Functional Specification

Year: 2020 **Semester:** Fall **Team:** 6 **Project:** Snow-weAR Goggles
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Assignment Evaluation:

Item	Score (0-5)	Weight	Points	Notes
Assignment-Specific Items				
Functional Description		x3		
Theory of Operation		x3		
Expected Usage Case		x3		
Design Constraints		x3		
Writing-Specific Items				
Spelling and Grammar		x2		
Formatting and Citations		x1		
Figures and Graphs		x2		
Technical Writing Style		x3		
Total Score				

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

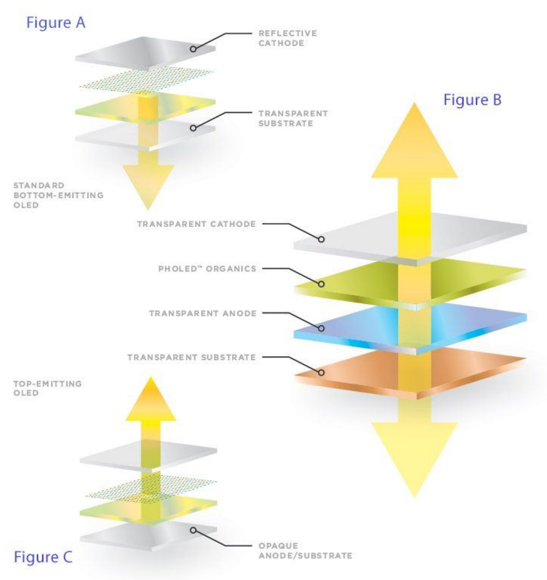
General Comments:
Relevant overall comments about the paper will be included here

1.0 Functional Description

The Snow-weAR Goggles allows users to visualize metrics such as average speed, incline, temperature, and location while providing the user the ability to send and receive GPS information of other headsets using Radio communication. An Inertial Measurement Unit (IMU), Global Positioning System (GPS), temperature sensor, and radio chip pair will provide relevant information to a transparent OLED display whose current visible metric may be toggled at the user's convenience via button located on the device. A battery power supply connected to the goggles may be stored safely in a jacket pocket during use.

2.0 Theory of Operation

Perhaps the most interesting hardware component featured in our project is the TOLED display. TOLEDs use an optically transparent cathode in addition to the usual transparent anode so that the entire display can be viewed without hindering a user's field of view. In the diagram below you can see that the typical reflective cathode in Figure A is traded for one of transparency as seen in Figure B.



[5]

Accelerometers and gyroscopes in the IMU give the skier metrics like incline or acceleration by measuring forces in the X,Y, and Z directions over time. Newton's Second Law of Motion dictates that the sum of all forces is equal to mass times acceleration [6]. The acceleration given here gives contexts necessary to calculate these metrix

3.0 Expected Usage Case

The Snow-weAR Goggles are expected to be worn by a single user in temperatures below freezing. They will be portable and require minimum manual operation by the user while skiing. Demographics for skiers in the United States show that around 70% of skiers are under the age of 35 [3]. Based on this, it can be assumed that the majority of people using the goggles will belong to this age group and will be familiar with similarly operated products and have average technical literacy.

4.0 Design Constraints

4.1 Computational Constraints

The primary microcontroller's main computational tasks will be filtering data from the IMU, synthesizing data to get accurate and relevant metrics for the user, and displaying the data in a user-readable and user-editable format based on input from the pushbuttons. It will also need an internal clock to assist in calculations. The GPS will update the computer when needed, the compass will update the computer every second, and the IMU will update the computer several times a second, requiring computation and calculations over a set interval to best determine current speed and direction. Average acceleration from the IMU over the past few seconds will be calculated and the acceleration since stopping will be known, which can be cross-referenced with GPS data to provide a more accurate speed reading.

The secondary microcontroller's main computational task will be maintaining communication with another separate nearby microcontroller and receiving its radio signal. These will be a pair of LoRa chips.

4.2 Electronics Constraints

The primary microcontroller will need to interface with the secondary microcontroller, inertial measurement unit (IMU), display, user push buttons, global positioning system, OLED display, and the compass. These devices will make use of the I2C, SPI, or UART communication protocols depending on which components are selected, and a microcontroller will have to have a sufficient number of each type of output pin. An ADC will be connected to the battery supply to monitor power and then use a communication protocol to relay the data to the main microcontroller.

There may be a need for a memory buffer between the IMU, compass, GPS, radio receiver and the main microcontroller, separately. The microcontroller will need to store enough information to accurately display each metric if requested by the user. An antenna and interface will be necessary to transceive and convert radio data.

4.3 Thermal/Power Constraints

The goggles need to be functional at low temperatures typically experienced while skiing. Body heat will provide some warmth to the project, but the goggles will be exposed to the open air. Oakley rates their AR Goggles at a temperature of 14 degrees Fahrenheit; however, the Snow-weAR goggles should operate at 0 degrees Fahrenheit [1]. This shall be considered the goal threshold for functional performance.

As a wearable device, the goggles must be completely battery powered. They must be able to operate for an entire day of skiing. The target battery life is 5 hours. For multiple day ski trips, they should be fully rechargeable overnight and the target charging time is 5 hours.

4.4 Mechanical Constraints

All components of the AR Goggles except the battery pack will be packaged on either side of snow goggles so each side will be required to have a footprint of height approx. 2 inches. Weight is a common issue for Augmented Reality ski goggles [1]. The entire SnowweAR Goggle design, not including battery pack or goggle frames, is expected to weigh 0.5 pounds with 0.2 pound tolerance to compete with that of RideOn's AR Goggles of similar functionality [2]. These mechanical constraints will also be effective in ensuring the user's continued protection. The component enclosure and battery pack must be waterproof.

4.5 Economic Constraints

Given that the mountain sport industry is considerably more expensive relative to other sports and outdoor industries, an economic price for this consumer good is not a very pressing factor. With that being said, this project is not without economic constraints. For example, given the global impact of COVID-19, worldwide supply chains are somewhat fractured at the moment giving our team motivation to source parts from U.S. based suppliers. The cost of this device should not exceed that of a higher end sport watch that can report similar metrics, such as the Garmin Forerunner 645 at $450 USD. [3]

4.6 Other Constraints

5.0 Sources Cited:

[1] OutdoorGearLab.com. 2020. *OutdoorGearLab LLC*. [online] Available at: https://www.outdoorgearlab.com/reviews/snow-sports/ski-goggles/oakley-airwave [Accessed 6 May 2020].

[2] NoCamels.com. 2020. *NoCamels*. [online] Available at: http://nocamels.com/2015/02/rideon-ar-ski-goggles/ [Accessed 6 May 2020].

[3] CrescentSkiCouncil.org. 2013. *SIA/Physical Activity Council.* Available at:https://www.crescentskicouncil.org/2013FallConfPresentations/7-2013%20Participation%20Study_Full%20Version%20with%20Appendices.pdf [Accessed 6 May 2020].

[4] buy.garmin.com. 2020. *Garmin Ltd*. [online] Available at: https://buy.garmin.com/en-US/US/p/612476 [Accessed 3 September 2020].

[5]Oled.com. 2020. *Universal Display Corp*. [online] Available at: https://oled.com/oleds/transparent-oleds-toleds/ [Accessed 3 September 2020].

[6] PhysicsClassroom.com. 2020. *The Physics Classroom LLC*. [online] Available at: https://www.physicsclassroom.com/class/newtlaws/Lesson-3/Newton-s-Second-Law#:~:text=Newton's%20second%20law%20of%20motion%20can%20be%20formally%20stated%20as,the%20mass%20of%20the%20object. [Accessed 3 September 2020].