ARABIC CHARACTER RECOGNITION USING SPIKING NEURAL NETWORK

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ARABIC CHARACTER RECOGNITION USING SPIKING NEURAL NETWORK

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

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DEDICATION

Specially dedicated to,

My beloved father Mohd Said Bin Abdul

Wahab,

My Family and Friends,

&

Supervisor Encik Muhammad Raihan Bin Kamarudin

ABSTRACT

Spiking Neural Network is a new generation which is the third generation of architecture neural network. This network is based on a biological mechanism that encodes the information using a pulse or spike. It has advantages in terms of training speed compared to the previous generation. This project uses a handwriting Arabic character dataset that has 28 characters. There are challenges because the handwriting Arabic character does not have many datasets, which is difficult to train. The size is not the same, and it is also different from other characters because of Arabic writing in cursive. When written, it will have many different writing styles, even if it is the same letter. Therefore, this project will increase the dataset using the augmentation process and enhanced pre-process to resize so that all sizes are the same and spiking neural networks can apply. Next, this project will validate the accuracy and compare it with another neural network model that uses a handwritten Arabic dataset. So, on this project, BindsNET will be use as the main framework, and then it will use PyCharm software to run this project. Handwritten Arabic dataset from Kaggle will be used to train Arabic characters. In conclusion, at the last of this project spiking neural network can be applied for Arabic character recognition.

ABSTRAK

Rangkaian Neural Spiking ialah generasi baharu yang merupakan generasi ketiga rangkaian neural seni bina. Rangkaian ini adalah berdasarkan mekanisme biologi yang mengekod maklumat menggunakan nadi atau spike. Ia mempunyai kelebihan dari segi kepantasan latihan berbanding generasi sebelumnya. Projek ini menggunakan set data aksara Arab tulisan tangan yang mempunyai 28 aksara. Tulisan Tangan Arab tidak mempunyai banyak set data, yang sukar untuk dilatih. Saiznya tidak sama, dan ia juga berbeza dengan aksara lain kerana tulisan Arab dalam huruf kursif. Apabila ditulis, ia akan mempunyai banyak gaya penulisan yang berbeza, walaupun ia adalah huruf yang sama. Oleh itu, projek ini akan meningkatkan set data menggunakan proses pembesaran dan pra-proses yang dipertingkatkan untuk mengubah saiz supaya semua saiz adalah sama dan rangkaian neural spiking boleh digunakan. Seterusnya, projek ini akan mengesahkan ketepatan dan dibandingkan dengan model rangkaian saraf lain yang menggunakan set data Arab tulisan tangan. Jadi, pada projek ini, BindsNET akan digunakan sebagai rangka kerja utama, dan ia akan menggunakan PyCharm software untuk menjalankan projek ini. Set data Arab tulisan tangan daripada Kaggle akan digunakan. Kesimpulannya, pada akhir projek ini rangkaian neural spiking boleh digunakan untuk pengiktirafan aksara Arab.

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LIST OF SYMBOLS AND ABBREVIATIONS

SNN	:	Spiking Neural Network
CNN	:	Convolution Neural Network
ANN	:	Artificial Neural Network
STDP	:	Spike-Timing-Dependent Plasticity
ACR	:	Arabic Character Recognition
LIF	:	Leaky Integrate Fire

CHAPTER 1

INTRODUCTION

1.1 Background Research

Spiking Neural Network is well known that biological neurons generate pulses or spikes to encode information. Biological neurons also retain information in the timing of spikes. According to studies on Spiking Neural Networks, the third generation of neural networks uses spikes to indicate information flow, just like their biological counterparts. Such techniques improve the realism of the neural stimulation and the invocation of the time notion. It has been established that pulse coding can significantly improve image recognition speed.

The character recognition technique automatically categorizes a batch of text documents into multiple categories based on a predetermined group structure. Character recognition is a very significant and rapidly increasing academic subject because there are many text documents available online that are expanding every day.

Many individuals from different nations utilize the Arabic alphabet. It would be excellent if Arabic character recognition could transform a large number of papers into a digital format that could be consulted electronically. From Table 1.1, there are the Arabic alphabet characters consist of twenty-eight alphabet characters.

Table 1.1 Arabic Alphabet Characters

ا	Alif	ز	Zai	ق	Kof
ب	Baa	س	Sin	ك	Kaff
ت	Taa	ش	Shin	ل	Lam
ث	Tha	ص	Sod	م	Mim
ج	Jim	ض	Dod	ن	Nun
ح	Haa	ط	Tow	ه	haaa
خ	Kha	ظ	Zow	و	Wau
د	Dal	ع	Ain	ي	Yaa
ذ	Zal	غ	Ghen		
ر	Raa	ف	Faa		

'Izhikevich' has established a comparison analysis of 11 spiking neuron models regarding biological accuracy and computational load. He categorized the models by biological accuracy and demonstrated the first five most biologically accurate models.[1]

For this project, Spiking Neural Networks (SNNs) are introduced to recognize more easily on Arabic character. The reason for selecting this network is because it brings new learning algorithms for unsupervised learning. SNNs are also considered more suited for data processing jobs involving temporal data since the neurons that make up SNNs naturally synthesize their inputs across time. Furthermore, their binary spiking or no spiking operations align well on hardware simulation that is quick and energy-efficient.

Even though Spiking Neural Networks are not commonly utilized as machine learning systems, new research indicates that they have the potential to be. Unsupervised learning rules are frequently used to train SNNs to learn a usable representation of a dataset, then used as a feature in supervised learning methods. Lastly, a new Python module has been introduced for simulating spiking neural networks, focusing on machine learning and reinforcement learning. BindsNET software, which has a user-friendly, simple syntax, enables spiking networks' fast construction and modeling.[2]

1.2 Objective

1. To expand the Arabic dataset using the augmentation process and apply the data using reservoir spiking data.
2. To modify the existing model using multireservoir with the combination of the original image and augmented image.
3. To validate the accuracy of the modified model on the different number of classes.

1.3 Scope of Work

The only goal of this project is to determine the accuracy of the original shape Arabic character. The current Arabic character dataset is not directly usable with the BindsNET package. First, the image in the dataset does not have the same dimensions as the MNIST dataset. As a result, it should be resized to regular size. Physically modifying the image may change its pixel structure. However, this will affect the recognition process. Run the Arabic dataset using several models provided in

BindsNET using PyCharm software. Next, the dataset of Arabic has fewer images than the MNIST dataset. So, it is important to expand the dataset, such as by data augmentation.

1.4 Problem Statement

- The cursive nature of Arabic writing which does not allow direct application of many algorithms created for other languages.
- Unavailability of sources such as Arabic text dataset makes more difficult to develop Arabic characters recognition systems.
- The unevenness of Arabic font, certain letter in a specific font can be misinterpreted as a different letter in another font.

1.5 Significance of the project

The project's goal is to educate the scientific community about Spiking Neural Networks. Researchers working in machine learning who are interested in biomimetic neural algorithms for fast information processing and knowledge can benefit from this initiative. It will provide a survey of such techniques and examples of applications where they have been implemented.

CHAPTER 2

BACKGROUND STUDY

This section briefly explained the theoretical background and associated studies on the Arabic Character Recognition using Deep Neural Network and Spiking Neural Network.

2.1 Arabic character recognition using second generation neural network

Handwritten Character Recognition for Arabic characters is an ongoing research subject that continually looks for methods to enhance accuracy. Many studies on Arabic character recognition are done using various Deep Neural Network methods, the second generation of neural networks. Among the most frequently used are Convolution Neural Network (CNN) and (ANN). From Arabic Handwritten Character

Recognition with Convolution Neural Network by El-Sawy, A., Loey, M., & El-Bakry, H. papers, the size network used is 88476. The layers are the convolution, pooling, and fully connected layers, as shown in Figure 2.1. The data set was compiled from 16800 characters written by 60 individuals ranging in age from 19 to 40 years, with 90% of participants writing in the right hand. Each block is automatically segmented using Matlab 2016a to get its coordinates. The database is divided into a training set (13,440 characters to 480 photos per class) and a test set (3,360 characters to 120 images per class). It demonstrated in an experimental portion that the findings were encouraging, with a 94.9 % classification accuracy rate on testing photos. In the future, to increase the accuracy, CNN needs a huge training data to get a good result, so it has to collect a big dataset of handwritten Arabic characters. [3]

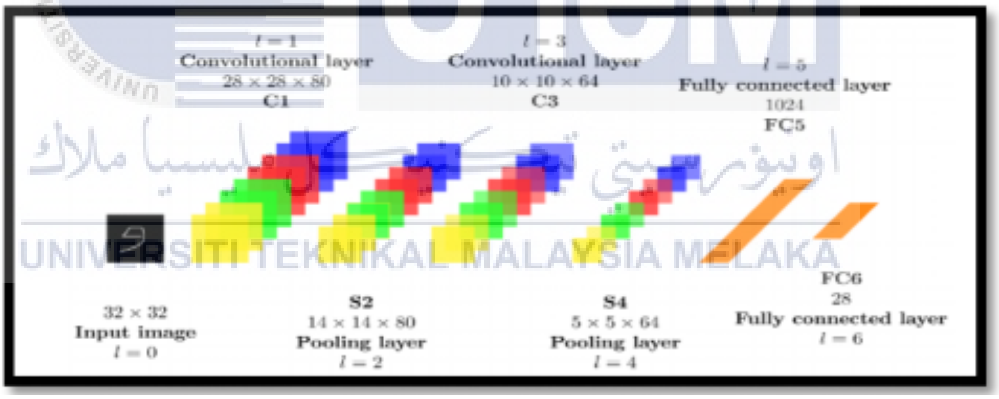

Figure 2.1: The proposed CNN for Arabic handwritten character recognition [3]

Using Artificial Neural Network research, online Handwritten Arabic Character Recognition by Addakiri, K., & Bahaj, M. presents an effective method for recognizing online Arabic handwritten characters. Three stages are involved in the procedure: First, pre-processing converts the original picture to a binary image. Second, neural networks are trained using the feedforward back propagation

technique. Finally, the character is recognized with the application of neural network methods. The suggested method has been tested on 1400 different characters written by ten other users. Each user typed 28 Arabic characters five times to generate distinct writing styles. The data set obtained from the proposed system is divided into three major segments. First, as a user writes a character on a separate window on the screen, the (x, y) coordinates of the pixels that make up the character are recorded and saved in an array. Second, a bounding box is formed around nature, and structural information about the character is retrieved. The surface can recognize using the gradient descent learning approach for feedforward neural networks. Character recognition has evolved as one of the most effective uses of neural network approaches, serving as one of the primary testing grounds for these systems. This study presents an online Arabic handwritten character recognition system based on a neural network. The trial findings showed that the machine detected the character's string with an average accuracy of 83%, proving the efficiency of our technique.[4]

Arabic Handwritten Character Recognition using Convolution Neural Network by AlJarrah, M. N., Mo'ath, M. Z., & Duwairi, R. proposed that Arabic handwritten recognition using a convolution neural network consists of four stages. For data pre-processing, a dataset is read in the form of an array as one vector for each character. Secondly is feature extraction, which extracts Low-level features in the first convolution layer by performing the conventional operation that depends on the number of filters and each filter size. The third is Low-level features are extracted in the first convolution layer by performing the conventional operation that depends on the number of filters and each filter size—lastly, training and evaluation of the CNN Model that leverages Keras API to perform training. From Figure 2.2, there is the proposed CNN model for Arabic handwritten recognition that size network is 3016.

This study uses a dataset of handwritten Arabic characters called AHCD provided by El-Sawy et al. It consists of 16,800 Arabic characters written by 60 participants ranging in age from 19 to 40 years. Most of the participants are right-hand. The used dataset is divided into training and testing. The training set comprises 13,440 characters, while the rest 3,360 characters are the testing set. The work results showed outstanding recognition performance on the testing dataset compared with other models - where the proposed model achieved accuracy equal to 97.2%. Data augmentation has been applied to improve the model's performance, where accuracy has improved and is equal to 97.7%. [5]

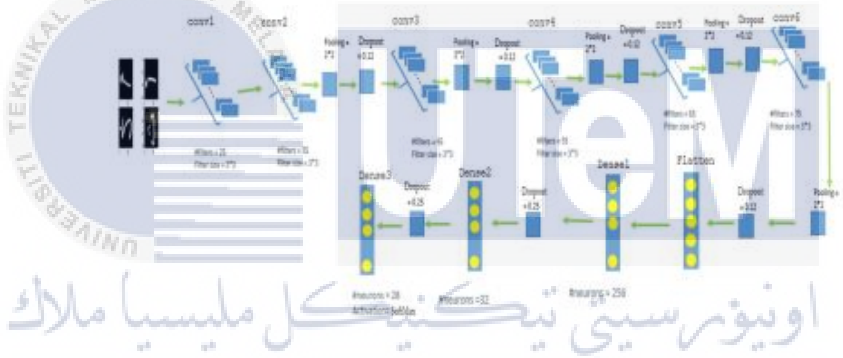

Figure 2.2: The Proposed CNN Model for Arabic Handwritten Recognition [5]

For next paper Elbashir, M. K., & Mustafa, M. E., they built a Convolutional Neural Network model of Arabic handwritten letter recognition in a tensor flow environment using the Keras library's sequential model. The CNN model built using a dataset supplied by the University of Science Arabic Language Technology department. Before submitting it to the CNN model, all character pictures should resize to fit in a 20 x 20 pixels area and then centred in a scaled image of 28 x 28 pixels using the centre of mass. It finished by removing every row and column completely black on