Developing a Forex Expert Advisor Based on Japanese Candlestick Patterns and Technical Trading Strategies

Watthana Pongsena, Prakaidoy Ditsayabut, Panida Panichkul, Nittaya Kerdprasop, and Kittisak Kerdprasop

Abstract—Foreign Exchange or Forex market is considered the largest trading market in the world. Trading in the Forex market, traders need to have a good trading strategy in order to make profits and be a successful trader. However, there are some factors that create limitations for many traders, such as, trading behaviors, emotions, and time. The development of Expert Advisor or EA allows automation of the analytical and trading processes under the MT4 platform. An EA with a good trading instruction can provide the ability to make profits and fulfill the limitations of human trades. In this research, we propose a novel EA that performs an automatically trade following the trading strategy. Our trading strategy is the combination between technical analysis including the ancient but powerful Japanese candlestick patterns and the modern technical indicators. The results of the evaluation by using the strategy tester function in the MT4 platform reveal that the proposed EA performs a good performance as it makes approximately 150 percent growth in a year. In addition, we perform an extensive experimentation in order to compare the performance of the proposed EA with the existing two EAs. The results show that the proposed EA have a better performance than both existing EAs testing in the same period of time and currency pairwise.

Index Terms—Expert advisor, automated trading system, foreign exchange market, forex, technical analysis.

I. INTRODUCTION

Foreign Exchange (Forex) is a global distributed market where all currencies are traded. Presently, Forex is defined as the largest financial market in the world with daily trading volume exceeding $5 trillion [1]. Trading in the Forex market, there are two types of strategies, which are commonly used for analyzing the movement of the market including fundamental and technical analysis [2]. Fundamental analysis is a technique of analyzing at the forex market by looking at news, financial reports, economic announcements, social and political forces [3]. Unlike fundamental analysis, technical analysis is a technique that uses charts as it is the easiest way to visualize historical data [4] and study the price movements [5]. When looking the chart, technical analysts are looking

for similar patterns that have been formed in the past and expects that movement of the price may act in the same way as it did previously [6]. In technical analysis, technical indicators are mathematical calculations based on historical data that are generally plotted as a chart pattern. There are several technical indicators, which often used, such as, Moving Average Convergence Divergence (MACD) [7], Relative Strength Index (RSI) [8], and Stochastic oscillator [9]. Many traders include these technical indicators to make it easier for them to forecast the market direction.

In order to make a profit and be a successful trader in the Forex market, a trader requires a powerful trading strategy and trades following the strategy. Various existing trading strategies have been developed since the Forex market is established. Some strategies are developed based on fundamental analysis [10]-[12], while some are based on technical analysis [13]-[17]. However, many traders still lose their money in forex trading, even if they have a good trading strategy. A majority problem due to the human trading behaviors [18]. For an instant, the survey conducted by Rodriguez in 2016 [19] demonstrates that many traders are doing well at the identification stage. They can identify profitable trading opportunities and when to close the trades out at a profit. However, they ultimately lost as the average loss far outweighed the gain because they cut-loss or close the trades earlier rather than let the profit run. A problem due to the emotion. Some traders when they lose a trade. They use their emotion instead of using their trading strategy to open another trade immediately with the expectation that they will get a capital return. This may lead to the loss in trade again. As the Forex market is considered to be a highly liquid [20] and a very sensitive market [21], every opened trade should be monitored carefully. This should be another problem for traders, who may have not enough time for monitoring the movement of the price.

Expert Advisor is a trading robot. In other words, it is an automated Forex trading program that allows automation of the analytical and trading processes in the Forex market under the use of Meta Trader 4 (MT4) platform [22]. The EA can be used for solving the problems of trading by human described above as it can analyze the data and trades following a given trading instruction [23]. In addition, EA is forced to stick with the instruction and takes the valid trade signals without emotions. Moreover, it reacts to quick market movements instantly, even it has the ability to trade while a trader away from the monitor. Several EA has been developed and published [24]-[25]. In this research, we aim to develop a novel EA based on the combination of the two technical analysis including the ancient but powerful

Japanese candlestick patterns and the modern technical indicators.

The rest of this research is organized as follows. Section II describes the data and the methodology used for conducting this research. The empirical results are discussed in section III. Finally, section IV represents our conclusions and makes suggestions for future research.

II. MATERIALS AND METHODS

A. Trading Strategy using Japanese Candlestick Patterns

In this research, we focus on using the technical analysis strategy to develop our trading instruction for our EA development including the ancient but powerful Japanese Candle Stick Patterns, especially the patterns related to the candlestick with the long shadows, combined with the popular technical indicators.

B. Candle Stick with Long Shadows

The upper and lower shadows of a candlestick can provide valuable information related to the trading period of time. Candlesticks with short shadows indicate that the prices swing near the open and close, while candlesticks with long shadows represent the prices widely swing far away from the open and close [26].

A candlestick with a long upper shadow and a short lower shadow indicates that the volumes of buy or long orders overwhelmed during the beginning of the session. However, the volumes of sell or short orders later forced the prices down. At the end of the session, the close created a long upper shadow. Conversely, a candlestick with long lower shadows and short upper shadows indicates that the volumes of sell or short orders dominated during the beginning of the session and makes the prices drop far away from the open. However, at the end of the session, the volumes of buy or long orders later forced the prices upward, and the close near the open creating a long lower shadow.
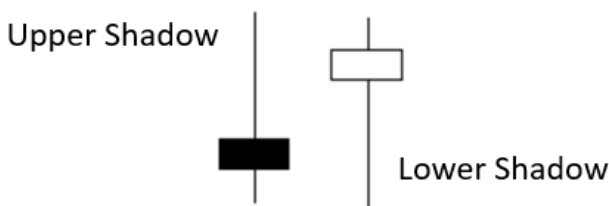

Fig. 1. Candlestick with Long Shadows.

C. Long Shadow Reversals

There are a couple of pairs of single candlestick reversal patterns. Generally, the candlestick in these patterns contains a small real body, one long shadow, and one short or non-existent shadow [27]. The first pair is Hammer and Hanging Man, and the second pair is Shooting Star and Inverted Hammer. The Hammer and Inverted Hammer form after a decline and are bullish reversal patterns, while the Shooting Star and Hanging Man form after an advance and are bearish reversal patterns [28].

D. Hammer and Hanging Man

The Hammer and Hanging Man look exactly alike, but they have a different meaning in term of the types of the reversal trend. Both Hammer and Hanging Man consists of a small real body (black or white), short or non-existent upper shadows and long lower shadows. The shape of the Hammer and Hanging Man show in Fig. 2.
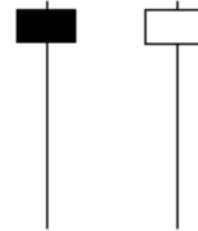

Fig. 2. Hammer and Hanging Man.

The Hammer is defined as a bullish reversal pattern that forms after the prices are decline continuously. In addition, the hammers potentially mark as the bottoms point or support levels. In contrary, the Hanging Man is defined as a bearish reversal pattern that can mark as the top point or resistance level. The conditions, which are used for determining whether it is the hummer or hanging man are described as following:

Hummer:
Trend = Down and Open – Close > 0 and LS > 2×Body

Hanging Man:
Trend = Up and Open – Close < 0 and LS > 2×Body,
where   Body = |Open – Close|,
        LS = Open – Low, if Open – Close > 0, and
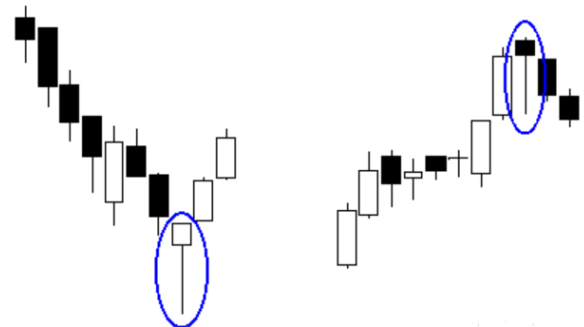   LS = Close – Low, if Open – Close < 0

Fig. 3. The example reversal patterns of the Hammer (left) and The Hanging Man (right).

E. Inverted Hammer and Shooting Star

Like the hammer and hanging man, the inverted hammer and shooting star look exactly like each other, but they are different implications due to the movement of the previous price. Typically, both the inverted hammer and shooting star candlesticks consist of a small real body (black or white), long upper shadows and small or non-existent lower shadows. The shape of the inverted hammer and shooting star show in Fig. 4.
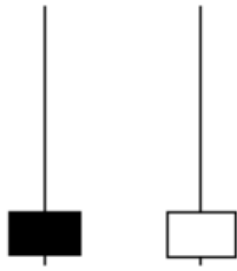
Fig. 4. Inverted Hammer and Shooting Star.

The inverted hammer is defined as a bullish reversal pattern, while the shooting star is defined as a bearish reversal pattern as illustrated in Fig. 5. The conditions, which are used for determining whether it is the inverted hummer or shooting star are described as following:

Inverted Hummer:
Trend = Down and Open – Close >= 0 and US > 2×Body

Shooting Star:
Trend = Up and Open – Close <= 0 and US > 2×Body,
where Body = |Open – Close|,
US = High – Close, if Open – Close > 0, and
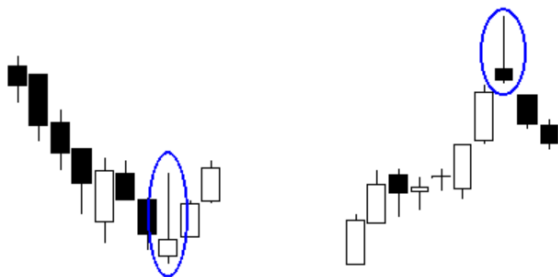US = High – Open, if Open – Close < 0

Fig. 5. The example reversal patterns of the Inverted Hammer (left) and the Shooting Star (right).

F. Technical Indicators

For technical analysis, traders can analyze trend and behavior of the market using indicators. Indicators represent a statistical approach to technical analysis as opposed to a subjective approach. By looking at money flow, trends, volatility, and momentum, they provide a secondary measure to actual price movements and help traders confirm the quality of chart patterns or form their own buy or sell signals.

Although using a candlestick with long shadow reversal patterns seem to be enough act on, they require further information in order to make the trading strategy more accurate [29]. For this reason, we have included the two popular technical indicators (Relative Strength Index and Stochastic Oscillator) in our trading strategy, which is used as an instruction for our EA development.

G. Relative Strength Index

The Relative Strength Index (RSI) was developed by Wilder in 1978 [30]. The RSI is an oscillator, which can be used for measuring the speed and change of price movements. The value of RSI can oscillate between 0 and 100.

Generally, RSI can also be used to identify the market prices. In Forex, for example, the RSI value is above 70 indicates that the currency pairwise is overbought (sell or short signal), while the currency pairwise is oversold when the RSI value is below 30 (buy or long signal). The basic formula of RSI is:

RSI = 100 – (100 / (1 + (Average of Upward Price Change / Average of Downward Price Change)))

Fig. 6. Using RSI indicator for technical analysis.

H. Stochastic Oscillator

The stochastic oscillator is a momentum indicator that demonstrated the location of the close relative to the high-low range over a set number of periods [31]. The value of the stochastic oscillator can be ranged between 0 to 100. In general, stochastic indicator displays as in the two lines graph, which is the fast oscillating %K and a moving average of %K (commonly referred to as %D). The basic stochastic (14 periods) is calculated as follows:

$$\%K = 100((C - L14) / H14 - L14)),$$

where C = Latest Close, L14 = Lowest low for the last 14 periods, and H14 = Highest high for the same 14 periods.

$$\%D = \text{simple moving average of } \%K$$

Typically, the currency pairwise considers as an overbought when the values of %K and %D above 80 (sell or short signal), while the values of %K and %D below 20 is considered an oversold (buy or long signal).

Fig. 7. Using stochastic indicator for technical analysis.

I. Overview of the EA

The EA is developed using Meta Quotes Language version 4 (MQL4). For trading instruction, we combine the technical strategies using Japanese candlestick patterns and indicators described in section II (A) and II (B) respectively. Fig. 8 shows the flow diagram of our trading strategy, which is used as an instruction for the EA.
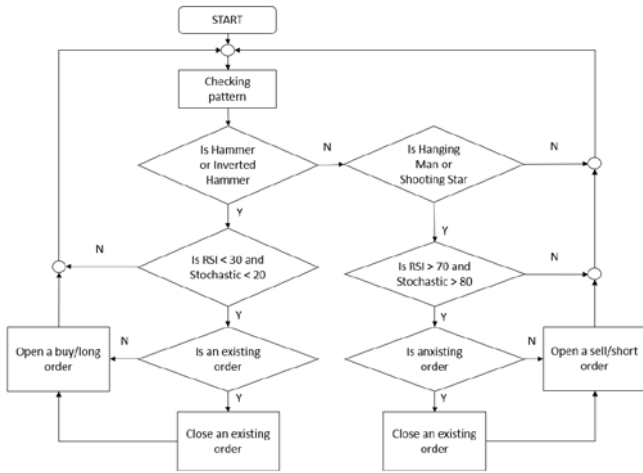

Fig. 8. The flow diagram of the trading strategy based on the combination techniques between candlestick with long shadow patterns and technical indicators.

The description of our trading instruction demonstrated as followed:

Sending Buy / Long ticket when:
1) The Hammer or the Inverted Hammer pattern occurs
2) The value of RSI < 30
3) The value of Stochastic < 20

Sending Sell / Short ticket when:
1) The Hanging Man or the Shooting Star pattern occurs
2) The value of RSI > 70
3) The value of Stochastic > 80

Sending Close ticket when:
1) A new pattern, which opposite the current order occurs.
2) The value of RSI > 70 if current order ticket = Buy, or the value of RSI < 30 if current order ticket = Sell
3) The value of Stochastic > 80 if current order ticket = Buy, or the value of Stochastic < 20 if current order ticket = Sell

Note that After the current order is closed, sending a new order ticket opposite the previous order immediately.

J. Evaluating the Performance of the EA

For performance evaluation, the proposed EA is evaluated using a strategy tester function (Back Test) [32] provided by the MT4 platform. The historical data used for testing is EUR/USD from 2017/01/02 to 2017/12/29. In addition, we also perform the tests, in the same environment in order to make it fair enough to compare the performance of the proposed EA and the two existing EAs, which are developed by Pinto and Silva in 2012 [24] and Osunbor and Egwali in 2016 [25].

III. RESULTS AND DISCUSSIONS

Fig. 9 represents the testing journey of the proposed EA. An initial balance is set to $10,000. As can be seen in Fig. 9, on the final balance grew from $10,000 to $15,017.18 (approximately 150.18%). Based on this result, it could be concluded that the proposed EA performs good performance and can be potentially profitable.
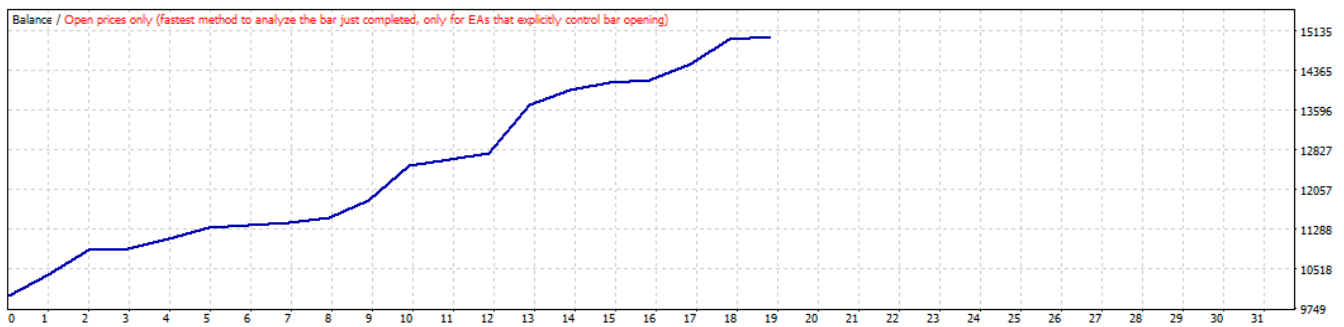

Fig. 9. The graphical representation of the profits produced by the proposed EA.
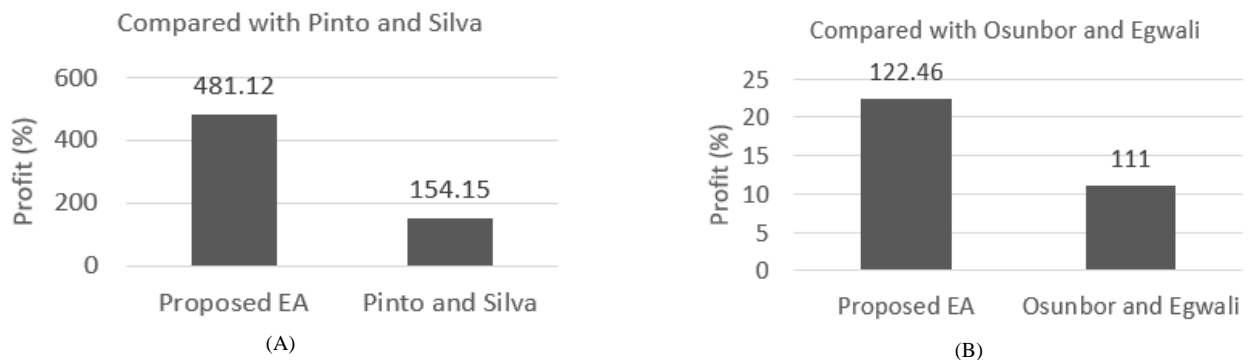

(A)

(B)

Fig. 10. The performance of the proposed EA compared with the existing EAs, (A) comparing with Pinto and Silva (2012) and (B) comparing with Osunbor and Egwali (2016).

We also perform an extensive experiment in order to compare the performance between the proposed EA and the existing ones. Fig. 10 shows the percentage of the profits produced by each EA. As is illustrated in Fig. 10 (A), the proposed EA produces benefits 481.12% while the EA proposed by Pinto and Silva produces 154.15% growth in the financial balance. As can be seen in Fig. 10 (B), the proposes EA makes 122.46% growth while the EA developed by Osunbor and Egwali makes approximately 111% growth. Based on these results, it could be concluded that the proposed EA performs a better performance than both existing EAs.

IV. CONCLUSION

There are some limitations of the human for trading in Forex market due to the trading behaviors, emotions and time. The development of EAs provides the ability to automatically analyze and trade following the trading rules or instructions. Using EA, it can fulfill the limitation of human trades. In this research, we propose a novel EA that performs automated trades following the instructions. The trading strategy, which is given as the trading instruction for the proposed EA is the combination between the candlestick with long shadow patterns and the two popular technical indicators. The empirical results reveal that the proposed EA perform a good performance (approximately 50% growth in a year), even a better performance compared with the existing EAs.

REFERENCES

[1] M. Amiri, M. Zandieh, B. Vahdani, R. Soltani, and V. Roshanaei, "An integrated eigenvector--DEA--TOPSIS methodology for portfolio risk evaluation in the FOREX spot market," *Expert Syst. Appl.*, vol. 37, no. 1, pp. 509-516, 2010.

[2] C. Neely, P. Weller, and R. Dittmar, "Is technical analysis in the foreign exchange market profitable? A genetic programming approach," *J. Financ. Quant. Anal.*, vol. 32, no. 4, pp. 405-426, 1997.

[3] M. AbuHamad, M. Mohd, and J. Salim, "Event-driven business intelligence approach for real-time integration of technical and fundamental analysis in forex market," *J. Comput. Sci.*, vol. 9, no. 4, p. 488, 2013.

[4] C. D. Kirkpatrick II and J. A. Dahlquist, *Technical Analysis: the Complete Resource for Financial Market Technicians*. FT press, 2010.

[5] R. D. Edwards, J. Magee, and W. H. C. Bassetti, *Technical analysis of stock trends*. CRC press, 2007.

[6] Y. Kara, M. A. Boyacioglu, and Ö. K. Baykan, "Predicting direction of stock price index movement using artificial neural networks and support vector machines: The sample of the Istanbul Stock Exchange," *Expert Syst. Appl.*, vol. 38, no. 5, pp. 5311-5319, 2011.

[7] G. C. Friesen, P. A. Weller, and L. M. Dunham, "Price trends and patterns in technical analysis: A theoretical and empirical examination," *J. Bank. Financ.*, vol. 33, no. 6, pp. 1089-1100, 2009.

[8] T. Young, "Moving Average Convergence Divergence (MACD)."

[9] T. T.-L. Chong and W.-K. Ng, "Technical analysis and the London stock exchange: testing the MACD and RSI rules using the FT30," *Appl. Econ. Lett.*, vol. 15, no. 14, pp. 1111-1114, 2008.

[10] K. S. Kannan, P. S. Sekar, M. M. Sathik, and P. Arumugam, "Financial stock market forecast using data mining techniques," in *Proceedings of the International Multiconference of Engineers and computer scientists*, 2010, vol. 1, p. 4.

[11] R. M. C. Pinto and J. C. M. Silva, "Strategic methods for automated trading in Forex," in *proc. of 2012 12th International Conference on Intelligent Systems Design and Applications (ISDA)*, 2012, pp. 34-39.

[12] P. R. Kaltwasser, "Uncertainty about fundamentals and herding behavior in the FOREX market," *Phys. A Stat. Mech. its Appl.*, vol. 389, no. 6, pp. 1215-1222, 2010.

[13] M. AbuHamad, M. Mohd, and J. Salim, "Event-driven business intelligence approach for real-time integration of technical and fundamental analysis in forex market," *J. Comput. Sci.*, vol. 9, no. 4, p. 488, 2013.

[14] S. H. M. Yazdi and Z. H. Lashkari, "Technical analysis of Forex by MACD Indicator," *Int. J. Humanit. Manag. Sci.*, vol. 1, no. 2, pp. 2320-4044, 2013.

[15] M. Ozturk, I. H. Toroslu, and G. Fidan, "Heuristic based trading system on Forex data using technical indicator rules," *Appl. Soft Comput.*, vol. 43, pp. 170-186, 2016.

[16] R. Krishnan and S. S. Menon, "Impact of Currency Pairs, Time Frames and Technical Indicators on Trading Profit in Forex Spot Market.," *Int. J. Bus. insights Transform.*, vol. 2, no. 2, 2009.

[17] M. R. Adariani, "Evaluation of the profitability of technical analysis for Asian currencies in the forex spot market for short-term trading," *AU-GSB e-JOURNAL*, vol. 5, no. 2, 2012.

[18] M. Baddeley, C. Burke, W. Schultz, and P. Tobler, "Herding in financial behaviour: A behavioural and neuroeconomic analysis of individual differences," 2012.

[19] D. Rodriguez. (2018).Why Do Many Forex Traders Lose Money? Here is the Number 1 Mistake. [Online]. Available: https://www.dailyfx.com/forex/fundamental/article/special_report/201 5/06/25/what-is-the-number-one-mistake-forex-traders-make.html.

[20] L. Mancini, A. Ranaldo, and J. Wrampelmeyer, "Liquidity in the foreign exchange market: Measurement, commonality, and risk premiums," *J. Finance*, vol. 68, no. 5, pp. 1805-1841, 2013.

[21] F. Jin, N. Self, P. Saraf, P. Butler, W. Wang, and N. Ramakrishnan, "Forex-foreteller: Currency trend modeling using news articles," in *Proc. of the 19th ACM SIGKDD international conference on Knowledge discovery and data mining*, 2013, pp. 1470-1473.

[22] O. Volkov, "System and method for trading tournaments." Google Patents, 2012.

[23] B. Klapuch, "Trading Orders Algorithm Development: Expert System Approach," *Pattern Recognition and Classification in Time Series Data*, IGI Global, 2017, pp. 107-126.

[24] R. M. C. Pinto and J. C. M. Silva, "Strategic methods for automated trading in Forex," in *proc. of 2012 12th International Conference on Intelligent Systems Design and Applications (ISDA)*, 2012, pp. 34-39.

[25] V. I. Osunbor and A. O. Egwali, "Development of OSEG: A FOREX Expert Advisor.," *Pacific J. Sci. Technol.*, vol. 17, no. 2, 2016.

[26] T. Kamo and C. Dagli, "Hybrid approach to the Japanese candlestick method for financial forecasting," *Expert Syst. Appl.*, vol. 36, no. 3, pp. 5023-5030, 2009.

[27] M. C. Thomsett, "Powerful Timing Tools: Expanding Swing Signals with Candlestick Reversals," *Options for Swing Trading*, Springer, 2013, pp. 133-163.

[28] S. Nison, *The Candlestick Course*, vol. 163. John Wiley & Sons, 2004.

[29] Q. Lan, D. Zhang, and L. Xiong, "Reversal pattern discovery in financial time series based on fuzzy candlestick lines," *Syst. Eng. Procedia*, vol. 2, pp. 182-190, 2011.

[30] J. W. Wilder Jr, "The relative strength index," *J. Tech. Anal. Stock. Commod.*, vol. 4, pp. 343-346, 1986.

[31] L. Markus and A. Weerasinghe, "Stochastic oscillators," *J. Differ. Equ.*, vol. 71, no. 2, pp. 288-314, 1988.

[32] E. C. Nwokorie and E. O. Nwachukwu, "A model for trading the foreign exchange market," *West African J. Ind. Acad. Res.*, vol. 14, no. 1, pp. 13-17, 2015.

Watthana Pongsena is a Ph.D. student in the School of Computer Engineering, Suranaree University of Technology (SUT), Thailand. He received his B.E. and M.E. in computer engineering from Suranaree University of Technology, Thailand, in 2008 and 2012. His research of interest includes Software Engineering, Data Mining, Artificial Intelligence, and Human-Computer Interaction.

Prakaidoy Sitsayabut is a Ph.D. student in School of Biotechnology. Institute of Agricultural Technology, Suranaree University of Technology, Thailand. She graduated with a bachelor degree of Animal Production of Technology, Suranaree University of Technology in 2006. After graduation, In 2012, she graduated Master degree in School of Biotechnology, Institute of Agricultural Technology, Suranaree University of Currently, her research of interest includes animal reproductive technology and data mining.

Panida Panichkul is a lecturer at Faculty of Business Administration and Accounting (Business Computer Program), Sisaket Rajabhat University, Thailand. Her current research focuses on management information system and data mining.

Nittaya Kerdprasop is an associate professor and the head of Data Engineering Research Unit, School of Computer Engineering, Suranaree University of Technology (SUT), Thailand. She received her B.S. in radiation techniques from Mahidol University, Thailand, in 1985, M.S. in computer science from the Prince of Songkla University, Thailand, in 1991 and Ph.D. in computer science from Nova Southeastern University, U.S.A., in 1999. Her research of interest includes Data Mining, Artificial Intelligence, Logic, and Constraint Programming.

Kittisak Kerdprasop is an associate professor at the School of Computer Engineering, Chair of the School, and the head of Knowledge Engineering Research Unit, SUT. He received his bachelor degree in Mathematics from Srinakarinwirot University, Thailand, in 1986, MS in computer science from the Prince of Songkla University, Thailand, in 1991 and Ph.D. in computer science from Nova Southeastern University, U.S.A., in 1999. His current research includes Machine Learning and Artificial Intelligence.