A Proposal of
Low Temperature Dehydration

(LTD)

MICROPROCESSOR-MICROCONTROLER

Ngo Qui Thu - 1652595

Contents

December 2, 2019

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 [1]. In the industry, many machines that embed the LTD technique for food preservation. Most of these machines are imported, stand-alone, locally controlled and expensive [2][3]. These machines mainly operate continuously or periodically or fixed conditions. It leads to wasting energy, decreasing the machine life expectancy, increasing labor cost. Most importantly, it does not save the sensor data that can be used to improve the system for the next operation.

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. It sends temperature and humidity information to the IoT server in real time via Wifi/3G connectivity. The IoT server saves the data to the database for the future use and send them to the user app. The user app that can run on an Android or iOS cellphone, is used to check the status of the current operation of the LTD machines and to send new commands for any LTD controller.

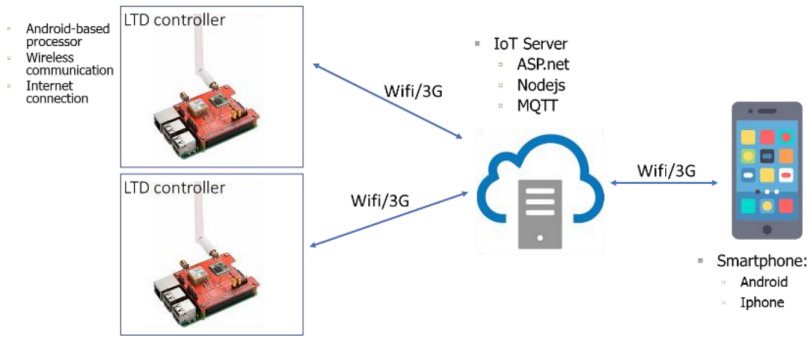

Figure 1: A typical architecture of a SMART LTD system

An individual LTD machine normally includes three fans, a heater, a heat-pump/dehydration machine and an LTD controller. The LTD controller can sense the temperature and humidity inside and outside the dry room as well as can control fans, the heater and heat-pump/dehydration machine adaptively. Moreover, the LTD controller can also obtain commands from the user app to operate appropriately.

Since the operations of the SMART LTD system based on temperature and humidity sensor located inside the dry room, it becomes a single point of failure in this system. We use a triple redundancy technique that uses three sensors connected to three pins of a processor in order to

improve the system reliability. This system still operates if one sensor fails. The failed sensor is notified to the system admin so that it will be replaced as soon as possible without interrupting the LTD machine operation.

With the support of the SMART LTD system, we believe we can improve productivity, save energy and help Vietnamese farmers preserving their food effectively resulting in improving agricultural product values.

2 LTD System

2.1 Features

- Automatically detect temperature and humidity inside the machine.

Description: Using 3 or multiple of 3 sensors (depend on size of the machine) to detect the temperature and humidity inside the machine, building base on PID system.

- Ultraviolet light treatment for fresh produce.

Description: UV light is using to delay and sanitize microbial growth on the fresh-cut produce surface without altering its quality has been demonstrated. Fresh produce will be treated to remove microbial spoilage before drying.

- Multiple mode: Auto drying, manual drying.

Description:

• The controller for auto drying system operates as:

1. At the beginning, if the target is fresh produce, using UV light to clean fist, open UV light for a time.

2. 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.

3. 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.

4. 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

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

6. Please note that when the heater is on, the heat pump is off and vice versa.

7.The user can set the timer so that the heater and heat pump can be turned on periodically.

8. The controller should add time out for each operation.

9. Time for drying is based on the original user's setting.

• Manual drying:

1. Select auto mode or not before dry, if not using auto mode, select all options: time, limited temperature, kind of products.

2. Base on limited temperature and time, adjust the speed of fans, heater and pump heat.

3. There are 3 Led on the machine surface to determine the state of the machine at current time: Working, Warming and Error.

2.2 Components

Types	Name	Predicted price ($)
Temperature & Humidity sensors	- Temperature: + DHT22: -40 ~80 celsius, accuracy 0.5 celsius + TMP117: -55 - 150 celsius, accuracy 0.3 celsius - Humidity: + DHT22: 0~100%, accuracy 2% + HIH-4030: 0~100% accuracy 3%	Min: 6 Max: 18
Current sensor	MCR family : -150A-150A	Min: 1.5 Max: 4.5 (mouser)
UV Light	N/A	~10
Internet Access Module	- SIM8320E: 2G, 3G, A-GPS - SIM7600E-H: 2G/3G/4G - SIM7000: 2G, 3G, GPS	50 30 70

2.3 LTD Controller

We will use a simple FSM to display how the machine works:

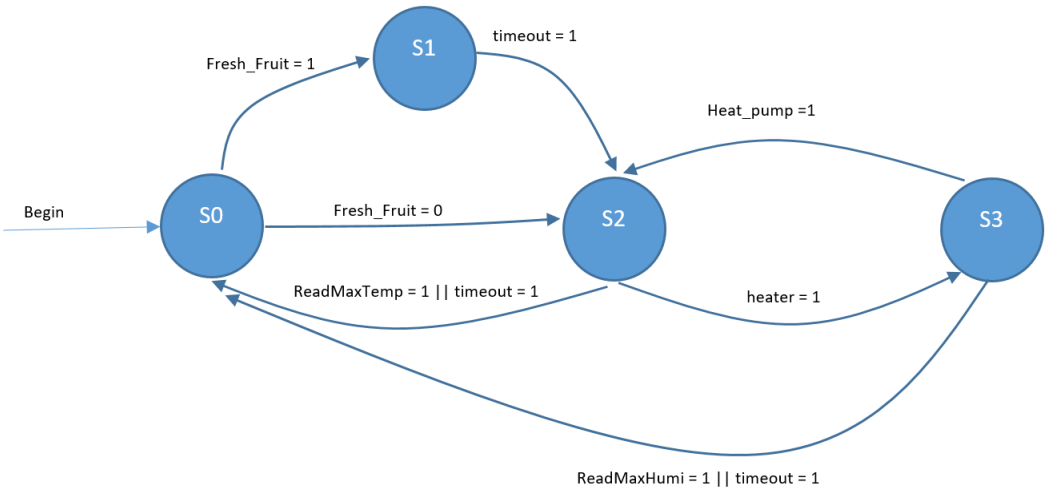

Figure 2: Finite State Machine for LTD systemt

Description:

S0: Select feature and initial define.

S1: UV light system works to clean the products.

S2: Heater on, heat pump off, fan2 on.

S3: Heat pump on, heater off, fan3 on.

Variables:

Fresh_fruit: Define the product is fresh or not.

timeout: Determine the state is time over or not.

heater, Heat_pump: Define current state of heater and heat pump respectively.

ReadMaxTemp, ReadMaxHumi: The temperature and humidity inside the machine is over the limitation.

2.4 Methology

1. PID controller

PID controller normally applies for feedback system. On this project, we use this to read humidity, temperature and current flow of the machine, devided into 3 steps:

1. Measuring data of each sensor.
2. Build a algorithm to compare data.
3. Make conclusion.

2. Tracking components

The main reason for tracking components that to define that ones are working well or not, we will base on 3 method:

1. Using current sensor to make sure that electrical devices working (exist current if it is working).

2. Data analysis, over the time. Get data of every sensor at a period of time to watch the change, this will help to define the broken ones.

3. Timeout case and comparison. Each state of FSM will consist a timeout case, that mean the state is error, we need to check the component of that state.

2.5 Flow Chart

To describe more clearly that how the machine work, we also draw a flow chart to determine the principle of the machine:

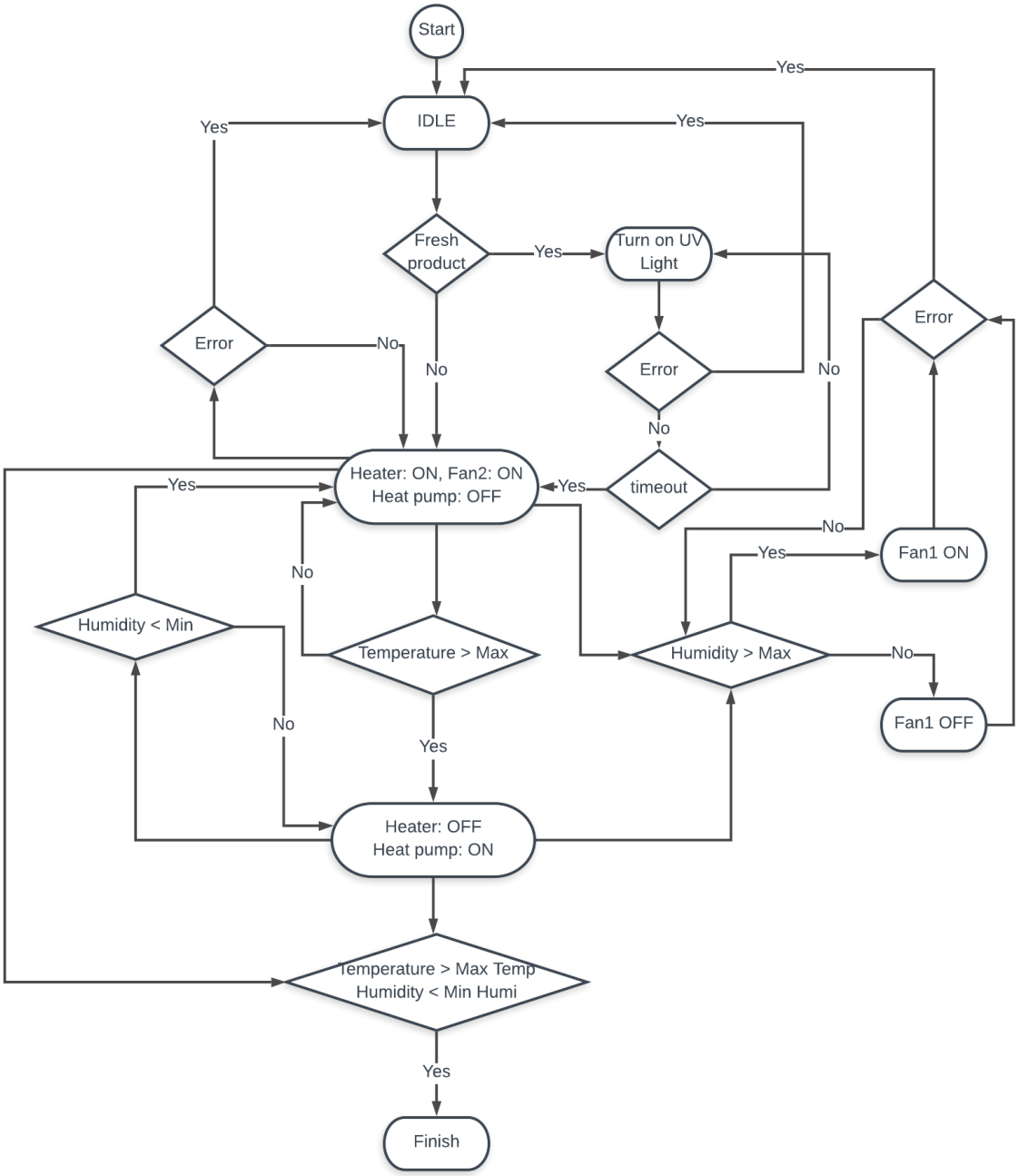

Figure 3: LTD system Flow chart

Demo version of simplest case: **https://github.com/quithu165/LTDSystem.git**

References

[1] Nguyen, Nguyen Tran Huu. "A SMART LOW-TEMPERATURE FOOD DEHYDRATION SYSTEM", Microprocessor-Microcontroller laboratory requirement. Ho Chi Minh City University of Technology.

[2] Raponi, Flavio, et al,. "Monitoring and optimization of the process of drying fruits and vegetables using computer vision: a review." Sustainability 9, no. 11 (2017): 2009.

[3] IKE, Food Drying Machine. Products overview of IKE. Received from: https://www.ike.cn/food-dehydrator?gclid=Cj0KCQjwyLDpBRCxARIsAEENsrK_htCWl-ZA-RiykGxbWBvy9AJZ4qFIe_FKwnWwEGXQ2Zog05JTzcwaAmA9EALw_wcB

[4] Industrial Food Drying Machine. Received from: https://www.food-drying-machine.com/