J. Basic. Appl. Sci. Res., 2(6)5570-5575, 2012

ISSN 2090-4304
Journal of Basic and Applied Scientific Research
www.textroad.com

Stuck Drill Pipe Prediction with Networks Neural in Maroon Field

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ABSTRACT

Drilling practice abounds with a number of problems and an efficient way to deal with problems in this area is a key to continuity of the process. Through careful consideration of some important points and in time action during such practices it is practical to avoid some of these problems or at least lessen them to a desirable point. One of a kind of this problem in drilling practice is pipe sticking in the well. A number of factors are associated with this phenomenon. Today experts and engineers rely mostly on utilizing the old methods which is experimental way to estimate the condition on which such sticking occur. In recent years, Artificial Neural Networks has gain a lot of recognition and its highly functional merits prompt us to use this method in order to estimate pipe sticking in drilling industry. In this research feed forward neural networks and back propagation network training was employed to predict sticking related to pressure difference, well narrowness (Mobile and Chili circulation), weak hydraulic of drilling mud, weak geology of drilling mud, non regulated drilling line , with geological effects were estimated during drilling. The obtained results suggest that neural networks have the potential to predict efficiently drill string sticking in different cases and they proved effective enough to deal with problems in this area.
KEY WORDS : drilling - Neural networks - drill string sticking.

INTRODUCTION

Stuck pipe can be defined in a concise statement as “inside-well force which obstructs the outlet of tubes from well”. In oil and gas drilling, drill string is always accompanied with drilling. As soon as sticking occur many efforts initiates to take them out. Engineers utilize a wide variety of known methods including increased upward strength, increased upward weight and etc. so that they are able release drill string which is stocked inside well yet these methods proved badly chosen and costly, however in most cases they lead to release of drilling line. Drill string sticking turn out to be more and more consequential when due to any possible reason it becomes difficult to take out drill string of the well. In this case the only alternative will be cutting of drilling line inside the well and in the worst case the blockage of the stock and drilling line can occur in this case drilling a secondary rout and changing of drilling plan and extra expenditure happen to be inevitable.[1] This phenomenon is more important in marine practices where pipe sticking will increase about 30% of the whole developmental process of such wells which is highly pricey.[2] Therefore, any attempt to lessen drilling line pipe sticking considered essential in reducing the cost of drilling.

Research has conducted on pipe sticking since 1950. In 1985, Kingsborough and Hemp King [3] handled their task through ecstatic analysis of pipe sticking based of drilling parameters. Their work focused on comparing and contrasting stocked and non stocked wells and parameters of both examples examined and subsequent drilling plans carried out through careful consideration of non stocked wells. Kingsborough and Hemp King examined 221 parameters in 131 stocked wells in Mexican well and predicted possibility of sticking in adjacent wells. In 1994, Biegler and Kuhn [4] provided a data collection for 22 drilling parameters in 73 non stocked wells in Mexican gulf and did the same task for 54 stocked well and scrutinized the problem. They are considered as pioneers for primary analysis in this area and conducted their task through integration of drilling variables. They not only predicted the possibility of stuck but also were able to determine the mechanism by which it occurs. In 1994, Howard and Glover [5] improved the existing predictability models in pipe sticking. They carried out their task in Mexican gulf through careful examination of 100 wells. The models they were applying prevented pipe sticking or they could help as a means to release. An artificial neural network has recently been utilizing to predict sticking which is based on pressure difference in Mexican gulf. [6]

Drill string sticking is commonly divided into two general categories. First is mechanical sticking and next is pressure difference sticking. During stick resulting from pressure difference tube upward and downward circulation is

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not possible; however the total drilling mud circulation proceeds which is in contradiction to mechanical stocking.[2] there are a number of parameters involved in drill string sticking some of which include drilling mud properties, arrangements of equipments inside well, circulation properties and etc. however, finding an appropriate connection between such parameter is not so straightforward and a relatively good knowledge is essential. Artificial network methods and particularly artificial neural network is capable of elucidating difficult condition of sticking. [7]

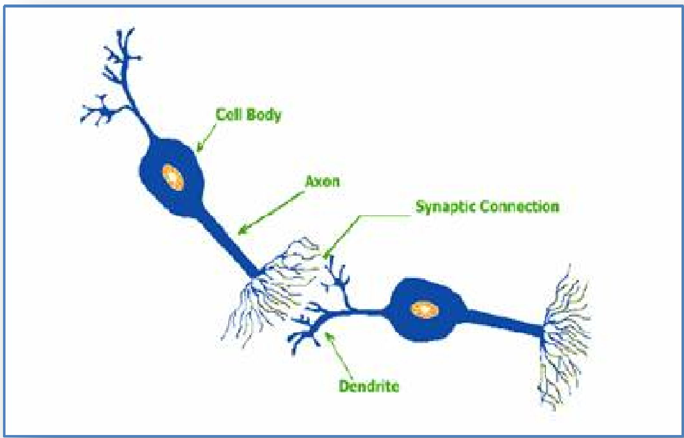
MATERIALS AND METHODS

Artificial neural networks

Artificial neural networks which are precursors of artificial intelligence work based on a paradigm which is derived from human brain and it has gain popularity and progression in recent decades. Artificial intelligence comprises a collection of analytical apparatus which aims at imitating human beings manner. During the last decade it has served as a device to facilitate solution of highly sophisticated analytical problems which were considered impossible without them.

Structure of neural networks

The exact way by which our brain functions is still a mystery and only a part of this sophisticated network has been cleared. Like any other organ, brain is made up of cells which a collectively called neurons. Each neuron consists of 4 units, cell body which contains nucleus, dendrites and axons. Dendrites receive signals from adjacent cells. Information enter the neuron through electrochemical signal and enter neuron’s central unit called soma and several output signal sent to other neurons through synapses which is based on situation by which signal received.



Figure(1):schematic of Neural cell

Mechanism of neural networks

In a complete scenario of neural network function on data, each data divided into 3 categories: training, validation and testing. During training phase each artificial neuron accomplishes a number of main tasks. First, it inspects input data dividing it to corresponding weight (W) delivers it to summation equation. The product of receiving data with corresponding weights (W.I) is explained through optimal value. Comparison is carried out to determine the amount of exit. Transfer of input and output data is accomplished by an activating function. In a network with back propagation algorithm, all connection within the network selected in random fashion and then the first collection of input and output data is given to network. Receiving data follows feedforward fashion in network then weights and corresponding functions work on them so that output obtained. This output latter contrast with optimal output and the existing error propagates in the network and corrects network weights. This process continues until medium network errors go below the determined errors and thus the network continues.

Practical application of neural network in predicting drill string sticking in Maroun square

There are crucial steps in utilizing neural networks in order to predict drill string sticking, lack of each result in wrong outcomes. These steps include A: data collection B: data processing
C: data division and work with neural networks

A) data collection

Data derived from Maroun square in years 84 -85- and 86 are the basis for our project which are obtained through daily reports. Maroun square consist of eight main sectors. More than 70 parameter related to six drilling sub categories can be obtained from these daily reports. Intrinsic and extrinsic factors are known as factors in drill string sticking and they provide the basis for our project. Table (1) shows all central factors which are involved in drill string sticking (detailed explanation of drill string sticking mechanism is not applicable in our article). Out of 750 data with effects of 31 parameters brought into play in25 wells in Maroun square.

In this base, 11 collections speak about sticking effects and 739 collections relate to non sticking effects of drilling practice. Both collections are divided into stocked and non stocked series. Stocked and non stocked collections are regarded as output neural parameters and number 100 is assigned to stocked collections and 0 is given to non stocked.

Table(1): considerable parameters on stuck for this project

Mud Properties	BIT	STAB.	DRILL COLLER	DRII. PIPE	SURFACE EQUIP.	OTHER PARAMETER	Geology
MAX.WT	BIT SIZE	STAB.SIZE	DC.SIZE	D.P.SIZE	PUMP.PRES	PRES.DEPTH	FORMATION
MIN.WT	NOZZLE. SIZE	STAB.NO	DC.LENGHT		PUMP.OUT	PREV.DEPTH	- AGHAJARI
VIS.M.F	BIT.METERAG	M.				D.METRAGE	- MISHAN
W.L	W.O.B					DRILL.TIME	- GS:7,6,5,4,3,2,1
PH	JET.VELOCITY					CASING SHOE	- ASMARI
SALT						OPEN .HOLE	SECTOR*
CALCIUM						INTERVAL	- SEC.1(NORTH)
SOLIDS %						ANN.VELOCITY	- SET.5
TEMP.F.L						ROP	- SEC.7
PV						LOSS	- SEC.8(NORTH)
YP						RPM	- SEC.8(SOUTH)
INITIAL GEL						Pore pressure	- SEC.6
10 MIN GEL							- SEC.4
							EASTING*
							NORTHING*

B) data processing

In this phase collected data from Maroun square are processed, analyzed and their veracity is measured before applying into the program. This phase is highly crucial and it has high effect on obtained results. Data processing contain 2 phases including

1) data analysis and verification of veracity
2) data normalizing

C) data division and work on neural networks

After data collection and processing it is time to work on neural networks. In this phase input data in neural networks should be divided into 3 collections including: 1: network training data collection 2: cross validation data collection 3: testing data collection. The significant issue in this area is to collect data corresponding to the three phases. In most network practices 85% of data are for training, 10 % is employed for cross validation and 5% is utilized for testing of network. Generally, data division requires a broad knowledge of network processing and appropriate distribution of data in each well. One of the essential notes in distribution process of data is to provide the highest and lowest of each parameter in training data. In this project out of 20 wells for training network, 2 wells are for cross validation and 1 well is employed for testing of network. Table(2) shows the distribution of data in 3 collection including training, cross validation and testing of network.

Table(2): data distribution

Data type	data number	unstuck data number	stuck data number
(Training data)	648	639	9
(Validation data)	80	79	1
(Testing data)	30	29	1

Network was ready for Run practically after dividing data into 3 main parts. Two promoting functions of TANSIG and PURELIN were used for distribution to hidden layers and output neural network. Moreover, for training purposes a predetermined of 1000 epoch is also applied. With initiate of training, software considers the primary amounts for weights of network and calculates determined output error with the exact amount of output. Mean Square Error (MSE) is the mean of error between network output and optimal output. While networks are training, the error equation decrease with increase in epochs but this in no way show proper network training and the network may have extra training. When a network gain extra training it may remember the training paradigm and it may not generalize properly. Cross validation is one of a kind of methods to stop network training. With any increase in cross validation, network training should be halted and in this point the network has gain the highest level of generalization. Network generalization means that network should be able to provide right outputs for a collection of test which have not been used in the network. In this project a number of applications were done with software as a pre processing step and hopefully the results were satisfactory. In these applications the whole entering parameters were not exercised and due to data abundance and entering parameters application of each phase was time consuming. The aim of these pre processing works is to determine the appropriate topology for network. With the help of these techniques it is possible to find appropriate neurons and necessary exchange equations. Software has shown that neurons between 30 and 40 and two activating equations TANSING and PURELIN could provide the best results. In subsequent phases all input parameters of network exercised. In this phase which is considered the last phase and it is real time phase the optimal neurons should be determined so that the best results obtained. The best topology is one which contains the least errors and at the same time provides the optimal outputs with the lowest distinction for data in cross validation phase. Obtained results from neural networks for the best neuron formation (34neurons) for three collections of data training validation and test are given in tables (3) & (4).

Table(3): Neural Network Output for testing data

stuck % (**predicted by** Neural Networks)	**stuck %** (**actual output**)
-0.128890665	**0**
-0.743786592	**0**
-1.7910437	**0**
-0.598078222	**0**
2.634978148	**0**
5.61286163	**0**
-0.332801485	**0**
2.367498316	**0**
-3.951899789	**0**
3.859598114	**0**
1.826397698	**0**
5.1452723	**0**
36.26388127	**0**
-3.114327195	**0**
-2.482475591	**0**
-3.754261215	**0**
-0.09901773	**0**
1.388578218	**0**
2.347760429	**0**
1.323793437	**0**
-0.556549472	**0**
1.20940859	**0**
1.743355781	**0**
-4.032269091	**0**
1.128979709	**0**
2.66317472	**0**
3.074803803	**0**
61.80934977	**100**

Table(4): Neural Network Output to stuck data for testing, Training and Validation data data

stuck data	stuck % (predicted by Neural Networks)	stuck % (actual output)
Training	89.16053183	100
Training	51.92938176	100
Training	98.7212949	100
Training	57.40188653	100
Training	81.20567066	100
Training	91.45873451	100
Training	99.61861493	100
Training	51.74230142	100
Training	88.86455807	100
Validation	72.99927914	100
Testing	61.80934977	100

According to results obtain in this project the best topology are for networks with 34 neurons and with the least error of 0.000887304 and it is related to training part of network and weight since it has the best responses for cross section and test phase. As you see for stability test of neuron network with such topology collection of data in test phase (28 internal) were exercised. In this collection 27 collection display non stocking and only one collection display stocking of drilling line . Table (5) displays function of neural network with corresponding internal data.

Table(5): Neural Network prediction for testing data

Testing input data	unstuck data	stuck data
28	27	1

	predicting by Neural Networks for Testing data (testing data total =28)	actual output
unstuck data	26 < 6%	0 %
	1> 36%	
stuck data	1 > 61%	100 %

According to table (5) predicting neural network for the only sticking is 61%. Based on the fact that out of 750 input data only 11 cases showed drill string sticking thus we can assume that the output of program is considerable and the program has made it possible to determine drill string sticking to 61 %. This highly careful consideration of program is outstanding and is due to 2 factors, first a great amount of input data given to program and latter is high accuracy and alertness of program. The fact that is more crucial than network application is the accuracy and alertness of data since it is crucial in converging responses. Moreover, prediction of test data display none stocked except in one case is less than 6 % and in some cases this value is minus. Neural network predict none stocking in 36 % in one case however the output value should be zero. Thus it is necessary for output data to define an optimal value which exactly define sticking non sticking and critical points. Table (6) illustrates optimal values for neural network exit.

Table(6): Neural Network Output optimization

	Stuck chance 100%	Stuck chance 0%	Potential for stuck
Output Neural Network	≥ 51	≤ 6%	51 ≥ خروجي > 6

Conclusion

1) as for the application of neural networks and processing data obtained in this practice we can assume that neural networks are considered as appropriate in determining drill string sticking and they are capable of reducing drilling problems such as sticking and at the same time the proved helpful in decreasing the costs.

2) according to satisfactory results in this project, neural networks succeed in determining real time drill string sticking in Maroun square. The effects of more than 30 parameters are brought into play to determine sticking which in turn is considerable amount in neural network.
3) in this project a great deal of endeavor has also been given to include topological conditions on drilling patterns a point which is of less significance in most projects due to lack of adequate knowledge. Hopefully a technical approach (zero and one technique) was given to our project to investigate topological factors in network.
4) application of neural networks is mainly relates to situations in which problems of data collection needs to be tackled (which may be related to data shortage or costly practice of it) or in situations which finding a balanced equation between data is difficult. We made use of such application of neural systems by which we determined 31 parameters related to drill string sticking. Moreover dealing with all the problems together was very difficult and we successfully managed to predict drill string sticking.
5) important factors that affect output results of neural systems include appropriate selection of data related to validation training and testing collection. It is applicable to reach proper results by considering proper generalization of data.

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