Electric Motor Speed Control System Using Artificial Neural Network Based Controlling System for Electric Motor

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Abstract:

This paper uses Artificial Neural Networks (ANNs) in estimating speed and controlling it for a separately excited electric motor. The rotor speed of the electric motor can be made to follow an arbitrarily selected trajectory. The purpose is to achieve accurate trajectory control of the speed, especially when the motor and load parameters are unknown. Such a neural control scheme consists of two parts. One is the neural identifier which is used to estimate the motor speed. The other is the neural controller which is used to generate a control signal for a converter. These two neural networks are trained by Levenberg Marquardt back-propagation algorithm. ANNs used in this are the standard three layers feedforward neural network with sigmoid activation functions in the input and hidden layers while linear activation function is employed for the output layer. The conventional constant gain feedback controller fails to maintain the performance of the system at acceptable levels under unknown dynamics in load torque. On the other hand, ANNs act as an effective tool to implement the model and adaptive control in a complicated non-linear system having expansive allocations.

Keywords: *ELECTRIC motor, MATLAB, DAQ card, ANN Controller.*

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1. Introduction

Nowadays, the field of electrical power system control in general and motor control in particular has been researching broadly. The new technologies are applied to these in order to design the complicated technology system. One of these new technologies is Artificial Neural Network (ANNs) which based on the operating principle of human being nerve neural. It is composed of a large number of highly interconnected processing elements (neurons) working in unison to solve specific problems. ANNs, like people, learn by example. An ANN is configured for a specific application, such as pattern recognition or data classification, through a learning process. Learning in biological systems involves adjustments to the synaptic connections that exist between the neurons. This is true of ANNs as well. There are a number of articles that use ANNs applications to identify the mathematical ELECTRIC motor model. Then, this model is applied to control the motor speed. The inverting forward ANN with two input parameters for adaptive control of ELECTRIC motor ANNs are applied broadly because all the ANN signal are transmitted in one direction, the same as in automatically control system, the ability of ANNs to learn the sample, From the very beginning, it has been realized by systems theorists that most real world dynamical systems are nonlinear. However, linearization's of such systems around the equilibrium states yield linear models, which are mathematically obedient. In particular, based on the superposition principle, the output of the system can be computed for any arbitrary input, and alternately, in control problems, the input, which optimizes the output in some sense, can also be determined with relative ease. In most of the adaptive control problems, where the plant parameters are assumed to be unknown, the fact that the latter occur linearly makes the estimation procedure straightforward. The fact that most nonlinear systems thus far could be approximated

satisfactorily by linear models in their normal ranges of operation has made them attractive in practical contexts as well. It is this combined effect of ease of analysis and practical applicability that accounts for the great success of linear models and has made them the subject of intensive study for over four decades. In recent years, a rapidly advancing technology and a competitive market have required systems to operate in many cases in regions in the state space where linear approximations are no longer satisfactory. To cope with such nonlinear problems, research has been underway on their identification and control using artificial neural networks based entirely on measured inputs and outputs.

2. Background

The purpose of this research is to improve the tolerance of controller output for changes in system parameters with respect to time. The benefits of increasing the tolerance is that the controller can mitigate the disturbances in plant process to certain extend. For example, in case of motor operated valve used in polymer application, the valve friction increases if it's not operating for a certain period due to deposit of particles between seating area. This results in change in moment of inertia of rotor and the controller will not be able to give proper output because the tuned controller parameters correspond to the system without any friction. The PID controllers may produce overshoots as the performance of system deteriorates due to change in various system parameters. Self-tuning control strategies well suits for such system with time varying characteristics. Deep learning controllers find its applications in controlling complex nonlinear processes because of the approximation properties to predict precise output from the sample inputs. ELECTRIC motors are widely used in various control applications as final control element. These applications vary from robot arm control used in automation industry to feed pump driver in rocket engines. In literature [7] the authors proposed a deep learning controller for speed control of ELECTRIC motor which was designed by learning the PID controller. I

3. ANN CONTROL

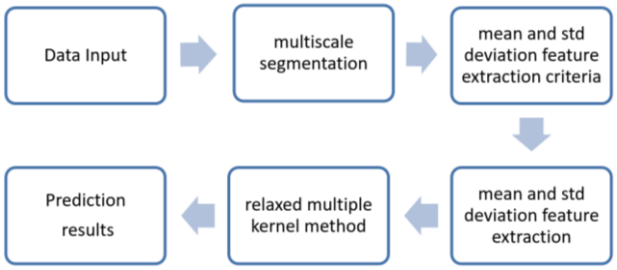

Figure 1. ANN Controller System

ANN controller architecture employed here is Non linear Auto Regressive Model reference Adaptive Controller [13]. Computations required for this controller is quite less. It is simply a rearrangement of the neural network plant model, which is trained offline, in batch form. It consists of reference, plant output and control signal. The plant output is forced to track the reference model output. Here, the effect of controller changes on plant output is predicted. It permits the updating of controller parameters. In the study, the frequency deviations, tie-line power deviation and load perturbation of the area are chosen as the neural network controller inputs [5]. Control signals applied to the governors in the area act as the outputs of the neural network. The data required for the ANN controller training is obtained by designing the Reference Model Neural Network and applying to the power system with step response load disturbance [7]. NARMA-L2 is one of the neural network architecture that has been implemented in the MATLAB for prediction and control. NARMA-L2 controller design is performed by two stages. 1. System identification and 2. Control design. In the system identification stage, the neural network model of the plant which is to be controlled is designed. For controller design, the plant model which is identified is used. The neurocontroller designed is referred by two different names. (i) NARMA-L2 control and (ii) Feedback Linearization control. When the plant model is in companion form, then it is said to be NARMA-L2 control and when the plant model can be approximated by companion form is feedback linearization control [11]. In NARMA-L2 control, the controller design is simply the rearrangement of plant model, which is trained offline, in batch form. It requires the least computation than model predictive and model

reference controllers. If neural network is used as a controller, the parameters of NARMA-L2 have to be adjusted to achieve on line control. Only approximated methods are used in practice for controlling [12].

4. Feed forward neural network structure

Recently, computational intelligence systems and among them neural networks, which in fact are model free dynamics, have been used widely for approximation functions and mappings. The main feature of neural networks is their ability to learn from samples and generalizing them and also their ability to adapt themselves to the changes in the environment. In fact, neural networks are very suitable for problems in the real world. These networks with participation of a special kind of parallel processing are able to provide the modeling of any kind of nonlinear relations. Higher accuracy, robustness, generalized capability, parallel processing, learning static and dynamic model of MIMO systems on collected data and its simple implementation are some of the importance characteristics of the neural network that caused wide applications of this technique in different branches of sciences and industries, especially in designing of the non-linear control systems [9] [20]. The salient feature of artificial intelligent technique is that they provide a model-free description of control systems and do not require the ac-curate model of the plant. Thus, they are very suitable There are some deviations and uncertainties due to changes in system parameters, characteristics and load variations in power systems that for the controller design have to be considered. On the other hand, very high (and unknown) model order, uncertain connection between subsystems; broad parameter variations and elaborate organizational structure of the power system preclude direct application of standard robust control methodologies. In order to overcome this drawback, we propose a new Non-linear Artificial Neural Network (NANN) controller based on μ-synpaper technique. Figure 5 shows the designing procedure of the NANN proposed controller for two-area power system. The Multi Layer Perception (MLP) neural networks for the design of the nonlinear AGC controller in two areas power systems are being used.

5. Implementation

3.1. Data Collection: In any case we will give a short presentation on the information assortment. Te ongoing information of movement status and battery status, gathered by vehicle-mounted data assortment gear, was shipped off the far off information observing focus each 5~10 seconds by GPRS remote transmission organization, and for capacity.

3.2. Data Processing. Te data about vehicle state and battery status communicates through the remote organization. Simultaneously, the transmission can be affected by many elements, for example, climate, building thickness, channel conflict, information dependability, etc. Therefore, there will be information misfortunes and blunders in the gathered information.

3.3 Random forest Model:

An Random-forest is an AI procedure that is utilized to take care of relapse and order issues. It uses group realizing, which is a strategy that joins numerous classifiers to give answers for complex issues.

An Random-forest comprises of numerous choice trees. The 'woods' produced by the irregular timberland calculation is prepared through packing or bootstrap totaling. Sacking is a troupe meta-calculation that works on the exactness of AI calculations.

The Random-forest calculation builds up the result dependent on the forecasts of the choice trees. It predicts by taking the normal or mean of the result from different trees. Expanding the quantity of trees builds the accuracy of the result.

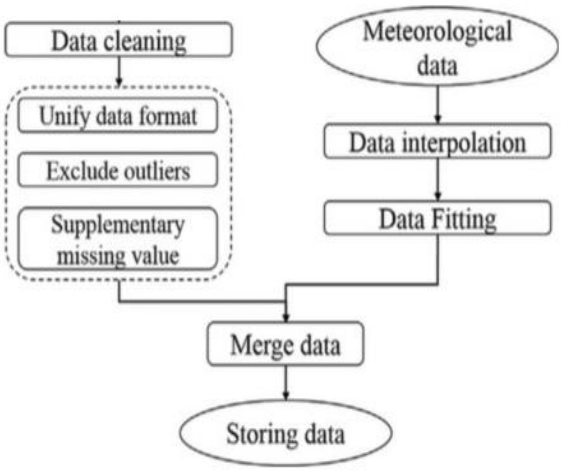

Fig. 2. Prediction Model

6. Results

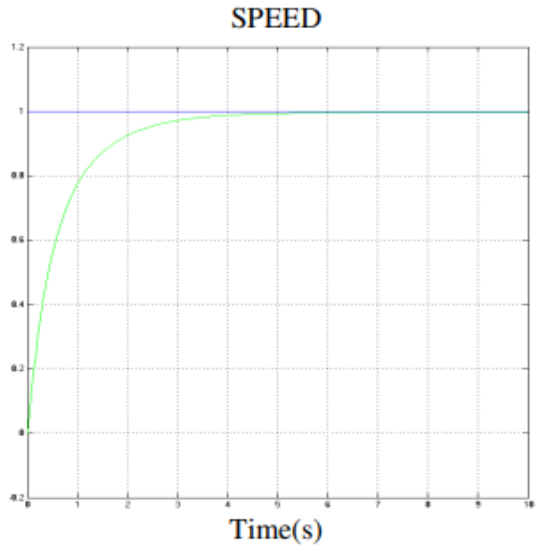

Figure 3. response of speed of ELECTRIC Motor with PID Controller

The above figure show the response of speed of ELECTRIC Motor without using Artificial Neural Network .tantalize the better result we need to apply a controller as Artificial Neural Network. to design a controller we used a simple feed forward neural network with reference signal.

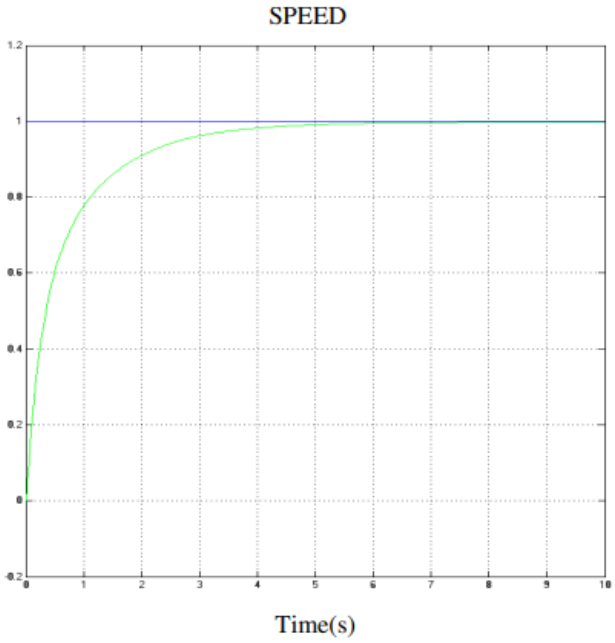

Figure.4- response of speed of ELECTRIC Motor with PID Controller with Tm1=75%Tm

The above figure shows the response of speed of ELECTRIC Motor without using Artificial Neural Network .with sully voltage to analyse the better result we need to apply a controller as Artificial Neural Network. To design a controller we used a simple feed forward neural network

1. CONCLUSION

The ELECTRIC motor has been successfully controlled using an ANN. Two ANNs are trained to emulate functions: estimating the speed of ELECTRIC motor and controlling the ELECTRIC motor, Therefore, and so ANN can replace sensors speed in the model of the control systems. Using ANN, we don‟t have to calculate the parameters of the motor when designing the system control. It is shown an appreciable advantage of control system using ANNs, when parameters of the ELECTRIC motor is variable during the operation of the motors. The satisfied ability of the system control with ANNs, ANN application can be used in adaptive controlling in the control system machine with complicated load. Nowadays, in order to implement the control systems using ANNs for ELECTRIC motor on actual hardware, the ANN micro processor is being used. Artificial Neural Network was used as a trainable non-linear mapping system. The speed of a self exited electric motor was controlled using the proposed ANN based adaptive controller. The details of development of the proposed controller were presented, including all analytical derivations. Programming and implementation details including hardware interfacing were given as well, for both the computer setup and the physical experimentation. To controlled speed of ELECTRIC Motor we used PID Controller for tuning the ANN to improve accuracy of speed. During the experimentation and after observing the results it has been proved that the proposed ANN based controller has a good ability to control the speed of the Separately excited electric motor, which shows the non-linearity behavior. Experimental results verify that this ANN and PID controllers both are controlled of speed of ELECTRIC Motor with comparatively result.

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