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Plate Recognition Using Backpropagation Neural Network and Genetic Algorithm

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Abstract

Plate recognizer system is an important system. It can be used for automatic parking gate or automatic ticketing system. The purpose of this study is to determine the effectiveness of Genetic Algorithms (GA) in optimizing the number of hidden neurons, learning rate and momentum rate on Backpropagation Neural Network (BPNN) that is applied to the Automatic Plate Number Recognizer (APNR). Research done by building a GA optimized BPNN (GABPNN) and APNR system using image processing methods, including grayscale conversion, top-hat transformation, binary morphological, Otsu threshold and binary image projection. The tests conducted with backpropagation training and recognition test. The result shows that GA optimized backpropagation neural network requires 2230 epochs in the training process to be convergent, which is 36.83% faster than non-optimal backpropagation neural network, while the accuracy is 1,35% better than non-optimized backpropagation neural network.

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Keywords: Bacpropagation Neural Network; Genetic Algorithm; Optical Character Recognition; Computer Vision; Top-Hat Transformation

1. Introduction

In the recent years, automated systems have become an integral part of daily tasks that only a human can do before. Automated systems are meant to help human to do task that involves knowledge, reasoning and experience. The integral part of an automated system is artificial intelligence and one of the application of artificial intelligence in automated system is Optical Character Recognition (OCR). OCR let a computer recognize character through visual interpretation and recognize character automatically without help from human. There are several algorithms that we can use to create OCR system, such as template matching, support vector machine (SVM), hidden markov model, hausdorff distance and artificial neural network. Artificial neural network is the most popular algorithm that has been

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used by researcher to solve pattern recognition problems[1]. Artificial neural network can be used to solve many problems and it can be trained over time to gain its knowledge or to enhance its accuracy in recognizing patterns.

Artificial neural network is an abstraction of biological neural network that simulate the way it works in biological brain. Neurons are interconnected by synapsis that carries information and it can be modified by training process. There are several training processes that can be used to train artificial neural network, one of them is backpropagation training method. Backpropagation training method involves feedforward of the input training pattern, calculation and backpropagation of error, and adjustment of the weights in synapses.

2. Background

There are two variables that affect the speed of training process and the accuracy of pattern recognition, those are learning rate and momentum rate. Learning rate and momentum rate values that are optimal in a backpropagation neural network topology might not be optimal in another backpropagation neural network topology because each topology is unique to its usage domain. Those two variables also affect the tendency of backpropagation process fall into local minima that makes the artificial neural network recognition performance becomes sub-optimal[2].

There are several methods that can be used for a priori determining learning rate and momentum rate, those are trial-and-error and second-order method. Trial-and-error method needs human interaction; therefore, it is time consuming and needs effort. Second-order method is a method that can adjust learning rate using information gathered from training process. This method is rarely used because it needs massive computation resources[3]. The learning rate that is too high will lead into overcorrecting problem in the gradient descent process, yielding sub-optimal accuracy and longer training process[4].

Beside the learning rate and the momentum rate, the number of neuron in the hidden layer also affects the speed of backpropagation process and its accuracy. Logically, the more neuron it has, the more information can be stored, but it affects the speed of the training process. A non-optimal number of neuron also leads into a problem. Too many hidden neuron will lead into overfitting problem. In contrast, if there is only a few neurons, it will lead into under fitting problem. Both will make the artificial neural network cannot generalize the input, yielding sub-optimal performance[5, 6].

There are several methods for determining the number of neuron and layer in an artificial neural network, they are rule-of-thumb and structured trial-and-error. Rule-of-thumb method is a compilation of rules that concluded by researchers. Rule-of-thumb method doesn't guarantee the optimality of neural network because the activation function and training algorithm also affect the determination of neuron's number. Structured trial-and-error is a naïve programming method to determine the number of neuron and layer. This method will generate random number for neuron and layer number and train the neural network by trial and error. If the training process fails to converge, then the number of the neuron and layer will be increased and the neural network will be trained again. This iteration goes on up until the neural network converges[6].

In order to build an optimal artificial neural network, an algorithm that can optimize learning rate, momentum rate, and count of hidden neuron simultaneously is needed. This research introduces an approach in optimizing those variables. The algorithm that we use is genetic algorithm. Genetic algorithm mimics the natural selection. An individual will be eliminated naturally if it cannot adapt to the environment. That individual will be replaced with a new individual from crossover and mutation process. Genetic algorithm is an optimization technique, so that it can be used to find the most optimal solution from available solutions[7]. The combination of genetic algorithm and backpropagation algorithm enable the backpropagation neural network to have better accuracy, speed up the recognition and the training process rather than a backpropagation neural network without optimization process which leads to efficiency of CPU time.

3. Methodology

Genetic algorithm was used to define the optimal learning rate, momentum rate and the number of neuron in the hidden layer of a backpropagation neural network. Then the backpropagation neural network is applied in plate number recognition system. Valid Indonesia plates that comply with the regulations and with black background were used as our sample. See Fig. 1.