ECE4011/ECE 4012 Project Summary

Project Title	Smart Look
Team Members (names and majors)	Rahul Balamurali || Major : Computer Engineering Madeline Loui || Major : Computer Engineering Tara Poteat || Major : Computer Engineering Caleb Alexander || Major: Electrical Engineering Jake Webb || Major: Computer Engineering
Advisor / Section	Primary advisor: Dr. Linda Wills
Semester	Semester/Year Spring/Summer 2020 Intermediate (ECE 4011)
Project Abstract (250-300 words)	This project is a prototype design of a mirror with touch-sensitive smart capabilities and that is pairable with smart home systems like Alexa. The project will include utilizing a Raspberry Pi kit, an LCD display device, and other electrical components (such as RGB, heat sinks, etc.) as needed. There will be four modes in which this prototype can be used: normal mirror, smart mirror, portrait display, video entertainment. Upon either voice or touch command, the regular mirror can turn into a smart mirror with a smart-information display projecting information like weather, calendar, tasks, or even your Spotify music, and other programmable items for the Raspberry Pi unit. Additionally users can take notes or draw on the mirror. Users would be allowed and encouraged to personalize smart features and its layout to their satisfaction using a desktop customization tool. The product will feature live feedback of smart features and be able to connect to virtual AI assistants like Alexa, made possible by a Wifi and Bluetooth enabled Raspberry Pi unit. The Wifi and Bluetooth enabled unit can also enable Smart Look to be used as a home entertainment system, by casting videos and playback sound via wireless speakers. Additionally, Smart Look can personalize the living space by being used as a picture, portrait, or painting, which the user can utilize when leaving their home or living space. All modes can be operated using either voice commands or touch input, where the touch responses will be captured using IR frame technology. Smart Look will also offer an optional camera to provide gesture control and facial recognition to secure personal data as well as provide personalized experiences for multiple users on a single device.

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List **codes** and **standards** that significantly affect your project. Briefly describe how they influenced your design.	I. **IEEE 802.11 standards and FCC Part 15** This is a standard for wireless local and area connection and Bluetooth communication. It will be used with the Raspberry Pi unit and a respective router which supports 802.11 bandwidth and Bluetooth 4.0 or above standards necessary for wireless network operations. II. **Amazon Developer Tools Standards Agreement** Alexa virtual assistant will be the primary support for user voice commands features using the Raspberry Pi unit. Users must acknowledge and adhere to Amazon Developer Tools Terms & Conditions prior to configuration. III. **Modular Connections** SBCs, including Raspberry Pi devices, contain one or more of the following: PCI, audio/visual I/O, SD storage, USB connections, and power supply I/O. If the unit does not contain an integrated IEEE 802.11 wireless controller, then one of the USB interfaces to provide wireless functionality via an adapter. IV. **Windows 10 IoT Core** Windows 10 IoT Core is the operating system that the Raspberry Pi will be configured. Users must acknowledge and adhere to Microsoft's Terms & Conditions prior to installation. V. **Power Management** Regulation and management for a system like this with many different devices will likely not be handled solely by the Raspberry Pi. It can only source common standard voltage levels like 5V and 3.3V over interfaces like USB. External devices like cameras or touch sensors may require common 9V or 12V regulated power that can source higher current than USB standard 500mA and 900mA. VI. **Facial Recognition API** Microsoft Kinect Software Development Kit or other open source APIs like OpenCV will be used depending on the camera system implemented.
List at least two significant **realistic design constraints** that applied to your project. Briefly describe how they affected your design.	As a team, our constraints are determined by the complexity of certain features, such as facial recognition security features or the addition of other more complex features. Practical constraints are size, cost, and most functionalities. **Cost:** The items needed to make this product are not cheap. For example, the incorporation of touch sensitive displays will require an IR frame, and the price of one IR frame varies but increases as size increases. There are also other modules to consider including the Raspberry Pi kit, a display, any adapter modules, and other devices. We also need to take into consideration the need for spare parts in case of product or human error during the building phase. **Size:** The size/position of the modules and parts and the thickness of the mirror will affect the aesthetic and portability aspect of the smart mirror technology. **Functionalities:** The functionalities are limited by the complexity of the code required to implement certain software features. In the next section, we consider an option that enables the smart mirror to have a facial recognition aspect. However,

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<tr><td></td><td>being able to understand, let alone program, such high-level software may not be within ability, given the limited amount of time. We will need to determine whether or not it is possible to complete in a semester. Since our team consists of 3 members, we will have to make choices on which features to spend our time on implementing.

Touch Screen Precision and Accuracy: The degree to which we want the smart mirror touch screen to be precise and accurate is a constraint to the project. The gestures and functionality we choose to incorporate into the mirror will determine how precise and accurate the screen will be and what type of sensors / IR frames we will need to include.

Storage capacity: Many of the functionalities require the hardware, in our case the raspberry pi unit, is capable of handling and operating multiple tasks at once. But, there are a few latest versions that are equipped with 4GB of RAM, which is currently the largest memory capacity of current raspberry pi technology. However, these latest versions are more expensive. Normally, 1GB of RAM would be sufficient to handle simple smart mirror operations. However, the project aims to incorporate touch-frames, touch enabled features, casting video playback, and other features, which all require more memory capacity to be able to sufficiently operate multiple features simultaneously. In addition, if we have time, gesture controls is a feature that is under consideration to be implemented. For that, it would require an external camera module that would also require additional memory space and power transference.

Power: Power is a similar situation to storage capacity. Because of the functionalities and features that the project is taking on, it will draw a lot of power, especially the touch frame, and our raspberry pi need to not only be able to maintain and distribute sufficient power but also disperse heat efficiently and effectively so that it wouldn't overload the unit and cause hardware malfunction.

Thermal Management: The type of touch interface and camera modules and system dimensions will determine electrical thermal dissipation which could affect safety, performance, or cause mirror/screen warping. Temperature sensing and venting areas may be required.</td></tr>
<tr><td>Briefly explain two significant trade-offs considered in your design, including options considered and the solution chosen.</td><td>Full-size mirror w/full-size display extending to mirror dimensions using a larger display unit.
Pros:
- Extended display size for smart features allows for more space for features and customizability options
- Could implement a 4-in-1 purposed design
- Compact design in terms of thickness because few components and modules, meaning more flexibility for home decor
Cons:
- Larger display size will result in more power usage
- The additional features and customizability could mean that the amount of RAM may be too limited
- All the features and customizability will require more power to maintain all the systems being controlled by the raspberry pi unit, which might be an overload. Therefore, using power management we need to offset or have power consumption be distributed or controlled appropriately. There are ways to overcome all the cons, in this option.</td></tr>
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	For all options: Gesture controls will require the use of an external camera module that will also add on to cost of expenses. Gesture control is not a requirement, however, just an optional feature that will be implemented if time permits.
Briefly describe the **computing aspects** of your projects, specifically identifying **hardware-software** trade offs, interfaces, and/or interactions. *Complete if applicable; required if team includes CmpE majors.*	The computing aspect for this project involves coding. This includes, but is not limited to, creating a personalized layout, enabling real-time data connections, accurately enabling bluetooth connection for displaying real-time smart data, and also programming the Raspberry Pi to be an Alexa-enabled device for voice commands. The coding will be mostly done through a desktop customization tool using HTML and C or C++ language on a Linux interface. The tradeoff is mostly power-based, where depending on the size and number of devices will greatly increase power consumption. It is important to keep in mind that the Raspberry Pi unit may not be able to handle too high of power consumption, however, this can be offset by providing external power supply. More power leads to more heat production. The raspberry pi unit will need to be able to disperse and manage heat transfers efficiently. The new generation of units are equipped with active and passive copper heat sinks and coolant fan to help with heat dissipation. They also come equipped with a higher USB-C power supply that would be capable for the project's power handling requirement without needing an external power supply, but the external power supply can be used in addition if needed. Of course, the power and heat management materials like the USB-C power source, copper heat sinks, fans, and other parts all add on to the new generation unit's per unit cost. Similarly, depending on the amount of functionality and features being programmed into the Raspberry Pi unit, we need to make sure the unit is capable of handling all the processes running simultaneously. Sufficient memory is estimated to be at least 4GB RAM. It is possible to offset this issue by using multiple units to distribute the memory process loads, though additional units means more power will be needed to support each unit added. However, this is just an untested theory and in the event this is not a possible fix means wasted resources, especially cost. It would be best if one unit, with the latest generation that supports 4GB RAM capacity, was used at the start to avoid any additional future expenses. For example, these individual units are more expensive compared to the older generation 1GB RAM capacity units. However, with the working offset theory mentioned earlier, 4 or more old generation units would be required to provide optimal memory capacity, which would cost more than just the one new generation, 4GB RAM unit. And if the offset theory is not possible, then a unit of the new generation model would have to be purchased anyway. Finally, depending on camera choice, facial recognition will need to fit into the previously mentioned available processing power. More expensive cameras can do much of the processing on board and others upload image sequences to the internet for processing. These will require hardware interfaces to the Raspberry Pi and/or access to the internet. They will also need to interface with non-volatile storage to save user facial recognition data. Interaction with the display will also be required so the screen will turn on when the user walks in or turn off if an unidentified user is detected.

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Leadership Roles (ECE4011 & Forecasted for ECE4012) (NOTE: ECE4012 requires definition of additional leadership roles including: 1.Webmaster 2. Expo coordinator 3. Documentation	Rahul Balamurali – *Team coordinator / Hardware Lead / Documentation* Madeline Loui – *Software Lead / Webmaster / Communication* Tara Poteat – *Integration Lead / Expo Coordinator* Caleb Alexander – *Hardware / Software / Documentation* Jacob Webb – *Software / Integration / Hardware* *Note: All members, in addition to their roles, will provide additional support where needed. With only three members on this teams currently, a lot if not all of tasks may overlap with multiple or all three members*
International Program: Global Issues (Less than one page) (Only teams with one or more International Program participants need to complete this section)	