Air Conditioning System with Fuzzy Logic and Neuro-Fuzzy Algorithm

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Abstract Fuzzy logic controls and neuro-fuzzy controls are accustomed to increase the performance of air conditioning system. In this paper, we are trying to provide the new design air conditioning system by exploitation two logics, namely fuzzy logic and neuro-fuzzy management. This paper proposes a set of rule and uses 2 inputs specifically temperature and humidness and 4 outputs specifically compressor speed, fan speed, fin direction and mode of operation. These outputs are rule-based output. At last, compare simulation results of each system exploitation fuzzy logic and neuro-fuzzy management and notice the higher output.

Keywords Fuzzy logic controls · Neuro-fuzzy controls · Air conditioning system · Membership function

1 Introduction

The air conditioning systems are usually found in homes and publicly capsulated areas to make snug surroundings. Air conditioners and air conditioning systems are integral part of nearly each establishment. It includes atmosphere, energy, machinery, physical science and automatic management technology [1, 2].

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1.1 Conventional System

Conventional style strategies need the event of a mathematical model of the control system then use of this model to construct the controller that is represented by the differential equations. The task of dehumidification and temperature decrease goes hand in hand just in case of typical AC. Once target temperature is reached AC seizes to perform sort of a dehumidifier. Within the typical methodology, it is very troublesome to interaction between user preferences, actual temperature and humidness level and it is too nonlinear [3]. Typical AC system controls humidness in its own means while not giving the users any scope for ever changing the point for the targeted humidness. However, this limitation has been overcome by exploitation fuzzy logic management. It is the power to handle nonlinear systems.

1.2 Problem Definition

The optimum limit of temperature that is marked as temperature is 25 °C and saturation point is 11 °C. Standard AC system controls set the target purpose by its own approach. This drawback takes 3 input variables user temperature preference, actual temperature and space saturation point temperature. Fuzzy logic algorithmic program is applied on these variables and finds the ultimate result. User temperature is deducted from actual temperature and then sent it for fuzzification, once this fuzzy arithmetic and criterion is applied on these variables and also the consequence is shipped for defuzzification to urge crisp result.

1.3 Fuzzy Logic Control

Fuzzy logic may be a straightforward however very powerful drawback solving technique with in-depth relevancy. It is presently employed in the fields of business, systems management, physical science and traffic engineering. A fuzzy logic deals with uncertainty in engineering by attaching degrees of certainty to the solution to a logical question. A fuzzy logic system (FLS) will be outlined as the nonlinear mapping of an information set to a scalar output data. Fuzzy logic is employed for management machine and shopper merchandize. Several applications have successfully uses fuzzy logic management, for example environmental management, domestic merchandize and automotive system [4].

The fuzzy sets are quantitatively outlined by membership functions. These functions are generally very straightforward functions that cover a fixed domain of the worth of the system input and output. Fuzzy logic management is primarily rule-based system, and therefore, the performance of it depends on its control rules and membership functions (Fig. 1).

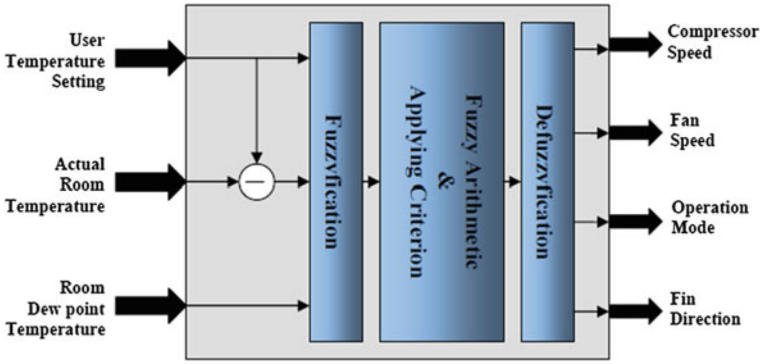


Fig. 1 Block diagram of controller

1.4 Neuro-Fuzzy Logic Control

One of the key issues of the fuzzy logic management is that the problem of selection and style of membership functions for a given downside. Neural networks provide the likelihood of finding the matter of standardization. Neural fuzzy systems will generate formal logic rules and membership functions for advanced systems that a standard fuzzy approach could fail. Hence, combining the adaptive neural networks and formal logic management forms a system known as neuro-fuzzy system. Neuro-fuzzy system is based on the neural network that learned from fuzzy if-then rules. Neural network performance is dependent on the quality and quantity of training samples presented to the network. Neural nets can solve many problems that are either unsolved or inefficiently solved by existing techniques, including fuzzy logic [5, 6].

2 Fuzzy Logic Control Algorithm

Fuzzy logic management primarily based on air conditioning system consists of two inputs that are actual temperature and room temperature dew point (humidity). When measuring actual temperature, the user temperature (Ut) is subtracted from actual temperature for realize the temperature distinction (Td) and sent it for fuzzification. Fuzzy arithmetic and criterion is applied on the input variables, outcome is defuzzified to induce output, and these output signals are distributed to manage the compressor speed. During this case, the range of actual temperature is taken to be 15–50 °C and range of its taken to be 18–30 °C; therefore, the temperature distinction arises between −3 and 32 °C. The input has 2 membership functions. The size over that membership functions for temperature is represented as 0–50 °C and membership functions for humidness is represented as 0–100 %. The output additionally has four

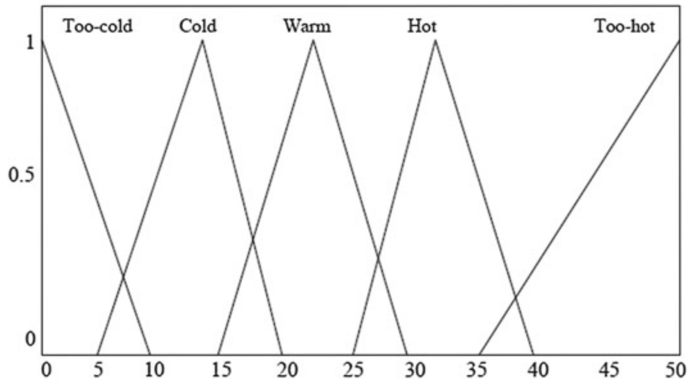


Fig. 2 Temperature membership functions

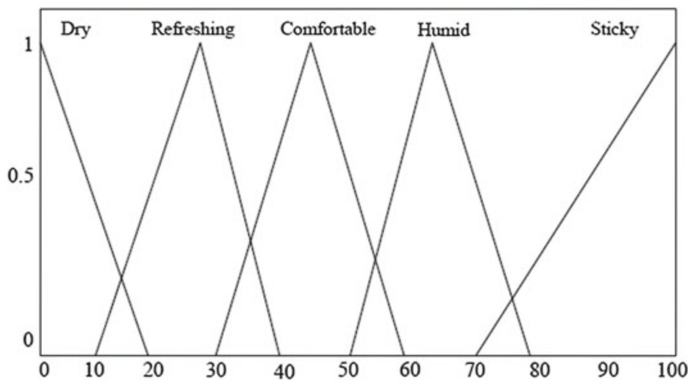


Fig. 3 Humidity membership functions

membership functions particularly compressor speed, fin direction, fan speed and operation mode. The principles base for coming up with is as "IF Temperature is just too cold AND humidness is dry THEN compressor speed is Off, Fin direction is Away, Fan speed is Off and Operation mode is AC" and so on [7, 8] (Table 1).

3 Neuro-Fuzzy Algorithm

Neuro-fuzzy management primarily based on air conditioning system additionally consists of 2 inputs that are actual temperature and space room (humidity). The input, temperature takes the name "input1" (In1) and range is taken to be 0–40 °C for membership function. Similarly, the input, humidness takes the name "input2" (In2) and range is taken to be 5–85 % for membership function. The output, compressor speed amendment the name as "output1" (Out1), fin direction named as "output2"

Table 1 Fuzzy rules for proposed design

Rules	Input		Output			
	Temperature	Humidity	Compressor speed	Fin direction	Fan speed	Operation mode
1	Too cold	Dry	Off	Away	Off	AC
2	Too cold	Refreshing	Off	Away	Off	AC
3	Too cold	Comfortable	Off	Away	Off	AC
4	Too cold	Humid	Off	Away	Very low	AC
5	Too cold	Sticky	Very low	Towards	Low	Dehumidifier
6	Cold	Dry	Off	Away	Off	AC
7	Cold	Refreshing	Off	Away	Off	AC
8	Cold	Comfortable	Very low	Away	Very low	AC
9	Cold	Humid	Very low	Towards	Low	AC
10	Cold	Sticky	Low	Towards	Low	Dehumidifier
11	Warm	Dry	Very low	Away	Very low	AC
12	Warm	Refreshing	Very low	Away	Very low	AC
13	Warm	Comfortable	Low	Away	Low	AC
14	Warm	Humid	Medium	Towards	Medium	Dehumidifier
15	Warm	Sticky	Medium	Towards	Medium	Dehumidifier
16	Hot	Dry	Low	Away	Low	AC
17	Hot	Refreshing	Medium	Away	Medium	AC
18	Hot	Comfortable	Medium	Towards	Medium	AC
19	Hot	Humid	Fast	Towards	Fast	Dehumidifier
20	Hot	Sticky	Fast	Towards	Fast	Dehumidifier
21	Too hot	Dry	Medium	Away	Medium	AC
22	Too hot	Refreshing	Medium	Towards	Medium	AC
23	Too hot	Comfortable	Fast	Towards	Fast	Dehumidifier
24	Too hot	Humid	Fast	Towards	Fast	Dehumidifier
25	Too hot	Sticky	Fast	Towards	Fast	Dehumidifier

(Out2), fan speed named as “output3” (Out3) and operation named as “output4” (Out4). The principles are applied consequently in Table 2.

4 Experimental Results

Result of this experiment is predicated on fuzzy rules and neuro-fuzzy rules. Figures 2 and 3 show input values for fuzzy logic management, and Figs. 4 and 5 show input values for neuro-fuzzy management. Supported these inputs acquire results when simulation of fuzzy logic management is based on air conditioning system that are shown in the following figures. Figure 6 shows the compressor speed memberships of air conditioning system. Compressor speed may be either off or may be varied between 10 and 100 % (Fig. 7).

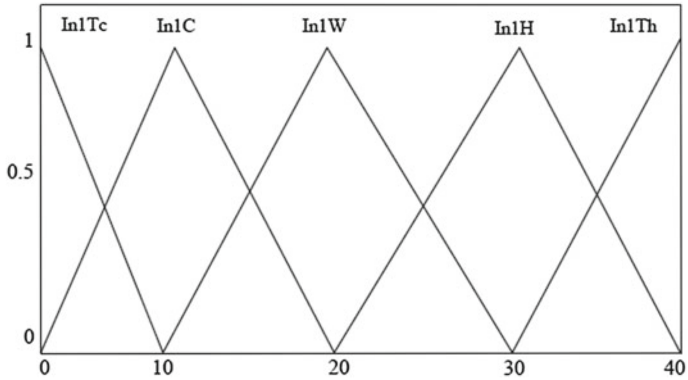


Fig. 4 Input1 membership functions

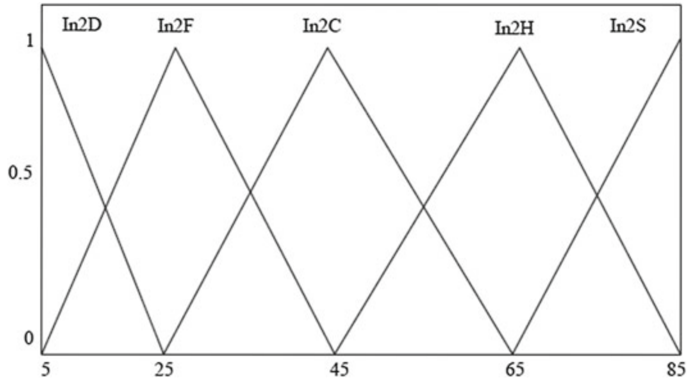


Fig. 5 Input2 membership functions

Figure 8 shows the operation mode memberships of air conditioning system. Mode of operation decides whether AC works like a dehumidifier only or normal. Figure 9 shows the fin direction memberships of air conditioning system. Fin direction directs air from the AC towards or away from occupants.

Figure 10 shows compressor speed with respect to temperature by using fuzzy rules. Figure 11 shows compressor speed with respect to humidity by using fuzzy rules. Figure 12 shows the output1 with respect to input1 by using neuro-fuzzy rules. Figure 13 shows the output1 with respect to input2 by using neuro-fuzzy rules.

Table 2 Neuro-fuzzy rules for proposed design

Rules	Input		Output			
	Temperature (Input1)	Humidity	Compressor speed	Fin direction	Fan speed	Operation mode
1	In1Tc	In2D	Out1Of	Out2A	Out3Of	Out4AC
2	In1Tc	In2R	Out1Of	Out2A	Out3Of	Out4AC
3	In1Tc	In2C	Out1Of	Out2A	Out3Of	Out4AC
4	In1Tc	In2H	Out1Of	Out2A	Out3Vl	Out4AC
5	In1Tc	In2S	Out1Vl	Out2To	Out3L	Out4D
6	In1C	In2D	Out1Of	Out2A	Out3Of	Out4AC
7	In1C	In2R	Out1Of	Out2A	Out3Of	Out4AC
8	In1C	In2C	Out1Vl	Out2A	Out3Vl	Out4AC
9	In1C	In2H	Out1Vl	Out2To	Out3L	Out4AC
10	In1C	In2S	Out1L	Out2To	Out3L	Out4D
11	In1W	In2D	Out1Vl	Out2A	Out3Vl	Out4AC
12	In1W	In2R	Out1Vl	Out2A	Out3Vl	Out4AC
13	In1W	In2C	Out1L	Out2A	Out3L	Out4AC
14	In1W	In2H	Out1M	Out2To	Out3Of	Out4D
15	In1W	In2S	Out1M	Out2To	Out3M	Out4D
16	In1H	In2D	Out1L	Out2A	Out3L	Out4AC
17	In1H	In2R	Out1M	Out2A	Out3M	Out4AC
18	In1H	In2C	Out1M	Out2To	Out3M	Out4AC
19	In1H	In2H	Out1F	Out2To	Out3F	Out4D
20	In1H	In2S	Out1F	Out2To	Out3F	Out4D
21	In1Th	In2D	Out1M	Out2A	Out3M	Out4AC
22	In1Th	In2R	Out1M	Out2To	Out3M	Out4AC
23	In1Th	In2C	Out1F	Out2To	Out3F	Out4D
24	In1Th	In2H	Out1F	Out2To	Out3F	Out4D
25	In1Th	In2S	Out1F	Out2To	Out3F	Out4D

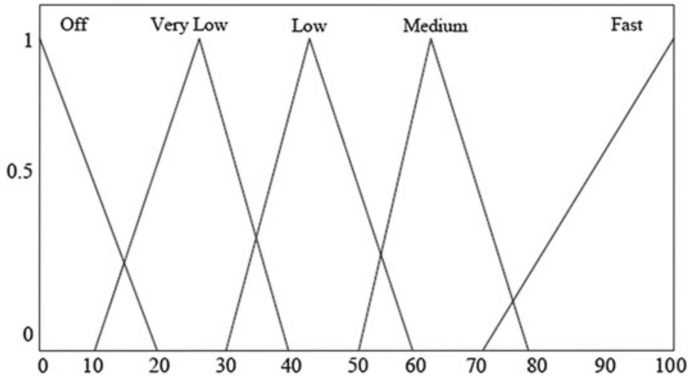


Fig. 6 Compressor speed membership functions

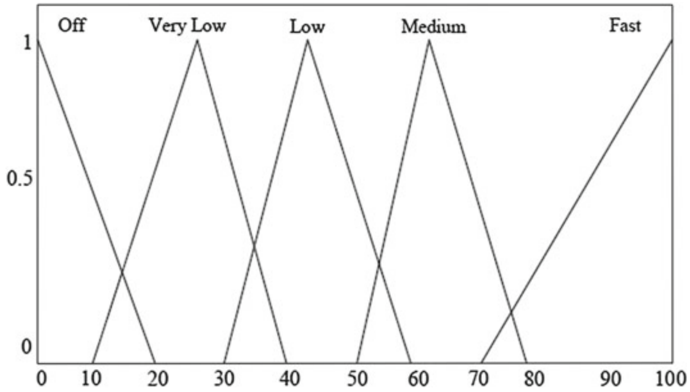


Fig. 7 Fan speed membership functions

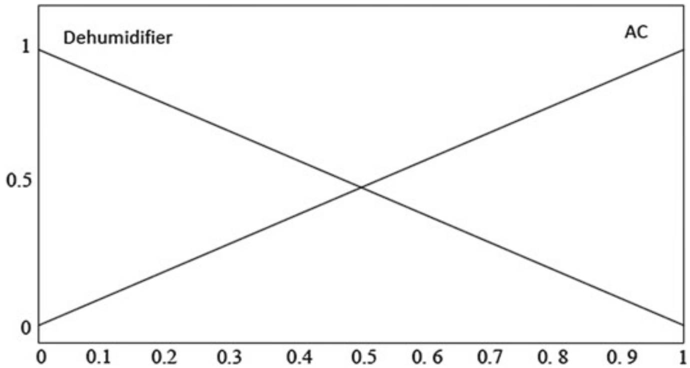


Fig. 8 Operation mode membership functions

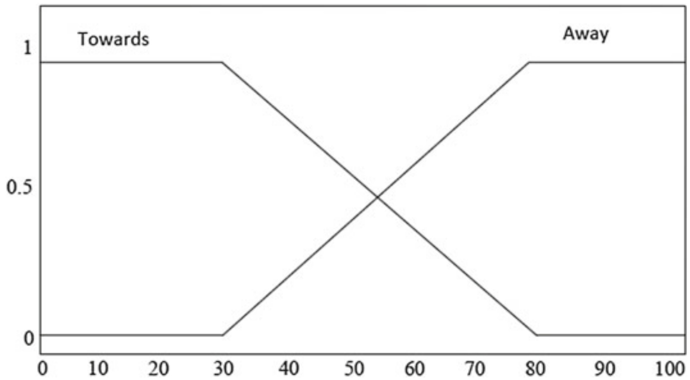


Fig. 9 Fin direction membership function

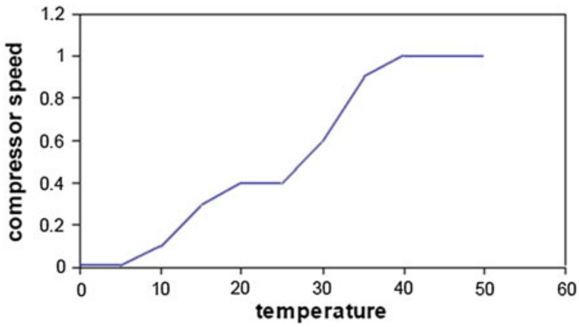


Fig. 10 Compressor speed with temperature

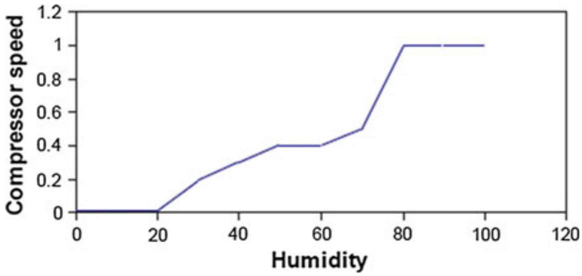


Fig. 11 Compressor speed with humidity

Fig. 12 Output with Input1 (temp)

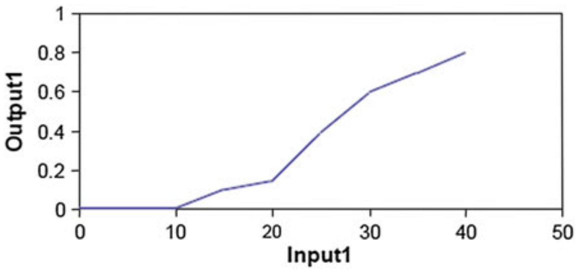
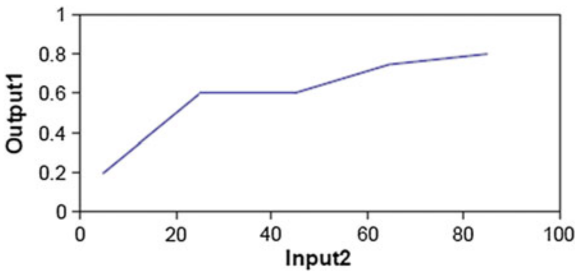


Fig. 13 Output with Input2 (humidity)



5 Conclusion

Neuro-fuzzy algorithm is better than fuzzy logic algorithm in air conditioning system. Neuro logic algorithm gives a better control than fuzzy logic. In neuro logic algorithm, performance of compressor speed is much better than fuzzy logic algorithm. In fuzzy logic control design, the compressor speed remains constant for temperature range from 35 °C onwards, but in neuro-fuzzy control design, it increases consistently with respect to temperature. By this, it provides proper output and save energy. It controls the room environment and weather.

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