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Design and Development of an Integrated Relative Humidity, Temperature Measurement and Gas(LPG) Sensing System Using PIC18F25K20

RAJESWARI CHERUKURI¹ and RAGHAVENDRA RAO KANCHI^{2*}

¹Research Student, VLSI & Embedded System Laboratory, Department of Physics,
Sri Krishnadevaraya University, Anantapuramu, 515003, India.

²Professor, VLSI & Embedded System Laboratory, Department of Physics,
Sri Krishnadevaraya University, Anantapuramu, 515003, India.

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*For Correspondence

Raghavendra Rao Kanchi, VLSI & Embedded
System Laboratory, Department of Physics, Sri
Krishnadevaraya
University, Anantapuramu, 515003, India.

E-mail: kanchiraghavendrarao@gmail.com

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ABSTRACT

The design and development of a relative humidity(RH), temperature(T) measurement and gas (LPG) sensing system using PIC18F25K20 is presented in this paper. PIC18F25K20 microcontroller is the heart of the whole system which reads the digital equivalent of relative humidity (RH), ambient temperature (T) and gas sensing data (LPG) with the help of on chip 10-bit analog to digital converter (ADC). LPG(MQ-2) gas sensor and HSM 20 G (Humidity and temperature) sensor are interfaced with PIC18F25K20. The measured parameters are displayed on LCD which is also interfaced with PIC18F25K20. Developed system with PIC18F25K20 microcontroller is portable and whole system works with 9V DC battery.

INTRODUCTION

Today as the world is modernizing, the life of common man becomes more comfortable with the use of advanced technologies. Intelligent systems are using most of these technologies. These intelligent systems comprises of different subsystems for lighting control, telegraphed systems, radio systems, temperature monitoring, gas level monitoring and certain other systems. This paper has carried out with a design to build an intelligent system which could be governed in humidity, temperature, and gas level monitoring (Figure 1). Nowadays; there is lack of awareness to the importance of humidity in our daily walk of life. Suitable humidity level is needed to stabilize our environment and the world ecosystem including ourselves. For example, in an AC (aircondition room) room suitable temperature with humidity levels gives comfort but low temperature or high temperature causes discomfort because suitable humidity cannot maintained in that room (Figure 2). Temperature monitoring is the common measurable parameter in the environment and gas sensing also plays an important role. When gas leakage occurs in home if persons are at home or not leakage of gas detected with systems ^[1].

Keeping the above facts in view point, we have developed a portable system for temperature, humidity and gas detection system (Table 1). Humidity and temperature monitoring have placed important role in many sectors. such as dampness, dryness in environment causes discomfort to public, toohigh or toolow humidity level condition can effect the quality of wood furniture and important appliance in agriculture ^[2]. In industrial sector for chicken's eggs hatching humidity and temperature monitoring needed ^[3]. Temperature parameters effect the plant growth. When the leaf temperature is 76°F, its transpiration will be the maximum. For

every degree rise about 76 F, plant loses 10% transpiration and at 81 F the transpiration of leaf goes down to 50% [4,5].

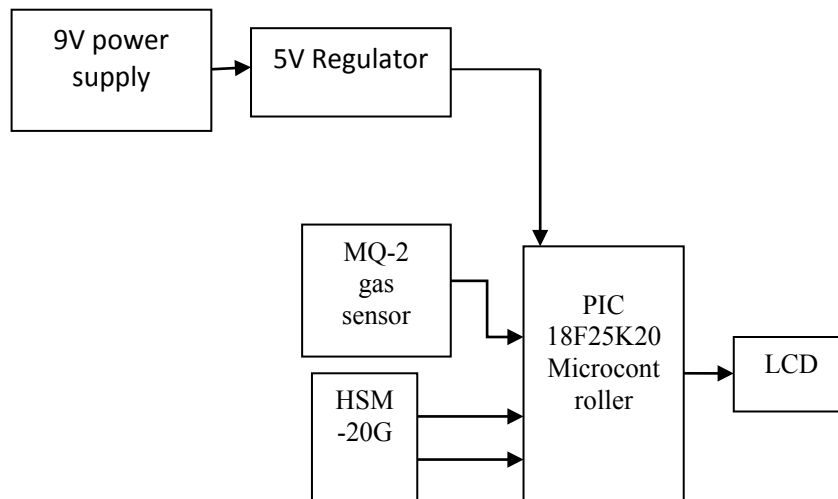


Figure 1: Block diagram of the project.

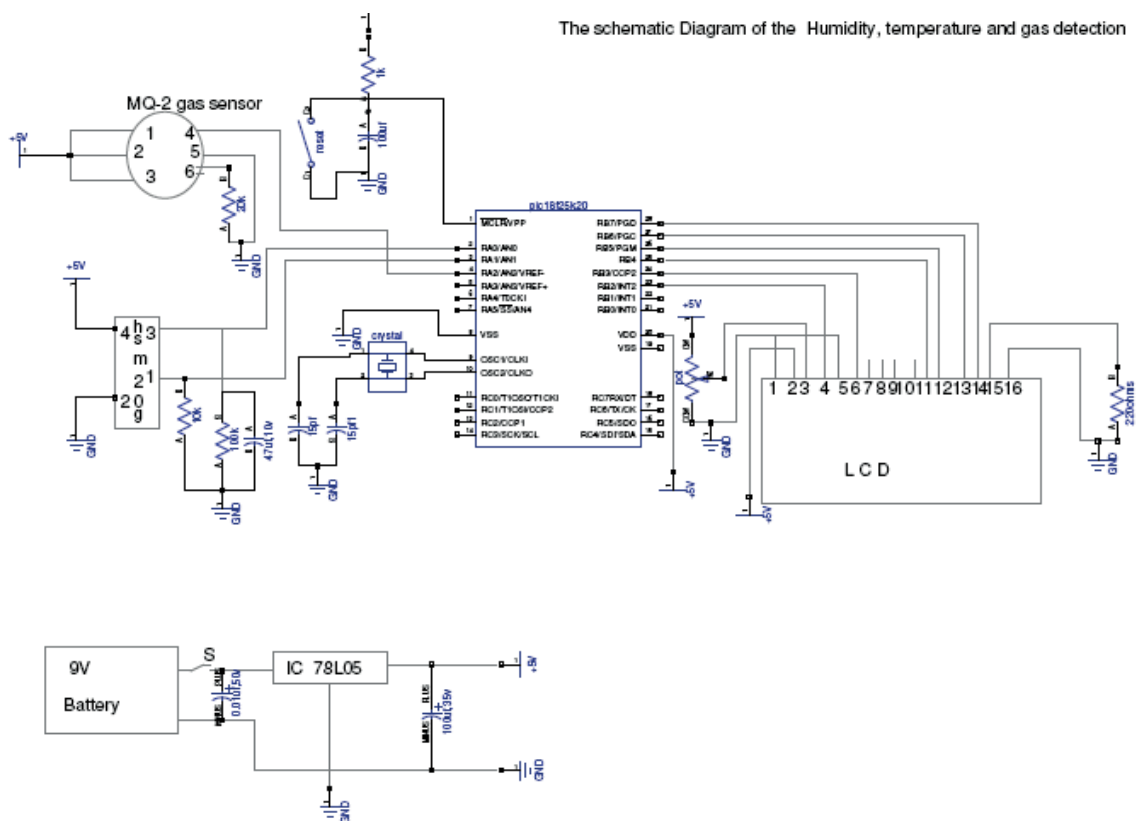


Figure 2: The schematic diagram of the relative humidity, temperature and gas measurement system.

Gas detecting systems are also have plenty of uses. Which are used in workshops, commercial buildings and fire etc [6]. Gas leakage effects the humidity and temperature parameters like leakage of gas in hazardous environment creates an impact in increasing the concentration of temperature and humidity [7]. Which used in industry sector also, why because any industries like automobile, steel and metal processing, power generation, food and drink, chemical industries, etc., gas usage plays an important role. Thus many companies responsibility to providing safety systems design to protect the personnel, equipment and processes of customers against potential dangers. Many industries depend on the consumption or release of gases on a dailybasis. In some industries pipes with gas far away from the workers and some times which cannot be visible in such cases when gas sensors are installed which give the leakage information. At least one gas sensor has to be mounted every kilometer along the pipes supplying LPG to house holds to protect them from gas incidents [8].

Table 1: Temperature and Relative Humidity Data.

Temperature with Designed system in °C	Temperature with commercial thermometer °C	Percentage error in temperature	Relative humidity measured with the designed system	Relative humidity measured with the dry and wet thermometer	Percentage error in humidity
24.5	25	2	38	40	5
27.3	28.3	2.8	40	43	6.9
29	29.6	2	44	46	5
32	32	0	47	50	6.9
33.6	34	1.17	50	z53	6.9
33.5	34	2	58	60	5
36	36.5	0.5	60	62	5

Hence we would like to propose this device that can read humidity level and the temperature in order to help us to be aware of humidity condition around us and gas level in houses and in the atmosphere. Dimensions of the sensors used in the present developed system are small enough to incorporate them in a portable unit^[9]. With the help of the designed and developed set up the Relative humidity, Temperature and Gas sensing in the atmosphere are measured. In different journals similar type of work is carried out but salient features of this work are that the system is portable, can take it anywhere in the field and it works with low power.

MATERIALS AND METHODS

The hardware developed in the present work is completely portable, humidity, temperature and gas reader are to read the level of humidity, temperature and the level of gas at desired place. Readings are displayed by output LCD continuously. The device will need a battery of 9V to operate and the voltage regulator will regulate the voltage to 5V for device usage. The size of the device is also so small and hence it is quite handy for users. The device is portable and take it to field wherever wants to measure environmental parameters like humidity, temperature and gas level. The relative humidity, temperature and gas levels (LPG, SMOKE) are sensed through the respective humidity, temperature sensor and gas sensor and respected data is sent to the PIC microcontroller. The sensed analog signals are converted to digital through ADC (Analog to digital converter). The sensed humidity, temperature and gas levels are displayed on the LCD^[10,11].

PIC18F25K20 Microcontroller Special Features

PIC18F25K20 microcontroller is low-cost high performance controller from microchip company. It has exceptional features like whose operating voltage range is 1.8V to 3.6V. A powerful 8-bit RISC CPU, self-programming under software control, has Precision 16 MHz internal oscillator block and at sleep mode controller consumes 100 nA current (Figure 3). Analog-to-Digital Converter (ADC) module has 10-bit resolution with 13 External Channels. In-circuit debugging with two pins^[12].

Humidity Sensor

HSM-20G humidity sensor is a type of sensor that senses the amount of water vapor in air and temperature in the atmosphere. Output of the HSM-20G sensor is Voltage analog output for both humidity and temperature, Small size makes it easy to conceal and high sensitivity to humidity in the air^[13].

Gas Sensor

MQ-2 gas sensor is mainly use for the detection of LPG, butane, propane, methane, alcohol, hydrogen, and smoke. They are used in gas leakage detecting equipments in houses and industry. MQ-2 gas sensor has wide detecting scope, fast response and high sensitivity, stable and long life and simple driver circuit^[14].

Interface Lcd (2 X 16 Characters) With PIC18F25K20

TO use the LCD display, users have to solder 16 pin header pin, LCD used to display the corresponding data. JHD162A LCD is used in this project.

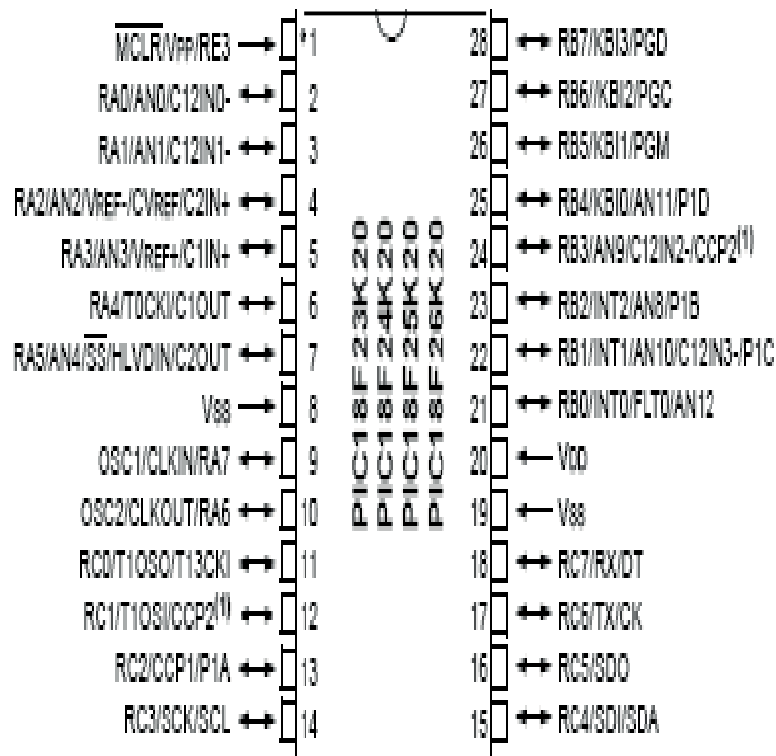


Figure 3: Pin diagram of PIC18F25K20.

User Interface

Generally the goal of human being is to produce a user interface which makes it easy, efficient and enjoyable to operate a machine in the way which produces the desired results. The developed system designed like such to read the value of humidity, temperature and gas level. First user will “ON” the main switch to provide power to the circuit then sensors will operate gives corresponding analog voltages to PIC by using program corresponding analog voltages converted into RH, Degree celcius, and PPM finally data will be display on LCD.

Calibration Of Sensors

For relative humidity and temperature sensing HSM-20G sensor is used. It is an analog voltage converter. By using Figure 4 calibration curve data relative humidity measurement equation is obtained. In this the output voltage and RH are related by the equation ^[15,16] relative humidity (RH) = 31*(analog voltage) - 12.

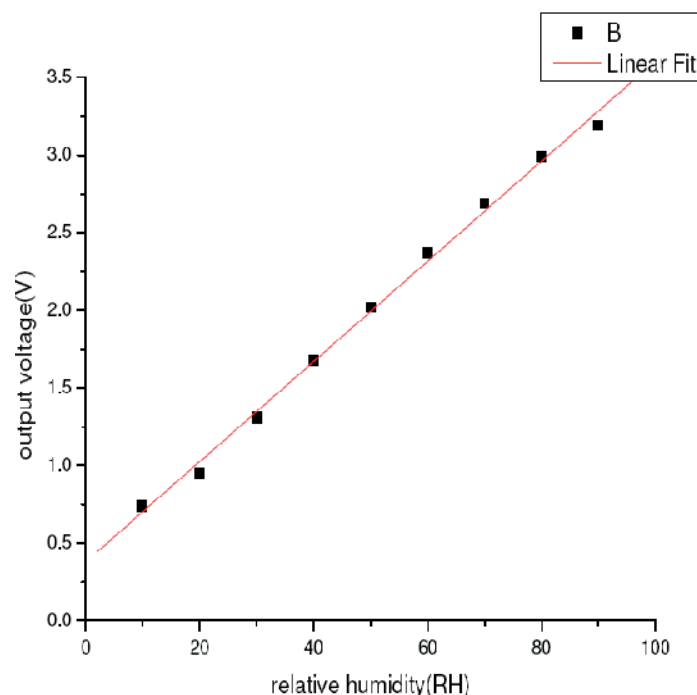


Figure 4: Calibration curve for relative humidity(R_h) Sensor.

By using Figure 5 calibration curve data temperature measurement equation is obtained. The relation between temperature and output analog voltage from sensor is $\text{Temperature}(T) = 2[9 * (\text{analog voltage}) + 6]$.

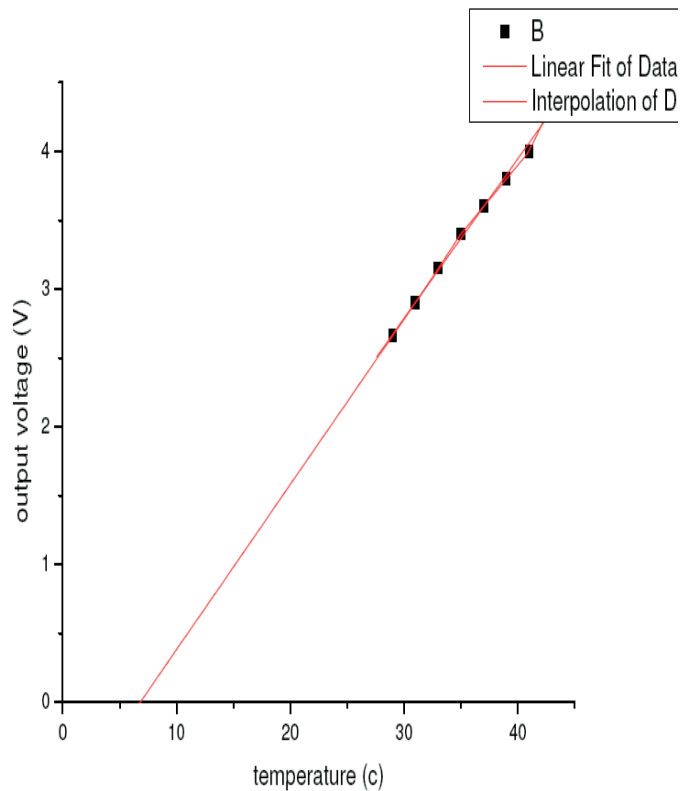


Figure 5: Calibration curve for temperature(T) Sensor.

MQ-2 gas sensor is used to sense the LPG ,Smoke gas. MQ-2 sensor is a resistive type and output is the analog voltage. By using Figure 6 calibration curve data gas level measurement equation is obtained. So the relation between resistance of sensor (R_s) and analog voltage (V_r) is $R_s = (V_r/V_{r1} - 1) R_1$.

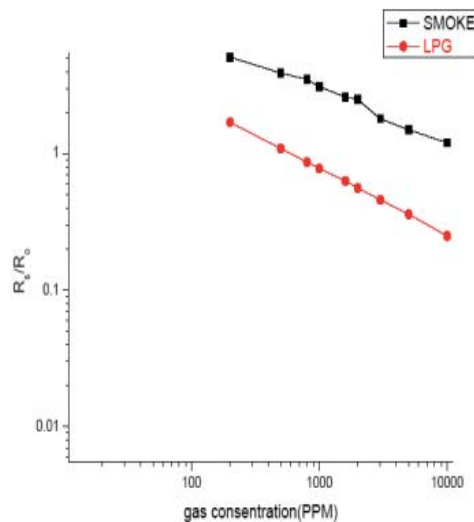


Figure 6: Calibration curve for Gas Sensor.

FOR LPG

The relation between gas concentration (PPM) and (R_s/R_0) is

$$\text{PPM} = e^{(3.0855 \cdot \ln y / 0.4822)}$$

FOR SMOKE

The relation between gas concentration (PPM) and R_s/R_0 is

$$\text{PPM} = e^{(3.4880 \cdot \ln y / 0.4218)}$$

In gas sensor sensitivity adjustment was important one, without this cannot use the sensor in a desired way. In this the sensor is calibrate to detector for 1000ppm LPG,1000ppm I-butane etc., in air and used value of load resistance(R_s) that is about $20\text{ K}\Omega$ ^[19].

RESULTS

Results obtained from present developed system are tablelated below. Temperature was compared with another standard temperature sensor as thermometer and relative humidity was compared with standard dry and wet thermometer which are available at whether station near to Srikrishnadevaraya University Anantapuramu (Figure 7). Good correlation in results and error obtained from designed system is predictable. In temperature measurement average error is 1.49%. In humidity measurement average error is 5.81%. The gas sensor was used to measure the air quality in several places inside the Srikrishnadevaraya University and included different gases levels but focused mainly on measuring two main gases: Liquid Petroleum Gas (LPG) and SMOKE (Figure 8). A sample of obtained results from both clean environment and lab are shown in Table 2.



Figure 7: Photograph of relative humidity and temperature measurement system.

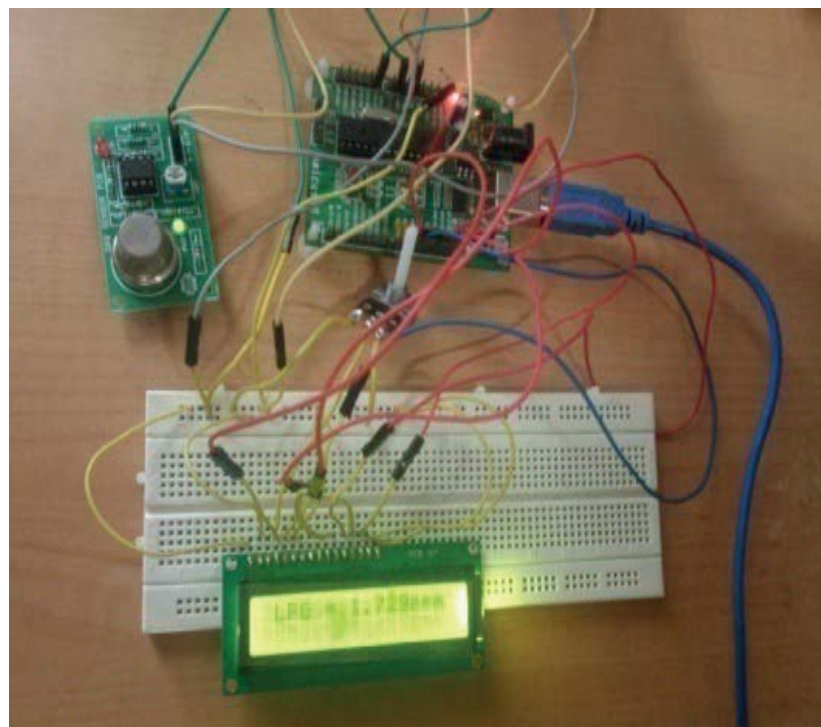


Figure 8: Photograph of gas level measurement system.

Table 2: LPG, SMOKE, Gas Detection Data.

S.No	In clear air LPG (ppm)	In Lab with LPG (ppm)	S.No	In clear air SMOKE (ppm)	In Lab with SMOKE (ppm)
1	3.46	100.12	1	8.67	50.07
2	3.97	198.67	2	8.12	48.76
3	3.07	150.86	3	9.37	36.82
4	3.13	200.29	4	8.38	56.97
5	4.76	163.78	5	7.62	60.02
6	3.67	133.69	6	9.12	45.76
7	3.43	190.72	7	9.47	55.67

CONCLUSION

A relative humidity, temperature and gas sensing system is developed. Since the sensors output is directly connected to the A/D converter channels, there is no need of trimming for adjustment of analog output. The developed system together with the stable reference reduces the error and noise. The sensors comes with atmosphere calibrated data. Hence errors due to the developed system are predictable. Moreover, the system is capable of independent humidity, temperature and gas sensing (LPG). Results obtained also fruitful.

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