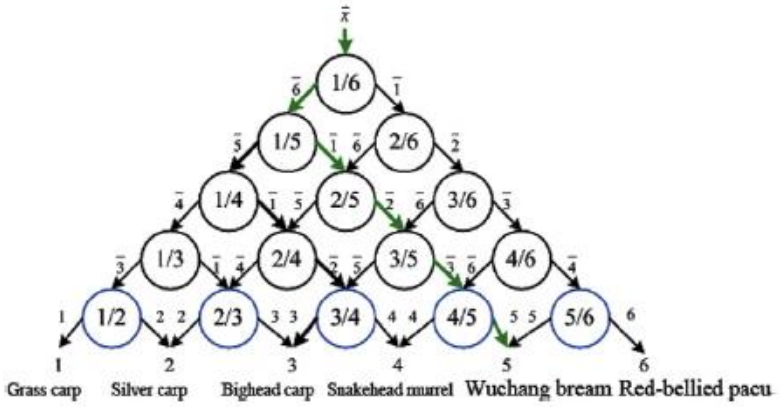


Figure2.1: DAGMSVM for fish classification

The root node and intermediate nodes were denoted as solid line circularities in black, while leaf nodes are denoted in blue. MSVM achieved a level of accuracy only 0.19% lower than VBMSVM in their work. As per the report [4], result of DAGMSVM is shown in table2.2.

Table 2.2: Classification results of DAGMSVM

Classification results of DAGMSVM.

Species	Classification		results				Sample number	Accuracy (%)	Times (ms)
	GC	SC	BC	SM	WB	RP			
GC	90	0	0	0	0	0	90	100	10.1
SC	0	83	4	1	2	0	90	92.22	18.5
BC	0	2	87	1	0	0	90	96.66	15.9
SM	0	0	0	90	0	0	90	100	9.4
WB	0	1	0	0	89	0	90	98.88	12.8
RP	0	0	0	0	1	89	90	98.88	9.5

From the paper [3], we get some information about Robust Feature Extraction using Neural Network. Fish attributes can be computed and collected from size and shape measurements tools like size of mouth, angle of head, caudal fin length, dorsal fin length, caudal angle and the angle between the mouth and the eye through the distance and geometrical tools and the process of doing this kind of calculating is called feature extraction. Here using landmark point detection where they found that the one point to another point measure of fish. 97% as a maximum percentage of accuracy. For implementing this method, they used MATLAB programming language for their research work.

Researchers used 500 hundred fish images families for testing their method where 350 fish images for training and the rest 150 for testing. In feature extraction, they used 10 features that rely on distance measurements and 5 features that rely on angles measurements. They defined 18 anchor/landmark points on the shape of pattern of fish, where 4 landmark/anchor points could be defined automatically using our program. In table2.3 shown overall accuracy of their work [3].

Table2.3: Overall accuracy of training and testing

Description	Results
Overall Training Accuracy	89%
Overall Testing Accuracy	86%

2.3 Research Summary

The above all discussion has been done on several types of research works from different research teams. It is being show up to us that recently research on our own local fish of our country no work has been done. Tropical fishes recognition, sea fish recognition and many different type of fish's recognition are shown in different papers. The age, disease, color and many characteristics of fish are shown by Image Processing. But those fishes are not our country's local fishes. In the upper sector food's, fruit's many classifications and other works discussed on those paper works. Though enough resources are not present but hope is that this field is becoming more resourceful within very next days.

2.4 Scope of the Problem

The papers which we are discuss above from those we found the problems where huge data cannot proceed. The condition of a fish changes with the season of the year and the geometry changes also happen. Some of the results that is close to the minimum percentage which occur some problems where a noise identification interruption to the neural network. The problem in fish recognition is to find meaningful feature based where image segmentation and features extraction. The accuracy may be change because they depends on the classifications and other algorithms which are used those papers.

2.5 Challenges

The main challenge of this work is that dealing with the datasets. To solve this challenge we need some skilled approaches to perform it but unfortunately there are not enough recognized approaches to do it. Another challenge is, the pictures of fishes in different angles may be some time occur geometrical problems which solutions are very difficult to solve. Then there is not having enough resources regarding this topic where we can discuss about other problems which are related with this.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

This chapter mainly handles all the theoretical information of our research. Anyone will get clear impression thought about our thesis. Making it more commodious to understand we assembled some important knowledge shortly. For learning machine learning or data mining, data is very significant. So we discuss data collection procedure very briefly. And in the content of statistical analysis, it involves calculations and illustrates all data set to make it more logical explanation. In the content of Workflow, we will give clear concept about our method for recognition the fish. Apart from this chapter is being closed by giving distinct interpret of the implementation requirements.

3.2 Research Subject and Instrumentation

The interpretation of research subject is that field which we want to study about the related work and from these anyone can understand this domain clearly. Not only making it clear but also research subject is bounden for accomplishing our thirst of several types of research parameters. On the other hand, instrumentation mentions to the required instruments or tools that are used by the researcher. Besides research questions are answered by using instrumentations by how to, when to, where to gather data and how to analyze data. These decisions must be made as plan for the research based project. They support to guide for reaching the goal of our study and answer all types of research questions.

3.3 Data collection procedure

We need to collect some data on local fishes, for working purpose. Because of that, we can easily identify those fish's locality, their physical structure etc. Instead of downloading pictures from internet we work with those pictures which had been taken by capturing fresh fishes.

At first, we collect some local fishes from fish market which come from different ponds, rivers and lakes during rainy season. These fishes are not found in any other county, that's why they are introduced as local fishes. We select six suitable fish family for

work such as PUTI, BELE, PABDA, KHOLSHE, MENI, BOU and all of them are different in category.

Using a white background, we captured front view and both sides of a single fish with an electronic device. Every selected single fish going through the same process, the light and the environment are same for all of them. 30 still pictures are captured for a fish and in total they are more than 180.

3.4 Work Flow of Recognizing Local Fish

Work flow refers to how to preprocess data and how to arrange them step by step very well to understand all the methods very quickly and having the scope for analyzing data to draw some limitations. In Shown fig: 3.1, we are going to discuss step by step what method we used for our work.

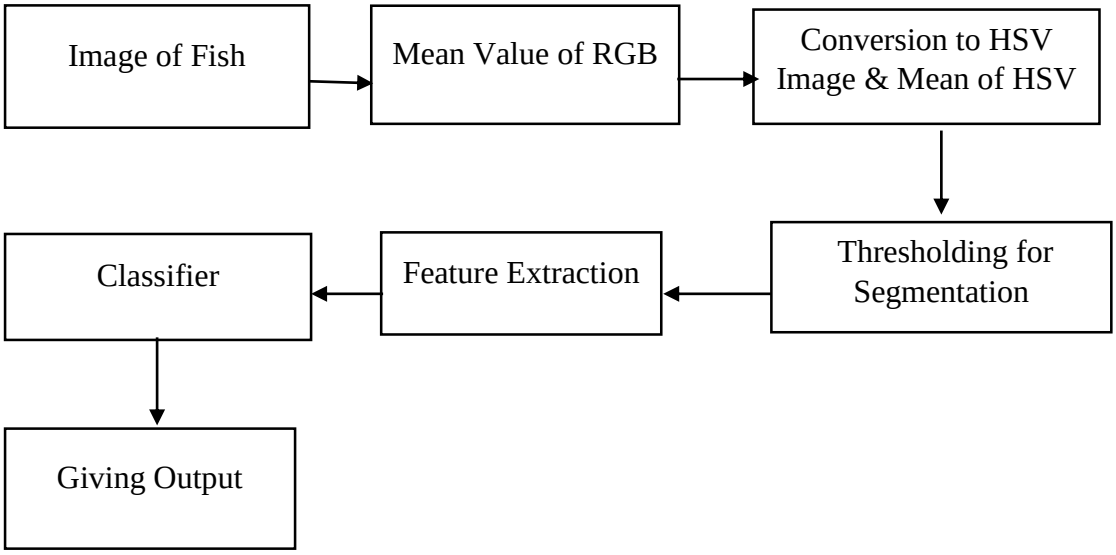


Figure 3.1: Block diagram of Recognition of fish method

3.4.1 Image of fishes

At first we put all the local fishes above a white background for taking pictures of them. Using white background makes the pictures more translucent. When taking pictures some conditions should be remembered. Pictures can be captured by using any angle and or any dimension. Pixels and resolutions do not matter for making the pictures more clear. But here 512*512 dimensions is used by us for assisting our research.

3.4.2 Feature Extraction

We mean by feature extraction is the reduction process of dimensionality where all elementary data set of raw variables that are needed for processing are reduced in a controllable groups for identifying informative and non-redundant data. In machine learning or image processing feature extraction can measure data and build derived values for reducing the amount of resources that are required to describe a big amount of data set. When in an algorithm the input data are too much that interrupted to process informative data, then we know that those data are redundant. So we have to reduce them and put them in some features to make it more convenient. One very important application of feature extraction is machine vision those features help to recognize fiber, fin, gill, color, edge all types of natures that a fish have.

Some features are mentioned as follows:

Color analysis:

For extracting features, at very first our first priority is to do color model. Form this application we need RGB and HSV that's very advantageous for us. Not only those models, but also we have to do some covert of color model to manufacture the process for better implementations.

The RGB color model is an additive color model that has three colors of its own. They are: Red, Green and Blue. They are added simultaneously in a various ways to reproduce a huge section of color arrays. In electronic systems such as TV, computer are used RGB color model for sensing, representation and display of images those which are the main purpose of this color model. RGB is a device-dependent color model. For numeric representation a color in the RGB color model is described by pointing how much of each of the red, green, and blue is included. Each color individually indicate zero to maximum values. We use RGB color model because all the fishes have different colors. This is the equation, we used to calculate Red component, Green Component, Blue component and Mean of RGB space. Here, N_{FI} refers to the number of calculated pixels in color images of fish (FI).

$$\mu = \frac{1}{N_{FI}} \sum_{(i,j) \in FI} I(i,j) \qquad (3.1)$$

But RGB is not very efficient for color analysis so we convert RGB image to HSV space. HSV is the alternative color representation of RGB model where human vision perceives color attributes to make it more closely classify. Putting black at the bottom and white at the top, colors of each hue of HSV color model arrange it through radical slice, around central axis of neutral colors.
In color making attributes there are some contents that make it more understandable such as hue, radiance, luminance, brightness, lightness, colorfulness, saturation etc. This color model is very useful for color analysis. Here, we also use same equation to calculate Hue, Saturation, and brightness components in HSV space.

Segmentation:

Segmentation is the next step to do our research complete. We mean the segmentation is the process to partition a digital image into multiple segments using pixels. It simplify and/or to represent an image to something changing that is more meaningful and easy to analyze. More precisely image processing is typically used to locate objects and boundaries as line, curves etc. As a result we can see it can do segmentation by collectively cover the entire image that is extracted from the image. In a region each of the pixels are similar with some characteristics such as color. For finding the region where the fish exists, segmentation is needed. In our research, we use threshold for segmentation. It is the simplest method of image segmentation. Helping of a black pixel it can replace each pixel in an image if the image intensity is less than some fixed constant, that is $I_{ij} < T$ or a white pixel if the image intensity is greater than constant.

Some category of thresholding are:

- ✓ Histogram shape-based method where peak, valley or curvatures of the histogram that can smoothen are analyzed.
- ✓ Clustering methods help to detect gray level scale that is responsible for our research.
- ✓ Entropy based method can cross entropy between the original and binarized images.

  In our search, we use Histogram shape based method for segmentation because there is only one object we have defined.

  In fig 3.2, we show the segmented image where we use thresholding method.

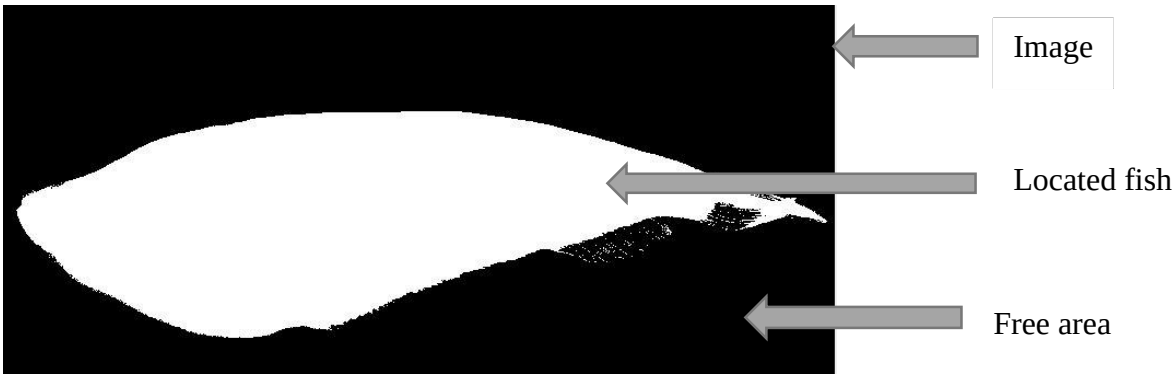


Figure 3.2: Thresholding for segmentation

Geometric Features:

Machine learning and computer vision are combined to solve visual tasks in geometric feature extraction techniques. Finding a set of representative features of geometric form to collect data from images and use them for efficient machine learning methods, it's the main goal of geometric feature. Geometric feature not only solve recognition problems but also it have idea to give exact input from image by analyzing them. Geometric features are constructed by a set of geometric elements like points, lines, curves or surfaces. These features can be corner features, edge features, Blobs, Ridges, salient image texture and so on, which can be detected by feature detection methods.

In our research, after segmentation we get pictures of fishes where we set the fishes above a white background, so geometric features help to indicate the edges of fishes and calculate the area where the fish exits.

In this work we add six features; height and width, area, solidity, perimeter, convex area, mean intensity.

1) Height and Width: We take six different fishes for our research. Those fishes are different in height and width. So, we use this feature in our research. For calculating height and width, we count the pixel of height and width where the fish exits. In fig. 3.3, we show that different fishes can have different measurement of height and width.

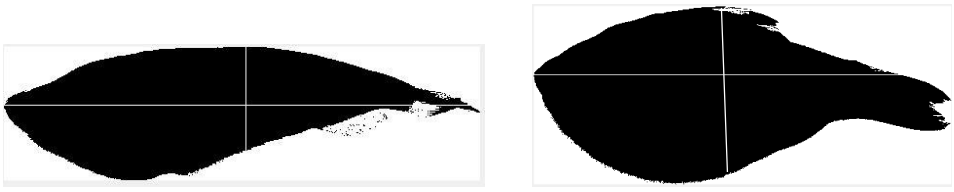


Figure3.3: Height & width of two different fish

2) Area is used for measuring the fish in the segmented image. This feature can detect all the area of pixel that have enough resolution. Area (Ar) is actual number of the pixel insider the object.

   Solidity (So) is the proportion of pixels which is the set of convex. Solidity defines as the percentage of the circumference that contains material of high solidity and low solidity. Convex (Cv) is the number of pixel in the convex hull. Perimeter (Pr) is the distance around the boundary of the object. Eccentricity (Ec) is the eccentricity of the ellipse. It calculates how the un-circular the curve is. Here is a for Solidity where S is solidity

   $$S = Nc/2\pi r \qquad (3.2)$$

   Fisher are different in seize so we use this feature for our research.

3) Mean Intensity:

   Intensity of an image can be mean pixel intensity measure. Measure of intensity can be how bright the image comparing the other image. So in our research, we compare the segmented image with gray scale image and then calculate the intensity. As, fisher are different from each other so this feature is also important for our work.

Fourier Transform:

Fourier transform is used to compute the complex data sequentially. After geometric features, we do some transform to collect some data step by step that help to make it clear. With this data the periodic two dimensional that discuss some functions of objects. It is in the frequency domain. The Fourier transform is a general concept of the complex Fourier series in the limit which is $L \to \infty$. It has to be replaced with the discrete A_n with the continuous $F(k)\,dk$ while letting$n/L \to k$. Then change the sum to an integral, and the equations become as given;

$$f(x) = \int_{-\infty}^{\infty} F(k)\, e^{2\pi i k x}\, dk \qquad (3.3)$$

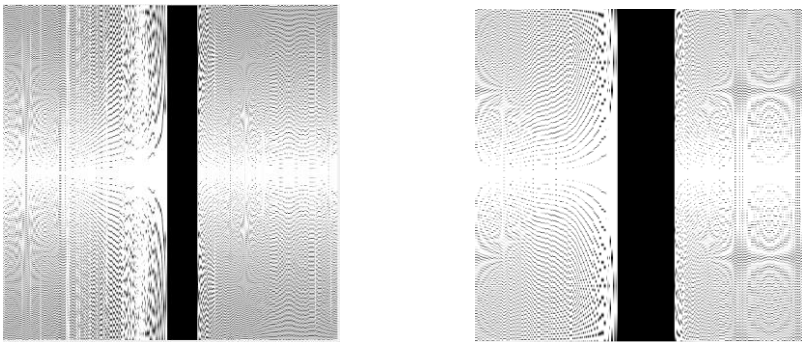
$$F(k) = \int_{-\infty}^{\infty} f(x)\, e^{-2\pi i k x}\, dx. \qquad (3.4)$$

Here,

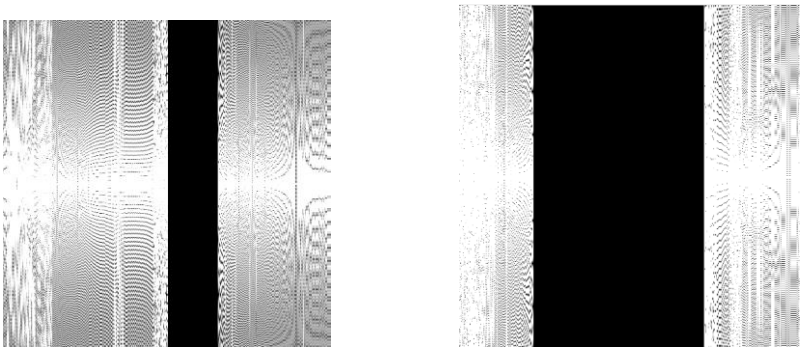
$$F(k) = \mathcal{F}_x\,[f(x)]\,(k) \qquad (3.5)$$

$$= \int_{-\infty}^{\infty} f(x)\, e^{-2\pi i k x}\, dx \qquad (3.6)$$

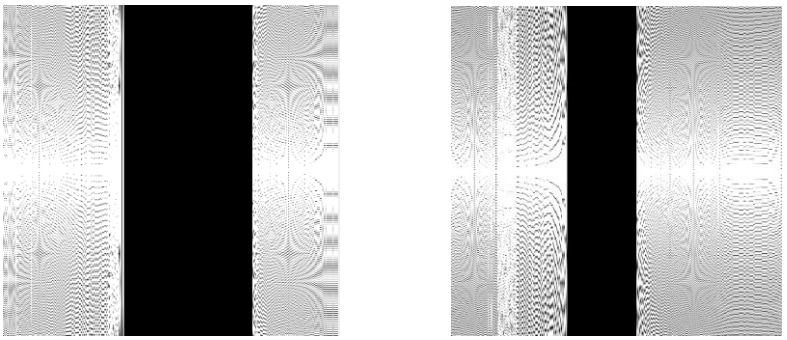
Fourier transform is one of the good feature extraction for our study. It gives good result for identifying the fishes. In fig. 3.4, we have shown that different fishes have different value for Fourier transform.



(a) (b)



(c) (d)



(e) (f)

Figure3.4.4:Fourier transform of segmented image (a)Pabda, (b)Bele (c)puti (d)Kholse (e)boumach (f)Meni

Texture Analysis:

For reaching our goal, we also use texture analysis. In texture analysis, image texture is important for matrices that calculated in image processing that is designed to quantify the perceived texture of an image. Image texture gives us knowledge about the local arrangement of color or intensities in an image. In statistical approach, an image texture works as a quantitative measure of arrangement.

Some statistical approach known as edge detection, co-occurrence matrices, laws texture energy measures.

- GLCM Features: In texture analysis we use feature that is GLCM. GLCM texture image is represented by the operator that produces virtual variables of a single beam echogram. GLCM means Gray Level Co-occurrence Matrix. It is associated the calculations of image analysis techniques.

  In GLCM algorithm;

  - First we have to do quantization to quantize the data.
  - Create the GLCM that is the number of levels specified under quantization.
  - Making symmetric GLCM and normalize the data.
  - The feature should be calculated.

GLCM, the set of features are based on second order statistics. In our research GLCM is used to reflect, the overall average for degree of correlation between pairs of pixels in different aspects. GLCM is the separation of distance between pixels after color model is selected. GLCM represents only have a group of pattern that with help of a recognition system we can use for identify or classify different characteristics of our application. This equations are used to calculate contrast, homogeneity, co-relation, energy of the image. In table 3.1, equation of GLCM that we use in our study.

Table 3.1: Equation of GLCM

Energy feature $Energy = \sum_{i,j=0}^{N-1} \left(P_{ij}\right)^2$	Contrast feature $Contrast = \sum_{i,j=0}^{N-1} P_{ij}(i-j)^2$
Correlation feature $Correlation = \sum_{i,j=0}^{N-1} P_{ij} \frac{(i-\mu)(j-\mu)}{\sigma^2}$	Homogeneity feature $Homogeneity = \sum_{i,j=0}^{N-1} \frac{P_{ij}}{1+(i-j)^2}$

3.4.3 Data Procedure

After feature extraction, we have get data for each fishes. In our study, we used six different fishes and every fish has data of thirteen features. We use 180 images for testing and training data.

3.4.4 Classifier Fitting

For training and testing data, after feature extraction we set up some classifier. Some classifier is known as KNN, SVM and Ensemble. We do the classifier fitting because which classifier gives better accuracy we have to know. After knowing we can choose which classifier can give good result.

- ✓ KNN: In KNN, the function is only approximated locally and all computation is deferred until classification. It is a simple classifier among all machine learning algorithm.
- ✓ SVM: SVM means Support Vector Machine. SVM classifier builds a model that put new examples to one category or the other and making it a non-probabilistic binary linear classifier.
- ✓ Ensemble: The ensemble classifier is the supervised learning algorithm. It can be trained easily and then used to make predictions for testing data. Ensembles can do better results when there is significant diversity among the models.

3.5 Implementation Requirements

After informative analysis of all features doing theoretically there is a requirements we need to complete our work. This requirements help to generate some algorithm to recognize fish properly. Some tools are needed for some unique research. The probable necessary things are:

Hardware/Software Requirements:

- ✓ Operating System (Windows 8.1)
- ✓ Hard Disk (4 GB)
- ✓ Ram (2 GB)

Developing Tools:

- ✓ Camera for capturing fish image
- ✓ Matlab (R2016a)

CHAPTER 4

EXPERIMENTAL RESULTS AND DISCUSSION

4.1 Introduction

This chapter is mainly focus how we implement and brief analysis of data that used in our research project. In this chapter, we also discuss about the experimental results of our research briefly.

4.2 Data Collection

Data collection is very important part of research project. We implement our procedure of the machine vision based local fish recognition as per the description in the previous chapter. The first point of our work is capturing image of fish in white background. There are many types of local fishes in Bangladesh. We use six different types of fishes for our research.

4.3 Image Preprocessing

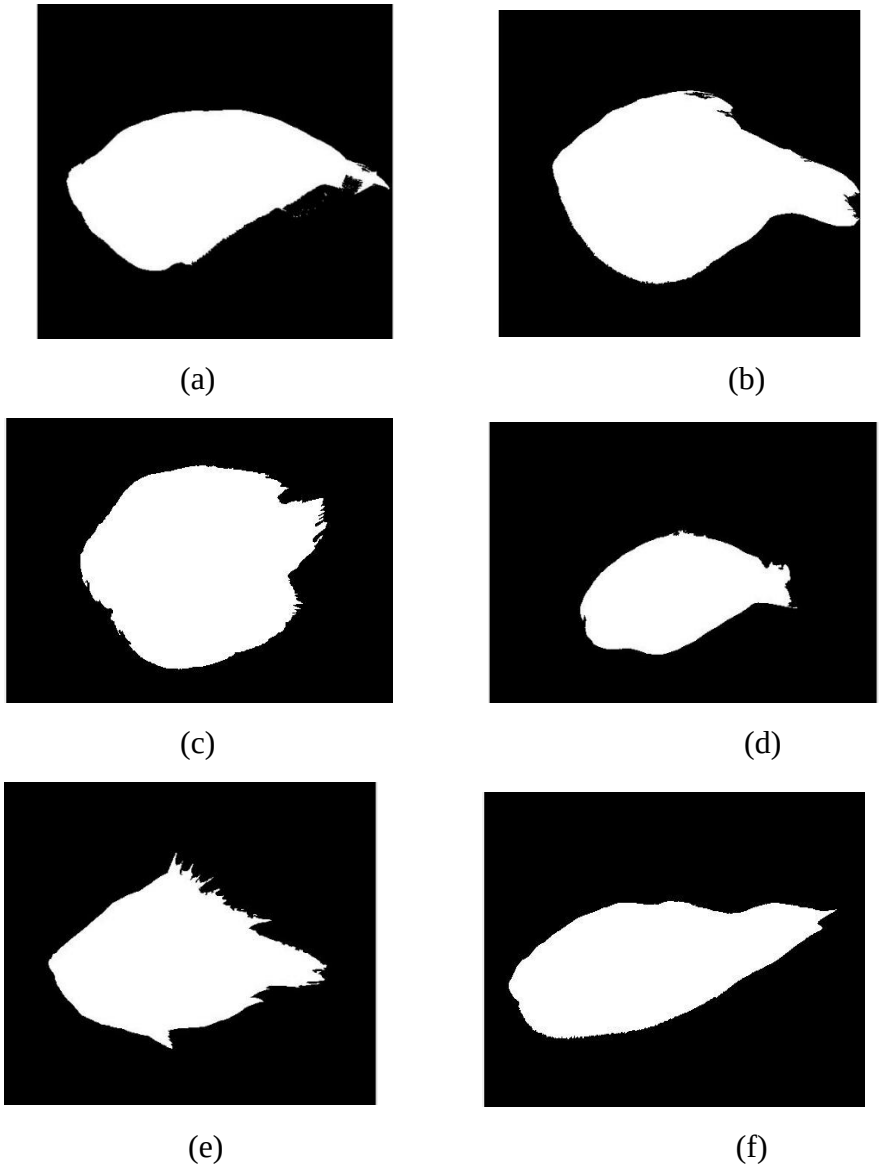
This step requires some operation like image smoothing, filtering, resize and segmentation so that the image can be converted into binary image which contains only object (fish) and background. We only do resize and segmentation in image preprocessing. For image preprocessing, we have to write code and we write it in Matlab (R2016a). At first, we have to convert the picture into 512 * 512 pixel so that all the image can be in same size. After that we mean the RGB and HSV value for color analysis. Then we have to convert the image into Gray-scale where the number of gray shade is 256. If r is red, g is green and b is blue component then g is converted value of gray scale image.

$$g = (0.3 * R) + (0.59 * G) + (0.11 * B) \quad (4.1)$$

After converting the image into grayscale, we do our next step which is segmentation. We do the segmentation using thresholding which is Histogram based method. And it is one of the easy and mostly used for segmentation method. We have given two values of thresholding to convert gray-scale image to binary image. Two thresholding values are θ_L and θ_H whose each pixel is represented by pi(x, y), is converted into a binary image, whose each pixel is represented by bi(x, y), where

$$bi(x,y)=\begin{cases}1, & if\ \theta_L \le pi(x,y) \le \theta_H \\ 0, & otherwise\end{cases} \qquad (4.2)$$

The binary image contains of object and background. And if there is any noise, it is eliminated from binary image. That's how, we do our first step which is image preprocessing. In fig 4.1, we have shown some segmented image after thresholding.



(a) (b)

(c) (d)

(e) (f)

Figure 4.1: Segmented Images (a)Pabda (b)Puti (c)kholse (d)Boumach (e)Meni (f)Bele

4.4 Feature Extraction

Feature extraction is one of the major part in our research. It requires for calculating certain features of an object to be classified in order to find measurement value to be very similar for objects in the same class and very different for objects in different classes. In section [3.4.2], we discuss about some feature extraction, we calculates the values of those features for classifying the fishes so that we can identify fishes which are in same class and different from another class. We have to write program for calculating the values of features that are selected. We write the program in Matlab (R2016a) platform. In figure 4.3.1, we have shown the segmented images.

4.5 Fitting Dataset for Classifier

To build a model, we have to divide our dataset into two types such as training set and testing set. As we have taken thirty images for each fish and each fish has thirteen features for classifying for six different classes. So the total image of fishes are 180. We divide these images into training set and testing set. We divide datasets into two ratio,

1. Training set 50% and testing set 50%
2. Training set 70% and testing set 30%

We change the ratio, so that we can find if classifier accuracy change for changing the ratio of training and testing set. As, we use different classifiers to find which classifier is best for our research work. So, we import package of classifier using Matlab (R2016a) platform.

4.6 Experimental Result

After implementation, some images of local fishes are trained by using classifier. After classification we have done several experimental test that can determine whether it's enough hard to recognize local fishes.

4.7 Accuracy Model

In this section, we will show confusion matrix for our model for the classifier (SVM, KNN, Ensemble) which we use for our research. Confusion matrix is a table that is known to describe the performance of classification model or Classifier.

SVM Classifier

- For 50% training data (15 images per fish) and 50% testing data (15 images per fish)

Table 4.1: Confusion Matrix of 50% training data for SVM classifier

Predicted /True class	Pabda	Puti	Kholse	Boumach	Meni	Bele
Pabda	14	1	0	0	0	0
Puti	1	14	0	0	0	0
Kholse	0	1	12	0	2	0
Boumach	0	0	0	14	1	0
Meni	0	2	0	0	13	0
Bele	0	0	0	0	0	15

Accuracy of SVM classifier of 50% (15 images per fish) training set = 91.1%

Table4.2: Testing data(50%) accuracy for SVM Classifier

Fish Names	Accuracy
Pabda	1.00
Puti	0.80
Kholse	1.00
Boumach	1.00
Meni	1.00
Bele	1.00
Total/Average	0.97

Accuracy of Testing data (50%) using SVM Classifier = 97%

- For 70% training data (20 image per fish) and 30% testing data (10 image per fish)

Table 4.3: Confusion Matrix of 70% training data for SVM classifier

Predicted /True class	Pabda	Puti	Kholse	Boumach	Meni	Bele
Pabda	18	2	0	0	0	0
Puti	2	18	0	0	0	0
Kholse	0	1	18	0	1	0
Boumach	0	0	0	20	0	0
Meni	0	2	1	0	17	0
Bele	0	0	0	0	0	20

Accuracy of SVM classifier of 70% (20 images per fish) training set = 92.6%

Table4.4: Testing data (30%) accuracy for SVM Classifier

Fish Names	Accuracy
Pabda	1.00
Puti	1.00
Kholse	1.00
Boumach	1.00
Meni	1.00
Bele	1.00
Total/Average	1.00

Accuracy of Testing data (30%) using SVM Classifier = 100%

KNN Classifier

- For 50% training data (15 images per fish) and 50% testing data (15 images per fish)

Table 4.5: Confusion Matrix of 50% training data for KNN classifier

Predicted /True class	Pabda	Puti	Kholse	Boumach	Meni	Bele
Pabda	14	1	0	0	0	0
Puti	3	12	0	0	0	0
Kholse	0	3	11	0	1	0
Boumach	0	0	0	14	1	0
Meni	0	1	2	0	12	0
Bele	0	0	0	0	0	15

Accuracy of KNN classifier of 50% (15 images per fish) training set = 86.7%

Table4.6: Testing data (50%) accuracy for KNN Classifier

Fish Names	Accuracy
Pabda	1.00
Puti	1.00
Kholse	1.00
Boumach	1.00
Meni	0.80
Bele	1.00
Total/Average	0.97

Accuracy of Testing data (50%) using KNN Classifier = 97%

- For 70% training data (20 image per fish) and 30% testing data (10 image per fish)

Table 4.7: Confusion Matrix of 70% training data for KNN classifier

Predicted /True class	Pabda	Puti	Kholse	Boumach	Meni	Bele
Pabda	19	1	0	0	0	0
Puti	4	16	0	0	0	0
Kholse	0	3	16	0	1	0
Boumach	0	0	0	20	0	0
Meni	1	3	1		15	0
Bele	0	0	0	0	0	20

Accuracy of KNN classifier of 70% (20 images per fish) training set = 88.4%

Table4.7.8: Testing data (30%) accuracy for KNN Classifier

Fish Names	Accuracy
Pabda	0.93
Puti	1.00
Kholse	1.00
Boumach	1.00
Meni	1.00
Bele	1.00
Total/Average	0.98

Accuracy of Testing data (30%) using KNN Classifier = 98%

Ensemble Classifier

- For 50% training data (15 images per fish) and 50% testing data (15 images per fish)

Table 4.9: Confusion Matrix of 50% training data for Ensemble classifier

Predicted /True class	Pabda	Puti	Kholse	Boumach	Meni	Bele
Pabda	15	1	0	0	0	0
Puti	2	13	0	0	0	0
Kholse	0	1	13	0	1	0
Boumach	1	0	0	14	0	0
Meni	0	0	0	0	15	0
Bele	0	0	0	0	0	15

Accuracy of Ensemble classifier of 50% (15 images per fish) training set = 94.4%

Table4.10: Testing data (50%) accuracy for Ensemble Classifier

Fish Names	Accuracy
Pabda	1.00
Puti	0.70
Kholse	1.00
Boumach	1.00
Meni	0.9
Bele	1.00
Total/Average	0.94

Accuracy of Testing data (50%) using Ensemble Classifier = 94%

- For 70% training data (20 image per fish) and 30% testing data (10 image per fish)

Table 4.11: Confusion Matrix of 70% training data for Ensemble classifier

Predicted /True class	Pabda	Puti	Kholse	Boumach	Meni	Bele
Pabda	19	1	0	0	0	0
Puti	1	19	0	0	0	0
Kholse	0	2	18	0	0	0
Boumach	0	0	0	20	0	0
Meni	0	0	0	0	20	0
Bele	0	0	0	0	0	20

Accuracy of Ensemble classifier of 70% (20 images per fish) training set = 96.7%

Table4.12: Testing data (30%) for Ensemble Classifier

Fish Names	Accuracy
Pabda	1.00
Puti	0.98
Kholse	1.00
Boumach	1.00
Meni	1.00
Bele	1.00

Accuracy of Testing data (30%) using Ensemble Classifier = 98%

Compare Algorithm

- For 50% training data (15 images per fish) and 50% testing data (15 images per fish)

Table 4.7.13: Compare accuracy for all classifier

Algorithm	Accuracy
Support Vector Machine	91.1%
K–Nearest Neighbors	86.7%
Ensemble	94.4%

- For 70% training data (20 image per fish) and 30% testing data (10 image per fish)

Table 4.7.15: Compare accuracy for all classifier

Algorithm	Accuracy
Support Vector Machine	92.6%
K–Nearest Neighbors	88.4%
Ensemble	96.7%

4.8 Descriptive Analysis

We divide our data in two type ratio. At first, we use Three classifier for training data then test it with testing data where 50% training data and 50% testing data. Then we again train and test data changing the ratio of total data set where training data is 70% and testing data 30%. For finding if the accuracy change when we change the ratio of the total dataset.

In our research, we find that if we change the ratio of the total data sets then accuracy of classifier change with the ratio of the datasets but change of accuracy is less than 2%. From the table, we can see that accuracy of Ensemble classifier is the highest and accuracy of KNN is the lowest. Even though Ensemble classifier gives highest accuracy but when we test our data, it give highest error. And SVM classifier give lowest error for testing data. In 70/30 ratio, SVM classifier give none error for testing data. So, we can say that SVM classifier can be best classifier for our research work.

4.9 Summary

After getting the accuracy, SVM is the most reliable for ore research work. And if we change the ratio of training data and testing data, accuracy of the classifier also change and the difference is not much (<2%). If we want more accuracy then we have to increase our dataset.

CHAPTER 5

SUMMARY, CONCLUSION, RECOMMENDATION & IMPLECATION FOR FUTURE RESEARCH

5.1 Summary of the Study

A good number of works has been done with the field of image processing among them fruit, food and disease of fruits are remarkable. However, a couple of work on tropical fish also exists and more are happening right now. Apart from this, the fishes of Bangladesh which are mainly found in rivers, ponds, lakes and water of rainy season was not highlighted for any kind of research work. That's way we are taking an attempt to work with the local fish of Bangladesh. With the help of machine vision, we are working here for recognize some Bengali fishes.

5.2 Conclusions

In this report we used color analysis, gray scale, and geometric feature to recognize fishes. To find out the best accuracy for our work, we used three types of classifier. And finally, the result is here, working level of SVM was best to recognize fishes. Most important is the more training set will be happed the more accuracy will be given by SVM.

5.3 Limitation

1) If there are two or more objects in picture and different background, it will give wrong result.
2) We don't use lot of data in our study

5.3 Recommendations

1) More data set will give excellent output on this research work

2) Different category images (horizontal, vertical) training set will give the better result

5.4 Implication for Further Study

1) To get better result more and more data will be needed

2) In this study, we work with 6 species of fish, so more class will be needed to add

3) Number of classifiers can be used for more accuracy or Neural Network can also be used for better result.

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Appendix

Research Reflection

When we go through our research, it's not enough simple for us to solve all problematic features. At first we had to determine which methodological approach is better for our project. In addition there were not much related work based on our project in this field, that's a limitation for our work. Another problem was that deep learning known as neural networking was not understood by us. Up to expectation we used here supervised classifier such as KNN, SVM or Ensemble etc. for better accuracy. Whichever a problem was even collecting data from fish market was exhausting for us, rather than we had to keep collecting data manually. After continuing a long process with our hard-working, finally we had finished our entire research-based project.

Plagiarism Report Screenshot: