Developing an Interactive GUI dashboard for the RAHT Racer

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Abstract

This project is a partnership with Kronfeld Motors, in which our team is developing software for their revolutionary vehicle known as the "RAHT Racer". This vehicle is an enclosed electric cycling car that combines the efficiency of an electric vehicle with the convenience of a mobile workout machine. The RAHT Racer uses a battery charging method that resembles an exercise bike so that a driver can both workout and charge their vehicle while driving. The RAHT Racer constructed so far does not have a proper interface for the driver, our team's primary goal is to develop an interactive dashboard so that the user might be able to view data regarding the watts generated as a result of pedaling, the distance peddled as well as the data from the speedometer.

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1. INTRODUCTION

The idea of an electric vehicle that was powered by no fossil fuels dates to the 1800s, but was never quite feasible until modern advancements in battery cell technology at an affordable level. There were multiple different reasons to enhance research into fully electric vehicles; such as rising prices in gasoline, increased worries about carbon emission in the environment, and even the fact that gasoline would eventually disappear one day as a non-renewable resource (Matulka, 2017). It was a combination of all of these reasons that helped influence Rich Kronfeld with the innovation of his new vehicle, the RAHT Racer. The RAHT Racer is a fully electric vehicle that also functions as a mobile exercise bicycle by combining the ability to use the pedals inside of the vehicle to charge the battery, even while driving down the road. The RAHT Racer is a fully enclosed vehicle that is highway legal (classified as a motorcycle) and can reach speeds of up to 100 mph and has already drawn investors from across the country. The purpose of our research was to design a Graphical User Interface (GUI) for the vehicle that would allow the driver of the vehicle to view information provided by the vehicle while driving both accurately and safely. The reason this goes beyond an average vehicle dashboard is due to the inclusion of functions and data that are generated by the exercise bicycle component of the vehicle, such as watts generated while pedaling and other common statistics. The inclusion of additional viewable parameters that must be represented in the vehicle display created additional requirements that would not be seen in the display of a typical vehicle. This paper will discuss the design techniques utilized, the reasoning behind the importance of this display, and how the team went about implementing these techniques.

2. HISTORY OF THE RAHT RACER

The RAHT Racer is the brain child of Rich Kronfeld who grew up as an avid bicycle lover in suburban Minneapolis. When Rich started to work in the Twin Cities area, he decided he wanted to commute to work through bicycling as a way to exercise during his everyday travel. While commuting on bicycle, Rich would run into interruptions in his commute such as a poor weather. In order to combat this issue, Rich began to consider purchasing a covered bicycle so that he could continue his commute during poor weather, but was shocked to see an incredibly high price tag for something that would still just be a daily commuting bicycle. After investigating his options, Rich started to think of his own solution. He wanted to create an enclosed vehicle that would allow him to travel as he pleases just like a car, but still have the option to get exercise during his commute; and through this idea, the RAHT Racer was born. Rich started Rahtmobile, LLC (now under the name Kronfield Motors) with Cofounder Robin Doroshow and gained the help of his Chief Body Designer Lyon Smith to make his idea come to life. Since the inception of the RAHT Racer, it has received praise from all around the country for its ingenuity. One such

situation of this was when the team of Rich and Lyon became the winners of the “All American Makers” business competition series on the Science channel.

3. THE IMPORTANCE OF A GOOD USER INTERFACE/ USER EXPERIENCE

If you were to ask a person to think of a perfect user interface (U.I.), most people automatically go to the artistic aspects of design; things such as color, shape, and symmetry. What most people fail to realize is that a great U.I. design goes much deeper than just simple aesthetics. Great design substantially increases the amount of trust a visitor gains with your product, therefore increasing the amount of business they are willing to do with your company. The opposite can be said for an inadequate design. If fact, a bad design tends to send users bouncing away in search for something more reliable. The UI design impacts every single moment a user spends with your product. It can be the difference between a great user experience (U.X.) or a poor one, which ultimately can drive or lose business.

In today's vastly changing business world the user experience is considered to be a huge component of a company's brand. It contributes to a consumer's overall impression of how a company handles business. It is the reason consumers become brand loyal customers. For example, take a look at Apple products. Owners of these products continue to purchase from Apple because they are accustomed to the simplistic U.I. which created a great U.X. Technology journalist Zach Epstein from bgr.com stated in his article titled '*8 Reasons I Still Can't Leave the IPhone and Switch to Android*', "*Android has made great strides where performance and fluidity of the user experience are concerned, but it just can’t ever seem to catch up to iOS. Things as simple and integral as scrolling never exist without hiccups on even the most powerful and modern of Android devices. Meanwhile, anyone who has used an iPhone 6s or even earlier iPhone models will tell you that the iPhone’s user experience is smooth as silk.*" Apple proved that a good U.I. creates a good U.X. They understood that a good U.X. is very good for business because it facilitates less product abandonment, more customer loyalty, and generates more business through customers sharing their experience of said product.

When the U.I. is focused more on the U.X., designers need to take into account issues of cognitive psychology, Industrial psychology, anthropology, and sociology, as well as principles of graphic and content design. By abiding by this philosophy designers ensure that the U.X. is great in every aspect of interaction with a specific product. This

ultimately creates an optimal interaction between your business and your customers, while informing analysis of current user behaviors for future re-designs.

4. HOW THE VEHICLE CURRENTLY HANDLES THE INTERFACE AND WHAT IS WRONG WITH THE CURRENT SETUP

RAHT Racer constructed so far can be driven by the user by inserting the key and powering the vehicle up. It does not need a dashboard to start up or to drive. But for the vehicle to be actually used by the driver on the road, it needs to display information regarding the car's status. A car can be driven without a dashboard but it cannot be driven "safely" without it because the information regarding the status of the car is critical for the driver in order to drive safely (Harel & Sitko, 2003).

There are two options for the dashboard, electromechanical and electronic, the electronic one has advantage over the non-electronic as it provides more versatility and is easier to connect with electronic controls. It also provides flexibility in changing the interface design in later models (Jurgen, 1981).

Some car companies have used a similar approach for the user interface, the most prominent example is that of Tesla Model S which includes a touch screen interactive display with the help of which user can control the car, this type of interface allows for future software updates. The interface provides navigation services with the help of maps. Model S also includes a mobile app which keeps track of car's charging, temperature and its location in real time (Tesla, Inc., 2017).

In the light of importance of a user interface for an automobile, this paper presents the design of a dashboard that will make driving experience of RAHT Racer more comfortable for the driver.

Owing to size of the vehicle, the current interface of RAHT Racer is a small sized touch panel which displays information in the form of a bar graph. It lacks a number of important features that must be the part of a vehicle's dashboard, for example: display of current speed, battery charge level, temperature of the vehicle, watts generated by the driver and distance extended by the vehicle.

Furthermore, our client has other requirements as well regarding the use of RAHT Racer as an exercise bike. RAHT Racer is to provide functionality associated with a fitness machine. For example displaying user's profile data like age, height and weight. Also the number of miles pedaled by the driver, the number of calories burnt and watts generated as a result of pedaling are to be displayed on the interface so that the user can use RAHT Racer to keep track of her/his performance. The machine is also supposed to provide navigation to the user in the form of preprogrammed routes on a map.

5. METHODS

5.1 FRONT END IMPROVEMENTS

The vehicle's graphic user interface (GUI) was designed based on the needs of the product owners as well as its intended users. The intended users in this case were identified as anyone wishing to work out on a bicycle, or someone wishing to commute on a bicycle. To cater to the needs of both sets of users the GUI provides the functionalities of a motor vehicle's dashboard as well as the functionalities of a fitness machine's display screen.

On Power up, the home page (Figure 1) is made available to the driver, which provides the latter with the option to create their own account or open/delete their already existing account if they are not a new user. The home page also provides its user with immediate access to the recently opened accounts in the system as well as the readily available Guest Driver account. Moreover, the home page provides the driver with two different ways to search for their account namely the search bar, and the Other Driver option.

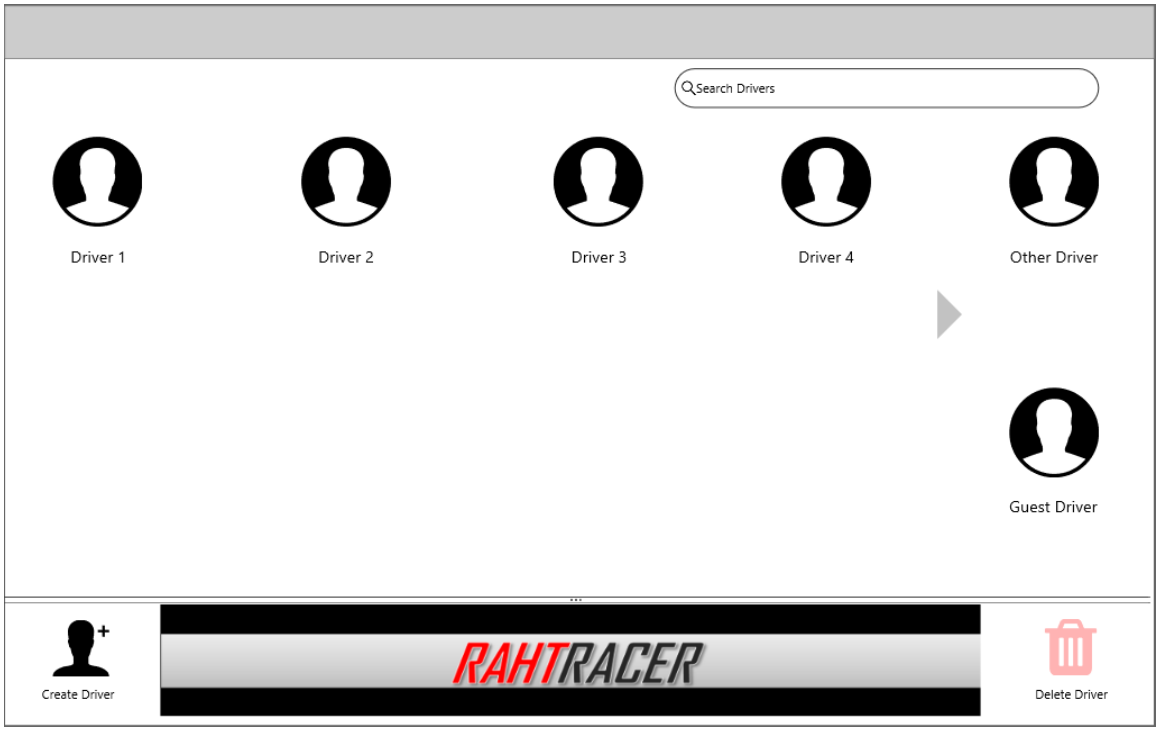

Figure 1: RAHT Racer Home page

The Guest Driver account was meant for onetime drivers. It allows the driver to use every features of the RAHT Racer without having to create an account or provide a password. The only feature this account does not provide its user is storage of the user's fitness data. As a result, the user will not be able to track their fitness progress while logged onto this account. The lack of storage in this account makes it suitable for drivers who plan on riding the vehicle once or for drivers who are not interested in keeping track of their fitness progress.

With the search bar, and the Other Driver option, the driver with two different ways to find their account. The search bar allows the driver to isolate their account from the rest of the accounts I the system by using the driver's username. As the driver enters their username, the screen is populated with the account(s) that match the name entered. In addition to that, the Other Driver option gives the driver the list of all the accounts registered in it.

The delete option gives the driver to carry out a soft delete or a permanent delete of a user account. The Soft delete allows the driver to delete an account from the list of recently accessed accounts, without deleting it from the system. In the same light, the permanent delete performs the same task as the soft delete but in addition to that, it permanently removes the account and its records from the system. With this delete option, the driver is able to control the number of accounts in the system. However, the delete

option only affects the user created accounts and has not effect on the Guest Account.

The User created accounts (Driver accounts) give the driver access to all the features of the vehicle. Unlike the Guest Driver Account, the Driver Accounts are password protected (Figure 2) and allows the storage of fitness data. However, a driver wishing to create an account will be prompted to fill out a short form (Figure 3). Logging onto any of these accounts, gives the driver access to the Account page (Figure 4).

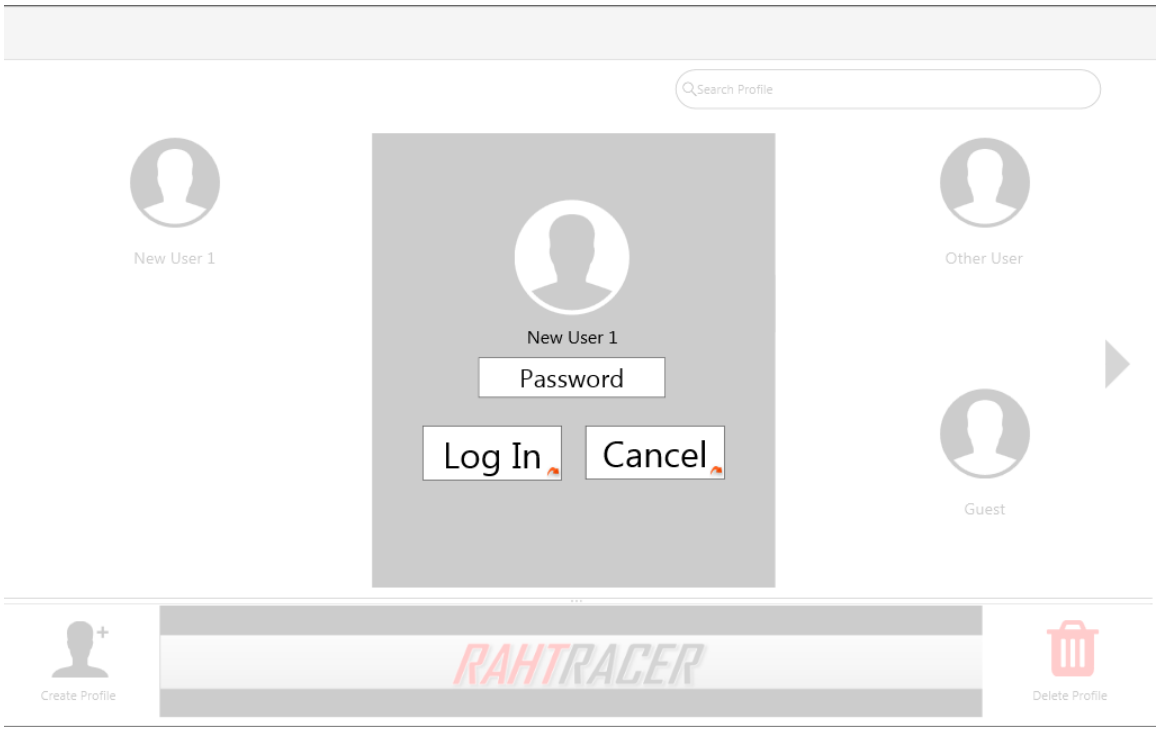

Figure 2: Login Page

On the Account page, the driver will be able to see a map that that displays the vehicle's current position. To complement the map, the page will have a dynamic cross-sectional terrain map which displays the situation of the vehicle with respect to the topography of the vehicle's surroundings. The Page will also provide information pertaining to the driver's fitness performance as they paddle. Along with the fitness data, the Account page will display data related to the vehicle's speed, battery charge levels, and time of the day. The Page further provides options to the user to adjust their fitness mode, logout of their account, adjust their account settings and even switch user accounts

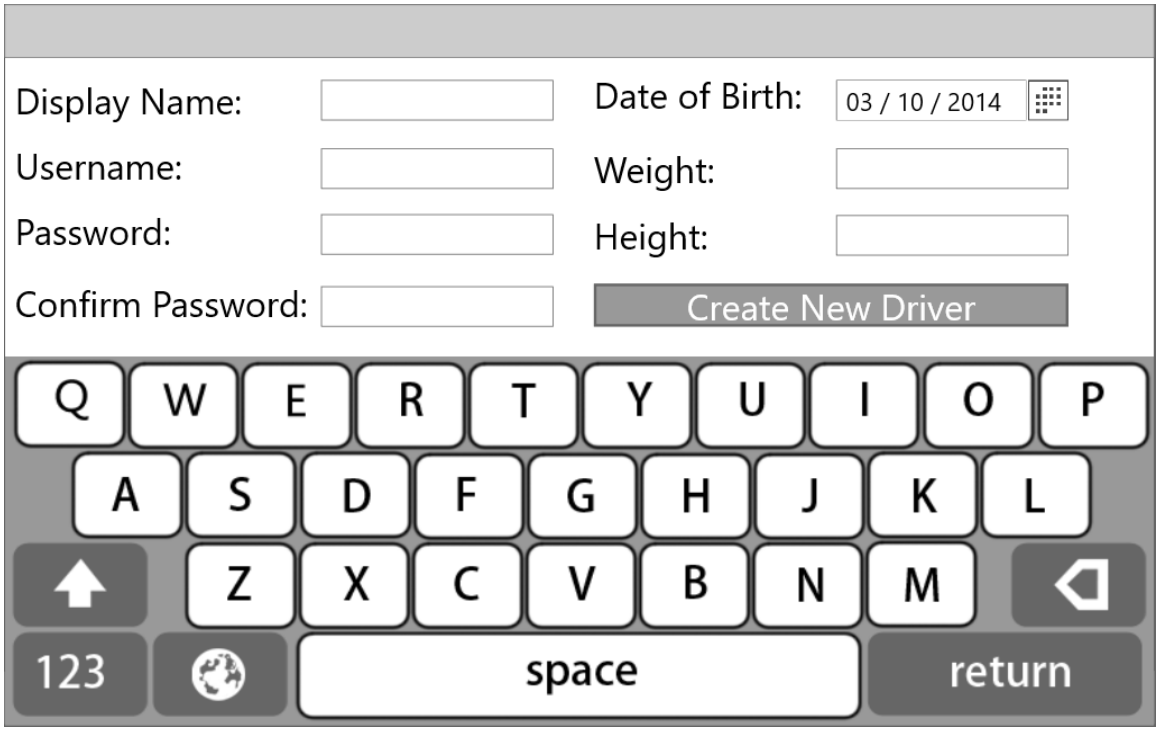

Figure 3: Create account

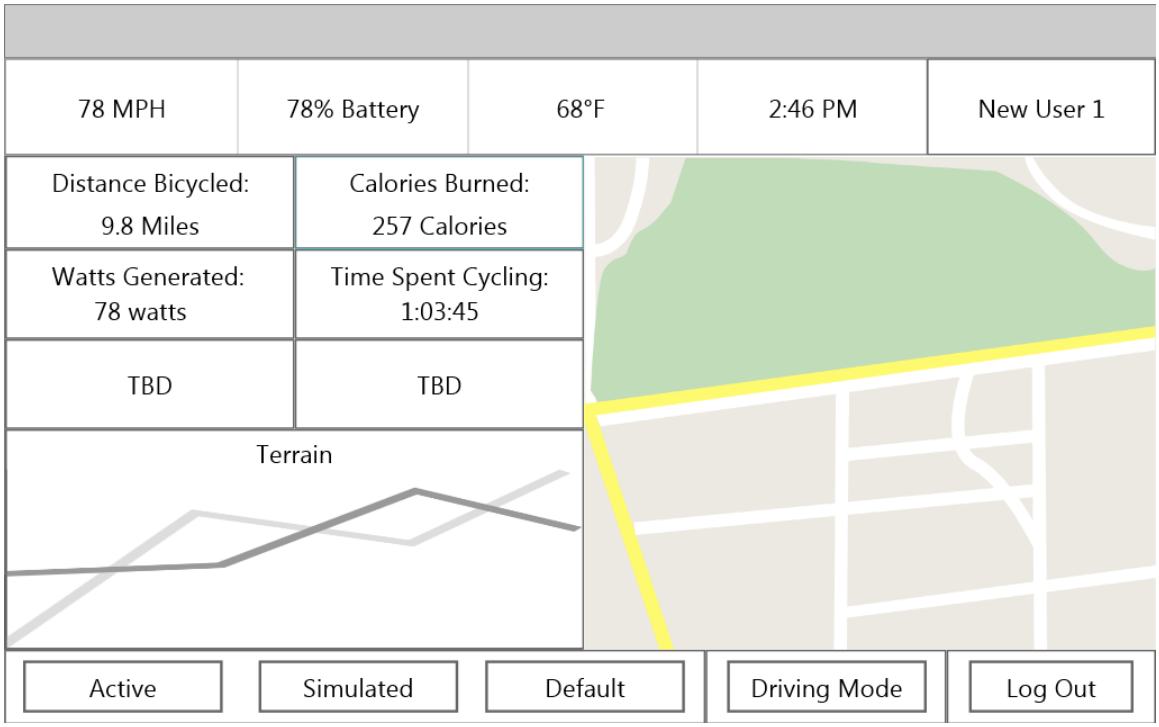

Figure 4: Account Page

5.2 BACK END IMPROVEMENTS:

The backend of RAHT Racer application will be developed using open layered architecture with one or more components in each layer. The layers consist of application layer, database layer, hardware controller layer and the hardware layer. In open layered architecture a layer is able to interact with any other layer below it, thus increasing performance of the system (Kumar, 2014). Although this architecture might reduce the reusability of the layers but performance has a higher priority as a non-functional requirement as compared to reusability in this system. Using a layered architecture will allow us to have high abstraction in the system and the ability to add or remove layers thus making the software more flexible as well as more modifiable (Sosio & Paoli, 1996). This section briefly discusses all four of these layers.

The hardware layer consists of sensors which will gather data from the vehicle such as the speed, location, temperature, battery charge level, distance extended by the vehicle, distance peddled by the driver etc. The data gathered by this layer will be communicated to the hardware controller layer. The hardware controller layer, coded in Arduino software, will be responsible for receiving data from the hardware layer and forwarding it to the application layer.

The application layer will further perform calculations on the data such as determining the number of calories burnt by the user etc. It will also be responsible for sending the relevant data into the database layer regarding the vehicle. The data entered by the user through the user interface will also be forwarded to the database through the application layer such as the user profile information. The application layer will be coded in java in android studio.

The database layer will be used for storing the user information as well as the information regarding the vehicle. Data to be stored related to the user profile includes the user name, password, birthdate, weight and height. Data related to the vehicle includes the distance travelled, route taken, the start and end time of vehicle usage. Data for the user fitness profile includes the number of calories burnt and the distance peddled by the driver. This data will be stored in the form of a database file in the android tablet's storage space. We are using SQLite Database package available for android studio for this purpose with the help of which a private database will be created for the application. An android tablet is being used in RAHT Racer consequently storage space is limited, thus SQLite is a good choice for this system as it is a lightweight database and requires limited memory at runtime (SQLite, 2017). The database size is also small which is according to our requirement as we do not need to store huge amount of data for our application.

6. CONCLUSION

Technology is constantly evolving in the world of software and new techniques are being constantly created to keep up with it. While new methods of implementing these technologies are being created, it is important to fully utilize new techniques that have been finely crafted throughout the history of software engineering. This is shown in full force with the team's strong focus on creating a quality user interface for the RAHT Racer, which is mainly noted for its key innovative features. These techniques may be seen by many as unexciting and rigid, but they are so integral in the quality of life for day to day users of any technology.

Innovation will continue to happen in the world, but it would not exist without the knowledge of the software engineers who continue to lay the foundation for it to exist.

7. REFERENCES

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