TRANSLATION OF BAYBAYIN CHARACTERS THROUGH ARTIFICIAL INTELLIGENCE

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FRANCIS BERT L. DOLOT
JOSE MIGUEL A. ESCALONA
LORENZO IAN A. PAJANTOY
DEAN ANDRE M. REYES
GEOFF AARON C. TOPACIO

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ABSTRACT

Name of Institution : Elizabeth Seton School-South

Address : Anabu II-D, Imus City, Cavite

Title of Research : **TRANSLATION OF BAYBAYIN CHARACTERS THROUGH ARTIFICIAL INTELLIGENCE**

Authors : Francis Bert L. Dolot
Jose Miguel A. Escalona
Lorenzo Ian A. Pajantoy
Dean Andre M. Reyes
Geoff Aaron C. Topacio

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Preserving the nation's history and culture is one of the best ways of being a patriot to your country. Baybayin, being the Philippines' original handwriting system, was overthrown by the Spanish colonizers in replacement to the Latin form of handwriting. Today however, Senate bills which entail to promote and re-teach Baybayin as a writing system is only a step away from being enacted. Creating a tool capable of detecting and interpreting Baybayin characters is only appropriate as it is inline with the Senate Bill. Apart from this, the tool will utilize Artificial Intelligence as its backbone due the technology being often used on almost everything (Bayern, 2018). The researchers chose the method of utilizing Artificial Intelligence along with computer vision instead of purely being based on computer vision only. The development revealed that it was possible to create a system that is able to detect and interpret Baybayin characters, along with this is the respondents positive view of the system regarding the concept as useful, enticing, and satisfying as a tool which promotes in turn promotes learning and using Baybayin as a writing tool.

APPROVAL SHEET

This research entitled "**Translation of Baybayin Characters through Artificial Intelligence**", prepared and submitted by Francis Bert L. Dolot, Jose Miguel A. Escalona, Lorenzo Ian A. Pajantoy, Dean Andre M. Reyes and Geoff Aaron C. Topacio in partial fulfillment of the requirements for capstone, has been examined and is recommended for acceptance and approval for oral defense.

Jeniffer E. Paje, LPT
Research Adviser

Research Review Panel
Approved by the Committee on Oral Examination with a grade of _____.

Mr. Ferdinand V. Alido, MBA
Member

Mr. Jojo L. Potenciano, LPT
Member

Dr. Roberto T. Borromeo, Ed.D
Chair

Accepted and approved in partial fulfilment of the requirements in Capstone

Nenet L. Ayson, LPT
JHS/SHS Assistant Principal

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The Researchers

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INTRODUCTION

Background of the Study

The Filipinos, like any nationality, is identified and distinguished through its set of cultures. According to Oak (2018), culture is a diverse yet a cohesive piece for social control that makes up a community. It also serves as the identity of a community, separating them from other countries (Spencer, 2014). To further expound the idea of culture, Birukou et. al. (2013) stated that culture is something that is partaken and/or acquired by a group of people by means of knowledge, belief, art, law, morals, custom and others. Simply put, culture is a unique set of identities of a nation's citizens that come in forms of knowledge which can include historical knowledge and language, belief which may be supernatural in form, art that shows the creative identity of a certain nation, morals that uphold the citizens in order for them to live better and custom which include their practices of living. All of this collectively forms an identity of the nation's people.

One representation of the nation's culture is Baybayin. According to Lazaro (2009), Baybayin is an alpha syllabary writing system or also known as abugida. It means that a single character or symbol in baybayin corresponds to a single letter or a syllable of today's modern alphabet. Before Spanish colonization, the single modern alphabetical letters that corresponds to a baybayin character are all the vowels while the syllabic ones contain two or three letters starting with one or two consonants and ends with a vowel. It is said that the writing system originated from the Cham or the people who inhabited the kingdom of Champa in southern Vietnam (Wade, 1993) and was changed into a form we now know as Baybayin. According to the book of Woods (2012), during the early Spanish colonial period, Baybayin was deemed to be ineffective due to the unavailability of translating words that ends in consonants which is why the Spaniards modified and added a few characters that correspond to single lettered consonants, transforming into a new writing system.

Baybayin was mostly famous during the pre-colonial Spanish era and according to Woods (2012), Baybayin hardly survived until now mainly because of three reasons. First is that the materials it was written on such as bamboo and palm leaves did not survive nor it was supposed to. Second is that the nature of writings or the way it is delivered was not intended to last in long periods of time. Lastly is because of the Spanish intrusion. The Spaniards found out that the Philippines was both oral and literate in terms of their language and writing system but lacks greatly in literacy which makes it one of the underlying reasons on why the implementation of Spain's new writing system and those that are associated with it and uses its technology such as culture became immediate.

Today, it is a fact that the Baybayin wasn't entirely lost and is being given importance. According to the Senate Bill No. 1899 of the 16th Congress and Senate Bill No. 2440 of the 16th Congress or namely as the Baybayin Act of 2013 and the National Writing System Act of 2014, it is important and a must to accentuate the continuation of the old tradition in script writing for a few remaining indigenous communities because scripts are connected to language and literature.

This law intends to give priority to the Filipino culture and to emphasize patriotism and nationalism. It also promotes the national language of the country allowing cultural and linguistic diversity. In terms of societal progression, it can now be used as a business specifically tourism. Some netizen's in social media showed their interest in Baybayin by having their tattoos written in Baybayin, showing images that contain Baybayin characters while having a nationalistic caption, trying to practice writing Baybayin on their own using their names as an example thus proving a spark of interest amongst Filipinos. Groups like Singhabi revive the writing system by teaching them to the youth ("Pagsusulat ng Baybayin, layong buhayin ng grupong Hibla Sanghabi", 2017), according to the organization's leader Leo Emmanuel Castro (n.d.) , they are teaching it the youth so that they will learn and be able to feature the way we write before the time of the Spaniards.

Artificial Intelligence is a branch of computer science that aims to bring human intelligence to machines through certain algorithms that can mimic the human mind. According to Swarup (2012), the concept of artificial intelligence was initially thought of since the time of ancient Egypt albeit in a form of a folklore. But it was in the 1940s where it can take form already with the advent of electronic computers at that time. With this, it can be inferred that humans have long aimed to improve and simplify their lives by using different technologies. Some of the well-known example of this are the simple machines which aided the early ancestors of humans in making certain physical tasks simpler to do, the 1800s saw the use of the steam engine in accelerating the process of production of different industries thus referring to it as the industrial age, and the digital age which simplifies the work of the human mind by offloading most computational tasks to an electronic machine.

Computers in general are good at executing smart tasks but is deficient in thinking up those smart ideas (Evarista, 2015). This is where artificial intelligence takes in to place, where Evarista also stated that AI aims to take computing to a higher level while also being able to think and not just execute smart ideas. Artificial Intelligence as a concept is old according to Miailhe et. al. (2017) which can be proven since it was first coined by John McCarthy back in 1956. In order to retain it as relevant and useful as possible three trends must be converged for it to stay relevant which are big data, machine learning and cloud supercomputing (Miailhe et. al., 2017).

Big data is referred as large sets of complex data that is in a structured or unstructured form which makes traditional algorithms and solutions unable to operate well, Taylor-Sakyi (2016). Since traditional approaches cannot be used for such data problems, the technique called machine learning can be used in order to solve the problem as mentioned in earlier in the three trends. Machine Learning according to Das et. al. (2015) is a subset of AI where the machine "learns" or is "trained" on its own without coding the instructions in highly detailed manner. Simon (2015) also stated that machine learning works with the combination of pattern recognition and computational learning theory, she also stated that it works by learning and making predictions or inferences based from the data it was trained from.

Machine learning being a subset of Artificial Intelligence shows a machine's capability to resolve and learn things given a learning algorithm. Simon (2015) also stated that machine learning can be applied in areas where human expertise is lacking or the problem is just too hard and incomprehensible for humans alone to solve. Learning through scanning for patterns alone is not the most efficient or even the most accurate way of learning. Traditional machine learning approaches, while good, are still limited in processing data sets that are in natural form (LeCun et. al., 2015).

Deep learning solves this problem, this subset of machine learning which comprises numerous hidden layers of artificial neural networks which are the computer version of neurons of the human brain (Vargas et. al, 2018). As a whole, the use of machine learning with deep learning in image and object classifying, object detection and optical character recognition, in form Baybayin in this case, is one of the best ways of doing it. Given with correct reference or training data, it could detect the characters with utmost accuracy without the need of explicitly coding the features that the system must look out for.

In order to use the AI in object detection, computers must be also able to "see" things, this is where Computer Vision is applied. Computer vision, according to Learned-Miller (2013), is a field of science wherein computers and other machines are endowed with vision or the ability to see, this is by extracting information from the digital images (Krishna, 2017). Since its inception, its applications became numerous which include: face detection, scene recognition, self-driving cars, optical character recognition and others which enhance and simplify the lives of humans. Computer or machine vision, simply needs two components which are sensing and interpreting devices (Krishna, 2017). The sensing device include the camera which gathers light to its image sensor which is then converted into electrical signals that is then transferred to the interpreting device which is the computer to be analyzed for. The computer will do all of the processing and interpretation with the use of an algorithm, which is usually specialized and designed for specific purposes.

Applying artificial intelligence to the algorithm part of computer vision solves the issue of the limitations of coding specialized algorithms by allowing the computer to think on its own based from the lessons it gathered from its training which can be also applied in to other applications thus making more generic in purpose.

Using an innovative approach, the researchers hope to help in enhancing the Philippines' cultural heritage by aiding in promoting the concept of Baybayin through technology. Baybayin is considered to be one of the national treasures of culture since it is truly unique in the Philippines. Promoting Baybayin aims to promote to Filipinos their own culture which in turn will give of a sense of national pride.

Conceptual Framework

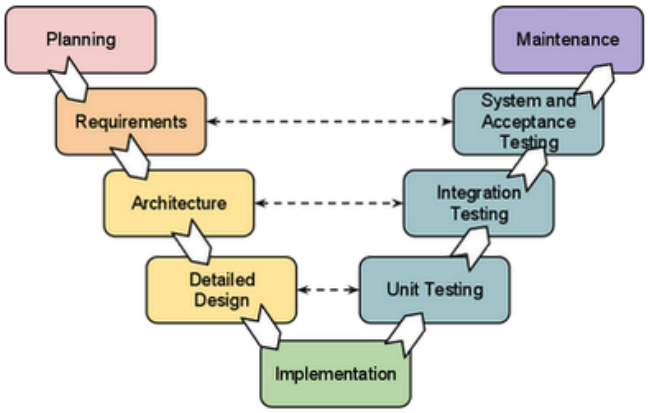

Figure 1 - Conceptual Framework

Statement of the Problem

This research aims to develop a program that will be able to detect and translate Baybayin characters into Roman/Latin syllable equivalents. The problems to be solved are as follows:

1. How accurate is the system in detecting and translation of characters?
2. How fast is the system in detecting and translating characters?

3. Is it possible to create a Baybayin Translator that utilizes artificial intelligence that is capable of interpreting and translating Baybayin characters to Roman/Latin Alphabet?

Significance of the Study

This study can be beneficial to these individuals:

Archaeologists - Translation of Baybayin texts will be a lot more easier through the use of translator.

Students - Learning Baybayin can easily be done through the use of technologies such as translators.

Citizens - Due to the potential implementation of designating Baybayin as a National Writing System.

Teachers - Teaching Baybayin will be a lot more easier through the use of a translator.

Filipinos - Promotion of the use of Baybayin can be addressed as preservation of national identity and culture.

Future Researchers - Provides possible machine learning models for future researches or software to base on.Writing System, Filipino Citizens may be required to learn Baybayin.

Scope and Delimitation

The translator generated through this research is limited to the translation of Baybayin texts to Roman/Latin script. The translator is also limited to written texts and voice translation will not be implemented anymore. The system is also limited to 17 Baybayin characters which include:

Vowel	A	E	O											
Alphasyllabirics	Ba	Da	Ga	Ha	Ka	La	Ma	Na	Pa	Ra	Sa	Ta	Wa	Ya

Table 1 - Trained Character Set

According to Lahi.PH (2018), Leo Emmanuel Castro stated that there are only 17 fundamental symbols in Baybayin which can serve as the basis for other syllabics as well.

The system is also sensitive to various factors such as but not limited to lighting, image distance or size, handwriting of the writer and the orientation of the written character.
This requires for the input to be written at an upright manner similar to how traditional letters were written in order for the system to recognize the character.

Definition of Terms

- Artificial Intelligence - a branch of Computer Science that aims for a computer to do tasks that require human intelligence.
- Characters - a letter or symbol that is either printed or written that can be read visually.
- Convolutional Neural Networks - a type of deep artificial neural networks that are used primarily for computer vision which is applied commonly in image classification, similarity clustering of images, and object recognition.
- Deep Learning - a subset of machine learning that is inspired by the structure and function of the human brain in form of artificial neural networks
- Inference - usage of the model for learning about the data
- Machine Learning or ML - an subset of artificial intelligence which provides a system the ability to learn and improve automatically through patterns and experience without explicitly programming it
- Prediction - usage of the model in predicting the outcomes from new data points
- Writing System - a system of characters or symbols that are used to represent a language

METHODOLOGY

This part of the study will project statement states the steps and procedures to be taken in order to complete the objective of the project.

Project Management

The project was divided into five major segments:

Step 1: Initial app development

The app was created where at this stage it functions in its basic form without the AI. Only the GUI, Camera capabilities and external libraries and frameworks are added in the program. The development was done with the use of Eclipse IDE, Java and Python. This part of the process was done first to make sure that the program already executes well before the training begins which is the most time consuming part of the entire process.

Step 2: App Testing and Data Collection

After the app was created, it was tested on a pre-trained AI model which resulted to improvements and optimization. Once the system has been proven to be functioning, the data about Baybayin, in form of images, are collected. The researchers wrote thirty samples for each character and was then taken with different backgrounds and lighting. The letters were written in a one-fourth sheet of a clean bond paper either horizontally or vertically. The images were then resized to 20% of its original size or with resolutions of less than 800 pixels, this was done due to the limited computational resources that the researchers have. Apart from the self-created images, some samples were gathered from the internet as well. The images were then annotated and labelled with the use of image annotation software to mark the parts of the image that contain the Baybayin character.

Step 3: Pre-Training and AI testing

After the collection and processing of the training images, the data was then be trained with different AI training model on different configurations. Once the desired goals have been met the training model used along with its configuration was then used to the other parts of the training as long as it maintains its integrity on accuracy and speed. The end product of this step is an inference graph file which the AI can use to be able to detect the characters.

Step 4: AI Training and Continuous Development

By this part of the process all forms of data including from online sources are also included as part of the training data to ensure the system's robustness to complex inputs. Along with this is the continuous development of the system which was constantly tested each build.

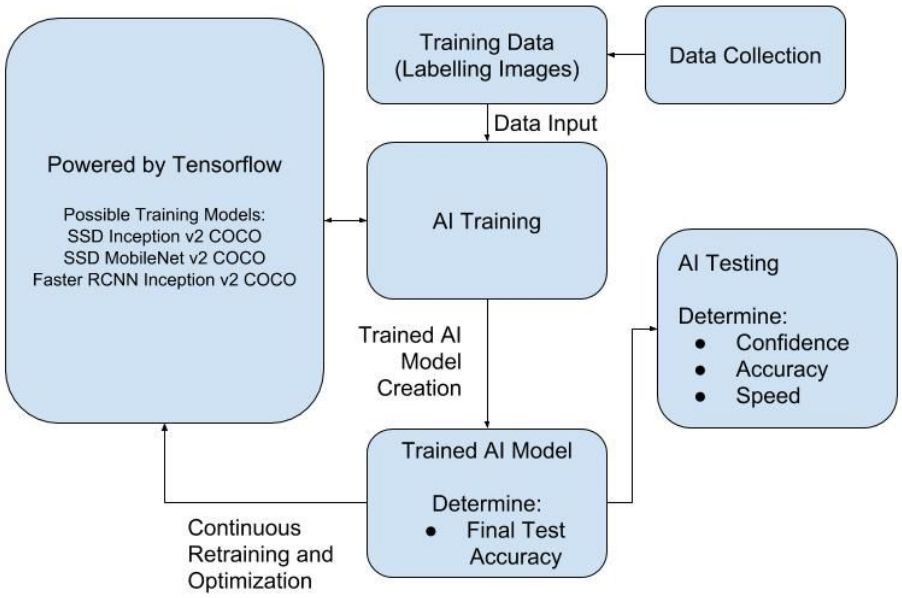

Figure 2.1 - AI Training Workflow

Step 5: Integration and Validation

Nearing to the end of the entire process, the final AI model, with the highest final accuracy score, was selected to be integrated to the app for the final deployment which was then tested through a systematic test called user acceptance testing (UAT) to validate that it functions as it should.

The user acceptance tests were executed in the following manner. The respondents were given a brief lecture about the research and the flow of the user acceptance test. The researchers then asked the respondents to write a Babayin character that is within the scope of the model. Once the respondents were able to finish choosing and writing their desired character, they were then asked to let the system identify it. The respondents were then given a survey form to be answered whether or not the system successfully identified the character they have written.

Along with the user acceptance test is the systematic test where the accuracy was determined with the use of the success rate.

Optional Step: Continuous Training

Given that the one of the system's goal is to give an accurate detection and translation of the Baybayin characters. The AI model will be still trained and tested to further enhance its capability to discern detected images for Baybayin characters if given the time to do so.

Specifications and Requirements

The App

The app was designed to run on a Windows based platform for the reason that this is the most common platform for computers.

Details of Technologies Used

The key technologies of this prototype system or application are primarily founded and used on technologies that use Artificial Intelligence (AI) specifically Machine Learning(ML). TensorFlow will be used as the key technology of this system which is an open-source or free machine learning library or framework. It contains all of the API and tools needed for the development and training of the AI informs of scripts that are either written in Python or C++. According to Abadi et. al. (2016), TensorFlow supports a wide range of applications that focuses on deep neural network training, inferencing and prediction.

He also stated that TensorFlow was the predecessor of Google's previous machine learning system called Distbelief and was then open-sourced in 2015 (Metz, 2015). The AI training models and Object Detection method include but are not limited to Faster Regions with Convolutional Networks (Faster R-CNN), You Only Look Once (YOLO) & Single Shot Detection (SSD) which are all convolutional neural network based which can be all used and executed in TensorFlow. The neural network will come with the following feature extractors which include but are not limited to: ResNet, MobileNet and Inception architectures with MobileNet (Howard, et. al., 2017) and Inception, both being a creation of Google. The training models to be selected are not being limited on what was previously mentioned but may expand further if needed.

Performance

The performance target for this set of applications revolves around its accuracy and speed with the app being able to recognize or detect characters close to real time. The concept is the same with latency, the closer it is to 0 milliseconds the better.

System Requirements

The project necessitates certain parameters of specifications for its creation and usage. The software and hardware requirements for this application will be divided into two segments which are AI related and App related. The AI was trained with the use of a script created with TensorFlow in Python programming language. The script was used to read all training images for recognition. AI training is resource intensive for computers since it is done in a computationally intensive manner. This is why a high performance computer or server is recommended for this part but the researchers don't have the financial capacity so instead a standalone system will be used for the training instead.

The hardware specifications for the AI training are as follows based from the recommendation of TensorFlow and Nvidia:

Component	**Requirement**
CPU	2 cores minimum, more cores are highly recommended
RAM	2GB minimum, more RAM is highly recommended
GPU	Nvidia GPU recommended for CUDA Acceleration (Optional)
Python Version	Python version 2 or 3
Operating System	Ubuntu 16.04 or later; Windows 7 or later

Table 2.1 - Recommended System Specifications for AI Training

Based from the specifications stated above, the proponents of this project have prepared two systems for training purposes to guarantee compatibility of training and system availability.

Component	**System 1**	**System 2**
CPU Cores	2	4
CPU Threads	4	4
RAM Capacity	4GB	12GB
GPU	Intel HD Graphics 2000 (Non-CUDA)	Nvidia GTX 1050Ti

Table 2.2 - Specifications of Systems used in AI Training

As the training took place, it was determined that System 2 was more feasible and efficient because of its capability, capacity and performance in training which was proven in the figure below.

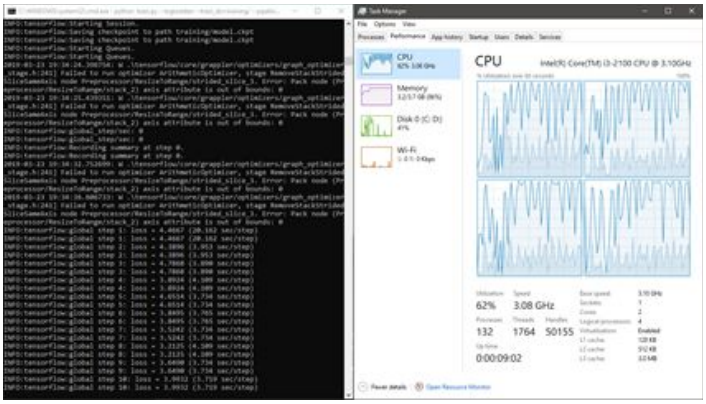

Figure 2.2 - System 1 in Training

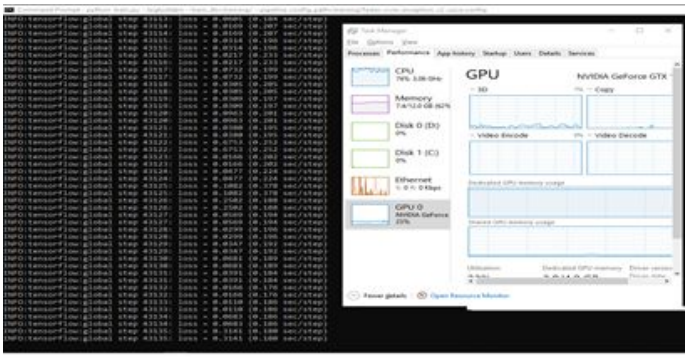

Figure 2.3 - System 2 in Training

The figure shows that System 2 trains the AI much faster at a rate of ~0.1 seconds per step in comparison to System 1, this is due to System 2 having more RAM at 12GB and having a Nvidia Graphics Card as an accelerator in comparison to the preceding system with only 4GB of RAM and being executed only by a CPU.

System Design

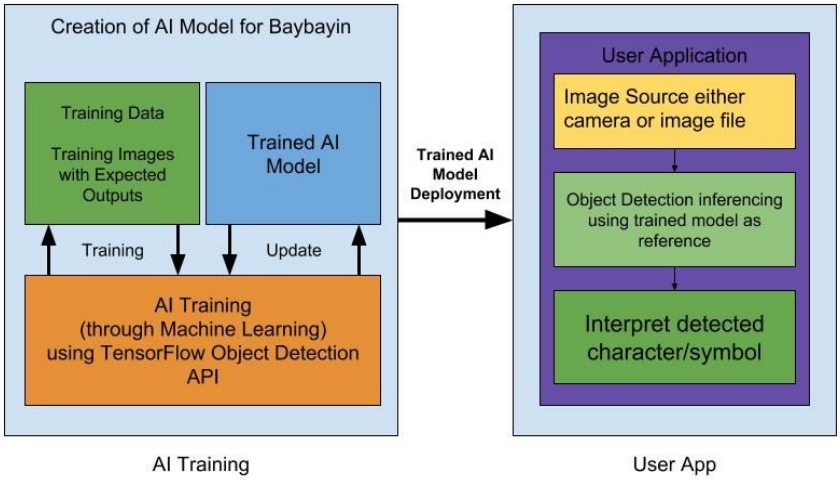

Figure 2.4 - Overall System Design

AI Training

The training model selected is a major contributor to the system's overall performance and accuracy. The researchers have selected the Faster R-CNN Inception v2 COCO model for its exceptional performance, for training and deployment, and accuracy in comparison to other models in relation to the computer systems that the researchers are training and running from. According to "Zero to Hero: Guide to Object Detection using Deep Learning: Faster R-CNN,YOLO,SSD" (n.d.), Faster-RCNN achieves higher accuracy albeit at lower speeds in detecting objects, which in this case are characters. Despite the possible speed disadvantages in comparison to its alternatives, the main point of this project is detect the characters accurately rather than quickly.

Figure 2.4 – Training Accuracy and Speed Comparison

Also, the article determined that Faster-RCNN is capable of detecting a wide range of object sizes which is beneficial since writing can vary in size.

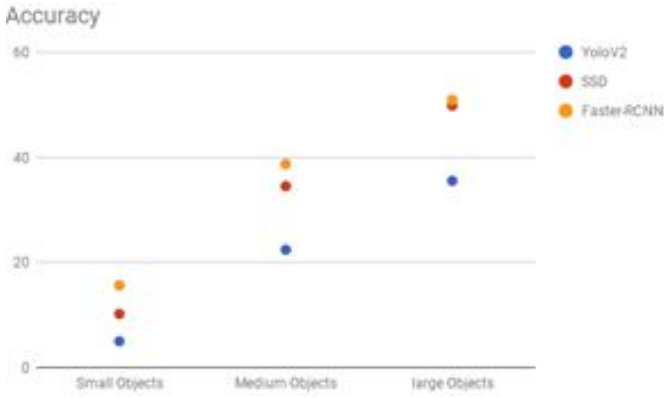

Figure 2.5 – Accuracy Comparison at Different Object Sizes

The data shown below are the configuration and result data of the training with the best possible accuracy. The training configuration is as follows:

Component	**Value**
Machine Learning Model	Faster R-CNN
Feature Extractor	Inception v2
Pre-trained dataset	Common Objects in Context (COCO)
Number of classes	17
Number of Images in Training Folder	355
Number of Images in Testing Folder	59

Table 2.3 - Training Configuration

Performance and Accuracy Testing

The performance will be determined by adding a code that will measure the time for the AI to make detections from input to output.

The UAT was done to determine if the system works on its own on an uncontrolled environment. The testing was done on 50 respondents, 25 of which are random students from high school and 25 teachers. After this, the systematic accuracy was then done where the proponents asked random people to write a sample of a character. Each character then must accumulate total samples. The computation for the accuracy was determined by the use of the success rate formula (Maloney, 2018):

$$S = \frac{A_S}{A}$$

Figure 2.6 – Success Rate Formula

S = Success Rate

A_s = Successful Attempts

A = Total Attempts

According to Nielsen (2001), the success rate is a simple usability metric where testing can be done in a small quantities rather than huge quantities, albeit this must be done as frequent as possible. The reason for this is for the developers and engineers to be able to identify and fix a problem as soon as it is raised.

The test was done in a room with a 87 lux window lighting and 13 lux ambient overhead lighting with a distance of about 40 inches away from the camera with an variation allowance of 3 inches, this was done to ensure minimal environmental differences between attempts.

Roles and Responsibilities

There are five proponents in this project. Each of the general tasks are to be performed by the following:

Name of the Proponent	**Roles and Responsibilities**
Francis Bert Dolot	Documentation and Data Gathering
Jose Miguel Escalona	AI Testing and Development, System Development
Lorenzo Ian Pajantoy	Tester and GUI Designer
Dean Andre Reyes	Documentation and Data Gathering
Geoff Aaron Topacio	System Quality Assurance and GUI Development

Table 2.4 - Roles and Responsibilities

The table shows the tasks which are distributed to each member. Each member is tasked to do the following tasks in order to finish the paper accordingly.

DATA AND TESTING

This part of the study contains the Data and Testing of the research which include the data collected, methods and results.

System Performance

The performance of the prototype system will be tested on three computer systems with varying specifications.

	System 1	**System 2**	**System 3**
CPU	Intel i3-2100	Intel i7-6700HQ	AMD Ryzen 3 1200
CPU Speed	3.1Ghz	2.8	3.1
CPU Cores	2	4	4
CPU Threads	4	8	4
RAM	4GB	16GB	12GB
GPU	N/A	Nvidia GTX 960M	Nvidia GTX 1050Ti
VRAM	N/A	4GB	4GB

Table 3.1 - System Specifications for Performance Testing

The performance testing was done with the following conditions:

1. The system was rebooted prior to the test
2. Latest OS updates are installed
3. All installed software versions are the same as stated in Appendix A.

Confidence Level

The confidence level of the system can be modified within the code. Initially the confidence level of the AI was set to filter 60% and below which simply means that anything that it is not confident enough will be discarded in the detections. Upon testing however, the value turned out to be erratic and continuously bringing out false detections along with the correct ones. The value was then set to 80%, this in turn reduced the erraticness of the AI in detecting and reduced the false detections to a minimum.

Public Demonstration

To determine the system's capability in detecting the predetermined set of characters, the researchers conducted a test wherein users were asked to write set of characters which will be used to test the system. The users consisted of 50 random persons, 25 of which are students from High School and another 25 coming from the faculty of Elizabeth Seton School-South.

Accuracy Testing

Determining the accuracy of the system requires the use of the success rate formula, the formula is as follows (Maloney, 2018):

$$S = \frac{A_s}{A}$$

Figure 3.1. - Success Rate Formula

S = Success Rate

A_s = Successful attempts

A = Total Attempts

This was done since the target of this test is to determine how frequent the system gets the trained characters correct. The test was done in 5 attempts per character that is included in the training for a total of 85 attempts. The testing material was gathered from random people who have been asked to copy the Baybayin characters instinctively but correctly as possible.

According to Nielsen (2001), the success rate is a simple usability metric where testing can be done in a small quantities rather than huge quantities, albeit this must be done as frequent as possible. The reason for this is for the creators to be able to identify and fix a problem as soon as it is risen.

The test was done in a room with a 87 lux window lighting and 13 lux ambient overhead lighting with a distance of about 40 inches away from the camera with an variation allowance of ± 3 inches, this was done to ensure minimal environmental differences between attempts.

RESULTS

Following the tests and surveys are the results below which are categorized according to their purpose.

Accuracy

Out of the 17 characters, 12 of the characters reached an accuracy of 80-100% which is more than the target 65% accuracy.

Letter/ Syllable	Attempts	Success Quantity	Rate	Accuracy
A	5	5	100.00%	Accurate
E/I	5	4	80.00%	Accurate
O/U	5	0	0.00%	Not Accurate
Ba	5	5	100.00%	Accurate
Da	5	4	80.00%	Accurate
Ga	5	4	80.00%	Accurate
Ha	5	5	100.00%	Accurate
Ka	5	5	100.00%	Accurate
La	5	3	60.00%	Not Accurate
Ma	5	5	100.00%	Accurate
Na	5	5	100.00%	Accurate
Pa	5	0	0.00%	Not Accurate
Ra	5	0	0.00%	Not Accurate
Sa	5	5	100.00%	Accurate
Ta	5	5	100.00%	Accurate
Wa	5	4	80.00%	Accurate
Ya	5	3	60.00%	Not Accurate

Table 4.1 - Individual Success Rates

It was determined that 5 characters were detected inaccurately, most of which are false detections. The following characters that it completely failed to detect correctly are O, Pa, and Ra. Some of the characters that are not considered to be accurate have a success rate.

Reasons for such misdetection are due to the possible noise included in the training data. These noises may include distance of the letter being too far, blurred images, improper handwriting and inconsistent angle.

Figure 4.1 - Training images with good accuracy

Figure 4.2 - Training images with bad accuracy

While the five aforementioned characters where not detected correctly or not completely detected at all during the test, it was detected on the preliminary testing during the development stage which means that it is also possible that the environment of the detection affects the detection of the characters.

As a whole, the entire system successfully detected 62 characters out of 85 characters which results to 72.94% accuracy.

Overall Total Attempts	**Overall Total Successful Attempts**	**Success Rate**
85	62	72.94%

Table 4.2 - Overall Accuracy

While the figure of accuracy is good for being a prototype system, it certainly needs improvement in comparison to other solutions as demonstrated by Jaderberg et. al. (2014) where their model achieved 99.2% accuracy of Latin character detection thus improvement is still needed.

Performance and Speed

The system performed its predictions at 0.17s or 170ms which is close to realtime, this is in part to model selected, camera resolution and the computer's specifications which accelerated by its GPU. While the detection part is fast, it can be determined that the starting loading speed of the AI is quite slow since the neural network of the AI has to be prepared first before the system can be used, currently there are no possible fixes for this with the current state of technology when the research was conducted.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

To conclude, the researchers compounded the following in relation to the statement of the problem:

1. The translator produced an accuracy of 72.94% which can still be improved.
2. The system detects and translates the characters with a delay of 0.17 seconds which is near real-time, albeit it depends greatly on the system hardware specification.
3. It is possible to create a Baybayin Translator that utilizes artificial intelligence.

As the technology improves, eventually this system will be more portable, functional, accurate and faster than its current state.

Recommendations

Following all development and testing, the researchers recommend to further research with regards to the system's improvement in terms of performance and accuracy. Along with this recommendation, it can be said that as technology improves, the system may eventually be completed with better performance, accuracy and even portability.

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APPENDIX A: FINAL DEVELOPMENT AND RUNTIME PLATFORM

The contents of this appendix are the detailed list of software and hardware used in the development, training and runtime of this project.

Software:

Type	Software/SDK/API/Library	Version
Integrated Development Environment	Eclipse Java; Download Link: https://www.eclipse.org/downloads/packages/release/neon/3/eclipse-ide-java-developers	2018.x; can be higher than 2018
Software Development Environment	JDK SE Download Link: https://www.oracle.com/technetwork/java/javase/downloads/jdk8-downloads-2133151.html Note: End of Public Updates: January 2019 (Java SE. (n.d.). Retrieved from https://www.oracle.com/technetwork/java/javase/overview/index.html & Kril, P. (2018). Oracle sets date for end of Java 8 updates. Retrieved from https://www.infoworld.com/article/3269332/oracle-sets-date-for-end-of-java-8-updates.html)	1.8.0_192
Computer Vision API	OpenCV (Windows) Download Link: https://opencv.org/releases.html	4.0.1 (x64)
Machine Learning API	TensorFlow (Java) Download Link: https://www.tensorflow.org/install/lang_java	1.12.0

List of software used in Development

Type	Version	File
Java Runtime Environment	Java JRE 1.8.0_201 (x64)	Included at the installation of JDK Otherwise, download here https://www.oracle.com/technetwork/java/javase/downloads/jre8-downloads-2133155.html
OpenCV Dynamic Link Library (DLL) x64	OpenCV 4.0.1	opencv_java401.dll File size: 44.9MB
TensorFlow Dynamic Link Library (DLL) x64-CPU	TensorFlow 1.12.0	tensorflow_jni.dll File size: 58.1MB

List of software to be used in Runtime

Note: The dynamic link library files must be place in the System32 folder of Windows (C:\Windows\System32).

Type	Software/SDK/API/Library/Repositories	Version
Computer Vision API	OpenCV (Windows) Download Link: https://opencv.org/releases.html	4.0.1 (x64)
Machine Learning API	TensorFlow (Java) Download Link: https://www.tensorflow.org/install/lang_java	1.12.0
Python	Python x86-64 Download Link: https://www.python.org/downloads/release/python-367/ Packages/Modules (to be installed by pip installer): tensorflow-gpu==1.12.0 pillow lxml cython jupyer matplotlib Pandas opencv-python	3.6.7
Tensorflow Models	TensorFlow Models Repository Source: https://github.com/tensorflow/models	N/A
Model Files	Pre-trained model files Source: https://github.com/tensorflow/models/blob/master/research/object_detection/g3doc/detection_model_zoo.md	N/A
Protobuf	Protobuf compiler Source: https://github.com/protocolbuffers/protobuf/releases/tag/v3.7.0	3.7
Tensor Object Detection	TensorFlow Object Detection Repository https://github.com/EdjeElectronics/TensorFlow-Object-Detection-API-Tutorial-Train-Multiple-Objects-Windows-10	N/A

List of software used in AI Training (CPU & GPU)

Type	Software/SDK/API/Library	Version
CUDA Toolkit	CUDA Toolkit Download Link: https://developer.nvidia.com/cuda-90-download-archive File Size: 1.4GB	9.0.176 (Windows 10)
CUDA Profiling Tools Interface (CUPTI)	Included in the toolkit	N/A

cuDNN SDK	cuDNN Download Link: https://developer.nvidia.com/cudnn Note: Nvidia Developer Membership is required, though it is free.	7.4.1.5

List of additional software used in AI Training (GPU)

Type	Software/SDK/API/Library	Version	Notes
Image Annotator	LabelImg Source: https://github.com/tzutalin/labelImg	Windows 1.8.1	Used for annotating images Version 1.8.0 has YOLO annotating support
Image Resizing and Compressing	Caesium Image Compressor https://saerasoft.com/caesium/	1.7.0	Image file size and resolution reduction

Miscellaneous software used

All of the scripts/code below are either self-written or are sourced from the following sources/repositories:

- https://github.com/EdjeElectronics/TensorFlow-Object-Detection-API-Tutorial-Train-Multiple-Objects-Windows-10
- https://github.com/tensorflow/models
- https://stackoverflow.com/questions/11270453/how-to-remove-spaces-from-file-names-in-bulk
- https://github.com/kalaspuffar/rcnn-model-test/blob/master/src/main/java/org/ea/waldo/RunInference.java

Script/Code	Purpose	Notes
update_image_xml_csv_record.bat	Updates XML, CSV and TFrecord files of Images	Batch script
train.py	Initiates training process	Python script
generate_tfrecord.py	Converts .csv to .record files used for training	Python script; executed by update_image_xml_csv_record.bat
Object_detection_webcam.py	Runs camera with the trained model	Python script
xml_to_csv.py	Converts xml created by labelImg	Python script; executed by update_image_xml_csv_record.bat
RunInference.java	Inferencing Image	Java file

List of scripts/code used in AI Training and Runtime

Hardware:

Component	System 1	System 2 (Used for Training)	Component	System 1	System 2 (Used for Training)
CPU	i3-2100	Ryzen 3 1200	**GPU Cores**	N/A	768
CPU Release Date	2011	2017	**GPU Frequency**	850 MHz	1290

CPU Frequency	3100Mhz	3100Mhz	**GPU RAM Capacity**	N/A	4GB
CPU Cores	2	4	**Python version**	3.6.7	3.6.7
CPU Thread	4	4	**OS**	Windows 10 (x64)	Windows 10 (x64)
RAM Capacity	4GB	12GB			
GPU	Intel® HD Graphics 2000	GTX 1050Ti			
GPU Release Date	2011	2016			

Table G.6: Detailed specifications of the computers used for AI Training

Component	**Developer System**	**Component**	**Developer System**
CPU	Ryzen 3 1200	**GPU**	GTX 1050Ti
CPU Release Date	2017	**GPU Release Date**	2016
CPU Frequency	3100Mhz	**GPU Cores**	768
CPU Cores	4	**GPU Frequency**	1290
CPU Thread	4	**GPU RAM Capacity**	4GB
RAM Capacity	12GB	**OS**	Windows 10 (x64)

Table G.7: System Specifications used in software development

Component	**Specification**
Brand	Mikuso
Model	WC-MS-001-M
Resolution (MP)	1.3 MP
Resolution (Pixel)	640x480
Frame rate (FPS)	30

Table G.8: Camera Specifications used in Development

Type	Configuration
Pre-trained model	Faster R-CNN Inception v2 COCO
Image Size	196px (Minimum), 1024px (Maximum)
No. of Classes	17

Table G.9: AI Training Configuration

APPENDIX B: ADDITIONAL TECHNICAL INFORMATION AND ISSUES FOUND DURING DEVELOPMENT, TRAINING AND TESTING

A. Why CUDA Toolkit 9.0?

a. **Key Solution:** Use CUDA Toolkit 9.0
b. **Problem/Error:** Not working at CUDA Toolkit 10.0
c. **Error occurrence:** Issue occurred at Appendix F
d. **Reason:** "**TensorFlow officially supports CUDA 9.0.** However it is **compatible with CUDA 10.0 but not supported currently**. For using TF with cuda 10, you have to build it from sources yourself. You can also take a look at installations done by another users to make it work." -Github user: ymodak
e. **Source:** https://github.com/tensorflow/tensorflow/issues/22872 by ymodak

B. Why numpy 1.16.2?

a. **Error:** ModuleNotFoundError: No module named 'numpy.core._multiarray_umath'
b. **Error occurrence:** Issue occurred at Appendix F
c. **Key Solution:** Replace numpy with specific version (numpy 1.16.2)
d. **Notes:** numpy v1.15 and above must work
e. **Source:** https://github.com/alpacahq/pylivetrader/issues/73 by wishvivek

C. System must have msvcp140.dll at runtime

a. **Notes:** Required by TensorFlow library at runtime
b. **Locate:** "C:/Windows/System32/mvscp140.dll" if it exists, if not then refer to Key Solution
c. **Key Solution:** Download and Install https://www.microsoft.com/en-us/download/details.aspx?id=48145
d. **Source:** https://www.tensorflow.org/install/lang_java#run

D. CPU with AVX (Advanced Vector Extensions) instruction set possibly required to run

a. **Error:** Exception in thread "main" java.lang.UnsatisfiedLinkError: Cannot find TensorFlow native library for OS: windows, architecture: x86_64.
b. **Error occurrence:** At runtime
c. **Key Solution:** Limit Application Compatibility to CPUs with AVX Instruction Set
d. **Notes:** The test was done on systems of five different CPUs.
e. **Testing:** The test conducted was based from an installation guide of TensorFlow for Java

	CPU 1	**CPU 2**	**CPU 3**	**CPU 4**
Brand/Model/Variant	Intel/Core 2 Duo/E7300	Intel/i3/2100	AMD/Ryzen 3/1200	Intel/i7/6700HQ
Year of Production	2008	2011	2017	2015
Support for AVX	No	Yes	Yes	Yes
Support for AVX 2	No	Yes	Yes	Yes

However a possible isolated case occurred on the system with CPU 4 where the issue still occurred, but it was determined that msvcp140.dll may have been non-existent in Windows which is required by TensorFlow to run.

E. Source:

a. https://github.com/tensorflow/tensorflow/issues/20563
b. https://github.com/tensorflow/tensorflow/issues/19584
c. https://github.com/tensorflow/tensorflow/issues/18530
d. https://www.tensorflow.org/install/lang_java

F. Fix for possible error in generate_tfrecord.py

a. Error occurrence: Whenever launched
b. Fix: In the end of the if-else statements at the else portion, change "return None" to "return 0" as the value requests for an integer instead of a statement.

G. object_detection_webcam.py returns N/A as interpretation:

a. **Fix:** Update number of classes in relation to the number of classes
b. **Source:** https://github.com/EdjeElectronics/TensorFlow-Object-Detection-API-Tutorial-Train-Multiple-Objects-Windows-10/issues/46

APPENDIX C: BAYBAYIN AI - DEVELOPMENT REPORT

- **Current Version:** 0.11.10
- **Date Created:** March 20, 2019
- **Features:**
    - Camera Integration via Python Co-execution
    - TensorFlow in Python and Java
- **Installation Requirements:**
    - Executable Jar File
    - Python (pip installed modules)
        - tensorflow-gpu (v1.12.0)
        - pandas
        - pillow
        - lxml
        - cython
        - jupyter
        - matplotlib
        - pandas
        - Opencv-python
    - JDK or JRE 1.8
    - CuDNN
    - CUDA Development Kit
    - **Runtime Files:**
        - **Notes:**
            - To be located at C:\
            - Strictly follow this since files are needed to run
        - Some files are from the training folder (D:\tensorflow1\models\research\object_detection\inference_graph)
        - **File Structure:**
            - C:
                - Baybayin
                    - __pycache__
                    - assets
                        - cameramode_load.jpg
                        - cameramode.jpg
                    - export
                        - saved_model
                        - checkpoint
                    - training
                    - utils
                    - camera
                    - frozen_inference_graph.pb
                    - label_map_util.py
                    - labelmap.pbtxt
                    - run.bat
                    - saved_model.pb
                    - visualization_utils.py
- **Software & Hardware Limitations/Specifications:**
    - Requires a Nvidia GPU to run efficiently
    - Requires 4GB RAM
    - It can run on CPU but not on Camera Mode
    - JAR file size: 2.06MB
    - Runtime files (Baybayin folder): 100MB (as of 3-17-19)

- **AI Limitations:**
    - (as of 3/17/19)
        - Inaccurate detections due to the following:
        - Lighting
        - Insufficient training data
        - Background
        - Distance
    - Camera must be positioned at least 1 foot from the sample
    - Image must be captured at least 1 foot from the sample

From developer's point of view

System Related Recommendations:

1. Improve program efficiency
2. Improve GUI design and responsiveness to be more user friendly
3. Embed assets and other related files within the app or a predetermined directory upon applications installation thru a proper installer
4. Implement this in a mobile version, thus a use of a server is also suggested to conduct inferencing which is similar to the way Google Translate is implemented aside from local inferencing to improve performance, efficiency and accuracy.
5. Use other programming languages apart from Java for increased API support:
    a. Languages currently supported by TensorFlow:
        i. Android Java (most recommended for mobile due to extensive API support)
        ii. Java
        iii. Swift
        iv. Go
        v. Haskell
        vi. Javascript
        vii. C++
        viii. Python (most recommended due to extensive API support)
    b. Source: https://www.tensorflow.org/api_docs
6. AI Related Recommendations:
    a. Train on a system with higher specifications
        i. Possible solutions:
            1. Use of a server with more CPU cores, more RAM and/or better GPU
            2. Use of a TPU (Tensor Processing Unit) as a training accelerator
            3. Use of a cloud service for training for increased performance and reliability
            4. Reason: Due to RAM (CPU) and VRAM (GPU) usage during training resulting to slow training or eventual crashing
    b. Use more datasets with the following parameters
        i. Different lighting
        ii. Diverse fonts/handwritings
        iii. Note: Characters must be strictly upright since it is a reading character
7. Baybayin Recommendations:
    a. Ensure that the data used was academically accepted set of Baybayin Symbols
    b. Include more Baybayin Symbols (Modern Baybayin)

APPENDIX D: BEST TRAINING RESULT

Component	Value
Total Training Steps	67,716
Classification Loss (BoxClassifierLoss)	0.1640
Localization Loss (BoxClassifierLoss)	0.1072
Total Loss	0.3128

Training Results

APPENDIX E: SURVEY TALLY AND COMPUTATION

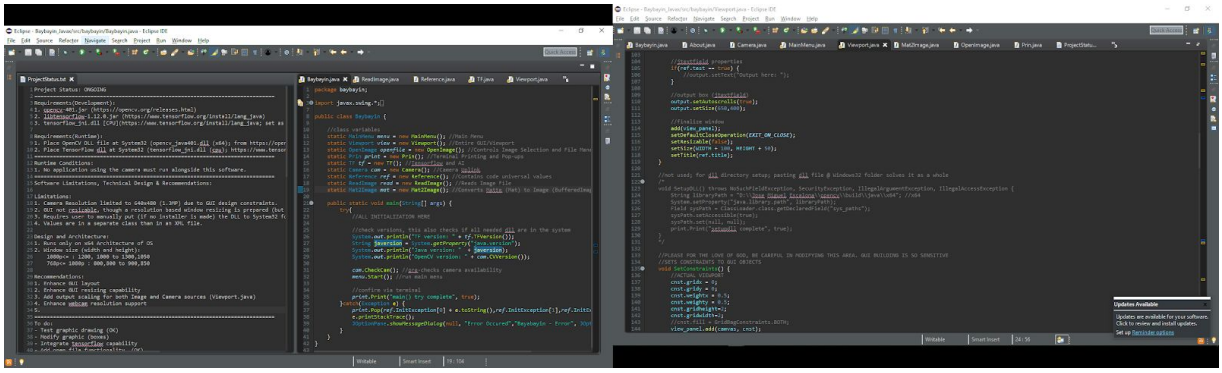
Respondent	Percent	Q1	Q2	Q3	Q4	Q5	Q6	Q7
1	99	3	3	2	3	3	4	5
2	99	4	4	3	4	4	4	3
3	99	5	5	5	5	5	5	5
4	0	2	4	4	3	5	4	4
5	98	4	4	5	3	5	5	5
6	90	5	5	5	5	5	5	5
7	95	5	5	5	5	5	5	5
8	80	4	5	5	5	5	5	5
9	95	5	4	5	4	5	4	5
10	98	5	5	5	5	5	5	5
11	99	4	5	4	5	5	5	5
12	99	5	5	4	4	5	5	4
13	99	5	5	5	5	5	5	5
14	80	4	4	5	3	4	4	4
15	98	4	5	3	4	3	3	3
16	80	4	4	4	4	4	3	5
17	90	5	5	5	5	5	5	5
18	99	5	5	5	5	5	5	5
19	99	5	5	5	5	5	5	5
20	80	4	4	3	4	4	5	5
21	90	5	5	4	4	4	4	5
22	0	4	4	3	4	3	4	4
23	0	4	4	4	4	4	4	4
24	90	5	5	5	5	5	5	5
25	78	4	4	4	3	3	4	4
26	99	5	5	4	5	4	5	5
27	97	5	5	5	4	5	5	5
28	98	5	5	4	4	5	5	5
29	97	5	5	5	4	5	5	5
30	0	3	3	4	4	3	3	4
31	91	5	5	5	5	5	5	5
32	0	2	2	2	2	2	2	2
33	96	5	5	5	5	5	5	5
34	98	5	5	5	5	5	5	5
35	98	4	5	4	5	3	4	4
36	89	5	4	5	5	5	5	4
37	79	3	4	3	3	4	3	4
38	90	5	5	5	5	5	5	5

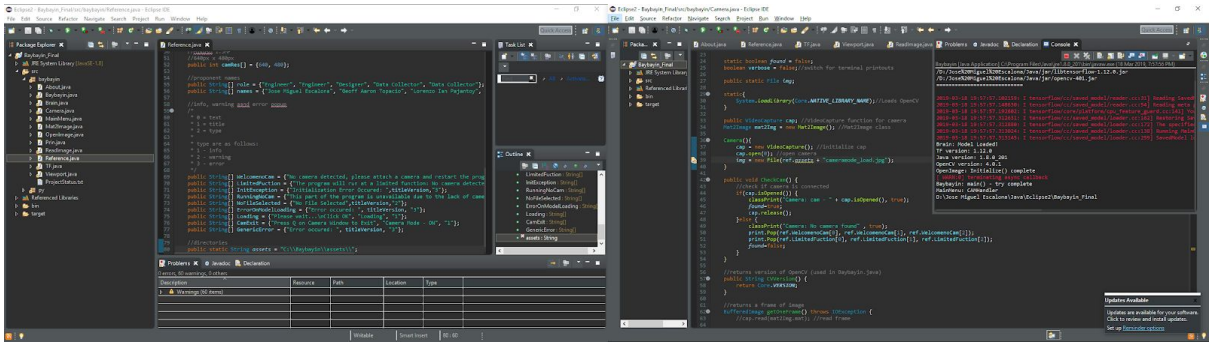
39	70	5	5	5	5	5	5	5
40	97	5	5	5	5	5	5	5
41	0	5	5	5	5	5	5	5
42	85	5	5	5	5	5	5	5
43	0	5	5	5	5	5	5	5
44	0	5	5	5	5	5	4	5
45	99	5	4	5	5	5	4	4
46	88	5	5	5	5	5	5	5
47	99	5	5	4	5	4	4	5
48	99	5	5	5	5	5	5	5
49	90	5	5	5	5	5	5	5
50	95	5	5	5	5	5	5	5
MEAN		4.52	4.6	4.44	4.44	4.52	4.52	4.64

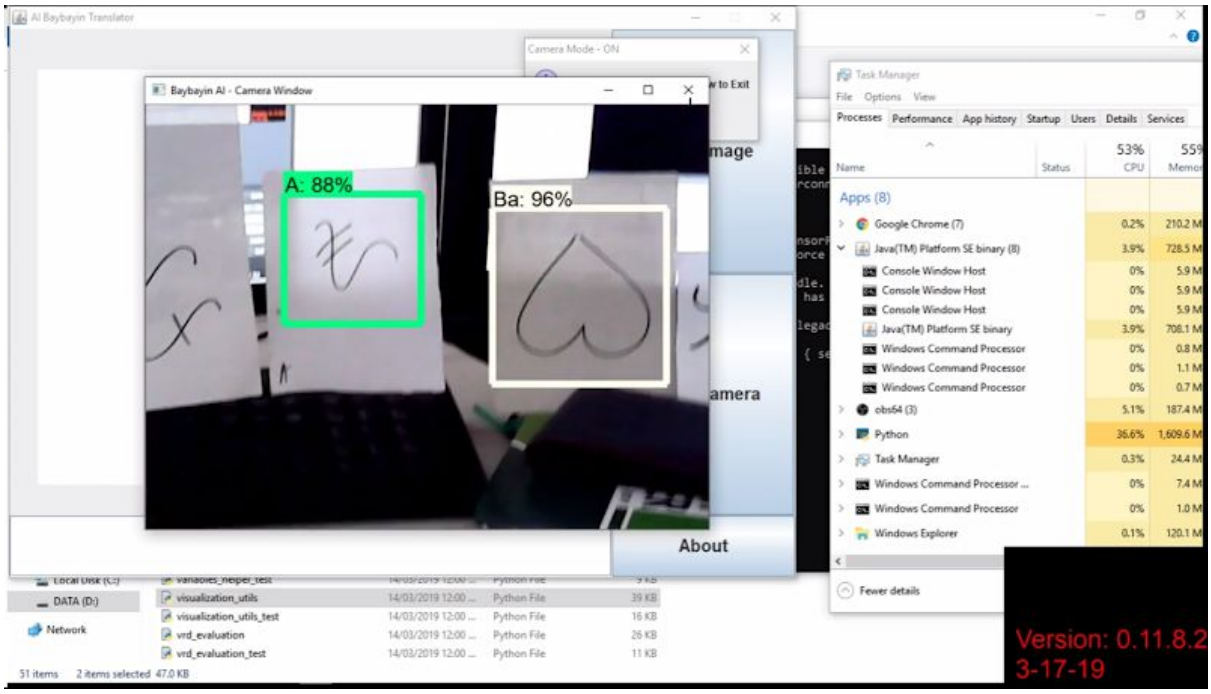
APPENDIX F: ACCURACY TEST

Letter	Attempts	1	2	3	4	5	Success Quantity	Rate	Accuracy
A	5	1	1	1	1	1	5	100.00%	Accurate
E/I	5	0	1	1	1	1	4	80.00%	Accurate
O/U	5	0	0	0	0	0	0	0.00%	Not Accurate
Ba	5	1	1	1	1	1	5	100.00%	Accurate
Da	5	1	1	1	0	1	4	80.00%	Accurate
Ka	5	1	1	1	1	1	5	100.00%	Accurate
La	5	0	1	1	0	1	3	60.00%	Not Accurate
Ma	5	1	1	1	1	1	5	100.00%	Accurate
Na	5	1	1	1	1	1	5	100.00%	Accurate
Pa	5	0	0	0	0	0	0	0.00%	Not Accurate
Sa	5	1	1	1	1	1	5	100.00%	Accurate
Ta	5	1	1	1	1	1	5	100.00%	Accurate
Wa	5	1	1	1	1	0	4	80.00%	Accurate
Ya	5	1	0	0	1	1	3	60.00%	Not Accurate
Ga	5	1	1	1	0	1	4	80.00%	Accurate
Ha	5	1	1	1	1	1	5	100.00%	Accurate
Ra	5	0	0	0	0	0	0	0.00%	Not Accurate

APPENDIX G: DEVELOPMENT AND RUNTIME SCREENSHOTS

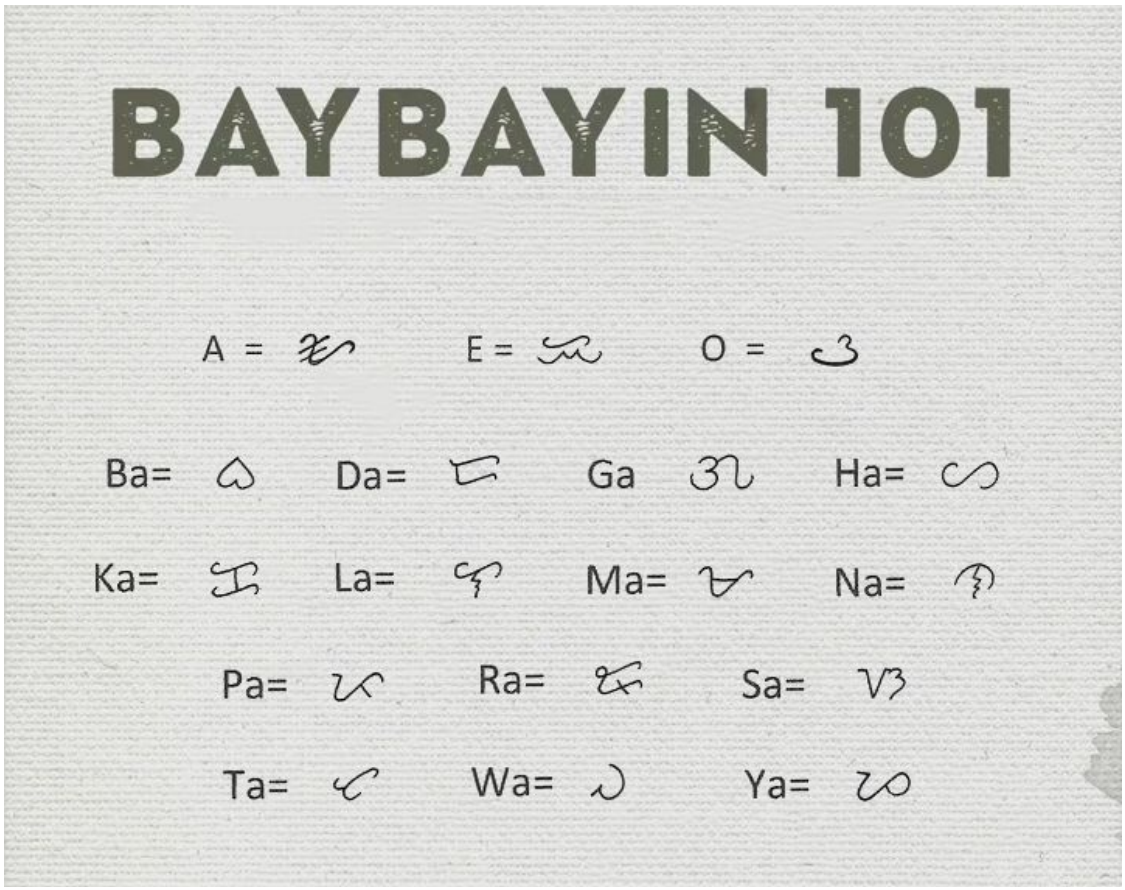






APPENDIX H: TABLE OF BAYBAYIN CHARACTERS

The following are the reference characters used in training the AI.



CURRICULUM VITAE

Francis Bert L. Dolot

Blk 9 Lot 14 Aston Martin Street,

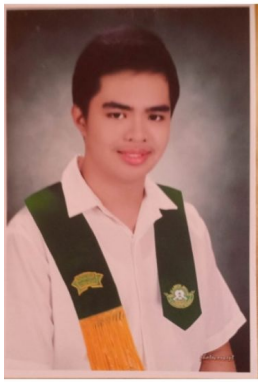
Citihomes Grand Plaza,

Anabu II-A,

Imus City, Cavite

09054576955

dolot.francis@ess.edu.ph



Personal Information

Age: 17

Civil Status: Single

Nationality: Filipino

Religion: Catholic

Language: Filipino & English

Gender: Male

Positions Held

N/A

Education Attainment

Elizabeth Seton School-South – Grade 11 Senior High School(2017 - Present)

Elizabeth Seton School-South – Grade 7-10 Junior High School(2013 -2017)

Elizabeth Seton School-South – Grade 4-6 Elementary(2010 - 2013)

Casa De San Miguel Montessori – Grade 3 Elementary(2009 - 2010)

Seiko Grandioso Montessori – Grade 2 Elementary(2008 - 2009)

Asiana Italia Montessori – Grade 1 Elementary(2007- 2008)

Mabolo Elementary School – Preschool(2004 - 2007)

Award Received

3rd Philippine Robothon: Expert Category – participant(2014)

Professional Organization

House of St. John XXIII – Member

The Climax – Member

Seminars Attended

Elizabeth Seton School - South: Career Week(2017)

Hour of Code(2016)

Seminars Conducted

Hour of Code(2016)

Action Research Conducted

Evaluation in the knowledge of Microsoft Powerpoint of the Senior High School Students of Elizabeth Seton School - South(2018)

The Impact of Social Media on the Political Stances of JHS Students from Grades IX-X (2017)

Jose Miguel A. Escalona

Blk 8 Lt 12 Campanilla St.

Area-D Parkplace Village,

Anabu I-D,

Imus City, Cavite

09275865581

escalonaschool@gmail.com

Personal Information

Age: 18 years old

Civil Status: Single

Nationality: Filipino

Religion: Roman Catholic

Language: English & Filipino

Gender: Male

Experience or Technical Skills

- Programming Languages: Java, C++, C#
- Computer troubleshooting and maintenance
- PC Assembly/Building

Positions Held

Film Editor – Philosophical Film Festival Entry: Excess (2019)

Film Editor – Only I (2018)

Auditorium Technical Director – 10-Noveleta: Les Miserable Play (2017)

Finance Manager – 10-Noveleta: Business Simulation (3rd Term, 2017)

Finance Manager – 10-Noveleta: Business Simulation (2nd Term, 2016)

Finance Manager – 10-Noveleta: Business Simulation (1st Term, 2016)

Educational Attainment

Elizabeth Seton School-South – Grade 12: Senior High School (2018-2019)

Elizabeth Seton School-South – Grade 11: Senior High School (2017-2018)

Elizabeth Seton School-South – Grade 7-10: Junior High School (2013-2017)

Elizabeth Seton School-South – Grade 1-6: Elementary (2007-2013)

Casa Real Montessori – Preparatory (2006-2007)

Statefields School – Nursery-Kinder (2004-2006)

Awards received

Participation in MCL Cup – Photoshop Competition (2017)

Participation in DISCS Programming Competition – Ateneo University Diliman (2017)

Professional Organization

House of St. Paul - Member

SiningGang Club - Member

Seminars Attended

ESS-South: Career Week (2017)

Hour of Code (2016)

Seminars Conducted

Hour of Code (2016)

Action Research Conducted

Evaluation in the knowledge of Microsoft PowerPoint of the Senior High School Students of Elizabeth Seton School – South (2018)

Allowance received by grade 10 students and their ability to save (2017)

Lorenzo Ian A. Pajantoy

B8 L24, Dao Street,

Villa Luisa Homes,

Dasmarinas Cavite

0927-501-9688

lorenzopajantoy@gmail.com

Personal Information

Age: 18 years old

Civil Status: Single

Nationality: Filipino

Religion: Roman Catholic

Language: English & Filipino

Gender: Male

Positions Held

● House of St. Peter	Member
● Robothon Team	Builder
● Seton Notes	Editorial
● Sining Gang (Arts, Music, Design Club)	Editor

Educational Attainment

Senior High School (Grade 11 – 12): Elizabeth Seton School – South (S.Y. 2017 - 2019)

- Competed at the Malayan Digital Poster Making (Grade 11)

Junior High School (Grade 7 – 10): Elizabeth Seton School – South (S.Y. 2013 - 2017)

- 1st runner up Table Tennis Singles A (Grade 7)
- Competed on Robothon (Robotics Competition) at San Beda (Grade 8)
- Competed on Robothon (Robotics Competition) at La Salle Laguna (Grade 9)
- Champion at Robotics (Sumo Bot) Intramurals (Grade 10)
- Saint Peter Intramurals Team Captain (Grade 10)

Primary Education (Grade 1 – 6): Vel Maris School (S.Y. 2007 – 2009)/ Elizabeth Seton School – South (S.Y. 2009 – 2013)

- Attended the gathering of scouts held by Imus Pilot (Grade 4)
- Joined the CCP performance (Grade 4)
- Performed "Sabayang Pagbigkas" (Grade 6)

Preschool (Nursery – Preparatory): Sta. Belina Learning School / Vel Maris School (S.Y. 2004 - 2007)

Awards received

Participation in MCL Cup – Photoshop Competition (2017)

4th Philippine Robothon – Participation, October 24, 2015

5th Philippine Robothon – Participation, October 2015

Professional Organization

House of St. Peter - Member

SiningGang Club - Member

Seminars Attended

- Anti- Bullying (2014) ESS- SOUTH Auditorium
- SHS Orientation (2015) ESS- SOUTH Auditorium
- Choices (Aug 2016) ESS- SOUTH Auditorium
- Alumni Symposium (July 2015) ESS- SOUTH Auditorium
- Team Building (Oct 10 2015) ESS- SOUTH Auditorium
- Career Week (Aug 2016) ESS- SOUTH Auditorium
- School Talk (September 6 2017)

Seminars Conducted

Hour of Code (2016)

Action Research Conducted

The Beneficial Effect of Utilizing Smartphones in the Classroom Among Grade 12 Students of Elizabeth Seton School Campuses (2018)

Dean Andre M. Reyes

Blk 8 Lot 12 Good Family Homes

Anabu 1-A Imus City, Cavite

(0935)-228-3868

deanreyes30@gmail.com

Personal Information

Age: 18 years old

Date of Birth: Dec 30, 2000

Gender: Male

Religion: Roman Catholic

Language/s Spoken: English & Filipino

Nationality: Filipino

Civil Status: Single

Educational Background

Senior High School (2017 - present)

Elizabeth Seton School - South (Grade 11 – Grade 12)

Anabu II-D Imus City, Cavite

Junior High School (2013-2017)

Elizabeth Seton School - South (Grade 7 - Grade 10)

Anabu II-D Imus City, Cavite

Grade School (2005-2012)

Jesus Good Shepherd School (Grade 1 – Grade 6)

Palico IV Imus City, Cavite

Pre-School (2004-2005)

Jesus Good Shepherd School (Junior Kinder – Senior Kinder)

Palico IV Imus City, Cavite

Pre-School (2003)

Day Care Center, Good Family Homes Anabu 1-A

Professional Organization

- JGSS Volleyball Varsity Member (2012)
- Basketball Club Member (2010 - 2012)
- The Climax Club Member (2017 - 2018)
- House of St. Paul Member (2013 - 2019)

Seminars Attended

Paths (July 2014) - ESS- South Auditorium
Anti- Bullying (August 2014) - ESS - South Auditorium
SHS Orientation (June 2015) - ESS - South Auditorium
Team Building (October 2015) - ESS - South Auditorium
Career Week (August 2016) - ESS - South Auditorium
Hour of Code (December 2016) - ESS - South Auditorium

Awards Received and Achievements

Grade 11 (2016- 2017)

Champion Volleyball Boys Intrams

Grade 10 (2016- 2017)

Off –Campus

Basketball 3rd Place Sports League (Subdivision)

In – Campus

Champion Volleyball Boys Intrams

Grade 9 (2015 – 2016)

Champion Volleyball Boys Intrams

Grade 8 (2014 – 2015)

Champion Volleyball Boys Intrams

Geoff Aaron C. Topacio

Blk 6 Lt 4 Hausland Subdivision,

Anabu 1-B,

Imus City, Cavite

09239120893

topacio.geoff@ess.edu.ph

Personal Information

Age: 18 years old

Civil Status: Single

Nationality: Filipino

Religion: Roman Catholic

Language: English & Filipino

Gender: Male

Positions Held

Sining Gang - Member

House of St. John XXIII - Member

Educational Attainment

Elizabeth Seton School-South – Grade 12: Senior High School (2018-2019)

Elizabeth Seton School-South – Grade 11: Senior High School (2017-2018)

Elizabeth Seton School-South – Grade 7-10: Junior High School (2013-2017)

Elizabeth Seton School-South – Grade 2-6: Elementary (2008-2013)

Cavite School of St. Mark - Grade 1: Elementary (2007-2008)

Logic Gestalt Integrated Learning School – Kindergarten - Preparatory (2005-2007)

Joy Learning School – Nursery (2004-2005)

Awards received

Bronze Medalist (Grade 11, 2017 - 2018)

MCL Gastronomic Challenge (Participation) – September 13, 2017

Silver Medalist (Grade 10, 2016 - 2017)

Best in Computer (Grade 10, 2016 - 2017)

DISCS Programming Opening (Participation) – February 2017

DLSU Spark 2016 – 3rd Place, April 8, 2016

DISCS Programming Open (Participation) – February 2016

CAL 2015 Battle of ICT Wizards (Nationals) – Participation, February 12, 2016

CAL 2015 Battle of ICT Wizards (Regionals) – 2nd Place, January 3, 2016

4th Philippine Robothon – Participation, October 24, 2015

UP Circle of Entrepreneurs Young Entrepreneurs Convention: Enable – Participation, October 10, 2015

Professional Organization

House of St. John XXIII - Member

SiningGang Club - Member

Imus Youth - City IT Officer

Seminars Attended

ESS-South: Career Week (2017)

Hour of Code (2016)

IYLDP (2016)

SPARK (2016)

UP Circle of Entrepreneurs Young Entrepreneurs Convention: Enable – October 10, 2015

Seminars Conducted

Hour of Code (2016)

Action Research Conducted

The Usability of Different Smartphones According to its Users (2019)

Evaluation in the knowledge of Microsoft PowerPoint of the Senior High School Students of Elizabeth Seton School – South (2018)

Effectiveness of Different Teaching Styles in Teaching Mathematics 9 in Elizabeth Seton School - South S.Y. 2016-2017 (2017)