ANALYSIS OF FISH CLASSIFICATION SYSTEM USING CONVOLUTIONAL NEURAL NETWORK (CNN) FOR DIFFERENT TYPES OF ACTIVATION FUNCTIONS

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This report is submitted in partial fulfilment of the requirements for the degree of Bachelor of Electronic Engineering with Honours

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DEDICATION

In dedication to my beloved family, friends, and most of all, my supervisor Dr. Zarina binti Mohd Noh for her generous guidance, patience, and never-ending support throughout the project.

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ABSTRACT

This project is about the classification of several types of fish by using the Convolutional Neural Network (CNN) with help of TensorFlow and Phyton. The coding process will be done by using the Google Colaboratory website. CNN is a form of artificial neural network that can be used in image recognition and processing. It has various types of activation functions, and this project will involve three types of activation functions, namely ReLU, tanh, and ELU. The dataset for this project will be obtained from the Fish4Knowledge website. The fish pictures will go through the pre-processing process for image height and width fixed resizing. After the process, the fish images will undergo a process of classification by species using CNN with three types of activation functions, namely ReLU, tanh, and ELU. Lastly, observations and comparisons will be conducted to determine which activation function is more accurate and saves time for fish classification according to the specified species.

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ABSTRAK

Projek ini adalah mengenai pengelasan beberapa jenis ikan dengan menggunakan Rangkaian Neural Convolutional (CNN) dengan bantuan TensorFlow dan Phyton. Proses pengekodan akan dilakukan dengan menggunakan laman web Google Colaboratory. CNN ialah satu bentuk rangkaian saraf tiruan yang boleh digunakan dalam pengecaman dan pemprosesan imej. Ia mempunyai pelbagai jenis fungsi pengaktifan dan dalam projek ini, ia akan melibatkan tiga jenis fungsi pengaktifan iaitu ReLU, tanh dan ELU. Dataset untuk projek ini akan diperoleh daripada laman web Fish4Knowledge. Gambar ikan akan melalui proses pra-pemprosesan untuk ketinggian imej dan saiz tetapan lebar. Selepas proses tersebut, imej ikan akan melalui proses pengelasan mengikut spesies menggunakan CNN dengan tiga jenis fungsi pengaktifan iaitu ReLU, tanh dan ELU. Akhir sekali, pemerhatian dan perbandingan akan dijalankan untuk menentukan fungsi pengaktifan yang lebih tepat dan menjimatkan masa untuk pengelasan ikan mengikut spesies yang ditetapkan.

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

TABLE OF CONTENTS

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

LIST OF FIGURES

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

LIST OF TABLES

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

LIST OF SYMBOLS AND ABBREVIATIONS

CNN	:	Convolutional Neural Network
ReLU	:	Rectified linear
tanh	:	Hyperbolic tangent
ELU	:	Exponential Linear Unit
Google Colab	:	Google Colaboratory
IDE	:	Integrated Development Environment
CPU	:	Central Processing Unit
GPU	:	Graphics Processing Unit

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

CHAPTER 1

INTRODUCTION

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

1.1 Introduction

Tracking the movement of numerous fish species across huge oceans is critical for understanding how cyclical marine biological systems work. Fish population quantity and migration range can provide crucial insights into the health of marine biological systems and be used as indices to track the changes in the marine environment. Visual classification of fish can assist in the detection of movement and reveal patterns in their behaviours, revealing more information about the species. By obtaining visual feedback from numerous locations and automating the visual welding process of fish, the exploration of fish behaviour may be automated, resulting in a bigger amount of data for pattern identification.

The most recent method, which is applied to the input image of the performing individual classification, focuses on the extraction and matching of shape and texture data [1]. Based on Table 2.1, most of the previous research is either based on a limited dataset that only distinguishes between a few species or has low precision. CNN is used in this project to make the procedure easier and more resilient, especially when working with massive data sets. As a mature data set, CNN is significantly more adaptable and can adapt to new incoming data. The Fish4Knowledge project's fish data set is a collection of fish images that were used to test the algorithm for this project. The fish classification method begins with image pre-processing by resizing the image height and width with a fixed size of 180x180 pixels which offers input to images that are then upgraded for classification using CNN. Then, the images from the pre-processing process will go through a training and validation process with the involvement of these three activation functions, namely ReLU, tanh, and ELU to enhance the classification accuracy. Lastly, the images will be classified into their class based on the fish species. The average testing accuracy of each activation function will be recorded to observe which activation function produces higher accuracy upon the classification process yet consume less time to execute all the process code.

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

1.2 Problem Statement

Manual methods for identifying fish can be quite time-consuming where they may require considerable sampling effort. Large-scale sampling processes can be detrimental to the marine environment and costly but yield limited data.

In addition, the lack of fish experts can lead to inaccurate and subjective identification. Therefore, with the advancement of existing technology, a system needs to be developed to ensure accuracy in classifying and identifying fish. The current accuracy that can be achieved is 92% [2]. Hence, this project aims to achieve at most 93% accuracy for the classification system.

1.3 Objectives

The objectives of the project are to:

1. Construct a CNN model using ReLU, tanh, and ELU activation functions for fish classification.
2. Compare the performance of CNN models to obtain a 93% and above level of image classifying accuracy.
3. Analyze the execution time between ReLU, tanh, and ELU activation functions.

1.4 Scope of Projects

This project uses a Google Colaboratory as the main IDE for Python programming. The reasons this project uses Google Colaboratory and Python are because both are open source [3]. Google Colaboratory is a web-based Python editor that allows anyone to write and run arbitrary Python code. It's particularly useful for machine learning, data analysis, and education. This project will run on the ASUS A407U with specs consisting of Intel(R) Core (TM) i5- 8250U, CPU 1.60GHz, graphic card NVIDIA GeForce MX130, GDDR5 2GB, and 4 GB RAM.

Lastly, the fish images in this project will be obtained from the Fish4Knowledge website which has open-source images [4]. Based on this dataset, contains 23 images of fish classes, but only 18 classes will be used in this project. A total of 2399 images of fish from 18 classes will be involved and each number of images contained has a different number between each class where fish from the species *Myripristis kuntee* have the most images which are 450 images, while fish from the species *Neoglyphidodon nigroris* have the fewest images of 16 images. These fish images will go through a training and validation process where 80% of the total images will be used in the training process, and the other 20% of the images will be used for process validation. The process will use 20 epoch cycles for each CNN model.

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CHAPTER 2

LITERATURE REVIEW

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2.1 Introduction

A review is conducted in this chapter to investigate and obtain more authoritative material related to this work. To perform a comprehensive study of numerous ideas and background studies, various research papers, journals, and internet resources such as online encyclopaedias are used. In general, the study centered on the intent of developing a fish classification system. As a result, various background research on the fish classification system has been explored.

2.2 Fish Classification

The act of recognizing and classifying fish species and groups based on their characteristics is known as fish classification. It uses the resemblance between the target fish and the type specimen image to identify and categorize the target fish into species [5]. This procedure is required for feature extraction, pattern and contour matching, behavioural and physical trait determination, and fish species quality control. Fish classification is beneficial for assessing and counting fish populations, monitoring ecosystems, and describing fish connections [6]. Because of the legal constraints on fishing techniques, precise fish species identification is essential, especially when their existence is endangered or threatened.

2.3 Convolutional Neural Network (CNN)

The CNN is a deep learning architecture based on the structure of the visual system. Hubel and Wiesel discovered it in 1962 while studying the primary visual cortex of cats. Receptive fields are small sub-regions of the visual field that are responsive to the cells in the cortex [7]. By creating an artificial neural network named LeNet-5 [8], and LeCun [9], laid the groundwork for the CNNs. The backpropagation algorithm was used to train this artificial neural network, which was employed to do the handwritten digit categorization [10]. Since the introduction of general-purpose graphics processing units (GPGPUs) and their use in machine learning, CNN has been pushed to a whole new level [11]. Using GPU processing, more effective ways of training CNNs have been developed [12]. Krizhevsky developed AlexNet, a new CNN design that showed significant improvement in image classification [13]. Following the success of AlexNet, further variants with improved performance were created, including GoogleNet [14], VGGNet [15], ZFNet [16], and ResNet [16][17].

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2.3.1 Convolutional Layers

One of the essential building elements of a convolutional neural network is the convolution process. The parameters of the convolutional layer are a set of learnable filters also known as kernels. Every filter is small in terms of width and height, yet it covers the entire depth of the input volume. The most common filter sizes are 3x3, 5x5, and 7x7. The number of channels in the input corresponds to the third dimension of the filter. The colour image has three (RGB) colour channels, while the grayscale image has one [18]. The size of the image is further decreased by adding further convolutional layers, and consequently, the image is dramatically reduced in size. Padding is a technique for increasing the amount of input data by surrounding it with constants. The process is known as zero-padding since this constant is typically zero. The output feature map has the same spatial dimensions as the input feature map, which is referred to as "padding" [19]. The overview of the CNN system is shown in Figure 2.1.

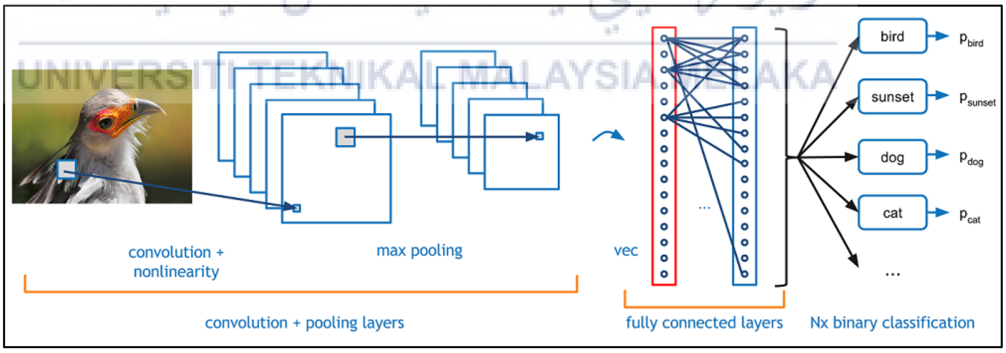
;


Figure 2.1: Convolutional Neural Network overview [20]

2.3.2 Pooling Layers

After convolution layers, CNNs commonly use the pooling layer technique to reduce the dimension, which is also described as subsampling or down sampling. The filter size and strides are represented by the pooling layer's hyper-parameters. This pooling layer with filter size 2 and stride 2 is the most usually applied. Max pooling and average pooling are two typical forms of pooling layers that take the maximum and average value, respectively. The use of maximum pooling is more common than the use of average pooling. There are no parameters to learn in the pooling layer. The idea behind max pooling is that a large number indicates the possibility of detecting a feature [18].

2.3.3 Fully Connected Layers

In previous systems, the fully connected layer is like a fully linked network. The result of the first phase is fed into the fully connected layer, which computes the product of the weight vector and the input vector so that it produces the final output [21]. Gradient descent reduces the cost function by calculating the amount throughout the full training dataset and only changing the parameters once each epoch. It creates global minima, but the time it takes to train the network increases as the training dataset grows larger. This approach of cost function reduction was replaced with stochastic gradient descent.

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