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Weather Data Transmission Driven by Artificial Neural Network

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Abstract - **Nowadays, the trend of big data that can be describe as a massive volume and unstructured data have become more complicated because of its difficulty to be process using traditional database and software techniques. Due to increase in size of data, there also demand for big bandwidth for the transmission of big data. Data transmission is important in communication in providing information at different location. In this project we focus on big data transmission in the context of weather data. Weather data is important for meteorologist as it helps them to make weather prediction. Real time weather prediction is really important as it would help in making quick decision to react with the environment and planning for our daily activities. The purpose of this project is to develop a real time and low bandwidth usage for weather data transmission driven by an artificial neural network perform weather forecast using Adaptive Forecasting Model. This project seeks an application context offshore because the data transmission from offshore to onshore is very costly and requires high usage of network bandwidth. Other than that, offshore weather can change rapidly and cause offshore activity to be delayed.**

This research is important as it would help in making faster decision for oil and gas daily activity and avoid loss of human life in natural disaster in the fastest way. In this research we propose a neural network based prediction to control weather data transmission. This system mainly has several parts which consist of data gathering module, neural network prediction module and transmission module. The data gathering module is developed using ODroid weatherboard sensor while the prediction module is developed using an artificial neural network technique and algorithm to make prediction. The transmission module is based on TCP/IP protocol. The prediction module works by using the data captured by sensor to be processed using neural network prediction. If the neural network predict major changes in weather condition or detect bad weather, it will send the weather data and result to the server so that the data can be published and alarm meteorologist and people on the oil platform to avoid loss of human life or another contingency plan on the current oil and gas activity. But if there are no major changes in weather prediction result, the module will only update the server on a daily basis. In this project, we consider to capture atmospheric pressure, temperature, humidity, visibility, Infrared index, altitude and UV index. Real time processing and transmission weather data will show improvement in predicting weather and saving the network bandwidth transmission.

Keyword-- Weather data transmission, data transmission, big data, artificial neural network, prediction, tsunami-UD

1 INTRODUCTION

Real time weather data transmission is important nowadays to make quick decision and keep out of danger. Weather information are important for planning and making decision for our day-to-day activities. Weather information might help farmers plan for the planting and harvesting of their crops. Weather information also might help in predict natural disaster such as flood and El Niño so that we can make preparation before natural disasters strikes.

In offshore communication, they used satellite communication to communicate with onshore. They used satellite communication to transfer important data in real time and for normal communication. With this long distance communication, the offshore will easily be connected as offshore can be remotely controlled from onshore. With this communication also, no need for many people to be offshore as all decision can be decide from onshore remotely.

The application of Artificial Neural Network (ANNs) is becoming famous in oil and gas industry. Its usage had increased widely in areas of engineering, communication and economic. ANNs had been proved its success in application of prediction market trends. Therefore, ANN also can be used for weather data transfer prediction as it is expected this model can save network bandwidth.

The highlighted problem is how to improve the network bandwidth usage for big weather data transfer. There are major problems in weather data transmission from offshore platform to onshore that have cause by latency and speed of data transmission. The connection between offshore and onshore usually have limited bandwidth which make big data such as weather data slow and require high bandwidth to transfer. This problem has negatively impact the oil and gas activity on the oil platform as most of the activities require real time and accurate information to determine the production and activity on oil platform.

By successfully identifying the arise problem, three objectives has been derived which are to develop a weather data gathering module based on using Odroid-C1 weatherboard and sensor, to develop an Artificial Neural Network modelling approach for weather prediction and

to develop a real time weather data transmission triggered by neural network weather prediction.

The significance study of this project is this project can help in optimize the network bandwidth usage by using neural network to predict weather condition that can change at any time without notice by human observation. Based on the prediction of neural network, the data transfer to onshore can be reducing as only important data being transfer to onshore. This weather prediction module also can help in making faster decision in oil and gas daily activities. This project also might help save human life from natural disaster such as flood and thunderstorm.

2 RELATED WORK

a. Data Transmission

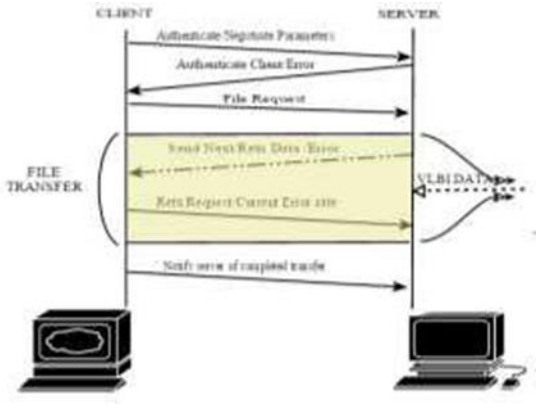


Figure 1: Tsunami UDP tranmission

Tsunami UDP: A fast user-space file transfer protocol that uses TCP control and UDP data for transfer over very high speed long distance networks designed to provide more throughput than possible with TCP over the same networks. The original early Tsunami UDP transfer protocol developed and released to the public in 2002 by Mark Meiss et al. at the Pervasive Technology Labs at Indiana University (IU). After release, several people have improved the code and have added more functionality. Currently two branched versions of the Tsunami UDP protocol, generic and real-time, are maintained by Metsähovi Radio Observatory / Jan Wagner.

Tsunami is one of several currently available UDP-based transfer protocols that were developed for high speed transfer over network paths that have a high bandwidth-delay product. Such paths can for example be found in the European GEANT research network. It can for example be a route from a local server PC to a local GEANT2 access node such as FUNET or SURFNET, then via GEANT's internal 10G to another country, and finally a local link via another node such as NORDUNET to some client PC. Currently these network links are capable of 1G..10G and can have some hundred milliseconds of roundtrip delay between the client and server PCs.

Custom UDP protocols are needed because average TCP/IP is not very well suited for paths with a large bandwidth-delay product. To take full advantage of the available bandwidth, the standard TCP slow-start congestion control algorithm needs to be replaced with e.g. HighSpeed TCP, Compound TCP, or one of several others. Some TCP parameters need to be tweaked, such as SACK, dynamic TCP window size. Most of the extended TCP features are already part of Windows Vista, with some partly implemented but not enabled in Windows XP and 2000. In Linux, far more extensive support and a much broader choice of options and congestion control algorithms is available.

Currently Tsunami runs in Linux and Unix. The source code should be largely POSIX compliant. It might be easily ported to Windows XP and Vista as they have a POSIX layer, but, porting has not been attempted yet.

In Very Long Baseline Interferometry, an interferometry based observation method in radio astronomy, the digitized noise recorded from stellar radio sources is often streamed over the network, and there's no requirement for reliable data transport as is guaranteed with TCP. A fraction of data can be lost without degrading the sensitivity of the method too much. In some cases, for example to maintain a high data stream throughput, it may be be preferred to just stream the data and not care about transmission errors i.e. not request retransmission of old missing data.

The Tsunami UDP protocol has several advantages over TCP and most other UDP-based similar protocols: it is high-speed (a maintained 900Mbps through 1Gbit NICs and switches isn't unusual), it offers data transmission with default priority for data integrity, but may also be switched to rate priority by disabling retransmissions. It is the most stable of the other available UDP-based similar protocols. Tsunami is completely implemented in user land and thus doesn't depend on Linux kernel extensions. It can be compiled and run from a normal user account, even a guest account, and does not need root privileges. The global settings for a file transfer are specified by the client - this is useful since the Tsunami user often has a priori knowledge about the quality of their network connection and the speed of their harddisks, and can pass the suitable settings through the client application to the server. Another benefit of Tsunami is that the client already contains a command line interface, no external software is necessary. The commands available in the Tsunami client are similar to FTP commands.

b. Artificial Neural Network

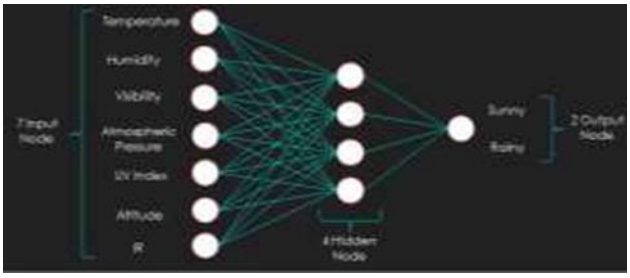


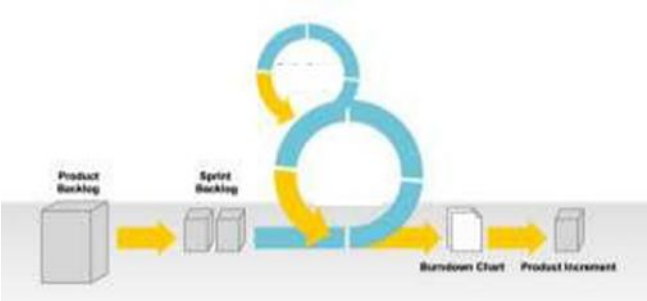
Figure 2: Neural network node design

Artificial Neural Network (ANN) has become popular and more frequently used because it has the ability to give solution without the use of conventional mathematical model (C. Siruvuri, S. Nagarakanti and R. Samuel, 2006) (R. A.Neto, N. Ebecken, L. P. Caloba and R. P. Bedregal) and it is not new. ANN is a powerful data modelling tool use complex computational to capture and represent complex input and output relationship that inspired from biological neural network. ANN was introduce together with Knowledge-Based Expert system (KBE) and Artificial Intelligence (AI) (T. Sadiq and I. Nashawi, 2000). ANN have proved that they were outstanding in predictive tools. Prediction of pattern and trend are example of success of ANN (T. Sadiq and I. Nashawi, 2000). ANN is a method which have ability of receiving signals and making proper response for the desired output through pattern recognition or data classification. ANN have very special characteristic such as it has large degree of freedom, makes them to solve the non-linier inside the system. Besides it also can adapt and ability to learn to the new environment. Therefore, with the introduction of new data, ANN can evaluate the data. In addition, ANN have the input and output mapping ability and have fault tolerance. With these qualities, ANNs are superior to conventional regression techniques

The reason of this neural network is to develop an artificial system that could perform "intelligent" tasks similar to those performed by the human brain. Artificial Neural Network have been used in many fields like pattern recognition, signal processing, function approximation, and process simulation (Guo et al 2001). The neural network is used to study the weather data transmission based on prediction and the establish model of neural network to provide efficient data transfer and saving bandwidth. The study on prediction of the weather by established a Backpropagation Neural Network (BPNN). The application of ANN is used in prediction of the weather condition and weather data transfer in saving the network bandwidth. This study was revealed another successful of ANN in application of data transmission which achievement in efficient big data transfers to save network bandwidth by using data priority.

3 RESEARCH METHODOLOGY

a. Application Development



In this project, the "Scrum methodology" was implemented. Scrum is an incremental agile software development methodology for managing product development. In this model, the whole requirement is divided into various builds. Multiple development cycle take place making each module smaller and more easily manage modules. During the first module software lifecycle, a working version of software is produced and each subsequent release of the module adds the function to the previous release. This process continues until the complete system is achieved. Scrum is a framework which people can address complex adaptive problem while productively and creatively delivering product of the highest possible value

b. System Architecture

During the design phase, system architecture is established to identify and describe the fundamental structure abstraction as well as process flow of the whole system. The system architecture consisted of 3 core focuses of the whole system which are weather data gathering, weather forecasting and weather data transmission. Collected weather data is process to make it readable by neural network. Supervised learning is adopted in ANN learning process as training dataset and target dataset are provided to the ANN in order to recognize the pattern of training dataset and categorized it based on the target dataset. Result produced is in binary form and it is converted into understandable phrase by the system to enhance system's user friendliness.

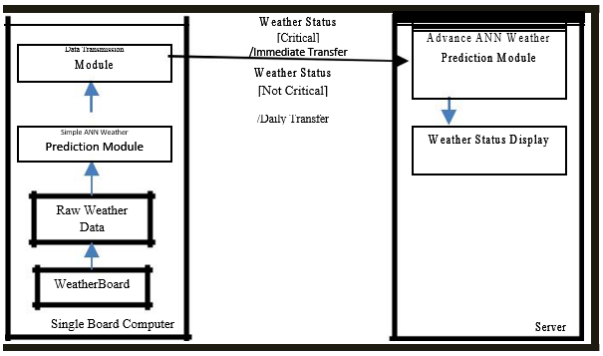
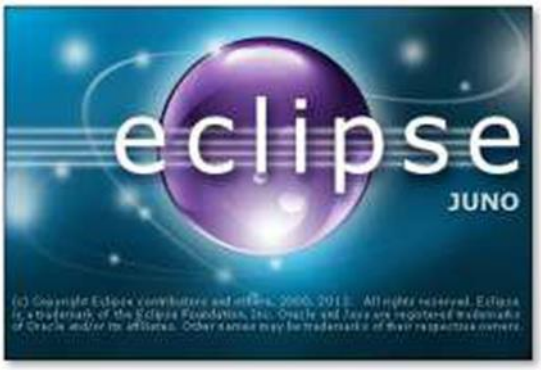


Figure 4: The proposed system architecture

As shown above, the neural network prediction is used to make weather forecast and then if there are major changes in weather condition, the system will transfer the data to the main server for further process. But if there are no major changes in weather condition, the system will only update the server on daily basis. This concept believes can reduce the network bandwidth usage by allowed only important data being transfer.

c. System Design Interface

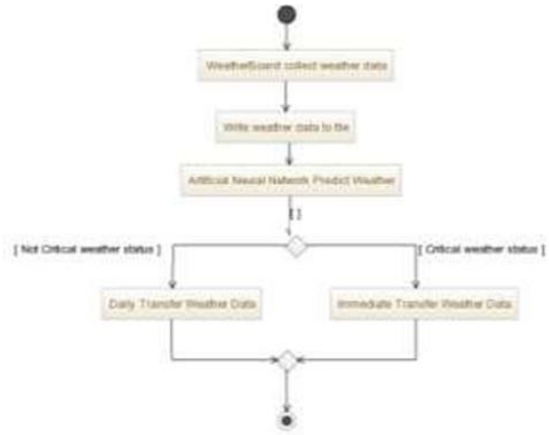
Arduino IDE - Arduino IDE is an Arduino open source software used to program the ODroid_SHOW. This software using C programming language is to control the ODroid display and get the sensor value from weatherboard.



Eclipse - Eclipse IDE is software use to develop an application. This software can use many languages programming to code. In this project, researcher use to code and design the neural network using C++ using this software.

QT Application - QT app is a software use to design and simulate the design of software. Researcher use this software to get the value of sensor to be display on screen and generate raw weather data in more structured and organize to be use in Neural Network processing.

d. System Testing



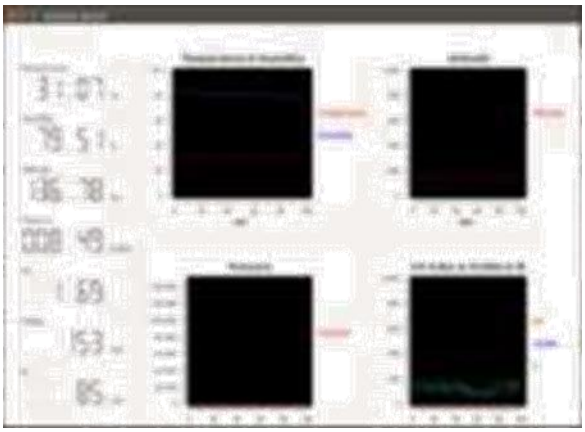
Activity Diagram shows the flow of this system from collection of weather data to transmission of weather data. The system starts with collecting weather data using ODroid weatherboard. Then the weather data is saving in a text file separated by every hour to be read by neural network. After that, the neural network predicts the weather using weather data stored. This neural network application is installing in the ODroid-C1 board. If the weather is not critical then it will only transfer at the end of day when the network not busy. But if the weather is critical which means have big changes in weather or bad condition, the data will be immediately transfer to be further process and notify the people on offshore and onshore. This type of data transmission surely will help reduce the usage of network bandwidth especially during critical or busy network.

4 RESULTS AND DISCUSSIONS

System Interface Screenshot

a. Data Gathering Module

ODroid WeatherBoard Sensor



Data Gathering Sensor Application

b. Neural Network Module

Neural Network Prediction

c. Data Transmission Module

Tsunami UDP Server

Tsunami UDP Client

Testing Results

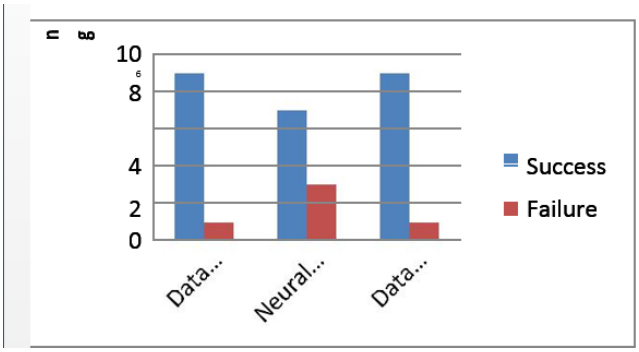


Figure above shows the testing result of module for weather data transmission driven by neural network. It shows that most of the modules worked as expected reduce the network bandwidth usage by neural network controlling the data transmission.

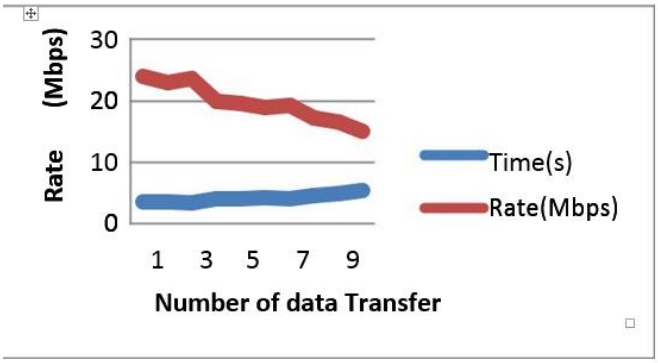


Figure above show the rate of data transfer using the application. The result show the rate is decrease as the time increase. This is because the size of data increase as time increase making the file transfer time longer.

5 CONCLUSION

This research consists of 3 parts. The first was learning the hardware architecture and data collection. These parts focus on data gathering using ODroid Weatherboard. The second part was learn the basic implementation of artificial neural network to predict weather condition based on data collected during part 1. This part researcher learns to develop a C++ application that implement neural network and train the neural network. The final part is learning data transmission to transfer weather data after being process by part 2. This part require researcher to use networking knowledge to transfer the weather data based on priority to control the data transfer thus save the network bandwidth usage.

To prove this assessment, development will be taking place to answer the concept. The idea of saving network bandwidth usage in data communication will give a lot of benefit to control the big data transfer and saving cost. The transmission of weather data is divided into 2 which are immediate transfer and daily transfer. The immediate transfer works when a major change in weather condition is detected while daily transfer works when there are no major changes in weather condition. This weather condition is determine using neural network that use weather data to make weather prediction by provide training to neural network to make the weather prediction accurate.

During the collection of data, the resource about big data transfer from offshore is very limited and learning a new hardware is very challenging. The implementation of neural network also hard to learn as this technique is complicated to develop and not many resources to referred. The communication technology used for data transfer in offshore also has high cost require researcher to change the data transmission method form satellite data transfer to network cable data transfer.

6 REFERENCES

[1] A. P. Clark, "Principles of Digital Data Transmission", Published by Wiley, 1983

[2] "Offshore communication", 3 28 2015, [Online] Available: http://www.circadence.com/markets/oil_and_gas

[3] Communication Links for Offshore Platform, 2012

[4] Rick Simonian (2012, June). Subsea Fiber and Digital Oilfield – Diving into Offshore Communications, *Scandinavian Oil-Gas Magazine (5),* 34-36

[5] S. Mohaghegh, "Neural Network: What It Can Do For Petroleum Engineers," SPE Paper, 1995.

[6] Muller B,Reinhardt J, Strickland M (1995) Neural Networks : An introduction. 2nd edition, Springer-Verlag, Berlin.

[7] McCulloch WS, Pitts W (1943) A logical calculus of the ideas immanent in nervous activity. Bull of Math Biophysics 5:115-133

[8] "Neural Network Activation Function", 3 28 2015, [Online]

Available : http://en.wikibooks.org/wiki/Artificial_Neural_Networks/Activation_Functions

[9] C. Siruvuri, S. Nagarakanti and R. Samuel, "Stuck Pipe Prediction and Avoidance: A Convolutional Neural Network Approach," SPE Paper, 2006.

[10] R. A.Neto, N. Ebecken, L. P. Caloba and R. P. Bedregal, "Artificial Neural Network use on Simulation of geological process," SPE Paper.

[11] T. Sadiq and I. Nashawi, "Using Neural Networks for Prediction of Formation Fracture Gradient," SPE Paper, 2000.

[12] "A Basic Introduction to Neural Network," 8 2 2014. [Online]. Available: http://pages.cs.wisc.edu/~bolo/shipyard/neural/local.html . 31

[13] G. Sun, S. J. Hoff, B. C. Zelle and M. A. Smith, "Development and Comparison of Backpropagation and Generalized Regression Neural Network Models to Predict Diurnal and Seasonal Gas and PM10 Concentrations and Emissions from Swine Buildings," American Society of Agricultural and Biological Engineers, 2008.

[14] "Malaysia broadband satellite internet", 3 28 2015.

[Online]. Available : http://blog.asiacube.com/malaysia-broadband-satellite-internet-provider-review.html

[15] Magdi S. Mahmoud, Control and Estimation Methods over Communication Networks, 2014

[16] "Introduction", Neural Networks in a Softcomputing Framework, 2006

[17] Yong Seok Kim. "A Real-Time Multimedia Data Transmission Rate Control Using a Neural Network Prediction Algorithm", Lecture Notes in Computer Science, 2005

[18] Nor Azam Ramli, Norrimi Rosaida, and Hazrul Abdul Hamid. "Future daily PM10 concentrations prediction by combining regression models and feedforward backpropagation models with principle component analysis (PCA)", Atmospheric Environment, 2013.

[19] Mohammed Ayoub. "Evaluation of Below Bubble Point Viscosity Correlations and Construction of a New Neural Network Model", Proceedings of Asia Pacific Oil and Gas Conference and Exhibition APOGCE, 10/2007

[20] Pazand, Kamran, and Hawshin Feizi. "Using Artificial Neural Networks in Investigations on the Effects of Ultrasonic Vibrations on the Extrusion Process", Applied Mechanics and Materials, 2011.

[21] P. Melin. "Neural Network optimization with a hybrid evolutionary method that combines Particle Swarm and Genetic Algorithms with fuzzy rules", NAFIPS 2008 - 2008 Annual Meeting of the North American Fuzzy Information Processing Society, 05/2008

[22] Danisman, K.. "Modelling of the hysteresis effect of target voltage in reactive magnetron sputtering process by using neural networks", Surface & Coatings Technology, 20091215

[23] Naraghi, Morteza Elahi. "Adaptive Neuro Fuzzy Inference System and Artificial Neural Networks: reliable approaches for pipe stuck prediction", Australian Journal of Basic & Applied Sciences, 2013.

[24] Mahmood, M.A.. "Evaluation of empirically derived PVT properties for Pakistani crude oils", Journal of Petroleum Science and Engineering, 199612

[25] Tang, Lujia, Lina Wang, Shuming Pan, Yi Su, and Ying Chen. "A neural network to pulmonary embolism aided diagnosis with a feature selection approach", 2010 3rd International Conference on Biomedical Engineering and Informatics, 2010.

[26] Nishiyama, K.. "Identification of typical synoptic patterns causing heavy rainfall in the rainy season in Japan by a Self-Organizing Map", Atmospheric Research, 200702

[27] El-Sayed Osman. "ARTIFICIAL NEURAL NETWORK

MODEL FOR ACCURATE PREDICTION OF PRESSURE

DROP IN HORIZONTAL AND NEAR-HORIZONTALMULTIPHASE FLOW", Petroleum Science and Technology, 1/1/2002

[28] Ul-Saufie, Ahmad Zia, Ahmad Shukri Yahaya, Nor Azam Ramli, Norrimi Rosaida, and Hazrul Abdul Hamid. "Future daily PM10 concentrations prediction by combining regression models and feedforward backpropagation models with principle component analysis (PCA)", Atmospheric Environment, 2013.

[29] AMAR KHOUKHI. "SUPPORT VECTOR REGRESSION

AND FUNCTIONAL NETWORKS FOR VISCOSITY AND GAS/OIL RATIO CURVES ESTIMATION", International Journal of Computational Intelligence and Applications, 2011

[30] Alizadehdakhel, A.. "CFD and artificial neural network modeling of two-phase flow pressure drop", International Communications in Heat and Mass Transfer, 200910

[31] Taşpınar, Fatih. "Improving Artificial Neural Network Model Predictions of Daily Average PM10 Concentrations by
Applying PCA and Implementing Seasonal Models", Journal of the Air & Waste Management Association, 2015.

[32] Rabiei, Arash, Hossein Sayyad, Masoud Riazi, and Abdolnabi Hashemi. "Determination of dew point pressure in gas condensate reservoirs based on a hybrid neural genetic algorithm", Fluid Phase Equilibria, 2015.

[33] Cong, Tenglong, Guanghui Su, Suizheng Qiu, and Wenxi Tian. "Applications of ANNs in flow and heat transfer problems in nuclear engineering: A review work", Progress in Nuclear Energy, 2013.

[34] Sener, Erhan; Terzi, Ozlem; Sener, Sehnaz and Kucukkara, Ramazan. "Modeling of Water Temperature Based on GIS and ANN Techniques: Case Study of Lake Egirdir (Turkey)", Ekoloji Dergisi, 2012.

[35] Kil To Chong. "Neural network prediction model for a real-time data transmission", Neural Computing and Applications, 06/2006

[36] Kulatilake, P.H.S.W.. "Mean particle size prediction in rock blast fragmentation using neural networks", Engineering Geology, 20100810

[37] Sanchez, Luis, Valentin Arroyo, Julio Garcia, Kalin Koev, and José Revilla. "Use of Neural Networks in Design of Coastal Sewage Systems", Journal of Hydraulic Engineering, 1998.

[38] Kitsikoudis, Vasileios, Epaminondas Sidiropoulos, and Vlassios Hrissanthou. "Assessment of sediment transport approaches for sand-bed rivers by means of machine learning", Hydrological Sciences Journal, 2015.

[39] E. M. FitzGerald. "Application of Artificial Neural Networks (ANNs) to sub-basalt imaging", SEG Technical Program Expanded Abstracts, 1999