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A Fuzzy Neural Control System

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ABSTRACT

This research is an introduction to Neural Network Control, concepts about it, and current and past works relating to this topic. There are many uses of neural network control in the field of electronics engineering specifically in the study of feedback and control systems. Some of the concepts to take note about neural network control are the topologies, multi-layer controller, single-layer controller, and feedback linearization. Other topics and discussions related to neural network control will also be expounded in this journal.

Key words: Neural Network, Control Systems, Electronics, Feedback Systems

1. INTRODUCTION

One of the concepts to take note of when talking about neural networks is that it is somehow based on the structure of biological nervous systems of humans as well as animals, which are tiny processing units that are connected to one another in order to create a complex network of both learning and adaptation. And this idea is not a new concept since it has been discussed in the past, specifically in the 1940s on the relating to binary threshold neuron where perceptrons were noted to like tools that are flexible when viewed from the perspective of performance of many different tasks. Another important topic relating to neural network control is the closed-loop control since it is the one responsible for giving the theoretical as well as the big difference when it comes to the controlling of nonlinear dynamical networks.

According to a journal by Chen, C., et al., Artificial Neural Network or NN may be defined as not only the practical but also the elegant as well as the mathematical machine when it comes to learning models. There was also a time when the use of neural networks was somewhat “stopped” after a publication by Minsky and Papert, entitled Perceptron on the year 1969 was published since it discussed the capabilities of perceptrons and that neural networks were mathematically proven as it cannot do much. With this, it was easily hypothesized that all neural networks could not do much, however what was not seen was that it only applies to some specific perception types and not for all neural networks. In current time, neural network is now seen as a big thing, especially with the rise of artificial intelligence.

Since neural networks are now considered as a big help in the topic of artificial intelligence, there have been various works that are about the study and discussion on neural networks and some of which are created with suitable conditions put into consideration. Also, there are studies that show that to be able to have a better investigation regarding the dynamic behavior of it, synchronization should be present.

In the said journal by Chen, C., et al., the combination of the closed-loop control method to the neural network in order to gain control of the system being targeted is applied in the control of the closed-loop. Discussion and analyzation of the global, finite-time, as well as the closed-loop control framework for a certain type of nonlinear neural network, are also included [1].

2. LITERATURE REVIEW

One of the concepts that are important when considering neural networks are the neurons. A paper that was published by McCulloch and Pitts in 1943 discussed the binary threshold neuron. In this paper, neurons are considered as propositional logic, this is because of the “all-or-none” characteristics that are present in the nervous activity relating to not only the neural events but also with its relation to one another, neuron to neuron. The most important to take note in this paper is the assumption that neurophysiological assumptions are equivalent when it is viewed in the sense wherein every net that behaves in a considered assumption, there is also another net which behaves under another assumption which is able to have an output of the same result with the first one [2].

Another paper, which is by Chen discusses the delayed Hopfield neural networks as well as the investigation of the global exponential stability. There were also given conditions that are enough in making sure that the global exponential stability is obtained [3].

Lastly, in the paper of Zhu S., et al., a discussion on the globally exponentially stable neural network is broadened with some topics on time-varying delay as well as with topics dealing on bounded noises which is able to converge faster compared to those that do not have noise. Also present in the

paper is a quantitative analysis of the influence of noise with regards to the global exponential stability of delayed neural networks [4].

3. THEORETICAL CONSIDERATIONS

There are many uses for neural networks and one of this is for approximations in nonlinear dynamic plants which is a topic dealing with control system design. In this paper from Quanmin, Z., et al., a study on a universally feasible U-neural network structure in facilitating a said design control for every dynamic system that is modeled with the use of equations that deal with linear as well as nonlinear polynomial state space. The paper also presented a study which is a proposal for a procedure in modeling independent control system design. A study on an analysis for properties of the U-control as well as a given step-by-step implementation for it [5].

There are also computational models for control of voluntary movement which was in a journal and a sample of the computational model is shown below [6].

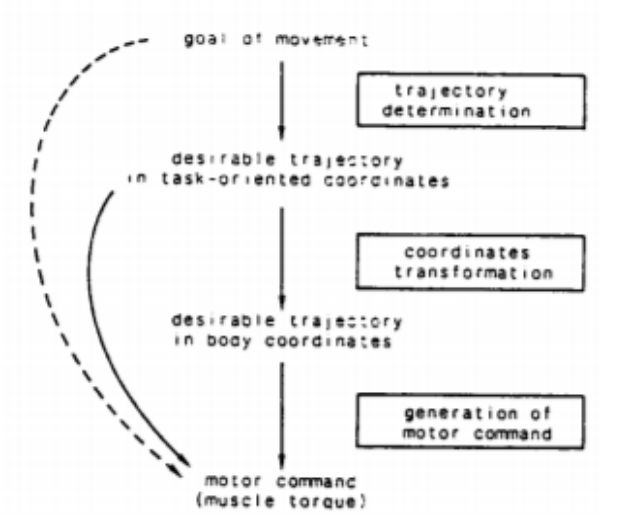

Figure 1: Control Model

Another paper which is from Liu, C., et al., is about a proposal to have a neural network control with the ability to be adaptive as well as containing fewer computations is stated in order to have a compensation for the uncertainty of the system. Another is a proposed control law as well as an adaptive law that gives proof for a uniform ultimate in the limits of the Lyapunov method. There is also a discussion on the effects of the number of hidden nodes relating to the adaptive neural network control for the topic of robot manipulators. Lastly, a proposal for a different approach is given in order to get the number of nodes that is sufficient which are not easily accessible for the said neural network control [7].

In another paper by Wang. F., et al., a discussion on the tracking control in relation to finite-time for a given stochastic quantized for a nonlinear system. The ideas which are discussed in this paper are far in comparison to the studies which are about the conventional finite-time control for the said systems. There is also a proposal for the adoption of how the ability of neural networks is approximated in the form of a strategy relating to adaptive neural control. The proof is shown with the combination of Jessen's inequality as well as the proposed criterion for the finite-time stability which was early on proposed. With this, the finite-time mean square stability of the mentioned nonlinear system will be given proof [8].

4. DESIGN CONSIDERATIONS

There are many different considerations for design on neural networks. One of these is from the paper by Yoo, Y. In the said paper a method is presented for the optimization of the hyper-parameter in deep neural networks. Another is the optimization for the performance of the network with the use of a univariate dynamic encoding algorithm which is mainly used for the purpose of searching. Also in the said paper is a proposal for the validation of a method that makes use of two models for the neural network having a data set from MNIST. Lastly, a computation for the amount in optimization of the hyper-parameter of the said network and also a fast convergence speed [9].

Also in another journal, there were comparisons in data obtained with predictions relating to the neural network of sunspots, as well as a hybrid prediction of sunspot, and ARIMA prediction of sunspot. A sample of the data from the journal is shown below [10].

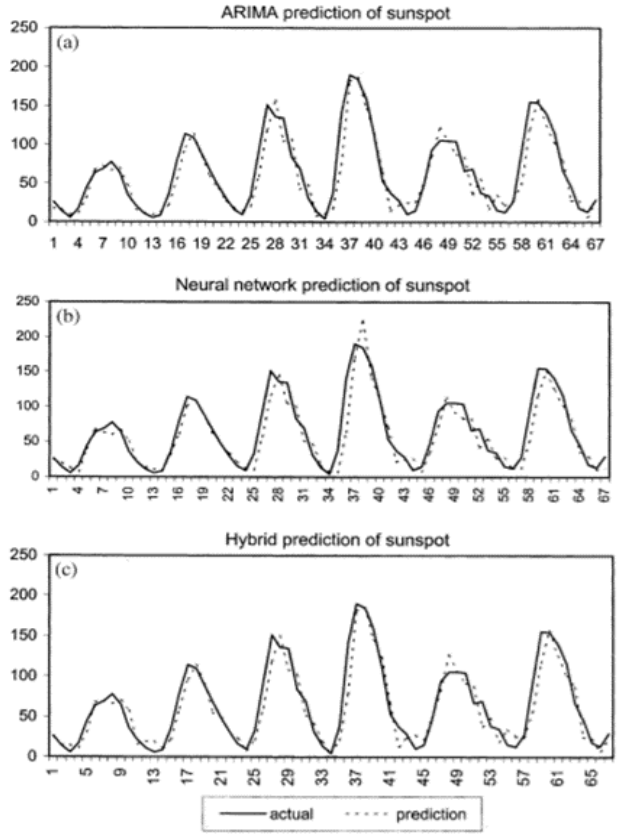

Figure 2: ARIMA Prediction This module has a powerful

The next design to be discussed is about a weight initialization method which was a paper by Jiang, N., et al. In this paper, there is a proposal for a novel controller in order to obtain a tracking synchronization for networked redundant manipulators. The authors of the paper were able to observe the neural weights from the studies that already existed were selected without concrete backup proof on why these weights were chosen which were noted to have a significant effect on the output desired by the researchers. The proposal of the researchers is a controller that contains methods that are universal and are assigned carefully. The tracking performance is improved by having the initial neural weight values near that of the ideal values [11].

Another example in this field is shown from data gathered from a journal titled Reducing the Dimensionality of Data with Neural Networks [12].

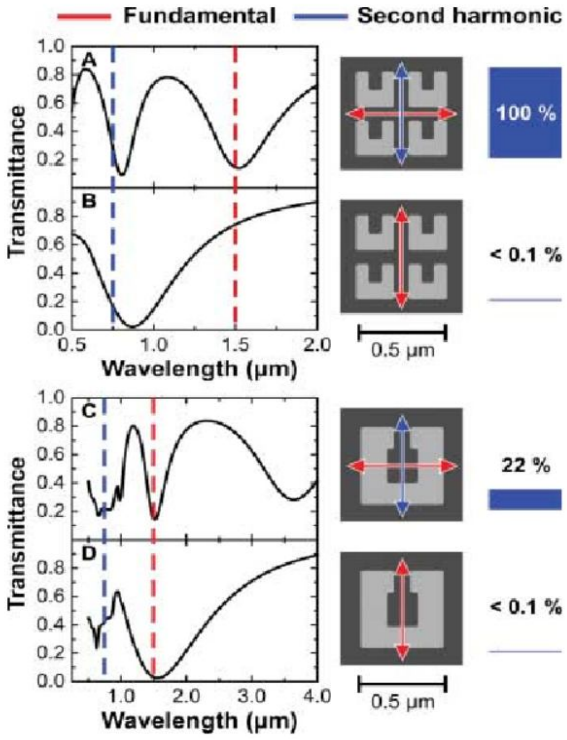

Figure 3: Fundamental Second Harmonic

Lastly, a paper by Tijskens, A., et al., discusses how neural networks could assist in building components. In the paper, the researchers proposed a metamodel which with the use of a memory mechanism would be able to give an output of an accurate prediction of the hygrothermal time series. Another is the recurrence of the neural network as well as the dilated causal convolution networks and these have the ability to obtain the complex patterns for the hygrothermal response. Next is the prediction for the relative humidity as well as the dilated causal convolution for the neural networks for the performance which is significantly better in comparison to the recurrent neural network. Lastly, there is also a dilated causal convolution for the networks which are able to be ten times faster compared to the train for the recurrent neural network [13].

In another journal, an example date from it is shown below which shows the interconnection among the cells and the response of the cells after the self-organization of it is completed [14].

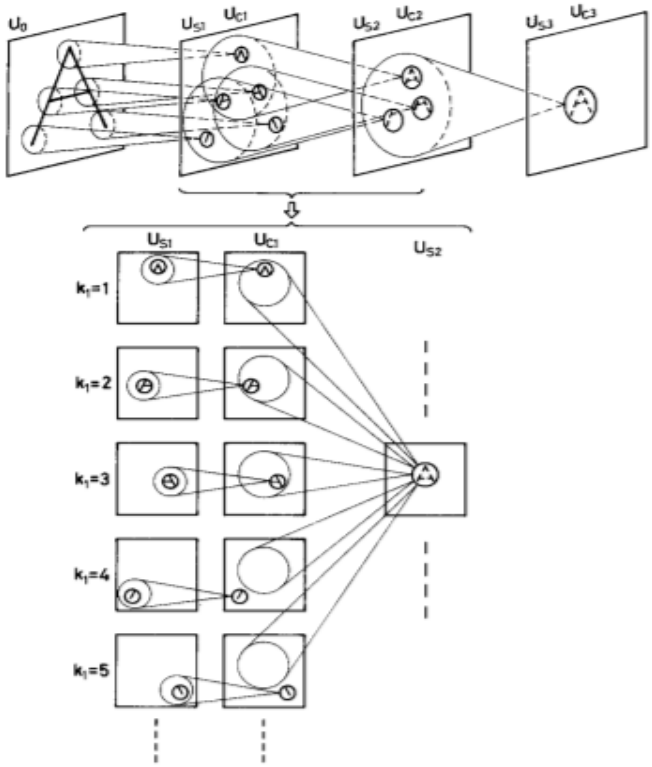

Figure 4: Fuzzy Neural System

Lastly, another is on the topic of Fuzzy Neural Networks (FNN) and the Type I, II, and III of FNNs are shown in the figure below [15].

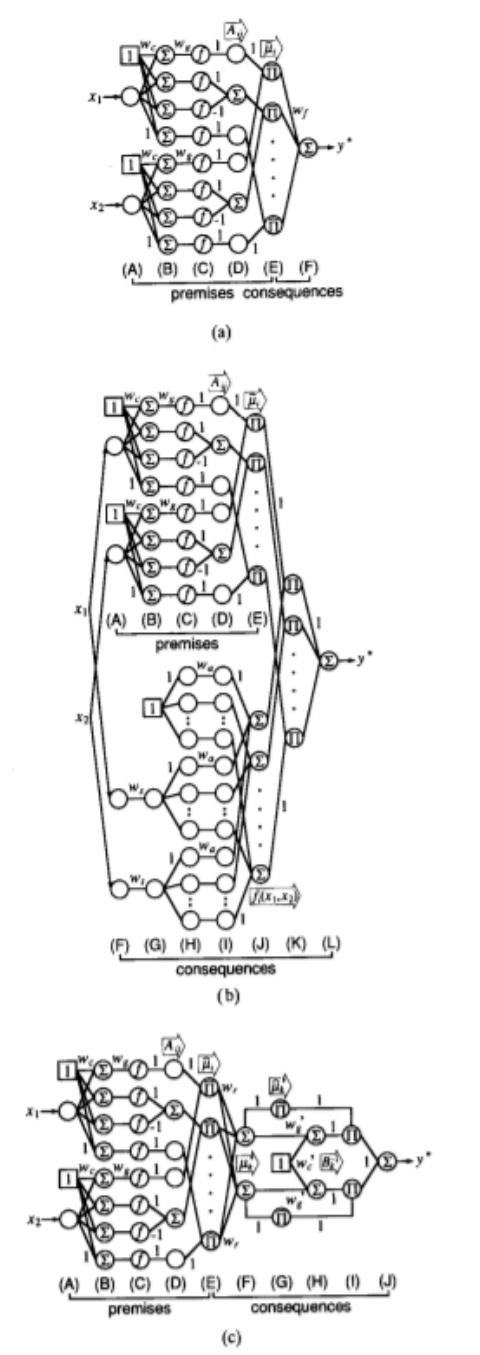

Figure 5: Fuzzy Neural System Types

5. CONCLUSION

It can be said that there are plenty of various uses of neural networks. Not only in terms of electronics engineering, specifically in feedback and control systems, but also in the field of artificial intelligence. In our world today, there are already various discoveries as well as inventions that are related to artificial intelligence. If this system is going to be programmed, it can follow the program structure of [16,17,18]. Its database configuration can duplicate the systems of [19, 20]. This paper concept can also be used in Machine Vision Systems [21,22,23,24]. Another Applications are PLC, System Diagnostics and Multipath Systems [25,26,27,28,29].

A very basic example of this is the artificially intelligent opponents that you can play with when you play chess or other games wherein the artificial intelligence gets an analysis on your moves and generates its own moves from it. This is just a basic example, today, there are already many different applications and experiments that have been done which are from the field of artificial intelligence. Also, a good lesson which may be derived from the discussions and the topics discussed in this paper is that one should not give up on the exploration for a certain topic after there are some findings and research which gives proof that a part of it would be unproductive to dwell upon, since a good example is neural networks, where there was a mathematical proof of perceptrons not having many capabilities.

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