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Research paper

Warning Sign Analysis of Traffic Sign Data-Set Using Supervised Spiking Neuron Technique

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Abstract

In this paper, two types of conditions have been applied to analyze the performance of SNN towards usable traffic sign, which are hidden region and rotational effect. There are 20 warning traffic signs being focused on where there are regularly seen around Malacca area. These traffic sign needed to be embedded in this system as a databased to counter the output for mean error and recognition process for both conditions applied. Early hypothesis was design as the mean error and recognition process will degraded its performance as more intrusion get introduced in the system. For hidden region, the values show a critically rising error value at 62.5% = 0.123. While for mean error rotational effect, the values show an increasing abruptly for error value between 80˚ to 90˚ with 0.087% to 0.130%. For recognition process at 6.25% hidden region, 100% of images are correctly matchup to its own image. At 50% of hidden region, there is only 10% of image that able to be recognize while at 56.25% and 62.5% are leaving to outperform. At 10˚ rotation, 100% of images are perfectly recognized to its own image. At 60%, there is 30% of image able to recognize leaving others at 70%, 80% and 90% degrees rotation of images were outperformed. In view of element occasion driven handling, they open up new skylines for creating models with a colossal sum limit of recollecting and a solid capacity to quick adjustment. SNNs include another component, the transient hub, to the representation limit and the handling capacities of neural systems.

Keywords: *detection; hidden region; mean error; rotation; recognition; SNN; traffic sign.*

1. Introduction

A great deal of work so far has devoted on fundamental issues like multifaceted nature of calculation, organic learning rules impacts, organic conceivable models and so on. Spiking neural systems is the second rate class level of neural systems that dynamically getting consideration since it is naturally more sensible model and computationally capable of machine learning strategy [2]. There is some application that has been utilizing spiking neuron system, for example, “Isolated Word Recognition through The Liquid State Machine (LSM)” by [3].

There is a downside in spiking neural system, it is more calculation requesting than the conventional neural system [1]. Be that as it may, by utilizing occasion based spikes time will permit a standard for efficient parallel usage by fundamentally bring down the heap in correspondence between neuron. Along these lines, the traffic sign venture will utilize spiking neuron as an answer since it is more viable than other neural system technique.

Signs are used to control and guide traffic and to promote road safety. They should only be used where they can usefully serve these functions. Warning signs will not promote road safety if used widely where there is no unusual degree of danger. On the other hand, their omission where guidance, control or danger warrants the use of a sign is not in the best interests of road users.

There are three main classes of road signs. Each class has its basic shape and certain colour is restricted to particular classes of signs. One of that important sign are warning sign. Warning sign give warning of a hazard ahead. The design of most warning signs is based on an equilateral triangle having its apex uppermost. They are sometimes supplemented by rectangular plates giving additional information as may be necessary.

Yellow traffic sign is a warning and directional traffic signs ready drivers to any activity design transforms they should know about. These Yellow Traffic Signs are effortlessly obvious for circumstances in which drivers should be unmistakably alarmed, for example, bike movement, frosty and tricky streets, no outlet, stop ahead, street shut, and the sky is the limit from there. Yellow Traffic Signs are moderate and produced using sturdy, intelligent materials to guarantee that they withstand unforgiving climate conditions and are very noticeable to drivers. With an assortment of mounting alternatives and sizes, activity signs keep your roadways safe and drivers mindful of changes out and about.

To perform the function for which it is intended a sign must be capable of transmitting its message clearly and at the right time to road users travelling at the normal speed for the road. To achieve this, the sign must have correct legibility distance, appropriate target value, simplicity of content and layout and effective illumination or reflectorization. Signs must be adequate in design and construction without being extravagantly expensive. In the previ-

ous work, many researches have been focused to implement intelligent system for traffic sign using image processing technique [6-10].
Therefore, a system manipulating the visual error needs to be produced to help the driver. It recognizes traffic signs error by analyzing the images taken by a camera of system. If an image contains signs error, the system gives an alert to the driver, indicating the respective error of sign. Briefly, the main target of this project is to execute spiking neural network (SNN) in image processing in MATLAB to recognize and categorize traffic of variety warning signs.

2. Model

A basic spiking model equation (1) and (2) are introduced as naturally plausible as the Hodgkin– Huxley show [2], yet as computationally productive as the integrate-and-fire model by the combination test investigations of animal and human sensory systems with numerical recreation of colossal scale cerebrum models depending on four parameters a, b, c and d. This model is claimed to be one of the simplest possible models that can display all the firing designs. This neuron model has been ordinarily acknowledged as an exact and computationally moderate model yet delivering a wide range of cortical pulse coding practices. In a mean time, v speaks to the membrane potential of the neuron and u speaks to a membrane recovery variable, which accounts for the activation of K+ ionic streams and inactivation of Na+ ionic streams and it gives negative feedback to v. After the spike achieves its apex (vth), the membrane voltage and the recovery variable are reset by the equation above. In the event that v goes over vth, it first resets to vth and after that to c so all spikes have square with extents. The part 0.04v2 + 5v + 140 is picked with the goal that v is in mv scale and time is in ms. In spite of the fact that this is known as the most down to earth exact model; still there are a few difficulties in understanding the model on advanced or simple circuits. The trouble of usage arises from the quadratic piece of the model, which is appeared by the parabolic curve as shown in Figure 1.

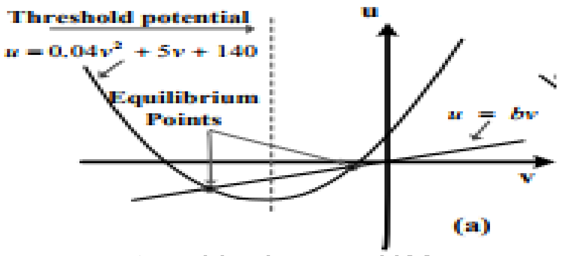


Fig. 1: Izhikevich neuron model [4]

Euler's Method of 2-D system with first order differential equation:

$$v' = 0.04v^2 + 5v + 140 - u + I \quad (1)$$

$$u' = a * (bv - u) \quad (2)$$

After spike-reset:

$$v \geq 30 = \begin{cases} v = c \\ u = u + d \end{cases} \quad (3)$$

where a-time scale for recovery variable u, b-Sensitivity for recovery variable v, c-After spikes reset value of membrane potential v and d-After spikes reset value of membrane potential u.

3. Architecture

The network architecture comprises in a feed-forward system of spiking neurons with various delayed synaptic terminals. The neurons in the system produce activity possibilities or spikes when the inner neuron state variable which called "membrane potential", crosses an edge. The connection between input spikes and the internal state variable is portrayed by the Spike Response Model (SRM), as introduced by Gerstner. Depend upon the decision of appropriate spike-response functions, one can adjust this model to reflect the flow of a huge wide range of spiking neurons. Figure 2 (a) shows spiking neural network architecture, while Figure 2 (b) shows an example of multiple synapses transmitting multiple spikes.

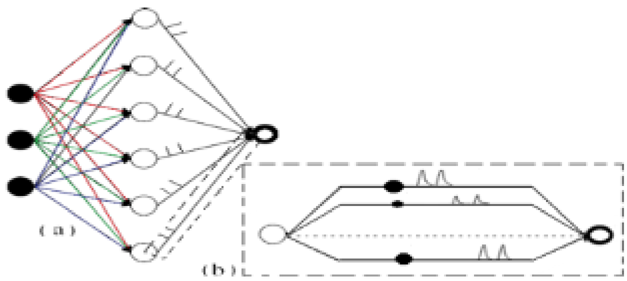


Fig. 2: (a) Spiking neural network architecture (b) Multiple synapses transmitting multiple spikes [5]

3.1. SNN Architecture for Clustering Images

The system built by three fundamental layers as shown in Figure 3: in an info layer, a concealed layer and a yield layer. The primary layer is comprising of three info which are red, green and blue (RGB). Confine actuation of every hub in shrouded layer is: ∅^2= ∅(|(|X-C_n |)|,σ_n); where ∅^n is an outspread premise work (RBF) restricted around Cn with the level of localization parameter by σ_n. Picking ∅ (Z,σ)= exp⁡〖Z^2/〖2σ〗^2 〗 deliver the Gaussian RBF. This will change genuine information to worldly information.

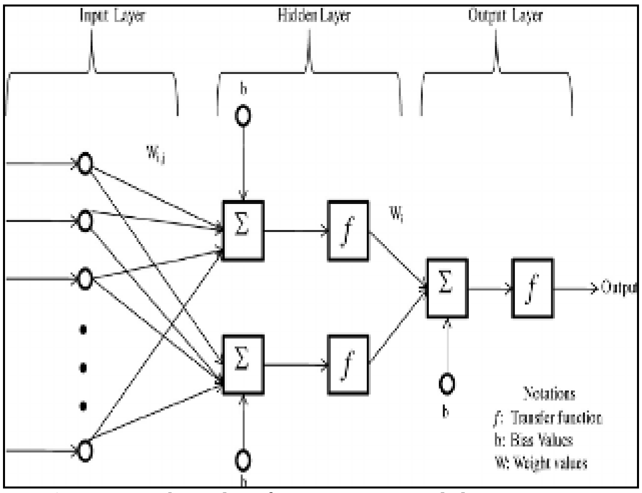


Fig. 3: Network topology for segmentation and clustering images

3.2. SNN Architecture for Cell Segmentation

The techniques uses in this design are watershed, edge based and area based strategies. This method likewise applying completely associated feed-forward as numerous deferred synaptic terminals however by executing two techniques, which are unsupervised and directed learning.
For managed taking in, a reference information set of pixels from an alternate picture is utilized for learning. Otherwise, for unsupervised taking in, the SNN play out the adapting straightforwardly on the picture to characterize. The primary layer of the engineering comprises of red, green and blue (RGB). Restrict enactment of every hub in concealed layer is:∅^2 = ∅(|(|X-C_n |)|,σ_n); where ∅^n is an outspread premise work (RBF) limited around Cn with the level of localization parameterized by σ_n. Picking ∅

(Z,σ) = exp〖Z^2/〖2σ〗^2 〗 create the Gaussian RBF. This will change genuine information to worldly information as shown in Figure 4 (a) and Figure 4 (b).

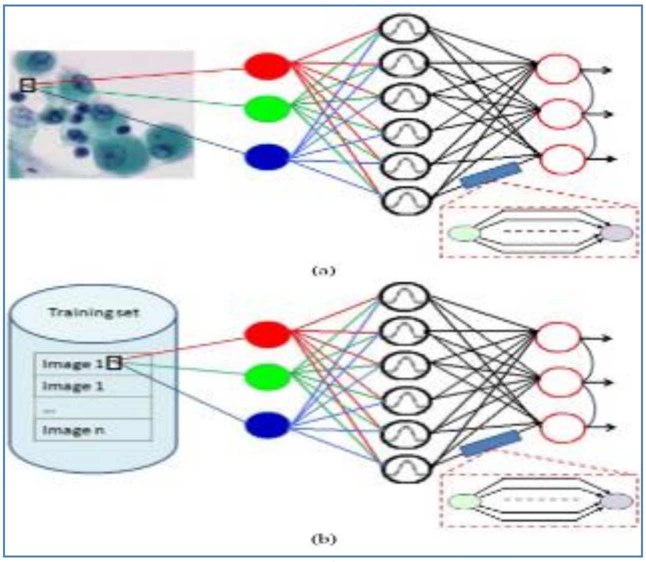


Fig. 4: (a) Unsupervised training of network topology (b) Supervised training of network topology

3.3. SNN Architecture for Edge Detection

The principal picture experiences a division procedure by utilizing spiking neuron. At the point when the division procedure is done, the information of movement of every yield neuron is recorded. The information pixel of a yield double will get to be 1 if the neuron is dynamic while if the neuron is latent the yield twofold will get to be 0. At that point, the picture experiences combination stage to deliver the last edges. This should be possible be taking the last picture then superimposing it. Network topology of SNN edge is shown in Figure 5.

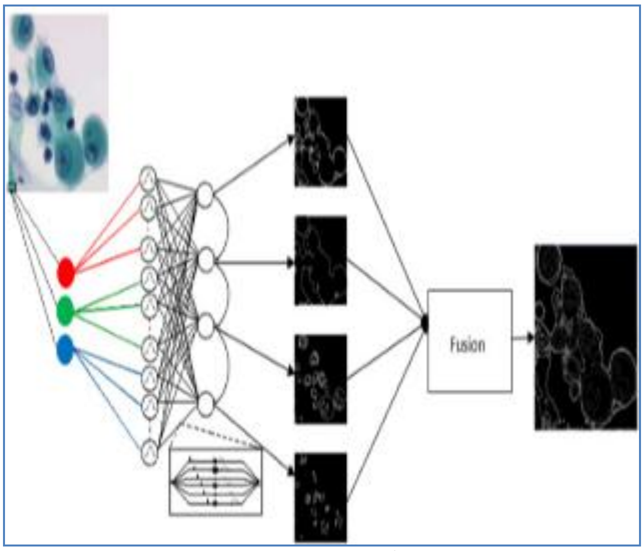


Fig. 5: Network topology of SNN edge

3.4. Spiking Neuron Implementation

The section v' = $0.04v^2 + 5v + 140 - u + I$ was acquired by fitting the spike start progression of a cortical neuron (different decisions additionally practical) so that the membrane potential v has mV scale and the time t has ms scale. The resting potential in the model is between 70 furthermore, 60 mV depending on the estimation of b. As most real neurons, the model does not have a settled edge; depending upon the historical backdrop of the threshold potential before the spike, the edge potential can be as low as 55 mV or as high as 40 mV.

3.4.1. Training with Neural Network Toolbox

Neural network Toolbox gives calculations, pre-trained models and applications to make, prepare, train and recreate both shallow and deep neural network, can perform classification, regression, clustering, dimensionality reduction, time-arrangement forecasting and dynamic system demonstrating and control. In this research, the scope will be focusing on 20 warning traffic signs which are regularly seen around Malacca area. All the traffic sign was classified such as in Table 1.

Table 1: Image classes

1) Caution Hump	11) Pedestrian Crossing
2) Double Arrow	12) Disabled Person
3) Animal Crossing	13) Railway Crossing
4) Steep Down-Slope	14) Caution Sign
5) Slippery Road	15) Start of Central Reserve
6) Road Narrows Ahead	16) T-Junction Left and Right
7) Bumpy Road	17) T-Junction Right
8) School Zone	18) Tow Away Zone
9) Falling Rocks	19) Dangerous Bend to Right
10) Blind Pedestrian	20) Cow Crossing

From the table above, all the sign is referred to yellow sign which are the warning sign used in Malaysia. To perform the neural network, MATLAB2013a is used to develop the classification for each image and the errors to analyze the output results. A folder of an input and target need to be specified first in order to perform the neural activity.

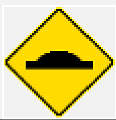
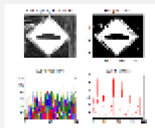
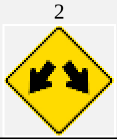
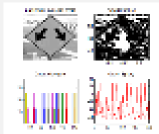
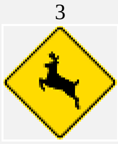
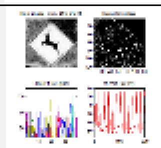
3.4.2. Detection and Recognition

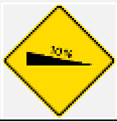
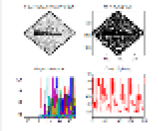
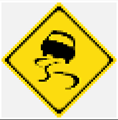
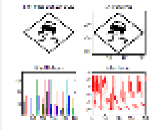
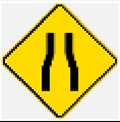
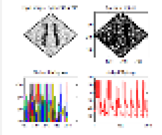
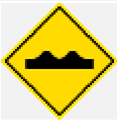
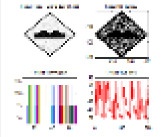
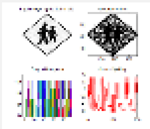
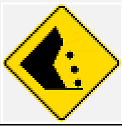
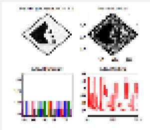
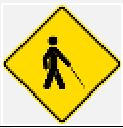
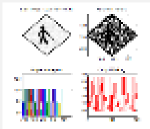
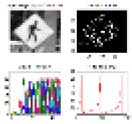
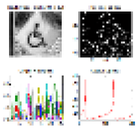
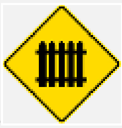
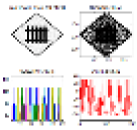
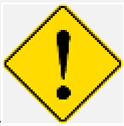
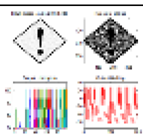
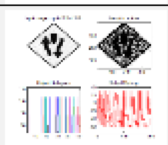
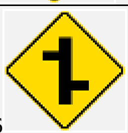
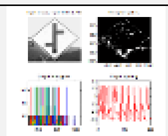
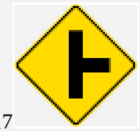
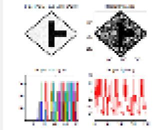
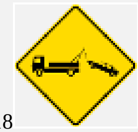
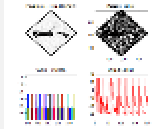
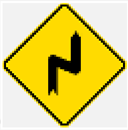
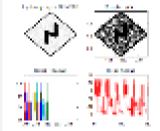
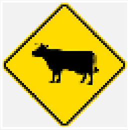
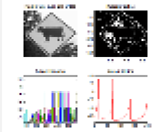
The output from spiking test then will be transferred as input for detection and recognition by the created block diagram. The result of recognition then been analyzed. To accomplish the output result, all the input images were assembled in a particular folder. Each of them was grouped into their own each objective. From that detection part, blob analysis block diagram is associated with perform rectangle bound as making it a particular recognition around the recognized traffic sign.

3.5. Spike Response Output

The 20 traffic signs were used to perform spike response. Each figure shows the comparison of voltage change at receptor 10 and receptor 200. Table 2 shows the output from spike response.
The network keeps training until the regression plot achieved its stability when Y = T signify the network was successfully trained correctly.

Table 2: Image perform spike response

1 	
2 	
3 	

4 	
5 	
6 	
7 	
8 	
9 	
10 	
 11	
 12	
 13	
 14	
15 	
 16	
 17	
 18	
 19	
 20	

Based on Table 2, it can conclude that each of the image traffic sign have their own data by refer the histogram. Histogram shows the pixel of intensity grayscale level for an input image. The histogram of an image was analyzed after complete spike response. Then, extract feature of the image for classification in the system. So, it shows that the system of detection and recognition will perfectly recognize if the input image on camera have a same data that stored in the system as sample of image. Subsequent to completing a perception, it can be discovered that relatively every image played out the low-threshold spiking (LTS) type. Caution Hump, Pedestrian Crossing, Disabled Person and Cow Crossing traffic sign have performed regular spiking (RS) type.

Low-threshold Spiking, LTS is the inhibitory cortical cells. Neurons fire high-frequency through the action possibilities, however with an observable spike frequency slowing down. These neurons have low firing threshold, which influences the estimation of b = 0.25 in the model. Regular Spiking, RS neurons are the most typical neurons in the external layer of cells. When activate with long boost, the neurons fire a couple of spikes between every one of them and after that the period increase. The decrease of frequency. Expanding the quality of the injected DC-current builds the spike between neurons frequency, however it never turns out to be too quick on account of substantial spike-after hyperpolarization. In this actualized model, its result the estimation of c and d. Estimation of d will be higher in view of the pulses jump of u and influences the estimation of c = - 65mV had influenced the voltage value resets for each cool down.

Resonator, RZ neurons have damped or supported sub-threshold movements. They resonate to input sources, which having reasonable frequency. This character can prompts esteem a wind up noticeably 0.1 and drives esteem b to 0.26. After played out the spike response, the project keeps on performing image classification to its own classes. These errors are produced from the non-real-time analysis to get their error value.

3.6. Mean Error Recognition

After played out the spike response, the project keeps on performing image classification to its own classes. In here, there are two kinds of conditions which are hidden region and image rotation. An investigation can be directed to think about each errors of image through their particular condition. Each condition will play out a particular error, at that point the estimation of each image through their own condition will sum up to produce the mean value as should be obvious to some degree A, B and C below.

3.6.1. Experiment 1: Hidden Region Effect

This experiment is to determine the effect of hidden region toward image recognition. The warning sign used was purposely hiding begins with 6.25%, 12.5%, 18.75%, 25%, 31.25%, 37.5%, 43.75%, 50%, 56.25% and 62.5% to see an error produce for each sign in system recognition. The mean error is collected for every sign used in every hidden region as shown in Figure 6.

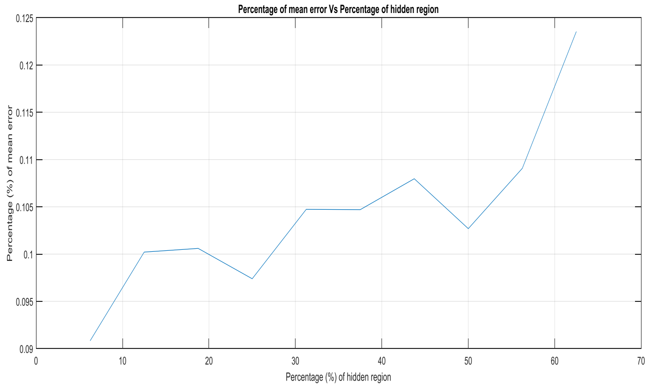


Fig. 6: Mean Error for hidden region

Based on the mean error for hidden region graph above, the values show a critically ascending for error value at 62.5% hidden region equal to 0.123 and has average value at others points. Thus, the hypothesis was accepted as the value of hidden region coverage will influence the increasing value of error.

3.6.2. Experiment 1: Hidden Region Effect

For this experiment, rotation for each sign used is purposely introduced. It begins with 10˚, 20˚, 30˚, 40˚, 50˚, 60˚, 70˚, 80˚ and 90˚ to see the rotational effects towards the image recognition of this system. The mean error graph was listed and shown in Figure 7.

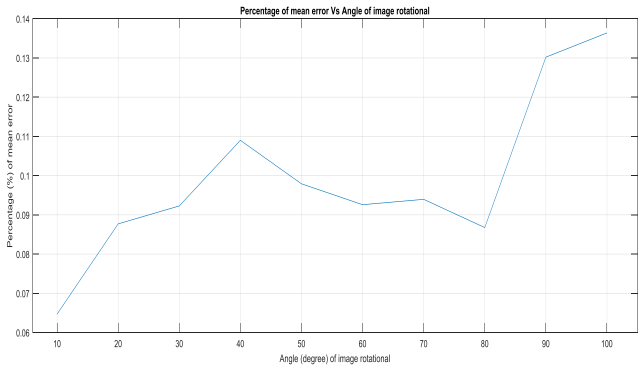


Fig. 7: Mean error for rotational

Based on the mean error for rotation graph above, the values show an increasing sharply for error value between 80˚ to 90˚ with 0.087% to 0.130%. Thus, the hypothesis was accepted where the higher image rotation, higher error value produced by each image.

3.7. Output Image Recognition

An analysis to shape display image likewise been conducted all through this project. In this part, the lowest and the highest an incentive for each image condition for hidden region and rotational were watched. To recognize each image contribution to its output, the output estimation of fundamental image in the wake of preparing process need to total up with the output error of each image in the wake of preparing process. Figure 8 and Figure 9 are utilized to compare between image output and input for hidden region.

3.7.1. Hidden Region

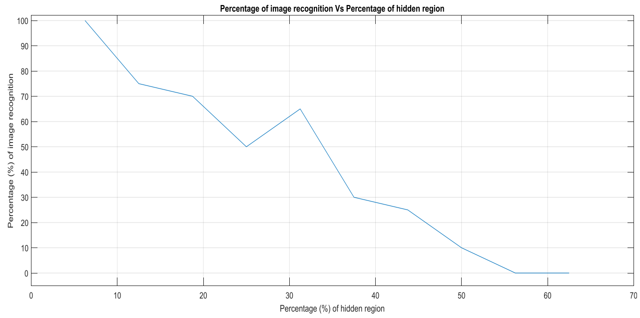


Fig. 8: Comparison image output and input for hidden region

To summarized, at 6.25% hidden region, 100% of images are correctly recognized to its own image. At 50% of hidden region, there is only 10% of image that able to recognize while at 56.25% and 62.5% hidden region are leaving to perform as out of range (no recognition process).

3.7.2. Rotational

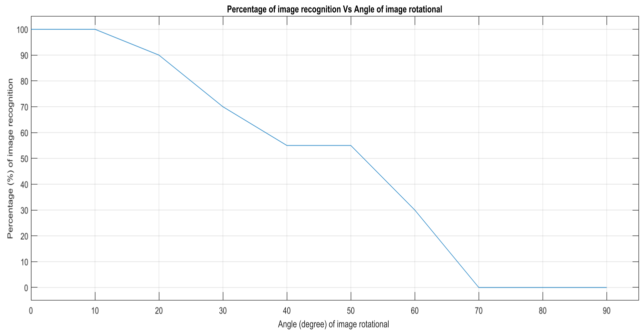


Fig. 9: Comparison image output and input for rotation

For 10 degree rotation, 100% of images are correctly recognized to its own image. At 60%, there is 30% of image that able to recognize while at 70%, 80% and 90% degrees rotation of images are performed an out of range (no recognition process).

4. Conclusion

In this research, information about warning traffic sign, traffic sign recognition, spiking neuron application and image handling with spiking neuron has been gathered. Image processing technique has been connected to MATLAB 2013a to investigate warning traffic sign based on 20 images databased. Although, not forget that information and knowledge on how to create and test the spiking neural network has achieved.

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