

CHAPTER 4

ANALYSIS AND DESIGN

4.1 Analysis

4.1.1 Dataset

Train and test data were taken from the NIST Handprinted Forms and Characters Database, which is the National Institute of Standards and Technology which provides train data in the form of Handprinted Sample Forms from 3600 authors, 810,000 character images isolated from the form, ground truth classification for these images. NIST has two editions the 1st Edition - March 1995 and the 2nd Edition - September 2016

The first edition provides a dataset in the form of a zip file containing images of letters from a to z and the characters from 0 to 9 and also provides a dataset in the form of a file in MD5 format. Meanwhile, the second edition provides several data options with category class, merge, field, write, pages. The data class is in the form of letters and numbers, combining data in the form of printed word images, data fields in the form of word fields on images, writing data in the form of handwritten characters, data pages in the form of document paper images. For the dataset, I use the first edition which has 100,000 images with test data. While the data used in this case is 15,015, 9006 for the train data and 6009 for the test data. The use of NIST as a dataset aims to create a train and test model that is simple and easy to process as input to the step image extractor and algorithm, the image character from the NIST dataset is a 128x128 image which makes the filtering process using CV2 more effective and fast.

Table 4.1: Tabel exmaple dataset 1-10 image train

Image_train	With	Height
test_7a_00000 (9).png	128	128
test_7a_00000 (9).png	128	128
test_7a_00000 (98).png	128	128
test_7a_00000 (98).png	128	128
test_7a_00000 (98).png	128	128
test_7a_00000 (96).png	128	128
test_7a_00000 (9699).png	128	128
test_7a_00000 (9698).png	128	128
test_7a_00000 (9697).png	128	128
test_7a_00000 (9697).png	128	128

4.1.2 Pre-processing Data

pre-processing of data is done by labeling x_{train} and y_{test} for train data using 9006 images and 6009 image test data. The train and test data contain aplahbet characters and numeric characters a to z and 0 to 9. Then the labeling process is carried out image test will be resized to an image size of 50 so that the incoming image has the same size. After that, each image test and image train will be identified where the image train will be labeled X and the image test will be labeled Y. Each image train and image test will be given a grayscale filter from open cv and after that it will be convert to an array value which still has 3 channels which means 3 columns and 3 rows. To simplify, normalization is done which will make each image only have 2 channels, which means it has 2 columns and 2 rows. Changing the image to be 2 channels (black & white) is done by dividing the image by the maximum value (255) of pixels. Furthermore, each image will be returned to its original size. And converted to an array value using numpy and after that it will be saved using a binary format with a pickle library

which will be used as an input algorithm. The results of the train and test labeling will be saved with X_train and Y_test.

4.1.3 Image Feature Extraction

The image extractor is in the form of a batch normalization (making image train to have same width and height), convolutional layer that has conv2d (convolutional layer), max-pooling (aims to find important parts of each pixel in the train image), using relu activation (linear rectifier). use a convolutional layer to find the important parts of the image and then maxpooling to save the most important parts of the image with a kernel size [1,2,2,1] which means the maxpooling kernel that will be run is 2x2. And using Relu activation is the Linear Rectifier using the formula

$$f(x) = \max(0, x)$$

which is used to assess and classify the pixel character if the pixel has a value of 1 then the linear rectifier will dig up the pixel to have a solid image located on that pixel. The process

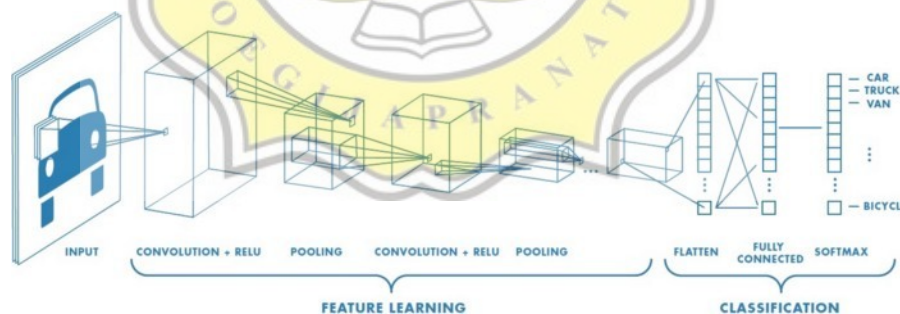


Illustration 4.1: Image feature ekstraksi with convolutional layer
 source: <https://medium.com/@RaghavPrabhu/understanding-of-convolutional-neural-network-cnn-deep-learning-99760835f148>

4.1.4 Algorithm

In the algorithm, the result of the feature extraction process will be entered into the input from the algorithm with a residence layer 128 as processing the incoming data. The hiding layer uses the sigmoid activation function. the use of the sigmoid and tanh functions as a mathematical formula for assessing the

introduction of character pixels from feature extraction, for the sigmoid formula in the algorithm:

$$S(x) = \frac{1}{1+e^{-x}} = \frac{e^x}{e^{-x}+1}$$

is used to make the value of the character pixel between 1 and 0. The use of sigmoid is used during the forgate gate process with the formula

$$F_t = \sigma(wf[ht-1, xt] + bf)$$

F_t = forgate gate $ht-1$ = output previous from LSTM

wf = weight for respective gate neuron xt = current time stamp

bf = biases for the respective

the output results will be saved and processed back to the cell gate which functions to store data for comparison with data will enter again, the cell gate uses the formula

$$C_t = F_t * \hat{C}_{t-1} + I_t * \hat{C}_t$$

ct = cell gate \hat{C}_{t-1} = current cell gate

F_t = forgate gate I_t = input gate

\hat{C}_t = cell memory

The image extraction data will also enter the input gate which is intended as input data or input which will later enter the cell state as input to the cell gate. input gate has the formula

$$I_t = \sigma(wf[ht-1, xt] + bi)$$

I_t = forgate gate $ht-1$ = output previous from LSTM

wf = weight for respective gate neuron xt = current time stamp

bi = biases for the respective

the result of the input gate will multiply by

$$\hat{C}_t = \tanh(x_t + h_{t-1}) * I_t$$

\hat{C}_t = cell memory h_{t-1} =output previous from LSTM

x_t =current time stamp I_t =input gate

tanh activation is used to produce values that only have a range of -1 to 1 so that the output results are easy to process and recognize. activation tanh with the formula

$$\tanh(x) = 2\sigma(2x) - 1.$$

Which is then stored in the cell gate. In the process of making a cell gate that is used as memory, it is done by adding the results of the forget gate and the sum of the cell state, input gate

$$C_t = F_t * \hat{C}_{t-1} + I_t * \hat{C}_t.$$

C_t =cell gate \hat{C}_{t-1} = current cell gate

F_t =forget gate I_t =input gate

\hat{C}_t = cell memory

the results of this cell gate which will later be used as a comparison memory whether the incoming data can be used or not used as a comparison for the incoming data again, the cell gate is also used as a data prediction (y_t). The output gate is done by using the

$$O_t = \sigma([h_{t-1}, x_t]) * \tanh$$

O_t =output gate x_t =current time stamp

h_{t-1} = output previous from LSTM

function to produce output (h_t).

Next, train the data that has been recognized by the algorithm by adding an optimizer with Adam as the optimization of the learning rate for the data and calculating the accuracy, calculating the loss with softmax cross entropy. Then

train with epoch 10 to produce a model that has good accuracy. The use of epoch 10 is intended to train the data 10 times by recognizing the test data (Y_test) and then producing a model that will be saved in ckpt (checkpoint) format with tensorflow format. After going through the train process, the model has an Accuracy: 0.9827 and a loss: 12.060161829 and saved with name lstm_ocr.model

4.1.5 Text detection and Text extraction

In text detection and text extraction the model that has been trained will be loaded again to detect the incoming image. In this step load the model into the checkpoint directory using the tflearn library. tflearn will detect the saved model based on the checkpoint file which points to the prepared model directory. The next step is to create a class containing the letters A to Z and the numbers 0 to 1. This class is used for the extraction part from images to text. To assist in marking regions containing words, we use the Opencv library which is used for image processing. image will be input using im.write then the image will be given a grayscale filter, then using otsu binarization and dilation using the bounding box is done by calculating the width, height and the pixel difference between the background and text. The image will enter the grayscale filtering stage using cv2.COLOR_BGR2GRAY then give the image back with the cv2.THRESH_OTSU otsu binarization filter. dilation the incoming image with cv2.dilate. The use of filters on images is used to make image processing in finding ROI (Region of interest). The ROI (Region of interest) method is used to mark the detected text area in the incoming image.

4.1.6 Evaluation

Steps in the evaluation are done by training the pytesseract model with the dataset that has been prepared. train steps done with Clone the tesstrain repo at <https://github.com/tesseract-ocr/tesstrain> then enter the dataset into the / tesstrain / data / my-custom-model-ground-truth folder, run make training MODEL_NAME = my-custom-model START_MODEL = eng TESSDATA = ~ / src / tessdata_best.

This pytesseract model will detect the 10 same image with different size as lstm_ocr.model with different font. Evaluation is done with the formula

$$Accuracy = \frac{(TP+TN)}{(TP+FP+FN+TN)}$$

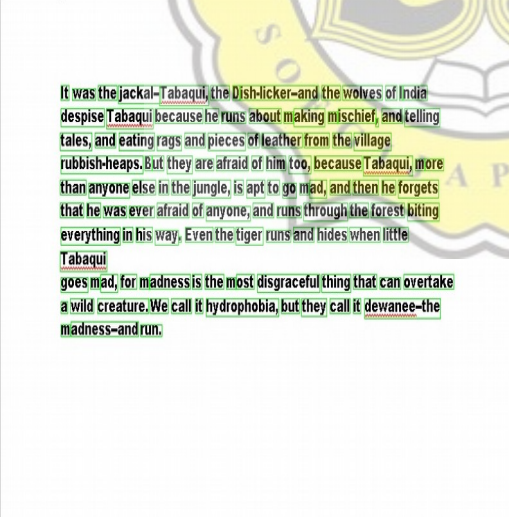
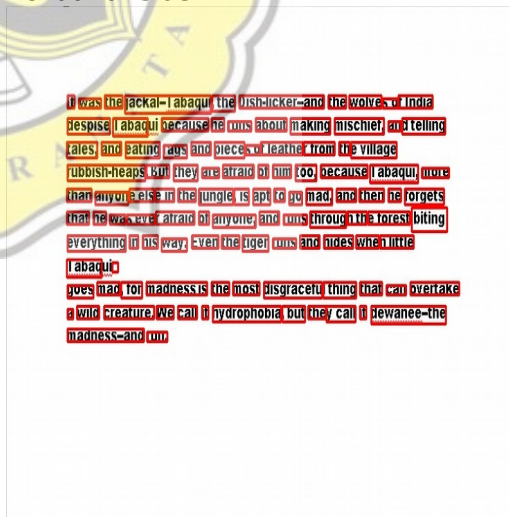
TP: True Positive

TN: True Negative

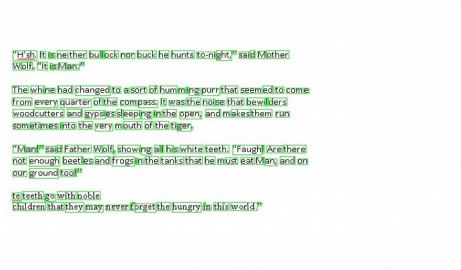
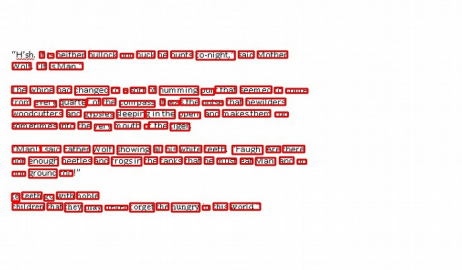
FP: False Positive

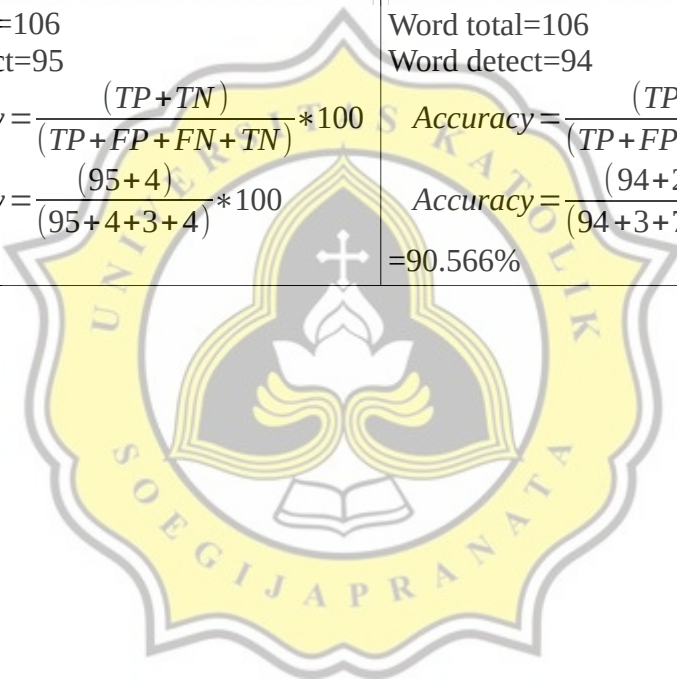
FN: False Negative

then the results are as follows:

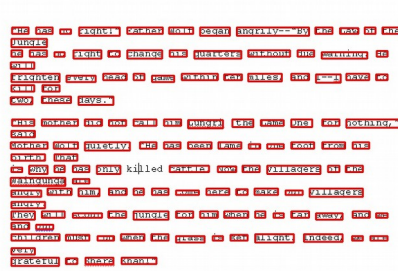
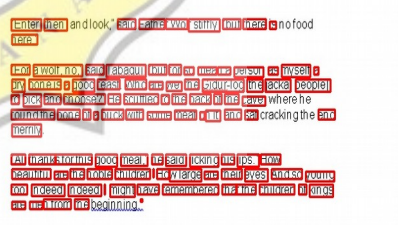
Lstm_ocr.model	Pytesseract
<p>Evaluation_01 Size: width =508, height =817</p>  <p>Font arial black Word total=108 Word detect=107</p> $Accuracy = \frac{(TP+TN)}{(TP+FP+FN+TN)} * 100$ $Accuracy = \frac{(107+0)}{(107+0+1+0)} * 100$	<p>Evaluation_01 Size: width =508, height =817 Font arial black</p>  <p>Word total=108 Word detect=107</p> $Accuracy = \frac{(TP+TN)}{(TP+FP+FN+TN)} * 100$ $Accuracy = \frac{(107+0)}{(107+0+1+0)} * 100$

<p>=99.074%</p> <p>Evaluation_02 Size:width =492, height =815 Font arial italic</p> <p>The bushes rustled a little in the thicket and Father Wolf drooped with his haunches under him, ready for his leap. Then, if you had been watching, you would have seen the most wonderful thing in the world—the wolf checked in mid-spring. He made his bound before he saw what it was he was jumping at, and then he tried to stop himself. The result was that he shot up straight into the air for four or five feet, landing almost where he left ground.</p> <p>"Man!" he snapped. "A man's cub! Look!"</p> <p>Directly in front of him, holding on by a low branch, stood a naked brown baby who could just walk—as soft and as dimpled a little atom as ever came to a wolf's care at night. He looked up into Father Wolf's face, and laughed.</p> <p>Word total =125 Word detect = 115</p> $Accuracy = \frac{(TP+TN)}{(TP+FP+FN+TN)} * 100$ $Accuracy = \frac{(115+3)}{(115+3+0+3)} * 100$ <p>=97.520%</p>	<p>=99.074%</p> <p>Evaluation_02 Size:width =492, height =815 Font arial italic</p> <p>THE BUSHES RUSTLED A LITTLE IN THE THICKET AND FATHER WOLF DROOPE WITH HIS HAUNCHES UNDER HIM, READY FOR HIS LEAP. THEN, IF YOU HAD BEEN WATCHING, YOU WOULD HAVE SEEN THE MOST WONDERFUL THING IN THE WORLD—THE WOLF CHECKED IN MID-SPRING. HE MADE HIS BOUND BEFORE HE SAW WHAT IT WAS HE WAS JUMPING AT, AND THEN HE TRIED TO STOP HIMSELF. THE RESULT WAS THAT HE SHOT UP STRAIGHT INTO THE AIR FOR FOUR OR FIVE FEET, LANDING ALMOST WHERE HE LEFT GROUND.</p> <p>"MAN!" HE SNAPPED. "A MAN'S CUB! LOOK!"</p> <p>DIRECTLY IN FRONT OF HIM, HOLDING ON BY A LOW BRANCH, STOOD A NAKED BROWN BABY WHO COULD JUST WALK—AS SOFT AND AS DIMPLED A LITTLE ATOM AS EVER CAME TO A WOLF'S CARE AT NIGHT. HE LOOKED UP INTO FATHER WOLF'S FACE, AND LAUGHED.</p> <p>Word total =125 Word detect = 120</p> $Accuracy = \frac{(TP+TN)}{(TP+FP+FN+TN)} * 100$ $Accuracy = \frac{(120+1)}{(120+1+1+3)} * 100$ <p>=96.8%</p>
<p>Evaluation_03 Size:width =440, height =815 Font arial narrow</p> <p>Now, Takagi knew as well as anyone else that there is nothing so unlucky as to compliment children (other faces). It pleased him to see Mother and Father Wolf look uncomfortable.</p> <p>Takagi sat still, enjoying in the mischief that he had made, and then he said softly:</p> <p>"Shere Khan, the Big One, has shifted his hunting grounds. He will hunt among these hills on the next moon, so he has told me."</p> <p>Shere Khan was the tiger who lives near the Wangungo River twenty miles away.</p> <p>Word total=85 Word detect = 62</p> $Accuracy = \frac{(TP+TN)}{(TP+FP+FN+TN)} * 100$ $Accuracy = \frac{(62+2)}{(62+1+6+2)} * 100$ <p>=90.140%</p>	<p>Evaluation_03 Size:width =440, height =815 Font arial narrow</p> <p>Now, Takagi knew as well as anyone else that there is nothing so unlucky as to compliment children (other faces). It pleased him to see Mother and Father Wolf look uncomfortable.</p> <p>Takagi sat still, enjoying in the mischief that he had made, and then he said softly:</p> <p>"Shere Khan, the Big One, has shifted his hunting grounds. He will hunt among these hills on the next moon, so he has told me."</p> <p>Shere Khan was the tiger who lives near the Wangungo River twenty miles away.</p> <p>Word total=85 Word detect = 84</p> $Accuracy = \frac{(TP+TN)}{(TP+FP+FN+TN)} * 100$ $Accuracy = \frac{(84+0)}{(84+0+1+0)} * 100$ <p>=98.823%</p>

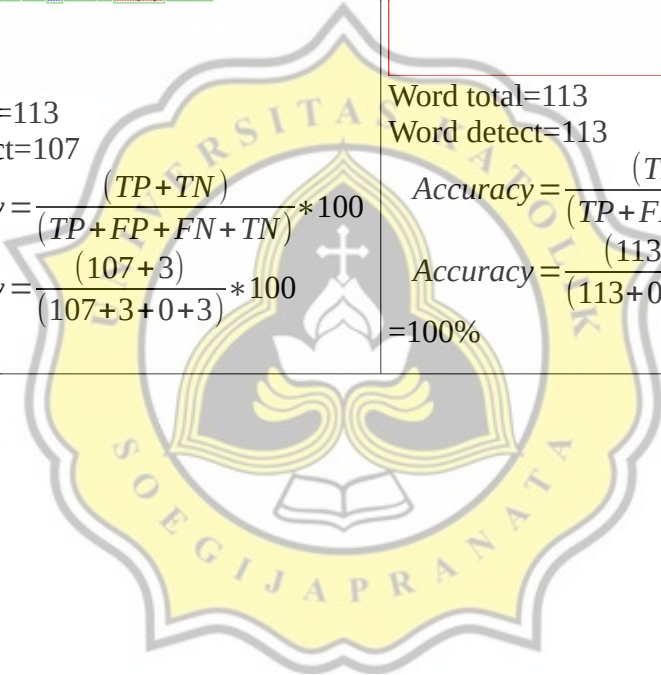
<p>Evaluation_04 Size:width =441, height =819 Font calibri light</p>  <p>Word total=106 Word detect=95</p> $Accuracy = \frac{(TP+TN)}{(TP+FP+FN+TN)} * 100$ $Accuracy = \frac{(95+4)}{(95+4+3+4)} * 100$ <p>=93.396%</p>	<p>Evaluation_04 Size:width =441, height =819 Font calibri light</p>  <p>Word total=106 Word detect=94</p> $Accuracy = \frac{(TP+TN)}{(TP+FP+FN+TN)} * 100$ $Accuracy = \frac{(94+2)}{(94+3+7+2)} * 100$ <p>=90.566%</p>
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<p>Evaluation_05 Size:width =463, height =809 Font calibri</p> <p>The n there was a howl—an un tigerish howl—from Shere Khan. "He has misse of said Mother Wolf. "What is it?"</p> <p>Father Wolf ran out a few paces and heard Shere Khan muttering and mumbling savagely as he tumbled about in the scrub.</p> <p>"The fool has had no more sense than to jump at a woodcutter's campfire, and has burned his feet," said Father Wolf with a grunt. "Taboqui is within."</p> <p>"Something is coming up hill," said Mother Wolf, switching on her ear. "Get ready."</p> <p>Word total=83 Word detect=70</p> $Accuracy = \frac{(TP + TN)}{(TP + FP + FN + TN)} * 100$ $Accuracy = \frac{(70 + 4)}{(70 + 4 + 5 + 4)} * 100$ <p>=93.396%</p>	<p>Evaluation_05 Size:width =463, height =809 Font calibri</p> <p>The n there was a howl—an un tigerish howl—from Shere Khan. "He has misse of said Mother Wolf. "What is it?"</p> <p>Father Wolf ran out a few paces and heard Shere Khan muttering and mumbling savagely as he tumbled about in the scrub.</p> <p>"The fool has had no more sense than to jump at a woodcutter's campfire, and has burned his feet," said Father Wolf with a grunt. "Taboqui is within."</p> <p>"Something is coming up hill," said Mother Wolf, switching on her ear. "Get ready."</p> <p>Word total=83 Word detect=81</p> $Accuracy = \frac{(TP + TN)}{(TP + FP + FN + TN)} * 100$ $Accuracy = \frac{(81 + 0)}{(81 + 0 + 2 + 0)} * 100$ <p>=97.590%</p>
<p>Evaluation_06 Size:width =479, height =817 Font courier</p> <p>The Law of the Jungle, which never orders anything without a reason, forbids every beast to eat Man except when he is killing to show his children how to kill, and then he must have caught the living grounds of his pack or tribe. Their reason for this is that man-killing means (soon or later) the arrival of white men on elephants, with guns, and hundreds of brown men with guns and rockets and torches. Then even body in the jungle suffers. Their reason for this is that among them he is the Man is the weakest and most defenceless of all living things, and it is unprofitable to touch him. If they lay too-and it is true—that man-eater becomes angry and loses their teeth.</p> <p>The purr grew louder, and ended in the full-throated "Aaaaah" of the tiger's charge.</p> <p>Word total=135 Word detect=115</p> $Accuracy = \frac{(TP + TN)}{(TP + FP + FN + TN)} * 100$ $Accuracy = \frac{(115 + 7)}{(115 + 7 + 6 + 7)} * 100$ <p>=90.370%</p>	<p>Evaluation_06 Size:width =479, height =817 Font courier</p> <p>The Law of the Jungle, which never orders anything without a reason, forbids every beast to eat Man except when he is killing to show his children how to kill, and then he must have caught the living grounds of his pack or tribe. Their reason for this is that man-killing means (soon or later) the arrival of white men on elephants, with guns, and hundreds of brown men with guns and rockets and torches. Then even body in the jungle suffers. Their reason for this is that among them he is the Man is the weakest and most defenceless of all living things, and it is unprofitable to touch him. If they lay too-and it is true—that man-eater becomes angry and loses their teeth.</p> <p>The purr grew louder, and ended in the full-throated "Aaaaah" of the tiger's charge.</p> <p>Word total=135 Word detect=134</p> $Accuracy = \frac{(TP + TN)}{(TP + FP + FN + TN)} * 100$ $Accuracy = \frac{(134 + 0)}{(134 + 0 + 1 + 0)} * 100$ <p>=99.259%</p>

<p>Evaluation_07 Size:width =445, height =800 Font tahoma</p> <p>"He has no right!" Father Wolf began angrily—"By the law of the jungle he has no right to change his quarters without due warning. He will frighten every head of game within ten miles, and I—[I] have to kill for two, these days."</p> <p>"His mother did not call him Hungri (the Lone One) for nothing," said Mother Wolf quietly. "He has been here in one foot from his birth. That is why he has only killed cattle. Now the villagers of the Mainunga are angry with him, and he has come here to make our villagers angry. They will scour the jungle for him when he is far away, and our children must run when the grass is set alight. Indeed, we are very grateful to Shere Khan!"</p> <p>Word total=132 Word detect=132</p> $Accuracy = \frac{(TP+TN)}{(TP+FP+FN+TN)} * 100$ $Accuracy = \frac{(132+0)}{(132+0+0+0)} * 100$ <p>=100%</p>	<p>Evaluation_07 Size:width =445, height =800 Font tahoma</p>  <p>Word total=132 Word detect=131</p> $Accuracy = \frac{(TP+TN)}{(TP+FP+FN+TN)} * 100$ $Accuracy = \frac{(131+0)}{(131+0+1+0)} * 100$ <p>=99.242%</p>
<p>Evaluation_08 Size:width =508, height =817 Font arial</p> <p>"Enter, then, and look," said Father Wolf stiffly, "but there is no food here."</p> <p>"For a wolf, no," said Tabouli, "but for so mean a person as myself a dry bone is a good feast. Who are we, the Sidu-log (the jackal people) to pick and choose?" He scuttled to the back of the cave, where he found the bones of a buck with some meat on it, and sat cracking the end merrily.</p> <p>"All thanks for this good meal," he said, licking his lips. "How beautiful are the noble children! How large are their eyes! And so young too! Indeed, indeed, I might have remembered that the children of kings are men from the beginning."</p> <p>Word total=125 Word detect=99</p> $Accuracy = \frac{(TP+TN)}{(TP+FP+FN+TN)} * 100$ $Accuracy = \frac{(99+8)}{(99+8+7+8)} * 100$ <p>=87.704%</p>	<p>Evaluation_08 Size:width =508, height =817 Font arial</p>  <p>Word total=125 Word detect=118</p> $Accuracy = \frac{(TP+TN)}{(TP+FP+FN+TN)} * 100$ $Accuracy = \frac{(118+0)}{(118+2+5+0)} * 100$ <p>=94.4%</p>

<p>Evaluation_09 Size:width =470, height =815 Font times new roman</p> <p>"Shall I tell him of your gratitude?" said Tabaqi.</p> <p>"OUI!" snapped Father Wolf, "OUI and hunt with thy master, thou hast done harm enough for one night!"</p> <p>"I go," said Tabaqi quietly, "Ye can hear Share Khan below in the thickets. I might have saved myself the message."</p> <p>Father Wolf listened, and below in the valley that ran down to a little river he heard the dry, angry, snarly, singsong whine of a tiger who has caught nothing and does not care if all the jungle knows it.</p> <p>"The fool!" said Father Wolf, "To begin a night's work with that noise! Does he think that our bucks are like his fat Wainounga bullocks?"</p> <p>Word total=113 Word detect=107</p> $Accuracy = \frac{(TP+TN)}{(TP+FP+FN+TN)} * 100$ $Accuracy = \frac{(107+3)}{(107+3+0+3)} * 100$ <p>=97.345%</p>	<p>Evaluation_09 Size:width =470, height =815 Font times new roman</p> <p>Shall I tell him of your gratitude? said Tabaqi.</p> <p>OUI! snapped Father Wolf, OUI and hunt with thy master, thou hast done harm enough for one night!</p> <p>I go, said Tabaqi quietly, Ye can hear Share Khan below in the thickets. I might have saved myself the message.</p> <p>Father Wolf listened, and below in the valley that ran down to a little river he heard the dry, angry, snarly, singsong whine of a tiger who has caught nothing and does not care if all the jungle knows it.</p> <p>The fool! said Father Wolf, To begin a night's work with that noise! Does he think that our bucks are like his fat Wainounga bullocks?</p> <p>Word total=113 Word detect=113</p> $Accuracy = \frac{(TP+TN)}{(TP+FP+FN+TN)} * 100$ $Accuracy = \frac{(113+0)}{(113+0+0+0)} * 100$ <p>=100%</p>
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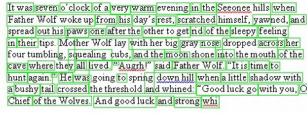

<p>Evaluation_10 Size:width =492, height =815</p>  <p>Font calibri body italic Word total=119 Word detect=77</p> $Accuracy = \frac{(TP+TN)}{(TP+FP+FN+TN)} * 100$ $Accuracy = \frac{(77+15)}{(77+15+14+15)} * 100$ <p>=76.033%</p>	<p>Evaluation_10 Size:width =492, height =815</p>  <p>Font calibri body italic Word total=119 Word detect=117</p> $Accuracy = \frac{(TP+TN)}{(TP+FP+FN+TN)} * 100$ $Accuracy = \frac{(117+0)}{(117+0+2+0)} * 100$ <p>=98.319%</p>
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Table 4.2: Evaluation

The use of a convolutional layer in OCR is used to recognize a dataset whether it is grayscale or RGB so that the convolutional layer can contain the feature map of the incoming dataset to be processed in the algorithm. At this stage the convolutional layer is not used to make a difference to the process of using the image feature extraction. Evaluation without using a convolutional layer with the dataset changed to Train 6017 and Test 5000 , Train 3000 and Test 3000

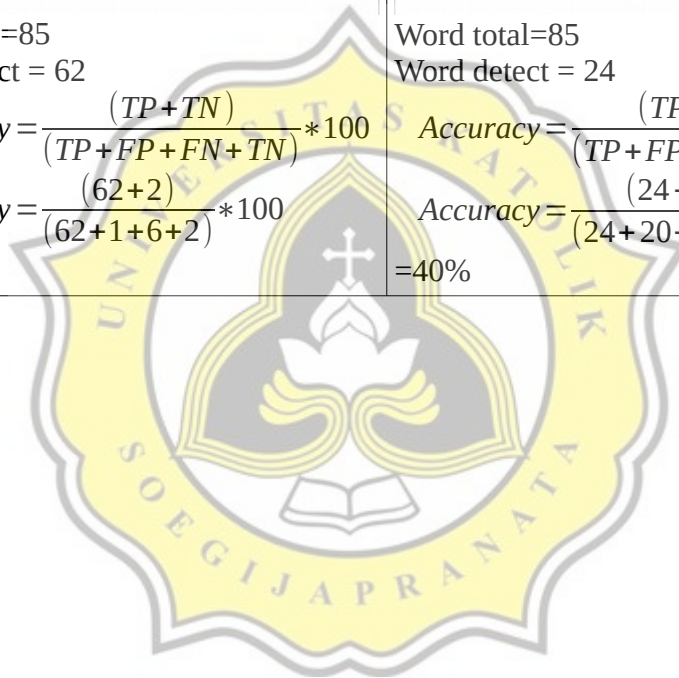
As follows:

Train	Test	Accuracy	Loss
9007 Image	6009 Image	0.9827	0.12060
6017 image	5000 Image	0.9826	0.04450
3000 Image	3000 Image	0.9727	0.11786

Table 4.3: Evaluation

Convolutional Layer	Without Convolutional Layer
<p>Size:width =508, height =817</p> <p>It was the jackal-Tabaqui, the Dish-licker-and the wolves of India despise Tabaqui because he runs about making mischief, and telling tales, and eating rags and pieces of leather from the village rubbish-heaps. But they are afraid of him too, because Tabaqui, more than anyone else in the jungle, is apt to go mad, and then he forgets that he was ever afraid of anyone, and runs through the forest biting everything in his way. Even the tiger runs and hides when little Tabaqui goes mad, for madness is the most disgraceful thing that can overtake a wild creature. We call it hydrophobia, but they call it dewanee-the madness-and run.</p> <p>Font arial black Word total=108 Word detect=107</p> $Accuracy = \frac{(TP+TN)}{(TP+FP+FN+TN)} * 100$ $Accuracy = \frac{(107+0)}{(107+0+1+0)} * 100$ <p>=99.074%</p>	<p>Size:width =508, height =817</p> <p>It was the jackal-Tabaqui, the Dish-licker-and the wolves of India despise Tabaqui because he runs about making mischief, and telling tales, and eating rags and pieces of leather from the village rubbish-heaps. But they are afraid of him too, because Tabaqui, more than anyone else in the jungle, is apt to go mad, and then he forgets that he was ever afraid of anyone, and runs through the forest biting everything in his way. Even the tiger runs and hides when little Tabaqui goes mad, for madness is the most disgraceful thing that can overtake a wild creature. We call it hydrophobia, but they call it dewanee-the madness-and run.</p> <p>Font arial black Word total=108 Word detect=86</p> $Accuracy = \frac{(TP+TN)}{(TP+FP+FN+TN)} * 100$ $Accuracy = \frac{(86+7)}{(86+7+8+7)} * 100$ <p>=86.111%</p>
<p>Size:width =492, height =815 Font arial italic</p> <p>The bushes rustled a little in the thicket, and Father Wolf dropped with his haunches under him, ready for his leap. (Then, if you had been watching, you would have seen the most wonderful thing in the world-the wolf checked in mid-spring. He made his bound before he saw what it was he was jumping at, and then he tried to stop himself. The result was that he shot up straight into the air for four or five feet, landing almost where he left ground.)</p> <p>"Man!" he snapped. "A man's cub! Look!"</p> <p>Directly in front of him, holding on by a low branch, stood a naked brown baby who could just walk-as soft and as dimpled a little atom as ever came to a wolf's cave at night. He looked up into Father Wolf's face, and laughed.</p> <p>Word total =125 Word detect = 115</p> $Accuracy = \frac{(TP+TN)}{(TP+FP+FN+TN)} * 100$ $Accuracy = \frac{(115+3)}{(115+3+0+3)} * 100$ <p>=97.520%</p>	<p>Size:width =492, height =815 Font arial italic</p> <p>The bushes rustled a little in the thicket, and Father Wolf dropped with his haunches under him, ready for his leap. (Then, if you had been watching, you would have seen the most wonderful thing in the world-the wolf checked in mid-spring. He made his bound before he saw what it was he was jumping at, and then he tried to stop himself. The result was that he shot up straight into the air for four or five feet, landing almost where he left ground.)</p> <p>"Man!" he snapped. "A man's cub! Look!"</p> <p>Directly in front of him, holding on by a low branch, stood a naked brown baby who could just walk-as soft and as dimpled a little atom as ever came to a wolf's cave at night. He looked up into Father Wolf's face, and laughed.</p> <p>Word total =125 Word detect = 82</p> $Accuracy = \frac{(TP+TN)}{(TP+FP+FN+TN)} * 100$ $Accuracy = \frac{(82+10)}{(82+13+20+10)} * 100$ <p>=73.6%</p>

<p>Size:width =440, height =815 Font arial narrow</p> <p>Now, Tabaqi knew as well as anyone else that there is nothing so unlucky as to compliment children to their faces. It pleased him to see Mother and Father Wolf look uncomfortable.</p> <p>Tabaqi sat still, rejoicing in the mischief that he had made, and then he said spitefully:</p> <p>"Shere Khan, the Big One, has shifted his hunting grounds. He will hunt among these hills for the next moon, so he has told me."</p> <p>Shere Khan was the tiger who lived near the Wanganza River, twenty miles away.</p>	<p>Size:width =440, height =815 Font arial narrow</p> <p>Now, Tabaqi knew as well as anyone else that there is nothing so unlucky as to compliment children to their faces. It pleased him to see Mother and Father Wolf look uncomfortable.</p> <p>Tabaqi sat still, rejoicing in the mischief that he had made, and then he said spitefully:</p> <p>"Shere Khan, the Big One, has shifted his hunting grounds. He will hunt among these hills for the next moon, so he has told me."</p> <p>Shere Khan was the tiger who lived near the Wanganza River, twenty miles away.</p>
<p>Word total=85 Word detect = 62</p> $Accuracy = \frac{(TP + TN)}{(TP + FP + FN + TN)} * 100$ $Accuracy = \frac{(62 + 2)}{(62 + 1 + 6 + 2)} * 100$ <p>=90.140%</p>	<p>Word total=85 Word detect = 24</p> $Accuracy = \frac{(TP + TN)}{(TP + FP + FN + TN)} * 100$ $Accuracy = \frac{(24 + 13)}{(24 + 20 + 31 + 10)} * 100$ <p>=40%</p>



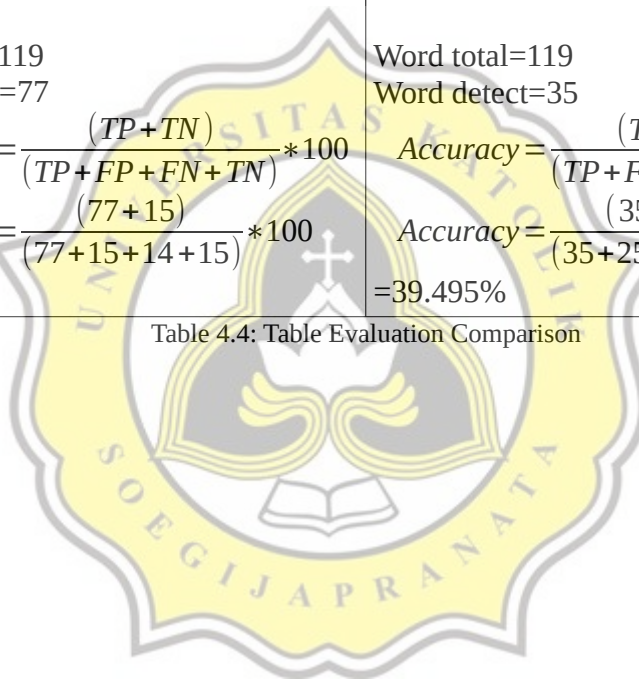
<p>Size:width =441, height =819 Font calibri light</p> <p>"Hush, it is neither bullock nor buck he hunts to-night," said Mother Wolf. "It is Man."</p> <p>The whine had changed to a sort of humming purr that seemed to come from every quarter of the compass. It was the noise that bewilders woodcutters and gypsies sleeping in the open, and makes them run sometimes into the very mouth of the tiger.</p> <p>"Man!" said Father Wolf, showing all his white teeth. "Faugh! Are there not enough beetles and frogs in the tanks that he must eat Man, and on our ground too!"</p> <p>Teeth go with noble children that they may never forget the hungry in this world."</p> <p>Word total=106 Word detect=95</p> $Accuracy = \frac{(TP + TN)}{(TP + FP + FN + TN)} * 100$ $Accuracy = \frac{(95 + 4)}{(95 + 4 + 3 + 4)} * 100$ <p>=93.396%</p>	<p>Size:width =441, height =819 Font calibri light</p> <p>"Hush, it is neither bullock nor buck he hunts to-night," said Mother Wolf. "It is Man."</p> <p>The whine had changed to a sort of humming purr that seemed to come from every quarter of the compass. It was the noise that bewilders woodcutters and gypsies sleeping in the open, and makes them run sometimes into the very mouth of the tiger.</p> <p>"Man!" said Father Wolf, showing all his white teeth. "Faugh! Are there not enough beetles and frogs in the tanks that he must eat Man, and on our ground too!"</p> <p>Teeth go with noble children that they may never forget the hungry in this world."</p> <p>Word total=106 Word detect=65</p> $Accuracy = \frac{(TP + TN)}{(TP + FP + FN + TN)} * 100$ $Accuracy = \frac{(65 + 8)}{(65 + 12 + 21 + 8)} * 100$ <p>=68.867%</p>
<p>Size:width =463, height =809 Font calibri</p> <p>Then there was a howl—an un-Anglo-Indian howl—from Shere Khan. "He has missed," said Mother Wolf. "What is it?"</p> <p>Father Wolf ran out a few paces and heard Shere Khan muttering and mumbling savagely as he tumbled about in the scrub.</p> <p>"The fool has had no more sense than to jump to woodcutter's campfire, and has burned his feet," said Father Wolf with a grunt. "Taboqui is within him."</p> <p>"Something is coming up hill," said Mother Wolf, twitching one ear. "Get ready."</p> <p>Word total=83 Word detect=70</p> $Accuracy = \frac{(TP + TN)}{(TP + FP + FN + TN)} * 100$ $Accuracy = \frac{(70 + 4)}{(70 + 4 + 5 + 4)} * 100$ <p>=93.396%</p>	<p>Size:width =463, height =809 Font calibri</p> <p>Then there was a howl—an un-Anglo-Indian howl—from Shere Khan. "He has missed," said Mother Wolf. "What is it?"</p> <p>Father Wolf ran out a few paces and heard Shere Khan muttering and mumbling savagely as he tumbled about in the scrub.</p> <p>"The fool has had no more sense than to jump to woodcutter's campfire, and has burned his feet," said Father Wolf with a grunt. "Taboqui is within him."</p> <p>"Something is coming up hill," said Mother Wolf, twitching one ear. "Get ready."</p> <p>Word total=83 Word detect=31</p> $Accuracy = \frac{(TP + TN)}{(TP + FP + FN + TN)} * 100$ $Accuracy = \frac{(31 + 6)}{(31 + 17 + 29 + 6)} * 100$ <p>=44.578%</p>

<p>Size:width =479, height =817 Font courier</p> <p>The Law of the Jungle, which never orders anything without a reason, forbids every beast to eat Man except when he is killing to show his children how to kill, and then he must hunt outside the hunting grounds of his pack or tribe. The real reason for this is that man-killing means sooner or later the arrival of white men on elephants, with guns, and hundreds of brown men with gongs and rockets and torches. Then everybody in the jungle suffers. The reason the beasts give among themselves is that Man is the weakest and most defenseless of all living things, and it is unportmanlike to touch him. They say too—and it is true—that man-eaters become mangy and lose their teeth.</p> <p>The purr grew louder, and ended in the full-throated "Aaarth" of the tiger's charge.</p> <p>Word total=135 Word detect=115</p> $\text{Accuracy} = \frac{(TP+TN)}{(TP+FP+FN+TN)} * 100$ $\text{Accuracy} = \frac{(115+7)}{(115+7+6+7)} * 100$ <p>=90.370%</p>	<p>Size:width =479, height =817 Font courier</p> <p>The Law of the Jungle, which never orders anything without a reason, forbids every beast to eat Man except when he is killing to show his children how to kill, and then he must hunt outside the hunting grounds of his pack or tribe. The real reason for this is that man-killing means sooner or later the arrival of white men on elephants, with guns, and hundreds of brown men with gongs and rockets and torches. Then everybody in the jungle suffers. The reason the beasts give among themselves is that Man is the weakest and most defenseless of all living things, and it is unportmanlike to touch him. They say too—and it is true—that man-eaters become mangy, and lose their teeth.</p> <p>The purr grew louder, and ended in the full-throated "Aaarth" of the tiger's charge.</p> <p>Word total=135 Word detect=59</p> $\text{Accuracy} = \frac{(TP+TN)}{(TP+FP+FN+TN)} * 100$ $\text{Accuracy} = \frac{(59+13)}{(59+24+39+13)} * 100$ <p>=53.3333%</p>
<p>Size:width =445, height =800 Font tahoma</p> <p>"He has no right!" Father Wolf began angrily--"By the Law of the Jungle he has no right to change his quarters without due warning. He will frighten every head of game within ten miles, and I--I have to kill for two, these days."</p> <p>"His mother did not call him Lunari (the Lame One) for nothing," said Mother Wolf quietly. "He has been lame in one foot from his birth. That is why he has only killed cattle. Now the villagers of the Mainunga are angry with him, and he has come here to make our villagers angry. They will scout the jungle for him when he is far away, and we and our children must run when the grass is set alight. Indeed, we are very grateful to Shere Khan!"</p> <p>Word total=132 Word detect=132</p> $\text{Accuracy} = \frac{(TP+TN)}{(TP+FP+FN+TN)} * 100$ $\text{Accuracy} = \frac{(132+0)}{(132+0+0+0)} * 100$ <p>=100%</p>	<p>Size:width =445, height =800 Font tahoma</p> <p>"He has no right!" Father Wolf began angrily--"By the Law of the Jungle he has no right to change his quarters without due warning. He will frighten every head of game within ten miles, and I--I have to kill for two, these days."</p> <p>"His mother did not call him Lunari (the Lame One) for nothing," said Mother Wolf quietly. "He has been lame in one foot from his birth. That is why he has only killed cattle. Now the villagers of the Mainunga are angry with him, and he has come here to make our villagers angry. They will scout the jungle for him when he is far away, and we and our children must run when the grass is set alight. Indeed, we are very grateful to Shere Khan!"</p> <p>Word total=132 Word detect=129</p> $\text{Accuracy} = \frac{(TP+TN)}{(TP+FP+FN+TN)} * 100$ $\text{Accuracy} = \frac{(129+0)}{(129+0+3+0)} * 100$ <p>=97.727%</p>

<p>Size:width =508, height =817 Font arial</p> <p>"Enter, then, and look," said Father Wolf stiffly, "but there is no food here."</p> <p>"For a wolf, no," said Tabou, "but for so mean a person as myself a dry bone is a good feast. Who are we, the Gidur-log (the jackal people), to pick and choose?" He scuttled to the back of the cave, where he found the bone of a buck with some meat on it, and sat cracking the end merrily.</p> <p>"All thanks for this good meal," he said, licking his lips. "How beautiful are the noble children! How large are their eyes! And so young too! Indeed, indeed, I might have remembered that the children of kings are men from the beginning."</p> <p>Word total=125 Word detect=99</p> $Accuracy = \frac{(TP+TN)}{(TP+FP+FN+TN)} * 100$ $Accuracy = \frac{(99+8)}{(99+8+7+8)} * 100$ <p>=87.704%</p>	<p>Size:width =508, height =817 Font arial</p> <p>"Enter, then, and look," said Father Wolf stiffly, "but there is no food here."</p> <p>"For a wolf, no," said Tabou, "but for so mean a person as myself a dry bone is a good feast. Who are we, the Gidur-log (the jackal people), to pick and choose?" He scuttled to the back of the cave, where he found the bone of a buck with some meat on it, and sat cracking the end merrily.</p> <p>"All thanks for this good meal," he said, licking his lips. "How beautiful are the noble children! How large are their eyes! And so young too! Indeed, indeed, I might have remembered that the children of kings are men from the beginning."</p> <p>Word total=125 Word detect=62</p> $Accuracy = \frac{(TP+TN)}{(TP+FP+FN+TN)} * 100$ $Accuracy = \frac{(62+14)}{(62+22+27+14)} * 100$ <p>=60.8%</p>
<p>Size:width =470, height =815 Font times new roman</p> <p>"Shall I tell him of your gratitude?" said Tabou.</p> <p>"O, it," snapped Father Wolf, "O, and hunt with thy master, I thou hast done harm enough for one night."</p> <p>"I go," said Tabou, quietly, "Ye can hear Shere Khan below in the thickets. I might have saved myself the message."</p> <p>Father Wolf listened, and below in the valley that ran down to a little river he heard the dry, angry, snarly, singsong whine of a tiger who has caught nothing and does not care if all the jungle knows it.</p> <p>"The fool!" said Father Wolf, "To begin a night's work with that noise! Does he think that our buk are like his fat Waugunga bullocks?"</p> <p>Word total=113 Word detect=107</p> $Accuracy = \frac{(TP+TN)}{(TP+FP+FN+TN)} * 100$ $Accuracy = \frac{(107+3)}{(107+3+0+3)} * 100$ <p>=97.345%</p>	<p>Size:width =470, height =815 Font times new roman</p> <p>"Shall I tell him of your gratitude?" said Tabou.</p> <p>"O, it," snapped Father Wolf, "O, and hunt with thy master, I thou hast done harm enough for one night."</p> <p>"I go," said Tabou, quietly, "Ye can hear Shere Khan below in the thickets. I might have saved myself the message."</p> <p>Father Wolf listened, and below in the valley that ran down to a little river he heard the dry, angry, snarly, singsong whine of a tiger who has caught nothing and does not care if all the jungle knows it.</p> <p>"The fool!" said Father Wolf, "To begin a night's work with that noise! Does he think that our buk are like his fat Waugunga bullocks?"</p> <p>Word total=113 Word detect=93</p> $Accuracy = \frac{(TP+TN)}{(TP+FP+FN+TN)} * 100$ $Accuracy = \frac{(93+0)}{(93+4+16+0)} * 100$ <p>=82.300%</p>

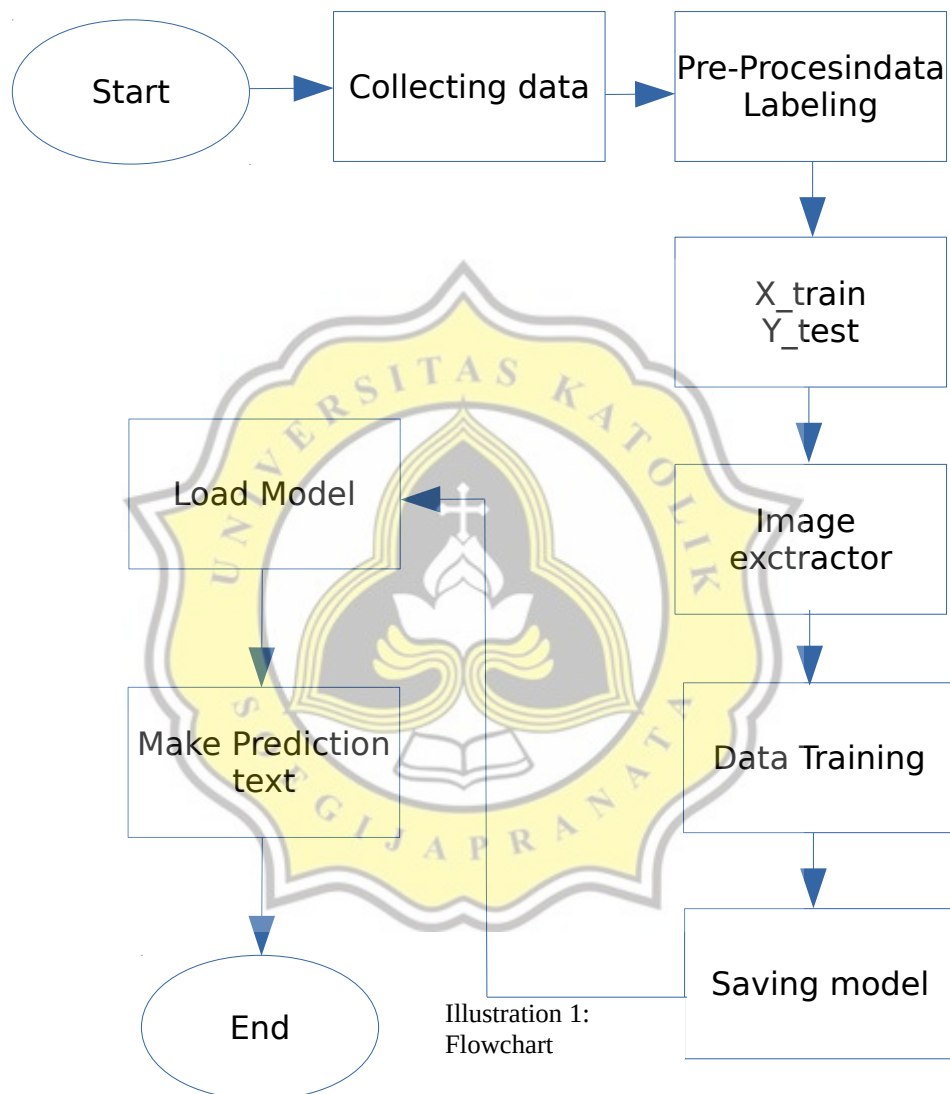
<p>Size:width =492, height =815 Font calibri body italic</p> <p>It was seven o'clock of a very warm evening in the Seconce hills when Father Wolf woke up from his day's rest, scratched himself, yawned, and spread out his paws on the other to get rid of the sleepy feeling in their tips. Mother Wolf lay with her big gray eyes dropped across her four tumbling, squealing pups, and the moon shone into the mouth of the cave where they all lived. "Augh!" said Father Wolf. "It is time to hunt again." He was going to spring down hill when a little shadow with a bushy tail crossed the threshold and whined. "Good luck go with you, O Chief of the Wolves! And good luck and strong whi</p> <p>Word total=119 Word detect=77</p> $Accuracy = \frac{(TP+TN)}{(TP+FP+FN+TN)} * 100$ $Accuracy = \frac{(77+15)}{(77+15+14+15)} * 100$ <p>=76.033%</p>	<p>Size:width =492, height =815 Font calibri body italic</p> <p>It was seven o'clock of a very warm evening in the Seconce hills when Father Wolf woke up from his day's rest, scratched himself, yawned, and spread out his paws on the other to get rid of the sleepy feeling in their tips. Mother Wolf lay with her big gray eyes dropped across her four tumbling, squealing pups, and the moon shone into the mouth of the cave where they all lived. "Augh!" said Father Wolf. "It is time to hunt again." He was going to spring down hill when a little shadow with a bushy tail crossed the threshold and whined. "Good luck go with you, O Chief of the Wolves! And good luck and strong whi</p> <p>Word total=119 Word detect=35</p> $Accuracy = \frac{(TP+TN)}{(TP+FP+FN+TN)} * 100$ $Accuracy = \frac{(35+12)}{(35+25+47+12)} * 100$ <p>=39.495%</p>
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Table 4.4: Table Evaluation Comparison



4.2 Desain

4.2.1 Flow Chart



Flowcharts explain how the program works from start to finish. The first step was to collect the NIST dataset, after which 15,0015 images were used, containing the characters a to z and the characters from 0 to 9. The next step was to create labeling train data and test data. The train data and test data will be labeled with X_train and Y_test. The data comes from the categorization of the

train and test folders, in the train folder there are 9007 images and in the test folder there are 6009 images.

After labeling, the data will enter the image extractor process, which uses a convolutional layer as the extractor and unpool to collect important data contained in the pixel section of the image. Then the next step is the data entered into the algorithm (LSTM) which will be recognized and will be trained with the algorithm and then stored in the form of a checkpoint model in the tensorflow format. The train data that has been prepared will be loaded again to be used to recognize the image that will be inputted to predict the letters in the image.

4.2.2 USE CASE

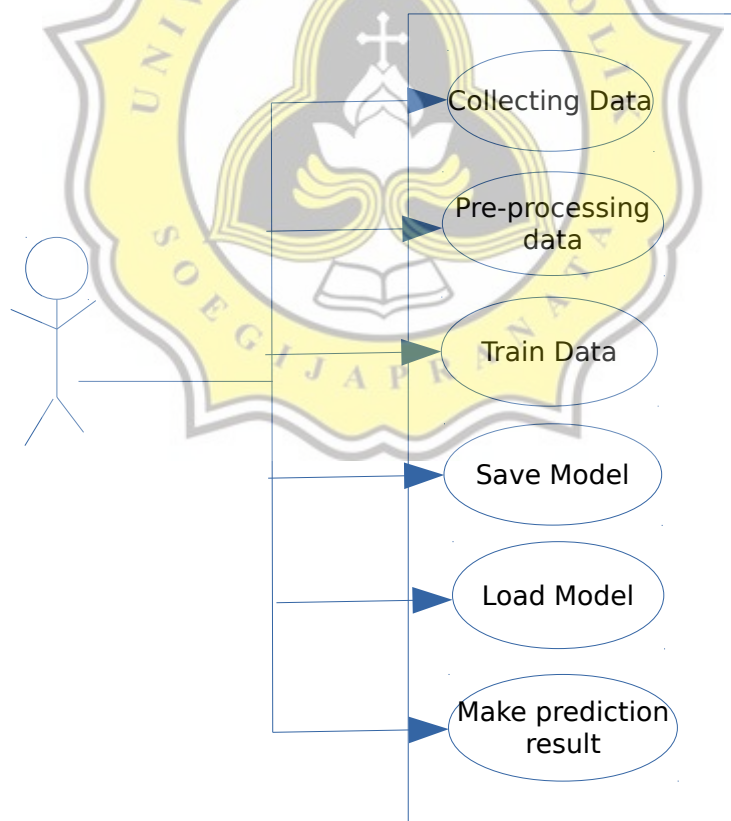


Illustration 2: Use Case Diagram