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An Online Simulation Model of a Digital Signal Processor (DSP) for Exchange Predictions

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Abstract
This paper, proposes an online prediction system exploiting Digital Signal Processing (DSP) techniques and an Artificial Neural Network (ANN) method in a dynamic simulation environment with real-time capabilities called SIMULINK. The proposed system is suitable for dealing with online markets and/or exchanges and has been applied to real-time data obtained from a financial widget price indicator.The results considering small and large percentage training inputs showed that the proposed system is able to predict the market price at accuracies of approximately of 90.2% and 100% respectively.

Keywords: *Online Markets, Neural Network, Percent Training, Prediction, Simulation*

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I. Introduction

Computers will remain an integral part of life; this is as a result of increasing number of areas where they have become indispensible. As a new application emerges computer practitioners are challenged and new systems or applications that address these new identified problems are designed and implemented. Sometimes, post implementation requirements crop up making modifications to already developed applications inevitable or engendering the need for a new application that encompasses all the requirements altogether (Charles, 2001).

Exchange markets have gained in popularity with the FOREX markets top on the list of trades that have been widely utilized. More formally, online marketing refer to any form of trading i.e. buying and selling including advertising that take place over the internet. Online markets are a way of making business more convenient for businesses which may be far away from one another. Through distant communication networks such as telecommunication, sub-sea optical fiber links and web programs over the internet framework these form of marketing have been made possible. In recent times there have been calls to make online marketing more intelligent, in particular helping businesses to survive stiff competition over the internet. We see this as a challenge since there is vast amount of online markets with a heavy presence on the internet.This research seeks to develop a system for online exchange rate using a Digital Signal Processing (DSP) statistical model.

II. Related studies

Several DSP statistical models have been used in forecasting online markets like electricity price market, stock markets, crude oil markets, widget market etc.

Du et al (2015) studied online market trends for product searches in Market response modelling. They proposed the notion that feature search trends are positively correlated with feature importance trends.

Wagner et al (2011) proposed a time series forecasting technique for dynamic market predictions in real world food distribution system.

Kuang and Chuen-Jiuan (2009) used the moving average autoregressive exogenous (ARX) prediction model and combined it with grey system theory and rough set theory to create an automatic stock market forecasting mechanism. The financial data used were collected automatically every quarter and were used in the ARX prediction model to forecast the future trends.

Fernandez (2010a,b) performs an out-of-sample forecast for short and long term horizons, employing daily natural gas and Dubai crude oil prices from 1994 to 2005 using an ARIMA(autoregressive integrated moving average) model. The results indicate that for very short-horizon forecasts, the ARIMA (autoregressive

integrated moving average) model performs better than the artificial neural networks and the support vector machine approaches but however for long-horizon forecasts, the performance of the ARIMA (autoregressive integrated moving average) model quite poor compared to the other approach.
Silva et al. (2010) investigated the performance of the hidden Markov model (HMM) to forecast the medium term future crude oil price movements. Their approach was based on a nonlinear time-series model which uses past time-series data to predict future oil prices.
Xie et al. (2006) used the ARIMA (autoregressive integrated moving average) method to predict WTI crude oil spot prices from January 1970 to December 2003. The results gotten were compared with those of support vector machine (SVM) and artificial neural networks methods. The ARIMA model was however unable to perform well compared to the other models.
Wang et al. (2004) used ARIMA (autoregressive integrated moving average) to model the linear component of monthly WTI crude oil data from January 1970 through December 2003. From out-of-sample forecasts indicators, it was discovered that linear ARIMA models exhibits poor prediction power when compared to the nonlinear artificial neural network and the nonlinear integrated fuzzy expert system approaches.
Weron (2006) reviewed statistical approach for day ahead forecasting such as the ARMA (autoregressive moving average) type, ARMAX, GARCH type, regime-switching etc.
Zareipour (2012) reviewed several linear time series models including but not limited to the ARIMA, ARX, ARMAX and nonlinear statistical models such as regression trees, artificial neural networks. These tools where then used to hourly forecast prices in the Ontario power market.
Khan et al (2011) developed a price prediction market model using artificial neural network (ANN). An ANN model was developed using a back-propagation algorithm and multilayer feed-forward network for the Bangladesh Stock Exchange Market which gave some realistic levels of accuracy.
Cheema et al (2019, 2020) developed forecasting technique for stock market data including multivariate time series for near-term stock market forecast using sentiment analysis (Cheema et al., 2020) and with oil price feature embedding influence (Cheema et al., 2019).
Li et al. (2011) presented an ARMA model combines with wavelet transform for wind speed prediction. The wavelet transform is used to pick up the low frequency parts of the whole wind speed. ARMA model is used to forecast the wind speed on the gentled data.
Hsien-Lun et al (2010) used ARIMA model and vector ARMA model with fuzzy time series method for forecasting. Fuzzy time series method especially heuristic model performs better forecasting ability in short-term period prediction. The ARIMA model creates small forecasting errors in longer experiment time period.
Palomares Salas et al. (2009) used an ARIMA(autoregressive integrated moving average) model for time-series forecast involving wind speed measurement. The results gotten show that ARIMA model is better than back propagation neural network for short time-intervals to forecast.
Abdulsalam et al (2010) used the moving average (MA) method to obtain values of variables from the database to predict the future values of other variables through the use of time series data. The advantage of the MA method is that it basically reduces fluctuations and shows the direction of trends with a fair degree of accuracy. The inputs used are financial information obtained from the daily activity equities published by Nigerian stock exchange.

III. Modeling

In building algorithm for DSP based systems, the underlying theory of operation needs to be clearly understood. Here we focus on the DSP systemprediction based on Artificial Neural Network (ANN) since this is a popular technical indicator particularly useful for time series exchange market predictions or forecasts in the machine learning community. Other statistical models include the Simple Moving Average, the Weighted Moving Average and the Autoregressive Integrated Moving Average Models (the ARIMA models).

3.1 ANN

ANN is a technique that allows computers to replicate part of the core functionalities of the mammalian brain. By so doing, ANNs are typically referred to as biologically inspired data observers and learners (Corea, 2017). ANNs were first introduced in the early forties by the code named “Threshold Logic Unit” as described in an original research (McCulloch & Pitts, 1943). Then after, there was a downtime due to a paper by (Minsky &Passpert, 1969) for over 40 years until the development of back-propagation trained multi-layered feed-forward neural networks in (Rumelhart *et al*., 1986).
In this research study, we focus on an emerging ANN inspired by intelligent operations in mammalian auditory cortex, A1 full details of which can be found in (Osegi, 2023).

3.2 Proposed System

The proposed forecasting system has been developed in MATLAB SIMULINK (see Fig.1). The system uses an embedded MATLAB function block as DSP processing engine and accesses weekly exchange rate prices continually from the MATLAB workspace. In particular,the system uses an ANN method proposed in (Osegi, 2023) for signal processing and its routine is implemented in an Embedded MATLAB function block as shown in Fig.2.

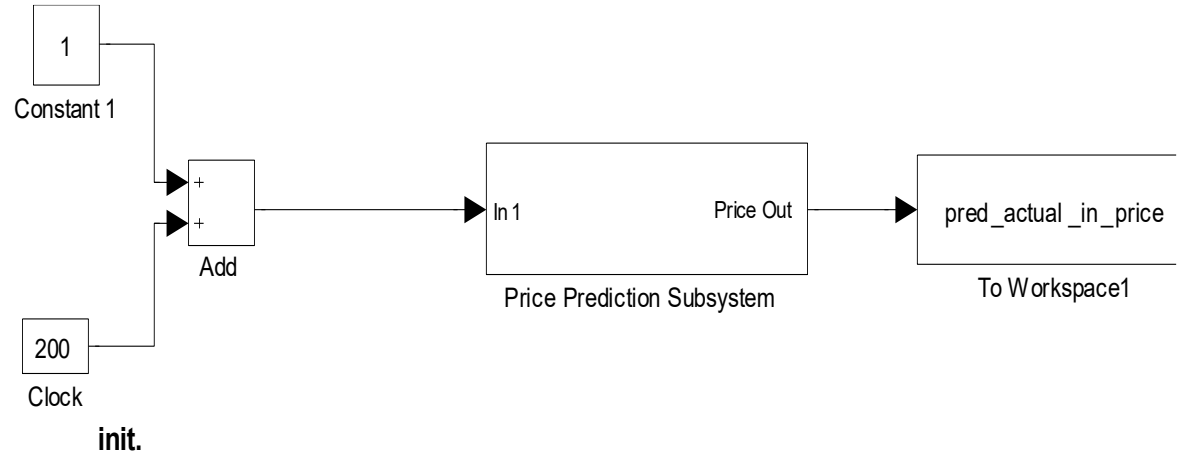

Fig.1.Architectureof proposed system model

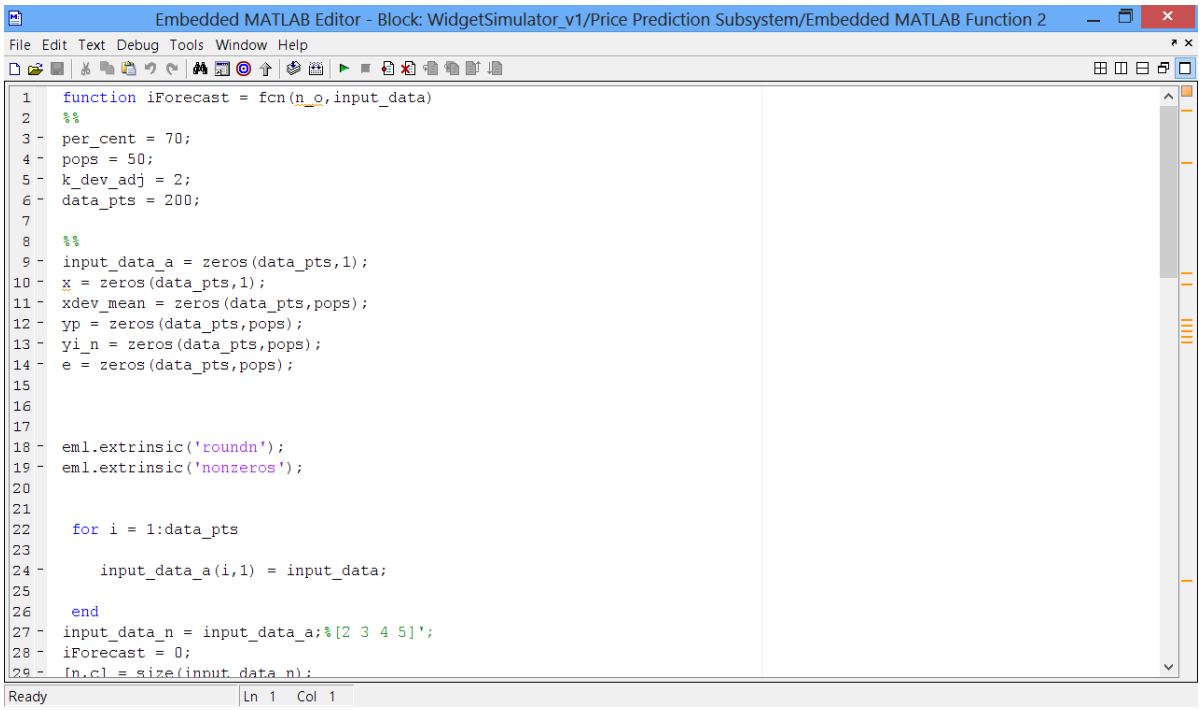

Fig.2. Embedded ANN routine snapshot

3.3. Dataset

The dataset represents simulated weekly price in USDbased on an online exchange trading company obtained wirelessly via streaming API widget financial indicator.For illustration purposes, only first 10 samples representing a streaming set of sequential data are as shown in Table 1.

Table 1: Weekly Exchange Market Widget Prices.

Weeks	Predicted price (USD)	Actual price (USD)
1	30.97	30.00
2	32.00	31.00
3	32.00	31.00
4	33.03	32.00
5	34.07	33.00
6	35.10	34.00
7	35.10	34.00
8	35.10	34.00
9	36.13	35.00
10	37.17	36.00

As can be seen from this data, the prices are not fixed but changes at each weekly time step.

IV.Results and Discussion

After developing the DSP ANN system model, it was simulated considering default ANN parameter settings of input percent training, neuron population anddeviant mean adjust equalling 30%, 50units and 2.0units respectively.

The resulting simulation is as depicted in Figure 3.

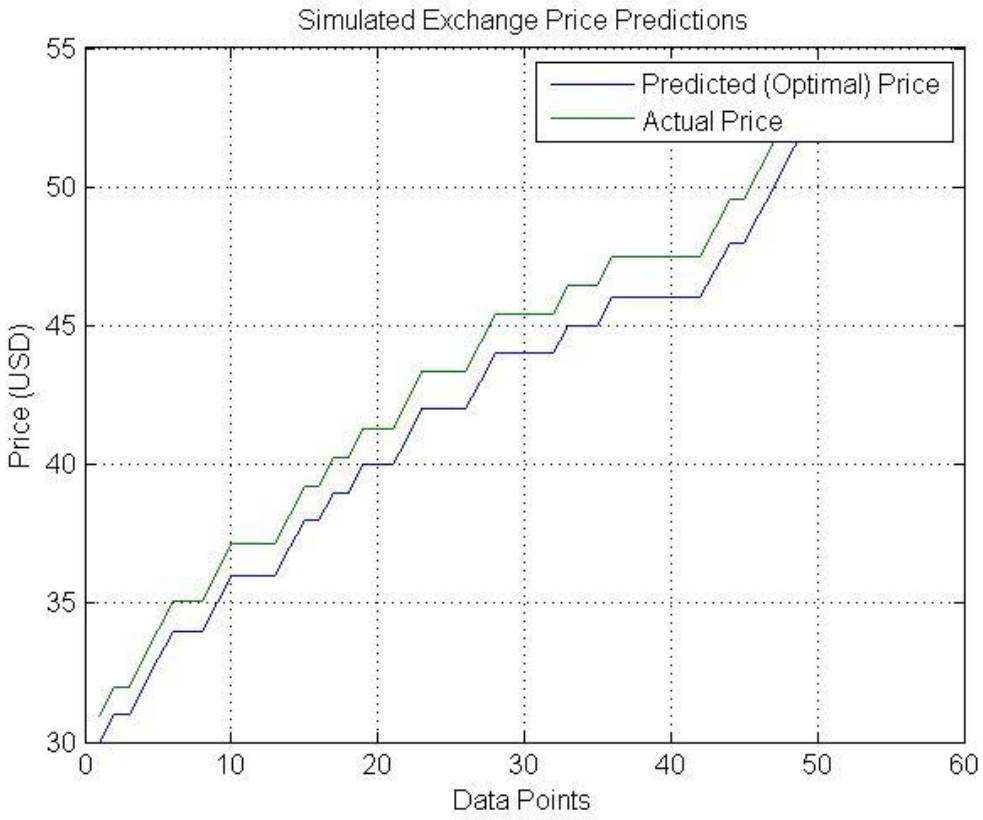

Fig.3. Result at the default ANN settings

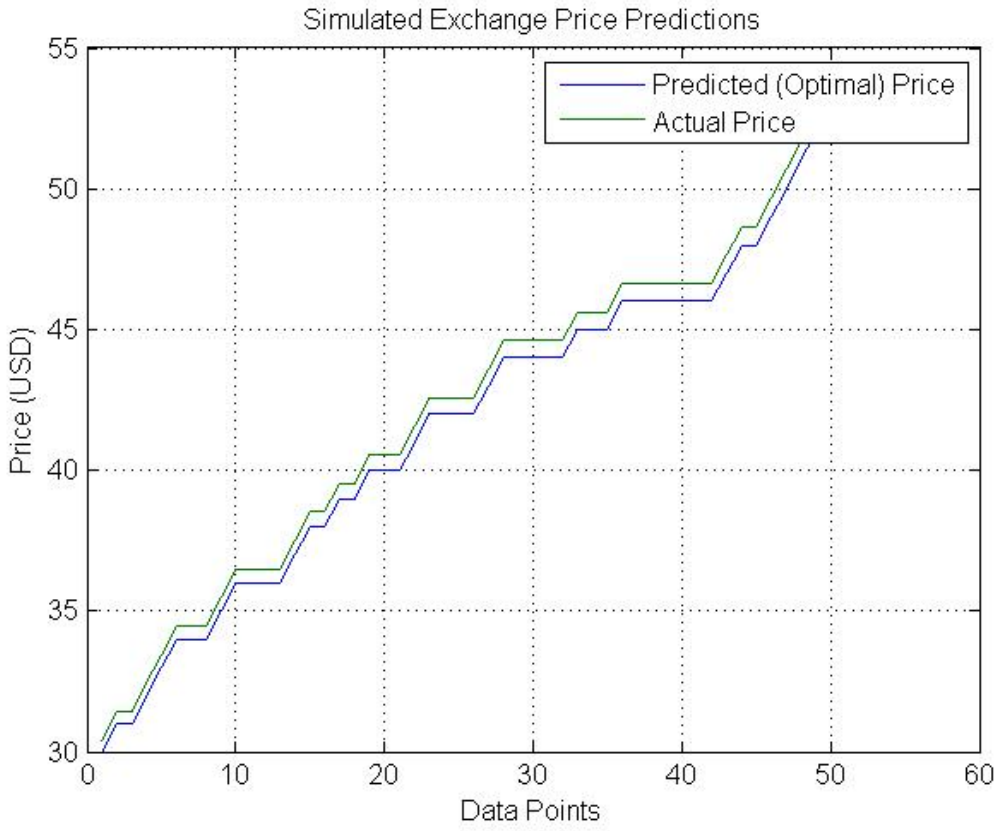

Fig.4. Result when input percent training is set to 70%,

4.1 Discussions

As can be seen from the simulated results, there are rough similarities between the predicted responses of the various techniques. Also consider. The simulated case, an accuracy of 90.2% was reported. However, by increasing input percent training to 70%, 100% accuracy was achieved; this enhancement in accuracy can be validated by the fitting plot as shown in Figure 4.

V.Conclusions

This study focused on the development of an online (continual) exchange rate market forecast tools using a DSP statistical learning modeling technique based on the moving averages technique. The moving average performs a trend forecasts or predictions by smoothing out fluctuations in data. The system was developed in the MATLAB-SIMULINK Signal processing blockset environment. Weekly forecasts of Widget prices for an auction company were predictedusing the developed model considering a unique ANN model.

The proof of concept for statistical learning of time series market data particularly when large variations exist is validated by changing percentage input data from small (30% of input data) to relatively large (70% of input data).

The proposed system has been implemented as a SIMULINK application. Using the system, online(continual) exchange rate market predictions can be carried out with minimum effort. The system is also adaptable to regular updates since it employs robust dynamic system model.

The developed system is recommended to DSP based online trading applications, web based exchange rate markets that employ some form of dynamic trading functionality. The system can also be used in organizations where some form of time series data needs to be analyzed and forecasted.

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