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Applications of Fuzzy Logics in Modern Systems: A Simple Survey

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ABSTRACT

Fuzzy logic has been widely used as a mathematical framework to handle imprecision and uncertainty. This paper explores the various uses of fuzzy logic in contemporary systems, including decision-making processes and engineering systems. The study offers an analysis of current advancements with a focus on useful applications and real-world case studies. Fuzzy control systems for industrial processes are among the applications discussed where fuzzy logic's adaptability and flexibility improve system performance. This paper also looks at fuzzy logic's use in Domestic appliances, medical diagnostics, demonstrating how fuzzy inference systems increase medical decision-making accuracy by accounting for the inherent uncertainties in diagnostic data.

An overview of emerging trends and challenges in this field, emphasizing the need for ongoing research to further refine and extend the applicability of fuzzy logic in addressing complex and dynamic systems. This study contributes to the understanding of how fuzzy logic continues to play a pivotal role in advancing technology and decision support systems across diverse domains.

Keywords: Fuzzy set, Fuzzy Logic, Medical Diagnosis & Domestic appliances.

1. Introduction

The notion of fuzzy set theory has caused great interest among both pure and applied mathematics. In the midst of the various paradigmatic changes in the technical era, one such concerns the concept of uncertainty. The modern concept of uncertainty was addressed by Lofti A. Zadeh[7] in 1965. He introduced a theory called fuzzy sets, a set with boundaries that are not precise. The proposal of fuzzy set handles uncertainty and vagueness. In fuzzy set theory, the membership function $\mu_A(x)$ of an element to a fuzzy set is a single value between zero and one. The theory of fuzzy topology was introduced by C.L. Chang[3] in 1968. Several researches were conducted on the generalizations of the notions of fuzzy sets and fuzzy topology. Fuzzy sets are designed to handle a particular kind of uncertainty, namely degree of vagueness, which results a property that can be possessed by objects to varying degrees. A particular type of Linguistic variables is quite useful in representing values in fuzzy sets, The concept of a linguistic variable and its applications to approximate reasoning was introduced by Zadeh L.A[8,9,10]. Several researchers identified an equal number of unique applications in distinct domains of Fuzzy logics. By enumerating it, In 2014, Temperature Control using Fuzzy logic was introduced by [6]Singhala.P, Shah D.N, Patel.B, and Medical Diagnosis System using Fuzzy Logic was introduced by [2]Awotunde J.W, Matiluko O.E, Fatai O.W. In 2017, a low cost floor cleaning mobile robot, automated by fuzzy logic was introduced by [5]Hossen.J, Sayeed.S, Bhuvaneswari.T. Fuzzy logic control of washing machine was introduced by Agarwal.M[1]. In 2018, [4]Hossein Ahmadi, Marsha Golamzadeh investigated a systematic and meta - analysis review on diseases diagnosis using fuzzy logic method.

2. Fuzzy Logics

The mathematical theory of fuzzy sets, a generalisation of classical set theory, serves as the foundation for fuzzy logic, which is an extension of Boolean logic developed by Lotfi.A.Zadeh[7] in 1965. Uncertainty is what the word fuzzy represents. Any specific occurrence that has no precise value (true or untrue) is ambiguous. Fuzzy logic adds a highly useful degree of flexibility to reasoning by allowing conditions to be in states other than true or false. This allows for the consideration of errors and uncertainties in the process of verifying a condition. Fuzzy logic is particularly effective in situations where precise measurements are challenging or impossible to obtain, and where a more flexible, adaptive approach is needed. Fuzzy logic serves as a valuable tool for modelling and handling uncertainty in complex systems. As technology advances and the need for intelligent, adaptive systems grow, fuzzy logic continues to play a vital role in shaping the future of artificial intelligence and decision-making processes.

3. In Domestic Appliances

Fuzzy logic is widely used in control systems for decision-making, where precise mathematical models are challenging to establish. For example, in automotive control systems, fuzzy logic can be applied for adaptive cruise control.

3.1 Fuzzy logic washing machine:

Fuzzy logic technology makes it simple to construct a washing machine that is more completely automated. It is also easier to build and maintain in the future since the design process emulates human intuition. Even though this specific example simply regulates the washing machine's wash duration, other control variables like water level and spin speed may be added to the design process without experiencing too many difficulties. Similar to how wash time is implemented; membership functions and regulations are developed and put into practice.

Additionally, In [1] we may determine a wash time for varying degrees and types of filth by utilising fuzzy logic control. The traditional approach needed human intervention to determine when various clothing should be washed. Stated differently, the machine now has the ability to analyse situations, which increases its level of automation and symbolises the ability to make decisions under the current arrangement. This study presents a clear picture of the benefits of integrating a fuzzy logic controller into a traditional washing machine, despite its primitive analysis.

Multi-variable Control, Advanced Filth Detection, User Customization are some future work recommended in the field of fuzzy logic technology for washing machines so that lead to more advanced and user-friendly appliances with improved efficiency and adaptability.

3.2 Fuzzy logic in floor cleaning machine:

Although robot cleaners may assist humans in cleaning floors in a variety of settings, including homes, restaurants, hotels, hospitals, businesses, and universities, they have drawn a lot of attention in the field of robotics research. The majority of the time, robotic cleaners are distinguished by the type of cleaning they can perform, such as dry vacuuming, floor mopping, etc. The obstacle avoidance systems that are employed rely on laser mapping or infrared sensors. Every robotic cleaner system has benefits and drawbacks of its own. For example, an obstacle avoidance system using infrared sensors is less expensive and requires less time owing to random cleaning, but it is more time-consuming and energy-efficient than an obstacle avoidance system using laser mapping techniques. Robotic floor cleaners are being imported at exorbitant costs from overseas by a number of economically developing nations. Therefore, manufacturing a low-cost cleaner is made possible by the employment of the suggested methodologies with fuzzy logic in control systems.

Thus, [5] presents the design and development of a single self-navigating obstacle-avoiding robot that may be used locally to do both mopping and sweeping tasks at a minimal cost. For seamless navigation and obstacle avoidance, fuzzy logic methods are employed. A working prototype has been built, and its functionality has been evaluated in an authentic setting. It has been discovered that the robot operates well in both manual and automated modes when sweeping and mopping.

In future, the research and development department can do their researches in Advanced Obstacle Avoidance Systems, Energy-Efficient Cleaning Algorithms in which the fuzzy logic makes them more accessible and beneficial in various domestic and commercial settings.

4. In Medical diagnosis systems

Medical decision support systems use fuzzy logic to accommodate inaccurate data for making diagnoses. One of the most crucial aspects of complex clinical decision making, which is typically accompanied by a degree of ambiguity and uncertainty, is diagnosis, which is the first step in medical practice. Since uncertainty is an inherent part of medicine, one of the greatest ways to reduce this ambiguity is through the application of fuzzy logic techniques. Numerous types of research on fuzzy logic techniques in a broad variety of medical diagnosis-related areas have recently been published.

As a result, In [2] they carried out a comprehensive assessment to ascertain the value of using fuzzy logic techniques to illness diagnosis across various medical specialties. The collection of data was carried out by linguistic variables directly for the out patients affected with fever. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses technique was used as the foundation method for performing this systematic and meta-analysis review, and eight scientific databases were chosen as suitable databases. Some inclusion and exclusion criteria were taken into consideration in order to restrict our inquiry with respect to the primary goal of this study. It is thought that treating malaria may be done effectively and affordably by using fuzzy logic in the architecture of the diagnostic system shown in this research.

5. Conclusion

In conclusion, the exploration of diverse applications of fuzzy logics in modern systems unveils the versatility and adaptability of this innovative approach. From artificial intelligence and robotics to control systems and decision-making processes, fuzzy logic has demonstrated its prowess in handling uncertainty and imprecision effectively. The applications discussed, ranging from medical diagnosis and financial forecasting to industrial automation, underscore the widespread impact of fuzzy logic across various domains. In essence, the exploration of fuzzy logics in modern systems not only enriches our understanding of complex phenomena but also lays the foundation for future advancements. As researchers and practitioners continue to harness the potential of fuzzy logic, we can anticipate further breakthroughs that will shape the landscape of technology and problem-solving in the years to come. The field of medical decision support systems using fuzzy logic could see advancements in accuracy, efficiency, and accessibility, ultimately leading to improved patient outcomes and healthcare delivery.

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