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Original Research Article

# ANDROID BASED FUZZY INFERENCE SYSTEM TO CONTROL THE FAN SPEED.

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**Abstract-** This research paper describes the design and implementation of an autonomous fan using fuzzy rule based control system. The rule base receives two crisp input values from temperature and humidity sensors, divides the universe of discourse into regions with each region containing two fuzzy variables, fires the rules, and gives the output singleton values corresponding to each output variable. The aim of this prototype is to design low cost portable device which can be easily used to control the fan speed. The features of this design are to have prototype of portable fan and circuit wirelessly connected to Android smart phones using Bluetooth and processing the data. The fan speed will be monitored and correct fan speed will be analyzed on Smart Phones using Fuzzy Logic. The results obtained from the simulation were found correct according to the design model. This research work will increase the capability of fuzzy logic control systems in process automation with potential benefits.

**Keywords***:* Fuzzy Inference System (FIS), Android, application (‘Apps),Fuzzy Logic(FL)

## Introduction

Project emphasizes on controlling the fan speed using the fuzzy logic based on physical parameters of surroundings. To develop a data acquisition system for temperature and humidity and send the data to the micro controller. The micro controller would process the data and send it to a application on a ANDROID based Smart Phone via BLUETOOTH. The Fuzzy Logic Application would process the data regarding the surrounding temperature and humidity and communicate the appropriate fan speed to the micro controller which in turn would control the fan speed.

A trend that is growing in visibility relates to the use of fuzzy logic in combination with neurocomputing and genetic algorithms. More generally, fuzzy logic, neurocomputing, and genetic algorithms may be

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viewed as the principal constituents of what might be called soft computing. Unlike the traditional, hard computing, soft computing is aimed at an accommodation with the pervasive imprecision of the real world. The guiding principle of soft computing is: Exploit the tolerance for imprecision, uncertainty, and partial truth to achieve tractability, robustness, and low solution cost.

## Theory

The past few years have witnessed a rapid growth in the number and variety of applications of fuzzy logic. The applications range from consumer products such as cameras, camcorders, washing machines, and microwave ovens to industrial process control, medical instrumentation, decisionsupport systems, and portfolio selection.

To understand the reasons for the growing use of fuzzy logic it is necessary, first, to clarify what is meant by fuzzy logic.

Fuzzy logic has two different meanings. In a narrow sense, fuzzy logic is a logical system, which is an extension of multivalued logic. But in a wider sense, which is in predominant use today, fuzzy logic (FL) is almost synonymous with the theory of fuzzy sets, a theory which relates to classes of objects with unsharp boundaries in which membership is a matter of degree. In this perspective, fuzzy logic in its narrow sense is a branch of FL. What is important to recognize is that, even in its narrow sense, the agenda of fuzzy logic is very different both in spirit and substance from the agendas of traditional multivalued logical systems.

A FIS is a way of mapping an input space to an output space using fuzzy logic FIS uses a collection of fuzzy membership functions and rules, instead of Boolean logic, to reason about data. The rules in FIS (sometimes may be called as fuzzy expert system) are fuzzy production rules.

The input stage maps sensor or other inputs, such as switches, thumbwheels, and so on, to the appropriate membership functions and truth values. The processing stage invokes each appropriate rule and generates a result for each, then combines the results of the rules. Finally, the output stage converts the combined result back into a specific control output value.The most common shape of membership functions is triangular, although trapezoidal and bell curves are also used, but the shape is generally less important than the number of curves and their placement. Fuzzy logic consists of membership functions which can be invoked to make appropriate decisions.

The front end design makes use of Android OS so as to help the user in customizing the fuzzy logic. Since there are numerous fuzzy membership functions, all can't be incorporated in the micro-controller based systems. Hence a mobile application is used to incorporate many fuzzy membership functions.

## Block Diagram

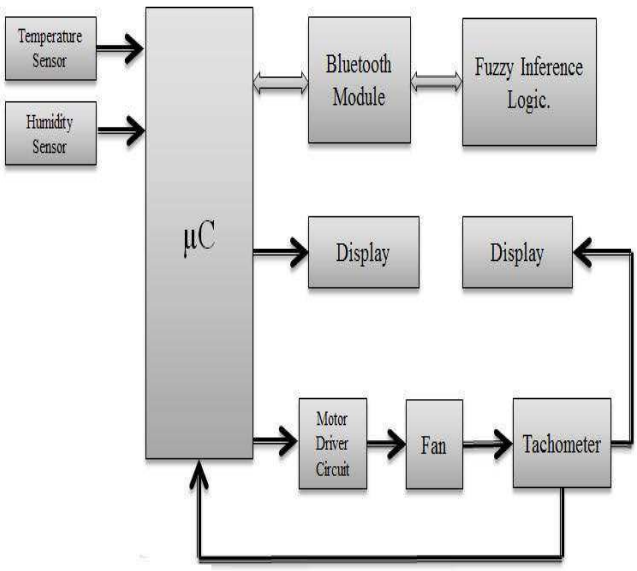


Fig 1. Block Diagram of FIS

**Temperature Sensor**

The LM35 series are precision integrated-circuit temperature sensors, with an output voltage linearlyproportional to the Centigrade temperature. Thus theLM35 has an advantage over linear temperature sensors calibrated in ° Kelvin, as the user is notrequired to subtract a large constant voltage from the output to obtain convenient Centigrade scaling. TheLM35 does not require any external calibration otrimming to provide typical accuracies of ±¼°C at room temperature and ±¾°C over a full −55°C to+150°C temperature range. Low cost is assured bytrimming and calibration at the wafer level. The lowoutput impedance, linear output, and precise inherent calibration of the LM35 make interfacing to readout orcontrol circuitry especially easy.[6]

**Humidity Sensor**

Based on a unique capacitive cell, these relative humidity sensors are designed for high volume, cost sensitive applications such as office automation, automotive cabin air control, home appliances, and industrial process control systems. They are also useful in all applications where humidity compensation is needed.

**Microcontroller**

PIC18F4550 which is 40 pin high performance USB Microcontroller with 32K Flash memory. It is used as data acquisition system to connect the input parameters with the Bluetooth module.

**Bluetooth Module**

The Bluetooth Module will make itself ready for transmission of data via serial communication. It will await a connection request from the Android Phone. Once connected the Bluetooth Module will send data serially and the Phone will save it for displaying. The HC05 Bluetooth module is used which will be interface with microcontroller. The digital value will be transmitted to the Smart phone. The Bluetooth will transfer the digital value to the smartphone where the value will be mapped.

**Tachometer**

Tachometer is designed using the motor driving circuitry, fan, and microcontroller. It is used to display the current operating fan speed and the corrected fan speed received from the phone after processing.

Android Phone OS

A smart phone will be used to display the membership functions and the fuzzy rules used. A application commonly known as app‟s will be developed for analysis of the input parameters received from the Bluetooth module.

Various membership functions and FIS will be used for analysis. The App developed will analyze and give result simultaneously through the Bluetooth module in turn controlling the fan speed.

AMPLIFER and CONTROLLER

The input from the LM35 is in millivolts hence amplification is needed. The voltage of LM35 varies as 10mv/°C which is very small as an input to the microcontroller which requires greater voltage. The first stage of amplification is buffer where the strength of the signal is increased with gain of 10. After buffering the Instrumentation amplifier is used. A Band pass filter is used to pass the particular band of signal. The band is selected according to the limit of the signal.

The PIC 18F4550 microcontroller has been used. The features of it are serial communication with V2.0 compliant. This family of devices offers the advantages of all PIC18 microcontrollers, high computational performance at an economical price – with the addition of high endurance, Enhanced Flash program memory. In addition to these features, the PIC18F4550 family introduces design enhancements that make these microcontrollers a logical choice for many

high-performances, power sensitive applications. Devices in the PIC18F4550 family incorporate a fully featured Universal Serial Bus communications module that is compliant with the USB Specification Revision 2.0. The module supports both low-speed and full-speed communication for all supported data transfer types. It also incorporates its own on-chip transceiver and 3.3V regulator and supports the use of external transceivers and voltage regulators [6]. All of the devices in the PIC18F4550 family incorporate a range of features that can significantly reduce power consumption during operation [6].

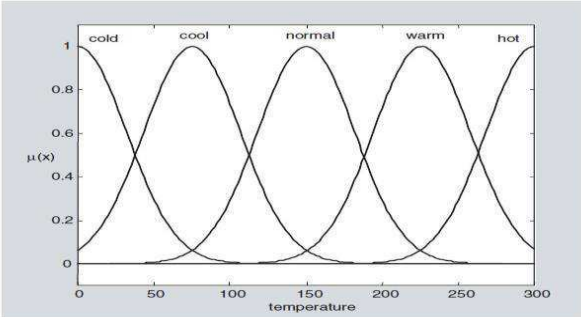


Fig. 2 Temperature Analysis using gauss membership functions

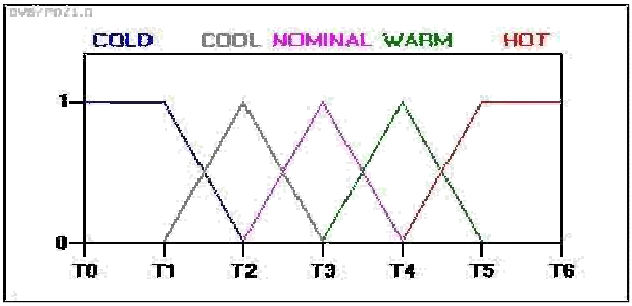


Fig. 3 Temperature Analysis using Triangular and Trapeziodal membership function

**Android Analysis**

There is various software available for Android Programming that is Basic4Android (B4A) and eclipse. The Eclipse is Java base programming tools whereas Basic4Android is „C" base app designing approach. Basic4Android have a many advantages as compare to other IDE for Android. Most of the IDE requires developers to learn Java with all its complexities as well as wrestling with the use of unfamiliar hardware platform. Basic4Android makes everything easy. Only B4A allows developers to easily create native and market- compatible applications without having to write any XML, achieving a performance that is similar to Java written applications. Basic4android generates standard signed Android applications which can be uploaded to app stores like Google Play, Samsung Apps. There are no special dependencies or runtime frameworks required. Basic4android is a simple yet powerful development environment that targets Android devices.Basic4android language is similar to Visual

Basic language with additional support for objects.Basic4android compiled applications are native Android applications; there are no extra runtimes or dependencies. Unlike other IDE"s, Basic4android is 100% focused on Android development.Basic4android includes a powerful GUI designer with built-in support for multiple screens and

orientations. Basic4android has a rich set of libraries that make it easy to develop advanced applications. After the development of app as APK file is generated and it can directly installed on Android phone.

The major part of our design is Android application. Android has cover more than 80% of market, and it is easily available on smart phones. The android has major advantage as compare to other operating system. The android application will be design in such a way that it will continuously monitor the signal; simply it will be a real time application. The application will consist privilege of using user defined and customizable membership functions. Android is an operating system based on the Linux kernel, and designed primarily for touchscreen mobile devices such as smartphones and tablet computers. The user interface of Android is based on direct manipulation, using touch inputs that loosely correspond to real-world actions, like swiping, tapping, pinching and reverse pinching to manipulate on-screen objects. Android became the most popular mobile OS, having the largest installed base, and is a market leader in most countries because of its low-cost and highly user friendly interface.

The user based processing capability is an important aspect of fuzzy systems taken into account in any design consideration of human centric computing systems. The human centricity plays a vital role in the area of intelligent data analysis and system modeling. The elements of fuzzy sets belong to varying degrees of membership or belongingness. Fuzzy sets offer an important and unique feature of information granules. A member- ship function quantifies different degrees of membership. The higher the degree of membership A (x), the stronger is the level of belongingness of this element to A. Fuzzy sets provide an ultimate mechanism of communication between humans and computing environment. The fuzzy logic and fuzzy set theory deal with non-probabilistic uncertainties issues. The fuzzy control system is based on the theory of fuzzy sets and fuzzy logic. Previously a large number of fuzzy inference systems and defuzzification techniques were reported. These systems/techniques with less computational overhead are useful to obtain crisp output. The crisp output values are based on linguistic rules applied in inference engine and defuzzification techniques [6]-[7].

The efficient industrial control with new techniques of fuzzy algorithm based on active rule selection mechanism to achieve less sampling time ranging from milliseconds in pressure control, and higher sampling time in case of temperature control of larger installations of industrial furnaces has been proposed [8].

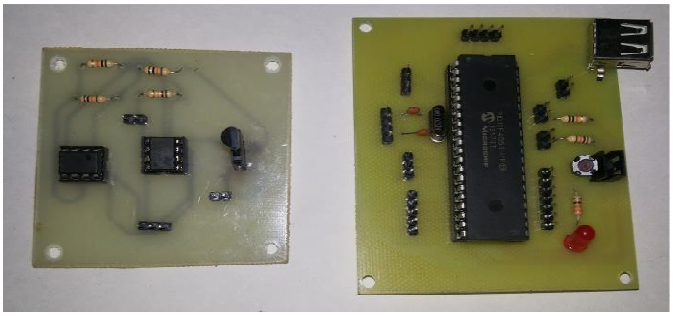

Fig 4. LM35 circuit with amplifier and PIC board

**Simulation**

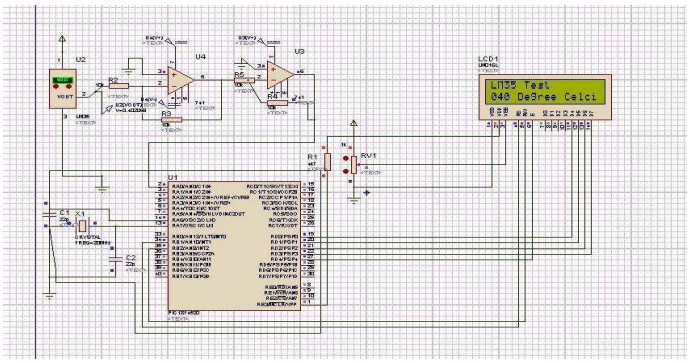


Fig 5. Simulation on PROTEUS of LM35 circuit.

Based PID-like Fuzzy Controller for Industrial Applications",IAENG, IJCS. 34:2 (2005)

PIC18F4520 chip running at 20MHz attached with a standard 16x2 LCD and LM35on AN0 pin. LM35 is a 3 pin device connect the +Vs Pin to 5v and GND to GND. The output must be connected to the analog input pin 0 of the PIC18F4520 MCU. It is labeled AN0 in the datasheet. It is pin number 2 on the 40 pin package. It is also calledRA0because it is shared with PORTA0. We will use our 40 PIN PIC Development board to realize the project. The base board has all the basic circuit to run the PIC. The extra part required for this project likeLCDand the LM35 temperature sensorare installed in the board.

**Conclusion**

The device is portable, user friendly and customizable. The performance of design is quite high. The designs available in the market currently are not feasible and include great amount of hardware are microcontroller based which cannot be user customizable. Android on the other hand gives the user luxury to set his own, membership functions according to the needs and control the fan speed. It also has an added feature as the output will be android which is easy to use. Thus the user does not require any training. With the further development we can modify the design.

**Acknowledgement**

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