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Use of Fuzzy Logic in Design of Smart Washing Machine and Air Conditioner: A Review

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ABSTRACT

This paper gives introduction to fuzzy logic and its application in design of a smart machine specially washing machine and air conditioner.It will give a review of some works done in last seven years . Nowadays fuzzy logic is a popular branch of mathematics in which lots of research is taking place. Researchers are converting crisp phenomena to fuzzy. Fuzzy Logic give the idea that members are not restricted to be true or false definitions. To give a glance of wide range of its applications include contributions in the field of artificial intelligence, economics, pattern recognition (fuzzy clustering), medicine (in the process of diagnosis of disease), ecology, psychology and cognitive science , ethnology(to classify and qualify principal postures of animals under observations), theory of information, neural networks and natural language. This paper will cover some applications of fuzzy logic in design of a smart machine specially washing machine and air conditioner.

KEYWORDS: Fuzzy Logic Control (FLC), Proportional Integral Derivative (PID),

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INTRODUCTION

The idea behind fuzzy logic has been around since 1965 when they were introduced by Lofti A. Zadeh. FL has not been used widely since 1965. In classical logic system an object is either a member or not a member of a set. FL gives the idea that members are not restricted to be true or false definitions. A member in a fuzzy set has a degree of membership to a set. For example, the set of temperature values can be classified using a crisp set as either not or not hot. This would require some cut-off value where any temperature less than that value is "not hot" and any temperature greater than that cut-off value is "hot". If the cut-off point is at 50° C then this set does not differentiate between a temperature that is 20° C and a temperature of 49° C. They are both "not hot". If a fuzzy set were to be used in this situation each membership of the set or each temperature would have degree of membership to the set of "hotness". The function that determines this degree is called fuzzy membership function. Number of different membership functions can be used for this purpose. The most common are triangular, Gaussian and sigmoid.

WHY FUZZY IS NEEDED?

In 1920's logicians first broached its key concept "Everything is a matter of degree". Fuzzy Logic manipulates such vague concepts as "warm" or "still dirty" which helps engineers to build air conditioners, washing machines and many other devices that judge how fast they should operate or shift from one setting to another even when the criteria for making those changes are hard to define.

No known mathematical model can back up a truck and trailer rig from a parking lot to a loading dock when the vehicle starts from random spot .Both humans and fuzzy systems can perform this nonlinear guidance task by using practical but imprecise rules such as "If the trailer turns a little to the left, then turn it a little to the right". "Fuzzy systems often glean their rules from expert s. When no expert gives the rules adaptive fuzzy systems learn the rule by observing how people regulate real systems.

HOW FL SYSTEMS WORK?

Fuzzy Logic is based on rules of the form "if...the...." that convert inputs to outputs, one fuzzy set into another fuzzy set. To build a fuzzy system an engineer might begin with a set of fuzzy rules from an expert. An engineer might define the degree of membership in various fuzzy input and output sets of curves. The relation between the input and output sets could then be plotted. Given the rule "If the air feels cool, then set the motor to slow" the input should be listed along one axis of a graph and the output (motor speed) along a second axis. The product of these fuzzy sets forms a

fuzzy patch, an area that represents the set of all associations that the rule forms between those inputs and outputs. The size of the patch reflects the rule's vagueness or uncertainty. The more precise the fuzzy set the smaller it become. The rule of a fuzzy system defines a set of overlapping patches that relate a full range of inputs to a full range of outputs. In that sense the fuzzy system approximates some mathematical function or equation of cause and effect.

LITREATUREVREVIEW: HOW FUZZY LOGIC IS BEING USED?

In recent years, the number of variety of applications of FL has increased significantly. These applications range from cameras, camcorder, washing machines, microwave ovens and air-conditioner. The FLC is considered as a good methodology because it yields results superior to those obtained by conventional control algorithms. FLC has two notable advantages. Firstly it easilydeals with the control processes which are too complex to analyze by conventional techniques and second the available sources of information are interpreted qualitatively inexactly as uncertainty.Nowadays every intelligent machine has fuzzy logic technology inside it. Different types of washing machines are commercially available and their control capabilities vary quite substantially. [8]In this paper some works by using FLC are discussed. Dash, S. K., Patanaik, B., Mohanty, G. and Mohanty, A.[1]considered climate conditions of coastal regions of Bubaneswar area in the state of Odisha situated in India, where the value of humidity are high as compare to non-coastal areas. They proposed a design using FLC to reduce electricity energy intake. Air conditioner is nowadays able to perform better than their previous systems and can perform various functions. They made a design in which input variables are user temperature, temperature difference, dew point, occupancy and time of day. And output variables were compressor speed, fan speed, mode of operation and fin direction. They analyze that fuzzy logic is more efficient in dealing with the problems that are difficult to study analytically but are easy to solve in terms of linguistic variables.Patanaik, A.[6] processed a FL system to maintain the temperature and humidity which also aims to reduce electrical energy intake of the AC. He considered a problem in which three variables were taken into consideration namely user temperature performance, actual room temperature and room dew point temperature and the outputs of this problem were compressor speed, fan speed, mode of operation and fin direction. He observed the performance of system from MATLAB and C++. It was observed that FL helped in solving complex problems without getting involved in intricate relationships between physical variables. Although many details were neglected still it helped in solving problems that were difficult to study analytically but were easy to solve intuitively in terms of linguistic variables. He aimed to simplify the problem by not allowing AC to reverse operation and act like a heat pumped humidifier. Eliminating the restriction all weather AC can be designed that will work in almost any part of the

world. He further suggested that infra red sensors can be added and aggregate data such as occupant location and body temperature which will help in controlling temperature, humidity and fin direction for optimal comfort and minimal energy use.Attia, A. H., Rezeka, S. F. and Saleh, A. M.[7]observed the and investigated fuzzy logic control of the air conditioning system of buildings for effective energy operation and comfortable environment. They derived a theoretical model of the fan coil unit and heat transfer between air and coolant fluid. Then chose room temperature and relative humidity and control consequents and percentage of chilled and hot water flow rates at summer and the percentage of hot water and steam injected flow rates t winter. They used the computer simulation and fuzzy control results and compared with conventional proportional integral derivative (PID) control. They observed that fuzzy controller operation is more efficient and consume less energy than that of PID control. They have used Mamdani's model in their study to model fuzzy matching, inference combinations and defuzzification. They used 55 rules for summer season fuzzy system and 20 rules for winter fuzzy system. They conducted numerical simulations in MATLAB for fuzzy and PID control system. They concluded that fuzzy control kept the room temperature and relative humidity at set levels according to desire at the same time PID control fails to adjust room temperature. Patil, S. N., Bhombe, D. L. and Nawgaje, D. D.[9] developed more advance system that consist of neuro fuzzy and fuzzy techniques that hlp the system to take its own decisions like release of water and washing powder as per need of cloth. They also included fabric detection technique. To amplify washing quality they used fabric detection sensor which include type of fabric, level of dirt and number of spins and amount of water and detergent to be released. They aimed to design a self-decision making washing machine which will take decisions with help of fuzzy rule and neural training. They used optical sensors which convert light rays into electronic signals. It measures the physical quantity of light and translates it into a form readable by instruments.Aissaoui and Tahour[2] presented a use of fuzzy logic to control the speed of a Synchronous Machine(SM). They observed that fuzzy controller creates the variations of the reference current vector of the SM speed control based on the speed controller realizes a good dynamic behavior of the motor, a perfect speed tracking with no overshoot and a good rejection of impact loads disturbance. The results of applying the fuzzy logic controller to a SM show best performance and high robustness than those of obtained by the application of the conventional controller. Their structure of a complete fuzzy control system is containing fuzzification, knowledge base, inference engine and defuzzification. In their study they are able to describe a complete fuzzy logic control based on synchronous motor. The working of system was composed by simulation to validate the theoretical concepts. To overcome the complexity of the FLC and to drop precision they opted for five subsets to explain the inputs and output variables. They noticed that control of speed by FLC gives fast dynamic response with no

overshoot and negligible steady state error. They also verified the decoupling, stability and convergence of the equilibrium point.Kumar, V., Kumar, S. and Kansal, H.[3] in 2014 designed a fuzzy logic controller in which heat, particle humidity and oxygen were used as input parameters and fresh air entrance and fan circulation were output parameters. They saved input, output and other variables in computer and it was observed that FLC made cheaper, effective, reliable and consistent air condition that is feasible in real operating room.Demetgul, M., Ulkir, O., Waqar, T.[4] developed a fuzzy control with four inputs and five different outputs. Their model was having more input and output variables than the earlier systems. They chose amount of dirt, type of dirt, sensitivity of cloth and amount of cloths as input variables and washing time, washing speed, amount of detergent, amount of water and water hotness as output variables. Their study was to develop a rule based fuzzy logic for washing machine which result in achieving economical washing procedure by sensing amount of dirt, type of dirt, sensitivity of cloth and amount of cloths. They made the entire washing procedure economical by reducing the amount of water, detergent, electricity and time. Their model is practically implementable by using mechanical and electronic engineering concepts.Virkhare, N., Jasntkar, R. W.[5]used a load auto sensor which determine the size of a load of dirty cloths and then add appropriate amount of water to the washing machine. The automatic temperature control was used which adjust water to correct temperature for the cycle of cloths. Their neuro-fuzzy control has sensors that automatically detects the fabric type and determine the detergent and water that is needed in the washing process. They used MATLAB to analyze data, develop algorithms, and createmodels and applications. Although various applications have been developed using fuzzy techniques but their combination of neuro and fuzzy is new in this domain. Combination of neuro and fuzzy can also be used to detect the fabric type that will be the most advance system and contribution towards the system.

FUTURE PROSPECT

Non- Linear systems with great complexity and uncertainty can be effectively controlled based on fuzzy roles without dealing with complex uncertain and error prone mathematical models. Fuzzy logic can make development and implementation much easier that the traditional system.

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