Initial Project Proposal

Year: 2020 **Semester:** Fall

Project Name: Snow-weAR Goggles

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Team Members (#1 is Team Leader):

Member 1: Kennedy Monaco **Email:** monacok@purdue.edu

Member 2: Carrie Kemmet **Email:** ckemmet@purdue.edu

Member 3: Mitchell Ciupak **Email:** ciupak@purdue.edu

Member 4: Peter Sumner **Email:** sumner3@purdue.edu

1.0 Description of Problem:

Reaching the next level in any activity usually demands one-on-one coaching, providing real-time objective analysis of desired metrics such as speed or efficiency of movement. Such assistance can also provide records of achievement by tracking average progress over time. Personal trainers or even group lessons can be expensive and reduce the consumer's schedule flexibility.

The problem of progress tracking in physical activities is not new. Fitbit Trackers feature heart-rate tracking, hourly activity, calories burned, etc. for casual exercises and general health [1]. Wahoo's KICKR Smart Trainer allows avid cyclists to train indoors while measuring speed, distance, power, and cadence. Similar to other trackers, the KICKR can connect to phone apps such as Zwift which tracks users' performance against other cyclists [2].

These solutions, while widely used, require the user to avert their attention away from their activity and surroundings to view their progress. Most of these similarly accessible products target activities with a large user base, which leaves more niche sports, such as skiing or snowboarding, with less specialized means to track user performance. A device that measures important metrics real-time for snow sporting enthusiasts is therefore desired.

2.0 Proposed Solution:

We propose a Heads-Up display to measure and report real-time metrics for snow sport enthusiasts to provide accurate data to users without diverting their attention from their surroundings. The display will be designed to present users of all skill levels a safer, more enjoyable, skiing or snowboarding experience.

Our solution is a pair of snow sport goggles that provide the user with real time metrics and the ability to locate a skiing partner through augmented reality. This product will provide the ability to track current and average speed, distance traveled, time spent skiing, and average incline for runs as toggleable metrics all on a heads up display. In an attempt to make the skiing experience as seamless and informative as possible, we have designed our product to help the user have fun and stay safe.

3.0 ECE477 Course Requirements Satisfaction

3.1 Expected Microcontroller Responsibilities

The main microcontroller will interface with an inertial measurement unit, global positioning system, transparent LED display, compass, and the radio transceiver chip (using a LoRa chipset). LoRa is a low-power wide-area network protocol that has a range of up to 10 km in rural areas and is available at low cost from most electronics distributors. Most of these units will communicate with the microcontroller via SPI or I2C protocols. It will use algorithms and inputs from the IMU and GPS to determine when to display data. The radio chip will be a separately programmed microcontroller with Bluetooth low energy capabilities for location data transfer between two sets of snow goggles. This will transmit and receive live GPS/time data from other chips and communicate with the main chip. There will be a single user push button to toggle displayed metrics.

Future capabilities may include data storage and computer interfacing, possibly through USB. In addition, the existing bluetooth capabilities could be expanded to include mesh networking and connection across multiple snow goggle sets.

3.2 Expected Printed Circuit Responsibilities

ECE477 is an embedded systems course which requires the use of a student-designed and built printed circuit board (PCB). For the proposed project, the PCB is expected to incorporate a microcontroller, inertial measurement unit (IMU), GPS module, transparent LED display, and LoRa radio transceiver. The PCB will also interface the battery power supply and regulation circuitry required by the final product. The power supply will be toggled via switch. Other functionality may be included as the ECE477 design semester progresses.

Another section of the circuit will be dedicated to the BLE chip, which transmits and receives information from another, nearby BLE chip. This will have to include its own power management as well as an antenna and any other analog necessities.

4.0 Market Analysis

Skiers and snowboarders who are looking for a way to track their performance metrics and identify the location of other skiers in their party are the primary target audience. This group of people includes new skiers and people skiing for fun with friends and family.

In the month of February 2020 alone the app *Slopes* has had over 60,000 downloads on the Apple App Store [3]. This app [13] has similar features to the team's intended project without providing the convenience of an AR heads up display. Other phone applications like this exist on Android and iOS plus or minus some features. An Android application like *Ski Tracks* sets out to deliver similar metrics and statistics as the team's product without the location tracking [14]. Across many devices people are actively seeking out these metrics and sharing them with their friends.

One team member, a hobbyist skier, noted that "this type of product would be very beneficial and fun to take out skiing." Many members of the team ski regularly throughout the year, adding expertise to the group. Combined with this and more market research, the team is set up to deliver an effective and fun product to all skiers and snowboarders.

5.0 Competitive Analysis

5.1 Preliminary Patent Analysis

5.1.1 US Patent Application US20170004371 A1:

Patent Title: “Hybrid orientation system”
Patent Holder: RideOn ltd.
Patent Filing Date: January 5, 2017

This patent [4], assigned to RideOn, describes a system consisting of a camera, orientation detector, GPS receiver and a processor. The processor identifies image data received from the camera and calculates the camera’s orientation relative to a velocity vector obtained using object displacement over multiple frames. The system claims to be able to get a more accurate orientation calculation by adding a correction factor that is obtained using the orientation detector and the velocity vector.

5.1.2 US Patent Application US20120194419 A1:

Patent Title: “AR glasses with event and user action control of external applications”
Patent Holder: Microsoft Technology Licensing, LLC
Patent Filing Date: December 30, 2011

This patent [5], assigned to Microsoft, describes an interactive head-mounted eyepiece that is integrated with a processor to allow the wearer to view the surrounding environment and displayed content that can be controlled. The device is configured to detect user inputs with a sensor to control the device. The types of user input can include head movements, eye movements, hand movements, and voice controls.

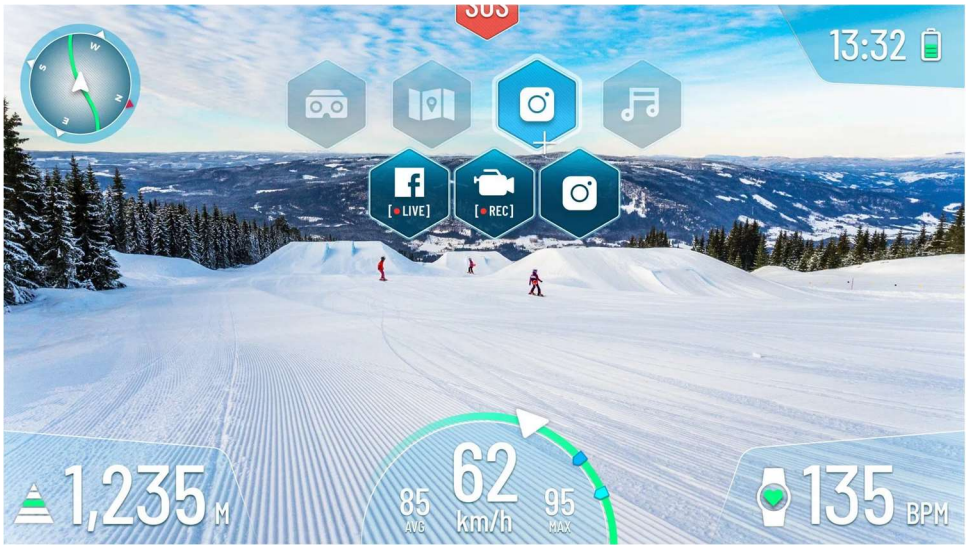
5.1.3 US Patent Application US20170176748 A1

Patent Title: “Text enhancements for head-mounted displays”
Patent Holder: Intel Corporation
Patent Filing Date: December 22, 2015

This patent [6], assigned to Intel, pertains to a head-mounted system that displays augmented reality text content to the wearer. The device includes a sensor that faces the wearer and detects head and facial movements using an accelerometer. The system is configured to display text for a specified time interval.

5.2 Commercial Product Analysis

5.2.1 RideOn AR Ski Goggles



This product is a pair of augmented reality ski goggles sold by the company RideOn. The RideOn website [7] lists information that can be displayed by the goggles to include altitude, max speed, current speed, average trip speed and heart rate. Some of these features can be seen in the above image [8] that depicts what the wearer would see. Using GPS integration, the goggles support buddy tracking and navigation via virtual maps that can be downloaded. The goggles support Bluetooth and WiFi connections and hands free calling, texting, and music control. RideOn has two patents related to this product. One describes a system that uses a camera, orientation detector, and GPS receiver to identify objects and calculate relative orientation and velocity. The other describes a system that uses magnetometers and sun positioning to improve the azimuth accuracy of line of sight calculations.

5.2.2 Oakley Airwave 1.5 Snow Goggles

This product is a pair of ski goggles with a heads-up display that shows trip information to the wearer. The display fits into the bottom right corner of the lens, as shown in the photo above [9]. Information that can be displayed, as listed on the Oakley webpage [10] includes altitude, max speed, current speed, max air on jumps, and average trip speed. Using GPS integration, the goggles support buddy tracking and navigation via virtual maps that can be downloaded. The goggles also support Bluetooth connections and music control. Oakley has a patent related to this product. One of the patents describes a data input management that uses data transmission technology such as Bluetooth and can be placed on a wearable frame with speakers, a microphone, and video display.

5.2.3 Smith I/O Recon Goggles

This product is a pair of ski goggles with a heads-up display that shows trip information to the wearer. The display makes up the bottom right corner of the lens, as shown in the photo above [11]. According to the Smith webpage [12], the goggles can display information including max speed, current speed, average speed, and jump time. The goggles support buddy tracking using GPS integration. Additionally, Bluetooth capability allows the wearer to connect to their mobile device to listen to music. Smith has a patent related to this product. It describes a heads-up display that uses location sensors to create a display environment for rendering 3D models.

5.3 Open Source Project Analysis

5.3.1 OpenArk

A C++ based tool used to build AR and VR programs at a higher level. Prototyping and Designing can be done using this tool.

5.3.2 AR GPS Glasses:

Arduino-powered GPS project that used a series of LEDs to identify what direction a person should follow to get to a certain point. This project can be referenced when incorporating the party location sharing features.

5.3.3 Android UI to AR Design

This is an open source project that intends to translate the user interface of phone apps to useful Augmented Reality and VR designs. This project can be referenced when building menus and assessing UX elements.

5.3.4 SPI Arduino Interfacing with TOLED Display

This is a simple set of examples on how to interface with the CFAL12856A0-0151B. The CFAL12856A0-0151B is the transparent OLED that the team intends to include in their product.

6.0 Sources Cited:

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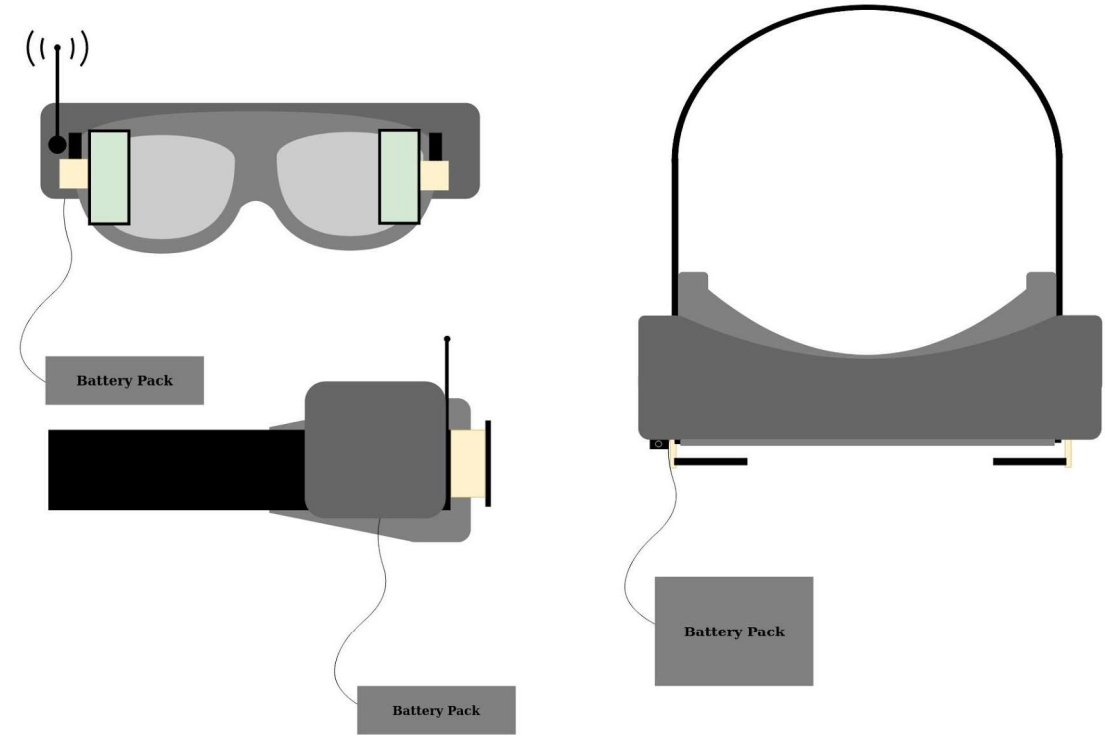
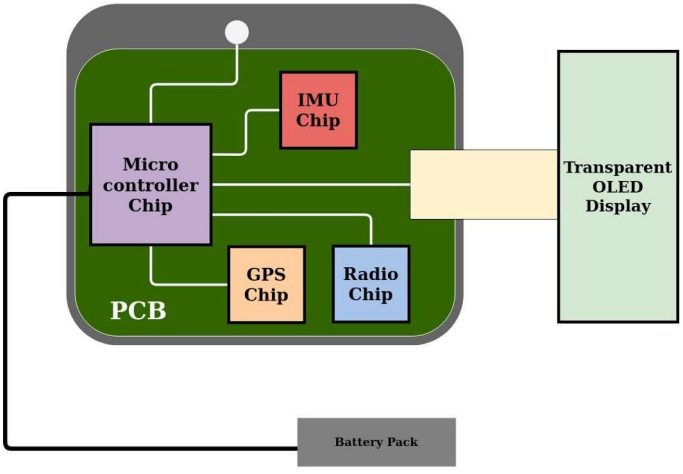
Appendix 1: Concept Sketch





Components

- Ski Goggles
- Microcontroller
- IMU
- Radio Transceiver
- GPS Module
- Transparent OLED Display (x2)

*Note: PCB will contain auxiliary components to support power regulation and chip interfacing.