COMPARISON SOME ALGORITHMS USING NEURON NETWORKS TO IDENTIFY THE BLACK BOX MODEL OF TWIN ROTOR MIMO SYSTEM

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ABSTRACT

Neural networks have universal approximation capabilities, so in recent years they are widely used and effective in the identification and control of nonlinear dynamical objects. When recognizing the actual object model, it is still a difficult problem to choose the network model and the control algorithm for simplicity, suitable for a specific object class. In this paper, the author compares the quality of the TRMS relative model through the mean squared deviation when using the above algorithms.

Keywords: *Black box model, Neural network, Yaw angle, Pitch angle, Identify, Mean squared error*.

1. INTRODUCTION

Artificial Neural Networks (ANNs) are intended to mimic the behavior of biological neural networks (NNs). In fact, there are many types of neural networks and their applications are also different. These networks need to be trained using the appropriate learning algorithms for a particular application. We select MLP network (Multi Layer Perceptron) to model the TRMS object with many different training methods. We can build a white box model, a gray box model or a black box model for the TRMS. Some authors have built TRMS model published in [1], [2], [3], [4]. We have studied the optimal problem solving methods in model predictive control in articles [5]. In [6], we builds a white box model of TRMS object according to Newton method. In the paper [7], [8] we have introduced algorithms such as: Gradient descent algorithm; Gradient descent with momentum and adaptive rate algorithm; the Levenberg-Marquardt algorithm, the BFGS quasi-Newton algorithm, the Bayesian regularisation algorithm. In this research, the author comparison some algorithms using neuron networks to identify the black box model of twin rotor MIMO system and proposes a reasonable algorithm choice.

2. THE MODEL OF TRMS

The physical model of TRMS system is shown in Fig***ures*** 1.

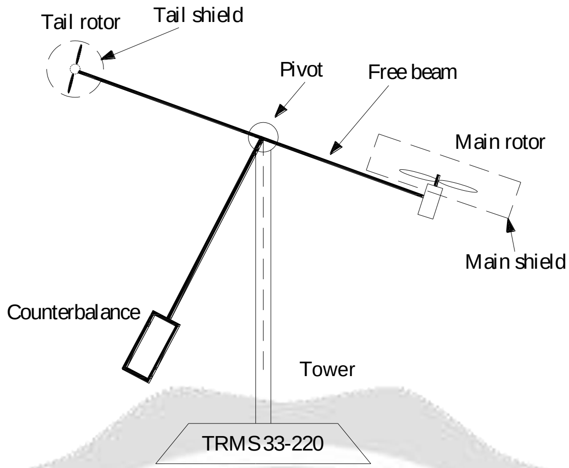

Fig 1. The physical model of TRMS

Model Structure Selection and Training algorithms is shown in Fig***ures*** 2.

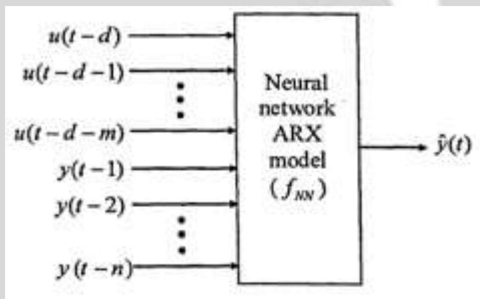

Fig 2. The NNARX model structure of a SISO system

The frequency of the training data ranges from 0.01Hz to 1Hz and cover amplitude between -2.5V and 2.5V, the minimum and maximum applicable voltages to the system respectively. Some algorithms used for comparison in this article are Gradient descent, Gradient descent with momentum and adaptive rate, the Levenberg-Marquardt algorithm, the BFGS quasi-Newton algorithm.

3. SIMULATION OF RESULTS

When using the above algorithms to recognize the black box model of the TRMS object with the above 2 degrees of freedom on Matlab / Simulink and the real model, we get the following figures 3 to 12.
The yaw angle of the TRMS model when using algorithms to train and test the network are shown in Figures 3 to 7 and the corresponding error between the real model and the NN-based model.

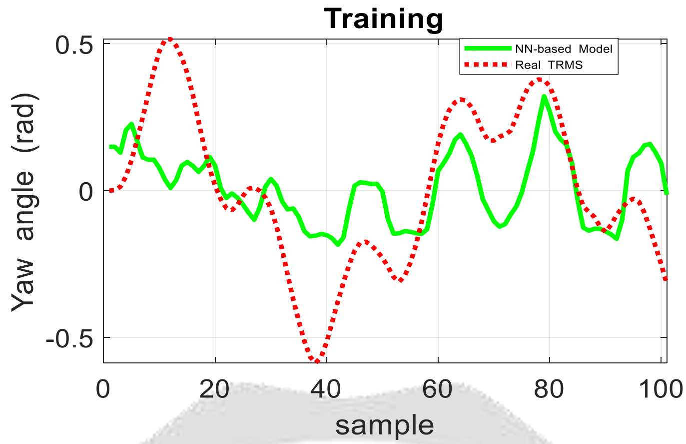

Fig 3. The yaw angle of the TRMS model when using the Gradient descent algorithm to train the network

The yaw mean squared error of training is: 4.669712. 10^{-2}

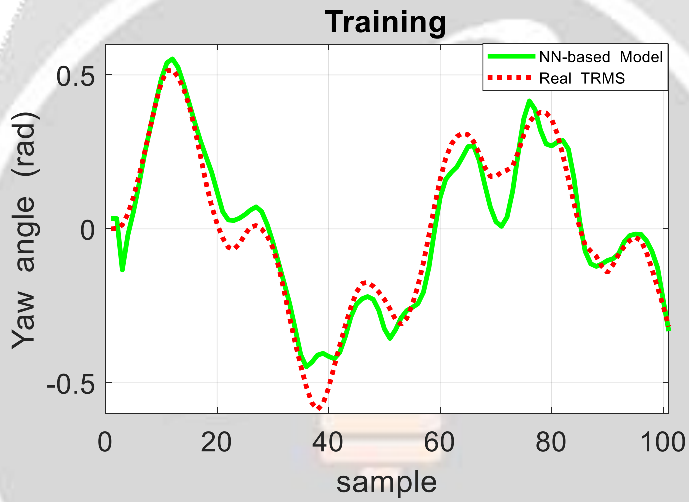

Fig 4. The Yaw angle of the TRMS model when using the Gradient descent with momentum and adaptive rate algorithm to train the network

The yaw mean squared error of training is: 5.579323. 10^{-3}

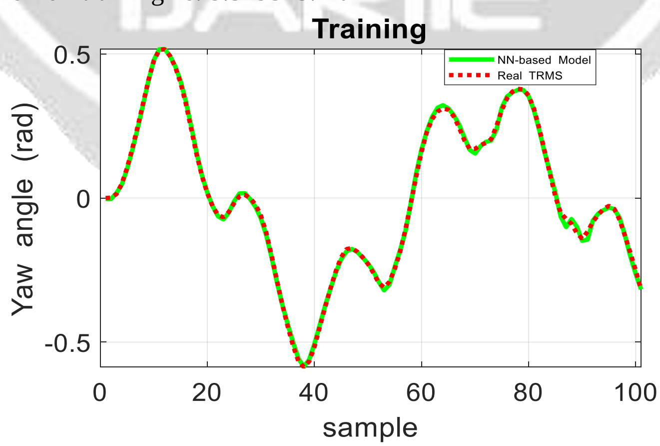

Fig 5. The yaw angle of the TRMS model when using the Conjugate gradient with Powell-Beale restarts algorithm to train the network

The yaw mean squared error of training is: 6.483548. 10^{-5}

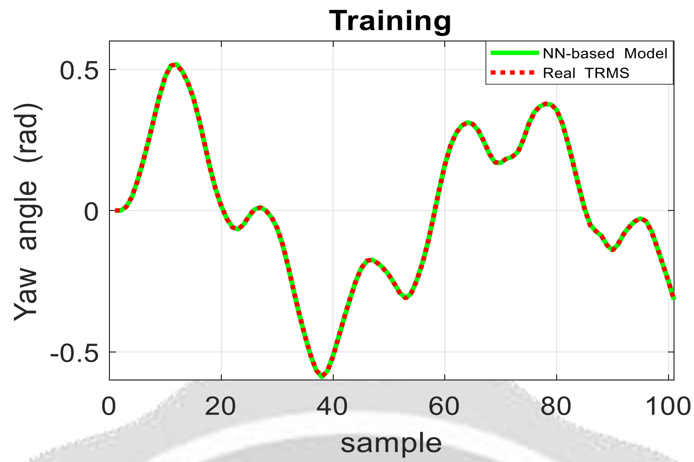

Fig 6. The yaw angle of the TRMS model when using the Levenberg-Marquardt algorithm to train the network
The mean squared error of the yaw angle in training process is 8.355767. 10^{-6}

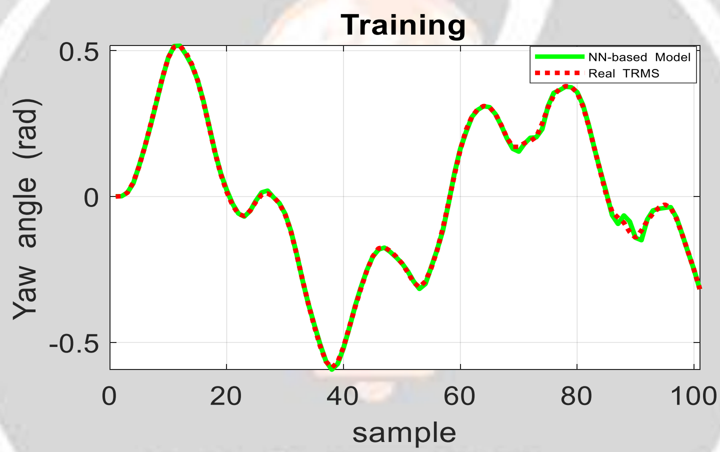

Fig 7. The Yaw angle of the TRMS model when using the BFGS quasi-Newton algorithm to train the network
The mean squared error of the yaw angle in training process is 5.769073. 10^{-5}

The mean squared error of the yaw angle between the real and identity models in the algorithms the Gradient descent, the Gradient descent with momentum and adaptive rate, the Conjugate gradient with Powell-Beale restarts, the Levenberg-Marquardt, the BFGS quasi-Newton are respectively 4.669712. 10^{-2}, 5.579323. 10^{-3}, 6.483548. 10^{-5}, 8.355767. 10^{-6}, 5.769073. 10^{-5}. These results show that using the same 50 data sets for identification, the approximation ability of the algorithm the Gradient descent is the worst and the approximation ability of the algorithm the Levenberg-Marquardt is the best.

The pitch angle of the TRMS model when using algorithms to train and test the network are shown in Figures 8 to 12 and the corresponding error between the real model and the NN-based model.

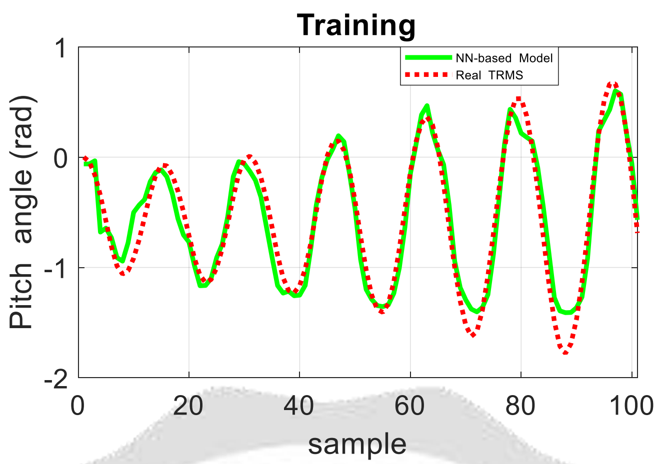

Fig 8. The pitch angle of the TRMS model when using the Gradient descent algorithm to train the network

The pitch mean squared error of training is: 2.518215. 10^{-2}

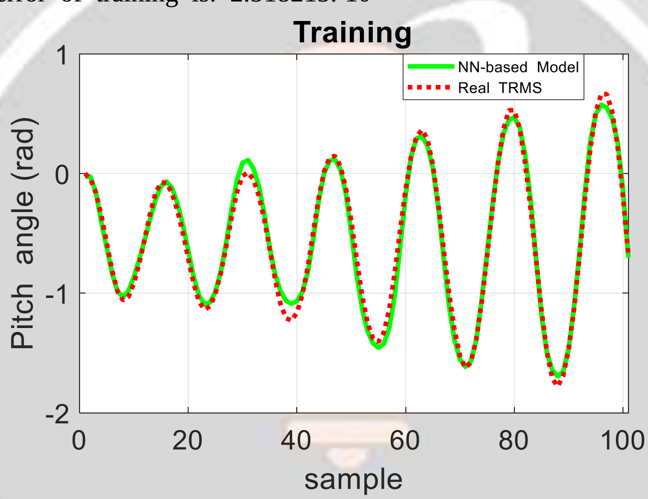

Fig 9. The Pitch angle of the TRMS model when using the Gradient descent with momentum and adaptive rate algorithm to train the network

The pitch mean squared error of training is: 3.106907. 10^{-3}

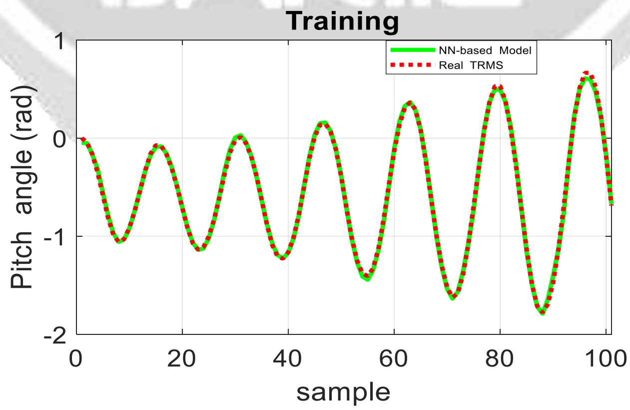

Fig 10. The pitch angle of the TRMS model when using the Conjugate gradient with Fletcher-Reeves algorithm to train the network

The pitch mean squared error of training is: 1.188296. 10^{-4}

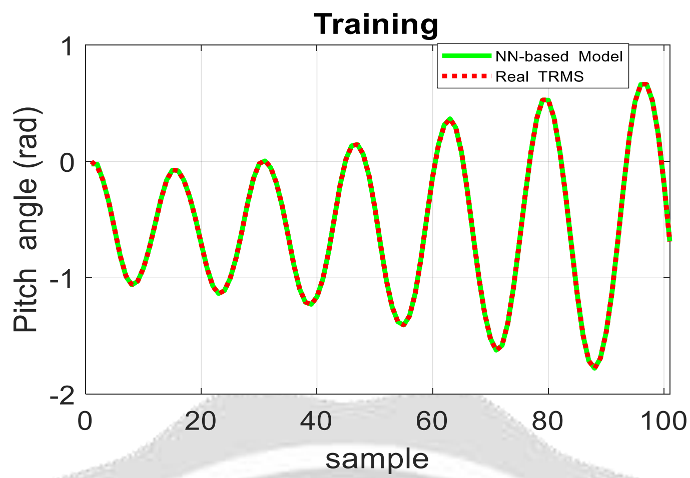

Fig 11. The pitch angle of the TRMS model when using the Levenberg-Marquardt algorithm to train the network

The mean squared error of the pitch angle in training process is $3.167360.\ 10^{-6}$

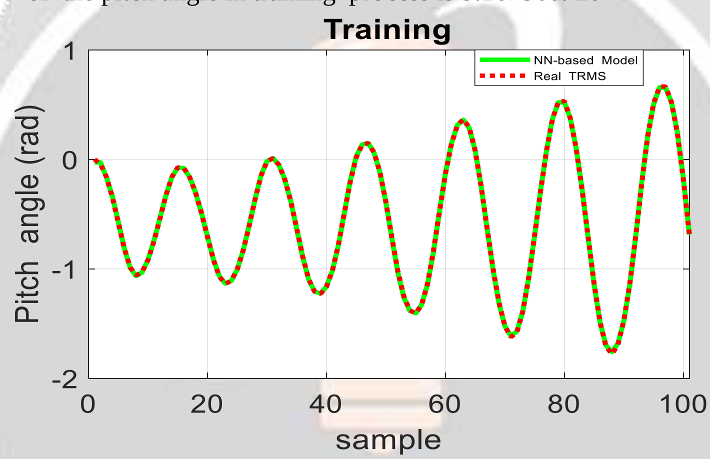

Fig 12. The pitch angle of the TRMS model when using the BFGS quasi-Newton algorithm to train the network

The mean squared error of the pitch angle in training process is $4.665457.\ 10^{-5}$

The mean squared error of the pitch angle between the real and identity models in the algorithms the Gradient descent, the Gradient descent with momentum and adaptive rate, the Conjugate gradient with Powell-Beale restarts, the Levenberg-Marquardt, the BFGS quasi-Newton are respectively $2.518215.\ 10^{-2}$, $3.106907.\ 10^{-3}$, $1.188296.\ 10^{-4}$, $3.167360.\ 10^{-6}$, $4.665457.\ 10^{-5}$. These results show that using the same 30 data sets for identification, the approximation ability of the algorithm the Gradient descent is the worst and the approximation ability of the algorithm the Levenberg-Marquardt is the best.

4. CONCLUSIONS

The model of the TRMS were built according to the black box model using Neural network through the simulation on Matlab and comparing with the real model shows that the mean square error between the training model in both yaw and pitch angles when using the MLP structure and 30 datasets, the LM algorithm is the most reasonable choice. In the next study, the author will change the number of datasets or change the structure of the neural network model.

5. ACKNOWLEDGEMENT

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6. REFERENCES

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