

CHAPTER 2

LITERATURE SURVEY

2.1 Fuzzy Logic

Fuzzy logic is very useful for various people who involved in research and development including several engineers like mechanical, electrical, civil, aerospace, chemical, agricultural, computer, biomedical, environmental, industrial, geological, and mechatronics. It also includes mathematicians, computer software developers, medical researchers, natural scientists, social scientists, business analysts, public policy analysts, and jurists. Actually, the applications of fuzzy logic, once supposed to be an ambiguous mathematical curiosity, can be establish in various engineering and scientific works. Fuzzy logic has been used in several applications such as air conditioners, facial pattern recognition, washing machines, antiskid braking systems, vacuum cleaners, transmission systems, knowledge-based systems for multi objective optimization of power systems, control of subway systems and unmanned helicopters, weather forecasting systems, medical diagnosis and treatment plans, models for new product pricing or project risk assessment, and stock trading. Fuzzy logic has been effectively used in various fields such as power engineering, control systems engineering, image processing, robotics, industrial automation, consumer electronics, and optimization.

Many researchers are working with fuzzy logic and making copyrights and research papers. Zadeh offered a report on the impression of fuzzy logic in March 2013 [6], According to this report there are 26 exploration journals on principle or applications of fuzzy logic, there are 22,657 publications or journals on principle or applications of fuzzy logic in the MathSciNet databank, there are

89,365 publications or journals on principle or applications of fuzzy logic in the INSPEC databank, there are 7149 copyright applications and copyrights issued interrelated to fuzzy logic in Japan and there are 16,898 copyright applications and copyrights issued interrelated to fuzzy logic in the USA. Many research contributions are increasing daily and are growing at an increasing rate.

Detection and Elimination of a Potential Fire in Engine and Battery Compartments of Hybrid Electric Vehicles is proposed by M. S. Dattathreya [7]. The main objective of this paper is presents a novel fuzzy deterministic non-controller type system and a fuzzy deterministic non-controller type inference algorithm. This system produces a deterministic non-fuzzy output by using fuzzy inputs. This system is an extension and substitute for the already existing fuzzy singleton implication algorithm. This paper applies fuzzy deterministic non-controller type to construct architecture for an intellectual system to identify and to eliminate prospective fires in the battery and engine compartments of a crossbreed electric vehicle. The fuzzy inputs involve sensor data from the battery and engine compartments namely temperature, voltage, moisture, and current of the battery. This system produces the data and discovers potential fires, takes action for removing the risk, and notifies the customers about the possible fire using a noticeable alarm. This paper also offers the computer simulation outcomes of the comparison among the fuzzy inference algorithm and singleton inference algorithms for identifying potential fires and responsible the actions for eliminating them.

Comparison of Detection and Classification Algorithms Using Boolean and Fuzzy Techniques is proposed by R. Dixit and H. Singh [8]. The main objective of this paper is to gives a figure of importance for comparing numerous logic analysis approaches and presents

effects for a hypothetical objective classification scenario. Innovative multi quantization Boolean methodologies also diminish the complexity of these multivariate investigates, building it possible to improved use the available data to estimated target classification. This paper indicates how such type of preprocessing can practically preserve result confidence and associates the results between Boolean, multi-quantization Boolean and fuzzy procedures.

BDD, BNN, and FPGA on Fuzzy Techniques for Rapid System Analysis are proposed by R. Dixit and H. Singh [9]. They focus at techniques to simplify data analysis of huge multivariate military device systems. This approach is demonstrated using representative fresh data from a video prospect analyzer. Firstly, develop fuzzy neural net associations by using Matlab. This represents the best devotion suitable to the data and will be used as orientation for comparison. Then the data is converted to Boolean and using Boolean Decision Diagrams methods, to find analogous relations between input vectors and output constraint.

A Fuzzy Preprocessing Module for Optimizing the Access Network Selection in Wireless Networks proposed by Kaleem Faisal, Abolfazl Mehbodniya, Kang K. Yen, and Fumiyuki Adachi [10]. The main objective of this paper is to presents the implementation and design of a fuzzy multi principles based on Vertical Handoff Necessity Estimation (VHONE) pattern which determines the appropriate time for VHO, however considering the quality and continuity of the currently developed service and the end users satisfaction also. This scheme was proposed to regulate the proper time for an upcoming handoff in order to reserve the quality and the continuity of the current session. Numerous parallel fuzzy logic controls were exploited

with multiple constraints measured from the modern Point of Attachment to determine the necessity of vertical handoffs.

A Soft Computing Approach to Crack Detection and Impact Source Identification (CDISI) with Field Programmable Gate Array Implementation proposed by Arati M. Dixit and Harpreet Singh [11]. The objective of this paper is to report on determinations to develop a computerized CDISI procedure and to communicate a technique such that the proposed technique can be certainly implemented on a chip. The CDISI fuzzy implication system is developed by using toolbox of fuzzy logic MATLAB. A VLSI circuit for CDISI is industrialized on basis of fuzzy logic prototype using Verilog, a hardware description language. The Xilinx ISE WebPACK9.1i is used for design, implementation, synthesis, and verification. The Crack Detection and Impact Source Identification (CDISI) field programmable gate array (FPGA) execution is done by using Xilinx's Spartan 3 FPGA.

Analysis of Adaptive Fuzzy Technique for Multiple Crack Diagnosis of Faulty Beam Using Vibration Signatures is proposed by Amiya Kumar Dash [12]. The main objective of this paper is to discuss the multi crack detection of the configuration using fuzzy Gaussian technique. The vibration constraints derived from the numerical approaches of the cracked beam are used to regulate several fuzzy rules for manipulating the fuzzy controller used to forecast the crack position and depth. Relative crack positions and relative crack depths are the output constraints from the fuzzy implication system. The method which proposed in the present analysis is used to estimate the dynamic response of cracked beam. The consequences of the proposed technique are in good settlement with the consequences obtained from the established experimental setup.

Effect of Road Traffic Noise Pollution on Human Work Efficiency in Government Offices, Private Organizations, and Commercial Business Centres in Agartala City Using Fuzzy Expert System is proposed by Debasish Pal and Debasish Bhattacharya [13]. The main objective of this study is to examine the problems of reduction of efficiency of individuals in his/her corresponding working places because of road transportation noise pollution in Agartala due to speedily growing traffic. This paper deals with modeling and monitoring of the disorders caused due to road traffic disturbed by traffic flow circumstances on personal work routine. Traffic volume amount and noise indices that data were collected concurrently at six selected locations of the city. A correlation was developed between dissimilar traffic noise constraints and its harmful impression on work experience of individuals using MATLAB. Regression equations developed to calculate the percentage of high displeasure among the individuals are suitable based on noise constraints and parameters related to traffic actions. In addition, statistical exploration was also carried out between predictive and measured values of the percentage of extremely bothered group of individuals. The present idea will appeal the attention of the State Government and it will support the policy maker to take the essential steps to diminish this problem.

H. Ramazi, and A. Amini [14] applied fuzzy logic in compiling multi geohazards macro-zone maps. L.A. Zadeh implemented it to find flexibility of protein motifs [15]. Y. Huang and Y. Li use fuzzy logic to outline differences between various poly nucleotides [16]. Z. Xiu-fen, P. Zi-shu, K. Le-shan and Z. Chu-yu Analyzed data for experimental expression [17] using fuzzy theory of adaptive resonance [15]. Some other researches applied fuzzy logic in aligning sequences for dynamic programming [18, 19], generating DNA sequencing [15], identifying the cluster genes from micro-array data

[20]. YQ Ren, XG Duan, HX Li, CLP Chen [21] proposed a multi-variable fuzzy logic control system for a class of distributed parameter systems. I. Pan and S. Das [22] enhanced PID Controller. M. Turkkan and N. Yagiz [23] developed active bus suspension system with help of fuzzy logic control system. A.M. Eltamaly and H. M. Farh [24] used fuzzy logic control to maximize power extraction from wind energy system. M. Togai and H. Watanabe [25] implemented for real time approximate reasoning. R. Kshirsagar et al. [26] developed an environment friendly air conditioner using fuzzy logic. B. Ganesh Kumar et al. [27] gives concept of induction control in diesel engine based on fuzzy logic and neural network. D. Petkovic et al. [28] proposed an adaptive neuro-fuzzy maximal power extraction of wind turbine with continuously variable transmission. A.I. Saleh [29] proposed a fuzzy matchmaking based system-oriented grid scheduler.

A fuzzy-set-theoretic interpretation of linguistic hedges [30], Decision-making in a fuzzy environment [31], Toward a theory of fuzzy information granulation and its centrality in human reasoning and fuzzy logic [32], Fuzzy logic and approximate reasoning [33]. A number of fuzzy inference system and defuzzification methods are proposed in last decade in order to improve performance of existing systems. A fuzzy logic controller for determining the air and fuel to be delivered to an engine proposed by [34]. A number of engineering application described by T. J. Ross [35]. An advanced control strategies for adjustment and preservation of air quality, thermal and visual comfort for buildings' occupants while, simultaneously, energy consumption reduction is achieved by [36]. Now a day a large number of researchers taking interest in application of fuzzy logic in home appliance like [37] presented a study of the air conditioning system by using fuzzy logic control. It will take into account the energy savings and the room temperature remained in range of comfort zone for the

resident's satisfaction. Fuzzy logic control for active bus suspension system was suggested by [38]. An evolutionary algorithm developed by [39] for an effective tuning of fuzzy logic controllers in heating, ventilating and air conditioning systems. M. Abbas described the design and implementation of an autonomous room air cooler using fuzzy rule based control system [40]. Various new algorithms are developed for air conditioning system including neuro-fuzzy controller algorithm for air conditioning system [41]. Neuro-fuzzy control mixes the learning capabilities of neural networks and control capabilities of fuzzy logic control.

TA Hiwarkar et al. list a wide range of applications of fuzzy logic in [42]. K.A. Verma in [43] discussed type-1 fuzzy system and origin of type-2 fuzzy systems and theories and application fields of engineering, finance and medical domains. Xia Feng et al. [44] designed scheduler for embedded control system using fuzzy logic based feedback. A priority scheduler has been developed for mobile ad hoc networks by C. Gomathy et al. in [45]. X. Zhang et al. [46] proposed a hierarchical fuzzy rule-based system optimized with genetic algorithm for short term traffic congestion prediction. A. Saleh proposed a grid-scheduling algorithm on fuzzy matchmaking approach [47].

Fuzzy logic based algorithms are getting more popularity now a day as Reza salami et al. developed an efficient task scheduling algorithm for computational grids using NSGA II with fuzzy variance based crossover [48]. In this algorithm two functions are defined to generate two inputs for fuzzy based system. Variance of costs and presence of resource in scheduling are used to specify probability of crossover. It provides better solution in less number of iterations. H. Chuan et al. discussed fuzzy job shop scheduling problem based in interval

number theory [49]. S. Mandloi et al. gives new idea based on ant colony optimization with genetic parameter selection for job scheduling in computational grid [50]. Fuzzy based scheduling algorithms implemented in cloud also. C. Yi Chun et al. proposed a fuzzy based dynamic load decision making scheme in cloud computing [51].

Fuzzy logic is a modeling method well suited for the control of complex and non-linear systems [52]. Control design of an ankle foot orthosis with the application of fuzzy logic is proposed by M. Kanthi, V. I. George and H. S. Mruthyunjaya [53]. Type-2 Fuzzy Logic in Decision Support Systems is proposed by Comas and Diego S [54]. Fuzzy Logic Applications in Flanges Manufacturing proposed by Turc, Cristian Gheorghe and George Belgiu [55]. Combining Boolean consistent fuzzy logic and ahp illustrated on the web service selection problem proposed by Dragovic and Ivana [56]. Application of the L-fuzzy concept analysis in the morphological image and signal processing proposed by Alcalde, Cristina, Ana Burusco, and Ramón Fuentes-González [57].

Intelligent maximum power point trackers for photovoltaic applications using FPGA chip is proposed by Chekired [58]. Interval type-2 fuzzy weight adjustment for back propagation neural networks with application in time series prediction is proposed by Gaxiola and Fernando [59]. Fuzzy Logic Applications in Control Theory and Systems Biology proposed by Xu and Sendren Sheng-Dong [60]. New Applications of Soft Computing, Artificial Intelligence, Fuzzy Logic & Genetic Algorithm in Bioinformatics proposed by A. T. Hiwarkar, and R. Sridhar Iyer [61]. Application of a model based on fuzzy logic for evaluating nursing diagnostic accuracy of students proposed by MHBM Lopes [62]. Knowledge representation in fuzzy

logic is proposed by L. A. Zedeh [63]. Expert systems using fuzzy logic are proposed by Yager, R. Ronald [64]. Fuzzy rules in knowledge-based systems proposed by Dubois, Didier, and Henri Prade [65].

Table 2. Applications of Fuzzy Logic

S.No	Product Name	Role of Fuzzy Logic
1	Air Conditioner	Prevents overshoot undershoot temperature oscillation and consumers less on off power
2	Anti-lock Brakes	Controls brakes in hazardous cases based on car speed and acceleration and on wheel speed and acceleration
3	Auto Engine	Controls fuel injection and ignition based on throttle setting, oxygen content, cooling water temperature, RPM, fuel volume, crank angle, knocking and manifold pressure
4	Auto Transmission	Select gear ratio based on engine load, driving style and road conditions
5	Chemical Mixer	Mixes chemicals based on plant conditions
6	Copy Machine	Adjusts drum voltage based on picture density, humidity and temperature
7	Cruise Control	Adjusts throttle setting to set the speed based on car speed and acceleration
8	Dishwasher	Adjusts cleaning cycle and rinse and wash strategies based on the number of dishes and on the type and amount of food encrusted on the dishes
9	Dryer	Converts load size, fabric type and flow of hot air to dry times and strategies
10	Elevator Control	Reduces waiting time based on passenger
11	Factory Control	Schedule tasks and assembly line strategies
12	Golf Diagnostic System	Selects golf club based on golfer's physique and swing
13	Health Management	Over 500 fuzzy rules track and evaluate an employee's health and fitness
14	Humidifier	Adjusts moisture content to room conditions
15	Iron Mill Control	Mixes inputs and set temperatures and times

16	Kiln Control	Mixes cement
17	Microwave Oven	Sets and tunes power and cooking strategy
18	Palmtop Computer	Recognizes handwritten kanji characters
19	Paper Industry	Pulp production
20	Plasma Etching	Sets etch time and strategy
21	Refrigerator	Sets defrosting and cooling times based on usage. A neural network learns the user's usage habits and tunes the fuzzy rules accordingly.
22	Rice Cooker	Sets cooking time and method based on steam, temperature and rice volume
23	Shower System	Suppresses variations in water temperature
24	Still Camera	Finds subject anywhere in the frame, adjusts autofocus
25	Stock Trading	Manages portfolio of Japanese stocks based on macroeconomic and microeconomic data
26	Television	Adjusts screen color and texture for each frame and stabilizes volume based on viewer's room location
26	Translator	Recognizes, translates word in pencil size unit
27	Toaster	Sets toasting time and heat strategy for each bread type
28	Vacuum Cleaner	Sets motor suction strategy based on dust quantity and floor type
29	Video Camcorder	Adjusts autofocus and lighting
30	Washing Machine	Adjusts washing strategy based on sensed dirt level, fabric type, load size and water level. Some models use neural networks to tune rules to the user's tastes.

2.2 Neuro Fuzzy Logic

Neuro-fuzzy architecture Fuzzy Adaptive Learning Control Network (FALCON) is proposed by C. T. Lin and C. S. Lee [87]. Architecture Adaptive Network based Fuzzy Inference System (ANFIS) proposed by R. R. Jang [88]. Architecture Neuronal Fuzzy Controller (NEFCON) proposed by D. Nauck and Kruse [89]. Architecture

Fuzzy Net (FUN) proposed by S. Sulzberger, N. Tschichold and S. Vestli [90]. Architecture Fuzzy Inference, and Neural Network in Fuzzy Inference Software (FINEST) is proposed by Tano, Oyama and Arnould [91]. Architecture, Self-Constructing Neural Fuzzy Inference Network (SONFIN) proposed by Jung and Lin [92]. Architecture, Dynamic/Evolving Fuzzy Neural Network (EFuNN and dmEFuNN) proposed by Kasabov and Song [93]. Architectural Generalized Approximate Reasoning based Intelligence Control (GARIC) proposed by H. Berenji [95]. Architecture of Fuzzy Neural Network (FNN) was proposed by Figueiredo and Gomide [94]. Neural fuzzy systems: a Neuro-fuzzy synergism to intelligent systems proposed by Lin, Chin-Teng, and C. S. Lee [100]. Neural networks in designing fuzzy systems for real world applications proposed by Halgamuge, K. Saman and Manfred Glesner [101].

JSR Jang proposed an adaptive network based fuzzy inference system [126]. The architecture and knowledge procedure underlying ANFIS is offered, which is a fuzzy inference system employed in the framework of adaptive networks. By using a hybrid knowledge procedure, the proposed ANFIS can build an input-output plotting based on both human knowledge and specified input-output data pairs. CF Juang proposed an online self-constructing neural fuzzy inference networks and its applications [127]. It proposed a self-constructing a neural fuzzy inference network (SONFIN) through online knowledge ability. The SONFIN is naturally a modified Takagi Sugeno Kang type fuzzy rule based model holding neural network knowledge ability. NK Kasabov, and Q Song proposed a dynamic progressing neural fuzzy inference system and its application for time series prediction [128]. It introduces an innovative type of fuzzy inference systems which indicated as dynamic, evolving neural fuzzy

inference system (DENFIS) for adaptive online and offline knowledge and their application for dynamic time series forecast.

CT, Lin and CS Lee proposed a neural network based fuzzy logic control and decision system [129]. This model associates the notion of fuzzy logic controller and neural network configuration in the form of feed forward multilayer net and knowledge, abilities into an incorporated neural network based fuzzy logic control and decision system. O Avatefipour, F Piltan, MRS Nasrabad and G sahanijoo proposed a Design New Robust Self Tuning Fuzzy Backstopping Methodology [130]. It is focused on suggested Proportional Integral (PI) like fuzzy adaptive backstopping fuzzy algorithm constructed on Proportional Derivative (PD) fuzzy rule base through the adaptation laws consequent in the Lyapunov sense. GO Tirian, I Filip, and G Proştean proposed an adaptive control system for continuous steel casting based on neural networks and fuzzy logic [131]. It defines a neural network based approach for crack extrapolation aimed at improving the steel casting process presentation by decreasing the number of cracks produced by failure cases. A neural system to approximation crack detection possibility has been designed, implemented, tested and incorporated into an adaptive control system.

Face finding in images proposed by Vincent and M. John [96]. The main objective of this paper was to describe work undertaken at BT Laboratories to produce a system, based on the use of neural network feature detectors, to robustly locate and track features in digital image sequences. We have concentrated on the location of eyes and mouths in human head-and-shoulders images, although the techniques described should be applicable to determining the position of localized features in other objects.

Sex recognition of faces using neural networks is proposed by B. Golomb and T. Sejnowski [97]. The main objective of this paper was to recognize the sex of conspecifics is significant: Expending one's devotions Q or one's seed Q on the wrong equality of partner could place one at a reasonable disadvantage. However selected animals use pheromones to identify sex, in humans being this task is mostly visual: "Many socially living animals... recognize each other as members of the same species, as individuals, and as social partners by means of visual signals and communicate their mood and intentions by the same sensory modality. In many primate species the individual structure of the face is the most important visual characteristic of each group member" (Grusser, Selke, & Zynda 1985). How sex is identifying from face is a core issue; until recently this received slight attention.

Neural architectures and algorithms proposed by Murray and Alan [98]. The objective of this paper was to describe that Artificial Neural Networks (ANNs) are intelligent, thinking machines. They work in the same way as the human brain. They learn from experience in a way that no conventional computer can and they will shortly solve all of the world's hard computational problems.

Electrical load forecasting proposed by Hsu, Yuan-Yih, and Chien-Chun Yang [99]. The application of artificial neural networks (ANNs) to forecast the hourly loads of an electrical power system is examined in this chapter. Two types of ANN's, i.e., the Kohonen's self-organizing feature maps and the feed forward multilayer neural networks, are employed for load forecasting. Kohonen's self-organizing feature map, which is a kind of ANN with the unsupervised learning scheme, is first used to identify those days with similar hourly load patterns. These days with similar load patterns are

said to be of the same day type. The load pattern of the day under study is obtained by averaging the load patterns of several days in the past which are of the same day type as the given day. After the hourly load pattern has been reached, a multilayer feed forward neural network is designed to predict daily peak load and valley load. Once the peak load and valley load and the hourly load pattern are available, the desired hourly loads can be readily computed. The effectiveness of the proposed neural network is demonstrated by the short-term load forecasting of Taiwan power system.

Theory and applications of neural networks for industrial control systems is proposed by Fukuda et al. [102]. The lead objective of this paper was to describe the principle and the applications of artificial neural networks, specifically in a controlled arena. Artificial neural networks try to simulate the nervous system in a mammalian brain into a mathematical model. Thus, neural networks have certain appropriate characteristics and skills which is similar to the brain system, such as nonlinear mapping, parallel processing, learning, and generalization. Recently, neural networks developed as innovative tools in various fields by many researchers such as information processing, pattern recognition, design, planning, and control.

A neural fuzzy control system with the structure and parameter learning is proposed by Lin, Chin-Teng [103]. This paper was proposed a common model, named as neural fuzzy control network (NFCN). This model is proposed for the understanding of a fuzzy logic control system. The proposed model is a feed forward multidimensional network, which incorporates the functions and basic elements of a traditional, fuzzy logic controller into a connectionist configuration which has scattered learning capabilities. This model can be built up from controlled training instances of machine learning

techniques, and the connectionist configuration can be accomplished to develop fuzzy logic rules and also find membership functions. Connected with the NFCN is a two-phase hybrid learning algorithm which exploits unsubstantiated learning patterns for structure learning and the back propagation learning pattern for parameter learning.

Stable adaptive control using fuzzy systems and neural networks are proposed by Spooner et al. [104]. This paper was presented a constant direct and indirect adaptive organizer, which use conventional fuzzy systems, Sugeno fuzzy systems, or a class of neural networks to deliver asymptotic tracing of a reference indication for a period of continuous-time nonlinear plants with poorly assumed dynamics. The direct adaptive structure permits for the integration of such a priori information in postulating the controller whereas the indirect adaptive structure permits for the enclosure of a priori information about the plant dynamics in relationships of particular mathematical equations or linguistics. We prove that both adaptive structures can “learn” how to deliver for restricted internal signals, control the plant, and accomplish asymptotically established tracking of a reference input with or without such information. In addition, for the direct adaptive structure a technique is accessible in which linguistic information of the reverse dynamics of the plant may be used to accelerate revision.

A new approach to fuzzy-neural system modeling is proposed by Lin et al. [105]. This paper developed simple and operative fuzzy-rule based models of compound systems from input-output data. For modeling systems, introduce a simple fuzzy-neural network and prove that it can characterize any continuous function over a compressed set. This model introduces “fuzzy curves” and uses them to identify significant input variables, set the initial weights and determine model structure in the fuzzy-neural network model. Method for input

documentation is computationally modest and, regulates the proper network structure and initial weights in advance, train the network rapidly. Viewing the network as a fuzzy model gives insight into the real system, and it provides a method to simplify the neural network.