gTrip

Your Sustainable Transportation App

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Date Submitted: April 12, 2011

Course: ECE1778 – Creative Application for Mobile Devices

Professor: J. Rose

Introduction

Sustainability is an increasingly important issue that is heavily dependent on people's choices. Despite its importance, the cause isn't being championed quickly enough. Transportation in particular has significant impact and potential to reduce these impacts through altering user behavior. The transportation sector in the United States is the largest consumer of energy at 26.8% of total supply and is also the least efficient at 25% (Lawrence Livermore National Laboratory, 2010). This is a significant opportunity for improvement which cannot be met by more efficient engines since personal transportation wastes energy by moving the car instead of the person (which is only a fraction of the weight). The answer lies in transforming people's mode choice to a vehicle with higher passenger capacity (such as mass transit) and/or a less energy intensive mode such as active transportation modes (walking and cycling).

However, the motivation to switch modes is not as simple since people have various priorities and preferences. Too often do the sustainable options get pushed onto people without them becoming informed and making the choice themselves. A preferred method is to inform users about the various impacts, provide them with the sustainable options and reward positive behavior.

To address these issues gTrip is an app that will demonstrate to users that they prefer the more sustainable modes of transportation and encourage sustainable behavior with positive reinforcement.

The way gTrip does this is by:

1. Obtaining the user's desired travel route
2. Calculating time, environmental impact and cost of the inputted routes
3. Displaying the attributes of each mode allowing the user to choose a mode
4. Displaying directions for the chosen mode
5. Tracking the user's travel patterns so there is observable improvement

Additionally, gTrip can collect data on difficult to obtain user behavior and preferences to be provided to transportation planners. This is critically important so that the transportation infrastructure can determine and evolve to meet the demands of the users.

App Design

Screens

Selection Screen: The user is displayed with all the functionalities (listed below) to select from.

Carbon Footprint Data: Data is fetched from the database carbon footprint of the user and displayed in a clear manner.

Travel Path Screen: The user is required to enter origin and destination addresses and other options such as avoiding highways.

Mode Evaluation Table: The user is given a table of the cost, travel time and carbon footprint for each mode possible.

Map & Route Display: After the user has picked their most desired mode and route the relevant Google Map is displayed to guide the user throughout the trip.

Monitor Block

The monitor block is used to track user's carbon footprint using GPS over a long period of time.

The steps the monitor block will take include:

1. Obtaining the location of the user using the GPS radio.
2. Calculating the travel path of the user between tracked consecutive GPS locations.
3. Calculate the carbon emission between each pair of points
4. Saving the data into a data base on the phone so that it can be viewed in the history module.

Direction Block

The direction block offers the user a variety of travel methods and path choices between 2 locations. Selections are compared in terms of travel time, distance, cost & carbon emissions.

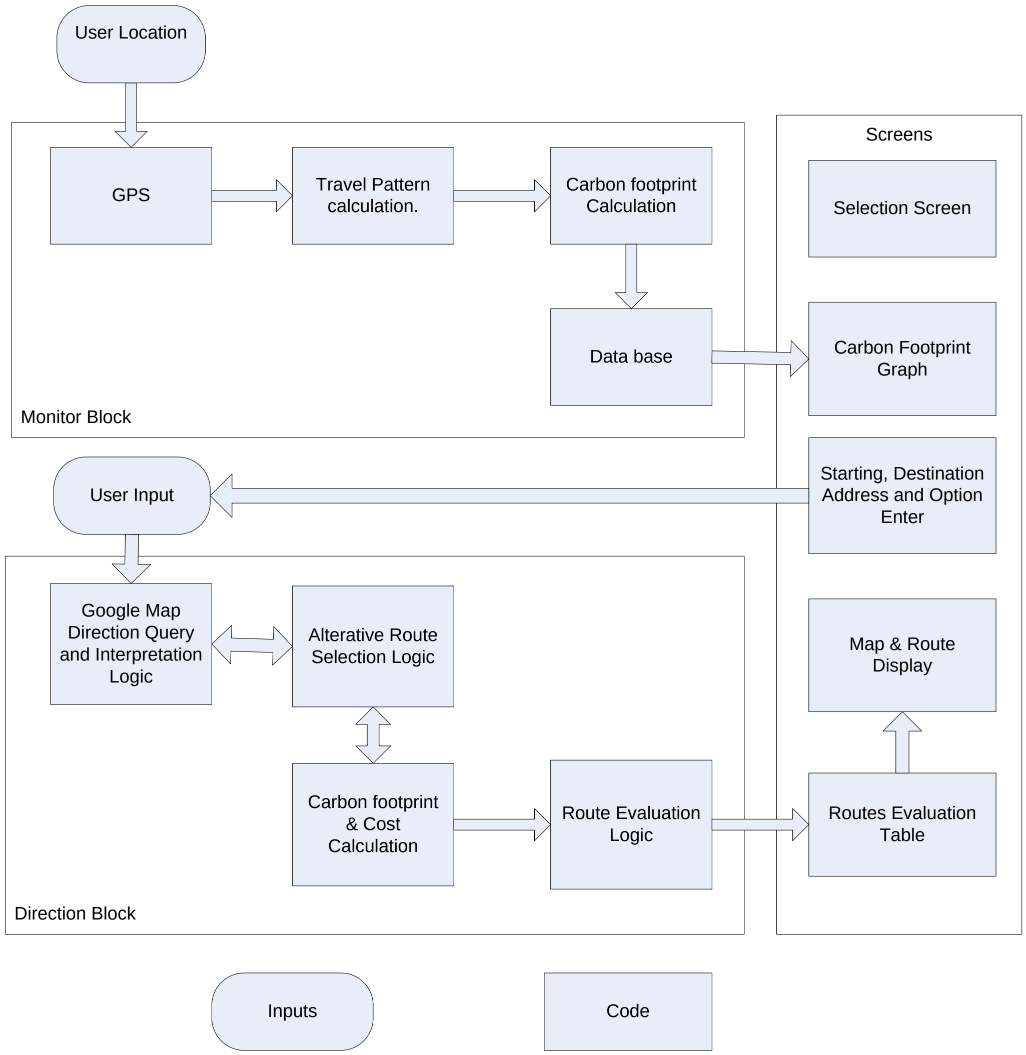
Google Map direction Query and Interpretation Logic

This block is the backbone of the entire program. It takes two geometric locations and a few other inputted travel parameters, requests Google Map Direction Web service and translates it into a data structure that the program can access.

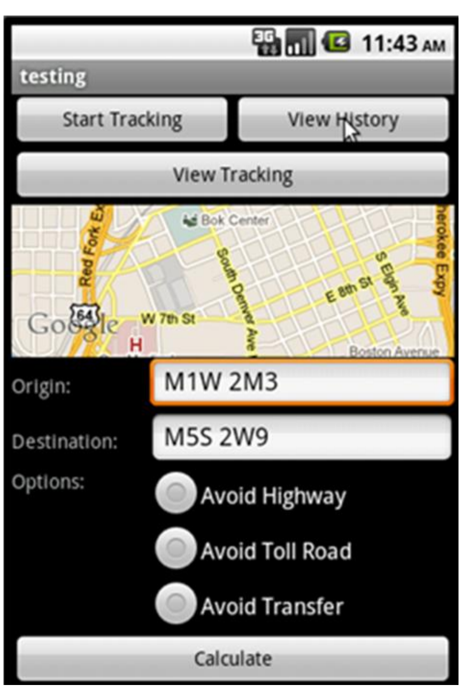
The Android platform does not offer any classes that can be used for directions. The only option for calculating the travel path between two locations is to request the direction from Google through URL requests. The data returned is the source code of the webpage and shows the directions in HTML. The HTML has to be interpreted by the program to extract detailed direction data.

Carbon footprint & Cost Calculation

This code block takes the distance and travel mode as inputs and generates the carbon emission that the travel option will produce. The calculation simply applies the proper emissions factor to each mode.

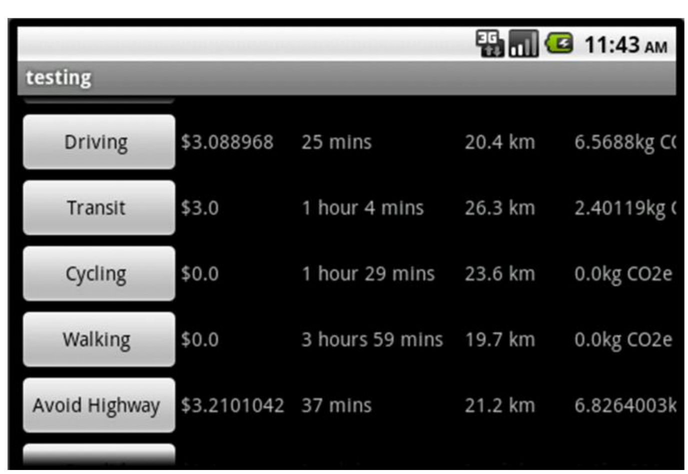


Statement of Functionality

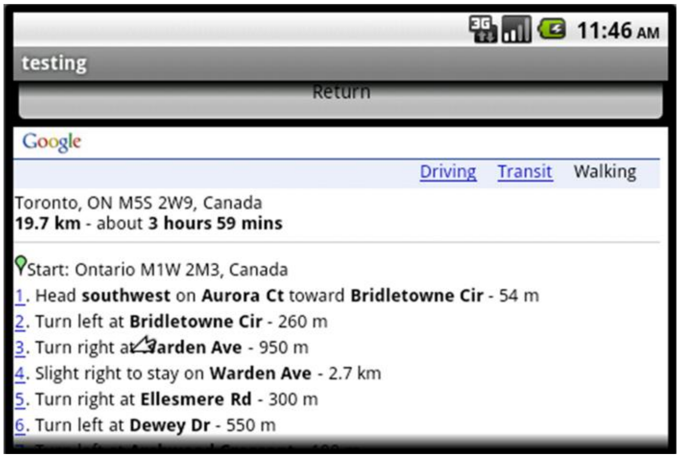


The user interface is intuitive and is similar to Google Maps with similar inputs and correctly queries Google Maps for HTML code.

The mode comparison function obtains data from Google maps, applies the appropriate factors and provides time, cost and GHG emission data for each mode. The most optimal mode based on the user's preferences is suggested. However, because the cost and environmental impact of cycling and



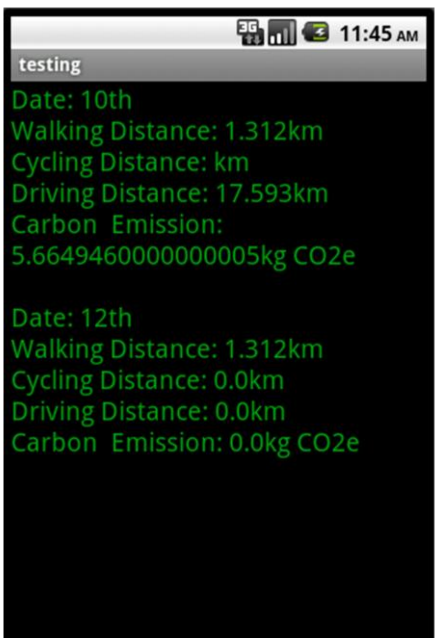
walking is usually factors less than their increase in time when compared to driving they are unrealistically favored. This function was not implemented in the end. Instead, the choice was left to the user based on the information they received.



The app tracks the user's travel path accurately by accessing the GPS radio and recording the location every few minutes.

The travel history is recorded and maintained on the phones memory. The display of data makes it easy to comprehend and observe user travel behavior.

The multi-mode algorithm was determined but because of time constraints was not implemented.



When selected, the app properly queries Google Maps to provide the same directions the user would receive from that service directly.

Learning Experiences

Throughout the project the challenges that have arisen have led to several learning opportunities in the areas of time management, creative thinking, compromises and communication.

Due to the strict timeline, determining the specific app to be created at an earlier stage would have been beneficial. Overcoming obstacles such as proposal incompatibility (with the course requirements) is the reality since some ideas don't meet all the objectives in the real world. One of the main causes of late implementation is creatively using the phone's capabilities in the area of sustainability and civil engineering. Various methods of brainstorming or creativity stimulation would have greatly improved the number of options. This eventually lead to not being able to implement a few features in the end. A key change for new projects would be to comprehensively understand the requirements before attempting to proceed.

Another realization is that there is always a need for compromise. While the app could be more robust with specific GHG values for different cars and transit modes or consider more of the user's preferences, there still needed to be simplicity and usability on a mobile device. This is common throughout many engineering activities where there is a trade-off made between two conflicting goals such as cost and timeliness. Sometimes an elegant solution to suit both needs but in situations where that is not the case it is best to re-evaluate the initial objectives and goals set out in order to determine where to make concessions.

Lastly, more effective communication between group members would have improved the overall workflow and learning experience. This furthers the point of having proper time management since the schedule of both group members were extremely busy, particularly with other projects closer to the end. Early predetermination of expectations in terms of communication, availability and work style would be helpful.

Group Member Contributions

Jimmy executed the 'apper' areas of the project such as determining which user preferences to consider, the normalization and weighing algorithm, which multi-mode options to be presented through analyses of user behavior and gathered all cost and GHG emission data.

The factors of time and cost were chosen by Jimmy due to their impact on user choice, quantitative nature and ease of attaining (Davidson & Davidson). Greenhouse gases as added as a factor to quantify 'sustainability' of the mode since it is a generally accepted measure and relatable to transportation. The factors were then multiplied with the normalized data for each mode and a final weighing of how well the mode suited the user's needs was obtained.

The multi-mode options to be implemented were determined by Jimmy to be bike-to-subway and drive-to-subway because they are the most common ways of overcoming high wait times for buses in the suburbs and significantly reduce the total travel time (City of Toronto, 2011). Unfortunately, they weren't implemented in time.

Denny implemented the theoretical functions into an app form, determined the various modules needed and their layout within the app. Denny also implemented all functional coding, particularly the querying of Google Maps and extracting the necessary transportation data from the HTML code. Debugging of the code and testing of the application in real life was also performed by Denny.

Impact on Sustainability and Transportation Engineering

Transportation forecasting is an area with significant impact on the environment. Transportation forecasting aids the development of transportation systems by predicting travel patterns such as where people travel, what mode they take, when they travel and what route is taken. Transportation engineers take these predictions and evolve the transportation system or influence travel behavior to optimize user utility. Mode choice influence is targeted by the app because of the conducive nature mobile devices provide for influencing user behavior and the opportunity for high environmental impact reduction with low user effort (Demographia, 2005).

The Transportation Tomorrow Survey is an initiative to gather data on user characteristics and travel patterns. It surveys 5% of the Greater Toronto Area every five years, requiring significant resources. The survey collects data on origins, destinations, purposes, time, mode and demographics (Transportation

Tomorrow). Engineers then correlate routes, modes and origin-destination pairs with the demographic information to predict who will travel where, when and how. The app on the other hand, gathers explicit data about what users care about (and how much), the actual amount of time taken to travel and their exact travel route (not just the beginning and end). This pushes the boundaries of determining travel behavior based on 'wants' instead of 'cans' and on explicit data instead of inferences. Transportation engineers can also use app data and see which routes are most used and compare the actual travel time with the theoretical travel time it would have optimally taken.

gTrip also gathers data on how users react to information such as a comparison of GHG emissions. If the app expanded to include notices about construction or congestion then the impact of that information could also be measured. This is of significance because the diversion of traffic helps relieve congestion and the switch to different modes can reduce the environmental impact. The impacts on user behavior are also more explicitly observed with the app whereas current general behavior changes can be caused by various influences and aren't attributable to specific changes.

gTrip uses a simpler (than the state of the art) methodology for determining how users choose their modes without the need for iterations or models. The methodology also only relies on three parameters which makes it much simpler if these three can be an accurate predictor. As the mode choices are being made the algorithm for them can be refined to become more accurate.

Finally, the sustainability aspect is unique in the sense that it targets user behavior instead of increasing the efficiency of the car's engine or compromising with hybrid/electric vehicles. Demonstrating to users that their preferences lean towards the more sustainable alternatives puts the user in control and uses positive reinforcement instead of negative imagery and forced changes.

Overall, gTrip defines a new method for mode choice analysis, gathers critical but difficult/costly to obtain data and is uses proactive and preventative methods to achieve transportation sustainability.

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Next Steps

Improvements for gTrip include being more comprehensiveness in considerations and calculations, implementing a graphical history of user impacts and multi-mode options, integration with Google accounts and commercialization. The best scenario for the app to be used is on a frequent basis by a large group of users.

The robustness could be improved in terms of refining the algorithm for the suggested mode choice since cycling and walking have disproportionately low GHG emissions and costs. These two factors constantly outweigh time for most scenarios but in reality it doesn't represent how people choose. The GHG emissions and costs could be more thorough if they took into consideration location, model of car and driving behavior. The inclusion of traffic incidents and construction would also be of help to users who want to avoid congestion. Lastly, only two multi-mode choices were considered (bike to transit and drive to transit). While many more do exist they are not as prominently used. The app could be expanded include new mult-mode trip forms as they become more prominent.

The two portions of the project which could not be completed in time would be preferred to be implemented into the app. A graphical display of user GHG emission history (and possibly cost history) could help make the data easier to view. Multi-mode methods would also have improved the number of attractive options to users since it helps reduce travel time and GHG emissions in most cases.

The integration into Google maps would allow users to plan their routes in advance on a computer. This simply extends the apps capabilities to users without smartphones. Tracking and maintaining a history of the users GHG emissions, time and cost is still possible by just taking the data used to suggest a mode but would not be as accurate as the real life tracking. Integration with a user's Google account (or other online accounts) would provide the usage tracking, GHG emissions and cost savings histories over time in a convenient manner.

The commercialization of this app has many opportunities because of its ability to gather real time data on user transportation priorities and choices. This data is of great value to engineers, researchers, city planners, public transit authorities and so on. The data could be sold but the collection may face public safety and security concerns. If the advertisement route was chosen then location and interest based advertisements such as nearby bicycle shops, gas stations, GPS devices and so on could be provided. A more passive method to generate income would be for this app to qualify for carbon credits on a market in the future and then sell the credits from reducing user production. However, this might be ineffective if the users end up generating more carbon.

Currently, the app has only been tested in Toronto but may be applicable to other municipalities with similar modes of transportation. The target audience for the app would be commuters but can be used by anyone. It is less applicable outside of areas/trips that do not have public transit or are less conducive to cycling. The greater the number of users the better the app can he used to understand behavior and also the more user data that could be mined.

Conclusion

gTrip is an app that takes user preferences and demonstrates that the sustainable modes of transportation suits those desires. It does this to improve the sustainability of trips taken and can also provide useful data to authorities for transportation planning purposes. It tackles the issue of transportation sustainability in a unique and powerful way by influencing user behavior positively while having the convenience of being on a mobile platform. While improvements to the user interface, precision of calculations and commercialization exist, the app has significant potential to improve sustainability of how people travel.

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