Project Deliverable G:
Prototype 2 and Costumer Feedback

Submitted by

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Abstract

This report documents the second prototype based on customer feedback, where the team plan is outlined, the feedback is given by the client and how it will be used to improve our solution. Included in this report is of a prototype that has a small, targeted objective with specific test plan and measurable rules. This prototype includes source codes and detailed images explaining its function. Additionally, we have included an analysis of critical components that must be included. Furthermore, as a form of testing, calculation was implemented using concepts such as digital waveform. Moreover, feedback was gathered from potential users/clients to further improved our prototype. Finally, we created a test prototyping plan for prototype 3 based on the feedback gathered.

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1 Introduction

A control system is essential for making the whole project automatically react to the change of temperature, we designed a prototype of the conceptual design proposed. This prototype including mostly software function. In addition, it can receive the data input from the sensor. After multiple re-iterations, our design of the prototype was built through the given instruction where it was broken down and used to improve our initial design. After building the prototype, the feedback is taken in consideration again to further refine the plan for the third prototype.

2 Customer Feedback from Prototype 1

Team Pandora met with the client on March 11, 2022, to present prototype 1 and the results of our critical analysis. Prototype 1 is composed of our piping network and HEC. For this prototype, we determined that:

Deflection Test:

- That the lid of the HEC will not fail when exposed to vertical ground pressures.
- The base of the HEC will not fail under the weight of the HEC and the contents inside of it.

Heat Transfer Analysis:

- The HEC can maintain a stable air temperature before the air enters the piping network.
- The piping network can increase the air temperature from the HEC to achieve temperatures over 20°C.

The client was receptive of our design and gave a general comment that was not specific to prototype 1; they noticed that we added a compressor to our design and asked if it could be removed. We are in agreeance and will remove the compressor from future designs. The compressor was added in our second iteration of design because we wanted to use it as a backup in case our low-tech system was not able to reach desired temperatures, however after completing our heat transfer analysis, we determined that the compressor was not necessary and should be removed. After considering our response, the client stated that our design is interesting, and they look forward to our future work.

3 Prototype 2: Description and Test Plan

The purpose of prototype 2 is to determine if our control system for HEC will enable the automation of temperature control. In this prototype, we are testing and analysing the function of the control program. The results will determine if we the program meet the expected performance. Once our proof of concept is complete, we will obtain additional feedback so that the system may be further improved in future prototypes. The building and testing process took a duration of 2 days from March 11-12.

Table 1. Prototype 2 Test Plan

Test ID	Test Objective (Why)	Description of Prototype used and of Basic Test Method (What)	Description of Results to be Recorded and how these results will be used (How)	Estimated Test duration and planned start date (When)
1	To ensure that the program react properly under different temperature input	One of the most important features of our project is the control to the fan when the temperature changes, it must be ensured that the output is correct under different circumstances.	It will be run on VS code for testing, based on the test result we will improve the function for the final prototype.	2 days March 11-12
2	To ensure that the entire program loops automatically.	To make sure that the temperature can adjust automatically even without the manual input, a loop must be added to the program.	The function will be converted into a logic circuit and will be tested through a digital waveform diagram.	2 days March 11-12

4 Analysis of Critical Components

4.1 Control System

Below is the completed code of temperature control program within a time loop. The program will be designed to open the file where the temperature sensor stores its data and read it for input, but for testing purpose, here in the screenshot below the program introduce two input option where we type in a number for temperature and another for desired temperature setting. The program will react based on these 2 inputs and give output as the command of the fan. And the loop makes this function run automatically once every 4 second, to check if the room temperature has exceeded or below the desired temperature.

Figure 1. Source Code for Fan Controller (Part 1)

```
import time
import board
from adafruit_emc2101 import EMC2101

i2c = board.I2C()  # uses board.SCL and board.SDA
emc = EMC2101(i2c)
settemp=input("set the desired temperature")
temperature=input("received temperature from sensor")
con1=settemp+0.5
con2=settemp+1
con3=settemp+1.5
con4=settemp+2
Fan=true
    while True:
        if temperature>con4
        print("fan is off")
        mc.manual_fan_speed = 0
        time.sleep(1.5)
        print("Fan speed", emc.fan_speed)
        time.sleep(1)

        if temperature>con3
        print("Setting fan speed to 25%")
        emc.manual_fan_speed = 25
        time.sleep(2)
        print("Fan speed", emc.fan_speed)
        time.sleep(1)

        if temperature>con2
        print("Setting fan speed to 50%")
        emc.manual_fan_speed = 50
        time.sleep(1.5)
        print("Fan speed", emc.fan_speed)
        time.sleep(1)

```

Figure 2. Source Code for Fan Controller (Part 2)

```
        if temperature>con1
        print("Setting fan speed to 75%")
        emc.manual_fan_speed = 75
        time.sleep(1.5)
        print("Fan speed", emc.fan_speed)
        time.sleep(1)

        if temperature<settemp
        print("Setting fan speed to 100%")
        emc.manual_fan_speed = 100
        time.sleep(1.5)
        print("Fan speed", emc.fan_speed)
        time.sleep(1)

        print("External temperature:", emc.external_temperature, "C")
        print("Internal temperature:", emc.internal_temperature, "C")

        print("")
        time.sleep(0.5)
```

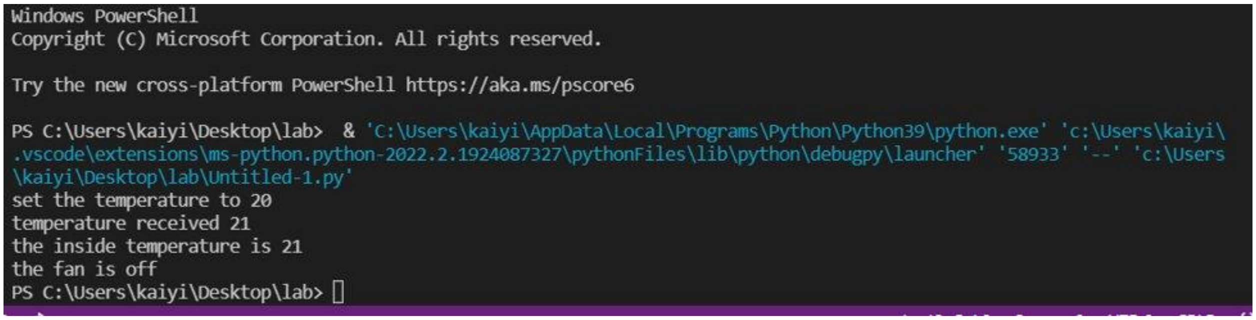
4.2 Control System Testing

1. To test if the pressure control function works, we created a simplified version of our actual program, and we run the program in VS code and the output results are as expected.

Figure 3. Source Code for Testing Purposes Only

```
temp=input("temperature recevied")
set=input("set the temperature to")
fan=True
if temp>set:
    print(fan is turned off)
    fan=False
if temp<set:
    print(fan is turned on)
```

Figure 4. Test Result when temperature is above desired temperature

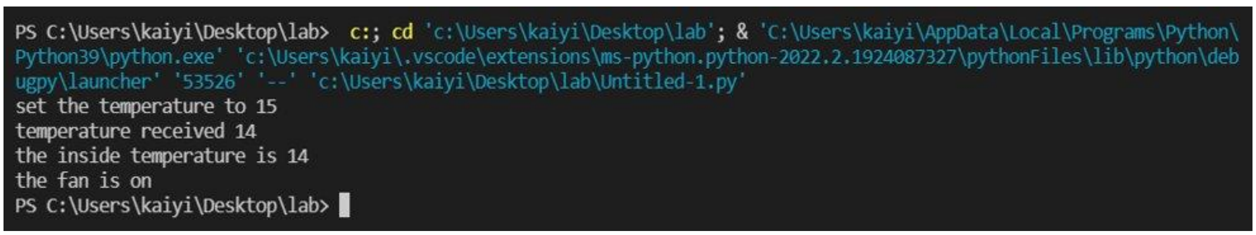


```
Windows PowerShell
Copyright (C) Microsoft Corporation. All rights reserved.

Try the new cross-platform PowerShell https://aka.ms/pscore6

PS C:\Users\kaiyi\Desktop\lab>  & 'C:\Users\kaiyi\AppData\Local\Programs\Python\Python39\python.exe' 'c:\Users\kaiyi\.vscode\extensions\ms-python.python-2022.2.1924087327\pythonFiles\lib\python\debugpy\launcher' '58933' '--' 'c:\Users\kaiyi\Desktop\lab\Untitled-1.py'
set the temperature to 20
temperature received 21
the inside temperature is 21
the fan is off
PS C:\Users\kaiyi\Desktop\lab>
```

Figure 5. Test Result when temperature is below desired temperature



```
PS C:\Users\kaiyi\Desktop\lab>  c:; cd 'c:\Users\kaiyi\Desktop\lab'; & 'C:\Users\kaiyi\AppData\Local\Programs\Python\Python39\python.exe' 'c:\Users\kaiyi\.vscode\extensions\ms-python.python-2022.2.1924087327\pythonFiles\lib\python\debugpy\launcher' '53526' '--' 'c:\Users\kaiyi\Desktop\lab\Untitled-1.py'
set the temperature to 15
temperature received 14
the inside temperature is 14
the fan is on
PS C:\Users\kaiyi\Desktop\lab>
```

2. To test the automation of the program, based on its input output characteristic, we drew a logic circuit to present the system, and the expected output result is validated through the waveform diagram.

Figure 6. Equivalent Logic Circuit of the Fan Control System

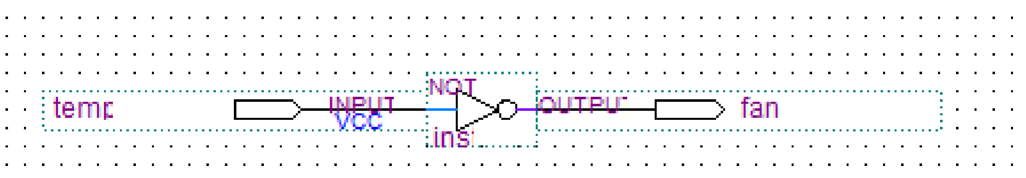
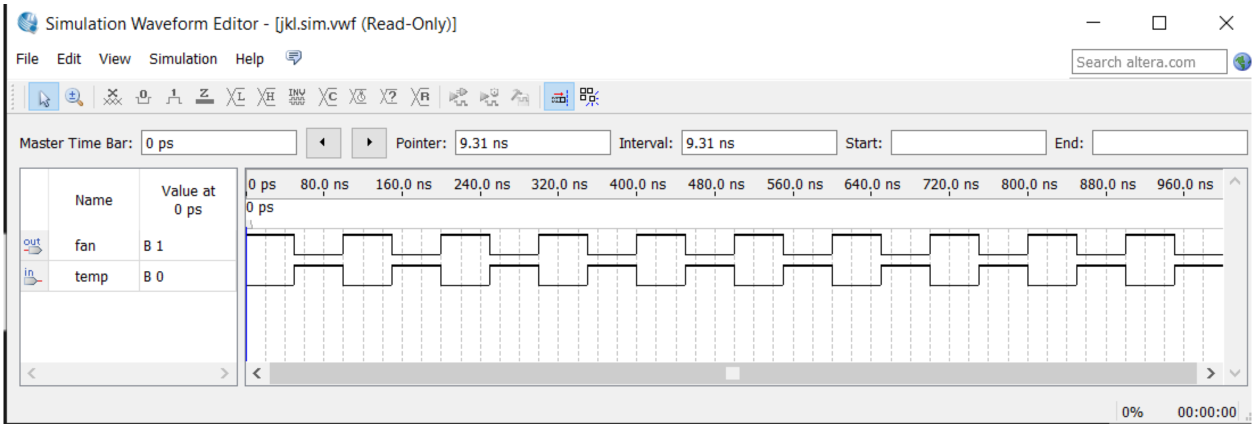


Figure 7. Waveform Testing Result of the Logic Circuit



5 Prototype 2 Feedback

Our design for prototype 2 is a combination of physical and simulated components; our piping network and HEC control system (Arduino, temperature sensors and pressure sensors). We received feedback from our program manager, who noted that our final prototype must be completely functional with no simulated parts. They stated that a functional system is impressive and appealing, so our plan for prototype 3 is to complete and test our physical build so that it is ready for Design Day.

6 Prototype 3 Test Plan: Control System

Table 2. Prototype 3 Test Plan

Test ID	Test Objective (Why)	Description of Prototype used and of Basic Test Method (What)	Description of Results to be Recorded and how these results will be used (How)	Estimated Test duration and planned start date (When)
1	Final Temperature Testing	Test entire physical system to determine the final temperature output of the prototype. This will be done by putting the air inlet pipe outside (by opening a window) and taking the outlet temperature	The temperatures throughout the system will be measured using a thermometer while the final temperature outlet that feeds into the control system will be measured with a temperature sensor connected to an Arduino	March 17-20

		measurement inside a building.	(our control system). The results will be used to determine how effective our final design is and if we have met client needs.	
2	Final Control System Testing	Test the control system with an Arduino connected to the temperature sensor and fan from the physical prototype. To see if the control system reacts appropriately to a fluctuation in temperature, a hair dryer on different settings (hot/cold) will be used to blow air into the system while we monitor fan settings and the temperature output of the system.	The temperature output should remain the same as the desired temperature input despite any fluctuations in temperature. An increase/decrease in temperature will determine if we built and programmed our control system correctly.	March 24-27

7 Conclusion and Recommendations

The second prototype was created using the feedback received from prototype one, in which it was later tested and completed. The team also labelled key components needed in our proposed design. The test plan was carefully documented and additionally the feedback taken from the prototype assisted in the testing plan to build prototype 3. As a result, these recommendations were incorporated in prototype 3 test plan. The third prototype will be built accordingly to class material on how to build a prototype testing plan. It was also accordingly built to the feedback of the potential client. We will then continue to build the design for prototype 3 and then test it in various ways. After doing so, the prototype 4 test plan will be finalized and therefore, the team will continue to assemble, program, design and test the various subsystems identified in the detailed design.