Microprocessors-Microcontrollers

LAB 5: A SMART LOW-TEMPERATURE FOOD DEHYDRATION SYSTEM

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1 Introduction

The dry food can be preserved for a longer duration and is less susceptible to spoilage caused by the growth of bacteria, molds, and insects. One of the most common techniques for the dry food is the use of Low Temperature Dehydration (LTD). LTD is a process of reducing moisture of food to low level in low temperature environments. The dry food using LTD can improve palatability, digestibility, color, flavor and appearance. In the industry, many machines that embed the LTD technique for food preservation.
In this research, we target to build a SMART LTD System that supports centralized and real-time monitoring for multiple LTD machines, high reliability, high availability and scalability as well as affordability for Vietnamese users. Figure 1 shows an overview of a typical architecture of a SMART LTD system. It includes LTD controllers, a centralized web server and a cell-phone app. The LTD controller controls the LTD machine based on the temperature and humidity inside and outside of the dry room.

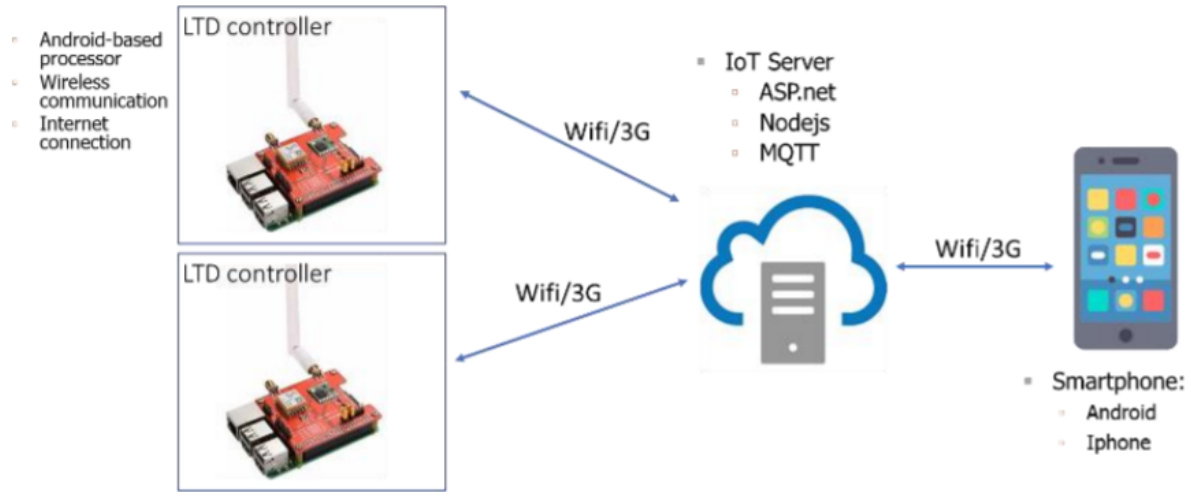


Figure 1: A typical architecture of a SMART LTD system

2 LTD System

At the beginning, the heater will be turned on to warm the dry room. When the temperature inside the dry room reaches a user-defined maximum temperature value, the heater will be stopped. When the heater is on, the fan2 will be on as well to make the temperature of the air be evenly distributed in the dry room. If the humidity inside the dry room is greater than a user-defined maximum humidity, the fan1 will be turned on to transfer the humidity air from the dry room to the outside. We can control the speed of the fan1. For example, when the humidity is about 90 or more, the fan1 will run in full speed. When 80, the fan will run at 80 of the full speed and so on. When the heat pump is on, the fan 3 is also on to help the heat pump work better. Please note that when the heater is on, the heat pump is off and vice versa. The user can set the timer so that the

Figure 1: LTD System

heater and heat pump can be turned on periodically. The controller should add time out for each operation.The controller should have at least three humidity sensors and three temperature sensors for reliability operations

2.1 Heater

At the beginning, the heater will be turned on to warm the dry room. When the temperature inside the dry room reaches a user-defined maximum temperature value, the heater will be stopped. When the heater is on, the fan2 will be on as well to make the temperature of the air be evenly distributed in the dry room

Figure 2: heater

Order	Name	Parameter	Amount	Price
1	Heat storm Pheonix HS-1500	• Installation: Floor-standing, • HangingPower: 0-1500W • Voltage: 220V • size: 18.75 x 4.5 x 12.75 inches • weight: 7kg	1	95.67$
Link	https://www.amazon.com/Heat-Storm-HS-1500-PHX-Attachable-Efficient-750-1500			

Figure 3: Config

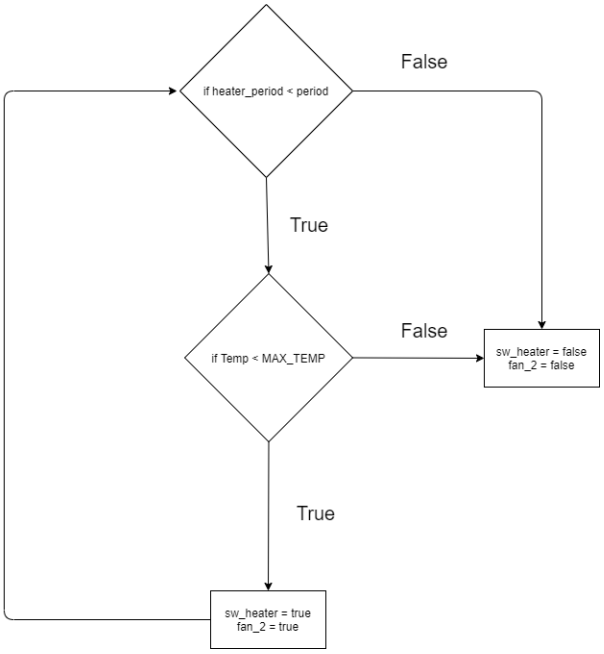


Figure 4: Implement

2.2 Fan

- Fan 1 turn on to distribute the air with high percentage of humidity out of the system and we can control fan 1 speed:
  - when lower 70 percent of humidity then fan 1 won't work.
  - when higher than 70 percent of humidity then the fan run at speed proportional with humidity mean the higher percentage of humidity the faster the fan run
- When the heater is on, the fan2 will be on as well to make the temperature of the air be evenly distributed in the dry room.

- When the heat pump is on, the fan 3 is also on to help the heat pump work better.

Figure 5: fan

Order	Name	Parameter	Amount	Price
1	Portable Ventilation Fan	• Installation: Floor-standing, • Voltage: 220V • size: 710 x 710 x 870 mm • weight: 8kg	1	32.99$
Link	https://www.sdwerwer.xyz/ProductDetail.aspx?iid=64562103&pr=32.99			

Figure 6: Config

2.3 Heat Pump

When the heat pump is on, the fan 3 is also on to help the heat pump work better. Please note that when the heater is on, the heat pump is off and vice versa. The user can set the timer so that the heater and heat pump can be turned on periodically.

Figure 7: heat pump

Order	Name	Parameter	Amount	Price
1	Heat pump MIMICO	• Installation: Floor-standing, • HangingPower: 0-1500W • Voltage: 380V • size: 710 x 710 x 870 mm • weight: 100kg	1	243.67$
Link	http://mimico.com.vn/heatpump-giai-nhiet-gio-nhiet-do-thap			

Figure 8: Config

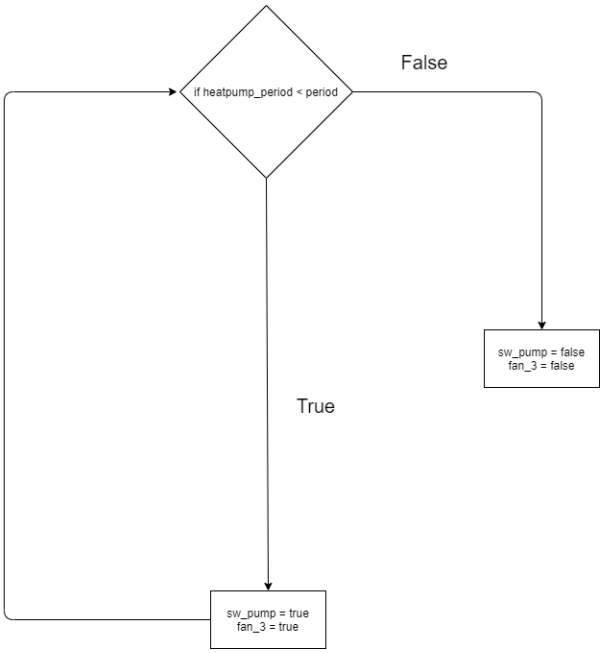
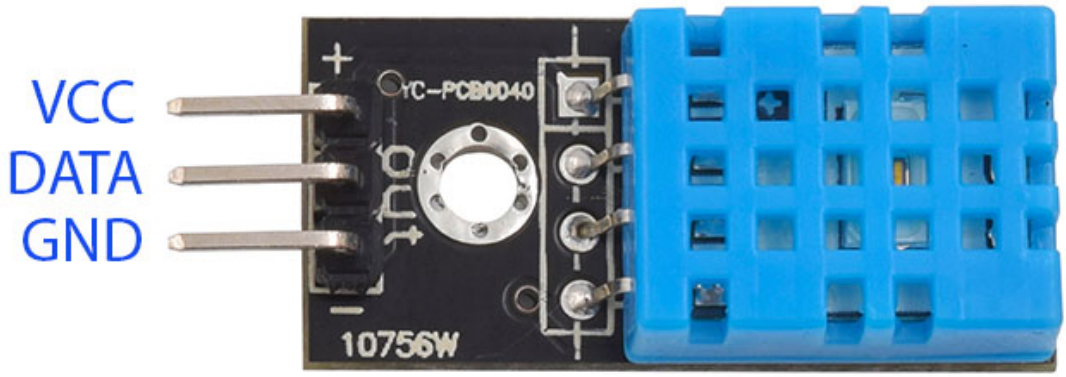
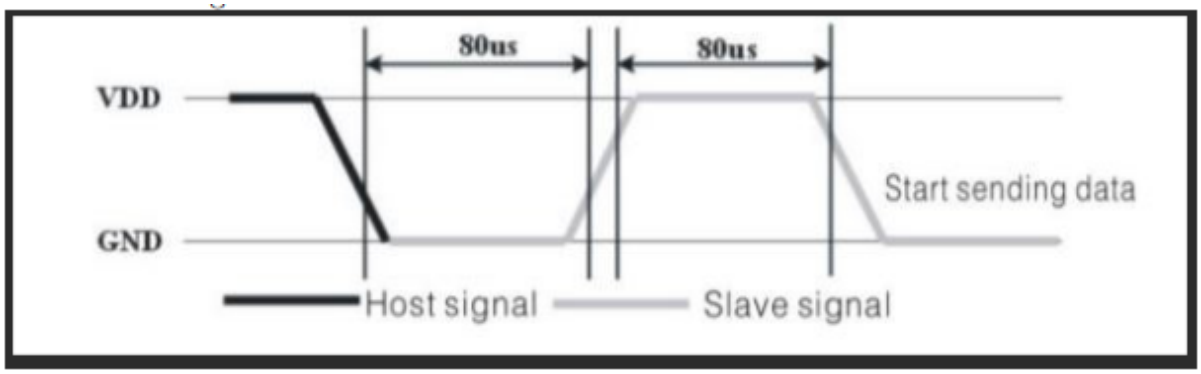


Figure 9: Implement

3 DHT11

The DHT11 is a basic, ultra low-cost digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air, and spits out a digital signal on the data pin (no analog input pins needed). Its fairly simple to use, but requires careful timing to grab data.





As you can see above, in order to initialize the sensor, we have to first pull the data line LOW for around 18 ms. After this DHT11 will pull the line LOW for 80 us and than HIGH for 80 us. Once this is done, the sensor will be initialized and start transmitting To initialize the sensor, the steps are as follows:

1.Set the pin (data) as output

2.Pull the pin low for 18ms

3.Release the pin by setting it as input

Response

In order to indicate it's presence, after receiving the start signal, DHT11 will send a

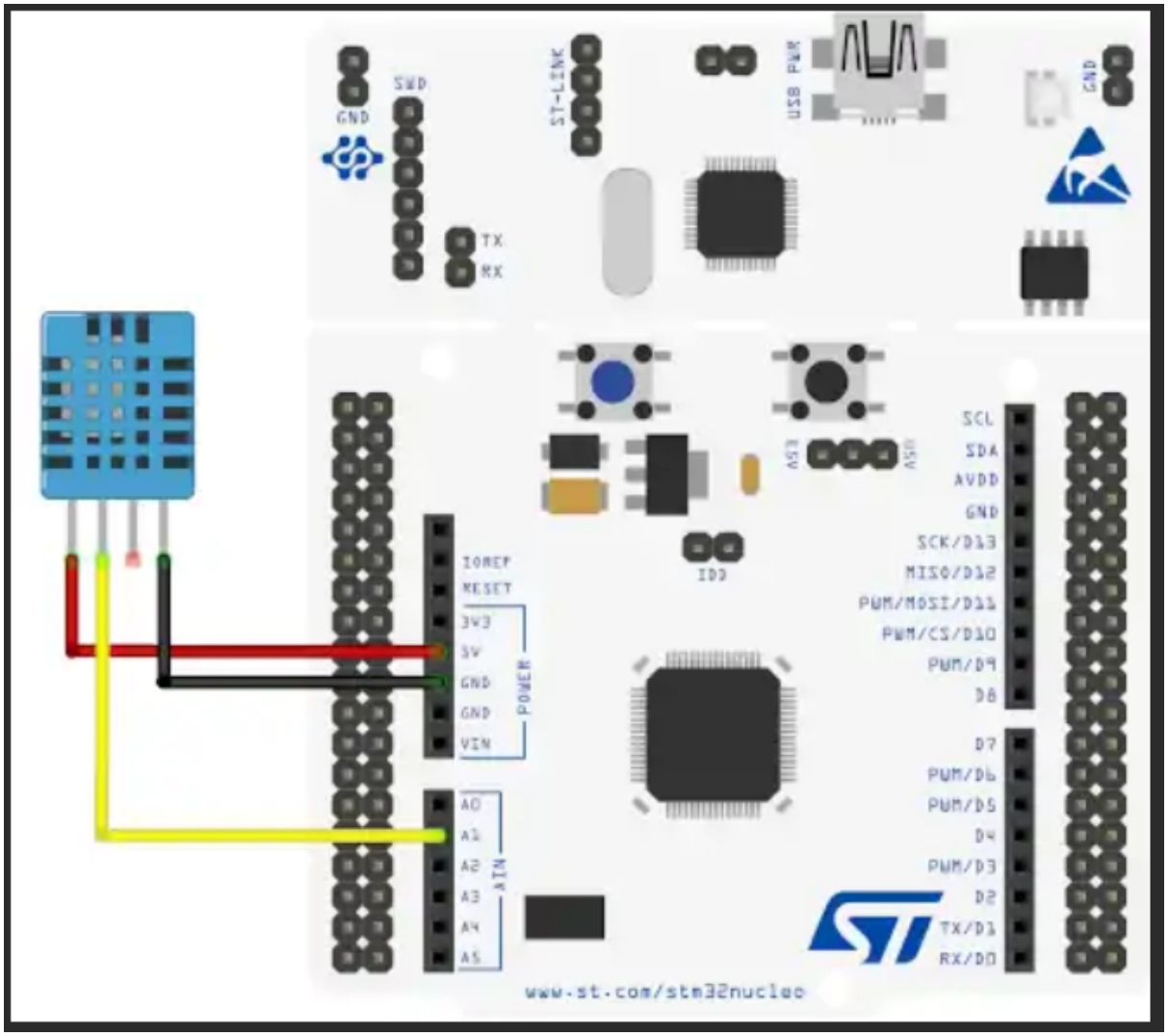


Figure 10: INITIALIZATION

Figure 11: DHT11 Host signal - DHT11 Slave signal

response signal. To do so, it will pull the data line low for 80 us, and than high for another 80 us. To read this response, we will do the following:

-Wait for 40 us

-Read the pin, it must be low at this point

-Wait for 80 us

-Read the pin, this time it should be HIGH

If the above conditions are satisfied, that means the sensor is present, and we can proceed with reading the data.

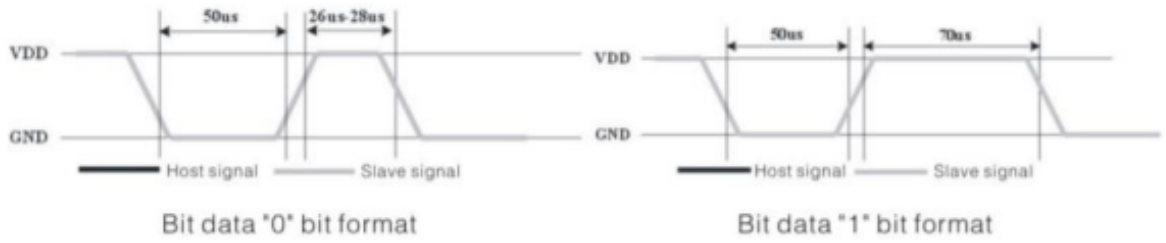


Figure 12: DATA Transmission

Now DHT11 will send 40 bits of data. Each bit's transmission begins with low-voltage-level that last 50 us, the following high-voltage-level signal's length decides whether the bit is "1" or "0".

If the length of high-voltage-level is around 26-28 us, the bit is "0"

And if the length is around 70 us, than the bit is "1"
The 40 bits sent by DHT11 are as follows DATA = 8 bit integral RH data + 8 bit decimal RH data + 8 bit integral T data+8 bit decimal T data + 8 bit checksum If the data transmission is right, check-sum should be the last 8 bit of "8 bit integral RH data+8 bit decimal RH data+8 bit integral T data+8 bit decimal T data".

Following are the steps to READ DATA from the sensor

-Wait for the pin to go high

-Wait for 40us. This is because the length of "0" bit is 26-28us, and if the pin is high after 40us, it indicates that the bit is "1"

-Write the respective values to the variable

4 Result

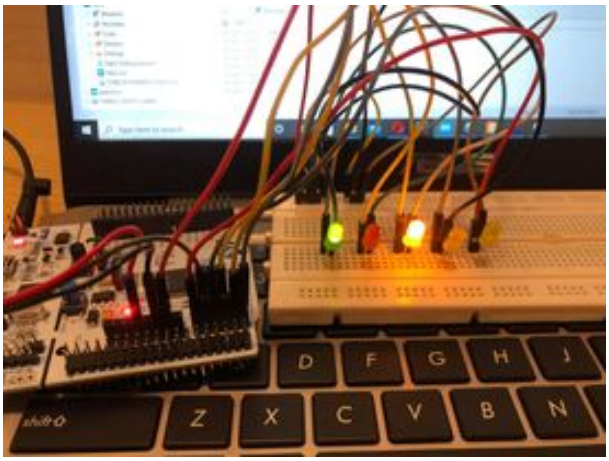


Figure 13: heater and fan 2 on pump and fan 3 off

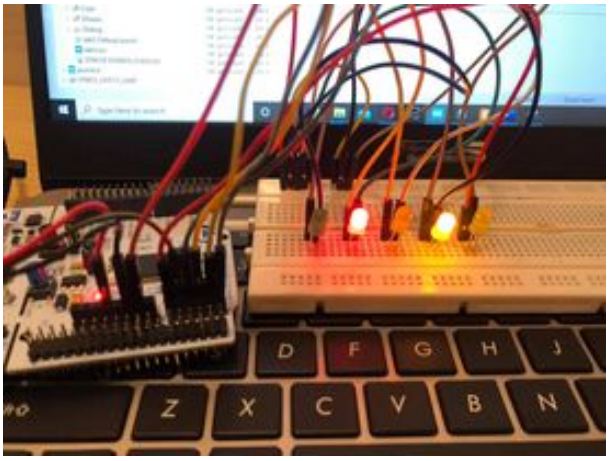


Figure 14: heater and fan 2 off pump and fan 3 on

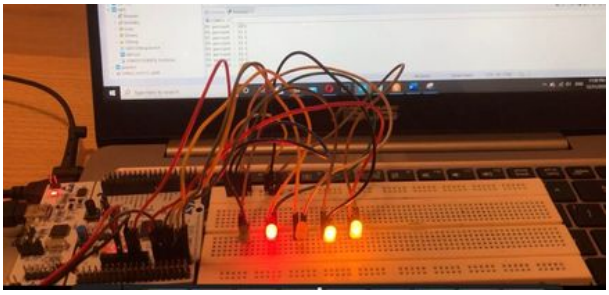


Figure 15: fan 1 on