IJCSE International Journal of Computer Sciences and Engineering Open Access
Research Paper Vol.7, Special Issue.3, Feb. 2019 E-ISSN: 2347-2693

Prediction of FX Data Using ANFIS and Ann with Combined Approach of Wavelet and Feature Extraction Technique

Richa Handa[1*], A.K. Shrivas[2], H.S. Hota [3]

[1,2]Department of IT, Dr. C.V. Raman University, Bilaspur (C.G.),India
[3]Bilaspur University, Bilaspur (C.G.), India

[*]*Corresponding Author: richihanda@yahoo.com, Tel.: 9893629888*

Available online at: www.ijcseonline.org

Abstract— This paper analyses the hybridization of intelligent techniques for time series data prediction of FX rate INR/USD to alleviate the limitation of statistical methods for non-linear data. This paper uses the feature extraction to extract the new features, five new features are extracted from the one original feature of INR/USD i.e Next week FX. Wavelet technique has been used for pre-processing the chaotic data series and prepares the de-noised data to get accurate prediction result. ANFIS is uses the non-linear functions and identify the non-linear components to predict the time series data with its fluctuating behaviour. Result came from ANFIS is compare with ANN technique, Error Back Propagation Network (EBPN). The empirical result of Hybridization of Wavelet and Feature selection with ANFIS and ANN shows that ANFIS produces the best prediction result with MAPE 1.568, MAE0.0136 and RMSE 0.0174.

Keywords-ANFIS(Adaptive Neuro-Fuzzy Inference System), ANN (Artificial Neural Network), Wavelet, Feature extraction

I. INTRODUCTION

To better understand the movement of FX rate for any country, prediction plays an important role done by many researchers and financial experts from last few decades. Many intelligent techniques are used to alleviate the limitation of statistical and conventional techniques for prediction of non-linear data. In this proposed research work combining approach of wavelet, Feature Extraction Techniques and ANFIS (Adaptive Neuro-Fuzzy Inference System) techniques are integrated to construct the predictive model for weekly FX rate prediction of INR/USD and compared with Hybrid approach with ANN.

In this proposed work wavelet is applied for pre-processing of data to remove noise without loss of information. Before de-noising, feature extraction technique has been applied based on our previous work [1] to taking out new features based on existing features. Feature extraction is usually the first step for constructing any time series data prediction model. These extracted features are given to the ANFIS and ANN models separately to get best and accurate prediction result from models. Fuzzy inference system utilizes fuzzy if-then rule to expert the model based on human behaviour, knowledge and reasoning [2] which is implemented in the framework of adaptive network [3].

The experiment was done by using self-written MATLAB code for ANFIS and ANN to train the model. The data is partitioned in Training and testing using k-fold cross validation technique. Mean Absolute Percentage Error (MAPE), Mean Absolute Error (MAE) and Root Mean Square Error (RMSE) are the error measurements used to check the accuracy of predictive model.

II. RELATED WORK

In this research paper many interesting research papers are included on FX rate prediction using different intelligent techniques. The review of literature also represents the hybrid approach by combining multiple suitable approaches for prediction. Author[4]has analyses the time series data using wavelet transform and GJR-GARCH model which is enhancement of GARCH model to improve prediction. Author [5] has discussed about the applications of wavelet indifferent fields and also done comparison between Fourier transform and wavelet transform.

To capture the large fluctuations of dataset, an Exponent back propagation neural network (EBPNN) is introduced by [6] ,The empirical research is performed in testing the forecasting effect of the EBPNN model and a comparison to back propagation neural network (BPNN). The outcome shown the advantages of EBPNN over BPNN. Different authors [7]–[9] give their suggestions and views to construct forecasting models. A hybrid ANFIS models are suggested by many authors [10]–[12] integrated with many intelligent techniques like SVR, feature selections and many more. A

hybrid ANFIS model with empirical Mode Decomposition (EMD) is suggested by author[13] for stock time series forecasting.

III. ARCHITECTURE OF PROPOSED WORK

The above figure 1 shows how the proposed model is going to work with combined approach of Wavelet and Feature extraction. Feature extraction has been applied to INR/USD data set and extracted 5 new features i.e SMA, EMA, WMA, Var and Std_Dev respectively, then after wavelet denoising is applied to all features including the original feature space.

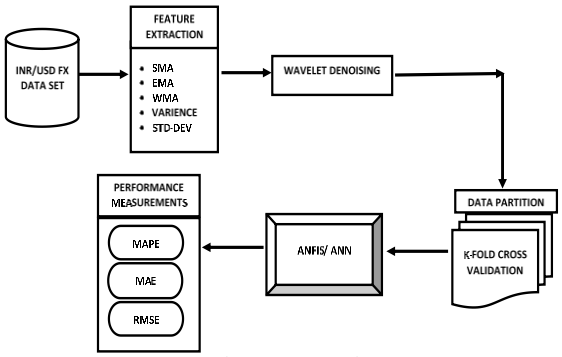


Figure 1. Process flow diagram of proposed work.

For data partitioning 10-fold cross validation technique has been applied[14] and given to ANFIS and ANN model for one week ahead prediction of FX rate data set and performance of measure by MAPE, MAE and RMSE.

IV. DATASET

In this proposed work 5 years INR/USD FX weekly data is consider here for experiment from site www.fx.sauder.ubc.ca. The data set is from period January-2012 to December-2017 with total 300 observations from site www.fx.sauder.ubc.ca. The data set is from period January-2012 to December-2017 with total 300 observations. Table 1 give the summarized information about dataset.

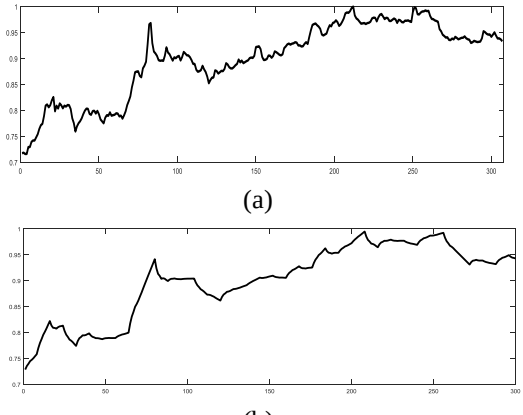
Table 1. Summary of dataset used in this research work.

Particular	Detail
Index Data	FX Data: INR/USD weekly data.
Period	01-January-2012 to 31-December-2017 (5 years)
Total # of Observations	300
Downloaded From	www.fx.sauder.ubc.ca
Data Partition	10-Fold cross validation

V. METHODOLOGY

A. *Wavelet*

Wavelet analysis is a mathematical function used to decompose original signals into different scale components[15]Wavelet is useful for signal processing and it also has an important application of signal denoising[16].Here in this paper MATLAB is used for wavelet analysis of signals using wavelet analyzer tool. There are different wavelet functions are available for wavelet denoising, here in this paper we have used Daubechies 2 (db2) wavelet at level 3 for reducing noise in FX rate data then analyze signal by decomposition at different scale. This denoised signal is then fed to the model as input signals and the result comes from this model is compared with original signal without wavelet denoising. Figure 2 depicts the Original and Denoised signal.



(a)

(b)

Figure 2. (a) Original INR/USD FX signal (b) INR/USD FX signal after de-noising using wavelet.

B. *Artificial Neural Network (ANN)*

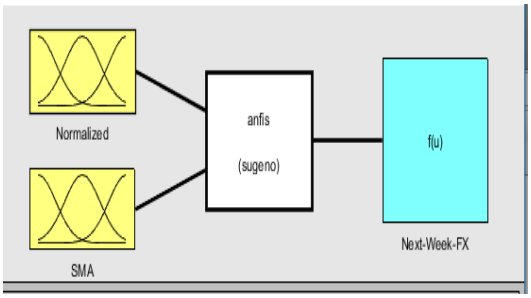
ANN is a computational model that is based on the working on neurons in brain. There are many ANN techniques has been used for prediction of time series data. In this research work Error Back Propagation Neural Network (EBPN) is used to construct the predictive model. EBPN is another method[17] of Artificial Neural Network (ANN), where the input is given to the input layer and it is propagated forward to the network until it reaches to the output layer then output comes from that layer is compared with actual output and then error value is calculated and then this error value is propagated back to the network and updates the weight and repeat until it comes nearer to the desired output [14].

C. *ANFIS*

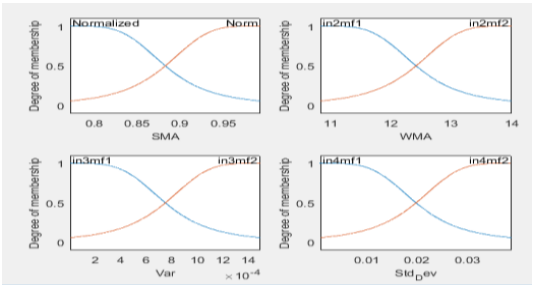
Integration of fuzzy system and neural network is known as Adaptive Neuro-Fuzzy Inference System (ANFIS) which easily convert the final model into if then rule. An adaptive system is a network that consist of nodes and directional links and there is no weight which is associated with it, input output behavior of overall system which is determined by the value of parameters that are modifiable through which nodes are connected[18]. An adaptive system is a multilayer feed forward network where each node is connected with the other node through a link and particular function is

performed by each node to the input signals to generate a single node output[3].

Most important thing while designing an ANFIS model is the number of membership functions during tuning of these parameters. A hybrid learning algorithm has been used by adaptive system to identify parameters of fuzzy inference system which is integration of Gradient descent method and lest square methods for training FIS membership function parameters to emulate a given training data set[19].



(a)



(b)

Figure 3. (a)Architecture of ANFIS (b) Generalized bell membership function (gbellmf) used in ANFIS in INR/USD data of indices SMA, WMA, Var and std_Dev.

The architecture of ANFIS is shown in figure3(a) where four features i.e. SMA, WMA, Var and Std_Dev are used as input, these inputs are given to the ANFIS model and 'gbellmf' is used as membership function of ANFIS and next week FX is generated as one output coming from the ANFIS model. ANFIS uses fuzzy if-then rule with appropriate membership function. In this paper generalized bell membership function is used, which specified by three parameters with function name 'gbellmf' as shown in figure 3 (b) and equation1.

$$bell(x;a,b,c) = \frac{1}{1+\left|\frac{x-c}{a}\right|^{2b}} \quad (1)$$

Where parameter b is usually positive, if b is negative then shape of MF become upside-down bell.

VI. Results and Discussion

This experiment is carried out with the hybrid technique of Wavelet and ANFIS with the five years historical FX weekly data collected from site **www.fx.sauder.ubc.ca**. We normalize the downloaded data set using simple normalization formula to range the value in between [0 1]. The new five features are extracted based on original feature as explained in section 4. Another pre-processing technique called wavelet is then applied to extracted features to reduce the noise from chaotic FX rate data as explained in section 5. After denoising of data all extracted features are given to ANFIS model and ANN model to check the accuracy of predictive model. The comparative study has been done between ANFIS and ANN model based on error measurements, so, it is observed that ANFIS is producing the better result in term of error measurements MAPE, MAE and RMSE as compared to ANN technique as shown in Table 2 and figure 4 depicts the comparison between ANFIS and ANN for FX prediction using error measurement MAPE.

Table 2: Comparative MAPE, MAE and RMSE on testing samples for INR/USD exchange rates using RRFST and ANFIS for 1-week-ahead prediction.

Technique	MAPE	MAE	RMSE
ANN	1.6142	0.0201	0.0145
ANFIS	1.5686	0.0136	0.0174

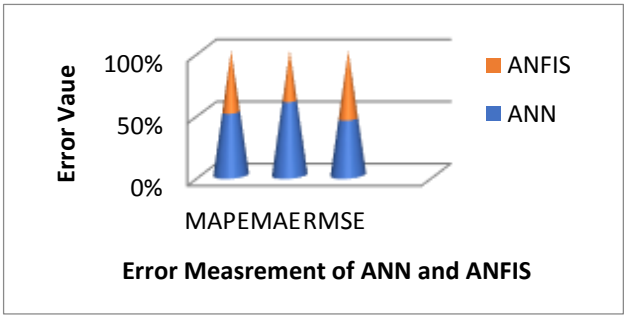


Figure 4. Comparative graph of ANFIS and ANN Technique using error measurement MAPE.

VII. Conclusion

In this paper a predictive model has been developed using combine approach of wavelet, Feature extraction, ANFIS/ANN for Next week FX rate prediction. This proposed work and predictive model can be concluded as new developed model where new features were extracted based on existing feature. Wavelet de-noising is used to construct the accurate predictive model by removing unwanted signals from it called noise which degrade the quality of signals. In this research work the result came from ANFIS model produce more accurate predictive result with

MAPE 1.568, MAE 0.0136 and RMSE 0.0174as compared to ANN model which are used for constructing the predictive model.

REFERENCES

[1] R. Handa, H. S. Hota, and S. R. Tandan, "Stock Market Prediction with Various Technical," vol. 3, no. 1, pp. 604–608, 2015.

[2] J. Shing and R. Jang, "anfis 93.pdf," *IEEE Trans. Syst. MAN Cibern.*, vol. 23, no. 03, pp. 665–685, 1993.

[3] N. Walia, H. Singh, and A. Sharma, "ANFIS : Adaptive Neuro-Fuzzy Inference System- A Survey," *Int. J. Comput. Appl.*, vol. 123, no. 13, pp. 32–38, 2015.

[4] M. Gherman, R. Terebes, and M. Borda, "TIME SERIES ANALYSIS USING WAVELETS AND GJR-GARCH MODELS," no. Eusipco, pp. 2138–2142, 2012.

[5] M. Sifuzzaman, M. R. Islam, and M. Z. Ali, "Application of Wavelet Transform and its Advantages Compared to Fourier Transform," vol. 13, pp. 121–134, 2009.

[6] H. Mo, J. Wang, and H. Niu, "Exponent back propagation neural network forecasting for financial cross-correlation relationship," *Expert Syst. Appl.*, vol. 53, pp. 106–116, 2016.

[7] S. Acadmy, "IMAGE FUSION BASED ON STATIONARY WAVELET," *Int. J. Adv. Eng. Res. Stud.*, vol. 2, no. 4, pp. 99–101, 2013.

[8] C. Tan, "Financial Time Series Forecasting Using Improved Wavelet Neural Network Master ' s Thesis," 2009.

[9] B. Kozlowski, "Time series denoising with wavelet transform," *J. Telecommun. Inf. Technol.*, no. 1, pp. 91–95, 2005.

[10] S. Barak, J. Heidary, and T. Tichý, "Wrapper ANFIS-ICA method to do stock market timing and feature selection on the basis of Japanese Candlestick," vol. 42, pp. 9221–9235, 2015.

[11] A. Kazem, E. Sharifi, F. K. Hussain, M. Saberi, and O. K. Hussain, "Support vector regression with chaos-based firefly algorithm for stock market price forecasting," *Appl. Soft Comput. J.*, vol. 13, no. 2, pp. 947–958, 2013.

[12] C. H. Su and C. H. Cheng, "A hybrid fuzzy time series model based on ANFIS and integrated nonlinear feature selection method for forecasting stock," *Neurocomputing*, vol. 205, pp. 264–273, 2016.

[13] L. Wei, "A hybrid ANFIS model based on empirical mode decomposition for stock time series forecasting," *Appl. Soft Comput. J.*, vol. 42, pp. 368–376, 2016.

[14] R. Handa, A. K. Shrivas, and H. S. Hota, "PREDICTION OF FOREX DATA USING NEURAL NETWORK," vol. 14, no. 2, pp. 111–116, 2017.

[15] L. Wang and S. Gupta, "Time Series Analysis, Modeling and Applications," vol. 47, pp. 229–247, 2013.

[16] MathWorks, "Wavelet Denoising," pp. 1–22, 2017.

[17] J. Z. Wang, J. J. Wang, Z. G. Zhang, and S. P. Guo, "Forecasting stock indices with back propagation neural network," *Expert Syst. Appl.*, vol. 38, no. 11, pp. 14346–14355, 2011.

[18] J. S. R. Jang and C. T. Sun, "Neuro-Fuzzy Modeling and Control," *Proc. IEEE*, vol. 83, no. 3, pp. 378–406, 1995.

[19] K. Rezaei, R. Hosseini, and M. Mazinani, "a F Uzzy I Nference S Ystem F or a Ssessment of T He S Everity of T He," pp. 263–271, 2014.

