Demo Abstract: TransitGenie - A Context-Aware, Real-Time Transit Navigator

James Biagioni, Adrian Agresta, Tomas Gerlich, Jakob Eriksson
Department of Computer Science
University of Illinois at Chicago
{jbiagi1, aagres1, tgerli2, jakob}@uic.edu

Abstract

A transit navigation system is described that integrates real-time transit and user tracking with existing transit schedules to improve the transit riding experience.

Categories and Subject Descriptors

H.4 [**Information Systems Applications**]: Miscellaneous

General Terms

Algorithms, Experimentation, Human Factors

Keywords

Public Transit, Navigation, Activity Classification, Cooperative Transit Tracking

1 Overview

Congestion on our roadways is a problem, and it is getting worse. In the Urban Mobility Report of 2009, the Texas Transportation Institute (TTI) at Texas A&M University estimates that in 2007, U.S. travelers endured almost 4.2 billion hours of delay – entirely due to congestion [1]. This is an increase of 1 billion hours from the year 2000 alone, and earlier years show a similar trend. In the last 20 years, travel in large metropolitan regions has increased by 72%, while roadway capacity on freeways and major streets has increased by only 45%. This imbalance between demand and supply on the road network inevitably results in congestion. One method used to combat increased congestion is reliance upon public transit. In 2007, transit riders were responsible for for 56 billion passenger-miles of travel, usage that the TTI estimates would have cost roadway users almost 646 million additional hours of delay – about a 14 percent increase in total delay – had transit users decided to use the roadway instead. Given the already increasing congestion statistics, it is imperative that users of public transportation continue using the service, and to encourage drivers to switch to public transport.

Ease of use is an essential characteristic of any transit system. For example, the City of Chicago has an extensive public transport system consisting of 8 train lines, and 152 bus lines. However, knowing which combination of these trains and buses provides the most effective way to get from Point A to Point B, even without taking delays into account, requires expert knowledge.

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The main aim of our system, TransitGenie, is to provide the ability to *easily* navigate from one location to another without requiring specific knowledge of the transit network.

A smartphone front-end allows TransitGenie a measure of context-awareness. Current location, current user activity and long term travel patterns are all available to guide the route computation. TransitGenie also tailors the provided routes according to the user's preferences, such as maximum walking distance or speed, preferred modes of travel etc.

2 Real-Time Routing

Transit vehicles invariably have a hard time adhering to their published schedules, especially during the morning and evening peak-periods (i.e., rush-hour), as they are crucially susceptible to the ebb and flow of passenger loading and unloading. Furthermore, irregular (but relatively common) trip events such as crashes, breakdowns, improperly timed signals, weather and special events [1] can cause a wide variety of unpredictable delays for both trains and buses.

In order to provide the most reliable trip-planning capabilities, real-time data concerning the arrival and departure time of transit vehicles must be integrated, as any basic schedule-based advice may be inaccurate, negatively impacting users' trust in the system. As such, in those cities where real-time tracking data for vehicles is available (typically using a solution based on GPS and cellular data service), their live data-streams are used to supplant the scheduled data. For example, Chicago's CTA bus services are tracked in real-time, and arrival time estimates are available for San Francisco's BART trains.

Therefore, rather than depend solely on transit schedules, TransitGenie combines transit schedules with these real-time tracking feeds to compute route recommendations based on the real-time state of the transit system.

3 Cooperative Transit Tracking

At present only a fraction of transit vehicles are equipped with real-time tracking devices. In order to support real-time routing on transit services that do not provide official tracking, we leverage a novel technique, 'cooperative transit tracking', in which TransitGenie devices carried by ordinary transit riders opportunistically track public transit vehicles.

Cooperative transit tracking is the result of combining two techniques: (a) activity classification and (b) trajectory matching. *Activity classification*, uses localization technology (e.g., GPS) and an accelerometer (commonly available

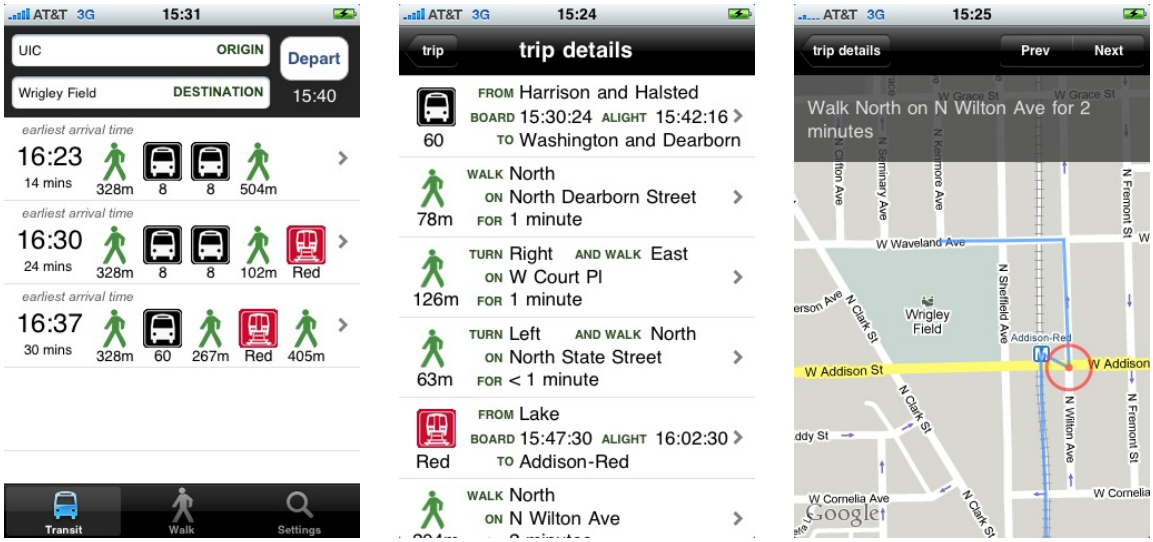

Figure 1. Screen shots from the current iPhone front-end. On the left, the main view which holds one or more route recommendations. In the middle, a route description screen. On the right, a detailed map view of a route.

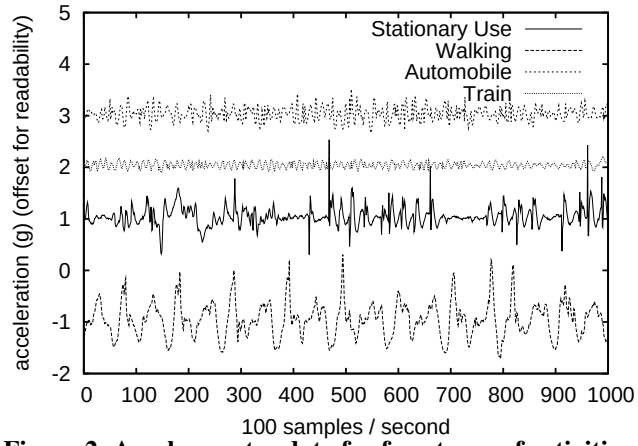

Figure 2. Accelerometer data for four types of activities.

in smartphones), to determine the user's current activity and whether they are currently riding in a vehicle. Figure 2 shows the raw accelerometer data from several activities, visually illustrating their different characteristics.

Having established that a user is riding a vehicle, *trajectory matching* determines whether it is a public transit vehicle, and if so, which one. This system extends real-time tracking coverage to vehicles without an official tracking capability, and can also be used to improve the tracking precision and update frequency of officially tracked vehicles.

4 The Demonstration

TransitGenie consists of a number of distinct functionalities, some of which will be demonstrated individually.

- **Real-Time Transit Navigation** As we are based in Chicago, the demo will focus mainly on Chicago-area transit services. Integrating real-time bus tracking feeds from the Chicago Transit Authority (CTA) with transit schedules for all Chicago-area transit services, we will demonstrate the real-time transit navigation support in TransitGenie. We may also include a smaller demonstration using data from the Bay Area Rapid Transit (BART) system. A version of the iPhone front-end will have been submitted, and may be available for download from the iTunes App Store, for subsequent use by conference attendees.
- **Cooperative Transit Tracking** Using recorded user location traces, we will demonstrate automatic matching of location traces to transit services. A map will illustrate location traces, parts of which are automatically labeled with the appropriate bus number or train line, if applicable. Labeling will be based only on static schedule and route data. We will use the official CTA bus tracking service as ground truth, to demonstrate the technique's usefulness in transit networks that do not provide official tracking data.
- **Activity Classification** This part of the demonstration will feature a person performing a number of activities, and demonstrate automatic classification of each activity. A video recording of a person performing the activities will be accompanied by accelerometer graphs on a screen, which will also display the output of an activity classifier. Potential activity types include *walking*, *running*, *biking*, *at-rest* and *riding-vehicle*.
- **Front End Features** The demonstration will showcase some use-cases on an iPhone front end, similar to what is shown in Figure 1. We will also demonstrate a number of interesting features, such as configurable user preferences, and a "live map" display incorporating real-time information.

5 References

[1] David Schrank and Tim Lomax. *2009 Urban Mobility Report*. Texas Transportation Institute, The Texas A&M University System, July 2009.