**CHAPTER 3**

**Theoretical Framework**

This chapter will discuss the basic concepts and framework that will be used In implementing Image Processing for copepod Identification and Classification.

**3.1 Noise reduction on images**

Signal processing devices which is categorized to analog and digital are vulnerable to noise. This noise often can be, random or white noise with an even level of frequency distribution, or frequency dependent noise introduced by a device's mechanism or signal processing [algorithms](https://en.wikipedia.org/wiki/Algorithm).

In images, noise are often acquired when one shoots a photo at night and/or with high ISO and with wide exposure latitude. To remove noise and attain a clear image of the copepod species, a filter must be applied to the image (Attila, n.d).

**3.2 Edge Detection**

Edge detection is the process of identifying and locating sharp discontinuities in an image. The discontinuities are abrupt changes in pixel intensity which characterizes boundaries of objects in a scene (Maini, 2009).

Edge detection methods can be grouped in to two main categories. First, Gradient which detects edges of the image by searching for the maximum and minimum in the first derivative of the image. Second, Laplacian methods which looks for zero crossing in the second derivative of the image (Igbinosa, 2013).

Most used edge detection techniques are the Sobel operator, Robert Cross operator, Prewitt detection, and Canny operator. The Sobel operator is a pixel-based edge detection which can detect edges by calculating partial derivatives in 3 x 3 neighborhood. The Robert Cross operator performs a simple and quick 2-D spatial gradient measurement on an image and it also consists of a pair of 2x2 convolution kernel. Prewitt detection is similar to the Sobel operator and it is used for detecting vertical and horizontal edges in images (Gonzales, 2002). Canny edge detector is the most rigorously defined operator and is widely used dues the following reasons:

1. Good Detection – low error rate
2. Good Spatial localization
3. Good Response rate

**3.3 Segmentation**

Image segmentation technique is used to partition an image into meaningful parts having similar features and properties. The main aim of segmentation is simplification i.e. representing an image into meaningful and easily analyzable way (Kaur, 2014).

Image segmentation can be categorized in to two types, one is Discontinuity detection-based approach where an image is segmented into regions via discontinuity. Two, Similarity detection-based approach where an image I segmented based on similarity.

Image segmentation techniques are as follow:

1. Thresholding methods

- This method divides the pixels with respect to their intensity and comes in three types. The Global thresholding which is done using any appropriate threshold value and the value T is constant for the whole image. Variable thresholding which is done by varying the value T across the image. Multiple thresholding has more than one threshold values i.e T0 and T1.

b. Edge Based Segmentation Method

- based on the rapid change of intensity value in an image because a single intensity value does not provide good information about edges.

c. Region Based Segmentation Method

-are methods which segments the image into various regions having similar characteristics.

d. Clustering Based Segmentation Method

- are methods which segment the image into clusters having pixels with similar characteristics.

e. Watershed Based Methods

- uses the concept of topological interpretation. It’s like Any grayscale image can be viewed as a topographic surface where high intensity denotes peaks and hills while low intensity denotes valleys.

f. Partial Differential Equation Based Segmentation Method

- These are appropriate for time critical applications.

g. Artificial Neural Network Based Segmentation Method

- simulate the learning strategies of human brain for the purpose of decision making.

**3.4 Feature Extraction for plankton images**

One of the most important method in Artificial Intelligence is Feature Extraction. It consists to extract the most relevant features of an image and assign it into a label. In image classification, the crucial step is to analyze the properties of image features and to organize the numerical features into classes. In other words, an image is classed according to its contents (Medjahed, 2015).

Many techniques of Feature Extraction come in major categories such as Color features, Texture features and Shape features.

**3.5 Feature Selection**

Feature selection is different from Feature Extraction. The latter creates new features from function of the original features, while the former returns a subset of thefeatures.

Three major selection methods are Filter, Wrapper, and Embedded methods. The Filter methods apply statistical measure in order to assign a scoring to each available feature. Each feature is then ranked based on their scores and selected to be kept or to be removed. The wrapper method considers selection as a search problem, where different combinations are prepared, evaluated and compared to other combinations. While the Embedded methods finds the best feature for the model while the model is being created. The most common type of embedded feature selection methods are regularization methods.

**3.6 Artificial Neural Network training**

The ANN is a model inspired by the human brain and its functions. The brain’s ability to learn new things and adapt to the changes in the environment is the key to this Network. It is a computational learning system that uses a network of functions to understand and translate a data input of one form into a desired output, usually in another form. Such systems "learn" to perform tasks by considering examples, generally without being programmed with any task-specific rules (Kukreja, 2016).

The following are the ANN’s strengths and limitations:

1. Adaptive learning
2. Faster than Normal Brain speed in processing information
3. Parallel operation
4. Fault Tolerance
5. Self-organization
6. ANN’s output is not clear compared to a normal program.
7. ANN can be used for applications that has unclear data
8. ANN cannot be utilized when the input and Output are known already.

**3.7 System Evaluation**

It is normal to evaluate the System in every research to measure the efficiency of that system. The MSE or Mean Square Error is one of the validation techniques used to evaluation the result of the neural network. The mean(average) magnitude of the squares of the error*:*i.e., the distance between the model's estimate of your test values and the actual test value (Rostampour, 2013).

The Confusion matrix is an evaluation technique for the classification algorithm. It can give you the idea of where and how is your classification algorithm right and what errors does it have.

The number of correct and incorrect predictions are summarized with count values and broken down by each class. This is the key to the confusion matrix (Brownlee, 2016).