

FUZZY LOGIC AND ITS APPLICATIONS IN SOME AREA: A MINI REVIEW

K. L. Vairal^{*1}, S. D. Kulkarni² and Vineeta Basotia³

¹Research Scholar of Shri JJT University, Jhunjhunu, Rajasthan, India

²Dept. of Mathematics, Pemraj Sarda College, Ahmednagar, Maharashtra, India

³Dept. of Mathematics, Shri JJT University, Jhunjhunu, Rajasthan, India

¹kailashvairal7@gmail.com, ²suprabha.jayant@gmail.com, ³vm.jjtu@gmail.com

Abstracts- The aim of the present review is to emphasize, how the fuzzy logic is useful in various fields regarding solving a problems and benefits for the human health and wealth. It revealed we considered that, applications of fuzzy logic and their related problems were in the fields like as commerce, politics, environment, chemistry, physics, statistics, medical, computer, engineering, agriculture etc. We show it as profitable tool for the controlling, screening, production potential, accuracy etc. of system and complex processes, as well as household and entertainment electronics along with other expert system. Fuzzy decision making process a crucial part of fuzzy logic system; may be carried out by various methods the suitability of these methods is dependent on degree precision required, available database, clarity of data etc. Fuzzy logic is the basic approach towards the all those software being used for modelling and forecasting.

Keywords: Fuzzy set, Fuzzy logic, Fuzzy inference system, Fuzzy logic controller, Fuzzy logic applications.

Introduction

The fuzzy set theory and fuzzy logic was an extensive overview of increasingly important application of mathematics. The fuzzy logic is a qualitative computational method which describes vagueness or partial truth. The innovative idealistic mathematical approach had been improved to accommodate partial truth by the introduction of fuzzy set theory invented by Zadeh, unlike classical set theory, fuzzy set theory is flexible, which is focuses on

the degree of being a member of set. The most successful approach is based on the fuzzy set notation proposed by Lotfi A. Zadeh in 1965 [1]. He had observed that conventional computer logic could not manipulate data that represented subjective or vague ideas.

Zadeh developed the fuzzy control system that is a based on fuzzy logic, a mathematical system that analyze the input values in terms of logical variables that take on continuous value between 0 and 1 (false or true). He proposed the concepts of fuzzy algorithms in 1968 [2]. In 1973, he published another seminal paper which established the foundation for fuzzy control [3]. He introduced the concept of linguistic variables and proposed to use fuzzy IF-THEN rules based to formulate human knowledge. Application of fuzzy sets and fuzzy logic were helped by Mamdani 1975 [4]. In 1980, the fuzzy sets, fuzzy logic were used for mathematics and engineering. Japanese engineers developed a new technology and they found that fuzzy controllers were very easy to design and work for many problems. In 1980, Sugeno began to create Japans first fuzzy application which was "control of a fuji electric water purification plant" and he was the pioneer of fuzzy robot in 1983. Sugeno and Nishida introduced a self-parking car that was controlled by calling out the commands in 1985. The fuzzy systems and control progressed rapidly in the decade 1980 to 1990. And new techniques (neural networks techniques) were used to determine membership functions in a systematic manners and demanding constancy analysis of fuzzy control systems was performed. In 1995, the technology of fuzzy set theory and its application to systems using fuzzy logic has moved rapidly and development of other

*Corresponding Author: Kailas Vairal, Department of Mathematics, P.V.P. College Pravaranagar, Loni (413713), Tal- Rahata, Dist- Ahmednagar, Maharashtra, India, E-mail : ¹kailashvairal7@gmail.com

theories such as possibility theory and evidence theory.

The inventory of successful application of fuzzy set theory had been growing steadily and developing many diverse applications. This include information and knowledge based systems in various area such as engineering, computer, physics, chemistry, biology, ecology, political science, geology, meteorology, nuclear engineering, medical science, medicine, economics, psychology, agriculture, and so on [5]. Research and development was continued on fuzzy application in software design, including fuzzy expert system and integration of fuzzy logic with neural network and genetic software systems, with the ultimate goal of building self-learning fuzzy control systems. The real world is complex, complexity in the world generally arises from uncertainty in the form of ambiguity. Problems featuring complexity and ambiguity have been addressed subconsciously by humans since they could think; these ubiquitous features pervade most social, technical, and economics problems faced by the human race [6]. The nature of uncertainty in a problem is a very important point that engineers should ponder prior to their selection of an appropriate method to express the uncertainty. Fuzzy sets provide a mathematical way to represent vagueness and fuzziness in humanistic systems. Fuzzy set theory and fuzzy logic developing many diverse application. These include information and information and knowledge base system, various area of sciences, various area of engineering, and virtually all problem area of decision making. Fuzzy logic is a powerful problem solving methodology and mathematically, it is superset of Boolean or Crisp logic. The term "fuzzy" refers to the logic involved which can deal with concepts that cannot be expressed as "true" or "false" but rather as "partially true" or partially false". This makes it easier to mechanize task that are already successfully performed by humans. The suitability of these methods is dependent on degree of precision required, available database, clarity of data etc. Fuzzy logic is the basic approach towards the all those software being used for modelling and forecasting. In the present task, this article represented some of the area related to fuzzy logic, which would be useful for solving any uncertainty in the various filed.

Commerce

In the area of commerce recently used fuzzy logic. The development of an expert system using fuzzy logic approach to assess the business to consumer websites 'features from the customers' perspective and to show that which features affect further the customers' purchase intention. The business to consumer websites features, namely security, privacy, and information. The data was collected through an online survey from the students with experience in online shopping through business to consumer websites. It was based on three business to consumer websites features, an assessment system based on fuzzy logic was developed together with its FIS to evaluate the features. All input variables in the FIS model used linguistic terms modelled as Gaussian MFs, and the Triangular MFs were applied for the outputs of the model. They defining that MFs for all inputs and output of fuzzy system, fuzzy rules were discovered to be used in the FIS. The results of the expert system showed the fuzzy logic capability of evaluating the business to consumer websites' features. The results showed that the customers' trust was more influenced by Security compared with other features of business to consumer websites with maximum levels about 0.656 in relation to the other features [7].

Trust is widely recognized as an essential factor for the continual development of Business to Customer Electronic Commerce (B2C EC). Many trust models have been developed, however, most are subjective and did not take into account the vagueness and ambiguity of EC trust and the customers' intuitions and experience when conducting online transactions. The work developed a fuzzy trust model using fuzzy reasoning to evaluate EC trust. This trust model is based on the information customers expect to find on an EC website and that is shown to increase customers trust towards online merchants. They argue that fuzzy logic is suitable for trust evaluation as it takes into account the uncertainties within E-commerce data and like human relationships, it is often expressed by linguistics terms rather than numerical values. The evaluation of the proposed model will be illustrated using two case studies and a comparison with two evaluation models was conducted to emphasize the importance of

using fuzzy logic. They presented a system based on fuzzy logic to support the evaluation and the quantification of trust in EC. Although, the system has addressed many issues that other systems did not such as taking into account the fuzzy nature of trust and using a substantial number of variables, we believe that the system can be improved in many ways. As stated in many trust models, there are other aspects that contribute to the completion of online transactions. This include the price, the rarity of the item and the experience of the customer. In order to develop an effective decision support system, future development should include some if not all of these aspects. The price of the item is certainly an important variable as it is shown in many studies that if the price is reasonably low, customers are ready to take the highest risk to purchase the item. Online transactions also depend on customer's experience and personality. Some customers may value some variables more than others. Hence we believe that future systems should allow customers to rank trust variables according to their own perception and experience [8].

The fuzzy logic as an effective, useful method to be applied to financial research and, the management of banking crises. The data sources were Web of Science and Scopus, followed by an assessment of the records according to pre-established criteria and an arrangement of the information in two main axes: financial markets and corporate finance. A major finding of this analysis was that fuzzy logic has not yet been used to address banking crises or as an alternative to ensure the resolvability of banks while minimizing the impact on the real economy. Therefore, this article relevant for supervisory and regulatory bodies, as well as for banks and academic researchers, since it opens the door to several new research axes on banking crisis analyses using artificial intelligence techniques [9].

The fuzzy system based certain trust model to support the evaluation and the quantification of trust in E-commerce. Trustworthiness especially for service oriented system is very important topic now a day in IT field of the whole world. There are many successful E-commerce organizations presently run in the whole world, but E-commerce has not reached its full potential. The main reason behind this is lack of Trust of people in e-commerce. Again, proper models are still absent for calculating

trust of different e-commerce organizations. Most of the present trust models are subjective and have failed to account vagueness and ambiguity of different domain. The proposed a new fuzzy logic based Certain Trust model which considers these ambiguity and vagueness of different domain. Fuzzy Based Certain Trust Model depends on some certain values given by experts and developers can be applied in a system like cloud computing, internet, website, e-commerce, etc. to ensure trustworthiness of these platforms [10].

Politics

Politics is interesting subjects of everyone. They discuss about an election, predication or result outcome, but fuzzy logic accurately solve the problem. It was possible to model fuzzy inference system allows creating events between different variables that correspond to the political marketing, helping to analyze the impact that a candidate might have for winning an election. The student's representative, who has to know how to offer his/her solution through an effective and quality campaign by listening to the needs of students in a specific market. By using current technologies such as Facebook and Twitter, which might be used as input data from statistics obtained at the end of the advertising campaign for data analysis, and to improve the fuzzy cognitive map, in such way that you can add new variables and collect comments from students analyzing further negative and positive causalities. The casual factor, under uncertainty, related to the decisions taken by students in the University of Guayaquil as voters; at the time of electing a candidate as a student representative; similarly, how effective are electoral marketing strategies applied by parties and students groups for vote-catching. The proposed a methodology based on fuzzy logic techniques and cognitive map to create causality models relying on expert criteria and being these modes useful for decision making, as well as analysis of hypothetical scenarios based on the underlying concept structures that have the most significant causal weight related to the effectiveness of electoral marketing strategies [11].

The efficiency perception impact assessment based upon the integration of Fuzzy Logic (FL) of the "Productive Reconversion "conservation program (PRP) instituted by the Mexican

government, in the Upper Gulf of California and the Colorado River Delta Biosphere Reserve (UGCCRDBR). They set a program, an efficiency-perception impact assessment based upon the integration of FL of the Productive Reconversion. This approach enables environmental analysis to deal with the intrinsic imprecision and ambiguity associated with people's judgments and conclusions. The application of FL to the assessments of program efficiency is illustrated in this work, demonstrating how subjective perceptions can be converted into quantitative values easy to evaluate during the decision making process [12].

A fuzzy ontology approach has been employed to provide insight into how knowledge can be represented and handled in order to offer the intelligent decision making process. The regional and international events contributes to the increasing challenges in political decision making, especially the decision to strengthen bilateral economic relationship between friendly nations. The decisions are influenced by certain factors and variables that are based on heterogeneous and vague information. A serious problem that the decision maker faces is the difficulty in building efficient political decision support system (DSS) with heterogeneous factors. The basic concept is a linguistic variable whose values are words rather than numbers and therefore closer to human intuition. Fuzzy logic is based on natural language and is tolerant of imprecise data. Furthermore, fuzzy cognitive mapping (FCM) is particularly applicable in the soft knowledge domains such as political science. IN that work a FCM scheme is proposed to demonstrate the casual inter relationship between certain factors in order to provide insight into better understanding about the interdependencies of these factors. It present work fuzzy algebra for governing causal propagation on FCMs [13].

The all party member are interested in winning elections depending on the best selection of a candidates on the ballot paper. The selection can be done for local election, legislative election, and parliamentary election, senate election or any team leader selection. In practice political parties use different institutions to select their candidate but some factor are common for all political parties. So in each selection there are more than hundreds of people willing to stand for election. But it

would be impossible for general voters to make a suitable choice. so its party leader responsibility to select an appropriate candidate to win the election using some useful properties such as publicity, number of years attach activity in politics, responsiveness, behavior, criminal records, age and education etc. fuzzy rule based selection evaluator is better select an appropriate candidate to win an election. Further it also decrease paper work and increase faith, cooperation and understanding among party members which positively increase the chances of winning of a party [14].

Environment

Now days, every ecological sources are deteriorating and there should need control it. Fuzzy logic system is used to solve various environmental problem such as water, water quality, pollution, etc. water is important for life of organisms and need good water for life. The water quality index more rational approach is needed as presents indices have number of discrepancies and need to be rectified. Water quality parameters consider for obtaining WQI is different for all indices. The crisp set theory an advanced computation method is required which is capable of handling imprecise, vague and fuzzy information is decision making on water quality. Hence there is need for more robust approach which can deal with uncertainty and ambiguity involved in assessment of water quality. To reduce uncertainty, ambiguity, vagueness and subjectivity in environmental issues fuzzy set theory has emerged as an excellent tool. He work of quantifying EIA by using fuzzy set theory , fuzzy logic has been used for quantifying pollutions in water and instead of WOI new nomenclature is done as FWPI (Fuzzy water Pollution Index). Higher the value of FWPI higher will be the concentration of pollutants [15].

Water quality managements is an important issues of relevance in the context of present times. Water quality indices are computed for classification of water wherein the integration of parametric information on water quality data and the expert's knowledgebase on their importance and weights are considered. The objective method of computing water quality index in order to presents a concise picture of overall water quality trends is often used as a tool in the administration of water quality

abatement program. However, in view of the uncertainties discussed above, the approach outlined in that work using fuzzy logic a soft computing technique could be a better representation of a dynamic system, and there by providing a new dimension of gauging river water quality for specific purpose. The agreements index for per capita water consumption based on consumer full satisfaction level is new concept of practical relevance. The past two decades have witnessed a dramatic growth in use of probability based methods in a wide variety of application centering on automation of decision making in an environment of uncertainty and in completeness of information. Thus the work believe that the fuzzy logic concept, if used intelligently, could be an effective technique for some of the environmental policy issues [16].

The fuzzy set theory accepts partial membership, and therefore in a sense of generalizes the classical set theory to some extent. Fuzzy decision making process a crucial part of fuzzy logic system may be carried out by various methods the suitability of these methods is depends on degree of precision required, available database, clarity of data etc. fuzzy logic approach is the basic approach towards all those software being used for modellings and forecasting. Fuzzy logic is complex mathematical method that allows solving difficult simulated problems with many inputs and outputs variables. In environmental engineering it is difficult to judge the severity of pollution by layman. In environmental modelling system fuzzy rule base approach can be utilized in significant way as it provides a comfortable approach while making decision through multiple criterions. They work as the air quality index has been calculated using fuzzy logic system [17].

Chemistry

Fuzzy logic has been used in chemical sciences. There are many illustrations based on the fuzzy logic in chemical science. Fuzzy logic is used in target tracking, pattern recognition, robotics, power systems, controller design, chemical engineering, biomedical engineering, vehicular technology, economy management, and decision making in aerospace applications, communications and networking, electronic and civil engineering. In many chemical engineering system, the classification of

product quality characteristics is performed by human experts, due to the absence of measuring devices. The development of mathematical models for such system is a rather difficult task, since no equations based on first principles can be written. Chemical engineering has employed fuzzy logic in the detection of chemical agent as well as gas recognition. It has also been applied to process control, batch distillation column, separation process, and kinetics. The work which was emphasized these applications in more detail. Fuzzy logic is considered as a superset of standard logic which is extended to deal with partial truth. It had become one of most successful technologies for developing complex control systems. Fuzzy logic is a design methodology that can be used to solve real life problems chemical engineering has employed fuzzy logic in the piping risk assessment, safety analysis, batch crystallizer, combustion process, food produce, fluidized catalytic cracking unit and separation process. It has also been applied to process and kinetics [18].

The fuzzy logic controller (FLC) in controlling the liquid level in the second tank of coupled-tanks plant through variable manipulation of liquid pump in the first tank the system modelling involves developing a mathematical model by applying the fundamental physical laws of science and engineering. They simulation studies are then conducted based on the developed model using MatlabR12a for Simulink. The study showed the behavior system in terms of time response including steady state error rise time and overshoot, and compare FLC adverse PID controller. A unique FLC using a small number of rules and straightforward implementation has been proposed to solve a class of level control problems with unknown dynamics or variable time delays commonly found in industry. The FLC on a level control problem with promising results can be applied to an entirely different industrial level controlling apparatus. As a future work one can develop design a FLC for a couple tanks system as adaptive fuzzy logic controller like PID algorithm, which gives high performance for systems and high intelligence [19].

Chemical process or chemical plant are a complex system requires good scientific knowledge on different issues including Process Safety Analysis (PSA). Fuzzy logic is the collective name for “fuzzy set analysis” and

“possibility theory” able to use random or approximate data in the PSA. The impact of fuzzy set theory for basic tools used in PSA. It also represents the sources and types of uncertainties encountered in PSA and also methods to deal with them. There are different methods to improve the quality of the PSA, for examples sensitively analysis, expert systems, statistics, and fuzzy logic. Fuzzy logic is one of the promising methods for reliability assessment. The traditional PSA tools like Fault Tree Analysis (FTA) and Event Tree (ET) were trimmed and free of uncertainty by the application of fuzzy logic. Now these tools provide correct process risk level and safety assurance. The mathematical model developed with fuzzy logic enables the identification of safety barrier implemented to prevent the top event from taking place and to control the effects. The result of PSA has showed that safety modelling based on fuzzy logic approaches provide safety analysis and designers with convenient tools that can be used at various stages of the design of chemical process [20].

Physics

Fuzzy logic can applied physics. It has been successfully used in solving problems. In this paper fuzzy logic is used to solve uncertainties in physics or related problems. The mathematical tool to handle different types of uncertainty. The fuzzy set theory and fuzzy logic use to solve problems which involve human factor such as decision making, utility theory and behavioral models of different factors that could not be formulated properly by mathematical model based on two valued logic or traditional set theory. In view of fuzzy human feelings and concepts, fuzzy human feelings cannot be described by black and white models only. Due to this generalization, theory of fuzzy sets has wider scope of applicability than that of an abstract set theory in solving problems which involves, to some extents, subjective evaluation. This theory of fuzzy sets and fuzzy logic has been studied through out the paper [21].

It is an interesting alternatives to the designers of nonlinear control laws for electrical or electromechanical system. They purposes a newly concepts on-site tuning strategy for a PID like fuzzy logic controller. They were proposed set of pre-established

setting for an open loop stable or evaluative electro technical process. This kind of fuzzy controllers depending on single loop identification test. They on site tuning method had been compare to the Ziegler-Nichols ones for conventional controllers. A second set of pre-established settings is then proposed. It is a robust one, which integrates, from the design procedure the robustness of the FLC in case of white noise, open loop process misidentification or high order process. Nevertheless, this kind of robust setting suppose that the user knows (or can acquire) the solicitation magnitude. Therefore, a second set of robust setting that integrates using 3D-extension of Taguchi quality design methodology, the robustness versus the solicitation magnitude is finally proposed. They proposed method based on experimental designs can be applied another time to find new set of pre-established settings [22].

Statistics

The statistical data analysis, where either data or techniques involved fuzzy modelling in statistical data, analysis or processing techniques. They developed in which a coalition of fuzzy set theory and statistics has been established with different purposes. First introduce to new data analysis problems in which the objective involves either fuzzy relationship or fuzzy terms, second establish too well formalized models for elements combining randomness and fuzziness and to develop uni and multivariate statistical methodologies to handle fuzzy valued data and to incorporate fuzzy sets to help in solving traditional statistical problems with non-fuzzy data. In spite of a growing literature concerning the development and application of fuzzy techniques in statistical analysis, the need is felt for a more systematic insight into the potentialities of cross fertilization between statistics and fuzzy logic.in the line with the synergistic spirit of soft computing, some instances of the existing research activities on the topic are recalled. Fuzzy logic to wide diversity of topics concerning applied aspects of the integration of fuzzy set and statistics [23].

The usage possibilities of personal statistics are introduced, which can be applied to improve the patient-specific evolution in heath monitoring systems these techniques is to obtain reliable results based on previous

measurements. This goal can be achieved by membership function tuning or modification, as well as by a preprocessing method, which is used to judge whether a situation is normal or not. The statistics based any time fuzzy decision support technique is introduced, which can fulfill these requirements. In possible crisis situations, the system is able to come to a decision in much shorter time. Furthermore, the method helps both in fitting the model to the person and to decide whether a situation is critical or not. The proposed technique allows to built-in the personal statistics into the decision resulting that the process becomes more sensitive, i.e. it fits better to the usual values of the patient, consequently, more likely filters out the critical situations. The input membership functions can be improved also by including the personal statistics, which represent the normal reactions of the patient. As the result of this modification the membership function is shifted towards the usual values, which makes the evaluation safer. This approach allows distinguish the persons who have seemingly same characteristics, but react differently under the same circumstances [24].

The statistical analysis, in traditional form, is based on crispness of data, random variables hypotheses, decision rules, and parameter so on. As there are many different situations in which the above assumptions are rather unrealistic, there have been some attempts to analyze these situation with fuzzy set theory. The introducing and developing fuzzy set theory, a lot of studies have been done to combine statistical methods and fuzzy set theory. This works called fuzzy statistics, have been developed in some branches. In this essential works on fuzzy estimation, fuzzy hypotheses testing, fuzzy regression, fuzzy Bayesian statistics, and some relevant fields [25].

Medical

Most of the medical knowledge available to physicians will always be fuzzy, when a person is given a medical examinations, a wide variety of parameters, called symptoms in medical language, can be ascertained and measured. Due to human body complexity. It is not possible to give a realistic limit for various criteria. But fuzzy logic has been used to solve complexities. The design processes of some fuzzy expert system application was used some

medical area. The fuzzy expert system used for the determination of prostate cancer risk, coronary heart diseases risk, child anemia, periodontal dental disease, iron deficiency anemia, drug doses, etc. The physicians was support to diagnosis with the help of all designed fuzzy expert system. He believe that the future in medicine and their uses with fuzzy logic, fuzzy control and hybrid fuzzy neuro systems [26].

The fuzzy expert system for the diagnosis of liver disease using complete blood counts. They used various blood parameters for the study. They developed system consists of four input variable and three output variable, the system uses Mamdani inference engine and is developed using MATLAB software. They was developed liver disease diagnosis system is faster, cheaper and reliable and it can prove to be very useful in comparison with other traditional diagnostic system [27].

The fuzzy was developed to obtain an approach integrating the fuzzy logic strategy for a therapeutic hepatitis-C virus dynamics optimal control problem. To test the efficiency of this strategy, the work proposed a numerical comparison with the direct method by taking the values of determinant parameters of this disease for people administrating the drugs. The results are in the good agreement with experimental data. To handle that problem, two numerical approaches have been compared to determine the optimal trajectories of these determinant parameters which responds to two control (interferon and ribavirin) of this disease hepatitis-C virus for a patient who is administrating drugs during 12 months. The results revealed that the two used methods are satisfactory and closed. The findings also show that, in terms of time, the hybrid approach integrating the fuzzy logic strategy has an advantage on the direct approach in terms of time. Consequently, it constitutes an important approach for the resolution of the optimal control problem. In particular, it gives the optimal trajectories of uninfected hepatocytes and infected hepatocytes and hepatocytes in the same way that it ensures their performance [28].

The classical control theory usually requires a mathematical model for designing the controller. The inaccuracy of mathematical modelling of the plants usually degrades the performance of the controller, especially for nonlinear and complex control problems the

advent of the Fuzzy Logic Controller (FLC) and the neural controllers based on multilayered neural networks has inspired new resources for the possible realization of better and more efficient control. The integration between fuzzy logic and neural networks namely Fuzzy Neural Network (FNN) has been proposed and developed; generally the combination of fuzzy logic and neural network is called as Adaptive Neuro Fuzzy Inference System (ANFIS). Neural system has many input and also has multiple outputs but the fuzzy logic has multiple inputs and single outputs. ANFIS which is used for nonlinear applications. The work proposed by Akhil et.al. (2013) revealed ANFIS controller for temperature of a water bath system. ANFIS based NFC is suitable for adaptive temperature control of a water bath system. ANFIS is the good controller as compared to other controller, and it is widely being used [29].

This system is a computer program which is designed to model a life situation of artificial intelligence using the vast resources of the computer system. In this system obtain symptoms such as temperature, vomiting, bleeding, diarrhea, muscle pain to instantly diagnose EHF. The advantage of this systems is that it accepts input from suspected patients in plain linguistic terms and processes these responses to draw inference on EVD status of the person. This will offer quick diagnosis and follow up of people who have visited Ebola infected places. The system can also be deployed on hand held mobile devices like phones and tablets. With its use, the possibility that wrong persons are quarantined or that infected persons are detected too late is greatly reduced. It is therefore an invaluable resource to complement the manual laboratory diagnosis of Ebola which takes three weeks to detect. The developed application will help to reduce mortality rate Ebola patients as the ailment will be diagnosed as quickly as possible and appropriate drugs will be administrated to the patients. While further work is ongoing to produce software using the approach, we also encourage other developers to use this approach produce EHF diagnostic application with enhanced efficiency and reliability [30].

Computer

The digital image processing has been increasingly used in several fields with great

impact. This paper describes the basic design and working of a knowledge based system based on fuzzy logic using the digital image processing techniques for identification of hidden or misplaced objects. The advancements in the fields of artificial intelligence (AI), data mining and digital image processing. It is possible to develop a system where in users are able to input the sketches or image of object under search and then scan for them. The system can also be automated to scan the area and compare the obtained image with that in the database, thus minimizing human inference. The automated system will aid in search and rescue missions among other image processing applications. This will help in bringing down the search time and help in faster identification of concerned objects [31].

The hybrid fuzzy logic-neural network (HFNN) model used in this research to solve credit risk management problem is capable of self-learning similar to the traditional neural network. It is capable of discriminating the “good” and the “bad” accounts with better accuracy compared to the traditional neural network. Unlike the neural networks “black box” configuration, which is an undesirable features for credit evaluation, the HFNN model is capable of generating the rules behind the discrimination of each account subject to it. The system behaves much like a traditional fuzzy logic system in this aspect. However, the HFNN model is better than the traditional fuzzy logic system because of its learning capability. Credits risk is the risk of loss due to a debtor’s non-payment of a loan or other line of credits. A method of evaluating the credit worthiness of a customer is complex and non-linear due to the diverse combinations of risk involve. To solve this problem a credit scoring method is proposed in this paper using HFNN model. The model will be implemented, tested and validated for individual auto loans using real life bank data. The neural network is used as the learner and the fuzzy logic is used as the implementer. The neural network will fine tune the fuzzy sets, remove redundant input variables, and exact fuzzy rules. The extracted fuzzy rules are evaluated to retain the best k number of rules that will give final and intelligent decision. The results showed that the performance of the proposed HFNN model is very accurate, robust and reliable [32].

The quality of service is a tool to measure the efficiency of the Ad-hoc network. The quality

of service is a complex function because it depends mainly on four factors say throughput, packets delivery ratio, end-to-end delay and jitter. These four factors are functions of internal factors and are variables with time. In the result, the quality of service is an ambiguous tool. They proposed a brand new method to solve this ambiguity, it will use the fuzzy technique to simplify the quality of service factor and summarize it in a simple form or in a single value for each application. They proposed that method on Mobile Ad-hoc network with different protocols. The new algorithm will summarize the efficiency of each protocol in a single (crisp) value for all applications. Finally, an important conclusion is proved, by experimental result, implying that higher throughput does not usually mean high quality of service supported by the protocols [33].

The navigation of autonomous mobile robots in dynamic and unknown environments needs to take into account different kinds of uncertainties. Type-1 fuzzy logic research has been largely used in the control of mobile robots. However, type-1 fuzzy control presents limitations in handling those uncertainties as it uses precise fuzzy sets. Indeed, type-1 fuzzy sets cannot deal with linguistic and numerical uncertainties associated with either the mechanical aspects of robots or with dynamic changing environment or with knowledge used in the phase of conception of a fuzzy system. As control using type-2 fuzzy sets represents a new generation of fuzzy controllers in mobile robotic issues, it is interesting to present the performances that can offer type-2 fuzzy sets regards to type-1 fuzzy sets. The work presented deep and new comparisons between the two sides of fuzzy logic and demonstrated the great interest in controlling mobile robot using type-2 fuzzy logic. It deals with the design of new controllers for mobile robots using type-2 fuzzy logic in the navigation process in unknown any dynamic environments. The dynamicity of the environment is showed by the presence of other dynamic robots. The performance of the proposed controllers are represented by both simulations and experimental results and discussed over graphical path and numerical analysis [34].

Engineering

The proposed work of an automatic bandwidth control method for the performance

improvement of Binary Amplitude Shift Keying (BASK) system for Giga-bit Modem in millimeter band. To improve the performance of the BASK system with a fixed bandwidth, the proposed method is to adjust a bandwidth of low pass filter in receiver using the fuzzy system. The BASK system consists of a high speed shutter of the transmitter and a counter and a repeater of receiver. The repeater consists of four stage converters, and a converter is constructed with low pass filter and a limiter. The inputs to the fuzzy system are the remainder and integral remainder of counter, and output is bandwidth. They used a Viterbi algorithm to find the optimum detection from output of the counter. The simulation results showed that the proposed system improves the performance compared to the fixed bandwidth [35].

They developed intelligent flow measurement technique by using ultrasonic transducers with the help of optimized fuzzy logic controller. The main objectives of this work was to make the intelligent flow measurement technique adaptive to variations in pipe diameter liquid density and liquid temperature and make a linear relationship between input and output parameter by using optimized fuzzy logic model system. The proposed technique was the subjective to the practical data which was done with the help of actual flow rate and output of the intelligent technique [36].

The importance of implementing a fuzzy inference system to support objective decision making when the kind of variables of the phenomenon to be modeled are vague and subjective. The proposed work revealed that Fuzzy Inference System (FIS) for auditing purposes in order to evaluate the achievements of goals in civil engineering projects. The relationship among these variables were established in order to measure three aspects in technical aspects, budget and administrative control. It is possible to have a project performance evaluation in terms of satisfaction. The reasoning processes of auditing expert are represented by means of a cognitive map that provides a structure of fuzzy rule (the knowledge base of the system). The possible identify to the strong and weak points of the planning and executing process, which supports the making of decisions that seek improvement. The model proposed yields consistent results for the hypothetical levels of the analyzed entry

variables, which would result in objective evaluation during auditing process [37].

Agriculture

In agriculture expert systems is suitable solutions of the farmers for all activities and uncertainty deals with various situations during sowing, weed management diagnosis of disease, insect, storage, marketing products, etc. In this article solve many agriculture issues by using fuzzy expert systems. Almond (*Termanili acatappa*) is one of the most popular tree nuts on a world-wide basis due to its huge benefits in human health, since it is not readily available in every country, research and investigations are still going on this particular. Therefore, here we have developed a unique model using Type-2 Fuzzy Logic Controller (T2FLC) approach to predict optimize the process. Through hundred percent recovery of oil by extraction of almond seeds is never possible, but controlling the process parameters at suitable condition, oil yield may vary within the range of 40 to 45%. Using the four input and one output parameters, four Mamdani fuzzy inference systems are formed depending on the different membership function of the variables. In T2FLC assists to trace inputs and outputs in a well-organized manner for building the inferences train so that various types of oil yield and its assessment can be predicated during extraction. Finally, a statistical analysis had been shown using type-2 fuzzy data set to improve the control of process parameters that can be easily determined in the type-2 fuzzy predication model to get high yield [38].

The potency of diagnosing and the proper time to irrigate enhanced the productivity and cut back the losses. The contribution of expert system with in the field of agriculture are growing hugely. With the advancement of technology especially, the expert systems designed will be of great use to the farmers in tackling the issues that arise at numerous stages of growth. Expert systems and decision support systems are widely used in the developed countries. This problem was solved with the fuzzy logic that, WHEN and HOW long to irrigate the field. Artificial intelligent and fuzzy logic was more solution implemented in an intelligent drip irrigation system. By taking the factors to be considered before irrigating are taken as input to the fuzzy system i.e. soil moisture, relative, humidity, temperature.

These inputs are given to the fuzzy inference system which decides the actual amount of value to open for sufficient amount of water for an optimum output [39].

The proposed method can process, analyze, classify and identify the fruits images, which are selected and sent in to the system based on color, shape and size and surf features of the fruits. The Fuzzy C-Means (FCM) algorithm is the appropriate and effective classification algorithm to be used in the Fruits Recognition System. The recognition system that can be developed is able to recognize all the test fruit images which are being selected by a user from the fruits selection menu which is based on Graphical User Interface (GUI) block in MATLAB on the system [40].

The electronic nose for classification of fruits at the time of harvest, post-harvest and during storage with various conditions. They developed specific e-nose system with fuzzy logic as pattern recognition tool and this system used for classification and identification of guava fruits at the time of pre-packaging. They were system comprises of an array of eight SnO₂MOS gas sensor, static order delivery system, signal conditioning circuit, data acquisition and pre-processing software using LABVIEW 2012. They found e-nose system with fuzzy logic based pattern recognition is capable to classify guava fruits up to the expectation and it would be a feasible system to be used in a real scenario [41].

Conclusion

During the study of various articles and research paper, it is required the fuzzy logic is one of the most accurate technique for processing data and obtained fruitful results. The objectives of the present study was to make a review, that, how the fuzzy logic is useful in various fields regarding solving problems, and benefits for the human health and wealth. In the study we had focused on the application of fuzzy logic and their related problems were discussed in the area of sciences. Fuzzy logic is the basic approach towards the all those software being used for modelling and forecasting. The continued to speculate about other ways in which fuzzy thinking in its various forms likely to affects our life's in the future. We may speculate about its effects on commerce, politics, environment, chemistry, physics, statistics, medical, computer,

engineering, agriculture, and so on, but we prefer to the reader, researcher to use his or her own imagination and knowledge learned from this article to form a personal fuzzy vision of the future.

References

- [1] L. Zadeh; Fuzzy Sets, Information and Control, 8, (1965): 338-353.
- [2] L. Zadeh, Communication Fuzzy Algorithms, Information and control, 12, (1968): 94-102.
- [3] L. Zadeh, Outline of a New Approach to the Analysis of Complex Systems and Decision Processes, IEEE Transaction on System, Man, and Cybernetics, 3(1) (1973): 28-44.
- [4] Mamdani, Assilian, An Experiment in Linguistic Synthesis with a Fuzzy Logic Controller, International Journal Man-Machine Studies, 7, (1975): 1-13.
- [5] G. J. Klir, Bo Yuan, Fuzzy Sets and Fuzzy Logic Theory and Application, Pearson India Education Services Pvt. Ltd. (2015).
- [6] T. J. Ross, Fuzzy Logic with Engineering Applications, Wiley India Pvt. Ltd. (2010).
- [7] Rad, Nilashi, et al. A Fuzzy Logic Analysis of E-Commerce Website Quality Factors For Customers Purchase Intention, Proceedings of Academics World International Conference Stockholm, Sweden, (2016) pp.1- 6.
- [8] Meziane, Nefti, Evaluating E- Commerce Trust Using Fuzzy Logic, (2007)
DOI: 10.4018/jiit.2007100102
- [9] Sanchez-Roger, Oliver-Alfonso, et al. Fuzzy Logic and its Uses in Finance: A Systematic Review Exploring its Potential to Deal with Banking Crises, MDPI, 7(1091) (2019): 1-22.
- [10] Nafi, Kar, et al. A Fuzzy Logic Based Certain Trus Model for E-Commerce, (2013)
doi: 10.1109/ICIEV.2013.6572693
- [11] Cevallos-Torres, Botto-Tobar, et al. Political-Electoral Marketing and Influencing Factors in Student Representatives' Elections Under a Fuzzy Logic Approach, Springer Nature Switzerland, (2019)
doi.org/10.1007/978-3-030-12018-4_10.
- [12] DRuiz-Lopez, Aragon-Noriega, A. Luna-Gonzalez; H. A. Gonzalez-Ocampo Applying Fuzzy Logic to Assess Human Perception in Relation to Conservation Plan Efficiency Measures Within a Biosphere Reserve, (2012)
doi:10.1007/s13280-012-0252-y
- [13] Shayji, El Zant El Kadhi et at. Fuzzy Cognitive Map Theory for the Political Domain, Proceedings of the Federated Conference on Computer Science and Information Systems, (2011) pp.179-186.
- [14] T. Rehman, Fuzzy Rule Based Candidate Selection Evaluator by Political Parties, International Journal of Advanced Research in Computer Science, 8(3) (2017): 1-7.
- [15] A. Khan, Fuzzy Logic Approach to Quantify Water Pollution, International Journal of Engineering Science and Computing (IJESC), 7(5) (2017): 12227-12233.
- [16] A. Deshpande; D. Raje; Fuzzy logic applications to environment management systems: Case studies, (2003)
doi: 10.1109/INDIN.2003.1300356
- [17] Anaokar, Khambete, Application of Fuzzy Logic in Environmental Engineeringfor Determination of Air Quality Index, International Journal of Engineering Technology, Management and Applied Sciences, 4(2) (2016): 109-116.
- [18] M. Emami, Fuzzy Logic Applications in Chemical Processes, The Journal of Mathematics and Computer Science, 1(4) (2010): 339-348.
- [19] Mahmood, Taha, Design Fuzzy Logic Controller for Liquid Level Control, International Journal of Emerging Science and Engineering, 1(11) (2013): 23-26.
- [20] Vijayaraghavan, Jayalakshmi; Fuzzy Logic in Process Safety Modeling of Chemical Process, International Journal of Advanced Engineering Research and Studies, II (IV) (2013): 118-121.
- [21] Mene, Soni, et al. A Study on Some Important Aspects of Fuzzy Logic, International Journal for Research in Applied Science and Engineering Technology, 5(V) (2017): 618-622.
- [22] Hissel, Maussion, et al. Fuzzy Logic Controllers for Electrotechnical Devices-On-Site Tuning Approach, The European Physical Journal Applied Physics, 16,(2001): 195-208.
- [23] Coppi Gil, et al. The Fuzzy Approach to Statistical Analysis, Computational Statistics and Data Analysis (2006) doi:10.1016/j.csda.2006.05.012
- [24] Laufer; Koczy, Patient-Specific Statistics-Based Decision Support in Health Monitoring Using Fuzzy Logic, Advanced Materials Research, Trans Tech Publications, Switzerland (2015)
doi:10.4028/www.scientific.net/AMR.1117.273
- [25] Taheri, Trends in Fuzzy Statistics, Austrian Journal of Statistics, 32(3)(2003): 239-257.
- [26] Allahverdi, Design of Fuzzy Expert Systems and its Applications in Some Medical Area, International Journal of Applied Mathematics, Electronics and Computers, 2(1) (2014): 1-8.
- [27] Zhenning, Vijayashree, et al. Fuzzy logic based diagnosis for liver disease using complete blood counts, Journal of Computer and Mathematical Sciences, 8(5) (2017): 202-209.
- [28] Ntaganda, Haggar; et al. Fuzzy Logic Strategy for Solving an Optimal Control Problem of Therapeutic Hepatitis C Virus Dynamics, open Journal of applied sciences, 5, (2015): 527-541.
- [29] Gite, Bodade, et al. ANFIS Controller and Its Application, International Journal of Engineering Research and Technology (IJERT), 2(2) (2013): 1-5.
- [30] Emokhare, Igbape, Fuzzy Logic Based Approach to Early Diagnosis of Ebola Hemorrhagic Fever, Proceedings of the World Congress on Engineering and Computer Science (WCECS), Vol II (2015).
- [31] Tibrewala, Malviya, Knowledge Based System based on Fuzzy Logic for Digital Image Processing, ACCENTS Transactions on Image Processing and Computer Vision, 1(1) (2015): 23-27.
- [32] Dadios, Solis, Fuzzy-Neuro Model for Intelligent Credit Risk Management, Intelligent Information Management, 4, (2012): 251-260.
- [33] D. R. Zaghar; T. S. Aldeen; A. Wahab; Simplified the Quality of Service Factor for the Ad-Hoc Network Using Fuzzy Technique, International Journal Communications, Network and System Sciences, 6, (2013): 381-387.
- [34] N. Baklouti; R. John; A. M. Alimi; Interval Type-2 Fuzzy Logic Control of Mobile Robots, Journal of Intelligent Learning Systems and Applications, 4, (2012): 291-302.
- [35] K. Eom; K. Hyun; K. Jung; The Performance Improvement of BASK System for Giga-Bit MODEM Using the Fuzzy System, International Journal

- Communications, Network and System Sciences (IJNS), 3, (2010): 441-445.
- [36] P. Dutta; A. Kumar; Intelligent Calibration Technique Using Optimized Fuzzy Logic Controller for Ultrasonic Flow Sensor, Mathematical Modelling of Engineering Problems, 4 (2) (2017): 91-94.
- [37] Jorge Morales; Santiago Hurtado; (2016) Application of a Fuzzy Inference System to Civil Engineering Projects, Proceedings of the American Society for Engineering Management International Conference, pp.1-9.
- [38] K. Roy; A. Mukherjee; D. Jana; Prediction of Maximum Oil Yield From Almond Seed in A Chemical Industry: A Novel Type-2 Fuzzy Logic Approach, South African Journal of Chemical Engineering, 29, (2019): 1-9.
- [39] Varun Khatri; Application of Fuzzy Logic in Water Irrigation System, International Research Journal of Engineering and Technology, 5(4) (2018): 3372-3375.
- [40] Sharma; V. Jaiswal; A. Goyal; Fruits Detection with Multiple Features Using Fuzzy Logic, International Journal of Advanced Research in Computer Science and Software Engineering, 3(11) (2013): 858-861
- [41] A. Kanade; A. Shaligram; Ripening State Determination of Guava Fruit (Psidium Guajava) Using E-Nose with Fuzzy Logic as Pattern Recognition Tool, International Journal of Scientific Research Engineering and Technology, 7(4) (2018): 362-367.

Journal of Engineering Sciences