CarbonRecorder: A Mobile-Social Vehicular Carbon Emission Tracking Application Suite

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***Abstract*—Excessive Green House Gas emission and high fuel consumption from vehicles has become not only an environmental but also an economic issue. This work demonstrates CarbonRecorder, a mobile-social application suite that are designed to enable individuals to track their daily vehicular carbon emission, and share them on social networks. It is intended to not only raise social awareness of vehicular carbon emission and encourage more efficient driving behavior, but also serve as a research platform for data collection for research in vehicular traffic management, carbon emission, and user behavior analysis in social network based applications.**

I. Introduction

As reported by the US Environmental Protection Agency (EPA), transportation sector is the second largest contributor to the Green House Gas (GHG) emission [1]. Within the transportation sector, vehicles used in our daily commute alone contribute to billions of tons of carbon emission each year [2]. It is commonly agreed that excessive GHG emission has huge negative impact on the global climate [3]. With the increasing oil prices, the issue of high fuel consumption and carbon emission has also become an economic one. Therefore, it is important to develop a platform that can track vehicular carbon emission on a personal and microscopic level and raise social awareness of the problem of excessive carbon emission.

Smartphones that offer advanced sensing, processing and storage capability with always-on Internet connectivity have become increasingly popular in the past few years. Since GPS receiver has become a standard feature on most smartphones, and most smartphone platforms provide an environment for application development, it is easy to develop mobile applications that can exactly track the trajectories of vehicles. Furthermore, using an instant fuel consumption model such as in [4], we can estimate the corresponding carbon emission produced. Although other factors such as vehicle's model, engine type, etc. also have impacts on vehicular carbon emission, estimating emission from trip information is a good approach to measure how individual driver's behavior affects carbon emission. Being able to measure personal vehicular carbon emission alone cannot provide enough incentive for users to keep engaged in the carbon emission measurement activity. Casual games based on social networks such as Facebook has been shown to be able to become highly engaging [6].

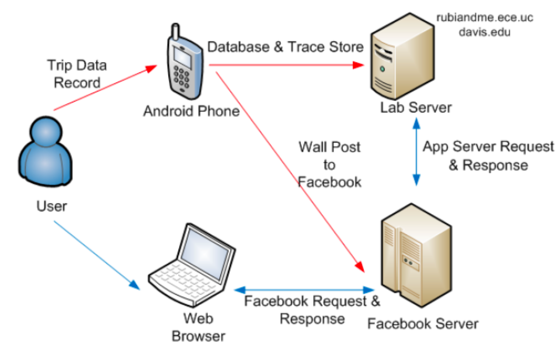
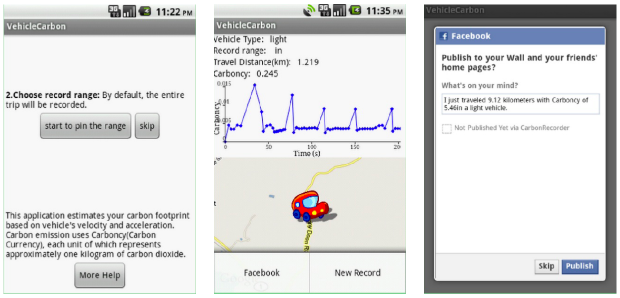


Fig. 1. CarbonRecorder System Architecture.

Therefore, tieing a corresponding Facebook application to the passive carbon emission measurement activity could encourage more user participation.

In this work, we demonstrate CarbonRecorder: a socially engaged vehicular carbon emission tracking application suite. In this suite, a mobile application for the Android smartphone platform [7] is used for tracking vehicular trip information for individual drivers, and estimating per-trip carbon emissions. Another Facebook application is also developed for storing and sharing trip and carbon emission records on Facebook, so that users could compare their results with their friends and earn virtual rewards. The Android application and Facebook application's records are linked and stored on a dedicated back-end server. The objectives of our mobile-social application suite are the following. 1) To raise social awareness of vehicular carbon emission. By helping individuals better understand their vehicular carbon emission patterns and turning the measurement activity into an engaging social game, individuals are encouraged to be more aware of their vehicular carbon emission, and possibly modify their driving behavior towards more efficient driving patterns. 2) To serve as a research platform for vehicular traffic management, carbon emission and social game research. Problems at a macroscopic level such as vehicle traffic management with consideration of carbon emission, how users interact with each other in social games, etc. could be studied from the rich data set aggregated from individual records.



(a) Selecting recording mode (b) Recording live carbon emission data (c) Posting results on Facebook

Fig. 2. Selected screenshots for the Carbon Recorder mobile application

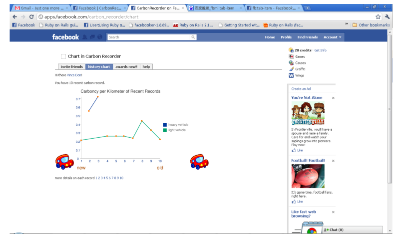
II. System Architecture

Figure 1 shows the system architecture of CarbonRecorder. It mainly contains three components: 1) a mobile client on the Android platform, 2) the Facebook application accessed through a web browser, 3) a back-end server. The mobile client is responsible for recording and visualizing trip and carbon emission information. It is also responsible for automatically transmitting the recorded information to the back-end server. The user could also choose to publish a wall post on his/her Facebook homepage reporting his/her travel and carbon emission information. The Facebook application is mainly responsible for visualizing historic records and provide social gaming functionalities. The back-end server stores all the records submitted by the mobile clients, and provides data to the Facebook application.

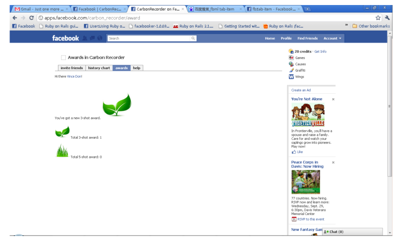
III. System Design and Implementation

A. *CarbonRecorder Mobile Client*

Figure 2 shows some screenshots of the mobile application. It runs on any Android device that has an OS version higher than 1.5, and equipped with GPS. Before starting to drive, the user needs to start the application and specify what type of vehicle he/she is driving (recording mode, as shown in Figue 2a). After the user starts driving and recording, the application then periodically retrieves the device's geographic location from the smartphone's on-board GPS unit. The update interval is less than one second. Upon each location update, the current location (latitude and longitude pair), distance from last location, speed, and possible accleration/deceleration are calculated. By employing the instant fuel consumption model in [4], instantaneous carbon emission is calculated, and displayed to the user in a dynamically updated carbon v.s. time graph. Besides the dynamic carbon graph, the user's current location is also displayed on Google Map, as shown in Figure 2b. When the user finishes driving and recording, all the past update records including time-stamps, GPS locations, speeds, acceleration rates and instant carbon emissions are transmitted to the back-end server. In addition, the user can also opt to compose a wall post on his/her Facebook profile, sharing information about how much carbon he/she has emitted after driving certain distance.



(a) Plotting historic carbon emission records



(b) Award for emitting less carbon multiple times in a row

Fig. 3. Carbon Recorder Facebook component demonstration

B. *CarbonRecorder Facebook Application*

Figure 3 depicts two of the functionalities currently implemented in the CarbonRecorder Facebook application. First the user need to installed the CarbonRecorder Facebook application located at [5]. After logging into Facebook and navigating to the CarbonRecorder application page, the user could choose to show all the carbon emission records submitted in the past (shown in Figure 3a). Figure 3b shows the "awards" feature. For each trip, the system calculates the user's average carbon emission per kilometers (CPK) travelled. If the user can generate less CPK multiple times in a row, different virtual awards will be granted to the user to encourage more eco-friendly driving manner.

IV. Demonstration

Our demonstration will contain three parts. First, we will demonstrate how to use the mobile CarbonRecorder Android application, both under the emulator environment and on a real Android device. Second, we will demonstrate the main functionalities of the CarbonRecorder Facebook application. Last, we will demonstrate a sample data set collected on our back-end server from multiple users.

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