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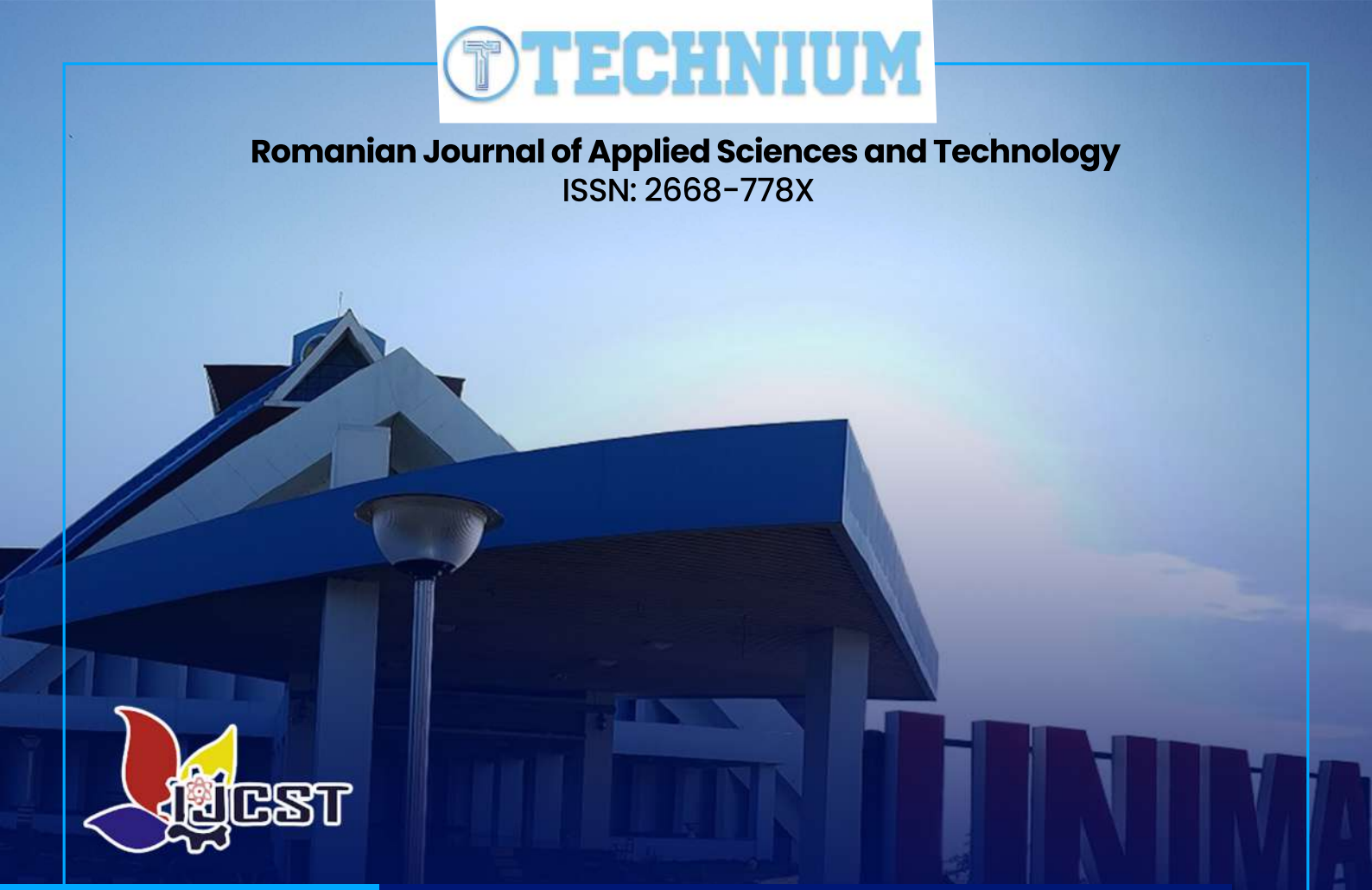

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Implementation Of Android-Based Fish Detection & Recognition System Using Convolutional Neural Network Method

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Abstract. Today the development of robots has increased a lot. Over time the robot can used as a medium of learning and education. The maze mapping system can be used as educational media in robotics. In this study, the idea was obtained to design a robot moving objects that are able to move on a flat striped plane like a line tracer robot. Robot it adopts a maze mapping system to find the fastest path in moving objects. These objects are in the form of mini objects that have been given a color consisting of red, yellow, green, and blue. The four colors are used as a reference for the robot to detect objects based on the color that will be moved from the object detection start point to the available finish point. The method to be used on the robot is A*. The A* algorithm is able to find the fastest route on the path traversed by the robot, by adding up the actual distance with the estimated distance thus making it optimal in the search for the route. The microcontroller used on This robot is an Arduino Due which functions to enter data from the results of sensor readings is on the robots. The sensors consist of an infrared module that functions as a detector line and TCS34725 color sensor to detect the object to be moved. This wheeled robot using a DC motor with a voltage of 12V to drive the two wheels. Than 10 times experiment to determine the fastest path with 1 type of color, obtained success with 70%. The results of this study can be used as a comparison material for the A* method with the A* method another fastest path search.

1 Introduction

Indonesia is the largest archipelagic country in the world which has 17,499 islands from Sabang to Merauke. Indonesia is also a country that has a water area that exceeds the land area. Indonesia's vast oceans have enormous marine and fishery potential [1]. The territory of Indonesia has a sea waters which has an area of approximately 5.8 million km2 (75 percent of the total area of Indonesia) consisting of 0.3 million km2 of the territorial sea area that belongs to Indonesia, 2.8 million km2 of the Indonesian archipelago sea waters, and 2.7 million km2 of sea from the Indonesian Exclusive Economic Zone (EEZ) [2].

The introduction of fish species is one way to identify fish based on special characteristics, either through pictures of shapes, fish body patterns, color on fish, or other characteristics. [3]–[7]. Fish are a type of cold-blooded animal (Poikilothermic Vertebrates) where these animals can live in water and breathe with the help of gills.

Digital Image Processing is a science that studies techniques in image processing, where the image in question is an image or video [8], [9]. The problem that exists in Indonesian society is the lack of knowledge about what types of fish can be farmed and cultivated. Seeing the huge potential regarding natural resources, the community must be able to take advantage of knowledge as well as technology that is able to also make it easier to add insight.

This research will create a system in the form of an application in determining the type of fish, which can be seen from the shape of the fish, the color of the fish, or the special characteristics of the body pattern of the fish. Based on the characteristics of the fish using a method, namely CNN (Convolutional Neural Network) as a determination of a problem. Convolutional Neural Network (CNN) itself is one of the methods in the classification which belongs to the Deep Learning group which uses a convolution layer to convert an input with a filter.

2 LITERATURE REVIEW

2.1 Fishery

The country of Indonesia has a lot of potential diversity of fish species because Indonesia is an archipelagic country which of course in the fisheries sector is very useful for supporting the country's economy and food. Based on data from the Indonesian KKP in 2018, there was an increase in fishery production which touched 17.22 million tonnes at the end of 2017. This fact is directly proportional to the high consumption of fishery in Indonesia which reached 46.49 kg/cap/year [10]. Indonesia is said to be the second richest country in the world in terms of

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fisheries. No less than 2000 species of fish are found in Indonesian waters, both from sea and fresh water such as lakes, rivers, swamps and others. [11], [12]. The process of identifying fish can be done by identifying fish based on special characteristics, such as through a description of the shape, body pattern of the fish, color and other characteristics.

2.2 Deep Learning

Deep Learning is a branch of machine learning that uses Deep Neural Networks to solve problems in the machine learning domain [13]. This is made to resemble humans, where neurons are connected to each other, thus forming a very, very complicated network of neurons, but capable of learning and adapting to large amounts of data and solving various problems. Deep learning has several types including: Convolutional Neural Network (CNN), Recurrent Neural Network (RNN), Long Short Term Memory Network (LTSM) and Self Organizing Maps (SOM)[14].

2.3 Citra Digital

Image is a representation (image), likeness, or imitation of an object. Images used as output from a data recording system can be optical in the form of images, analog in the form of video signals such as images on a television monitor, or digital in nature which can be directly stored on a storage medium [15]. While the meaning of digital here is that the processing of an image will be done in a digital way using the help of a computer [16]–[20]. Digital images can be divided into 3 namely color images, black and white images and finally binary images [21].

2.4 Convolutional Neural Network (CNN)

Convolutional Neural Network (CNN) is a Deep Learning method that is often used for recognition of a digital imagel [22]–[25]. In this case the Convolutional Neural Network (CNN) tries to imitate the way of image recognition in the visual cortex of humans or mammals. It also has the ability to recognize features in digital images through a convolution filter in the training process. Convolutional Neural Network (CNN) is deliberately designed specifically for image recognition and classification, has several layers or layers that extract information from images and determine the grouping of images in the form of classification. [26]. The Convolutional Neural Network (CNN) itself consists of neurons that have weight, bias and activation functions [27].

2.5 Android

Android is one of the operating systems used in mobile technology which has slowly become a necessity in society that can make it easy to carry out activities. One of the mobile technologies is a smartphone [28]. The public can obtain android-based information that is applied to mobile. Android is an operating system based on a modified version of Linux and other open tools. Android was originally purchased by Google to make software for mobile phones [29], [30]. Also, android has a large community of developers who can extend the functionality of the device [31]. The tool that can create Android applications is Android Studio, which is a code editor from Intellij and a development tool that provides many features to increase developer productivity when creating Android-based applications. The programming languages used are Java and Kotlin.

2.6 Android Studio

Android Studio which is an Integrated Development Environment (IDE) or also called the Integrated Development Environment for the development of an Android application, based on IntelliJ IDEA [32]. Android Studio has many features and libraries that can be used to help create and develop Android applications [33]–[36]. Using Android studio is enough to spend quite a lot of RAM on our device, but Android Studio can overcome these shortcomings with several advantages.

2.7 Teachable Machine

Teachable machine is a platform used to develop technology from Machine Learning [37], [38]. Machine learning itself is a technology that can be used for learning media in the introduction of fish species in this study [39]. This technology allows the user to manage and provide the ability for computers to learn without the need for traditional programs in it. The model in this technology has the function of positioning, detecting and identifying or classifying objects which makes it a major challenge in computer vision. Teachable machines are used to make it easier for someone to understand machine learning concepts so as to make it easier to process test data quickly [40].

3 METHOD

3.1 Data collection technique

The data used in this study comes from a website called kaggle with the following link: https://www.kaggle.com/datasets/markdaniellampa/fish-dataset. The dataset contains a large-scale collection of fish data. The existing data contains a set of 13,304 fish images, with a total of 1760 classes.
System Architecture Diagram

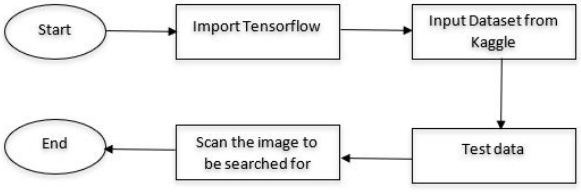

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Fig. 1. Architectural Modeling

Explanation

1. Start
2. Incorporate tensorflow where this tensorflow is used to create human brain-like networks on a large scale
3. Input the dataset that will be tested for data from Kagle
4. Testing the data whether the dataset can run well
5. Then enter the data or model that will be tried to search for
6. will bring up the results according to the scan is complete.

3.2 System Flowcharts

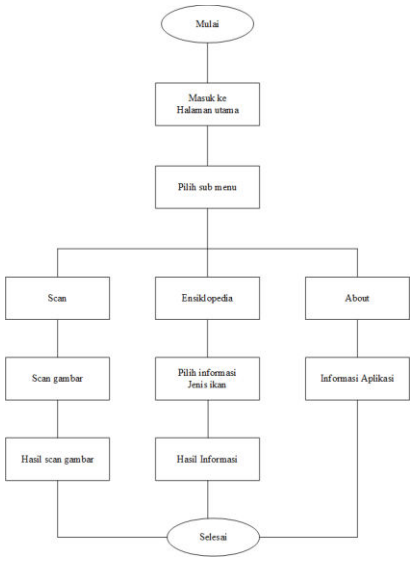

Fig. 2. System Flowcharts

Explanation

1. The user enters the application that has been successfully installed
2. After the user has successfully entered the application, 3 menu options will be displayed, each of which has a different function
3. Scan menu: this menu is used by the user to find out the type and name of the fish you want to know.
4. Encyclopedia Menu: this menu contains information about various kinds of fish that have been provided in the application.
5. About menu: this menu contains information about the application explanation of the functions and uses of the application that has been made, besides that it also contains information about the application developer.
6. If the user wants to know the name and type of fish he wants to know, then the user can immediately select the scan menu, where in the scan menu the user will be immediately redirected to the cellphone camera which is useful for detecting the name and type of fish.
7. If the user has successfully scanned, the system will display information about the name and type of fish.
8. After the user has successfully found out the name and type of fish, the user can exit the application by pressing the Exit menu.

Software System Design

1. Homepage

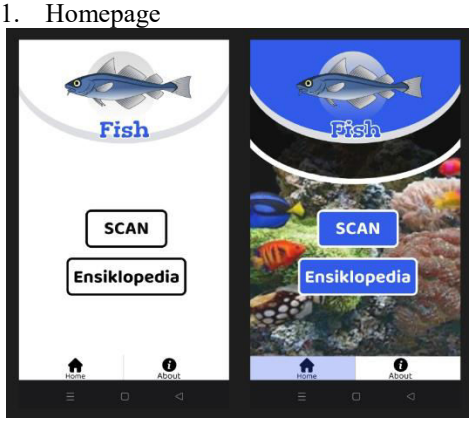

Fig. 3. Homepage View

Home is the display of the application's main menu which has several sub-menus, namely the scan menu, the encyclopedia menu. Users can access the menu easily because the display is friendly and easy to understand. In the Home view can be seen in the image below. If one of the menus is selected, the page appears according to the contents of the menu. the scan menu will immediately redirect or intent to the scan page and also the encyclopedia menu will also be directed to the fish list page and its information.

2. Scan Menu

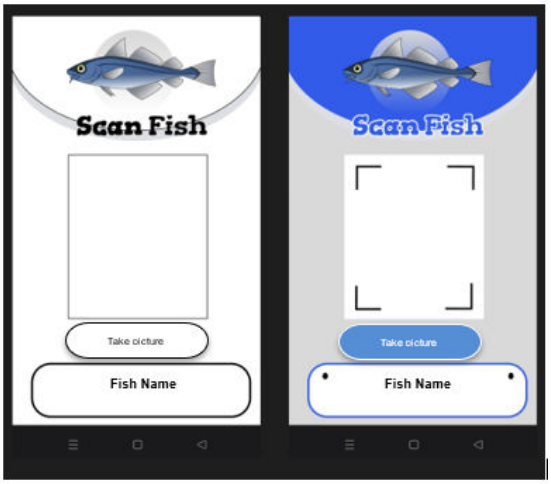

Fig. 4. Scan View

In this scan menu, users can take pictures of fish objects, after the pictures are taken, information about the fish will appear. This is a superior feature in the application to be designed. This application can help users find information quickly and precisely. Users who want to know information about a fish, don't need to look up the name of the fish first, but only need to take a picture of the fish through this scan menu and information about the fish being scanned will appear. Fish information will be displayed on the information menu.

3. Encyclopedia Menu

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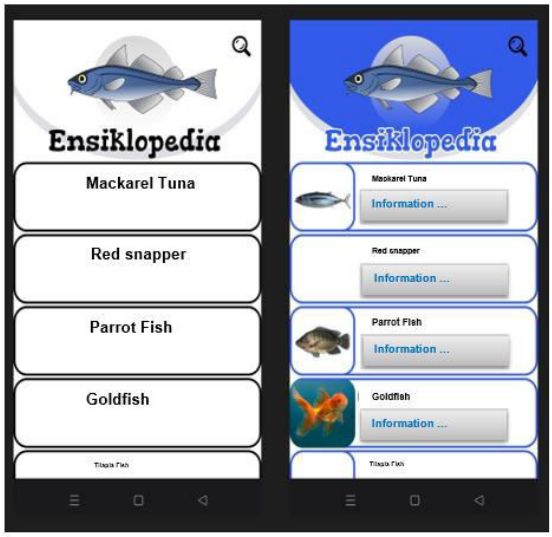

Fig. 5. Encyclopedia View

In the Encyclopedia view there is a list of fish along with their names and an information menu to view detailed information about fish. Search menu to make it easier to find the name of the fish you want to display the information on. In this encyclopedia users can view fish data without having to scan fish. For example the user already knows the name of the fish but still doesn't understand about the fish, then the user can enter this encyclopedia menu.

4. Information Menu

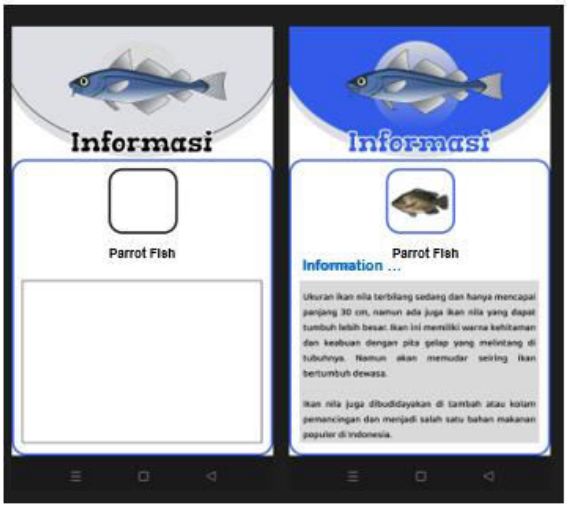

Fig. 6. Information View

This menu is to find information on existing fish such as types, names, characteristics, fish feed and information related to these fish. This information menu will display detailed information on the fish scanned on the application's camera. This menu will also include pictures to further clarify the types of fish.

5. About Menu

The About page displays information about the application or the function of the application that has been made and contains information about the application developer.

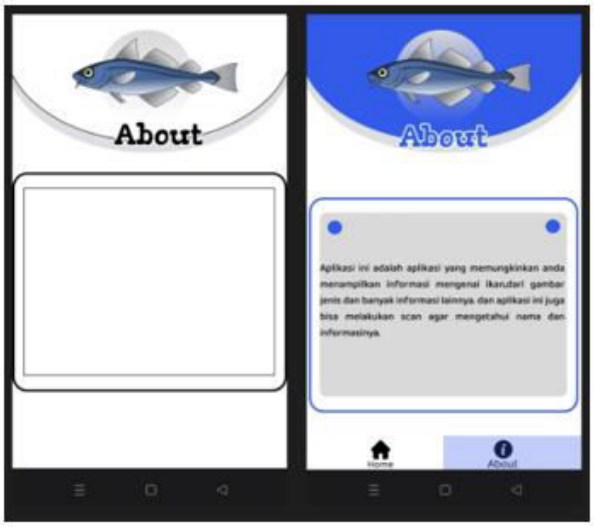

Fig. 7.. About View

4 Results and Discussion

This study uses a dataset containing images of various types of fish sourced from the website, kaggle.com. This dataset is divided into two parts: training data and testing data. The data training uses the Teachable Machine tool, which uses a convolutional neural network (CNN) architecture. Data training was carried out using 80% of the train data on the Teachable Machine for 50 epochs with a learning rate of 0.001 and testing the model using 20% of the test data. From the results that have been done, there are only 4 possible cases that occur:

1. True Positive (TP): This refers to the case where the prediction model correctly identifies the fish species as positive. That is, the type of fish that actually exists and is predicted correctly as the type of fish in question.
2. True Negative (TN): This refers to the case where the prediction model correctly identifies the fish as negative. In this context, the model correctly predicts that fish are absent.
3. False Positive (FP): This refers to cases where the prediction model incorrectly identifies a fish as positive, when in fact the fish is not there. In this case, the model gives false positive predictions.
4. False Negative (FN): This refers to cases where the prediction model incorrectly identifies a fish as negative, when in fact the fish is present. In this case, the model gives wrong negative predictions.

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Table 1. Confusion *Matrix*

		TRUE/ACTUAL VALUE							
PREDICT VALUE		A	B	C	D	E	F	G	H
	A	3	0	1	0	0	0	0	1
	B	0	3	0	0	0	0	0	0
	C	0	0	3	0	0	0	0	0
	D	0	0	0	3	0	0	0	0
	E	1	1	0	0	3	0	0	0
	F	0	0	0	0	0	3	0	0
	G	1	0	0	0	0	0	3	0
	H	0	0	0	0	0	0	0	3

Description:
A = Tilapia
B = Snakehead Fish
C = Goalkeeper Fish (Scat Fish)
D = Catfish
E = Mosquitofish
F = Green Spotted Pufferfish
G = Ornamental Gourami Fish
H = Goldfish

In the Confusion Matrix, the columns show the type of fish predicted by the system, while the rows show the actual type of fish. Each cell in the table represents the amount of data classified correctly or incorrectly based on the actual and predicted fish species.

In the table above the results:

- There are 3 Tilapia data which are correctly classified as Tilapia. However, there are 2 Tilapia data which are predicted to be wrong.
- There are 3 data of Snakehead Fish which are correctly classified as Snakehead Fish. However, there is 1 snakehead fish data which is predicted to be wrong.
- There are 3 data of Goalkeeper Fish which are correctly classified as Goalkeeper Fish. However, there is 1 fish data that is predicted incorrectly.
- There are 3 data on Catfish which are correctly classified as Patin Fish.
- There are 3 Mosquitofish data that are correctly classified as Mosquitofish.
- There are 3 data of Pufferfish which are correctly classified as Pufferfish.
- There are 3 data of Ornamental Gourami Fish which are correctly classified as Ornamental Gourami Fish.
- There are 3 goldfish data that are correctly classified as goldfish. However, there was one wrong data, and it was even predicted to be tilapia

Below is an image of the results of an experiment using the application with the matched data that has been input.

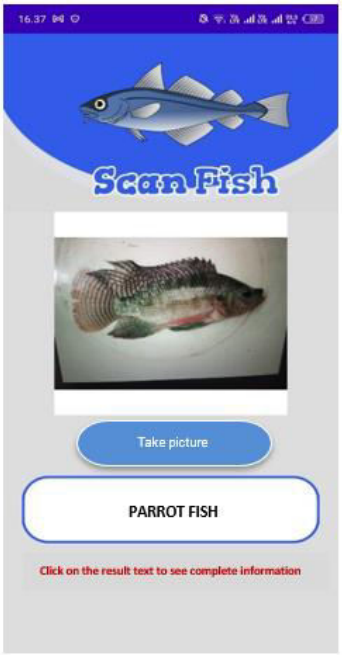

Fig. 8. Correct Detection Result

In the collection of images above, the system succeeded in detecting the appropriate type of fish, where in the experiment it entered a photo of a goldfish, and as a result the system was able to detect that it was indeed a goldfish, and inputting catfish, the system would detect that the image entered was catfish. This shows that the system has the ability to identify and differentiate fish species based on the visual features in the image quite well.

Apart from detecting the type of fish when a fish image is scanned on the system, the system can also detect an image if the image entered is not a fish image. The following is an example of the system if there are no fish in the image input by the user:

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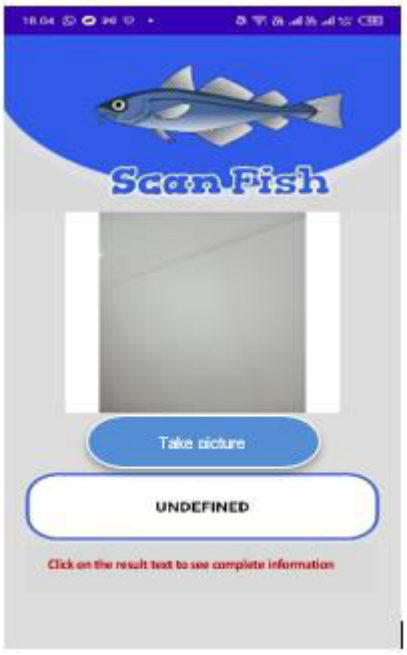

Fig. 9. Undefined Detection Results

The image above shows that the system can detect if the uploaded image is an image that is not in the data. The system provides undefined information which means the image cannot be interpreted or the image does not match the data.

The success of the several fish objects described above, this fish detection and recognition system also has several errors in recognizing several types of fish, such as for example tilapia and goldfish where at several test moments, there were errors in guessing the type of fish.

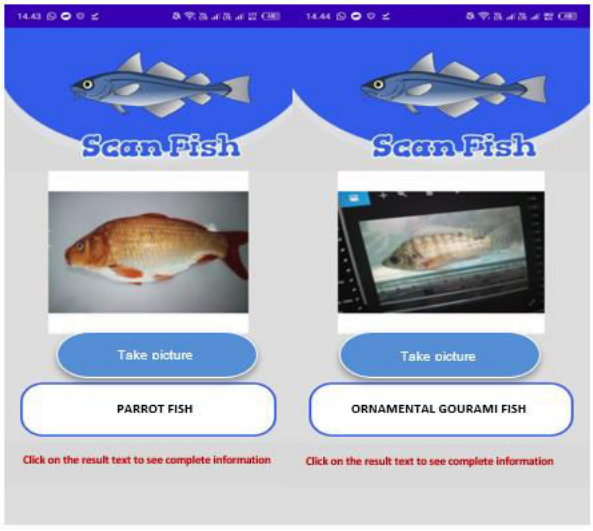

Fig. 10. Error Detection Results

In Figure 10 is an example of an inappropriate detection in this CNN-based Fish Detection System. The inaccuracy that occurs is due to the lack of related fish image data, which is in the dataset used.

Based on the presentation on the previous point which was described using the Table Confusion Matrix, the analysis is as follows:

1. Parrot fish:
- There are 3 Tilapia data that are correctly classified as Tilapia (True Positive).
- There are 2 Tilapia data which are predicted incorrectly as other types of fish (False Negative).
- There are 2 data that predict Tilapia even though it is not Tilapia (False Positive).
- Tilapia recognition accuracy of 3/5 = 60%.
- There is a systemic tendency to confuse Tilapia with other fish species.

2. Fish cork:
- There are 3 data of Snakehead Fish which are correctly classified as Snakehead Fish (True Positive).
- There is 1 data for Snakehead Fish which is incorrectly predicted as another type of fish (False Negative).
- The recognition accuracy of Snakehead Fish is 3/4 = 75%.
- The system tends to be good at recognizing Snakehead Fish, but there is still one case where Snakehead Fish is predicted incorrectly.

3. Goalkeeper Fish:
- There are 3 data of Goalkeeper Fish which are correctly classified as Goalkeeper Fish (True Positive).
- There is 1 data of Keeper Fish which is predicted incorrectly as another type of fish (False Negative).
- Goalkeeper Fish recognition accuracy of 3/4 = 75%.
- The system has a good level of accuracy in recognizing Goalkeeper Fish.

4. Catfish:
- There are 3 data of Catfish which are correctly classified as Patin Fish (True Positive).
- Accuracy in recognizing catfish is 3/3 = 100%.
- The system has a perfect level of accuracy in recognizing catfish.

5. Mosquitofish:
- There are 3 Mosquitofish data that are correctly classified as Mosquitofish (True Positive).
- There are 2 data that are predicted as Mosquitofish even though they are not Mosquitofish (False Positive).
- Mosquitofish recognition accuracy of 3/3 = 100%.
- The system has a perfect level of accuracy in recognizing Mosquitofish.

6. Puffer fish:
- There are 3 data of Pufferfish which are correctly classified as Pufferfish (True Positive).
- Pufferfish recognition accuracy is 3/3 = 100%.
- The system has a perfect level of accuracy in identifying pufferfish.

7. Ornamental Gourami Fish:
- There are 3 data of Ornamental Gourami Fish which are correctly classified as Ornamental Gourami Fish (True Positive).
- There is 1 data that is predicted as an Ornamental Gourami even though it is not an Ornamental Gourami (False Positive).
- The identification accuracy of Ornamental Gourami Fish is 3/3 = 100%.

- The system has a perfect level of accuracy in recognizing Ornamental Gourami Fish.

8. Goldfish:

- There are 3 Goldfish data that are correctly classified as Goldfish (True Positive).
- There is 1 goldfish data which is incorrectly predicted as another type of fish (False Negative).
- Goldfish identification accuracy is 3/4 = 75%.
- The system tends to be good at recognizing Goldfish, but there is still one case where Goldfish is predicted incorrectly.

The following table results of data analysis:

Table 2. Data Analysis

Code	Fish Name	TP	FP	FN	Accuracy
A	Parrot Fish	3	2	2	60%
B	Fish Cork	3	0	1	75%
C	Goalkeeper Fish	3	0	1	75%
D	Catfish	3	0	0	100%
E	Mosquitofish	3	2	0	100%
F	Puffer Fish	3	0	0	100%
G	Ornamental Gourami Fish	3	1	0	100%
H	Goldfish	3	0	1	75%
	Total	24	5	5	

5 CONCLUSION

Based on the results of the analysis above, it can be concluded that this fish species detection system has an accuracy of 82.76%, this shows the ability of the system to correctly classify most of the fish species in the dataset. A precision of 69.5% indicates that approximately 69.5% of fish classified as a certain type of fish really belong to that type, while a recall of 68.5% indicates the ability of the system to accurately detect a certain type of fish from all fish. which exists. Even though the results of this system's precision and recall do not reach a perfect level, it can be said that this system is quite good at detecting fish species.

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