PHOTOGRAPHER'S SOCIAL MEDIA TO IMPROVE PHOTO CONTENT USING DEEP LEARNING FOR CLASSIFICATION IMAGE

by

Nabhan Faisal Bariz

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Approval Page

To: Dean Xiangjun Zhao
     School of Information Engineering

This thesis, written by Nabhan Faisal Bariz, and entitled Photographer's Social Media to Improve Photo Content Using Deep Learning for Classification Image, having been approved in respect to style and intellectual content, is referred to you for judgment.

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Qing Li

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Haiyong Wu
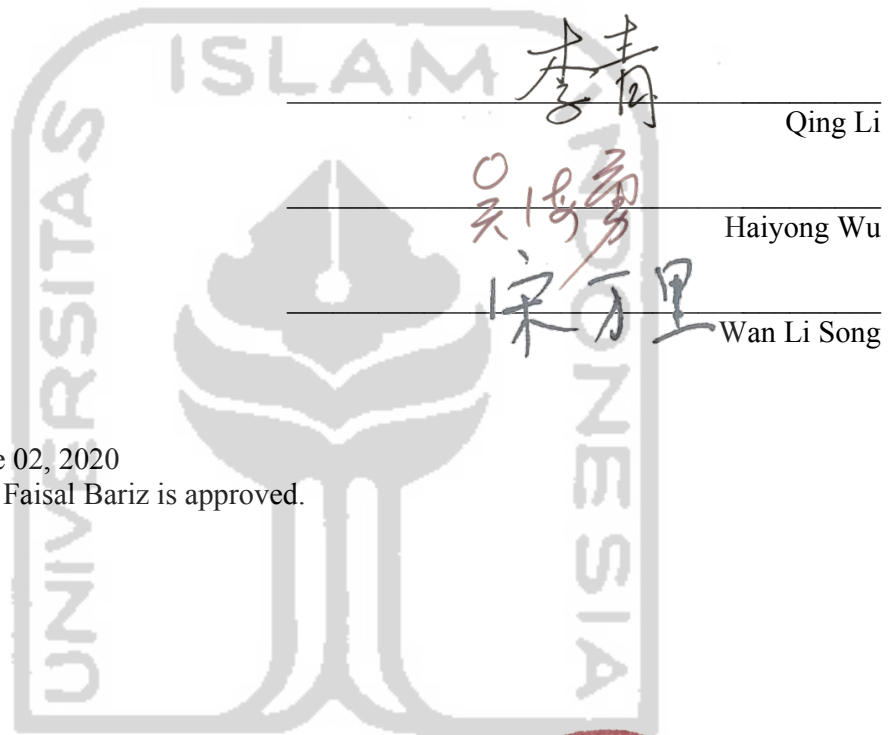
_____
Wan Li Song

Date of Defense: June 02, 2020
The thesis of Nabhan Faisal Bariz is approved.

_____
Dean Xiangjun Zhao
School of Information Engineering

Nanjing Xiaozhuang University, 2020

Declaration of Originality

I, the undersigned below:

Name: **Nabhan Faisal Bariz (潘法明)**

Student ID: L18139904 / 16523206

Study Program: Software Engineering

Faculty: School of Information Engineering

Degree: Bachelor Degree

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Acknowledgements

Abstract

The need and use of social media are increasing every year by millions of people around the world. This increase has a positive impact on users to be able to participate, share, and create content for social media. Over time, social media has an essential role in connecting business people with customers. Therefore, photographers must take steps to use social media as a reinforcement of the relationship between themselves and clients so that services can be improved.

In the current era of high mobility, the space for photography entrepreneurship is seen as narrow because of the movement of locations that are hard to find. In general, entrepreneurship photography is very carefully related to landscape facilities, comfort, and network facilities, as well as accessibility, while it is only slightly related to educational facilities. More specifically, sharing and contributing facilities for photographers in filling content.

Making social media is equipped with deep learning, namely image classification, to find out the genre of photos that enter the database. Image classification using the convolutional neural network model has the highest level of accuracy and the best classification speed among other models for use in image classification.

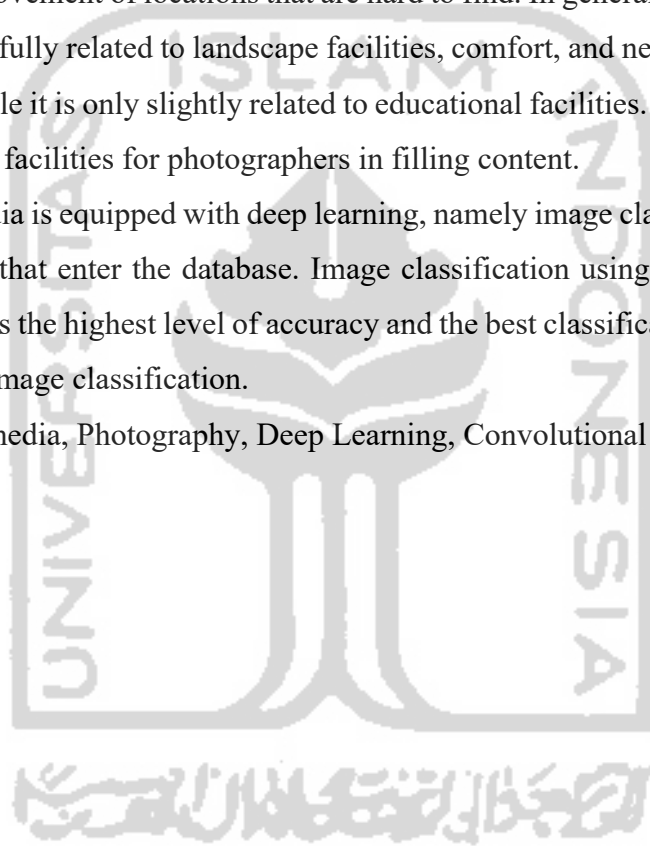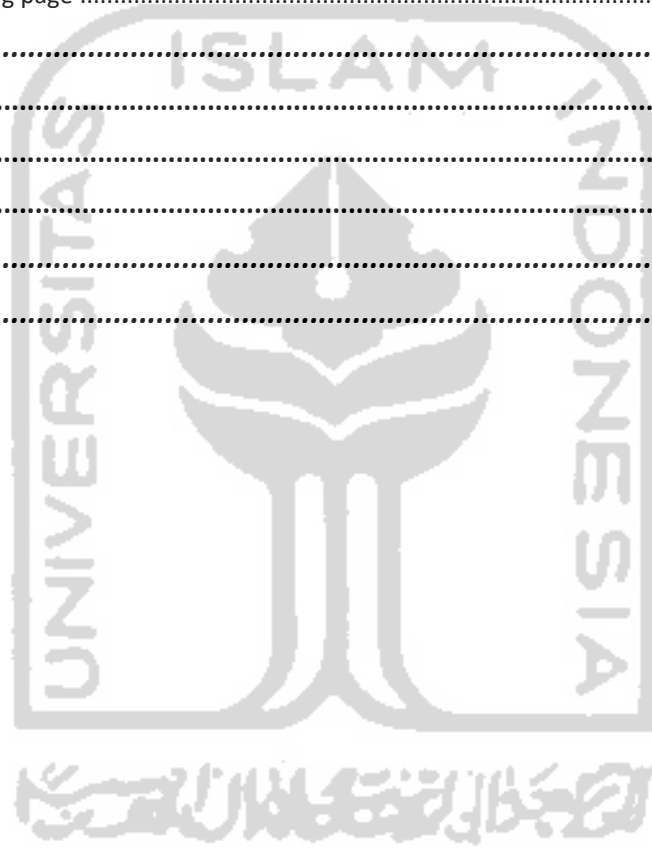Keyword: Social media, Photography, Deep Learning, Convolutional Neural Network

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1 Introduction

The escalation of photography in the creative industry field has been focused in recent years. This field has become one of the advanced fields in the creative industry due to its rapid spread and many new communities that have followed. Broadly speaking, photography has several shooting genres. This genre meets the needs of photographers to pursue the genre. Each style in photography also has different techniques and ways of taking pictures. This method is a benchmark of how true the photos taken by the photographer through established techniques.

The increasing number of players in the creative photography industry has made social media a promotional site. Besides, social media also provides access for photographers to share, contribute, and fill content[1]. On the business side, social media helps tie photographers to their clients. This is a good sign for photographers, of course.

One of the causes of social media is needed right now is the implementation of technology in it. Deep learning is a technology as well as a sub-field of machine learning related to algorithms and inspired by the structure and function of the brain called the neural network[2]. This field performs image recognition and provides output according to labeling. The genre of photography needs to be recognized and understood by machines to enhance the photographic experience of viewing the style. Although images are easily recognizable by humans, seeing the concept of photography is one of very tight academic discussion.

In photography, there are more than 50 genres that need attention[3]. This genre is likely to combine with other genres, along with the development of the world of photography. For this reason, it is necessary to describe the essential style of photography. The picture below represents several aspects of this type of photography, such as landscape, baby, astronomy, macro, wildlife, wedding, and sports photography.

Figure 1-1 Astronomy photography

Figure 1-2 Baby photography

Figure 1-3 Macro photography

Figure 1-4 Sport photography

Figure 1-5 Wedding photography

Figure 1-6 Wildlife photography
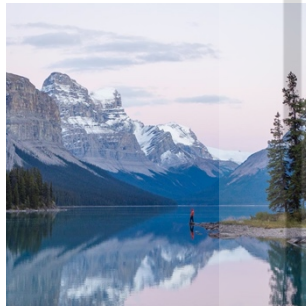
Figure 1-7 Landscape photography

With so many genres in the field of photography, deep learning models are needed that are suitable for being able to identify images accurately. One model used is the Convolutional Neural Network. The increasing power of computing nowadays has made CNNs very popular lately [4]. Unlike traditional artificial neural networks that are applied in image analysis, they do not operate on data obtained in images. CNN is a tool to extract features directly from a picture and then take action to get the expected final results, especially to make a classification [5]. CNN uses a sliding window to scan the entire image and make a feature map, and then make a classification of the observed objects [6]. CNN also has the central concept of going to study features found in new data when it discovers similarities of features in old data; that is, the data it has learned. [7].

Classification, according to Wang, [8] can recognize images with large numbers automatically. Many network architectures are built for image classification, such as Resnet,

Cifar10, VGG-16, etc. Resnet50 is one model that can analyze images quickly among other model architectures [9]. Based on these advantages, it was concluded that Resnet50 is one of the deep learning models intended to classify image data. From the explanation above, the authors researched to implement deep learning with Resnet50 for social media for photographers.

1.1 Problem Identification

From the formulation of the problems above, the issues that will be examined in the study are as follows:

1. How can social media applications being used by photographers?
2. How to build Deep Learning model Convolutional Neural Network for classifying images?
3. How can applications use the Convolutional Neural Network model to classify images as input?

1.2 Limitation of Study

The limitation of the problem that this research does so that it does not deviate from the subject matter is as follows:

1. Android-based application.
2. The Deep Learning Model used is Convolutional Neural Network and Resnet50 as an architectural network.
3. Collecting data using crawling method.

1.3 Purpose of the Study

The purpose of the study is as follows:

1. The application is used by photographers to be able to share, contribute, and fill content.
2. The app uses Deep Learning technology to classify images with the Convolutional Neural Network model.

1.4 Benefit of Study

The benefits of this research are as follows:

1. This social media application can make it easier for photographers to share, contribute, and fill content.
2. This application uses Deep Learning to classify images.

1.5 Research methodology

In developing this software, the authors use Rapid Application Development (RAD). This method uses an iterative and incremental approach but emphasizes more on deadlines and cost efficiencies according to needs[10]. The strategy of using Rapid Application Development (RAD) has the advantage of building applications with fast time while remaining in the corridor of application requirements for users. Some steps that need to be followed to build an application using the Rapid Application Development method are as follows:

1. Requirement planning

    In this stage, the user and the analysis meet to identify the goal or system to be developed. The orientation in this phase is to identify problems that exist in the company or group who will use the application. Although information technology or systems can steer from proposed methods, the focus is on achieving the goals of companies or groups of individuals.

2. Design workshop

    This phase is used to design and improve what can be described as a workshop. Analyzers and programmers can show users' visual designs and design patterns. During the design phase, the analyzer changes the modules and work patterns that have been designed according to the user's response.

3. Implementation

    In this implementation phase, the analyzer works intensively with the user to design technical aspects [11]. After points are agreed upon, new systems or parts of the system are tested and then introduced to the organization.

1.6 Writing structure

The structure of writing in this thesis is divided into five sections which are detailed as follows:

Chapter 1. Introduction

In this chapter, we will describe the background of the problem, the formulation of the problem, the limitation of the problem, the purpose of the research, the benefits of the study, the research methodology, and the structure of the writing will be clearly detailed.

Chapter 2. Related work

This chapter presents previous studies relating to the problem under review so that they can become conceptual references.

Chapter 3. Theoretical basis

This chapter discusses the theories and thoughts of previous research that support research for problem-solving. On the other hand, this chapter also contains approaches in the implementation of data collection and analysis of the data.

Chapter 4. Proposed method

This chapter describes steps to achieve problem solving, creating application, and build deep learning model.

Chapter 5. Implementation

This chapter will discuss the analysis of the results of the collection, processing and analysis of data obtained from research results.

Chapter 6. Conclusion

This chapter will discuss the conclusions obtained from the results of research and analysis of data that have been carried out as well as suggestions that can be applied from the results of data processing that can be a useful input in the future.

1.7 Schedule

Planning for making an application is detailed in a predetermined schedule. This scheduling is intended to create a structured application with a schedule that has been prepared so that it finishes at the right time.

No	Activities	Weeks								
		1	2	3	4	5	6	7	8	9
1	Literature review	█	█							
2	Analysis of needs/requirements			█	█					
3	Design				█					
4	Coding					█	█	█	█	
5	Testing						█	█	█	
6	Documentation									█

Table 1-1 Schedule application progress

2 Related work

Further research is very important for the writer to be a stepping stone. This is useful for research conducted by writers who have vital meaning for the development of science. On the other hand, it is also useful to avoid duplication of previous research with research conducted by the author.

Several previous studies have become the primary reference for author in making social media for photographers. The research becomes the foundation and formulates the problem of why this social media must be made. Several factors serve as a comparison glass for the author to digest further. The first factor that becomes a reference for the writer is the problem faced by the photographer. Usually, the photographer has a problem to be able to meet with clients. This is caused by the lack of information about the existence of the photographer itself. The second factor is the factor in which photography, which is one of the subfields of the creative industry, has contributed to raising the economy. And the last is connecting information technology with the creative sector so that the formation of social media for business people in the creative industry, especially photography.

According to Jinliao He [12], Nanjing is one of the cities in China that has difficulty finding photographers. This happens because there is not enough space for photographers to share or establish a community. They used regression analysis to find out how they spread the creative industries, especially photographers in Nanjing. This research by Jinliao He resulted in an uneven distribution of photographers' geographical locations.

Nowadays, social media has a significant role in advancing business. Business people usually make social media a company profile page, with the aim that various groups will easily access the company profile. Research conducted by Chae [13] and Corral [14] says that the use of social media has increased rapidly in the last ten years. The results showed that social media could be used to enhance a company's business income. Companies can also form a business bond to the customer that is beneficial for business continuity.

Xiangtong Meng researched the impact of social media. [15]. This research is aimed at seeing how much impact social media has on a company's business. Xiangtong Meng takes data from Guba, which is one of the social media platforms in the financial sector. The results of the study showed that social media even has an essential effect on shares.

Research conducted by Alexandra Elbakyan [16] that social media has a function to evaluate a business. Based on this research, it is written that users spend a lot of time uploading photos they take at a restaurant. The evaluation data was taken from various social media such

as LinkedIn, Instagram, Facebook, and Twitter. From the results of the study, it was found that each of the social media has an impact above 5% to evaluate how important social media is in the business field.

Research on social media has been carried out by Martin Rojas [17]. The analysis uses a social media approach to foster corporate entrepreneurship. Because various information has been available to develop the business through social media, it has become essential to be a tool for a company to do business. This research results that social media has a positive value in terms of communication, interaction, and cooperation. On the other hand, social media also provides a path for companies to evaluate the long-term business. Even so, there are still deficiencies in research regarding variable data used to minimize the effect of response bias.

The study was conducted by Tamara Grizane [16] to evaluate companies from social media. According to Tamara, social media has a valuable meaning to assess the ROI of social media lies not only in the complexity of methods used for the assessment. In this study, the underlying methodology used is based on the impact of social media on business. The term social media (Social Media 2020) is only used to describe platforms that allow internet users to interact with each other. By summarizing different opinions, it can be concluded that social media is a tool that allows for users to place and perceive information of different types and forms of publishing; thus, it can be used as a tool for marketing purposes [18], which requires constant updating. The results of this study say that social media offers companies the opportunity to gather information, monitor opinions of users, and engage users to dialogue with one another.

Research on the creative industry was carried out by Tae Kyu Sung [19] to review how far the economy is developing in this field. According to research, the rapid development of technology lately is an excellent opportunity to integrate with the old business model. The study found that the entry of the world of technology increased revenue for business people [20]. This is indicated by the increasing performance in a company that implements its business with technology such as e-commerce. The application of information technology is intended to see how much the potential of the creative industry. This research resulted in 3 meeting points between information technology and the creative sector. The first point is the company's performance improvement in terms of revenue ratio [21]. Second, the application of information technology for the creative industry combines the main activities with the following business, which makes all of these activities more efficient to do in collaboration. And the last is a more competitive marketing strategy for the long term.

Research conducted by Petrovi [22] to find out how much the creative industry increases the economy. In the study, it is said that the creative sector has significant potential and has a unique role in aspects of economic improvement for the future. It is predicted that future economic development is the result of the successful implementation of the global creative industry project. The creative industry can be defined as the potential to generate something new [23]. In contemporary economies, creativity becomes an economic activity when it produces an idea with financial implications or a service/product that can be traded, which implies their economic value and market realization. The link between creativity and economy, "from mind to market," should result in increased cost and wealth. Munro [24] initially argued the concept of a creative economy. When considering the creative economy, its broader impact on society must be taken into account, taking into account the importance of intellectual property for various sectors [25], including economically critical traditional activities, and in particular the role of patents from the perspective of companies' monopoly positions as well as copyright [26] and trademarks. It is essential to have in mind the implications of creativity in science and research and development on the placement of new products and services on the market, on business performance, and temporary growth.

Hidayat [27] researched creative industries in supporting the economy in Indonesia. In this study, the authors make the city of Malang as an example of a creative city. The town has many art observers because of its cultural diversity. The city has been named the most innovative town, according to merdeka.com [28]. Since the arrival of the labor force in the city of Malang, the city has experienced a very rapid increase. The increase can be seen from the census that accumulated as much as a 60% increase. The results of the study stated that the creative industry contributed 7.28% of the regional gross since the arrival of 450,000 labor forces in Malang [29]. This indicates that the creative industry needs to be lifted so that it can continue to grow in the future.

Research conducted by A Bujor on modern technology and business performance [30]. According to him, the creative industry is currently the most dynamic sector of the world economy and the work of producing international trade, income, export income while promoting social inclusion and human development. According to research conducted in 2009 [31], the creative industry has contributed 5.93% of Romanian GDP and generated around 100,000 jobs. The photographer is one of the fields with the most significant profit.

From this research, it can be concluded that photography is part of the currently developing creative industry. The increasing economic value shows this development through this industry channel. Therefore, there needs to be supervision and essential attention to the

creative industry. One of the solutions made by creative industries for writers is the creation of social media for photographers. This social media will become a place for photographers to interact with their clients. The client also does not need to be bothered or afraid of a lack of information to find the photographer sought. Photographers can also share their experiences through social media. This is expected to help the community to continue to develop in the future. On the other hand, photography that produces in the creative industry can also help improve the economy of the country. This is felt directly from the various studies mentioned above.

3 Theoretical basis

3.1 Software engineering

Software engineering is a technique that focuses on all aspects of software production at several levels of system specification. This can be used to maintain the application after the application has begun to be used. There are several reasons why it is essential to use software engineering techniques.

1. The current environment relies heavily on sophisticated software. This need is increasing with the necessity of a system that can be applied quickly and made economically. [32].

2. The software can be used for more quickly and inexpensively for an extended period. This software engineering technique has the advantage of building software in a smarter way [33].

The systematic approach used to create an application is called the software process. The software process is a sequence of activities that direct the steps of the creator of the software. There are four basic principles in the order of this activity. However, using this approach without prior assessment in directing to failure [34].

1. **Software specification**, software users and makers will analyze the needs of the software to be made. In this flow, users also provide limits in the process.

2. **Software development,** the software maker will do the design process and make the application.

3. **Software validation,** the software will be re-checked for its functions according to user needs.

4. **Software evolution,** the app is improvised to adjust its features according to the circumstances of the user and the market.

3.1.1 Rapid Application Development

Rapid application development is a software application development methodology that uses minimal planning so that it supports rapid prototyping. The prototype is a working model that is functionally equivalent to product components. In the RAD model, functional modules are developed in parallel as prototypes and integrated to make complete products for faster product delivery. Because there is no detailed initial planning, it makes it easier to include changes in the development process. [35].
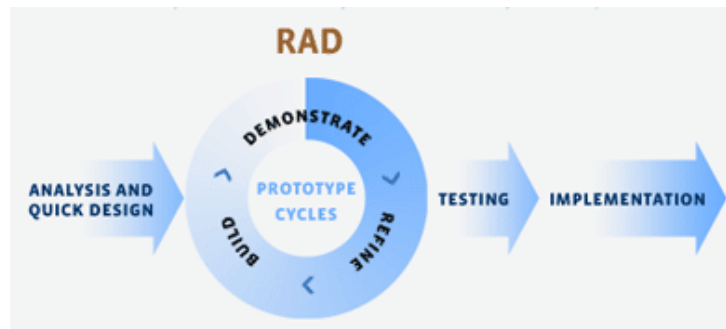
Figure 3-1 Rapid Application Development

1. Analysis and quick design

   In this stage, the user and the analysis meet to identify the goal or system to be developed. The orientation in this phase is to identify problems that exist in the company or group who will use the application. Although information technology or systems can steer from proposed methods, the focus is on achieving the goals of companies or groups of individuals.

2. Build

   When all the analysis needs of the application are fulfilled, this is the time when the application is made functional. Making functional applications is made in parallel. This helps prototype and integrated application development to make a whole product.

3. Testing

   This phase is used to design and improve what can be described as a workshop. Analyzers and programmers can show users' visual designs and design patterns. During the design phase, the analyzer changes the modules and work patterns that have been designed according to the user's response.

4. Implementation

   In this implementation phase, the analyzer works intensively with the user to design technical aspects [11]. After points are agreed upon, new systems or parts of the system are tested and then introduced to the organization.

3.1.2 Object Oriented Programming

As the complexity of making application development nowadays, the system has resulted in the use of object-oriented programming [36]. Object Oriented Programming (OOP) is the concept of making applications that assume all parts of the code are objects. This object functions to be used by other classes through the interface. Some well-known programming languages using the Object Oriented Programming structure are Java, C,

etc. By using Object Oriented Programming in making applications, the cost of programming expenses can be reduced. This object-oriented approach is also very suitable to be implemented in application projects that have groups of different programmers to combine and make a whole system.

3.1.3 UML (Unified Modeling Language)

The Unified Modeling Language is a set of structures and techniques for modeling object-oriented program designs. In the Unified Modeling Language, diagrams are divided into several sections and their functions, namely:

1. Use case diagram

   Use case diagrams are diagrams that illustrate interactions between external users, the system, and the external system itself. Besides, the use case diagram also explains how and in what way the user interacts with the system. When creating a use case diagram, a narrative use case is needed to describe the sequence of steps of each interaction.
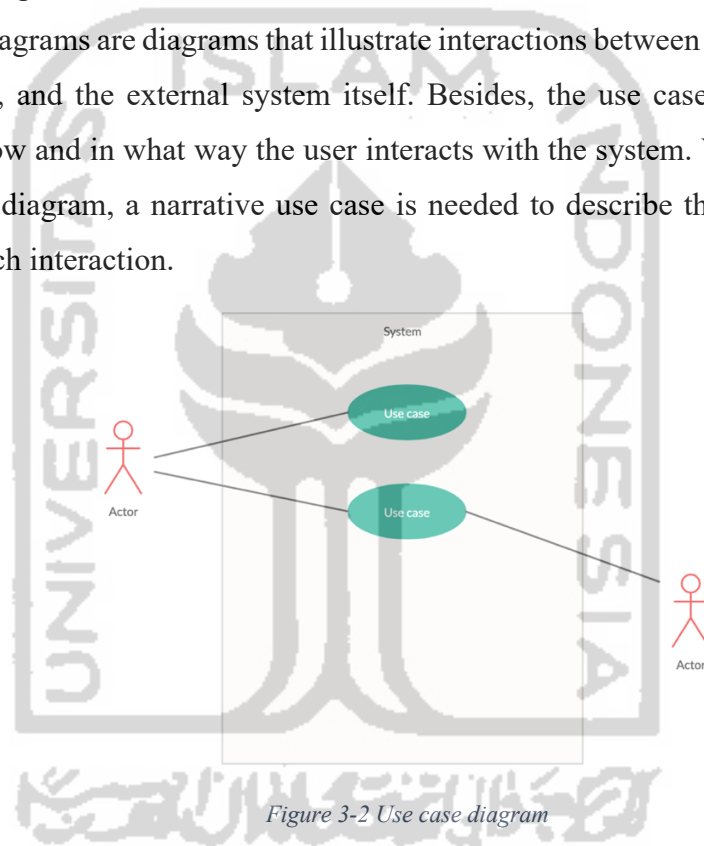

Figure 3-2 Use case diagram

Two essential things are needed to be considered for making use case diagrams. The following is an explanation of each of these sections:

   1. Actor

      Actors in use case diagrams represent users who start system activities with the aim of carrying out tasks so as to produce measurable values.

Actor

Figure 3-3 Actor

2. Relationship

The relationship in the use case diagram illustrates a line between symbols in the use case. A relationship is depicted with an edge that varies visually and functionally.

a. Association

Something is said to have associative ties when an actor and a use case interact. The association line is divided into two, the association with the line that has the tip of the arrow and the line association that does not have the tip of the arrow. The line with the arrow tip describing the use case can be done directly by the actor. While the line that has no arrow tip means that there is an action between the use case and the external actor or receiver.

b. Extends

A use case consists of functional complexes with several steps that make use cases logically understood. Every line that has a relationship extends must be labeled "<<extends>>."

c. Includes

An abstract use case is two or more use cases that display several practical steps. Whereas the uses or includes relationship connects the abstract use case with the use case itself. Every line that has a relationship includes must be labeled "<<Includes>>."

d. Depends on

A relationship between use cases that affect each other use cases. A use case cannot be run if another use case has not been run either. Every line that has a relationship depends on must be labeled "<< depends on >>."

e. Inheritance

This relationship is made if there are two or more actors who have the same task, and abstract actors are made to unite these actors. The line that signifies this relationship inheritance is the same as an association, which is an arrow at the end of the line.

2. Class diagram

A class diagram is a diagram that displays the system in a static form at the class level [37]. This diagram is used to explain class relationships in a particular use case. There are three approaches that we can use to draw and interpret class diagrams.

a. Conceptual approach

In this approach, the diagram will be drawn according to the rules that describe the concept in the learning phase.

b. Implementation approach

In this approach, there are already several classes with a simple implementation.

c. Specification approach

In this approach, the software is not just seen blindly, but the interface of the software is compared to its implementation.

The components in the class diagram consist of 4 main parts, namely:

a. **Class name**, name of the class.

b. **Attribute,** the state of a system needed in a class.

c. **Method,** the method used in the class so that it can be processed. Attributes and methods have three levels, namely public, private, and protected.

3. Activity diagram

The sequence of interactions or activities of a use case process is called an activity diagram [38]. This diagram can also be used as an example of modeling a system to be accepted by human logic.

No	Name	Description	Notation shape
1.	Initial node	This notation used for starting point in the interaction process.	●

2.	Actions	This notation used for describing the step by step process of each interaction. The notation should be in line with one another.	
3.	Flow	This notation used for movement through the action.	
4.	Decision	This notation is used if there are two or more conditions.	
5.	Fork	A black notation with one flow and two or more outflows. This notation means that an actions can be done at one time simultaneously.	
6.	Join	A black notation with two or more flows and one outflow. This notation means all of the actions will passed join notation should be done before going	

		to the next process.	
7.	Activity final	This notation is used to end all the activities.	◉

Table 3-1 Activity diagram notations

3.1.4 Database

Companies with large capacities nowadays need databases to store, process and distribute data that has a large enough size [39]. The use of a database at this time is very necessary to explore the data that has been stored by the company. More than that, there are some database capabilities that need to be known..

1. Organizing data in a data file environment.
2. Databases can improve business performance and decision making.
3. The database has excellent scalability, so the system used can be developed to provide changes to an organization.
4. Increased independence which reduces data redundancy can increase flexibility.

3.2 Photography

The world of the creative industry is currently providing a significant increase in the field of photography. This field requires more attention due to the lack of platforms provided.

Photography first appeared in Europe in the 19th century during the scientific positivism revolution [40]. Image-making technology takes hundreds of years to enable shooting on plates or films. Image management at this time is more comfortable and faster because of the mirror on the camera. The photography product, the photo, reveals a new world, triggers curiosity, and accelerates the journey of discovery. Currently, photography has more than 50 genres, with different characteristics in each type. Eight primary photography genres need to be known to develop it into the right combination.

1. Baby photography

    Baby genre is one genre that makes the baby the main object of shooting. This type of photography takes on the facial emotions found in a baby. This photography is usually done by a family that has just had a baby.

2. Astronomy photography

16

Astrophotography is a type of photography that takes photographs of star objects [41]. In 1840, the moon became the first object of a celestial body to be photographed [42]. At the end of the 19th century, technological advancements made it possible for cameras to capture objects in the sky that were not visible, such as stars in detail, nebulae, and the galaxy. This is due to exposure to light on digital cameras that can be stacked and the number of photons of light entering in a long period of time.

3. Landscape photography

Landscape photography shows the infinite and endless dimensions of spaces [43]. The subjects typically found in this photo are clearly defined as landscapes, weather, and ambient light. The success of this type of photography is when natural beauty can speak visually.

4. Macro photography

The word macro photography today is used as a synonym for close-up photography. Macro photography technically takes a photographed object with a size ratio of 1: 1 or larger. Macro lenses are lenses that reach a ratio of 1: 1 or higher [44]. Macro lenses are lenses that reach a ratio of 1: 1 or higher. Objects in this type of photography are usually small objects or creatures such as insects, flowers, and dew drops.

5. Sport photography

In most cases, the branch of sports photography is a branch of photojournalism. This type of photo includes various kinds of professional sports such as soccer, basketball, swimming, etc. A dedicated sports photographer usually works for a sports newspaper or magazine. However, sports photography is also used to promote sports and brands that cannot be achieved in an editorial way.

6. Wedding photography

Wedding photography is a specialty in photography that focuses on wedding activities [45]. This might include other types of portrait photography of the couple before the official wedding day, such as engagement and pre-wedding sessions. On the official wedding day, the photographer will document the entire contents of the activity at the wedding.

7. Wildlife photography

This type of photography has a relatively high level of risk with the state of subjects in the wild. Catching exotic animals in their natural habitat is about wildlife photography [46].

3.3 Social media

In the digital age, the use of social media has increased significantly. Social media has changed the way humans interact and collaborate.

Considering that software engineers are pioneers and early adopters of new communication technology, it is not surprising that they have used social media to manage work related to developing software more efficiently [47]. Here we provide a brief description of the media and its current use.

1. **Microblogs** like twitter is lightweight blogs that enable users to write and share the short message with a set of followers who have subscribed to receive them. Messages can be written by various types of mobile phones, allowing users to share notes anytime, anywhere. Yammer is currently [48], a microblogs application that provides services to keep secrets within the company.

2. **Blogs** are a series of short articles written by a group of writers or authors individually. Articles provide feedback to users in the form of comments and like to find out the readers' reactions.

3. **Social Networking** like Facebook, Instagram, and LinkedIn build graphs of social relationships that can be traced and explored by people. Information about a person can be obtained with recommendations given based on user treatment.

4 Proposed Method

4.1 Dataset collection

Researchers collect and make datasets in the form of images obtained from Google images. The Deep Learning models, especially CNN, usually require a lot of image data as training data and validation data. To collect images on Google Image manually will certainly spend a lot of time, so we need a solution to utilize Google Image to collect images automatically. Researchers use JavaScript programs to collect images from Unsplash and the Python program for Google Images. The program that has been created will directly download images from Google Image and Unsplash automatically.

The population in this study is the photos with the genre of astrophotography, baby photography, landscape photography, macro photography, wildlife photography, wedding photography, and sports photography taken with Google's Image search engine and Unsplash API. While the samples used in this study are images of stars, sky, babies, nature, sports, marriage, wild animals, and insects. In each class, we receive 400 images with a total of 2800 images.

The variables used in this study are explained in Table 4-1 Operational research definition of how the research definition and operations are.

Variable	Operational variable definition
Astrophotography	Photos with stars as the main subject.
Baby photography	Photos with the baby as the main subject
Landscape photography	Photos with nature as the main subject
Sport photography	Photos with sports model as the main subject
Wedding photography	Photos with wedding model as the main subject
Macro photography	Photos with small objects as the main subject
Wildlife photography	Photos with wild animals as the main subject

Table 4-1 Operational research definition

Image data is divided into two groups, namely, training data and validation data. Comparisons are made with different proportions, including 80% with 20%, and 70% with

30%. Then for the best model experiment using 70 photos, which contain ten images for each variable.

4.2 Deep learning

Deep learning is one of a variety of methods in machine learning that uses Artificial Neural Network (AAN). This way of learning is similar to how the basic system of the human brain works. That is why deep learning is called an Artificial Neural Network. There are several types of methods used in deep learning for knowledge.

4.2.1 Types of learning

1. Supervised learning

   The learning model with a supervised learning method is the most basic method in deep learning. This method is like a student listening to a lesson from a teacher explaining the experience. The intelligence of a student during the learning period depends on how many examples are given by the teacher. In the supervised learning method, we can imagine the input variables (x) and the output variables (Y). The algorithm will be used to study the mapping function from input to output. The goal is to estimate the mapping function very well so that when there is new input (x), we can expect the output variable (Y) from the data.

2. Semi-supervised learning

   Deep learning requires extensive data to be studied. Even so, only a small part of the amount of data that has labels to be explored. Some of the data used in the semi-supervised learning method are labeled data, but most are not. This causes deep learning to be referred to as semi-supervised learning.

3. Unsupervised learning

   This method has no labels on the dataset given from the system. So the system can develop and organize data, look for general characteristics of them, and change based on internal knowledge. An example of unsupervised learning is cluster classification, and the algorithm tries to include similar things in the cluster.

4.2.2 Convolutional Neural Network

Convolutional Neural Network is a type of neural network commonly used for image and video classification. CNN can be used to detect objects in an image and also video. Broadly speaking, Convolutional neural networks have the same principles as

MLPs, but use a convolutional layer consisting of weight, bias, and activation functions. Weights here function like heart parameters by using numeric numbers. In the Convolutional Neural Network architecture, layers are divided into two parts, namely the feature extraction layer and the fully-connected layer.

4.2.3 Convolution operation

The convolution operation is central to image processing and has been used extensively in various image processing software [49]. This operation applies the output function as a Feature map of the image input. These inputs and outputs can be seen as two real-valued arguments. Formally the convolution operation can be written as follows.

$$s(t) = (x * w)(t)$$

The function s (t) gives a single output in the form of a Feature Map, and the first argument is the input, which is x, and the second argument was the kernel or filter. If we see the data as a two-dimensional image, then we can assume t as a pixel and replace it with i and j. Therefore, operations for convolution to inputs with more than one dimension can be written as follows.

$$S_{(i,j)} = (K * I)_{(i,j)} = \sum\sum I_{(i-m, j-n)} K_{(m,n)}$$

The equation above is a basic calculation in convolution operations where i and j are the pixels of the image. The computation is commutative and appears when K is the kernel, I is the input, and the kernel is reversible relative to the input. As an alternative, convolution operations can be seen as a matrix multiplication between the input image and the kernel, where the output can be calculated with a dot product.

4.2.3.1 Feature extraction layer

The primary capability on CNN is its architecture, which is able to recognize predictive information of an object with a different position on an input. CNN controversy in the extraction layer feature lies in the convolution and pooling layer. Convolution works with the principle of the sliding window and weight sharing to reduce the complexity of calculations. Pooling layers are used to summarize information generated by a convolution to lower dimensions. Whereas vector results from several convolutions and pooling operations on the multilayer perceptron are known as fully-connected layers that are used to perform work such as classification.
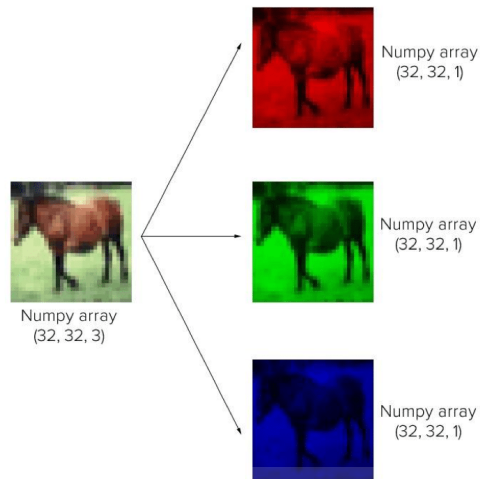
1. Convolution layer

Figure 4-1 RGB image

Source: https://www.cs.toronto.edu/~kriz/cifar.html

Figure 4-1 RGB image above is an RGB image with a size of 32x32 pixels, which is a multidimensional array with a size of 32x32x3 with three as the number of channels. Convolution layer consists of neurons that form a filter with length and height (pixels).

The first layer in the extraction layer feature is a convolution layer with a size of 7x7x3. These three filters will be shifted to all parts of the image. Each shift will be carried out a "dot" operation between the input and the value of the filter to produce an output activation map. The layer shift in convolution is shown in Figure 4-2 Convolution layer.
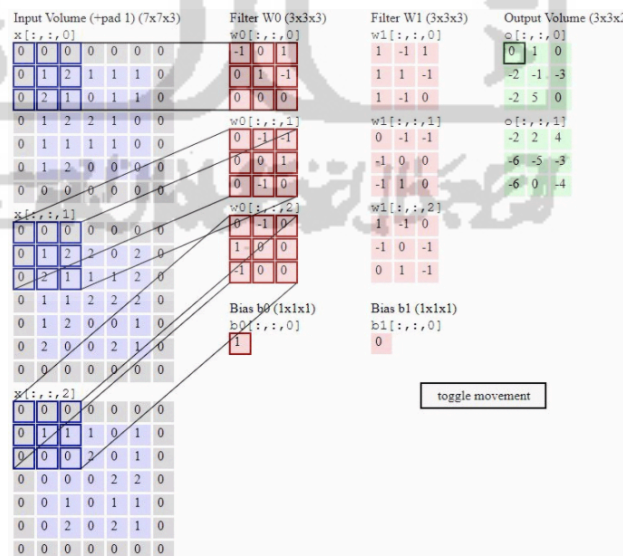

Figure 4-2 Convolution layer

Source: CS231n

2. Pooling layer

This layer comes after the convolutional layer. Consists of a filter with a specific size and stride that will shift across the entire activation map. Pooling used is max and average pooling. If max 2x pooling is used with stride 2, each shift of the maximum value filter in the 2x2 pixel area will be selected, while average pooling will choose the average value.
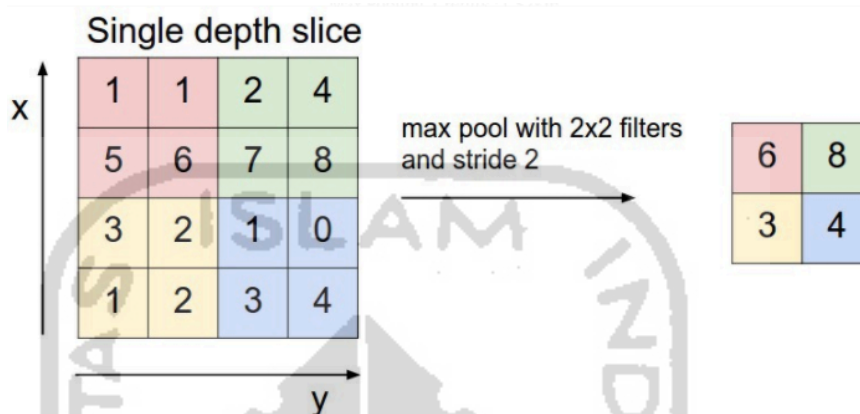

Figure 4-3 Pooling layer

Source: CS231n

The pooling layer is used to speed up computing because fewer parameters need to be updated and overcome overfitting.

3. Fully-connected layer

The activation map that produced from the feature extraction layer is still in the form of a multidimensional array, so it is necessary to reshape the activation map into a vector that can be used for a fully-connected layer. This layer has a hidden layer, activation function, output layer, and loss function. This layer is commonly used in implementing a multilayer perceptron to transform data dimensions. This is done so that it can be classified linearly.

Each neuron in the convolutional layer needs to be transformed into one-dimensional data first before it can be entered into the fully-connected layer. Because it causes data to lose spatial information and is not reversible, while the fully-connected layer can only be implemented at the end of the network.

Convolution layers with 1x1 kernel size perform the same functions as fully-connected layers, but while maintaining the spatial character of the data. So that makes the use of this layer on CNN not widely used today.

4.2.4 Residual Network 50 architecture

A deep residual network is a special type of neural network that helps handle more sophisticated learning tasks and models [50]. It has received little attention at IT conventions recently and is being considered to help deep network training. The framework presented by ResNets, it is possible to train a very deep neural network with hundreds or even thousands of layers, but still, achieve great performance. ResNets was initially applied to the task of image recognition but is now widely used for non-computer vision work to achieve high accuracy.

As we know that Deep Convolutional neural networks have a great ability to identify low, middle, and high-level features of images. Then the question arises whether stacking more layers will make the model performs better?.
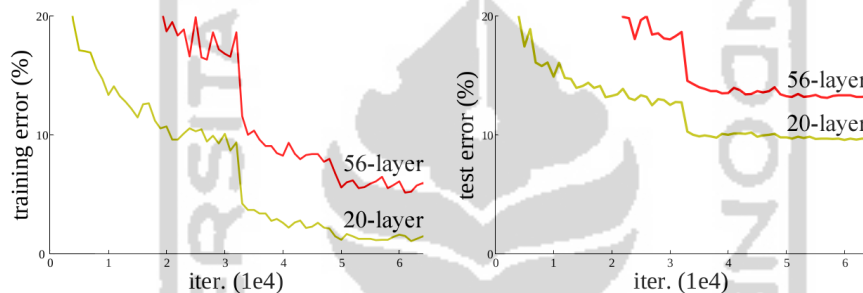

Figure 4-4 Deep layer graphic

Source: https://iq.opengenus.org/resnet50-architecture/

In the example of Figure 4-4 Deep layer graphic, we can see that a deeper model always raises more errors, which does not have to happen. The author uses Residual Network to overcome this problem, so for this, they introduce a shortcut connection that only does identity mapping.
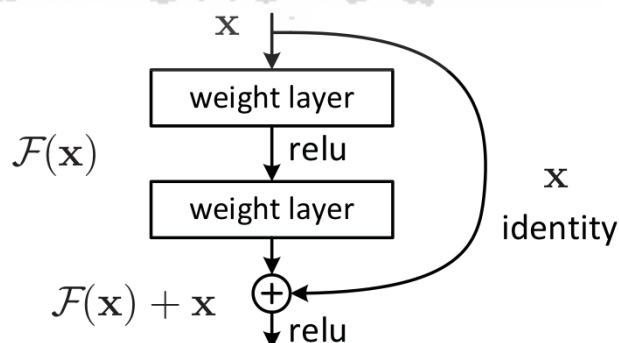

Figure 4-5 Residual learning: a building block

Source: https://iq.opengenus.org/resnet50-architecture/

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They explicitly leave the layer in line with the residual mapping and declare it as H (x), and they let the non-linear layer match the other mapping F (x): = H (x) −x so that the original mapping becomes H (x): = F (x) + x as can be seen in Figure 4-5 Residual learning: a building block. And the benefit of mapping this shortcut identity is that no additional parameters are added to the model, and also computing time is maintained.
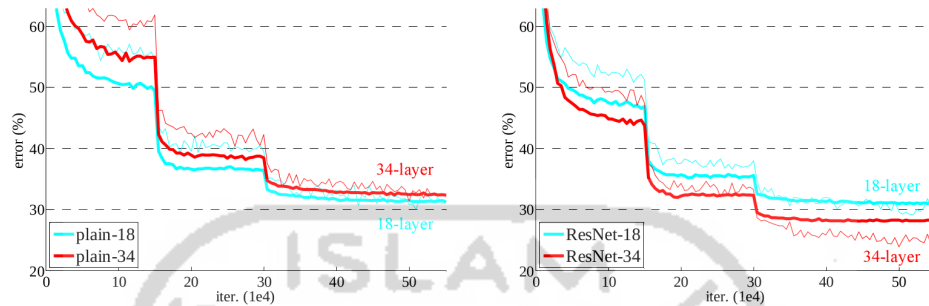

Figure 4-6 Training on ImageNet

Source: https://iq.opengenus.org/resnet50-architecture/

Thin curves indicate training errors, and thick curves indicate validation errors of the centerpiece. Left: plain 18 and 34 layers. Right: ResNets of 18 and 34 layers. In this plot, the residual network has no additional parameters compared to their counterparts.

4.3 System design

The system design is the phase to determine how the system will run and be used by users widely. In this phase, the author will explain how the program will run to use the deep learning model that has been formed into an android application. The system will use the RESTful API communication method architecture as a server that will receive responses and requests from clients while the client system will use an Android-based application that will send requests and receive responses from the server.

4.3.1 Architectural design

In developing this application, researchers used the concept of web services architecture to facilitate the server in responding to responses and requests given by users through the client. Android application will send a request to the server then the server will respond by providing a response. In this case, the server is useful so that it can be used repeatedly through different client applications. This is done to make room for the server to get more requests from clients.
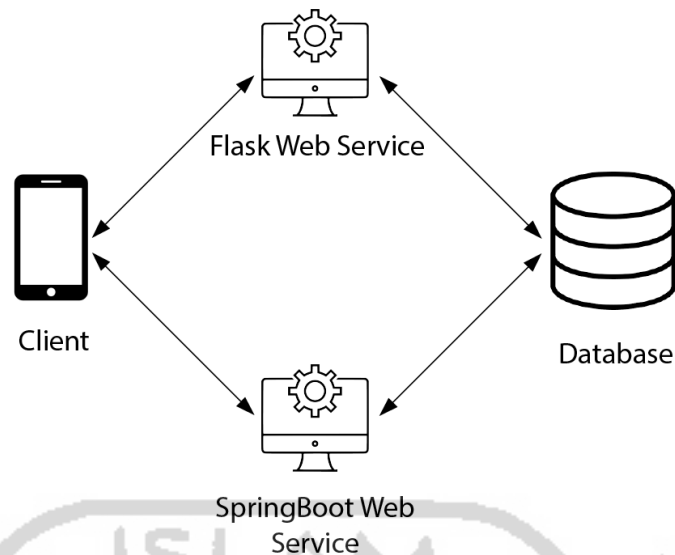
Figure 4-7 Architectural design

The picture Figure 4-7 Architectural design explains how the application runs to access the database. In this stage, the researcher uses two frameworks that work as a server to respond to the response sent by the user. The SpringBoot Framework will run as a REST API that responds to user requests to register, log in, and so on, while the Flask REST API is used specifically for storing photo data using a classification model that has been created.

4.3.2 Flask Web Service

RESTful Web Service is an architectural style, where data or structural components of a system are explained in the form of a URI (Uniform Resource Identifier) , and behavior is explained in terms of methods. Resources can be manipulated using CRUD operations (Create, Read, Update, and Delete). The communication protocol for REST is HTTP because it complies with the architecture requirements to be state-free communication across all Clients and Servers.

Flask is a minimalist (or micro) framework that refrains from imposing the way critical matters are handled. Instead, Flask allows developers to use the tools they want and are familiar with. For this purpose, it comes with its extension index and several tools that already exist to handle almost everything from logging to logging.

Using the Deep Learning model for image classification takes up a lot of memory when running. This is the main reason for specializing in Flask Web Service as a server that handles the work of the deep learning model contained in the web service. The lightweight structure of the Flask will make the application run lighter when walking and making predictive images.

4.3.3 SpringBoot Web Service

Spring framework is a java platform that provides infrastructure support for Java application development. The use of Spring Web Service in this application aims to provide space for all apps to run according to their individual needs. SpringBoot Web Service has the task of making several requests made by users through the android application. This is done to make it easier for Python servers to predict images that take a long time.

SpringBoot Web Service uses MVCS architecture flow, i.e., Model, View, Controller, and. Service. This use makes the application more structured to be developed in the future.

1. Model is structuring data in a reliable form and prepares it based on controller's instructions.
2. View is displaying data to user in easy-to-understand format, based on the user's actions
3. Controller takes in user commands, sends commands to the model for data updates, sends instructions to view to update interface.
4. Service are called to specifically that: accepting, loading and storing any type of data from any type of external source.
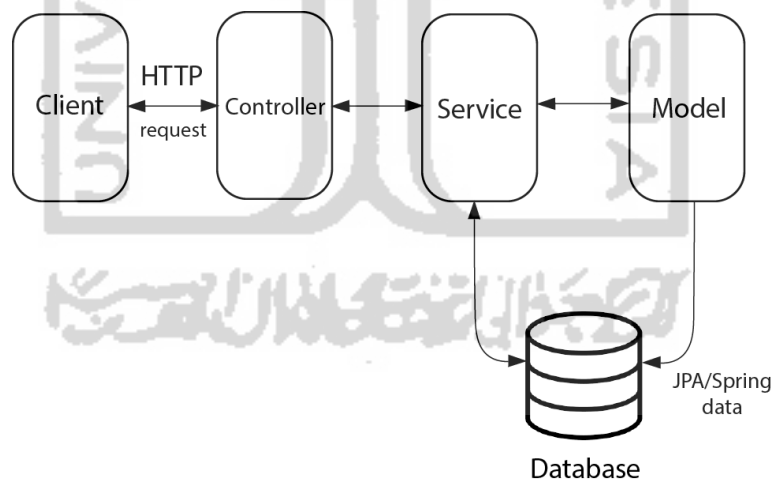

Figure 4-8 SpringBoot architectural flow

5 Implementation

In this study, researchers classified photography images by genre using the Convolutional Neural Network (CNN) model. Seven photography genres will be classified, namely astrophotography, baby photography, landscape photography, macro photography, wedding photography, sports photography, and wildlife photography. The main process in making the classification model by the CNN method is the design of the classification. The basic principle of this process is to conduct training on CNN to produce good models with higher accuracy. In CNN training, the dataset is divided into two groups, namely training data, and validation data. The dataset in the training data group will be used to train the CNN model, while the data validation is used to test how well the CNN model has been trained with training data. Model training using the Hard library with the Python programming language. Google developed Keras as a TensorFlow wrapper to implement and provide part of the folder contribution in the TensorFlow framework. Hard is designed to eliminate boilerplate code. A few lines of Hard code will make designing CNN easier and can run on GPU or CPU.

5.1 Collecting dataset implementation

Neural Networks require a lot of data to be trained. The amount of data is what will determine the high prediction value generated by a model. Collection of datasets for Deep Learning is a job that takes a lot of time because of the availability of data that might not exist yet. For this reason, the writer collects data using crawling techniques so that the data collected does not spend a lot of time.

To be able to crawl data, a script is needed to do this automatically. The author uses two programmings to gather as much data as possible. Here is how the explanation of data crawling is done using Python and JavaScript scripts.

5.1.1 JavaScript program crawling data

The JavaSript program created, uses the API from Unsplash to download the images provided. Unsplash itself is a website that provides thousands of images that can be downloaded for free.
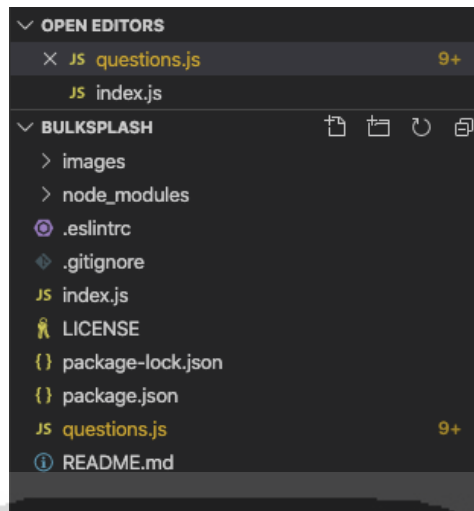
Figure 5-1 Program structure

1. Accessing Unsplash API

   In the index.py script, the program declares an id obtained when registering the program on the Unsplash website. This is done so that the program gets access to download images provided by Unsplash. After declaring the Unsplash id and base URL, the program will invoke class questions that contain questions when downloading images. Images that have been downloaded will be directly entered into the directory that has been provided for these images.

2. Data requirements

   When the script is running, question.py will show the requirement that contain questions before downloading images from Unsplash. The question is about the type of image to be downloaded, the size of the image, and the relationship between the images. This will facilitate research to get images that fit a size that is not too large. The validation function in this class functions to resize the image according to the input width and height entered.

5.1.2 Python program crawling data

   Besides using JavaScript scripts to crawling datasets from the internet, researchers also use Python scripts to retrieve data through Google images. This is done so that the types of data obtained have varied results.
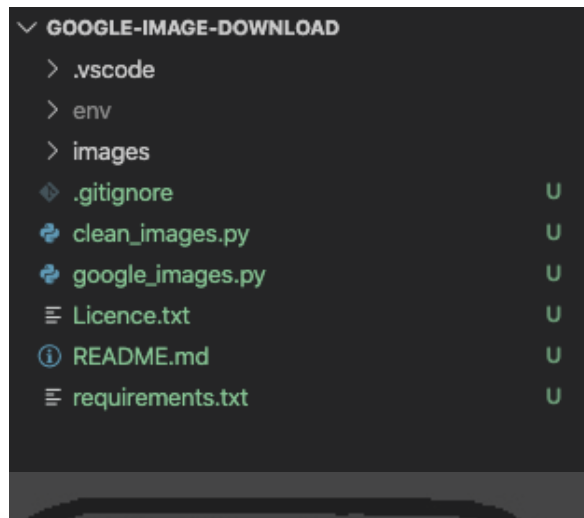
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Figure 5-2 Python script crawling data

The picture above shows the script structure for crawling data. In Figure 5-2 Python script crawling data, Python script data crawling script can be seen several Python files that have different functions for crawling data.

1. Accessing google image

   To be able to access Google Image, a script that will open all images with the given keywords is needed. In addition, the program also requires an additional Unix Executable program in the form of a chromedriver so that the Python program has permission to access Google Image. In this case, google_images.py contains a script to open a photo and put it in the directory following the given keywords. When the keyword in the argument is executed, the program will immediately create a folder according to the keyword in the "/images" directory. After creating the folder, all downloaded images will go into the folder.

   Figure Figure 5-3 Crawling script execution shows how Python scripts are executed and access data from google image. Whereas Figure 5-4 New directory added shows that the directory would increase according to the keywords for the image sought when the script is run.
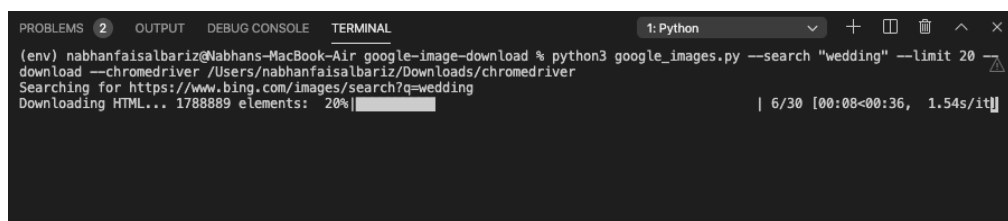

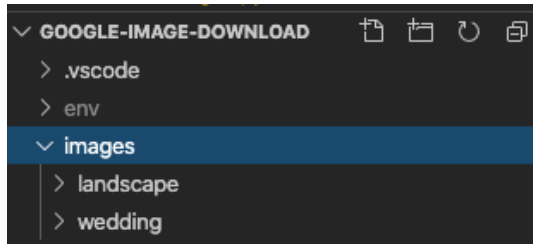*Figure 5-3 Crawling script execution*

Figure 5-4 New directory added

2. Cleaning image

   Before the data enters the "/images" directory to be saved, the downloaded data will be resized to a smaller size by the clean_images.py class. This script also works to delete all corrupted image data during the download process. This is done so that the downloaded data can be maximized in the training and dataset validation process.

5.2 Deep Learning model implementation

The Python program created functions to build a Deep Learning Convolutional Neural Network (CNN), model. Researchers chose to use Python because of the extensive library available specifically for conducting Deep Learning model training. Building an excellent Deep Learning model requires some individual steps so that the model formed can avoid overfitting and underfitting.
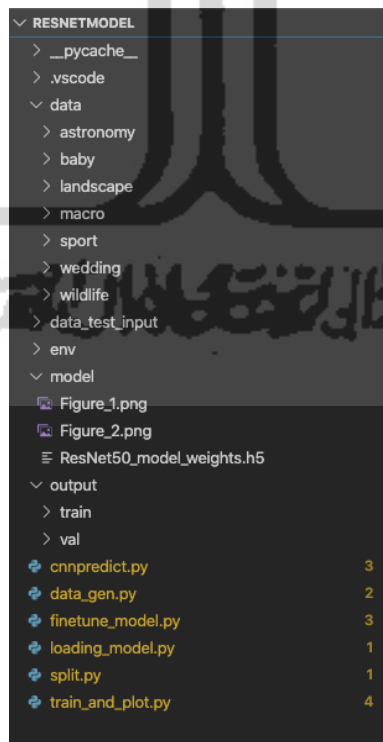

Figure 5-5 Deep learning training structure

1. Splitting dataset

   The dataset collected in the data crawling process must be divided into two parts, namely the training dataset and the validation dataset. The data is moved and stored in the "/data" directory with the name of the folder according to the class to be trained by the model. The training dataset is useful for preparing the Deep Learning model for learning. How well the model is formed will be determined by the number and types of datasets that are in the training data, while the dataset validation functions as a test data after the learning model of the training dataset. To divide the dataset, the author writes the split.py script and uses the split_folders library in Python. With the library split_folders, the researcher shares the data with a data-sharing ratio of 80% for the training dataset and 20% for the dataset validation. The shared dataset will enter the "/output" folder with each folder's name for training and validation.

2. Loading model

   After splitting the data, the next step is to load the model that will be used for training. Researchers use the ResNet50 architecture provided by the Keras library. In the loading_model.py script, the researcher loads the model from Keras. Then the model will change the input parameter shape width and height with each value that is 300. The input shape parameter will also resize the image with a width and height of 300 and an RGB channel.

3. Data generator

   Data previously divided into a training dataset, and validation dataset will now be used for data augmentation. Data augmentation is a transform technique for flipping, rotating, and scaling images. This technique can produce images with different rotations, reflections, and scales of one image. This helps researchers to collect more data without having to download it from the internet. Researchers use the DataImageGenerator library to conduct data generation. The first thing to do is to retrieve data in the "/output/train" directory and the "/output/val" directory. Then the researchers make a function to perform data augmentation. Data augmentation will enlarge the image with a range of 0.1, rotation of 90 degrees, and reflection horizontally and vertically. This data augmentation function is only applied to training data only because the training data requires more data. Each data generation function will load data from the directory specified for them.
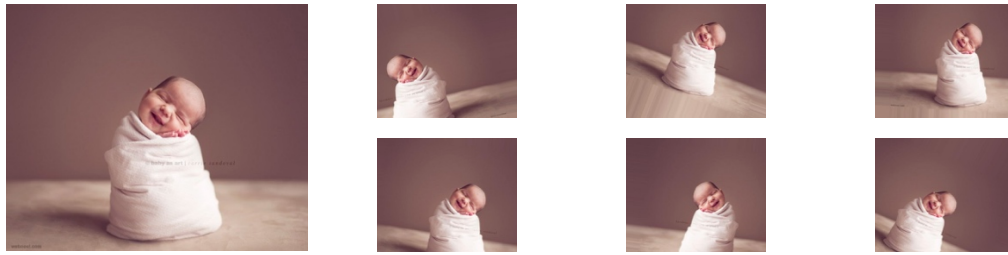
Data augmentation itself is only done for training data, not for data validation. This is done because the training data requires more datasets to be trained so that the model formed has higher accuracy. While data validation does not use data augmentation because we want to use data validation as closely as possible with the original data.

4. Finetuning model

The model formed from ResNet50 needs to disburse the rest of the network and continue training. Applying fine-tuning allows us to utilize pre-trained networks to recognize classes where they were not originally trained. The previously loaded model has not fine-tuned, for this reason, the researcher wrote the finetune_model.py script to fine-tune the model.

First, the researcher takes the last set of cut from the fully connected layer (e.g., "Head" of the network where the prediction of class labels is returned) from a previously trained CNN, namely ResNet50. Then the researchers replaced the head with a new set of layers that were fully connected with random initialization. From there, all the layers under the head are frozen so that the weights cannot.

5. Training data

The data collected will be used to train the Convolutional Neural Network model. In the train_and_plot.py script, the previously created function will be called. First, the data that has been shared will be called for training data and data validation. The data that has been loaded will determine the number of batch sizes that will be carried out by this model. Then the researcher uses the fit generator function, which will load the fine-tuning model. The amount of data that is quite a lot to be trained enough to take a long enough process to wait for the results of the training data. That is also caused by the number of epochs determined when modeling is 50. Researchers use the matplotlib library to see the value of accuracy and validation accuracy for each running epoch during the data training process. After the training process is complete,

the final results of the model will be saved into the "/ model" directory with the file name ResNet50_model_weights.h5. To be able to use the model continuously, the model will be moved into the directory for reuse compilation that wants to predict photographic images.

Models and datasets that have been loaded through the training and evaluation process. Accuracy can be said to be good if the value obtained is one or close to one.
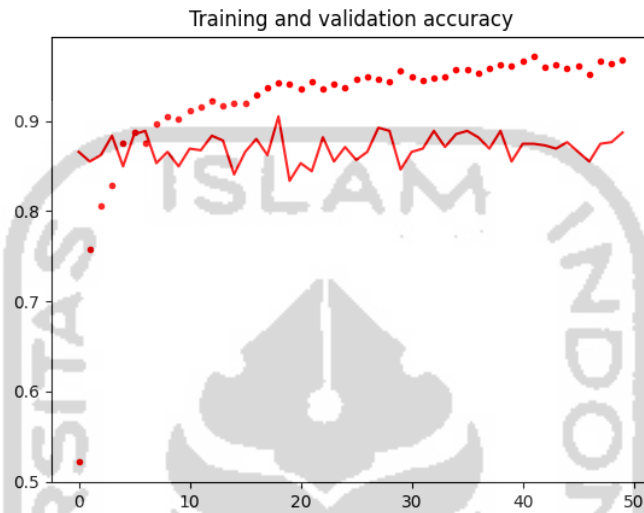

Figure 5-7 Training model accuracy

Figure 5-7 Training model accuracy shows the graph value at the last epoch approaching number 1 while the validation value is almost approaching number 0.9. number 1 means that an accuracy value is almost 100 percent, and a value of 0.9 for the validation value indicates that the validation is close to 90 percent. The picture below is a detailed accuracy value in epoch 50.

Figure 5-8 Training data process

Epoch in training data uses a value of 50 to avoid overfitting. Overfitting occurs if the value of training accuracy continues to increase, while the validation value decreases.

6. Predicting image

    After the model is formed, the model is used to test how accurate it is in classifying images. Script cnnpredict.py will load the model that has been formed and test it with new data input.

5.3 CNN parameter comparison

To ensure that the results of the model are the best, a comparison of other parameters is needed. In comparing these parameters, what will be compared is the amount of data, training scenarios, data augmentation, and the number of epochs.

1. The effect of the amount of data on the accuracy

    Researchers tried to use varying amounts of data in the CNN training model. The scenarios used are 80% training data and 20% validation data. After the training process, the accuracy results obtained are as the table below.

Amount of data	Accuracy value
3505	74%
3916	81%
4229	86%

Table 5-1 Relationship between the amount of data and the value of accuracy

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From experiments using varying amounts of data, it can be concluded that the amount of data influences the accuracy of a model. This is due to machine learning with how much amount of data obtained.

2. The effect of data augmentation on the accuracy

Data augmentation is often used in training data to increase the amount of data without having to collect new data. The researcher uses several experiments to see how important the data augmentation is applied to produce high accuracy values and make the model better in predicting.
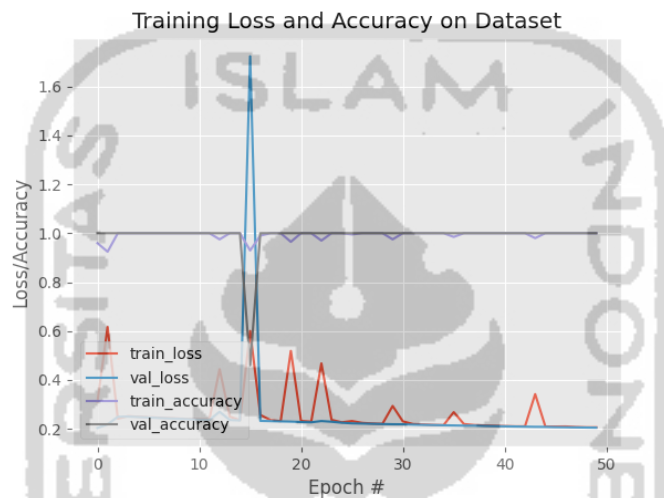
Figure 5-9 Data generation

Figure 5-9 Data generation above shows that the accuracy value using data generation is 100%. This accuracy value is classified as very large with deficient effort. Researchers try to use data augmentation to get 1000 images from 1 image.
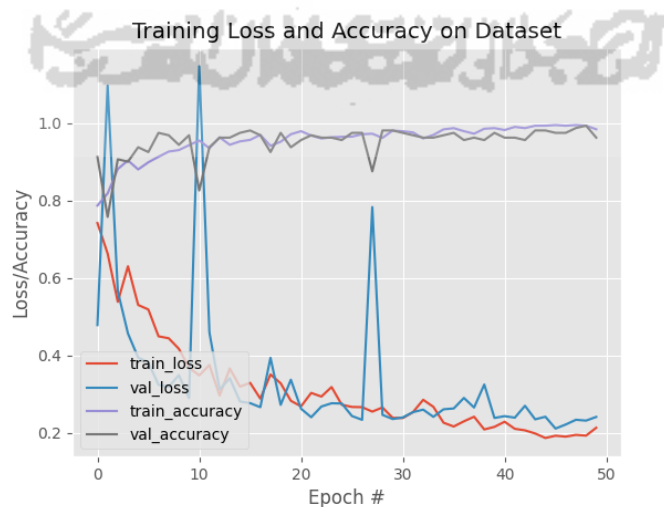
Figure 5-10 No data augmentation

The Figure 5-10 No data augmentation above is the result of training data without using data augmentation. The amount of data in this training uses 1000 data in each class. The accuracy obtained is almost 100%, but there is overfitting. At Epoch 30, we can see that the value of validation loss is increasing while the value of accuracy loss is decreasing.
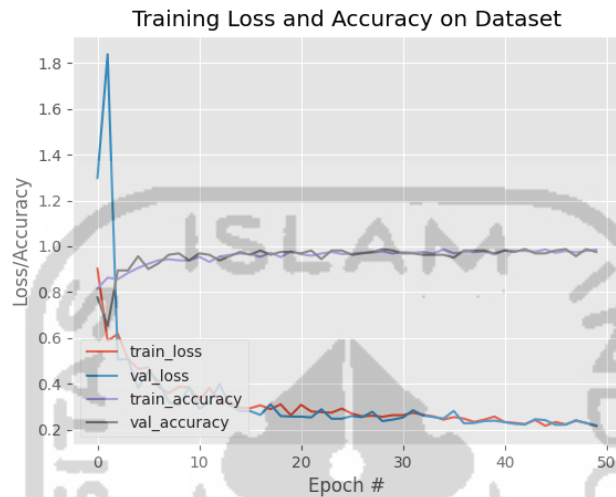
Figure 5-11 Data augmentation

Finally, the Figure 5-11 Data augmentation above shows the results of the training data using data augmentation. It can be seen that validation loss and loss accuracy fall together with a slight difference. Likewise, the accuracy and validation of accuracy go up simultaneously. By using data augmentation, researchers try to avoid overfitting. The Table 5-2 Data agumentation result summarybelow shows a summary of various experiments on data augmentation.

Data generation method	Accuracy value
Data generation	100%
No data augmentation	100%
Data augmentation	97%

Table 5-2 Data agumentation result summary

From the above table, it can be concluded that the data generation, namely the creation of data augmentation to make 1000 images of one image get 100% accuracy value. However, this value does not correspond to the use of little data in the real world. On the other hand, training data without using data augmentation gets high accuracy, too, but still faces overfitting in the model. Whereas the data augmentation

applied in the last training experiment got lower accuracy but was prevented from overfitting.

3. The effect of amount the epoch on the accuracy

    The number of epochs becomes very important in compiling the training data for the CNN model. Determination of the right number of epochs will avoid overfitting models, low predictive ability, and spend a lot of time on training. The Table 5-3 Amount of epoch below shows some of the experiments carried out to determine the right number of epochs for the best results.

Amount of epoch	Time consuming	Accuracy value
10	8 hours	85%
30	21 hours	84%
50	34 hours	88%

Table 5-3 Amount of epoch

From the table above, it can be concluded that the number of epoch 50 has the highest value after going through several processes. In Epoch 50 also a model made by researchers avoids overfitting and has the highest predictive value.

5.4 Web service implementation

As the author explained in chapter Flask Web Service, the author uses a web service as a data processing interface to and from the database. This is done because the deep learning model requires a large memory to predict the image data that the user inputted.

There are two web services created to access databases with different functions. Following is an explanation of how web services interact with clients and respond to clients.

5.4.1 Flask Web Service

Flask web service is made to handle storing and retrieving image data. Flask has the advantage of having a lightweight structure for working as a server. The researcher uses a database to store the name of the image entered by the user while the image itself is saved to the server.
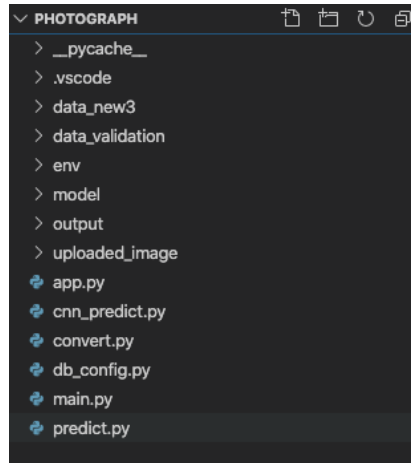
Figure 5-12 Flask web service structure

1. Connecting to database

Before the application can be used, the server is first connected to the database. Here researchers use MySQL as a database to store the path names of images that users will later enter. Because Flask does not have its configuration for connecting to databases, researchers use the Flaskext library to connect. This configuration is written in the db_config.py script. In this configuration, we only need to declare the user, database, and password. After the server can connect to the database, researchers will use it to store and read images.

2. URL design

The RESTful API is accessed using the HTTP protocol. Naming and URL structure that is consistent will produce a good API and easy for developers to understand. The API URL is usually called the endpoint in the call. Examples of proper URL / endpoint naming are as follows:

URL/endpoint	Description
/insert	Input an image to the database
/getImage/<filename>	Get an image from database

Table 5-4 Flask URL/endpoint

3. HTTP verbs

Every request made there is a method that is used so that the server understands what is being requested by the client, including the commonly used are:

a. POST

POST is an HTTP Request method that is used to create new data by inserting data in the body when the request is made.

POST/insert: Create a new image data

b. GET

GET is the simplest HTTP Request method; this method is used to read or get data from a source.

GET / getImage / <filename>: Returns image data

4. Predicting image

Users will enter data in the form of images and are accepted by the Flask server. The data will be stored in the database in the form of a file name that has been generated by the client on the Android system. Flask server has a function of predicting images when users input. The script is stored in the file cnn_predict.py, which will read the deep learning model in the "/ model" directory. Then the POST request will call the function and make predictions. The prediction results will be saved into the database along with the image input file.
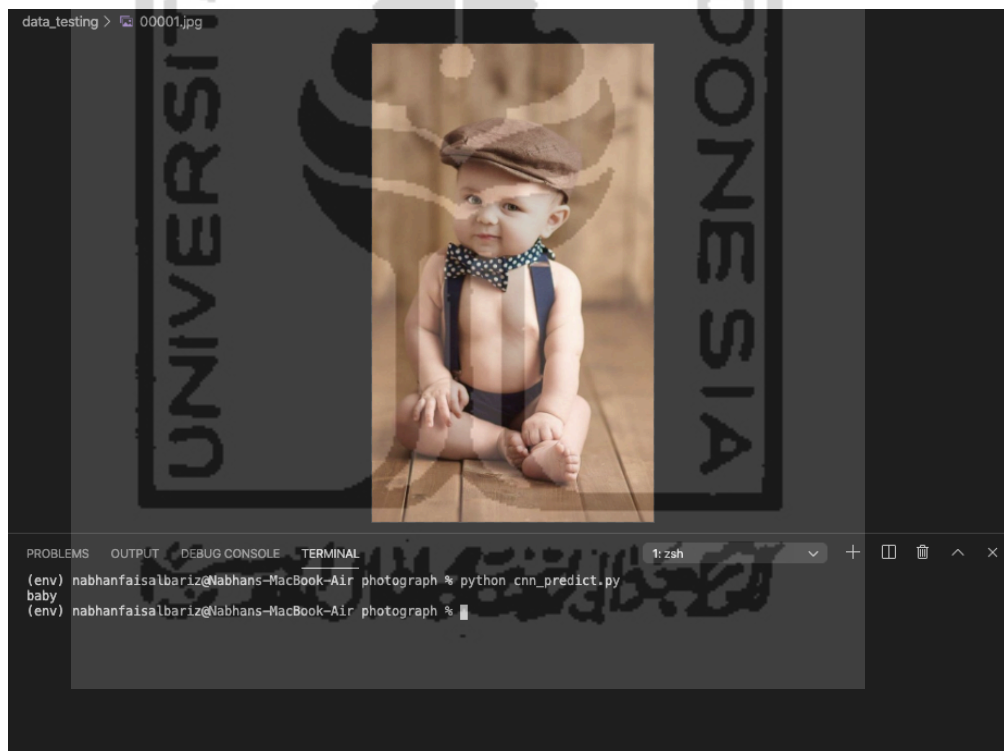
Figure 5-13 Test predicting image in Flask

5.4.2 SpringBoot Web Service

The SpringBoot server will make some requests made by users. This server has a task other than image prediction because the prediction process is quite long. With this server, requests from users will be able to be handled more. SpringBoot has an MVCS flow structure, namely, Model, View, Controller, and Service. The model contains functions that can be used to manage databases such as selecting, deleting, updating, and

pasting. The controller is the part that involves the link between the Model and View. The controller contains functions to process data, while the service is an additional layer that is useful to bridge the communication between the controller and the repository layer.
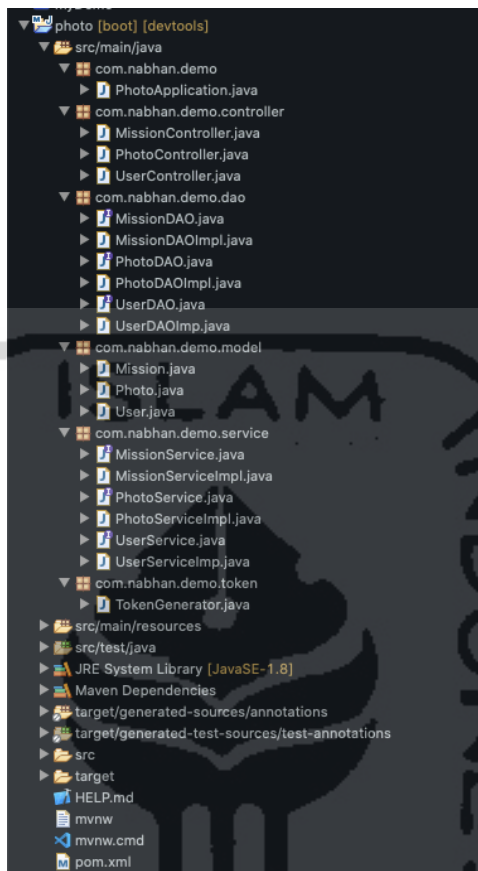
Figure 5-14 SpringBoot web service structure

1. Connecting to database

    SpringBoot has exciting features to use and is rich in libraries by Java developers. In order to connect to the database, the application simply uses the dependency JDBC. Then we give a declaration of the database name and user and provide the password in the "/ src / main / resource" folder. In the directory, there is the application.properties file to store the declaration of the database name, user, and password.

2. URL design

    The RESTful API is accessed using the HTTP protocol. Naming and URL structure that is consistent will produce a good API and easy for developers to understand. The API URL is usually called the endpoint in the call. In SpringBoot the naming URL / endpoint is given as follows:

URL/endpoint	Description

photo/photoList/{idUser}	Get all image uploaded by user
user/user/id	Get the user with the given id
user/profile	Logged in user with saving token
user/delete	Delete user account
user/updateUser	Update user information
user/login	Create user token and login into the app
user/register	Create new user

3. HTTP verbs

Every request made there is a method that is used so that the server understands what is being requested by the client, including the commonly used in SpringBoot:

a. GET

GET is the simplest HTTP Request method; this method is used to read or get data from a source. In SpringBoot some of the methods used are as follows:

GET / photo / photoList / {idUser}: Returns the user's photo

GET / user / user / {id}: Returns user data with ID {id}

GET / user / profile: Returns user data with a new token

b. POST

POST is an HTTP Request method that is used to create new data by inserting data in the body when the request is made. In SpringBoot some of the methods used are as follows:

POST / user / login: Create a new token data

POST / user / register: Create a new user data

c. PUT

PUT is an HTTP Request method that is usually used to update resource data. In SpringBoot some of the methods used are as follows:

PUT / user / updateUser: Update user data

d. DELETE

DELETE is an HTTP Request method used to delete data in a resource. In SpringBoot some of the methods used are as follows:

DELETE / user / {id}: Delete user data with ID {id}

5.5 Android implementation

Android is a mobile-based application used in this project to send requests and get responses from the server. This android application will access the Flask web service to enter image data, which will later be predicted by the server. On the other hand, the Android app will also access SpringBoot for user data processing purposes.

5.5.1 Landing page activity

The image below shows the landing page on the application. This page is the initial start of the application when a new program is run.

Figure 5-15 Landing page

5.5.2 Welcome page activity

The welcome page contains content that describes the photographer. This page will randomize three images with three different content. The image below shows the shape of the page.
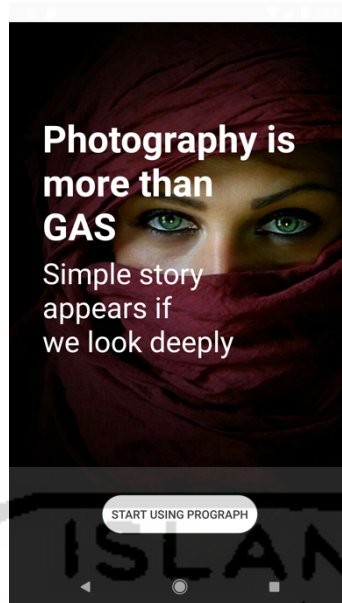
Figure 5-16 Starting page

5.5.3 Register page activity

The image below shows the user registration page on the android application. The page provides a form for new users to fill in and enter the new data into the database.
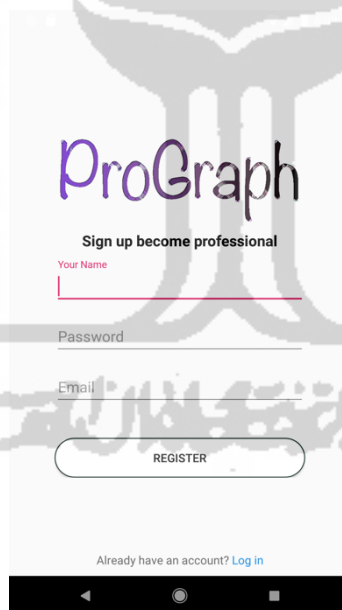
Figure 5-17 Register page

5.5.4 Login page activity

The image below shows the user login page on the Android application. On that page, the username and password forms are required to be filled in so that the user can enter the application.
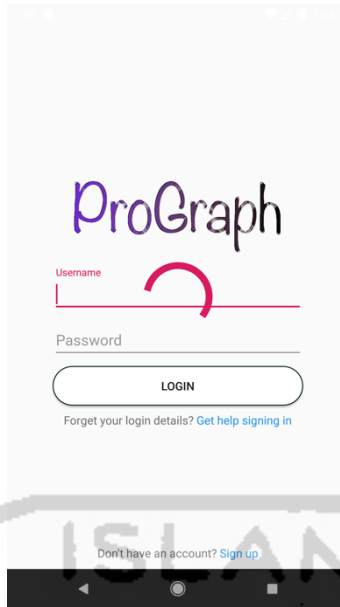
Figure 5-18 Login page

5.5.5 Home page activity

The image below shows the home page on the Android application. This page is equipped with a navigation sidebar that can point to the profile page.
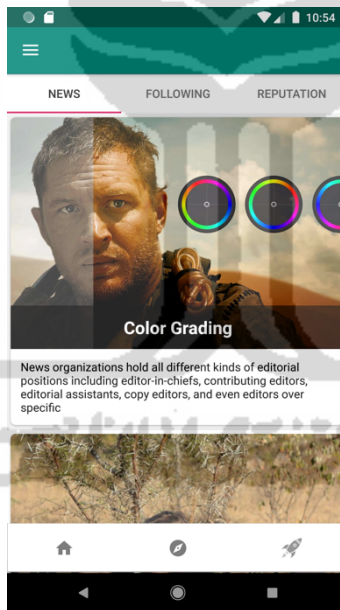
Figure 5-19 Home page

5.5.6 Profile page activity

The picture below shows the profile page on the android application. On this page, there are a number of photos that have been uploaded by users. There is also some information about the user, such as name, description, and website.

45
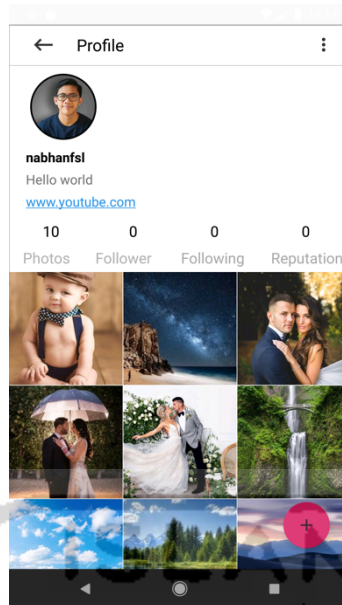
Figure 5-20 Profile page

5.5.7 Upload image page

The image below shows the upload image page on the Android application. On this page, the user will select a photo from the device file. This page has a caption form so users can fill in the description of the uploaded image.
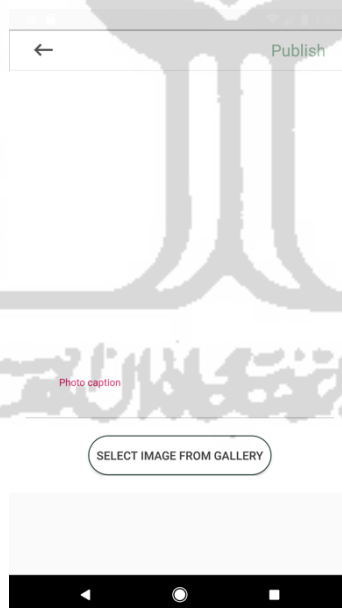
Figure 5-21 Upload image page

5.5.8 Cropping image page

The image below shows a page for cropping images on an android application. Before images enter the database, the application allows users to resize images according to the right size.
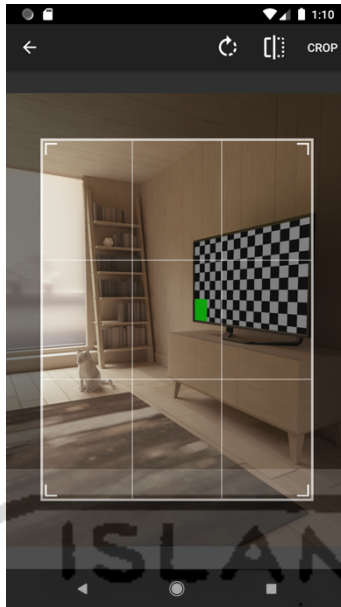
Figure 5-22 Cropping image

5.5.9 Account setting page

The image below shows the user settings options page on the android application. Users can edit their data if changes are desired.

Figure 5-23 Account setting page

6 Conclusion

6.1 Summary

Research conducted by researchers at this time is far from perfect. There needs to be a better model improvement with more data. Even so, the use of Convolutional Neural Networks gives good results for classifying an image. ResNet50, as an architecture model, also has accurate capabilities with several layers that have been applied in many other models.

6.2 Future work

Based on the conclusions above, some suggestions for future research can be given in order to become better.

1. The dataset created has more data so that the accuracy obtained is higher.
2. Use this model for application and make system recommendations.
3. Using higher computer specifications to be able to train models with extensive data.

6.3 Conclusion

Based on the analysis that has been done, the following conclusions are obtained:

1. Implementation of Deep Learning to classify the genre of photography is done by using the Keras package.
2. The CNN Architecture used is ResNet50.
3. The accuracy formed after the training model is 88%.
4. The classification results of 10 new data from each variable to be tested obtained three classification errors.

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Appendix

Appendix 1. Python script splitting dataset

```
#importing library
import split_folders

#splitting data function with the ration 80% for
split_folders.ratio (
     'data',
     output = 'output',
     seed = 1337,
     ratio = (.8, .2)
)
```

Appendix 2. Python script generating dataset

```python
from keras.preprocessing.image import ImageDataGenerator
from keras.applications.resnet50 import preprocess_input

#reading data from directories
DATADIRTRAIN = "output/train"
DATADIRTEST = "output/val"
IMG_SIZE = 300
BATCH_SIZE = 8
datagen = ImageDataGenerator()

#data augmentation for training dataset
data_augmentation = ImageDataGenerator(
    preprocessing_function = preprocess_input,
    rotation_range = 90,
    zoom_range = 0.1,
    horizontal_flip = True,
    vertical_flip = True
)

#reading data from directory dataset and resize it using billinear
interpolar
train_generator = data_augmentation.flow_from_directory(
    DATADIRTRAIN,
    target_size = (IMG_SIZE, IMG_SIZE),
    batch_size = BATCH_SIZE
)

# reading dataset for validation
validation_generator = datagen.flow_from_directory(
    DATADIRTEST,
    target_size = (IMG_SIZE, IMG_SIZE),
    batch_size = BATCH_SIZE
)
```

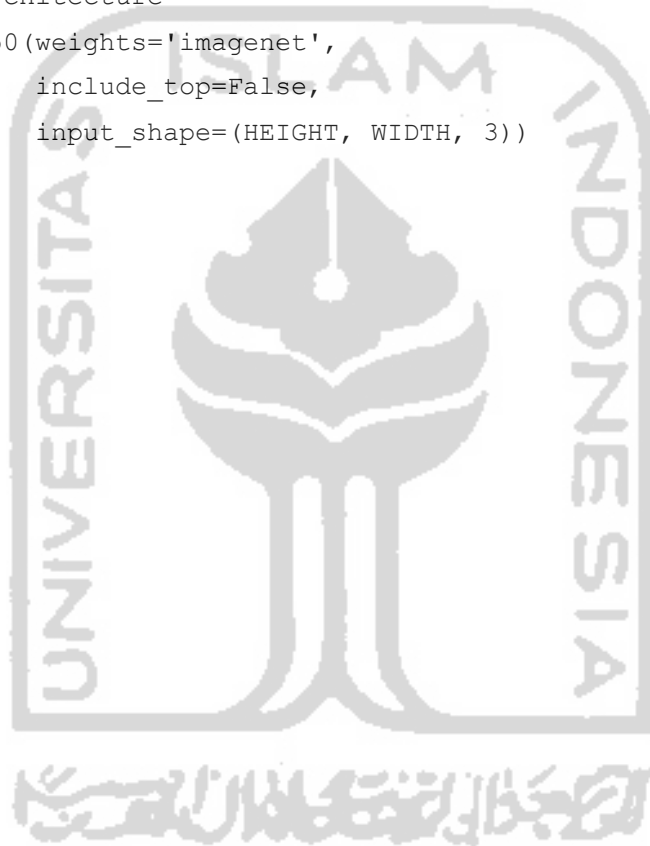## Appendix 3. Python script loading model

```python
#importing Keras library for loading model
from keras.applications.resnet50 import ResNet50, preprocess_input
import os

os.environ['TF_CPP_MIN_LOG_LEVEL'] = '2'

HEIGHT = 300
WIDTH = 300

#loading ResNet50 architecture
base_model = ResNet50(weights='imagenet',
                      include_top=False,
                      input_shape=(HEIGHT, WIDTH, 3))
```

Appendix 4. Python script loading model

```python
from keras.layers import Dense, Activation, Flatten, Dropout
from keras.models import Sequential, Model
from keras.applications.resnet50 import ResNet50, preprocess_input
import loading_model


base_model = loading_model.base_model


#fine-tuning base model ResNet50
def build_finetune_model(base_model, dropout, fc_layers, num_classes):
    for layer in base_model.layers:
        layer.trainable = False

    x = base_model.output
    x = Flatten()(x)
    for fc in fc_layers:
        # New FC layer, random init
        x = Dense(fc, activation='relu')(x)
        x = Dropout(dropout)(x)

    # New softmax layer
    predictions = Dense(num_classes, activation='softmax')(x)

    finetune_model = Model(inputs=base_model.input, outputs=predictions)

    return finetune_model

#describing class for dataset
class_list = ["astronomy", "baby", "landscape", "macro", "sport",
"wedding", "wildlife"]
FC_LAYERS = [1024, 1024]
dropout = 0.5

finetune_model = build_finetune_model(base_model,
                                      dropout=dropout,
                                      fc_layers=FC_LAYERS,
                                      num_classes=len(class_list))
```

Appendix 5. Python script training model

```python
import tensorflow as tf
from keras.optimizers import SGD, Adam
from keras.callbacks import ModelCheckpoint
import matplotlib.pyplot as pyplot
import finetune_model
import data_gen


NUM_EPOCHS = 50
BATCH_SIZE = 8
num_train_images = 2235
finetune_model = finetune_model.finetune_model
train_generator = data_gen.train_generator
validation_generator = data_gen.validation_generator


adam = Adam(lr=0.00001)
finetune_model.compile(adam, loss='categorical_crossentropy',
metrics=['accuracy'])


#saving model in directory
filepath="model/" + "ResNet50" + "_model_weights.h5"
checkpoint = ModelCheckpoint(filepath, monitor=["acc"], verbose=1,
mode='max')
callbacks_list = [checkpoint]


#training model with fine-tuning
history = finetune_model.fit_generator(
        train_generator,
        epochs=NUM_EPOCHS,
        workers=8,
        validation_data=validation_generator,
        steps_per_epoch=num_train_images // BATCH_SIZE,
        shuffle=True,
        callbacks=callbacks_list
    )


# Plot the training and validation loss + accuracy
print(history.history.keys())
acc = history.history['accuracy']
val_acc = history.history['val_accuracy']
loss = history.history['loss']
```

```python
val_loss = history.history['val_loss']
epochs = range(len(acc))

#showing plot of accuracy and validation accuracy
pyplot.plot(epochs, acc, 'r.')
pyplot.plot(epochs, val_acc, 'r')
pyplot.title('Training and validation accuracy')

#showing plot of loss and validation loss
pyplot.figure()
pyplot.plot(epochs, loss, 'r.')
pyplot.plot(epochs, val_loss, 'r-')
pyplot.title('Training and validation loss')
pyplot.show()

pyplot.savefig('acc_vs_epochs.png')
```

Appendix 6. Python script predicting new input

```python
import cv2
import tensorflow as tf
import os
import numpy as np


os.environ['TF_CPP_MIN_LOG_LEVEL'] = '2'


CATEGORIES = ["astronomy", "baby", "landscape", "macro", "sport",
"wedding", "wildlife"]


def prepare(file):
    IMG_SIZE = 300
    img_array = cv2.imread(file)
    new_array = cv2.resize(img_array, (IMG_SIZE, IMG_SIZE))
    return np.reshape(new_array, [1, IMG_SIZE, IMG_SIZE, 3])


model = tf.keras.models.load_model("model/ResNet50_model_weights.h5")
image = prepare("data_new_input/nature2.jpg")
prediction = model.predict(image)
prediction = list(prediction[0])


print(CATEGORIES[prediction.index(max(prediction))])
```