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Automation System for Humidity Using FPID

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ABSTRACT: The objective of this paper is to develop automation system for humidity implementing software Fuzzy with PID control algorithm (FPID). Now a day's controlling of process parameters in industrial application and other appliances plays a vital role among them one of the most critical and important parameter is humidity. For this relative humidity can be maintained constant continuously in required applications at constant temperature. Using Arduino mega2560 microcontroller [1] implementing FPID [2] for controlling the humidity control. The present work is proposed to implement the software program code for FPID control logic for reducing the hardware complexity in processing software using java programming language. In earlier works it is implemented by using inbuilt logics available in some software applications like MATLAB and LABVIEW.

KEYWORDS: HRT-393 humidity sensor, FPID, DC motor, Arduino mega2560 microcontroller.

I. INTRODUCTION

The amount of water vapour found in air can vary dramatically, from almost zero to the point of saturation. Insufficient or excessive humidity, or swings between the two, can damage sensitive materials and objects. Humans are also sensitive to humid air, and high humidity can cause discomfort. The human body uses evaporative cooling as its primary mechanism for regulating temperature. When the relative humidity is high, the rate of perspiration evaporating from the skin decreases because the amount of water vapour in the air is already close to saturation. Humans feel the rate of heat transfer from the body rather than temperature itself. We feel warmer when the relative humidity is high. When humidity is so high that perspiration cannot easily evaporate, the body may overheat, causing discomfort. A combination of high temperature and low relative humidity allows more effective cooling. Traditionally, many environments have been controlled based solely on measurements of temperature. In recent years, the measurement of humidity has become equally important. Humidity control is especially important in living, storage and manufacturing sites. Control of temperature and relative humidity is also critical in the preservation of many materials including medications, foods, fabrics and wood products.

Unacceptable humidity levels, especially when combined with temperature extremes, contribute significantly to the breakdown of materials. Heat accelerates deterioration, and high relative humidity provides moisture, which promotes harmful chemical reactions. When combined, these factors can encourage insect activity and the growth of mold. Extremely low relative humidity can also have damaging effects, desiccating sensitive materials and causing them to become brittle. Large fluctuations in temperature and relative humidity also cause damage through expansion and contraction, which helps accelerate deterioration.

Installation and operation of adequate climate controls to meet preservation standards will retard the deterioration of materials considerably. To control humidity and prevent damage or discomfort or to detect events that may have led to product damage in storage or transit, accurate measurement of humidity is vital and, ideally, must be available in a component form that enables easy, cost-effective integration with electronic controls.

II. PROCEDURE

The humidity can be controlled using Arduino mega2560 microcontroller implementing software FPID control algorithm for this reducing the hardware complexity. Relative humidity (RH) [7] is a measure of the amount of water

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Vol. 4, Issue 12, December 2015

in the air, at a specific air temperature, expressed as a percentage of the maximum amount of water the air can hold at that temperature. According to the measurement units, humidity sensors are divided into two types: Relative humidity (RH) sensors and absolute humidity (moisture) sensors. Relative humidity sensors are classified into ceramic, semiconductor, and polymer humidity sensors. Ceramic Sensing Material, humidity sensors based on water-phase protonic ceramic materials are used widely in industry and research laboratories. The adsorbed water condensed on the surface of the materials and protons will be conducted in the formed aquatic layers. For ionic sensing materials, if the humidity increases, the conductivity decreases and the dielectric constant increases. Detecting the relative humidity by using HRT-393 humidity sensor, it is a resistive based sensor and it gives output as voltage for appropriate relative humidity value at fixed temperature 30°C. The block diagram of total system as shown in Fig. 1.

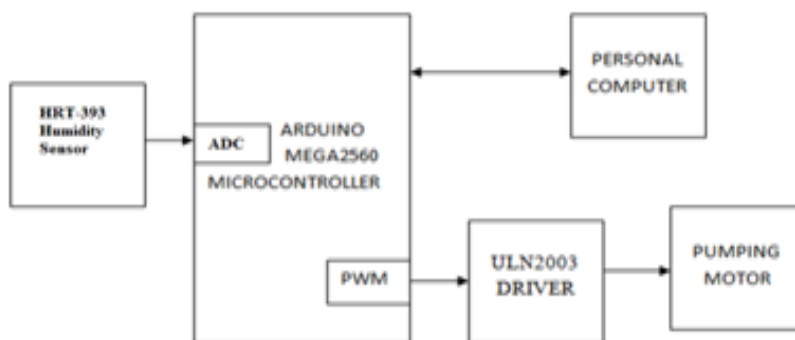


FIG. 1 Block diagram for humidity control

HRT-393 Humidity Sensor working principle is explained in FIG. 3. It is resistive type humidity sensor.



FIG. 2 Humidity Sensor

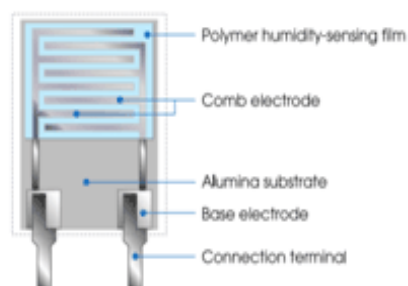


FIG. 3 Principle of humidity sensor

Thick film conductor of precious metals like gold, ruthenium oxide is printed and calcinated in the shape of the comb to form an electrode. Then a polymeric film is applied on the electrode; the film acts as a humidity sensing film due to the existence of movable ions. Change in impedance occurs due to the change in the number of movable ions. The humidity sensor HRT 393 gives voltage as an output, it is applied to the ADC of microcontroller for signal conditioning and based on digital data implementing the FPID[3][4] algorithm using DC motor which operating voltage is +12V through the ULN 2003 driver. The PWM of microcontroller controls the output of the DC pumping motor by applying Fuzzy logic with PID controlling technique. For the controlling of humidity the water pumping

International Journal of Innovative Research in Science, Engineering and Technology

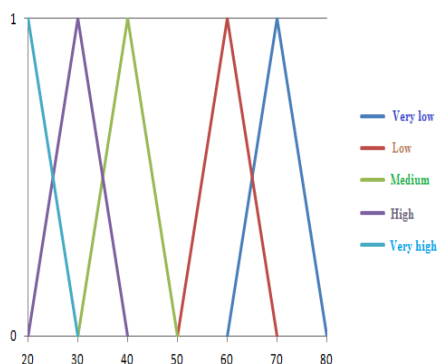
(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 12, December 2015

motor is used based on the humidity value the water pumped in to a closed container where the humidity control is required.

The FPID algorithm involves the both technical aspects of Fuzzy logic and PID control, implanting software algorithm for reducing the hardware complexity and improve the system reliability. The controlling technique fuzzy includes the three steps, they are fuzzification , rule set and defuzzification .The fuzzification [5] determines the input linguistic variables for required control and the fuzzy rule set can be determined with the drive values of PWM of microcontroller which used the technique is PID control and finally the defuzzification step is represents the PWM output drive percentage with respect to the PID [6] control determined in rule set.

The fuzzification represents in the form of membership function of input linguistic variables based on the error
Membership Functions for F (humidity) = { Very low, Low, Medium, High, Very high }



S. NO	Crisp input range (error= set value - measured value)	Fuzzy variable
1	0 to 30	Very low (VH)
2	20 to 40	Low (L)
3	30 to 50	Medium (M)
4	50 to 70	High (H)
5	70 to 80	Very high (VH)

Table 1 . Fuzzification

The Table 1. Shows the the fuzzy variables are intialised to crisp input range of present work and it explains the functioning of humidity control. It is one of the most important part in fuzzification.

S. NO	Fuzzy variable range output interms of digital data	Corresponding drive Percentage	Fuzzy variable
1	200 to 255	78.4% to 100%	Very low (VL)
2	170 to 200	66.6% to 78.4%	Low(L)
3	100 to 170	39.2% to 66.6%	Medium (M)
4	50 to 100	19.6% to 39.2%	High (H)
5	50 to 0	0% to 19.6%	Very high (VH)

Table 2 .Defuzzification

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 12, December 2015

The Table 2. Shows the defuzzification process, in it based on the fuzzy variable the output of the PWM of microcontroller is determined in terms of output fuzzy variable and also corresponding drive percentage.

III. EXPERIMENTAL RESULTS

The snapshot and the GUIs shows the results of automation system for humidity implementing FPID.

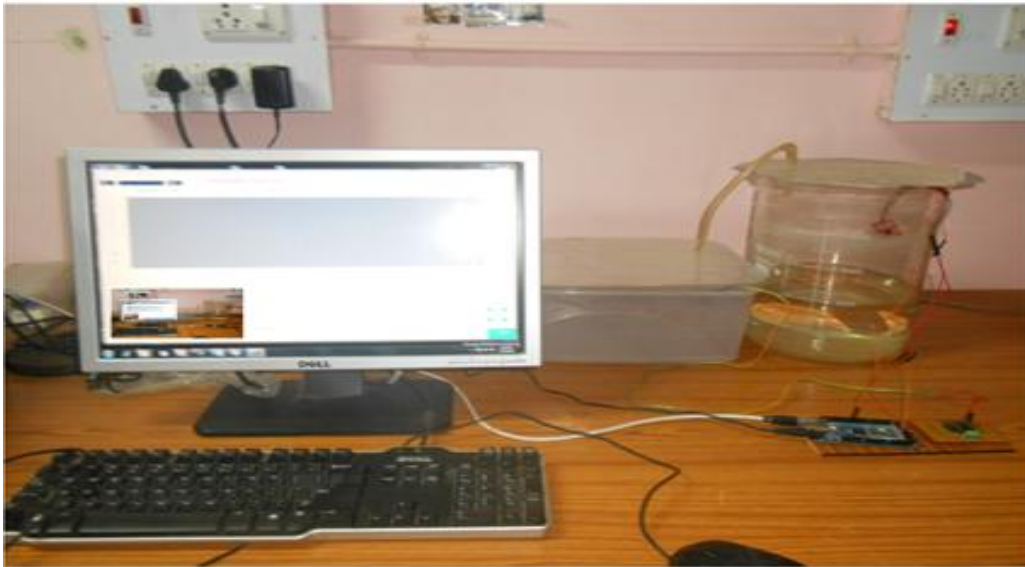


FIG. 4 Snap shot for humidity control

The FIG. 4 shows the total setup for measurement and control system for humidity photograph which includes the humidity sensor, water pumping DC motor, Microcontroller with driver circuit board and the results observed in PC.

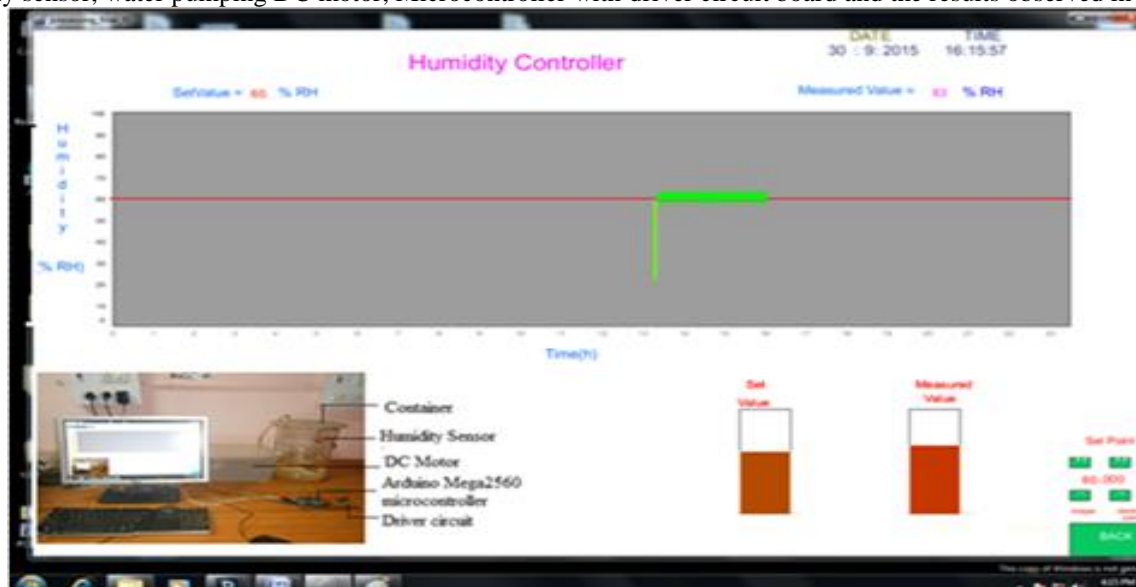


FIG. 5 GUI for automation system for humidity

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 12, December 2015

The FIG. 5 GUI represents the set value and the measured value ,the total system photograph ,slides for both set and measured values with the controlling buttons and the graph plot real time versus relative humidity.

IV. CONCLUSION

We have implemented an automatic humidity system implementing software FPID control for reducing the complexity of hardware and reliability of system. Our algorithm successfully detects the relative humidity and controls with less response time as well as settling time and steady state error. We have successfully experiment this system in lab and therefore proposed a web based humidity monitoring and controlling network with flexibility, further extension of this system is to control from any place via internet even with different type of devices. This could have a substantial benefit from this research work for efficient management of humidity.

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