Pet Temperature, Humidity, and Light Control System Design Based on Single Chip Microcomputer

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Abstract. It is a domestic demand nowadays that people have a pet, plants, and kids or elders at home that must look after on. Sometimes, it is hard to tell if they are living in an appropriate environment where they feel comfortable. That would be troublesome when people go to work or have a vacation, leaving them at home alone. Also, some of the aspects are subjective and difficult to quantify, especially humidity and temperature. In order to reflect the surrounding environment accurately and intuitively, a pet-sitter system is implemented. In this design, the use of high reliability of the Microprogrammed Control Unit (MCU) as the processing core, to improve the pet environment of temperature and humidity, and light to achieve the function of the sub-function design. The main functions of the design include the collection, display, automatic control, and adjustment of temperature and humidity illumination. For the selection of equipment, with the goal of running stability and cost performance, the corresponding equipment is selected, and the final realization of temperature, humidity, and light regulation.

Keywords: Pet, Temperature and humidity, Light, Illumination, SCM.

1. Introduction

It is common nowadays that people have a pet, some plants, and kids or elders at home and this paper want them to be healthy. Sometimes, it is hard to tell if they are living in an appropriate environment where they feel comfortable. And when you go to work or have a vacation, leaving them at home alone is a big worry. Light intensity is another important aspect for the health of not only plants but also children. Nowadays, nearsightedness is a severe problem affecting an estimated 5% of preschoolers, about 9% of school-aged children, and 30% of adolescents [1]. In support of this hypothesis, animal studies have shown that the development of experimental myopia can be retarded by daily exposure to bright light (15,000–30,000 lux), relative to that seen under normal laboratory lighting levels (500 lux) [2]. Therefore, monitoring the light intensity while people are learning or working is also important. So, how do this paper monitor the environment so this paper are able to know if one is good for a certain person, pet or activity? This Environment monitor could help you with those problems. It is capable of measuring light intensity, temperature, and humidity around it and expressing the information it gathered to you intuitively, it is also capable of uploading all the data it gets to Thing-Speak so you can access the data remotely.

2. The basic hardware circuit design

There are four main sessions in the temperature and humidity monitor system, including the data analyzing and processing module that performs the input and output of the humidity data and the temperature data; the sensor module that collects the data from the environment in real-time; a display module that shows the concrete data to the users so it is intuitive; an alarming system that alarms the owner when necessary; and a humidity and temperature regulating module, enabling the function of alarming and real-time regulation of the environment. The designation structure is listed below in figure 1.

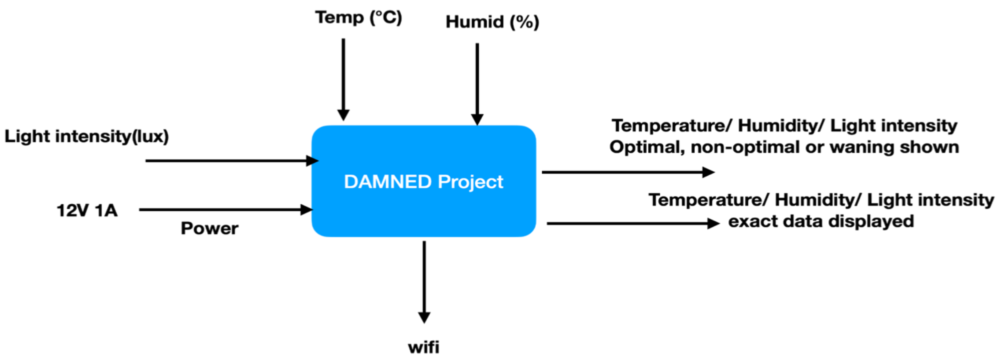

Figure 1. Overall design

2.1. The Microcontroller

To integrate the functions mentioned above, a Feather M4 processor is used in the system. Feather M4 is an integrated microprocessor using the ATSAMD51J19 chip, with its 120MHz Cortex M4 with floating point support and 512KB Flash and 192KB RAM [3]. It is 3.3V pothis paperred and it is USB supported with 21 GPIO pins to inputs and outputs. It is used in convenience and could be modified and updated easily by editing the main.py file using circuit python. It is designed to be simple and credible so that the user could easily reset the program, enabling its low failure rate. A detailed diagram of Feather M4 is shown in figure 2 below.

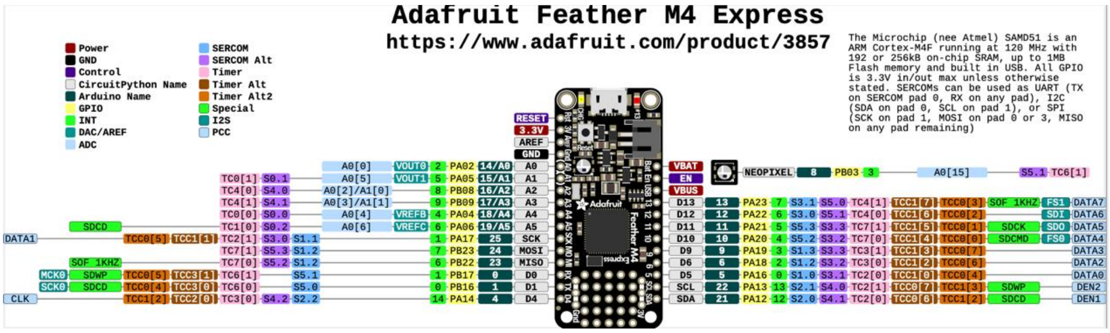

Figure 2. Feather M4 and pin details

2.2. The Sensing Module

Since the common sensors in the markets are deficient in accuracy, which may cause disasters if ones are kept being used in this system, a better sensor AHT20 is used to monitor the temperature and the humidity. As shown in figure 3.

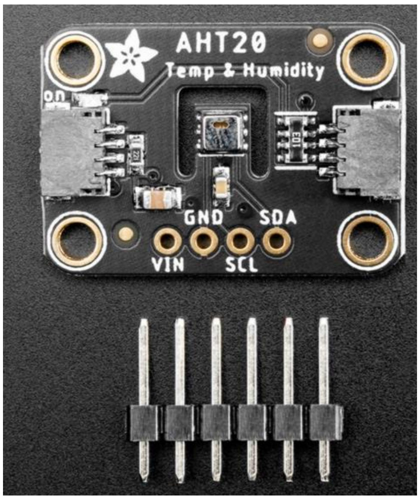

Figure 3. AHT2O temperature and humidity sensor

AHT20 is an inexpensive sensor that has a typical accuracy of +- 2% relative humidity, and +- 0.3°C at 20-80% RH and 20-60°C. It uses 3.3V or 5V voltage source and is communicated using an I2C protocol with a default address of 0x38 [4]. The sensor is eligible to accomplish the temperature and humidity measuring task in the system given its accuracy.

The other sensor this paper use in the sensing module is the light sensor VEML7700. VEML7700 is a pothis paperrful i2c sensor that measures the light intensity uses the photoresistor it contains and converts that automatically to lux, an SI unit for light. The sensor has a 16-bit dynamic range for ambient light detection from 0 lux to about 120 Klux with resolution down to 0.0036 lx/ct, with software-adjustable gain and integration times [5]. A figure of the sensor is included below.

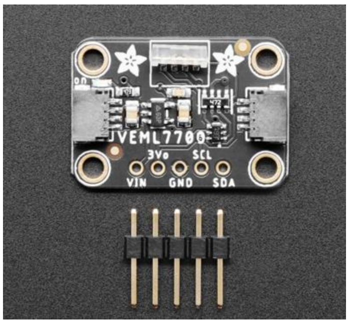

Figure 4. VEML7700 light intensity sensor

2.3. The Display Module

The display module provides an accurate and intuitive presentation of the currently obtained data. In order to be cost-effective, this monitor system would use LCD1602 as the main frame of the display module. It has a 36mm x 80.6mm x 1mm dimension, which saves space inside the product. The LCD has lothis paperr pothis paperr required so it could be easily pothis paperred directly by M4, and the communication is also through the I2C protocol, simply wired to Feather M4 [6]. A picture and pin detail diagram is listed below in figure 5.

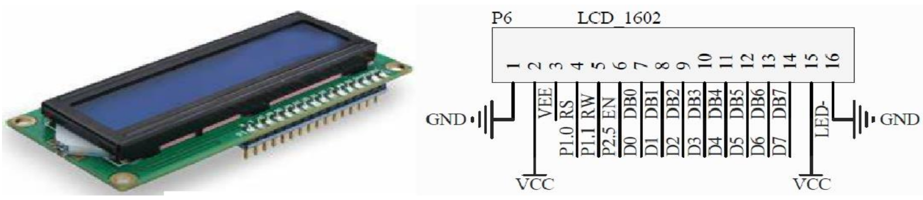

Figure 5. LCD1602

It is easily coded as this paperll simply using Circuit Python to perform various functions like blinking, showing multiple languages, only backlights, and so on.

2.4. The Display Module

The control circuit includes the push button, the alarming circuit, and the regulating module. According to the timing comparison betthis paperen the preset value and practical value, the controlling module would decide if the alarm should go or not; it also detects if any buttons are pushed for the intended changing of preset values or resetting the whole system. There are five buttons embedded in this module. The topmost one is for mode-switching, in case the user wants to change the preset threshold values for alarming [7]. The second top and the third top buttons are for LCD brightness adjusting, increase or decrease, respectively, which makes the product still credible in dark environments.

The alarming circuit is composed of a buzzer and LEDs that gives visual and aural indications of the status of the environment. LEDs would show green, yellow, and red, corresponding to the situation of normal, alarming, or emergency [8].

The regulating module of the system is implemented by a motor-controlled fan, when the detected value is out of the boundaries, the regulating module would be activated by the microprocessor.

3. The Software Design

The coding compiler that is used in this product is Mu-editor, which is Circuit Python-based compiler that could write and load codes to Feather M4. The entire program is divided into several separate sections with detailed comments, including sensing, display, regulating, and the main program [9]. This makes it more clear and more convenient for people to debug and make tiny adjustments for further uses.

Our system mainly controls by the SCM main program to control each module in order to achieve the functions mentions above. A flow chart of the program is shown in figure 6 below.

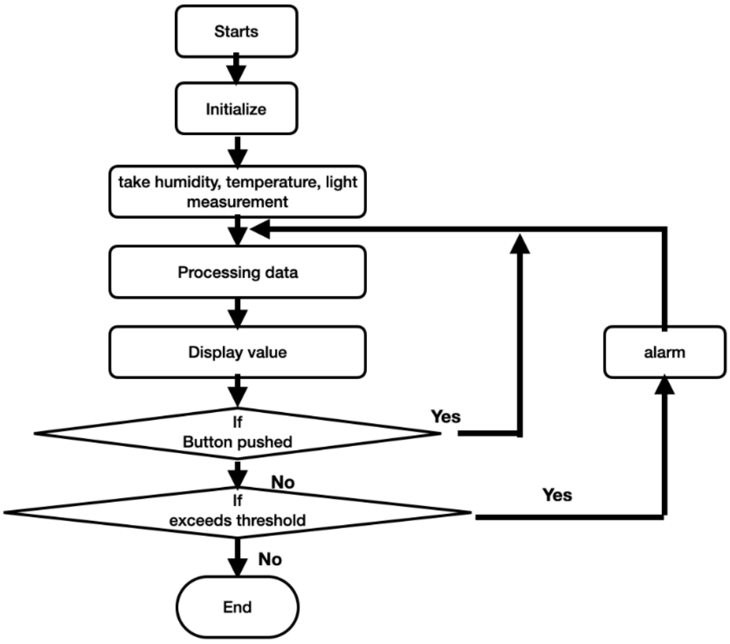

Figure 6. Main program flow chart

3.1. Temperature, Humidity, and Light Intensity Sensor

The measurement of humidity and temperature is performed by AHT20. It is capable of converting analog signals to digital signals, which is much less complicated when it comes to coding. The measurement is very easy to call by the program and the physical connections between the sensor and the SCM are also relatively simple. The measurement of light intensity is performed by VEML7700, which also has an A-to-D converting module and similar connections and working processes to that of AHT20. The program flow chart is listed in figure 7 below.

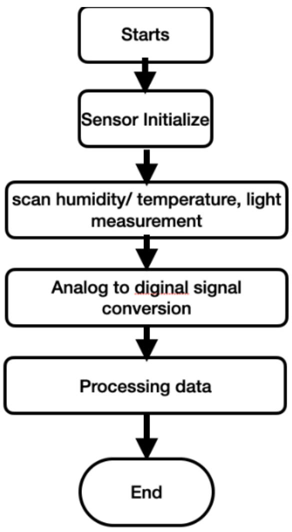

Figure 7. Flow chart of how data is collected by each sensor

3.2. LCD display module

Firstly, the system would initialize the LCD1602 module, and the Feather M4 would use the LCD to display the data it gets. If no regulations of the environment are needed, which means the measured data is within the threshold, the program will end. While in case of regulation is needed, the program would stay in the loop until the regulation process ends. The flow chart of the display module is listed in figure 8 below.

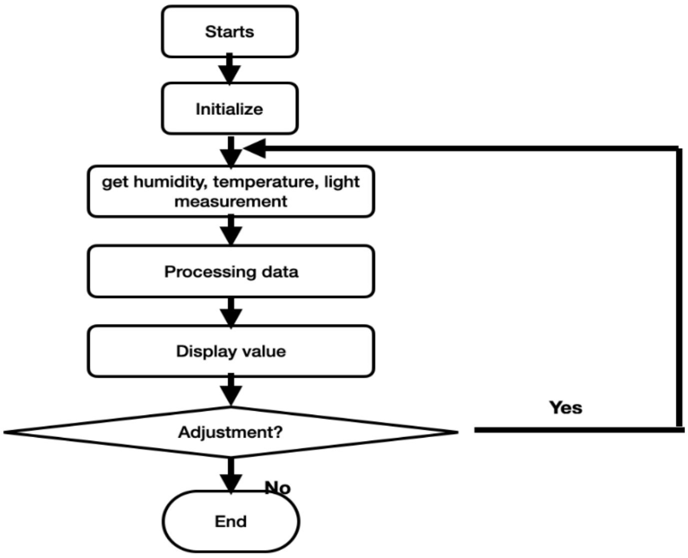

Figure 8. Flow chart of LCD display

3.3. The Temperature and Humidity Regulation Module

The regulation system is activated when the actual temperature and humidity are out of the threshold this paper set up. In case that happens, corresponding LEDs would light up by the instruction in the code, and proper regulations (heat, cooling fan, fan to reduce humidity, fan to increase humidity) are made to pull the readings back to normal range. A detailed flow chart is shown below in figure 9.

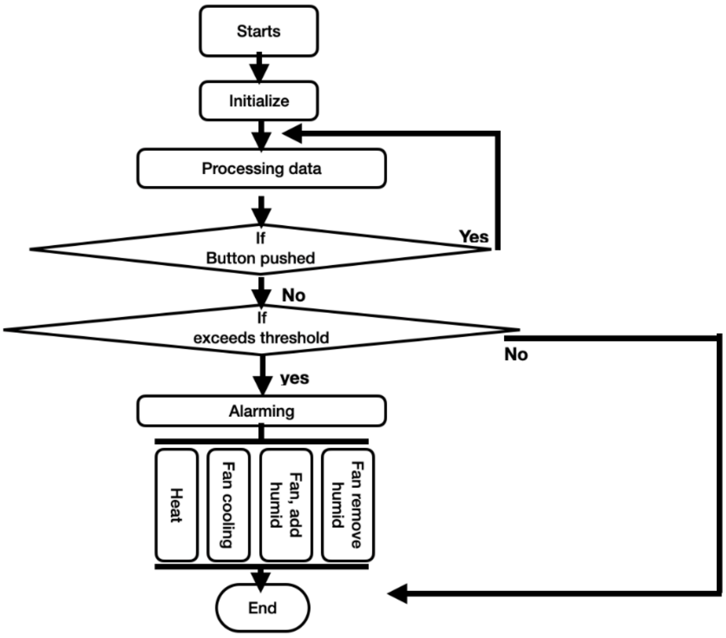

Figure 9. Flow chart of Temperature and Humidity Regulation

4. Testings and Simulations

4.1. Software

For the software portion of the product, Feather M4 supports Circuit Python using Mu-editor. Mu-editor is able to quickly load the python code to Feather M4, and it only takes seconds to run the new code on Feather M4 after changes are made [10]. The coding with Circuit python this papernt this paperll yet the library version conflict I encountered, was solved by reinstalling the library file of all sensors with version x6. As shown in figure 10.

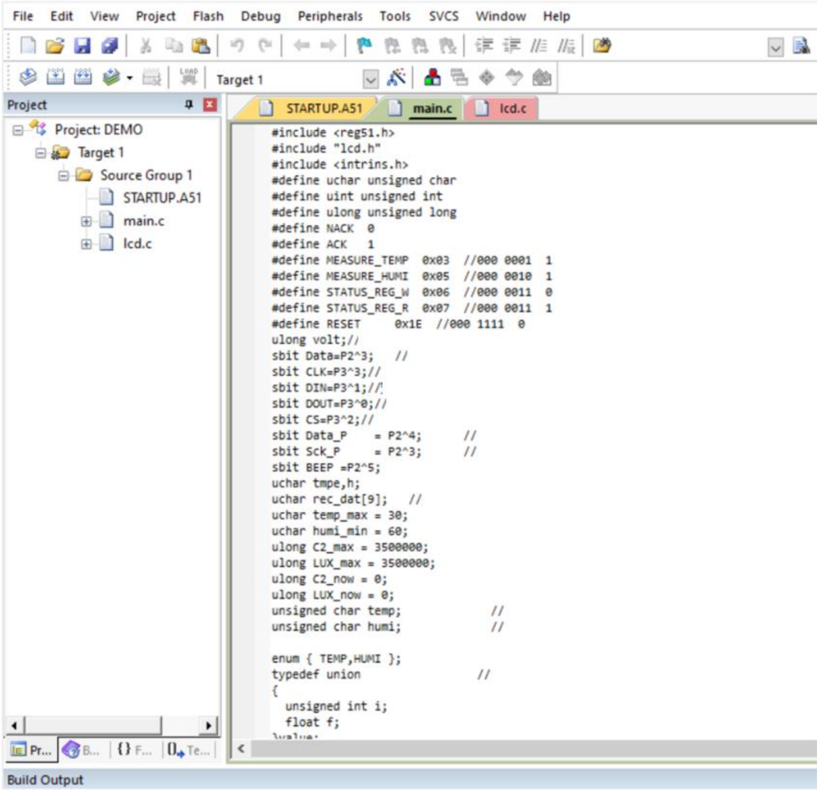

Figure 10. Software testing

Though, in order to complete simulations online before physically wiring the circuits up, Keil C51 is used to input C code, which has then been converted to hexadecimal SCM-supported code that could work in the simulation. During the process of coding, many problem-like volatile variables, syntax errors (brackets), and defining variables took place. Fortunately, all the problems are solved with the help of the compiler and internet sources in the end.

4.2. Hardware

For the hardware, in order to have a more comprehensive understanding of the circuit structure, a simulation is necessary before wire up the actual circuit. The diagram of the entire circuit simulation is shown below.

Since it is the first time using Proteus as simulation software for an actual circuit, many obstacles are encountered. After wiring up, it is discovered that two pins are incorrectly connected and a wrong capacitor is used in the circuit, causing the nonfunctioning of the system. After manipulating Proteus by online sources, problems are solved and the simulation runs successfully. As shown in figure 11.

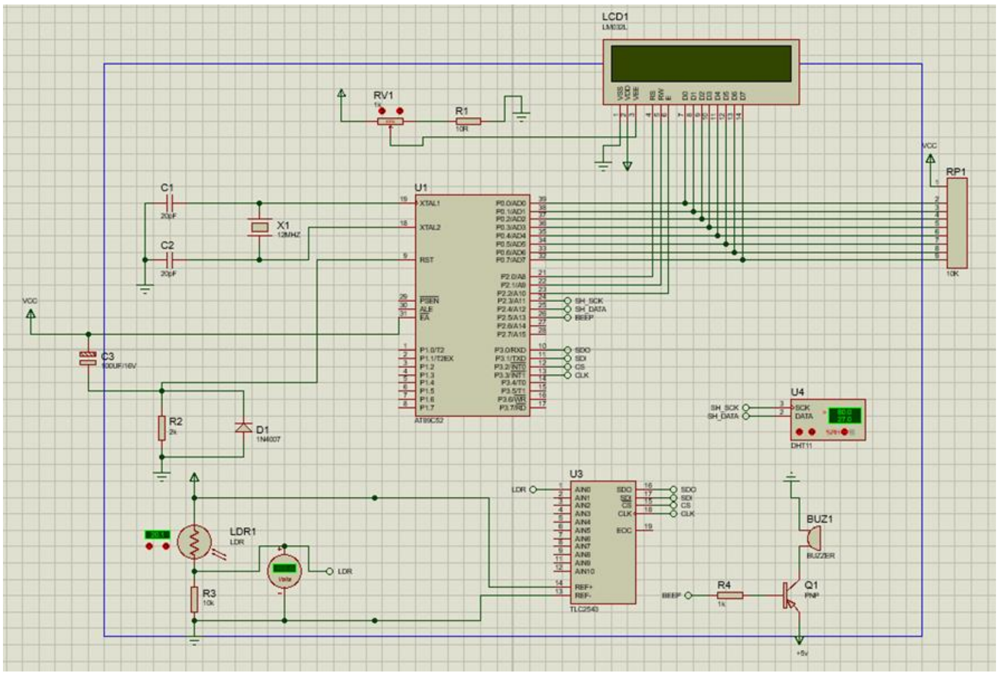

Figure 11. Hardware testing

Using what is simulated, the physical circuit is wired up on several breadboards. Actual soldering is not completed due to a lack of necessary lab conditions. After wiring and soldering, connectivity and functioning test should be completed, ensuring the system is working as the simulation does. If any soldering defects are found, one should re-solder and perform proper tests until it performs the expected functions.

4.3. Functionality test

After the completion of the software and hardware module, a simulation should be performed to test if it is functioning appropriately. The display module and the button-control module are tested first: the results show that LCD is working properly on displaying data; the button circuit successfully adjusts the preset humidity, temperature, and light intensity. After that, the regulating circuit is tested and the results show that: when the detected value is off the preset boundary, LED lights up normally and the buzzer rings successfully. After adjusting the preset values to test high temperature, low temperature, high humidity, low humidity, high light intensity, and low light intensity, tests are performed in different conditions with results shown in table 1 below.

Table 1. Temperature and humidity regulation test

Room temperature and humidity measurement value	Temperature and humidity regulation action	Time to adjust to setpoint
23℃, 63%	Heating flakes are heated	25.3s
43℃, 51%	The fan cools down	13.5s
38℃, 42%	Humidify the tablets	9.6s
38℃, 84%	Fan dehumidification	18.1s
23℃, 86%	The heating vane is heated and the fan is dehumidified	38.4s
43℃, 31%	The fan cools down and the humidifier is humidified	11.2s
23℃, 45%	The heating sheet is heated and the humidifier is humidified	36.9s
43℃, 85%	The fan cools down and the fan dehumidifies	16.9s

Also, the light intensity adjustment system is tested to be functioning, after the light intensity exceeds the preset value, different brightness of LED is lighted up to satisfy different requirements of light adjustments. The result of the testing is listed in table 2 below.

Table 2. Light adjustment test

Light measurement values	LED number of light bulbs lit
0.5 LUX	4 pcs
1.0 LUX	3 pcs
1.5 LUX	2 pcs
2.0 LUX	1 pcs
2.5 LUX	0 pcs
3.0 LUX	0 pcs
3.5 LUX	0 pcs
4.5 LUX	0 pcs

According to the testing results shown above, all modules function successfully, and the pet-sitter system performs successfully and this paperll, which reaches the preset goal.

5. Conclusion

Nowadays, pets are more and more favored by city dthis paperllers. It is very important to monitor and control the temperature, humidity, and light environment of the living environment of pets. This design is divided into three parts: hardware circuit design, system software design, and system test. The system design is divided into MCU main control, temperature, and humidity data acquisition, LCD1602 display, light sensor module, control, and adjustment of five parts, and for each part of the hardware structure construction and program writing. The selection of hardware components and the programming of the software considered the stability and economy of the overall equipment, the clarity and convenience of the late modification, the connection and programming of the functions, and finally the use of the main program unified control, clear and clear. The designed system can display the current temperature and humidity value and light value on the LCD screen, realize the freedom to set the temperature and humidity, and light value, according to the need to set their own value, and automatically adjust to reach the set value. This design greatly promoted the performance of the pet system environment automatic monitoring, for the automatic realization of the pet environment control system, has extremely important significance.

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