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Time Series Classification Using Autocorrelation Function as Training Data in 1D-CNN

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1. Introduction

Convolutional Neural Networks (CNN) is devised based on neurophysiological on the visual cortex of the brain of the creature. It has attracted attention mainly for use in image recognition. However, in recent years, CNN has also been use to time series data. That is one dimensional convolution neural networks (1D-CNN). In this research, 1D-CNN is used as a classification model, the autocorrelation function is used as training data.

2. Proposed Method

In this study, three types of myoelectric data is classified using 1D-CNN. The autocorrelation function of those data is calculated. Equations (1) shows autocorrelation function.

$$r_k = \frac{\sum_{i=k+1}^{n}(y_t - \bar{y})(y_{t-k} - \bar{y})}{\sum_{i=1}^{n}(y_t - \bar{y})^2} \tag{1}$$

n is the sampling number. k is the time lag. Figure 1 shows the example of the myoelectric data. Figure 2 shows autocorrelation function of the Fig. 1.

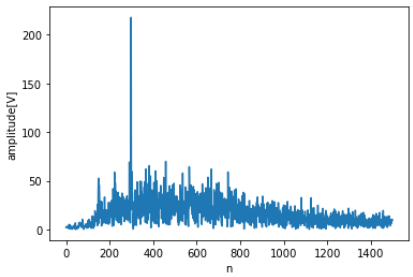

Figure 1: Original data.

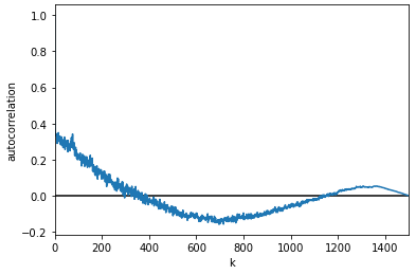

Figure 2: Autocorrelation function.

3. Simulation Result

1D-CNN is used for convention architecture. Figure 3 shows the structure of 1D-CNN.

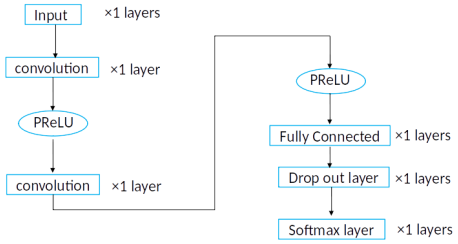

Figure 3: Structure of 1D-CNN.

Two convolutional layers are used. Drop out layer is prepared to prevent over learning. Classification results is derived the probability by the softmax activation function. Parametric Rectified Linear Unit (PReLU) function is prepared for the activation function. Equation (2) shows PReLU function.

$$f(\alpha, x) = \begin{cases} \alpha x & (x < 0) \\ x (x \geq 0) \end{cases} \tag{2}$$

α is a parameter that is determined by learning. The PReLU function learns values during training. Therefore, it can better adapt to weights and biases.

In this study, three time series data are classified. Seventy five training data and test data are prepared for each. The autocorrelation function is used as the training data, and the original data is used as the training data.

Table 1: Test accuracy

	test accuracy(%)
original data	64.3
autocorrelation	81.9

Table 1 shows ten times averaged test accuracy results. It can be seen that autocorrelation function test accuracy is higher than that of original.

4. Conclusion

In this study, three types of myoelectric data was classified using 1D-CNN. The training data was transformed into an autocorrelation function as a preprocessing step. We understood that test accuracy of autocorrelation function was higher than that of original. Therefore, it was understood that learning autocorrelation function was effective to improve test accuracy when classifying myoelectric data with 1D-CNN.