NAIT

Edmonton, Alberta

**Geek Goggles**

As a submission to

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&

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Computer Engineering Technology

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Statement of Contribution

This document was co-authored by Hayden Seivewright and Joshua Akinmoluwa. The list of contributions in the table below were reviewed for accuracy by both participants, and we view the division of effort to be approximately equivalent.

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| Abstract | Hayden Seivewright |  |
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Mr. Gary Munro, Mr. AJ Armstrong

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Dear Mr. Munro and Mr. Armstrong:

As per the requirements of CMPE2960, We are submitting the report titled Geek Goggles for evaluation.

This report goes into the details of the research, design and final implementation of the project. It reviews the challenges and triumphs encountered doing the development of the project. This report also examines the technical aspects for the software and hardware components included in the project.

We are proud of this project and all the interesting tools and techniques we learned along the way. We hope others can find this project as interesting and useful as we have.

We would like to like to extend a massive thank you to all the instructors at NAIT who have taught us so much over the years and help us grow into the technicians we now are. We would also like to thank our peers for the support, camaraderie and motivation they have provided. Finally, we would like to thank our family and friends for supporting us through our educational journey and for putting up with all stress and late nights.

Sincerely,

Hayden Seivewright & Joshua Akinmoluwa

CNT Students

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# **Abstract**

When doing electronics work, a technician, hobbyist or engineer may need to reference manuals or datasheets multiple times through-out a project. They may also need to read data from multiple instruments, or they may need to record and document the projects progress. All of these activates can pull a user out of a flow state and become distractions, Geek Goggles aims to provide a hands-free solution to all of these so a user can stay focused on the task at hand. To achieve this, Geek Goggles has three main components, a web app, head up display safety glasses, and a peripheral instrument to read voltages. The web app allows users to create and track projects and stores all info in a MySQL database. The current projects info is then uploaded to the Raspberry Pi powered safety glasses via web sockets allowing the user to view and record data. Finally, a ESP32 is used as a proof-of-concept voltmeter peripheral that streams voltage readings to the glasses via MQTT.

This project was very broad in scope, so there was a lot to learn and many challenges to overcome from HUD optics, to wireless communication, and even AI assisted voice-to-text. In the end we were able to create a prototype that achieved our goals but going forward we would love to enhance the optics so the user can more clearly see the display, update the physical design to be more aesthetically pleasing and maybe develop a native phone app so the device can communicate via Bluetooth.

# **Introduction**

After being personally frustrated with constantly needing to double check datasheets and device pinouts while building circuits in class, we decided to start thinking about a solution. Most people solve this problem by printing out datasheets or pulling them up on a computer monitor, we found these solutions less than optimal as desk space is usually at a premium while working and looking up at a monitor can distract you. We wanted to modernize these approach's while also combining some other common electronic instruments into one.

This project has three main elements we want to achieve. First, we want the user to be able to upload various documents and be able to view them in a heads-up display. Secondly, we want the user to be able to attach a peripheral device to get live data from. Finaly, we want the user to be able to record a project via pictures and notes. Even though this projected faced many challenges and some major pivots in both scope and design were required we were able to achieve most of our goals and we are proud of what we were able to accomplish.

The purpose of this report is to discuss the decisions we made, the challenges we faced, and how we ended up successfully creating Geek Goggles. The report will first explore a general overview of the project. It will dive into the design of the web app, then both the software and physical design of the safety glasses, and finally the Voltmeter. The report will then go into the implementation of all three parts into a single, unified system. Finally, it will review the successes and failures of the project and our overall conclusions.

# Overview

Geek Googles consist of three main elements, the web app, the glasses and the peripheral. Each one of these elements interact with each other and can be broken down into smaller units for easier understanding.

The first element is the web app. The web app is an application that can run on either a phone or a computer and is the primary place where user information is stored. The web app consists of a front-end UI designed with JavaScript and CSS, a back-end server designed with ASP.NET and a MySQL database. The web-app is where a user can login, create a new project and upload any important documents or notes to the glasses. These documents are then transmitted to the glasses on start up through a web socket so they can be viewed. Once the user is finished working on their current project and shut down the glasses, any new notes, pictures or audio files recording during their session are uploaded back to the web app.

The second element is the glasses themselves. The glasses are powered by a Raspberry Pi Zero 2 W which provides both sufficient processing power as well as wireless communication. The Pi is then connected to 2 primary sensors, a MEMS microphone for recording and sensing sound and a BME680 air sensor which tracks temperature, air quality, humidity and pressure. These sensors are used to trigger safety warnings such as excessive noise and poor air quality as well as relaying important data to the user. The Pi also is connected to a camera allowing the user to take pictures and document their project. Finally, all this info is displayed with a 0.2 inch micro display which is magnified and collimated through a series of lens and then reflected off a combiner to provide a Heads-up Display (HUD) that the user can view at a comfortable viewing distance. The user can interact with the device via 2 physical buttons or by using voice commands.

The final element is a proof-of-concept peripheral instrument that records data and live streams it to the glasses. Currently this peripheral is a voltmeter that allows the user to get voltage readings from the circuit or electrical project they are working on. These readings are published to a MQTT server on the web app to which the glasses are subscribed allowing the user to view them real time without needed to look up from their current work.

# Design

## Physical Design

### Research

The first step of creating the physical design was to begin researching and ordering the required parts. There were 4 main components that needed to be researched, the optics, the CPU/MCU, the air sensor and the microphone. The biggest unknown was the optics needed to create the heads-up display (HUD). There are roughly four main kinds of optics used for HUD’s but it is hard to categorize as most designs use some hybrid of each or try to come up with novel ideas. The four main styles considered for Geek Goggles were birdbath designs, prism based, combiner based and waveguides. The two biggest considerations were cost and time to acquire as both time and funding were very limited resources. Using a Waveguide would be the highest quality style of optics and many modern AR and HUD glasses such as Meta Orion, Vuvix blade, and Magic leap all use this technology (Simard, 2024). The problem is they are very expensive, with some options ranging from $800 to $4,000 as seen on one major suppliers’ website, www.displaymodule.com. Based off the project’s constraints, either a combiner-based approach or a prism based one began appearing as the best option. After some more research, it appeared that many hobbyists gravitate towards a combiner-based approach and there were many examples online of how a combiner design would look like, so we started moving in that direction (Mañolo, 2025). A combiner is a piece of semi-reflective material that can reflect light while also letting some light through provided a semi-transparent mirror like surface perfect for a HUD (Guttag, 2016). After settling on a hybrid style combiner that would contain a micro-display which gets magnified through a Fresnel lens and then made clearer with a collimating lens before reflecting off of the combiner. These multi lens system require extreme precision and some fairly in depth knowledge of optical design and physics which were outside of the scope of this project and still very costly.

Figure 1 - Heads up display optics

Diagram of a diagram of a human head

AI-generated content may be incorrect.

Source 1: Blanche (N.D)

Figure 1 shows an example of how a collimating and Fresnel lens can produce a holographic image at a comfortable viewing distance. After having a conversation with Mañolo Mancelli from the Mañolo youtube channel he pointed us in the direction of ordering a deconstructed viewfinder from a digital camera off of AliExpress, these view finders already have 3 parts of the combiner system required, a micro-display, Fresnel lens and collimating lens all already designed to work with each other and at a fraction of the cost of developing on ourselves. Shortly after this conversation, there was a suitable deconstructed viewfinder found on AliExpress, and it was ordered.

The next system that needed research was the microprocessor or microcontroller needed to be the brains of the glasses. Based on previous experience, size constraints and the fact that the project would require some form of wireless communication there were to main contenders, the Raspberry Pi Zero or a ESP32 based controller. The project was also heading in the direction of requiring a lightweight AI Voice recognition model to allow for voice commands so the processer would have to be powerful as well, this narrowed the choice to the Raspberry Pi Zero 2 W and the ESP32-S3. Once they display system was decided upon there was only one clear choice as the display used a composite video input, which the Pi would natively support but the ESP32-S3 would require a lot of extra work and possible externally modules to run. Due to there still being some unknowns, both the Raspberry Pi and the ESP32-S3 were ordered and the ESP32 would eventually be used to run the peripheral Voltmeter device.

The final system needing to be researched was the sensors required to give extra functionality to the glasses. There were two main functions required, a air quality sensor to give air quality warnings and a microphone to enable voice commands and sound level warnings. For the air quality sensor, after a quick search on Digikey, the BME680 was selected as it provided even more functionality than originally expected. It provided temperature, humidity, air quality and pressure all in one which allowed extra features to be added to the project with no increase in cost. As for the Microphone, the project required something that could clearly record voice audio as well as sense environmental noise levels. There are two main kinds of microphones that were considered, a micro-electro-mechanical system (MEMS) style or an electret condenser microphones (ECM) style. The MEMS emerged as the clear choice due to its price, size and availability (Rose, 2021). The first mic ordered was a Adafruit I2S as it was the first one to appear in a MEMS I2S search but unfortunately it came in broken, after looking for a different mic the INMP441 was found on Amazon and appeared to be the higher quality version of the original choice.

## Software Design

## Web User Interface

### Introduction

The Web User Interface serves as the primary interface that allows user to interact with the Geek Goggles. It allows user to upload documents, create and edit notes, switch display modes amongst many other functions.

### Features and Functionality

The Web application provides the following features:

* Document and image Upload
* Different display mode switching
* Timer configuration and Alerts setup
* Real time alerts for the Geek Goggles readings
* Notes editing and creation

The web application makes accessing and uploading images and documents easy. This is all done by the help clicking a button that is user friendly. After clicking this button opens a file dialog that once clicked, allows you to easily and quickly select the files and or images you want to upload. This process was designed in a way that makes file operations smooth and quick without over complicating it for users that are new to this website.

The website has another section which is responsible for different displays and mode switching. In it, there are their main specialties, one is responsible for telling the consumer the current time. The second mode is responsible for telling your surrounding environments’ temperature’s current condition. For example, if the consumer is in their home, and it is too humid and or too dry, the website will measure the air quality and update the individual on its finding, leading them to take necessary action to bring the temperature to a balanced state. Lastly, the last mode in different display modes switching is the “measurements” mode. This mode is there to help the consumer with measurements issues. For example, if the individual was outside one day and was looking at an object’s measurements and dimensions, then this mode would provide them with the specific measurements and dimensions needed for this item.

## Database Design

### Introduction

The project required a database to store and manage its users and their projects data. When researching databases systems for the project, MySQL stood out as the one with the most examples and with its proven performance with high-end applications like Facebook and Twitter(<https://www.mysql.com/why-mysql/> ). MySQL was chosen as the database system and Entity Framework was used in code-first approach for easy integration with C# and allows for easy database schema changes through migrations.

The code-first approach was selected for the project to define the database models directly with C# Models. This approach helps simplifies the database management by enabling easy updates through EF Migrations. In the approach the database creation and modification is handled by C# classes thereby reducing dependency on SQL Scripting.

### Entity Framework Code-First Approach

The code-first approach was selected for the project to define the database models directly with C# Models. This approach helps simplifies the database management by enabling easy updates through EF Migrations. In the approach the database creation and modification is handled by C# classes thereby reducing dependency on SQL Scripting.

### Database Schema Design

The database consists of several key tables that store the different aspects of the projects functionality. The major tables and their relationships is shown below

A screenshot of a computer

AI-generated content may be incorrect.

The Users table contains the user’s data while Projects table contains information about the users current project. Readings tables captures real-time data gotten by the AR Safety Goggles while MyFiles and Notes tables tracks and records documents and pictures either taken by the device or saved in the device for the current project being worked on.

### Code Implementation

The following C# class represents the model for the Notes table and its relationship with Projects table.

A computer screen shot of a program code

AI-generated content may be incorrect.

A project can have multiple notes which is represented by the Project Member in the Model. The Id is used as a unique identifier for each Project Note.

# 4.0 Implementation

# 5.0 Project Results

# 6.0 Conclusion

# 7.0 References

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# 8.0 Appendices