CS121 Final Project Report
(Smart Security Home Camera)

Group ICBC
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Report Video

Youtube link: https://youtu.be/ACcXMvZ7HWs
Alternate link:
https://drive.google.com/open?id=1nIrCUA0ma0hYlpZfq-_E4hcRtwMHUETt

(If none of the links work, please send an email to cwu5@uvm.edu)

Project Proposal

- **Original Copy:**
  We are trying to do a thermometer. Getting the weather data from websites through python and use LEDs and displays to show the temperature. This is a real-time internet-connected thermometer. It can show the temperature of each region. This is a multifunctional thermometer. You can use it to see the temperature in each city, and of course, you can use it to record the temperature in your room, because we've added temperature sensors.

  The other thing that we focus on is light, and we want to create different lights by changing the temperature. For example, if it's a rainy or snowy day, we use a dark theme color, and if it's a sunny day, we use a warm color. We considered the practicality of temperature timing when we designed it. Check the temperature in your room and city. We wanted to add some special features so it wasn't just a thermometer. So we added cameras and speakers.

  The camera you can transmit images to your phone over the wifi connection. This gives the product the ability to monitor the room in real-time. When you go out, you can watch the situation of your room through the camera, and it can also be applied to detect the real-time situation of your pets and children.

  The speaker functions as a reminder tool. You can set the speaker to sound when the temperature drops below. At the same time, the speaker can act as a Bluetooth speaker, which you can connect with your phone or computer to play music.

This project contains four main components: a motherboard & power supply, a temperature sensor, a SAKS expansion board, and a camera.

1) Motherboard & power supply: the mainboard of this electronic thermometer is Raspberry Pi that controls all the power and control systems. It contains the portals that need to be used by other components.
2) SAKS: it is used to display the temperature by its four digital tubes. Also, it includes a buzzer, which is used to remind a certain temperature (below or over).
3) Camera: this component is to monitor rooms in real-time.

- **Revised Version:**
  We are trying to do a security home camera. The system can monitor the target area 24/7, and get the weather data from websites through python and use LEDs to display system status. This is a real-time internet-connected camera. It can show the weather information of the target region.
  The other thing that we focus on is light, and we want to create different lights by changing the status of the system power. The red LED represents the system is on and the camera is monitoring a certain area.

  The camera can capture any dynamic object that is moving, and take the real-time photo(s) then upload to the Dropbox (a cloud Drive) for the owner to check the details whenever and wherever he/she wants.

  This project contains three main components: a motherboard & power supply, a LED, and a camera.

  1) Motherboard & power supply: the mainboard of this electronic thermometer is Raspberry Pi that controls all the power and control systems. It contains the portals that need to be used by other components.
  2) Red LED: this component shows the status of the system power.
  3) Camera: this component is to monitor rooms in real-time.

(Main reasons for the modifications: Due to the COVID-19 pandemic, we cannot receive the required components that we ordered, such as SAKS, Long breadboard, and the speaker, etc. Some items were canceled, and some could not arrive on time.)

Project Analysis

- **Task Assignment:**

Date	Task	Estimated Time (hr/hrs)	Actual Time (hr/hrs)
03/03/2020	Brainstorm the project and generate the proposal	3.0	4.0
03/07/2020	Purchase materials and basic needs	1.0	1.5
03/16/2020	(If materials arrive on time) Start to build the base structure of the project and test the basic circuit function	5.0	4.5
03/20/2020	Start to think about the principle codes for the prototype, check online resources	2.5	3.0
03/27/2020	Check the functionality of the code	3.5	4.5
04/03/2020	Debug	2.5	1.5
04/10/2020	Debug	2.5	2.5

04/17/2020	**Changing the new plan and Debug**	**2.5**	**3**
04/24/2020	**Debug**	**2.5**	**2.5**
04/25/2020	**Finish the program and assemble the prototype for testing**	**4.0**	**7.0**
04/26/2020	**Check all cables, boards, structures, and find potential problems**	**4.0**	**4.0**
04/27/2020	**Submit the prototype**	**N/A**	

Estimated total time: *33 hours*
Actual total time: *38 hours*

- **Budget:**

Items	Estimated Cost	Actual Cost
Temperature Sensor (Couldn't obtain)	**$9.99**	**$0**
Raspberry Pi Camera Module V2-8 Megapixel, 1080p	**$28.20 * 2**	**$28.20 * 2**
Raspberry Pi Camera Ribbon Flex Extension Cable	**$9.99**	**$9.99**
SAKS Hat (Couldn't obtain)	**$19.90**	**$0**
Structure Materials	**TBA**	**$0**
CQRobot Speaker 3 Watt 8 Ohm for Arduino, JST-PH2.0 Interface (Couldn't obtain)	**$7.99**	**$0**

Labors	**$495**	**$570**

(The note represents that this item couldn't be acquired by the cancellation of shipment due to COVID-19. We tried to manage this situation, but it seemed that changing the plan was the only option. This situation has also been discussed with the course professor James Eddy via email.)

Estimated total cost: *$599.27*
Actual total cost: *$636.39*

Group Contribution

- Kane Li (Project Manager): Leading the whole project, organize group meetings, update the group status reports, and keep pushing the project until finished. Main coding (camera & dropbox environment set) and debugging.

- Xun Zhang (Testing & Quality Assurance): Responsible for some code for the system and assembling the components, test the functionality, make sure the hardware works as expectations. Main coding (Grab the weather data and COVID -19 virus data from website) and debugging.

- Yao Shi (Network Engineer): Responsible for assembling the components. Coding assistance (Camera). Troubleshoot the code problem with team members for the project and debugging. Recoding video.

- Chaozhen Wu (Financial Manager & Hardware Guru): Responsible for the coordination with the associated team for procurement and financial management. Confirm the quality of each component. Coding assistance (weather data & COVID - 19 data) and debugging.

Reflection

Kane Li:

For the whole project, it is a huge challenge for us. Many of the hardware we bought did not arrive because of the virus. This made us have to change our plans when we did halfway.

For my work, I also encountered some problems, and a few of them impressed me deeply, and I think the process of solving problems is also a good process of learning. I remember when I tried to connect to dropbox with raspberry pi. I typed the name of the app incorrectly. I did not know how to solve this problem, and I was also

trying to delete this folder and reset it, but all failed. I learned to use Stack Overflow to solve the problem. There are many solutions to this problem. Here I found out how to reset the dropbox app name and reconnect to dropbox.

I also had a lot of problems with the cameras. First, how to capture a dynamic object is something I've thought about for a long time. I tried many methods. I've tried motion and OpenCV, but I've had some problems. These problems are the inability to clearly capture moving objects and the inability to save them. Motion is actually a nice approach, but I ended up using a python file to control my camera and capture dynamic objects. The setting camera took me a lot of time. For example, the size of the photo and the parameters of the camera. I'm glad it all worked out. As for me, the biggest challenge is the virus.

This teamwork made me understand the importance of it. A perfect project cannot be completed by one or two people. We have to keep communicating with our members of the team,and brainstorming. The most important thing is to assign tasks to each member. One person's power is small, a group of people's power is huge. And one more thing is solving the problem is a good way to learn.

Xun Zhang:

This coding experience made me understand: the needs will change at any time, I want to prepare to change the code at any time. Therefore, I must have good coding habits, and try to follow the logic and improve the readability of the code when programming. Of course, the biggest gain this time is that I consulted a lot of information and watched a lot of learning videos about Scalable Web Crawler. I learned how to use regular expressions, how to operate excel and sqlite3 in python, and how to analyze web pages tags (about html) and how to use requests, urllib and beautifulsoup4 libraries.

In the learning process, I also encountered many difficulties. The first is to know exactly what kind of knowledge you need to use. Since I haven't done any projects or assignments about crawling data before, I watched some videos on the web that teach web crawlers. Then I found that in the use of web crawlers, I only need to learn to correctly analyze the web page, master the knowledge about cookies, and learn to use the requests or urllib library. In fact, at the beginning I chose the application of the request library, but after reading some posts from netizens, it seems that choosing urllib is a better choice. Next is about analyzing web pages and crawling data. In order to grab the data I need, I watched some videos teaching regular expressions. During the period, I also learned about the greedy algorithm. Finally, in terms of storing data, I just started to choose to use the MYSQL database related to our courses, but then I found that I lack a lot of JavaScript knowledge. In addition, due to illness, the parts are not complete, and the direction of the project has changed, so I also chose to use python to operate and generate

excel files. During the integration of the code on the Raspberry Pi, I also encountered some episodes. The re and urllib libraries cannot be downloaded in the Raspberry Pi environment. So I spent some time on the Internet to check related issues, and finally found that there is no need to download.

In addition to learning new knowledge this time, I found that programming will bring us a new way of thinking, and also found that programming can bring a lot of convenience to our lives: we can let the computer do the tedious and boring things for us.

Yao Shi:

I was responsible for assembling a camera and LED light. Actually, it is not very hard to connect the LED light to the breadboard and the camera to raspberry pi, but there were still have something we need to pay attention to like we need to connect the camera before power supply connecting. I met a problem that I made the first camera broken since I did the wrong order for connecting. Therefore, I know that the correct order can protect the camera well. We have to attach more importance to details.

Besides, I made a cube box with 4 holes. The holes are for the LED light, power cable, camera, and cable connected to the computer. It makes our smart security camera much more beautiful and convenient to take.

However, I still faced many problems with camera settings. As Kane said, we tried a lot of ways to figure it out, such as motion and OpenCV, but both of them were failed. For me, I preferred OpenCV since it can recognize the specific items. We had many discussions before we came up with the best solution. Finally, we chose python to solve this problem.

From this project, I learned a lot of things.

For life:

Firstly, I found that it is very important to pay more attention to details. Whatever we do, correct orders and rigorous attitude are really essential. Besides, I feel that the power of teamwork. Everyone took serious on the project and did the tasks they responsible for so that we can make a satisfying work on time, it is helpful for enhancing the efficiency and quality of works. Third, we should always keep a calm and smart mind, to make enough preparation for all emergencies when they would happen. I remember we were very anxious at first when we heard that our orders were canceled and could not arrive. That meant that half of our plan for the project should be changed. However, we discussed and decided another plan in 3 days: Just make it become a smart security camera! After combining the code with the camera, and multiple tests, improvements. We completed it successfully.

For technique:

I learned how to use the code command to connect and operate the camera. Actually, before I took this class, I was very curious about how the hardware can be operated by typing code. Now I try it by myself, I also can make a product. It interests me. I believe that I will not stop doing it after this class end. Raspberry pi is really fantastic. I hope I can find more fun from it!

In conclusion, this project improves my skills in coding and operating. I think it left me a very deep impression and a kind of motivation to do more things because I believe I can!

Chaozhen Wu:

This project is one of the biggest group coding projects I have been through and I learned a lot from it, especially under this specific circumstance.

First, I learned how to convert my knowledge from class to actual operation. The lectures we were given are mostly basic, conceptual, and surface. The way how I expand and develop the basic knowledge decides the quality of my actual operation. I am glad that Professor James offered me the concepts of the course and the guideline of how to apply. The lab section helps me the most. It is always amazing to see how the code is running in front of you and how the goal has been achieved. However, problems always exist. Sometimes I encountered an undefined bug that was caused by a single typo which took me 2 hours to locate; sometimes I had internet connection error when it normally worked; and sometimes I had hard time trying to understand the lecture and the complex code. Every time I met such problems, I would go back to the beginning of the process and check every detail carefully. I never thought this is a waste of time, instead, I consider it a good chance to become more cautious and gain the ability to understand the knowledge more comprehensively while study new things. Second, teamwork. I am in a group that contains 4 members, where gathering everyone together to work is always a challenge. Fortunately, all of us understand the importance of teamwork, so we can always meet up with passion and enthusiasm. Each of us was clearly assigned a role and related task at the very beginning of the project, so we could complete the project in an orderly manner. At the same time, I actively communicate with my teammates to come up with solutions for those problems I met individually, and they were always willing to help. We worked together, helped each other, and shared our knowledge, this is the core of this project and how we succeeded. Last but not least, responsiveness. We were all aware that the plan might be slightly changed as the project unfolds, but we never thought about how huge the influence of COVID-19 is supposed to be. And this experience really taught how to react to certain circumstance more rapidly and efficiently. As the pandemic spread all over the world, many things have been significantly influenced, including our project. Most of the components we designed in our project were delayed or unavailable due to the

cancellation of delivery(oversea). We tried to find replacements or an alternate plan, but it seemed that changing the original one was the only option left to us. So we had to redesign the whole plan and edit the details. I am glad we worked it out, we got a plan that has almost the same functionality and complexity, and we turned it in kind with great effort.

Anyways, I appreciate Professor James Eddy for what I have learned in class, I appreciate TAs' help for the lab, and I appreciate all my team members for extraordinary teamwork. I sincerely appreciate all helps and resources that were offered to me, and I truly believe that we can get through this hard time all together.

References

Dropbox connect with Raspberry Pi:
https://github.com/andreafabrizi/Dropbox-Uploader

Camera setup code with Raspberry Pi:
https://www.raspberrypi.org/forums/viewtopic.php?f=43&t=45235
https://blog.csdn.net/u013162035/article/details/78580486

Web page for weather information:
https://weather.com/weather/tenday/l/0863aac4979c8782a8b6b0a01ef3efd00b49d2132fe8320b1df30e559a772459

Web page for COVID-19 information:
https://weather.com/coronavirus/l/0863aac4979c8782a8b6b0a01ef3efd00b49d2132fe8320b1df30e559a772459