International Journal of Recent Technology and Engineering (IJRTE)
ISSN: 2277-3878 (Online), Volume-8 Issue-6, March 2020

A Neural Network for Pattern Classification using Fuzzy Set Theory

Saranya D, Akriti, Oviya Sivakumar, S.S. Sanjay Krishnan

***Abstract:** The conventional algorithms related to the Artificial Neural Networks (ANN) have some innate shortcomings, similar to the probability of categorizing in native maximum outcome, which possess reduced speed in the learning procedure, thereby contributing to the failure in seeing a productive cell arrangement. To overcome this lacking factor, this given paper proposes a Neural Network Classifier (NNC) built combining the features of the Beetle Antennae Search (BAS) formula, termed BASNNC and Fuzzy Set Theory, which is a research and analysis proposal that can deal with problems relating to inconclusive, subjective and vague judgments. To enhance the weights of the NNC, the BAS formula is used. BASNNC consists of a three-layer structure- an input layer, a hidden layer and an output layer. The aim is to develop novel neural network that combines the significant features of Neural Network and the Fuzzy Set Theory into a common network. This process aims to get the efficient result while eliminating the errors. The objective will be to develop the system that achieves high accuracy results with the computational complexity, using the pattern classification. A pattern can be viewed physically or mathematically by the application of algorithms. To find results for a given set of observations, pattern classification is used. Quite differing from the normal technique employing the concept of gradient descent, the differences between the hidden and the output layers area are enhanced by the BAS formula, that successfully improves the process and gets the desired results. The domain used in the procedure is Artificial Intelligence (AI).*

***Keywords:** Artificial neural networks (ANN), Neural network classifier (NNC), Beetle Antennae Search (BAS), Artificial intelligence (AI), Fuzzy Min-Max (FMM).*

I. INTRODUCTION

The Artificial Intelligence (AI) [4] is a field of computer sciences that is concerned with the development and construction of the brilliant machines efficient of performing tasks that typically require human intelligence. AI [4] is a technology with a multitude accessions and developments in learning thereby, creating a phenomenal shift in virtually every sector of the technological industry. A neural network is technique that works like the tasks performed by neurons inside a human brain. Neural networks embody Artificial Intelligence (AI) [4].

Artificial Neural Networks (ANN) [1] is the key tool of machine learning. These are systems developed by the inspiration of neuron practicality within the human brain, which is able to replicate and lean information in the same manner we tend to do as humans. Neural Networks Classifier (NNC) [2] represent each input & output layer, further as a hidden layer containing units that modify input into output in order that the output layer will apply to utilize. These are the tools for locating patterns that are various & advanced for programmers to retrieve and train the machine to acknowledge the patterns. The correctness of the mechanism is conflicted with its quality and standards. By judging and understanding the human learning and adaptability efficiencies, folks came to the conclusion that intelligent management fuzzy logic, skilled system and neural network are the three typical management strategies. The inaccuracies and drawbacks of complicated systems are tough for scientists to comprehend a clear picture thereby making it terribly tough to determine skilled systems.

The two important universally accepted strategies namely are the intelligence and the neural networks. Both of them have their own pros and cons. Artificial Neural Networks (ANN) [1] can be explained as the smart systems that are vaguely inspired by the biological neural networks. Currently, the AI industry is focused mainly on the generation and fusion of efficient intelligent identification techniques which make lives simpler and convenient. The use of neural networks in the fields like, pattern classification, signal processing and intelligent systems make it a promising field in nearing future. It also promises utmost potential, skill development and success everyday in the making which really help to expand our knowledge base and working arena.

Artificial neural networks (ANN) [1] are specialized systems that have successfully provided solutions for numerous issues otherwise considered difficult to be solved with the current technical technology. They undoubtedly have their own special methods and intelligent features which lead to such optimizing discoveries. For improving the performance of the neural networks, the investigation of the novel multi-input Beetle Antennae [3] search Neural Network Classifier (NNC) [2]. It differs from the traditional one in many prospects and is a much better option. It uses the BAS training algorithm which overcomes the weaknesses of the traditional algorithm. Instead of being a complex structure, BAS [3] is a single-body intelligent search algorithm. Since there is only one individual

Manuscript received on February 10, 2020.
Revised Manuscript received on February 20, 2020.
Manuscript published on March 30, 2020.
* Correspondence Author
Ms. Saranya D*, Assistant Professor, Department of Computer Science and Engineering, SRM Institute of Science and Technology, Chennai, India.
Akriti, Student, Department of Computer Science and Engineering, SRM Institute of Science and Technology, Chennai, India.
Oviya Sivakumar, Student, Department of Computer Science and Engineering, SRM Institute of Science and Technology, Chennai, India.
S.S. Sanjay Krishnan, Student, Department of Computer Science and Engineering, SRM Institute of Science and Technology, Chennai, India.

when searching, the search speed is fast. The efficiency and the correctness of the BASNNC
are got through the mathematical results. The main work is based on the improvement and applications of advanced algorithm. For better results it is used extensively in network optimization and pattern classification. Most of the business applications and business firms build use of those technologies.
Their main aim is to resolve advanced issues like pattern recognition or biometric identification, knowledge analysis, handwriting recognition for check process, weather prediction, and signal process.

II. RELATED WORKS

Artificial neural networks ANN [1] have their applications listed far and wide. A very convenient example for it is, projecting the accommodative neural network management theme for a defined car model. This particular model uses the neural networks to calculate the mass and size of the given object (here in this context being the car.) ANNs are known to have stronger intelligence than the quality mathematics classification program that greatly elevated the precise quantitative relation. Neural networks supported the formula which in turn is widely utilized in the ANNs. The technique used by the efficient quality based neural network learning involves the following two processes: the continual flowing propagation of learning and additionally the rectification of the errors occurring. A continuous process is undertaken to calculate the differences got in the results through the divergence. The result is slowly got. Although, ancient Beetle antennae [3] neural networks have some inherent shortcomings, like the speed being slow which is combated well in the advanced versions.
In paper related to the 3-D convolution neural networks for human action recognition [2013], it discusses about how the convolution neural networks (CNNs) are a sort of complex model that may act directly on the given inputs. Therefore, for the precision purposes these models are presently restricted for handling only 2D inputs. The development of a one of a kind model for action recognition in 3D format is also established. The mentioned model accumulates options from each dimension by playing 3D convolutions, therefore accessing the knowledge. The developed model is responsible for the generation of multiple channels of data from the input frames, therefore combining the final feature characteristics from various resources. For improving the performance, the prospect to regularize the output with high levels is established. Then the mixing of the estimated range is added to the models. The most used application of these developed models is in the airfield surveillance videos.
Another reference used for the related work is a method which is flexible in nature. It is an examination technique used for the process of synchronizing the sampled-data related to Markovian neural networks exponentially using time-varying delayed signals [2017]. Here, the investigation of the matter synchronization of data related to the division of Markovian neural networks with reference to the delayed signals is supported with convex combination computational technique. This approach aimed at conservatives the political orientation of delay-dependent synchronization criteria.
Next work is related to the mechanism of event-triggered control accustomed with systems general switching policies for the fuzzy Markovian jump. The improvement of the classification performance by rectifying major drawbacks of the initial Fuzzy Min-Max (FMM) [5] network is the sole purpose of the whole experiment. Major necessities are three interrogative rules to reinforce training rule. Firstly, a replacement hyper box enlargement process to eradicate the overlaying drawback throughout hyper box growth method is usually approved. Secondly, the present hyper box overlap check process elaborated for finding alternative potential datasets. Thirdly, to resolve to resolve potential cases of overlapping the method used is the replacement hyper box contraction rule. Overall, evaluation of the effectiveness of EFMM is established using discrete information sets and a true examination procedure.
In research related to the data-core-based fuzzy Min–Max neural network for pattern classification [2011], used equipment for evaluation is Fuzzy Min-Max (FMM) [5] neural network data knowledge Core (DCFMN). It is used in the process of classification of the pattern. A process is operating for the categorization of nerve cell of DCFMN. It is embarked in the geometric centre of the hyper box. The core needs data which is provided by the datasets. Its robust strength and extreme correctness for categorizing the knowledge base and noise helps to get accurate results. The evaluation of the performance is done with the help of pre-defined datasets along with the comparison with traditional fuzzy neural networks. Finally, the pattern classification is evaluated on various parameters using different classifiers. At the end, the results obtained bring us to the conclusion that the performance of DCFMN is great.

III. PROPOSED SYSTEM

The objective of our project is to develop a generic neural network system that is built as a common framework containing the best features and operational functions of the Artificial Neural Network [1] and the Fuzzy Set Theory. The Neural network classifies the data using Beetle Antennae Search (BAS) [3]. Fuzzy Min-Max (FMM) [5] algorithm known as the most functional neural networks for the pattern classification is used in our system to provide a better level of accuracy in the process.
Fuzzy Min-Max (FMM) [5] neural network is basically processed in stages in terms of their effects in addressing pattern classification problems and analysing. They are as follows:
1. It examines the model that is proposed related to the earliest Fuzzy Min-Max (FMM) [5] model in comparison.
2. Identifies the problems related to it and its corresponding variants that might bring down the process in various factors that determine the end result accuracy and;
3. Discuss future trends that might help the process to grow into a higher degree of functional greatness and make proposal for ways to implement them in the future as per the needs of the user.

In comparison to the currently available traditional systems in used our proposed system is said to provide more accuracy. To provide a classified base decision, not all features are required completely to reach the accurate classification decisions. The process can also be done with a smaller number of features which are required for the selected process type.

The computational and network complexity is lowered in this process. It can be easily trained and customized to the users need by expanding the knowledge base of the system. The proposed system classifies input patterns with a smaller number of hyper boxes. At the minimum value of area of hyper box than the size of hyper box melded with models, a higher level of accuracy is observed. So, with the above algorithm we get reduced misclassification rate, and shorter complex structure at minimum value of area of hyper box, with minimal number of training samples. Fuzzy Min-Max (FMM) [5] has the ability of constructing a non linear decision boundary of varied shape that distinguishes the data samples from non-identically specific classes. The target classes mostly behave in same manner like each other so it creates the problem of overlapping classes.

Fuzzy Min-Max (FMM) [5] is able to build a nonlinear decisive platform where the extent of errors is minimized via removing the overlapping distinct classes. However, Fuzzy Min-Max (FMM) [5] needs a shorter time for training than those of alternative artificial neural network [1] models, like back propagation, cascade correlation.

In system diagram the data extraction takes place, here the data is taken from the database using back-end technologies like Python, Eclipse-IDE, and Sci-learn etc. After the data is extracted then the data evaluation takes place here the dataset is examined it does not make any assumptions about what the data contains. After data evaluation, the data pre-processing takes place. A compilation of data objects known as entities is observed as a data set here. Then after the data pre processing it starts the feature extraction. In this process the methods decrease the input conditions relatively in order to predict a target variable. Then based on the information available after the feature extraction the classification takes place based on the data available after the feature extraction. Then based on the classification the decision is made on what to select and what data to neglect and after this process the pattern classification takes place where the pattern is classified based on the decisions made. After all these processes it is sent to the front-end technologies like bootstrap and other web technologies to present it to the user.

In between the pre processing and future extraction, the fuzzy processing takes place here the crisp input is received from the pre processing process after collection of input, fuzzification process takes place where the crisp input received is converted to a fuzzy value and after this process it is sent to the neural network where the fuzzy rule base is added to it for processing and then after processing it is again sent for the Defuzzification. In this process the fuzzy values are converted to the crisp values and after the conversion it is sent as the crisp output back to the feature extraction process.

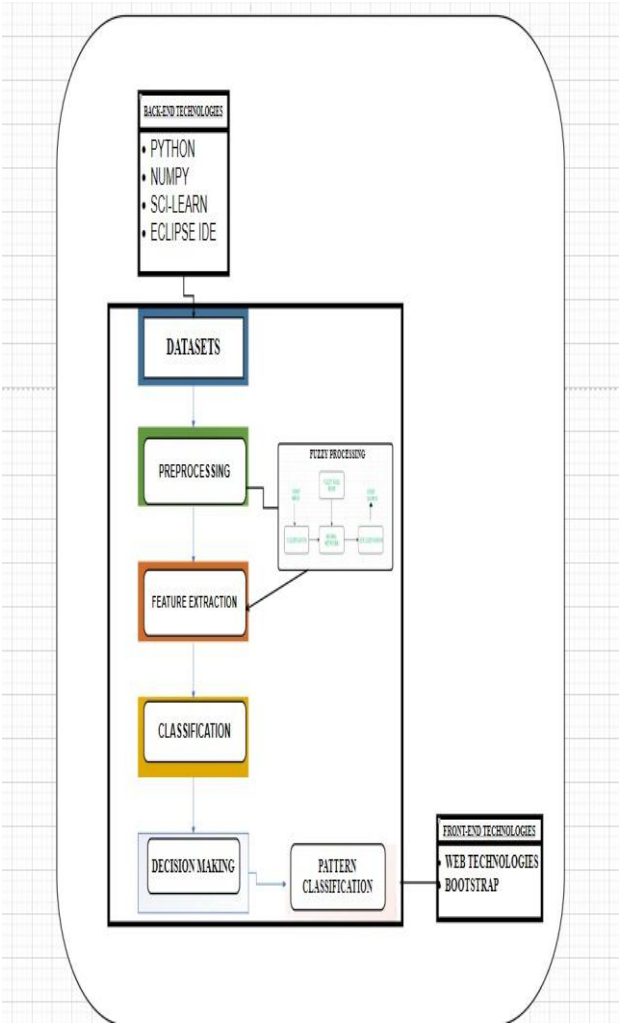

Fig 1: System Architecture

IV. SYSTEM MODULES

Module 1: Data Evaluation

The prime objective of data evaluation is to check the inputted datasets entered by the user. Initially in this stage the datasets are read by the system and their meaning and field is observed without making any assumptions about it. This type of observation helps in finding out the type of modelling that can be used statistically to process the data. We can also discover the causes of the behaviour to recognize patterns and its potential for the desired result to be obtained. The method which examines datasets to summarize the main characteristics is called the exploratory data analysis. It is in this process to extract all the possible spots of patterns.

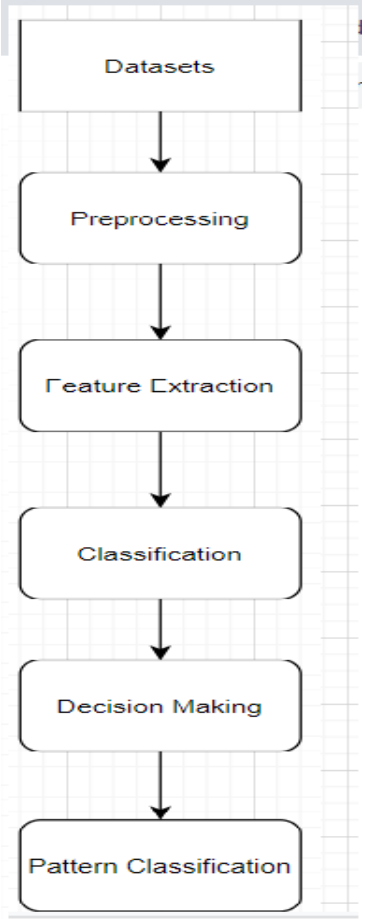

Fig 2: Data processing framework

In the process of analyse, the datasets that are newly entered into the system i.e., raw data can be processed by the analyst by either assuming that all the datasets entered are perfect and do not contain any form of error or miss and specific piece of data that might build a pattern that enables the system to process the required result more efficiently and ignoring the possibility of the datasets being manipulated at the time of entry by the used. This type of processing can commonly be termed as technical assumption as the system is built to process data on the theoretical basis of the datasets pattern so that the foremost optimum analytical algorithms used in the analysis is taken care of and resulting findings are accurate. The other type of assumption the analyst process information is Business assumptions which often goes unrecognized and influences the problem at hand by how it is presented without conscious awareness of the researcher or analyst in the beginning of the process which can cause significant difference at intermediate sectors of the process which would ultimately led to variation in the final result.

Module 2: Data Pre-processing

In this stage of the process the previously analysed datasets / records are further processed into its corresponding data objects. Pre-processing is done to segregate the input datasets into a more meaningful and understandable format to help the system process the information at a greater level of accuracy.

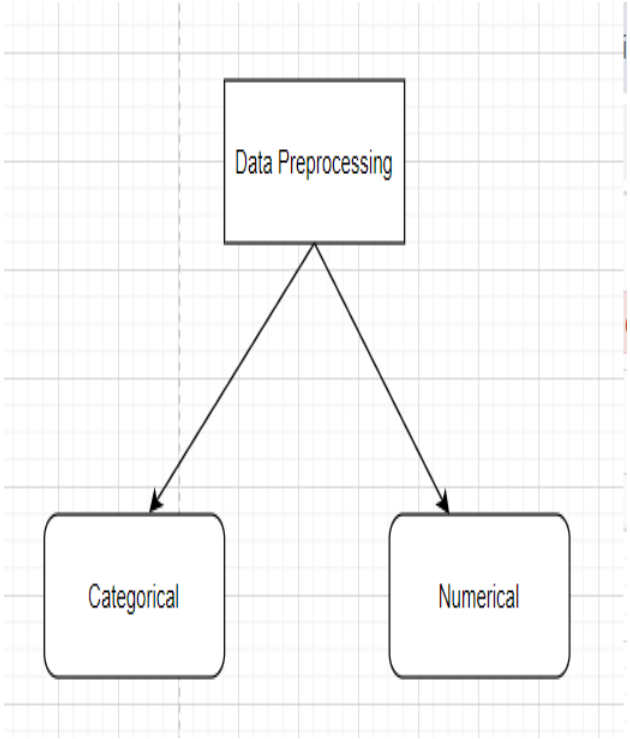

Fig 3: Data Pre-processing

The entered data objects include various elements. To list a few: points, vectors, patterns, events, cases, samples, observations, or entities. Data objects can be described by a number of features that capture the basic characteristics of an object like, the weight of the object, time at which the incident occurred, etc. Here the dimensions, variables, attributes characteristics, fields are described as features. In this system these features are broadly categorized into Categorical and Numerical.

Categorical: In this type the values of the datasets that are taken from a defined set of values for the features can be present. An easy way to understand this type is by the example, month in a year: {January, February, March, April, May, June, July, August, September, October, November, December. Regardless of the order in which it may be present these are the definitive 12 months that are present in the year. Elements that show similar characteristics fall under this category.

Numerical: This feature contains datasets whose values are either continuously in order (i.e. maybe numerically in ascending or descending order values.) or integers (single numerical values). They are generally depicted as numbers or mathematical instances and have all the properties of the numbers. A few examples for better understanding are: the number of steps to reach House A from House B, the speed at which the train travels per minute etc.

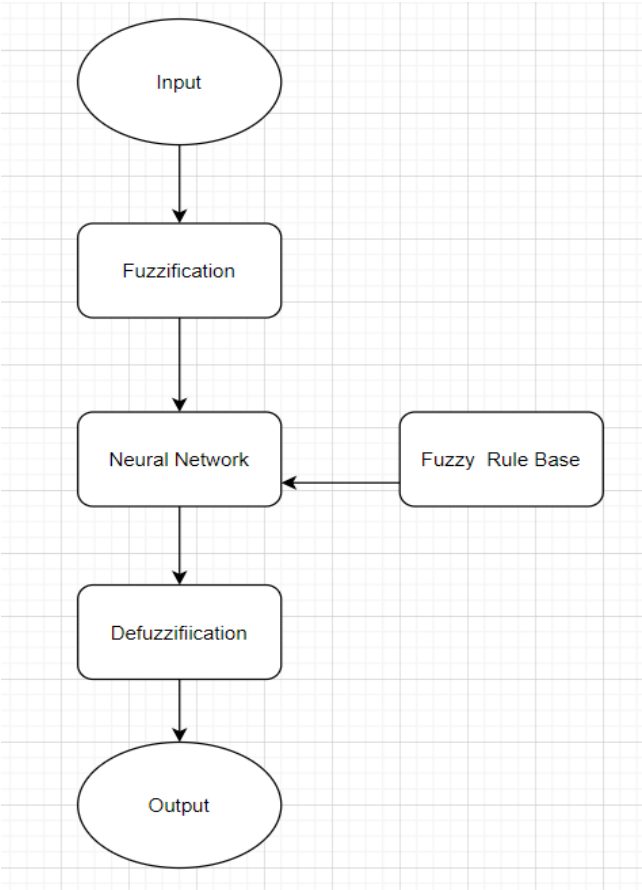

Fig 4: Fuzzy Processing

Module 3: Feature Extraction

As the name suggests this is one of the major parts of the entire process as it extracts only the best and most necessary values of the input datasets that the system believes it contains the final end result of the system. This method is mainly used to reduce the number of input variables to only the ones which are most useful to model in order to predict the target variable. Some predictive modelling problems have a greater number of variables which will slows down the development of models and occupies an outsized quantity of memory to boot questioning the efficiency of the module. If the input variable seems to be irrelevant to the target variable, then the performance of the models will decrease by default.

Wrapper feature choice strategies produce several models with completely different subsets of input options and choose those options that lead to the best performing model consistent with a performance metric. These methods are not concerned about the variable types due to the generic nature of the system, although they can be computationally expensive.

Generally, the statistic measure of the system model is directly dependent on the type of the value it takes. Most common categories are Integer (numerical or mathematical instances) or Categorical (Definitive set of values that convey a meaningful pattern). Based on the correlation between the input and the expected output the instances are filtered out by the process or priority elimination where the required features are extracted and sent to the next stage.

Module 4: Prediction

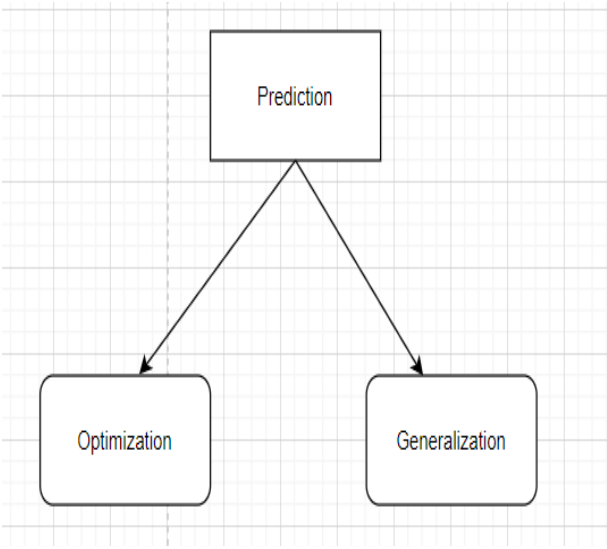

Fig 5: Prediction

One of the foremost vital issues once considering the coaching of models is that the tension between optimization and generalization. The process of adjusting a model to get the best performance possible on training data (the learning process) is called as Optimization. Generalization could be described as how efficiently the model works on data which is not known to the system during the time of basic training. The ultimate aim of the Neural Network System is to obtain the best generalization ability. At the beginning of training, those two issues are correlated. When the loss on training data is lowered, the loss on test data also lowered proportionally. After a definite number of iterations done on the training data, generalization automatically ceases to improve and the affirmation metrics freeze first, and then start to degrade. The model starts to over fit over time as it has learnt so well during the training data that has learned patterns that are too specific to training data and irrelevant to new data.Thus, the following modules are incorporated and used for the fundamental development and processing. They help to initialize, regulate and maintain a steady procedure in the needed environment to get optimum results.

V. RESULT

The aim is to develop Neural Network that combines the significant features of Neural Network and the Fuzzy Set Theory into a common network. The fact of creating and getting a better optimum result leads to this research and development work, which bears better results than its initial counterparts. It thus leads to a better, well-developed and well-maintained algorithm utilizing Artificial Intelligence (AI) [4].

VI. CONCLUSION AND FUTURE WORKS

The main objective of the research paper is to develop a generic Neural Network combining the best functionalities of BAS [3] and FMM [5] in a single framework that would classify the datasets to be processed and provide better rate of accuracy than those existing conventional systems that are being used.

The main intention is to determine a neural network structure which is relatively proper and easy to work with. Hence, to choose the number of neural network hidden layer neurons a method is established. For further analysis and identification of the success rate of the proposed model, numerous different classes of datasets are used, trained and tested for the procedure. This is done to examine the reliability of the network. The effectiveness and reliability of the algorithm is got from the results of numerical studies, applications and comparisons. Here the conclusion is deduced that the method proposed is capable of adapting quickly to situations. Thus, it can not only easily and efficiently categorize the datasets but also rectify the predominant defects of the traditional process algorithms. To improve the accuracy of the classification, future work can be done. The convenient and improved BAS algorithm is put to definite use by optimizing the numerous numbers of nodes in the hidden layer of the neural network. The area where the future scope lays in is the possibility to increase the number of layers in the neural network and the expansion of the hypothesis space of the defined neural network. This all will help in the application of the BAS in the areas of complex network neural structure research and optimization. The following methodology provides a clear picture of execution of a complex mechanism through an efficient, alternative procedure thus obtaining the necessary optimum results.

In future, this method can be used to increase the efficiency and effectiveness of neural system with additional knowledge base and layering in the network. The Artificial Intelligence (AI) [4] used helps to increase the mechanism and provide better stability and result. The guidelines are utilized to provide better stability and accuracy in producing the required result.

REFERENCES

1. L. Liu,Y.-J.Liu, and S.Tong made this invention ,''Fuzzy based multi-error constraint for switched nonlinear systems and its applications,'' IEEE Trans. Fuzzy Syst., to be published.
2. Z. Dong, J. Zhao, J. Duan, M. Wang, and H. Wang, ''Research on agricultural machinery fault diagnosis system based on expert system,'' in Proc. 2nd IEEE Adv. Inf. Manage., Communicates, Electron. Automatic Control Conf. (IMCEC), May 2018.
3. Y.J. Liu, Q. Zeng, S.Tong, C. L. P. Chen, and L. Liu ''Artificial neural network [1] control for active suspension systems with time-varying vertical displacement and speed constraints,'' IEEE Trans. Ind. Electron., to be published.
4. L. Liu, Z. Wang, and H. Zhang, ''Neural network based robust optimal tracking control for MIMO discrete-time systems with unknown uncertainty using adaptive critic design,'' IEEE Trans-neural Network Learn. System., vol. 29, no. 4.
5. M. F. Mohammed and C. P. Lim, ''an enhanced fuzzy min–max neural network for pattern classification,'' IEEE Trans-neural Network Learn. Syst., vol. 26, no. 3, Mar. 2015.
6. L. Jin, Z. Huang, Y. Li, Z. Sun, H. Li, and J. Zhang, ''On modifying multi output Chebyshev-polynomial feed-forward neural network for pattern classification of wine regions,'' IEEE Access, vol.7,2019.
7. J. P. Dominguez-Morales et al., ''Deep spiking neural network model for time-variant signals classification: A real-time speech recognition approach,'' in Proc. Int. Joint Conf. Neural Network. (IJCNN), Jul. 2018,
8. D. Chen, S. Li, and Q. Wu, ''Rejecting chaotic disturbances using a super-exponential-zeroing neuro dynamic approach for synchronization of chaotic sensor systems,'' Sensors, vol. 19, no. 1, 2019.
9. L. Liu, Y.J. Liu, and S. Tong, ''Neural networks-based adaptive finite time fault-tolerant control for a class of strict-feedback switched nonlinear systems,'' IEEE Trans. Cybern., vol. 49, no. 7, Jul. 2019.
10. D. Chen, Y. Zhang, and S. Li, ''Zeroing neural-dynamics approach and its robust and rapid solution for parallel robot manipulators against superposition of multiple disturbances inferences,'' Neuro computing, vol. 275, Jan. 2018.

AUTHORS PROFILE

Ms. Saranya D. has the degree of M.E. and is Assistant Professor in the Department of Computer science and engineering at SRM Institute of Science And Technology, Salem in 2011. She has research interest in areas of artificial intelligence and neural networks.

Akriti, Student, Department of Computer Science and Engineering, SRM Institute of Science and Technology, Chennai, India. She has research interest in areas of artificial intelligence and neural networks.

Oviya Sivakumar, Student, Department of Computer Science and Engineering, SRM Institute of Science and Technology, Chennai, India. She research interest in areas of artificial intelligence and neural networks.

S.S. Sanjay Krishnan, Student, Department of Computer Science and Engineering, SRM Institute of Science and Technology, Chennai, India. He has research interest in areas of artificial intelligence and neural networks.