ELEC 490/498 Project Blueprint

Project title: Smart Mirror

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1. Design problem

The Canadian Internet Registration Authority (CIRA) reports that in 2019, 73% of Canadians spend an average of 3-4 hours online per day and 1/5 of Canadians cannot stay away from regular internet usage for more than 8 hours [1]. Canadians see a growing need to remain connected with their online data and to integrate it with their daily life. CIRA, in the same 2019 study, has also found that 46% of all Canadians use their mobile phones while using the washroom [1]. While Canadians want to remain connected with their online media platforms, the washroom setting may act as a barrier. Using a digital device in a washroom creates risk for water damage which can become a safety hazard. Therefore, a device is needed to allow users to have access to relevant information in a washroom setting through a hands-free experience.

2. System specifications

The Smart Mirror project is mainly a software integration project. Therefore, the hardware components are mediums in which our software operates on. No hardware will be created from scratch, instead, they will be utilized as part of smart mirror system. The hardware involved includes a Raspberry Pi 3 Model B, Google AIY Voice Kit, and a 21" LCD monitor. Listed below are the hardware specifications of interest for the respected hardware.

Raspberry Pi 3 Model B	***Google AIY Voice Kit***	***Acer SB220Q bi 21.5" Full HD***
1.2GHz Quad-Core ARM Cortex-A53	1.6" speaker	21.5" Full HD (1920 x 1080) Widescreen IPS Display
802.11 bgn Wireless LAN and Bluetooth 4.1 (Bluetooth Classic and LE)		Refresh Rate: 75Hz - Using HDMI Port. 4ms Response time
1GB RAM		Processor Count: 1
64 Bit CPU		HDMI port
4 x USB ports		
Full size HDMI port		
Micro SD port for loading your operating system and storing data		

1	**Functional requirements**
1.1	Weather display which includes: a high and low temperature, average temperature, icon to determine condition, weekly forecast, pull data from openweathermap API
1.2	Location data display which includes city, province, and country
1.3	Time display which displays the current time in time zone located by openweathermap.API and includes the current date
1.4	Quote of the day (or static encouraging phrases) displayed on the screen such as: • You miss a 100% of the shots you don't take – Wayne Gretzky • Hey, sexy!
2	**Interface requirements**

2.1	Interface from device to user
	• Display information using icons and text, using Raleway or Quicksand. Other icons can be created in photoshop with a flat monochromatic design in white
	• Respond to the user with information on:
	  • Music
	  • Weather
	  • Time
	  • Calendar

2.2	Interface from user to device
	• Sync between user device and display to display calendar, weather, time
	• Request device with information on:
	  • Music
	  • Weather
	  • Time
	  • Calendar

3	**Performance requirements**
3.1	Able to pull data from an API using HTTP get requests over Wi-Fi
3.2	Updates the display portlets within a reasonable time (once per day)
3.3	Updates the clock once per minute
3.4	Recognizes and processes voice commands within the Amazon's Alexa API specifications

3. Methodology

3.1 Approach

The design approach that the team decided to go with a voice-controlled smart mirror. The smart mirror is a reflective surface that also displays relevant information to the user. It consists of a one-way reflective film that covers over an LCD monitor. The user-interface will be custom-designed, powered by a Raspberry Pi. A Google AIY voice kit module will be used on the Raspberry Pi to integrate Amazon Alexa API voice control features into the smart mirror's software capabilities. The smart mirror itself will be constructed using wooden panels which would act as the frame around the one-way film. An LCD screen would be used placed behind the one-way film, where the relevant applications will be displayed against the film diffusing over to the other side. The device's software system will feature a Linux OS powered by a Raspberry Pi unit. A PIR sensor will also be equipped on the device to detect the user's presence, allowing the device to power on or off automatically, lower overall inefficiencies to power usage.

3.2 Design tools, hardware, instrumentation

For the smart mirror project, the main hardware parts that will be used include the Raspberry Pi 3 Model B (RP3), Google AIY Voice Kit, and a 21" LCD monitor. The Raspbian OS will be running on the Raspberry Pi and the user settings app will be able to run on any Android device/android simulator.

Hardware instrumentations for this project include: HDMI cable, USB flash drive, conducting wires, micro SD memory card (32GB), wire cutters, multimeter, power adapters, RGB LEDs (optional), PIR sensor (optional), wooden frame, wood glue, hammer, saw, nails/screws, screwdriver, ruler, metal brackets, sandpaper, wood paint, paintbrush. The HDMI cable is used to connect the RP3 to the LCD monitor. The RP3 will also be connected to conducting wires and designed to support a PIR sensor for motion detection and RGB LEDs for visual indication. The entire smart mirror system will be held together by a woodworking frame that will be designed and built from scratch.

The hardware platform used for the project will be Raspberry Pi 3, running the default OS Raspbian. The default OS will be modified the GUI to display data using a combination of HTML, CSS, and JavaScript to create an interactive interface. The design of the wooden frame can be constructed and mocked with the use of a photo editing software to sketch out the dimension and physical specifications such as Adobe Photoshop, Pixlr free online editor, Solid Edge, as potential CAD software.

3.3 Validation

There are three distinct phases of testing for this project: software, hardware, and integration testing. The software and hardware of the mirror will be tested individually for proper functionality, which will then be followed by tests for integration between the two systems. For the software testing phase, rigorous stress testing will be done on the software applications to ensure that basic functionalities of the application are met. Various inputs, both valid and invalid, would be entered to attempt find mistakes or to crash the application. If the application crashes, the application integration code will be reviewed to check for potential bugs. An example of stress testing would include inputting various preference on the weather application and checking that the correct location, temperature, and time are displayed. In addition to checking functionality, the tests performed on the application can be also be used to diagnose the device's internet connectivity and application's visual fidelity on the LCD display. After the bugs in the application are identified and fixed, the testing process is repeated until no additional issues are found in later iterations. For the hardware phase of testing, the physical components used in the device such as the Raspberry Pi, Google AIY voice kit and the LCD display will be thoroughly tested for proper functionality. Proper testing of the physical components will ensure that the system integration between software and hardware will proceed more smoothly. Examples of functionality tests would include testing for accuracy and responsiveness of voice recognition on the AIY voice kit. The structural integrity of the mirror frame will also be tested to make sure that assembly of all the components will fit properly and that the device will have acceptable durability. The final integration testing stage will check for any issues in the compatibility between the software and hardware systems. Various tests will be done to check for the acquisition of data from hardware to software, such as correct outputs from software to hardware, normal/abnormal data entry, and in addition to overall system timing/performance.

4. Milestones

No.	Milestone	Due date	Responsible member(s)
1	• Research and Development: Have a detailed understanding of the entire network and finalize system design. (i.e. know how each component will be communicating with each other via which software platform).	Week 3	Ian, Adams, Kingsley
2	• Have a list of Bill of Materials submitted (not including wooden frame). • Will be able to run and display all preliminary API software on RP3.	Week 5	Adams Kingsley
3	• Have the Amazon Alexa API integrated into the system and allow apps to launch base on voice commands.	Week 8	Adams
4	• A well-designed display interface when running smart mirror system.	Week 11	Kingsley
5	• Create a server/database where it keeps track of registered users and preferred software API's that are used. Have a way to track other data (i.e. Time of use, duration).	Week 13	Ian
6	• Continuous testing and development of the integrated system to ensure all validation test cases are completed. • Blueprints and outline of the wooden frame are created. Bill of Materials sent for wooden construction.	Week 16	Adams, Kingsley Ian
7	• Wooden Frame Construction. • Integrated PIR Sensor or RGB LEDs (optional).	Week 19	Ian, Kingsley Adams
8	Final deliverable.	Week 23	All members
9	Final project report, presentation.	Week 24	All members

5. Budget

5.1 Materials and Supplies

Item	Price	Reference
1x3x6 Pine Lumber x2	$5.95 x 2 = $11.90	[2]
21' Monitor	$118.48	[3]
Window Film	$47.21	[4]
PIR Sensor	$5.99	[5]
RGB Programmable LEDs	$15.99	[6]
Google AIY Voice Kit	$27.77	[7]
32 Gb SD Card		
Subtotal	$227.34	
HST	$29.55	
Total	$256.89	

The budget table above includes all the materials that the team needs and has yet to purchase for the project. The items in the table without a price listed next to it are items that the team members already own and plan to use for the project.

5.2 Contributions from other sources

Currently, the team has no plans to utilize resources that go beyond the ECE department's support, and no plans on collaborating with other companies.

6. References

[1] Canadian Internet Registration Authority, "Canada's Internet Factbook 2019," Canadian Internet Registration Authority, March 2019. [Online]. [Accessed 18 September 2019].

[2] Home Depot, "THD 1x3x6 Select Pine," Home Depot, [Online]. Available: https://www.homedepot.ca/product/thd-1x3x6-select-pine/1000115573 . [Accessed 19 September 2019].

[3] Amazon, "Acer SB220Q bi 21.5" Full HD (1920 x 1080) IPS Ultra-Thin Zero Frame Monitor (HDMI & VGA Port)," [Online]. Available: https://www.amazon.ca/Acer-SB220Q-Ultra-Thin-Frame-Monitor/dp/B07CVL2D2S/ref=sr_1_3?keywords=21+inch+monitor&qid=1568864426&s=electronics&sr=1-3. [Accessed 19 September 2019].

[4] Amazon, "Gila Window Films PRS361 Privacy Residential Window Film, Mirror, 36-Inch by 15-Feet," Amazon, [Online]. Available: https://www.amazon.ca/Gila-LES361-Control-Residential-Platinum/dp/B000H5XTKG/ref=pd_bxgy_60_img_3?. [Accessed 19 September 2019].

[5] Amazon, "Aukru HC-SR501 Human Body Pyroelectricity Infrared PIR Motion Detector Sensor Module for Arduino, Raspberry Pi and Microcontrollers Electronic Projects," Amazon, [Online]. Available: https://www.amazon.ca/Aukru-Pyroelectricity-Raspberry-Microcontrollers-Electronic/dp/B019SX734A/ref=sr_1_1?ie=UTF8&qid=1522117240&sr=8-1&keywords=pir+sensor+raspberry+pi.. [Accessed 19 September 2019].

[6] Amazon, "ALITOVE 3.2ft 1M 60 Pixels Programmable Individual Addressable LED Strip Light WS2812B WS2811 Built-in 5050 RGB LED Strip DC5V Black PCB Non-waterproof IP33," Amazon, [Online]. Available: https://www.amazon.ca/ALITOVE-Programmable-Individual-Addressable-Non-waterproof/dp/B01MG49QKD/ref=sr_1_2?ie=UTF8&qid=1522117780&sr=8-2&keywords=programmable+rgb+led+strip.. [Accessed 19 September 2019].

[7] Amazon, "Google AIY Voice Kit," Amazon. [Online]. [Accessed 19 September 2019].