**PROJECT PROPOSAL**

**ECE198**

**SOLVING THE TRAFFIC LIGHT FLAW**

Arushi Basu, Bradley Norman and Hengyuan Wang

**INTRODUCTION**

A lot of people in this world are colorblind and a lot of colorblind people do drive, but what about the traffic lights? Most colorblind people can't differentiate between red and green with accuracy. This is a limitation in communication between the traffic lights and the colorblind people.

The stop and go traffic light example isn’t the only situation where red and green have been used to depict informational opposites in design. For example, symbols for safety and danger, yes and no, growth and decline etc. This is what is called the Traffic Light Flaw. [1]

Here’s why the traffic light flaw is important for us as engineers and designers to know about. Color blindness affects about 8% of men and about 0.5% of women which equates to about 300 million people. That’s a pretty large amount when it comes to design and inclusivity.[1]

The majority of traffic lights might have red, yellow, and green vertically stacked, but what happens when it becomes horizontal or when there are inconsistently placed blinking yield arrows? It causes confusion and you have to rely on other visual cues that may or may not be there. It makes it harder to make better informed split-second decisions that are needed when behind a wheel.[1]

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**DEFINING THE CUSTOMER: The customer includes colorblind individuals, especially drivers, who struggle to differentiate between red and green signals.[1] For our project, the region of study will be the colorblind individuals of Ontario.**

**PROBLEM STATEMENT**

Traffic lights relying on red and green signals create significant challenges for colorblind individuals, who struggle to differentiate between these colors. This "Traffic Light Flaw" affects the safety and decision-making of 300 million colorblind people worldwide, especially with inconsistent light placements.   
  
NEED: **There is a need for more inclusive designs that improve visual communication for all drivers, regardless of color perception.** Their needs are centered around inclusive design that accommodates color blindness, ensuring they can safely and effectively interact with visual communication systems, especially in scenarios requiring quick decision-making, such as driving.[1]

**GROUP SIZE**

Based on existing data[2], it is speculated that only in Ontario there are *36,750* drivers with colorblindness.

Since the base of color-blind people is too large, and the conditions are different in different places, we plan to conduct tests based on the actual situation of traffic regulations and people’s habits in Ontario.

In our project, we will focus on the conditions in Ontario with an aim to help the color blind community there.

**Previous Studies**

Several reports [3,4] have shown that CVD (Color Vision Deficiency) is found in many populations worldwide with sophisticated factors. It could cause inconvenience to the relevant groups (i.e. colorblind people) and lead to many potential problems, especially at the transportation level.  
According to studies [5,6], some effective methods have been applied to lead the color blind community to reduced risk of accidents caused by misinterpreting traffic signals, and greater independence and autonomy for colorblind individuals. Furthermore, an approach based on more comprehensible and easily perceived technology, which our project intends to create, would undoubtedly maximize this positive impact.

**Stakeholders**

1.Assigned Graduate TA Eric Yu

2.Color-Blind Individuals  
  
 Primary beneficiaries of the device.  
 Their needs and experiences should guide the development process.

3.Traffic Authorities  
  
 Municipal governments responsible for traffic management.  
 May be interested in implementing the technology city-wide.

4.Automotive Manufacturers

Could integrate the technology into vehicles.  
 May be interested in licensing or partnering on the technology.

5.Technology Companies

Potential partners for software development, hardware integration, or distribution.

6.Disability Rights Organizations

Advocates for accessibility and equal access to transportation.  
 Could provide valuable input on user needs and regulatory compliance.

7.Insurance Companies

May be interested in reducing claims related to traffic accidents involving color-blind drivers.

**Functional Requirements**

1.Reasonable Battery Life: To enhance the users’ experience, the device should need fewer interruptions for recharging and last for 8 hours on a single charge.

2.Accuracy Rate: To ensure the customers’ safety and build trust in the product among them, the device should correctly execute 95% of basic tasks, including changing color, emitting sound signals, and producing tactile cues, etc.

3.Connectivity Speed: To ensure the portability of the product, the devices must be connected within 2 seconds.

4.Timely Response: To optimize the user experience, the devices should respond to changes in the environment with sound, touch and vision within 400ms, which can catch the users’ reaction. [7]

**Technical Requirements**

1. Power and Energy: Consume, transfer, discharge, or expend less than 30W of power at any point in time and within any component of the design during its operation.

2. Durability: The device should be able to operate stably in a humidity range of 45% to 89% and a temperature range of 5°C ​​to 40°C, which covers every common weather condition and ensures the product's operating level under various circumstances. [8]

3. Connectivity: There must be transmission of information from one microcontroller and reception of that information on another microcontroller over a distance of one meter or greater.

4. Size: The system should ideally be smaller than 4 x 10 x 5 inches (10.16 x 25.4 x 12.7 cm) and should be lightweight, preferably under 5 pounds (2.27 kg), which is a suitable size for a portable device. [9]

**Safety Requirements**

1.Safe Voltage and Current:The voltage and current used in the project should be within reasonable household appliance standards.[10]

2. Selection of Materials: The materials used in the project should meet industrial hygiene and safety standards and will not cause unnecessary harm to the human body.[11]Principles:

1. Ohm’s Law: **Formula**: V=I×R

**Concept:** Voltage is directly proportional to current, with resistance being the factor that determines the amount of current for a given voltage.  
A basic but essential law to build the circuit structure.[12]

1. Kirchoff’s Laws[16]:   
     
   A. **Kirchhoff’s Current Law (KCL)**

* **Formula**: ∑ I in=∑ I out
* **Concept**: The total current entering a junction equals the total current leaving it.

B. **Kirchhoff’s Voltage Law (KVL)**

* **Formula**: ∑ Varound loop = 0
* **Concept**: The sum of all voltages around a closed loop is zero.

1. RGB color sensor (TCS34725): Working by shining white light through color filters onto a photosensitive element (usually a photodiode). This setup measures the amount of light absorbed by each filter, which corresponds to the intensity of red, green, and blue light in the reflected color.[13]  
     
   The **photoelectric effect** [18] is central to how the photodiodes convert light into electrical signals. When photons hit the photodiode array, they excite electrons, generating a current proportional to the intensity of the light.  
     
   The **wave-particle duality** [17] of light explains that different colors correspond to different wavelengths (e.g., red has a longer wavelength than blue). Filters selectively block or transmit specific wavelengths based on their optical properties.
2. Semiconductor Structure of LED: Emitting light by applying a forward current to the p-n junction of a compound semiconductor.[14]
3. Ampère's Circuital Law:

**Formula**: ∮B⋅d l=μ0 Ienc

* **Magnetic Field (B)**: The field produced by electric currents.
* **Path Integral (∮B⋅dl)**: The line integral of the magnetic field around a closed loop.
* **Enclosed Current (Ienc​)**: The total current passing through the loop.
* **Permeability (μ0​)**: Magnetic constant (vacuum permeability).

**Concept:** The [circulation](https://en.wikipedia.org/wiki/Circulation_(physics)) of a [magnetic field](https://en.wikipedia.org/wiki/Magnetic_field) around a closed loop to the [electric current](https://en.wikipedia.org/wiki/Electric_current) passing through the loop. The current passing through the wire generates an electromagnetic field, which causes the voice coil to vibrate and produce audio.[15]

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