Dashboard Eye Tracker

Technical Proposal

Abstract

Many people can identify that increasing mobile phone use leads to distracted driving. Our eye tracking technology can be used in light-motor vehicles to prevent this sort of distracted driving. In this proposal, we deliver a good eye tracking solution that has multiple integrated electronic and software systems. We see an increase in demand for our technology as more semi-autonomous vehicles are introduced in the near future, and a need arises to prevent distracted driving by early adopters of these semi-autonomous vehicles. Our device functions as a safety protocol to prevent accidents that would otherwise be caused by distracted driving. Our physical device is a robust stand-alone eye tracking device that utilizes near-infrared reflections of eyes to track the gaze point because of its versatility to a variety of lighting conditions inside the car. We utilize a python algorithm to detect if the driver is distracted, and to provide warning and alerts to regain his/her attention. We also provide mobile apps to fully-integrate our eye tracking device with Apple and Android mobile phones. With seamless software integration, the driver is able to initially calibrate the device to their own car. Then, using the statistics provided by our software, the driver can keep track of their driving habits. In addition, if the driver decides to share their statistics with us, they are able to get a discount on car insurance premium for being a good driver.

Introduction

Eye tracking is a technology that has been commonly used in designing of products, psychology studies, marketing research, and most importantly, it has been used as a sensing device to determine gaze direction. It works by determining eyeball positions of the user, then calculate where the user is looking at using computer algorithms. This technology can be adapted to be used as a supervisory technology to prevent accidents caused by distracted driving.

Distracted driving happens when the driver's attention is attracted by any other thing except driving. It is harmful for all the people on the road, including driver him/herself. By data provided by Ontario Collision Centre, in 2013, there is one person injured because of distracted driving every half an hour in Ontario. And this number is still increasing over the years. According to Transport Canada, Distracted driving was the cause of 21 percent of fatal collisions across Canada in 2016. The governments have spent money hiring safety advocates and highway designers to keep the attention of the drivers on the road. Distracted driving is extremely dangerous because, while driving, the driver needs to react fast to complicated traffic situations. And, any distraction that takes the driver's attention decrease the reaction time for the driver. Using cellphones and looking at other screen devices when driving is dangerous because the while the driver is not looking at the road ahead, he/she cannot respond to anything that happens in front of the vehicle.

There are many newly introduced supervisory technologies available to drivers. These include blind-spot detection, lane departure warnings and reverse automatic braking. Eye tracking technology is something that has not been explored in-depth, but provide a future opportunity, especially with the introduction of semi-autonomous driving systems. This eye tracking technology will fit into the same category as other supervisory technologies that are already in place.

Our Solution

The solution is an integrated eye tracking system that can monitor the alertness of any person driving a light motor vehicle. If the system detects that the driver is distracted, it will use audio and visual alerts to regain and deliver the person's attention to the road ahead. If these alerts don't work, a representative with OnStar will try and contact the driver through an intercom. If the driver still doesn't respond, the representative will notify police cruisers nearby and other appropriate emergency personnel. Meanwhile, if the car has a capable semi-autonomous driving system, it will pull over on the side of the highway.

Our solution can prevent fatal accidents happening due to distracted driving. The goal of this solution is to put safety precautions and warning systems in place to minimize distracted driving, and thus, preventing fatal accidents from occurring. Furthermore, this solution will be ubiquitous in all cars in the future, because it will be necessary to monitor alertness of drivers as more cars come pre-built with some type of semi-autonomous driving systems.

Some drivers of semi-autonomous cars rely heavily on these systems to the point that they seem to forgo any warnings or special instructions of periodic handling. Drivers completely let go of the control on freeway, leading to high-speed collisions. This happens because when a new technology such as a semi-autonomous driving system is first introduced, people tend to overestimate the capability of the technology. As this is the case, an adequate supervisory solution is very much needed in the future. Our eye tracking system can regain the alertness of the driver if it thinks that the driver is distracted. Our eye tracking system provides the ideal supervisory solution to this problem.

Our Eye Tracking System

Our eye tracking system consists of a device, software algorithm and user interface applications. Therefore, the technical details of the eye tracker include functioning of the device, software algorithm that implements a programmable control system, and software applications that manage the user interface.

Our Device

This is a representation of our device:

Our device will be mounted on the dashboard of the vehicle. It has a built-in weak near-infrared illuminator that is only strong enough to detect the eyes but not to harm them. It also has a modified camera that only detects infrared light. Most cameras have a near-infrared blocker. We remove this near-infrared blocker, and add additional filter to filter out true colors, leaving only near-infrared light visible.

Eye Tracking Method

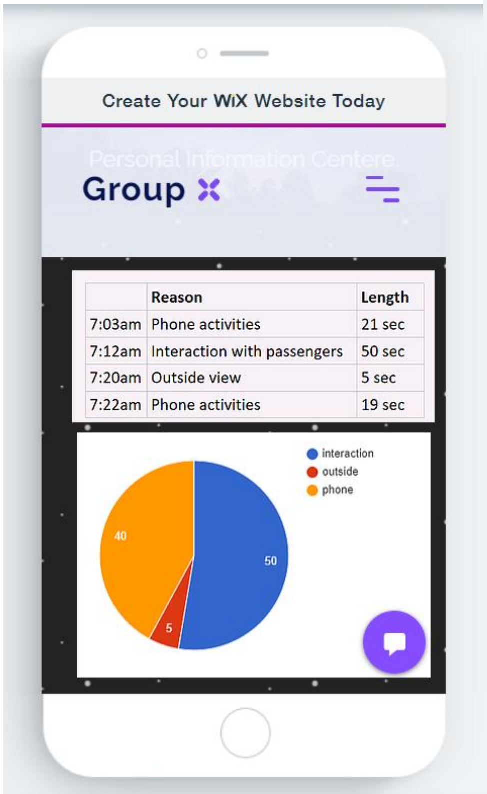
In order to measure gaze direction accurately, we will be using an infrared light source. This light source is directed to the driver's eyes, creating noticeable reflections in both the pupil and cornea. A camera captures the location of these reflections. Pupil Center Corneal Reflection (PCCR) is the name of this method of eye tracking. We utilize PCCR to obtain a point representing the gaze direction of the driver.

The on-board chip analyses the image to calculate a gaze point based on the vector between these reflections. Based on the vector between these two reflections, the gaze direction of the driver is approximated as a specific point. In other words, the gaze direction is mapped onto a specific point on an image of a dashboard. If our python algorithm detects that this specific point fall outside of recommended gaze direction, then the warnings are issued to the driver.

User Interface Applications

We developed a mobile phone application works on both android and iOS to seamlessly integrate our device with the driver's phone. This integration is necessary for initial calibration, data storage, and functioning of our intercom. In addition, the driver is able to view their driving statistics via a user-friendly mobile and web user interface.

At a glance, our user interface provides an overview of driving habits and advice. Further into the user interface, the application provides the drivers information about their driving habits organized into bar charts and pie charts. The drivers can manage their subscriptions to our services through a specifically designed secure section. They also have an option to share their driving habits in order to get a discount on car insurance.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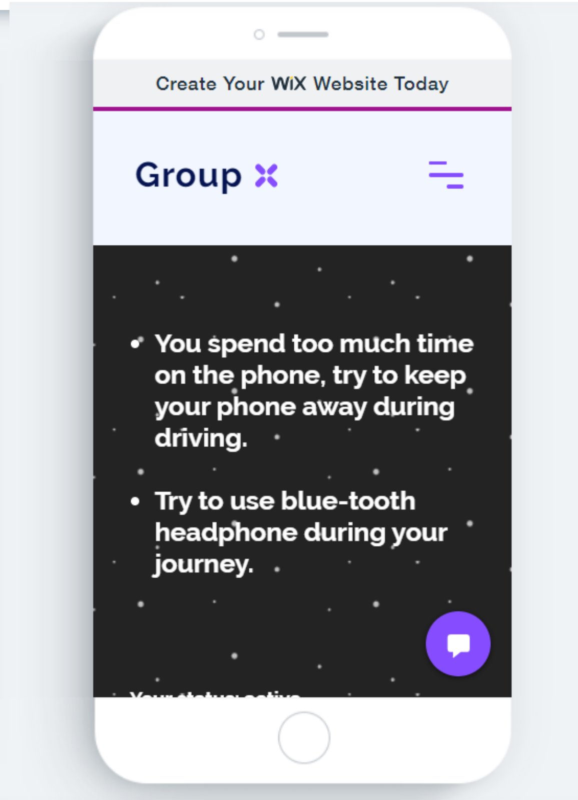
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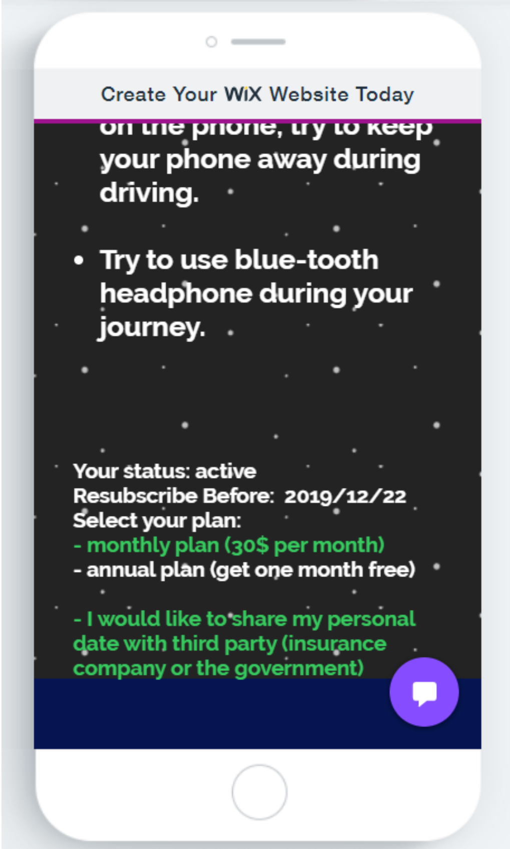
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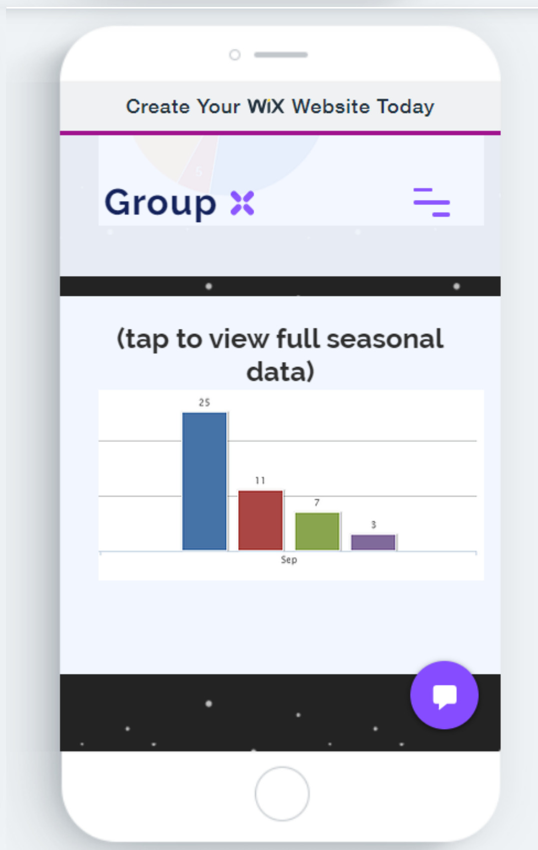
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Algorithm Demonstration

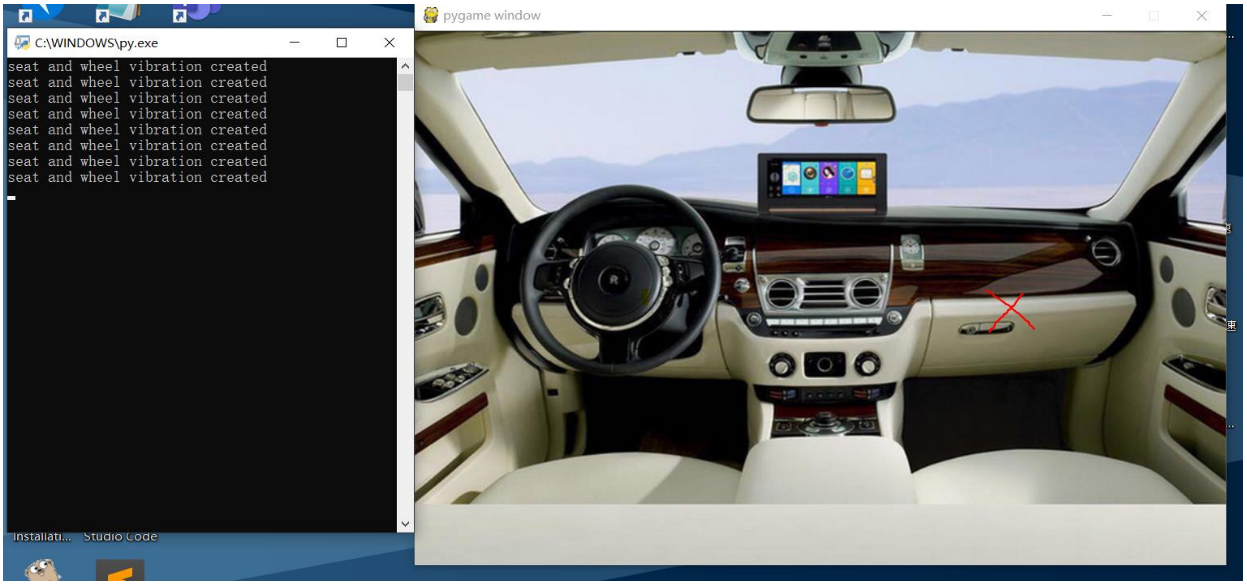
It is impossible for us to build the actual eye tracker using the current resource. However, we can still compute the basic algorithm of our project, and we can use Python to simulate the user interaction.

The algorithm of the eye tracker is very simple. We first get the user's gaze point, so that our device knows where the driver is looking at. When the driver looks at the wrong direction for too long, our device will give alerts in both vibration and sound. We basically divide the area inside the vehicle in two parts, one is the safe area and the other is the dangerous area. The only area that is considered safe area is the front window. All the other areas in the vehicle, such as the left and right window, monitor in the vehicle or any where below the front window(for example when the driver is using a cellphone, he/she will look down to the cellphone), are considered dangerous areas. When the user staring at the dangerous areas for a few seconds, out device will create alert.

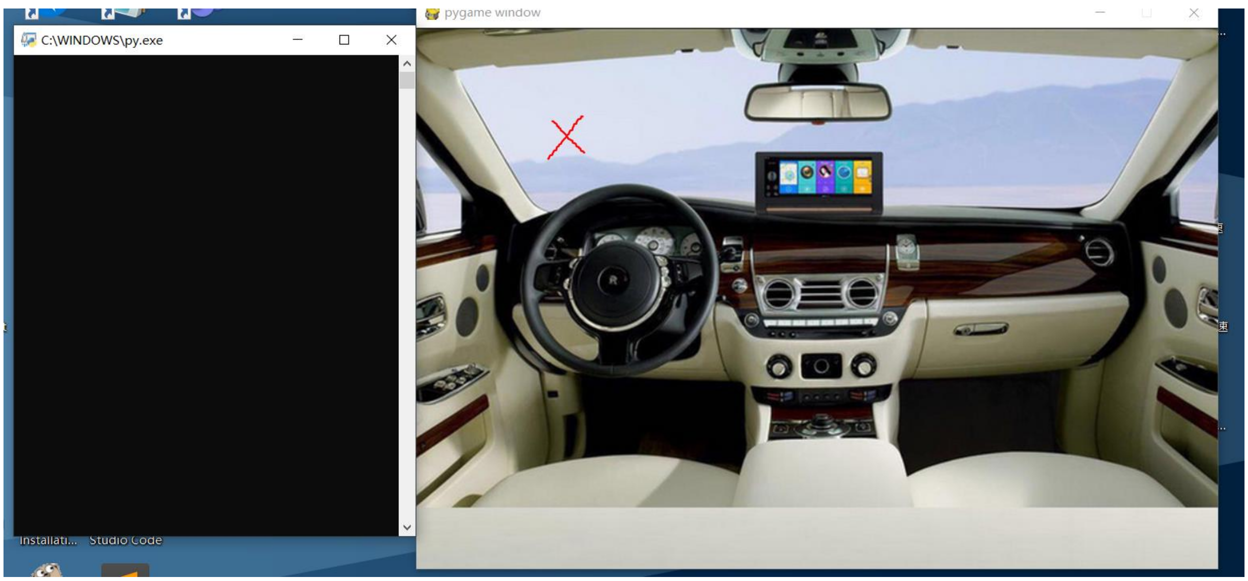
It is then important to determine the time interval of how long the driver looks to the dangerous direction is considered distracted. Our device can calculate this interval using the speed of the vehicle. Our users can decide whether they want the time interval to be longer or shorter. Make it shorter so that it is safer when driving or make it longer so that it is not annoying. It is all user's decision. However, no matter how long the user wants the time interval to be, it has to be less than a certain number so that our device is meaningful. The limit of the time interval is relatively quite short, for example, when the vehicle is moving at 50 km/h, the limit of the time interval will be around 5 second. It may seem too short; however, it is not. A vehicle with speed of 50 km/h can move 70 meters in 5 seconds. Which is a big distance that if the driver is not paying attention, the vehicle will just blindly move forward for 70 meters and any accident can happen. Any normal activities such as looking at the blind spot or looking at the passengers around intersections, usually take less than 2 seconds to finish. So, 5 seconds is long enough to be the limit. When the vehicle moves at 100 km/h, the limit will be only around 2.5 seconds, since the vehicle is super fast, and driver's attention is always needed.

The following images demonstrate a working demo of our alert system. There is a picture of the driver's perspective inside the vehicle. The red cross represents the gaze point of the driver.

The image below displays the state when the driver is distracted, and the warnings are activated, the warning will keep going on if the driver does not look back to the correct area which is the front window:



The image below displays the state when the driver is focused on driving. No alerts created:



Financials

Assuming we continue to retain and grow the customer base over the next 3 years, our revenue model is being represented in the following table.

	1st year	2nd year	3rd year
Sales Forecast (Devices)	$300,000	$500,000	$700,000
Revenue ($100)	$30,000,000	$50,000,000	$70,000,000
Revenue (Monthly $300, approximately)	$9,000,000,000	$15,000,000,000	$21,000,000,000
Total Revenue	$9,030,000,000	$15,050,000,000	$21,070,000,000
Cost of Device ($70 per device)	$21,000,000	$35,000,000	$49,000,000
Employee Overhead	$3,000,000	$2,500,000	$2,500,000
Licences & Leasing	$75,000	$75,000	$75,000
Advisement	$390,000	$390,000	$390,000
Head Office Rent	$200,000	$200,000	$200,000
Profit Before Tax	$9,005,335,000	$15,011,835,000	$21,017,835,000

This revenue model does not account for initial funding rounds, loan payments, and interest payments on loans.

Subscription Revenues

Each user would pay 30 dollars per month, if they decide to subscribe on a monthly basis. And, we have a promotion of an annual subscription which gives them one month for free.

User’s service plans:

- Monthly service fee: 30 dollar per month
- Annual service fee: 330 dollar per year

Long Term Resources

In order to sustain our business model over the next 3 years, we will need to acquire talent. We will also need to spend money on advertising to keep up the growth.

Long Term Expenses (3 years plan)

	Number of Positions	Time Period	Approximate Cost per Year
Software Engineer	4	36 months	$140,000 - $200,000
Embedded Engineer	2	12 months	$140,000 - $260,000
Business Development Manager	1	36 months	$40,000
Licences & Leasing (hardware & software)	N/A	36 months	$60,000 - $75,000
Cost of Device (Installation & Maintenance)	1,500,000 devices	36 months	$70 (per device)
Advisement (Google and Magazines)	N/A	36 months	$310,000 - $390,000
Head Office Rent	N/A	36 months	$160,000 - $200,000
Total cost			$120,690,000 - $120,965,000

Talent Management:

We will look for local talent by advertising our software development position on local job boards and campus websites. Our developers will work on developing and perfecting our python algorithm, and our user interface applications. We will position our head office in a large metropolitan area such as Toronto in order to have access to talented developers pool.

Conclusion

Driving itself, compared to other methods of transportation, is already one of the most dangerous human activities. When the driver is distracted, it can be life or death for all the people on the road. A solution is needed immediately. There are new technologies invented each year to lower the rate of traffic accidents and to provide safety to people who drive light motor vehicles. However, there is no perfect technology that solves the problem of distracted driving. Therefore, we are interested in using eye tracking technology to protect people's lives on the road.

We expect to bring to market a robust stand-alone eye tracking device that utilizes near-infrared reflections to track the gaze point of the driver. We use this gaze point as an input to our proprietary python algorithm detect if the driver is distracted, and if so, to provide warnings and alter to regain the attention of the driver. Our technology is aimed at preventing distracted driving by continuously monitoring the gaze point of the driver. Our system will act if it determines that the driver is distracted.

We intend to give drivers the ability to track their driving habits by providing them with an integrated software application for mobile phones. Our mobile application user interface will provide important statistics about driving habits. The drivers who share their statistics will receive a discount on their car insurance premiums. Our eye tracking technology not only provides safety, but also saves money for drivers who are safety conscious.

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