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Data Management System of an FLC-Based Temperature Monitoring for Air Conditioning System

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Abstract: An integrating home automation system is now becoming a trend in modern house concepts. These systems may include the function of remotely switching devices/appliances. Different technologies are being utilized to achieve this function for houses termed as "intelligent home". Using the related studies which are gathered and further analysed by the proponents, they have come up with the idea of creating a simple model for a remote switching application system. The proponents choose to develop a model using a telephone system. Telephone line is chosen to serve as the channel for the transmission of instruction signals. The system will be composed of a remote section and a local section. DTMF signalling, which is the standard dialling technique for telephone system, will be used as a means of transmitting of the signals to the local section. The generated signals from the control section will be decoded using a DTMF decoder. The brain of the system is an Arduino microcontroller. This will take care of the processing of the main functions of the system.

Key Words: Home Automation Systems; Intelligent Home; DTMF; DTMF Decoder; Telephone; Telephone Line; Arduino microcontroller

1. INTRODUCTION

Fuzzy logic is basically a form of logic and decisions tools which doesn't have definite restrictions like human. Reasoning of approximation is the main focus of fuzzy logic rather than precise and fixed. In the system of Fuzzy Logic Control (FLC), comprehensive model of knowledge is not a requirement unlike the other control systems. On the other hand, FLC system is a simple to develop that can be easily executed in a standard computer [1] [2].

Air conditioning systems are one of the important parts of almost every establishment. But they contribute to the large part of the total energy consumption. Based on some studies, majority of energy use in buildings is associated to the Heating, Ventilation, and Air-Conditioning (HVAC) systems, which contribute 50% of the total energy consumption [3]. Therefore, it indicates that the consumption of air conditioning system sets a major demand on the nation's electrical power consumption wherein most of the units are operating in heavy load. When the user uses the air conditioning system, lot of energy is wasted that will cause to an energy shortage because heating and cooling devices have the maximum power intake. [4]

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According to ASHRAE Standard 55-2010, the recommended indoor temperature is typically ranges from 20 °C to 26 °C and the recommended level of indoor humidity is ranges from 30% to 60% in air conditioned establishments. When the temperature and humidity exceed the normal comfortable indoor environment, it can cause to the negatively impact air quality and harmful to health. [5]

The main purpose of this system is to reduce the temperature oscillations and to monitor the humidity of the room by using MatLab Fuzzy Logic Toolbox. This proposed design work of data management system of an FLC based temperature monitoring for air conditioning units is the application of fuzzy logic Control system consisting different input variables. In order to assure the functionality of the system, it is essential to precisely and correctly detect the temperature and the humidity of a certain room to assure human comfort. The measurement basis for the temperature is Celsius (°C) and for the humidity measurement unit of air conditioning system is percentage (%). Moreover, the sensors of the systems have the combination of the temperature and humidity sensing capability. In which, the temperature and the humidity information response through sensors and the receiver will store the data into the database. The fuzzy logic control mechanism would acquire the data in the database and compare the temperature and humidity parameters requested by the user and calculate the membership function.

In this study, the proponents will use the theories and principles of fuzzy logic in order to monitor the temperature and humidity based on the parameters. The element to be considered for monitoring includes the temperature and humidity for air parameters. The parameters for the temperature is categorized as Very Cold (VC), Cold (C), Normal (N), Hot (H) and Very Hot (VH) while for the parameters of the humidity is categorized as Very Good (VG), Good (G), Fair (F), Poor (P) and Very Poor (VP). On the other hand, the output parameters are categorized as Highly Acceptable (HA), Acceptable (A), Just Acceptable (JA), Not Acceptable (NA) and Highly Not Acceptable (HNA).

The proponents preferred to use the Sugeno-style of fuzzy inference system. In terms of the input and output parameters, the proponents will use the triangular membership function. The proponents will validate and verify the results using MatLab Fuzzy Logic Toolbox and this study will be simulated purely mathematical.

1.1. Objectives

The general objective of the study is to design and develop a system that is capable of monitoring the temperature of the air conditioning system.

Further objectives are specified as follows:

a.) To develop a system that is hassle free for the students in notifying the control panel personnel about the condition of the room temperature; whether it is too hot or cold to adjust the air conditioning status.
b.) To meet the normal temperature that is highly recommended for humans in the room.
c.) To determine the parameters of the temperature monitoring system will meet the standard requirements using Fuzzy – Logic MatLab Toolbox Kit.

2. METHODOLOGY

2.1. MATLAB Programing Platform

MATLAB is one application that has a high-performance language for technical computing. It can be used for computing, visualizing, and programming an easy-to-use environment where the user can solve the problems easily, fast and legibly. It is also a communicating system whose basic data element is an array which doesn't required any dimensioning on the system. It is good in solving matrix, vectors or even a fraction to make the results simpler and accurate. [6]

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• Fuzzy Logic Toolbox

It provides functions, apps, and a Simulink block for analyzing, designing, and simulating systems based on fuzzy logic. The toolbox guides you through the steps of designing fuzzy inference systems. Functions are provided for many common methods, including fuzzy clustering and adaptive neuro-fuzzy learning.

The toolbox lets you model complex system behaviors using simple logic rules, and then implements these rules in a fuzzy inference system. You can use it as a stand-alone fuzzy inference engine. Alternatively, you can use fuzzy inference blocks in Simulink and simulate the fuzzy systems within a comprehensive model of the entire dynamic system.[7]

2.2 Block Diagram

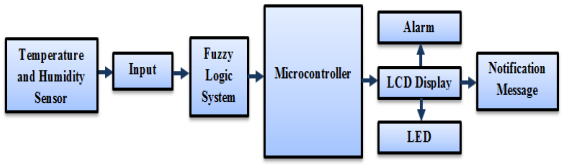

Figure 1. Systems Block Diagram

The Figure 1 depicts the process or the flow of the entire system. Using MatLab Fuzzy logic Toolbox, inputs that are from the temperature and humidity sensor are initializes in the fuzzy inference system to formulate a fuzzy logic rules. Then, the input will be send to the Microcontroller, which is the brain of the system. Then, output of the system will be display in and LCD display with corresponding alarm, notification message and LEDs will be turning on with the corresponding temperature and humidity.

2.3 IPO Chart

INPUT	PROCESS	OUTPUT
➢ Hardware knowledge in Arduino Microcontroller and DHT11 Temperature and Humidity Sensor. ➢ Software knowledge in Arduino IDE, MATLAB Fuzzy Logic Toolbox and Visual Basic.Net	➢ Planning ➢ Brainstorming ➢ Analysis of the Study ➢ Design and development of the Study ➢ Testing ➢ Improvement of the system.	Temperature Monitoring System

Table 1 Conceptual Framework Diagram

In order for the study to meet the requirements, the proponents had to have enough knowledge regarding with the Arduino Microcontroller and DHT11 for hardware and Arduino IDE, Visual Basic.Net and MatLab Fuzzy Logic Toolbox for the Software.

In the process of the system, planning is the first step to know the flow of the system. In terms of gathering and collecting data, brainstorming is one of the easiest way in order to have enough and valid data. Having also the brainstorming, the proponents were able to research about the study and analyzed every detail that can be used in the study. Then, it will follow by the designing and developing of the hardware and software part of the system. After that, several tests will be conducted in order to test the accuracy, reliability and especially the functionality of the system.

By finishing all the requirements, the output of the study is equivalent to the outcome of the input and process of the study that were able to come up and create a Temperature Monitoring system.

3. RESULTS AND DISCUSSION

3.1 Project Description

Data Management System of an FLC-Based Temperature Monitoring for Air Conditioning Units that will assess the environmental factors like temperature and humidity that will provide comfortable environment levels in terms of cooling and optimized electricity consumption. This system will monitor and control the temperature of a room. Once the system detects that the temperature reaches the given range, the system will trigger and will send a notification pop-up message to the control panel and will display in a monitor or LCD. With the use of Fuzzy logic the systems were able to determine its range of limitation and calculation on where it will notify the status of the temperature and humidity. The system will use Visual Basic.Net programming language as the GUI (Graphical User Interface) of the system.

4. EXPERIMENTS AND ANALYSIS OF RESULTS

Trials	Parameters	Input Values	Crisp Output (MatLab Fuzzy Logic Toolbox)	Linguistic Classification
1	Temperature	24°C	3	Just Acceptable
	Relative Humidity	50%		
2	Temperature	29°C	3	Just Acceptable
	Relative Humidity	61%		
3	Temperature	22°C	3	Just Acceptable
	Relative Humidity	44%		
4	Temperature	27°C	4	Acceptable
	Relative Humidity	54%		
5	Temperature	19°C	2	Not Acceptable
	Relative Humidity	43%		
6	Temperature	23°C	3	Just Acceptable
	Relative Humidity	47%		
7	Temperature	21°C	3	Just Acceptable
	Relative Humidity	52%		
8	Temperature	23°C	3	Just Acceptable
	Relative Humidity	48%		
9	Temperature	38°C	5	Highly Acceptable
	Relative Humidity	29%		
10	Temperature	18°C	1	Highly Not Acceptable
	Relative Humidity	80%		

Table 2. Simulation of FLC

The proponent conducted 10 trials as represented in Table 2 to verify the accuracy and reliability of the system and to accommodate possible crisp outputs of Highly Acceptable (HA), Acceptable (A), Just Acceptable (JA), Not Acceptable (NA) and Highly Not Acceptable (HNA) and it was verified that the fuzzy based system is working properly in accordance to programmer-defined rules.

5. CONCLUSION

This paper entitled "Data Management System of an FLC-Based Temperature Monitoring for Air Conditioning Units" is implemented using the microcontroller. The proponents used the MatLab to simulate the fuzzy logic wherein it consists of two inputs; the temperature and humidity. The proponents set different ranges both for the temperature and humidity. In term of output the proponents classified it as Highly Acceptable, Acceptable, Just Acceptable, Not Acceptable and Highly Not Acceptable. Also, several test is conducted to test the accuracy and reliability of the system that can satisfy the objectives of the study.

6. RECOMMENDATIONS

The proponents recommend to the future researchers the followings:

1. Future researchers can use a larger scale of rules and membership functions.
2. In this study the proponents uses the Sugeno style of FIS; future researchers can use the Mamdani Inference method instead.
3. Use other computational intelligence and implement it using a microcontroller.

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