Electrical Overview

Year: 2019 Semester: Fall Team: 1 Project: IntelliFace

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Assignment Evaluation:

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| **Item** | **Score (0-5)** | **Weight** | **Points** | **Notes** |
| **Assignment-Specific Items** | | | | |
| **Electrical Overview** | 5 | x3 | 15 |  |
| **Electrical Considerations** | 5 | x3 | 15 |  |
| **Interface Considerations** | 4.5 | x3 | 13.5 |  |
| **System Block Diagram** | 5 | x3 | 15 |  |
| **Writing-Specific Items** | | | | |
| **Spelling and Grammar** | 5 | x2 | 10 |  |
| **Formatting and Citations** | 5 | x1 | 5 |  |
| **Figures and Graphs** | 5 | x2 | 10 |  |
| **Technical Writing Style** | 5 | x3 | 15 |  |
| **Total Score** | 98.5 | | |  |

5: Excellent 4: Good 3: Acceptable 2: Poor 1: Very Poor 0: Not attempted

General Comments:

1.0 Electrical Overview

The Intelligent Interface serves the purpose of adding digital features to a cosmetic mirror to enhance the user’s daily routine and perform ancillary functions with over-the-air updates. The interface features an ambient light sensor which is responsible for controlling monitor brightness in order to conserve energy, allow the display to be visible in brighter environments, and to provide additional light to authenticate the user in low-lit environments. This sensor is retrofitted on the STM32F0 MCU [1], along with the temperature sensor that acts as a passive fire alarm, paging the user if an abnormality is detected. In addition to these, IR sensors are present to detect a user’s gestures to control the mirror interface.

The MCU communicates with the NVIDIA Jetson Nano module through a USART relay to transmit aggregated sensor data, which are the “wake” and “sleep” gestures to control the mirror interface power, the mirror interaction gestures, and ambient sensor data from the temperature sensor and ambient light values from a series of photoresistors.

The Jetson Nano module is interfaced with an HDMI monitor to display the mirror dashboard and the aggregated values, a camera to obtain a video feed of the users for authentication purposes [2,3]. The Jetson module requires a larger power output as a result, as it is also responsible for powerful computations including but not limited to image recognition through the usage of a You-Only-Look-Once Image Classifier Neural Network written in Tensorflow for Python [5]. The Jetson has been built for this purpose, but it will require a stable power source along with the other parts as described below.

2.0 Electrical Considerations

The STM32F0 Discovery Board operates on the default frequency of 48MHz [1]. However, as the microcontroller is obtaining sensor data from the 3 sensors and relaying it to the NVIDIA Jetson through a USART channel, the CPU of the microcontroller is not performing intensive tasks that warrant a larger frequency and thus we have allowed it to operate on 48MHz, its default [1]. Furthermore, the Jetson Nano operates on a maximum frequency of 2GHz which would be more than fast enough for our machine learning needs for the project, namely an image classifier neural network written using Keras for Tensorflow, as well as basic asynchronous remote procedural calls to obtain news, stocks, mail amongst others.

Apart from the STM32, other components that would be requiring a constant power source are the NVIDIA Jetson Nano and the Screen Monitor Dell E2216H [4]. The most power consuming part out of these is the screen monitor as it would be drawing 2.5A of current with a constant 12V power supply, when the device is in active mode. The Jetson would be the next highest source of power consumption with a 5V power and 2A constant current draw with an operating range of 10-15 watts of power through the micro USB slot, and if required a barrel-jack 5V, 4A power supply abandoning the micro USB. Finally, the STM32 would require 100 mA at 5V which is not that much compared to the other components [1]. Hence, we would be using 3 separate wall adapters to power our STM32, Jetson, and the screen monitor.

The interface contains sensitive components which will require power regulation, notably the sensors tethered to the STM32F0 MCU, the MCU itself, and the Nvidia Jetson. To that end, we are procuring a low power switching regulator to perform a 7V-5V conversion for usage in the sensor and MCU component of the project.

3.0 Interface Considerations

The interfaces used in our project have been listed below:

1. USART: USART communication will be set up between the STM32F0 and the Jetson Nano in order to send data from the temperature and light sensors from the microcontroller to the computer. The USART interface has a data transfer rate of 115,200 bps. This baud rate is sufficient for the functional specifications of our project.
2. **ADC:** The light, temperature and IR sensors will read analogue data and communicate this data with the STM32F0. The microcontroller will read these values and process them to convert them to digital values. These digital values will be sent to the Jetson Nano using the USART communication protocol and be displayed to the user.
3. **Micro USB:** The Jetson Nano is powered by a 2A 5V micro USB wall adapter with a power regulator to avoid damage to sensitive components
4. **USB/MIPI:** A MIPI Camera (currently) is tethered to the Jetson Nano Module using the CSI-2 Protocol standard in the industry. The team is currently exploring other options, including a medium resolution USB Webcam (Logitech C270) as an alternative to MIPI. However, as MIPI with the CSI-2 bus is the most popular option for low cost image capture on all MCUs, we are proceeding with the former.
5. **HDMI:** An HDMI (currently) cable is used to tether the Jetson Nano Module to the display, Dell E2216H. This was chosen over DisplayPort and VGA to ensure a higher resolution display. Controlling the monitor brightness can also be done through HDMI, which is not an option through the other methods.

4.0 Sources Cited:

[1] STMicroelectronics. (2019)STM32F0 Discovery Datasheet - STMicroelectronics. [Online]. Available: <https://www.st.com/en/evaluation-tools/stm32f0discovery.html>.[Accessed: 11-Sep-2019].

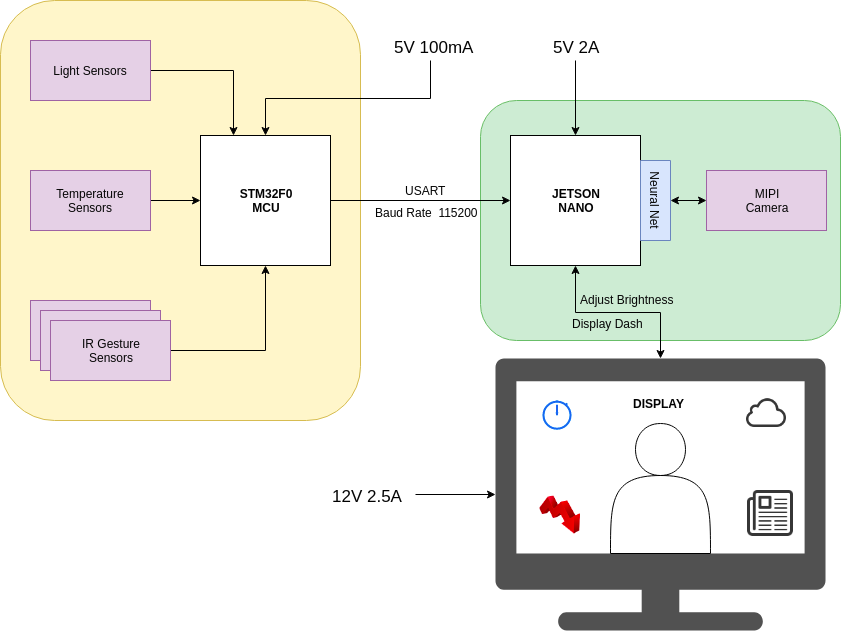
[2] NVIDIA Developers. (2019). *Jetson Nano System-on-Module Data Sheet*. [online] Available at: <https://developer.nvidia.com/embedded/dlc/jetson-nano-datasheet> [Accessed 13 Sep. 2019].

[3] MIPI. (2019). *MIPI Camera Serial Interface 2 (MIPI CSI-2)*. [online] Available at: <https://www.mipi.org/specifications/csi-2> [Accessed 13 Sep. 2019].

[4] Dell.com. (2019). Dell 22 Monitor – E2216H | Dell USA. [online] Available at: <https://www.dell.com/en-us/work/shop/dell-22-monitor-e2216h/apd/210-agmv/monitors-monitor-accessories> [Accessed 13 Sep. 2019].

[5] Redmon, J., Divvala, S.K., Girshick, R.B., & Farhadi, A. *You Only Look Once: Unified, Real-Time Object Detection.* 2016 IEEE Conference on Computer Vision and Pattern Recognition (CVPR), 779-788 [Accessed 13 Sep. 2019].

Appendix 1: System Block Diagram

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