StreetCATS: Customizable Atlanta Transit Service

Shiva Jaini
GVU Center.
Georgia Institute of Technology
85, 5th Street NW
Atlanta, GA 30332-0670
shivajaini@gatech.edu

Pam Griffith
GVU Center.
Georgia Institute of Technology
85, 5th Street NW
Atlanta, GA 30332-0670
pamgriffith@gmail.com

Mrunal Kapade
GVU Center.
Georgia Institute of Technology
85, 5th Street NW
Atlanta, GA 30332-0670
mrunalk@gmail.com

Sunyoung Kim
GVU Center.
Georgia Institute of Technology
85, 5th Street NW
Atlanta, GA 30332-0670
sunyoung@cc.gatech.edu

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Abstract
Public transportation in Atlanta and in many other cities is often unreliable and time consuming. Vehicles suffer breakdowns, fail to follow schedule, and may only come as often as once per half hour or even once per hour. As such, many people see public transportation as a poor alternative to private vehicles. It is difficult to run the different modes of public transit in a city successfully as all of them are interdependent; if one of the modes of transit fails it can negatively affect others. With the advent of high-speed communication technologies like wireless networks and Global Positioning Systems (GPS), it is possible to network different modes of public transit in a city together. We propose such a networked system for Atlanta that will connect all the vehicles (including shared-cars/taxis), using their current positions and destinations to dynamically create routes.

Keywords
Public Transportation, Traffic, Bus, Commute, Kiosk, Touch Screen

ACM Classification Keywords
H.5.2 User Interface

Figure1. Some initiatives in Atlanta promoting public transit

The Citizens for progressive transit (Cfpt), Atlanta's grassroots transit advocacy organization, is committed to working with MARTA and regional leaders to help bring about comprehensive, long-term improvements to public transportation throughout the greater Atlanta region. The Breeze smart card system introduced to the general public in early 2006 by MARTA administration replaces an aging fare collection system and helps MARTA plan routes and service schedules that better meet users' needs. MARTA runs special services for elderly and disabled like para-transit service. MARTA partnership with Flexcar (Car Sharing service) was entered in late October 2006. It is a transfer pay service from or to MARTA station using Flexcar, permanently parked around town and at convenient spaces near homes and workplaces [7]. This association is the attempt to improve accessibility aspect of public transit. Mobility 2030, Regional transportation Plan is a multilateral approach towards public transportation adopted by Atlanta Regional Commission [5]. It deals with the current and expected demands being placed on the Atlanta region's transportation System.

Introduction

The City of Atlanta, Georgia is the victim of its own success. Its energetic economy and mild climate have attracted millions of people, but at a price. The population of Atlanta has quadrupled in last half-decade [1]. Along with such a rapid population growth, the number of automobiles has grown rapidly [2]. However, only 15% of Atlanta commuters were using public transportation as their primary commuting transportation method in 2005 [1]. Not only is this resulting in heavy traffic congestion increasing commuting time, but also it became one of the most significant factors affecting environmental and airborne pollution. The city has had to face severe federal penalties for unhealthy air quality [4]. Meanwhile, gas prices have been on the rise: average U.S. retail gasoline price in 2005 was double what it was 10 years ago [3]. All these factors above can be solved, at least partially if not all, by using public transportation instead of private automobiles.

Based on these considerations, we designed the public transit service "StreetCATS" to encourage Atlanta commuters to use MARTA (the Metropolitan Atlanta Rapid Transit Authority) and alternative modes of transit like shared cars/taxis. Our design uses computing technologies to make MARTA/public transit more efficient, flexible, accessible, with reduced commute time thereby attracting commuters to use public transit. In this paper, we describe our design solution and detail the processes that we have followed.

User Study and Background research

A public transit system naturally has a very diverse user group and a diverse set of problems associated with it. This means that there are many possible designs that could solve some of the problems and very few, if any, that could work by themselves to solve all. Our target user group encompasses almost everyone who currently uses or who might use public transit in Atlanta. However, we feel that our final design is most beneficial to those who commute regularly and travel during peak times. The office employees who mostly live in the suburbs of Atlanta constitute a considerable portion of single-driver vehicles and are regular victims of traffic congestion. Our system also serves as a tool which supports the local governing bodies to run the local transport infrastructure efficiently.

We conducted field interviews with randomly chosen MARTA passengers at a MARTA station to understand why people do or do not want to use MARTA. Also, we referenced the 2006 quality survey data conducted by MARTA to understand the usage patterns and clarify reasons given by people for not using MARTA [8]. Some of the survey data and analysis are included in Figure2.

Requirements summary

After analyzing the data obtained from our user studies and from MARTA, we found that users do not use public transport since it does not offer the flexibility (to travel to any place of the city and at any time), convenience (convenient to be used for different purposes like going out with friends/family, going to office/school, carrying groceries from a super market) and accessibility (the vehicle should be reachable/within walking distance) that a personal vehicle can provide. So, our public transit solutions should improve upon the above three characteristic features.

Public transportation is cheaper than owning a personal vehicle, and many MARTA riders use public transit for

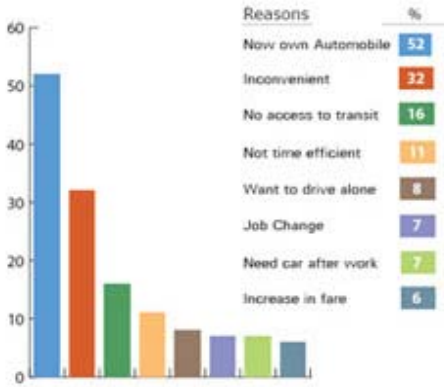

Figure2: WHY PEOPLE DO NOT USE MARTA? (Data from FISCAL YEAR 2006 Quality of Service Study – Study includes responses from former MARTA riders)[8].

Data obtained from the survey by MARTA shows that 52% of the previous MARTA users have quit because they own a car now. This shows that there are a plenty of things missing in the public transit when compared to a personal vehicle even though all the people were aware that public transit works out much cheaper than personal vehicles.

From our field interviews substantiated with survey data obtained from MARTA, we found three major reasons why people do not use MARTA; Inconvenience (32% & 6 participants), inaccessibility to transit (16%, 6), time inefficient (11%, 3). (Percentage in parentheses is from MARTA survey results and the number indicates the no. of our interview participants who felt the same). In another survey, MARTA found that 57% of the current users are using MARTA just because they do not own a car now.

just that reason. Even so, many of the frequent users did express concerns about price increases. Any system that is implemented must not result in an increase in fares or MARTA may lose the existing users.

Atlanta is a spread-out city with extensive suburbs. The transport system should be accessible to commuters throughout the city. The information about public transit system and timetable should be available to the users online and at every bus stop and train station so that users may be informed about when a vehicle is coming, particularly when they must wait a long time in between vehicles. Any technological solution that may be implemented should protect the privacy of the users at all times. It should also be easy for new users to learn even if those users are not technologically adept, as most of the users probably will not be.

Design alternatives and StreetCATS

We came up with several potential solutions to the problems with Atlanta's public transit. In one of these solutions, public transit riders would be able to see the actual arrival times of transit vehicles, which often vary from the posted schedules; riders would be able to plan around transportation inconveniences. In another solution, bus and train passengers would be able to play games together on public displays, perhaps fostering a sense of community and making the transport time more enjoyable.

StreetCATS (Street based customization of Atlanta transit service) facilitates different public transport systems existing in Atlanta (MARTA, and taxi/shared car companies like FlexCar) in operating efficiently and also makes them more accessible. StreetCATS would allow individuals to customize the transit service according to the individual destinations. In essence, it is public transportation on demand: users indicate to the system where they want to go via touch screens situated in bus stops and train stations throughout the city. The system locates the buses/public taxis/any vehicle that is registered with StreetCATS and is running on a route that matches the travel plans of the users and schedules one of the vehicle to pick up the passenger.

To evaluate the three design options, we participated in a two-hour poster session to receive feedback from the HCI community at Georgia Tech. Many of them felt that the StreetCATS idea has a lot of potential and can be challenging since it tries to redefine some of the ways in which the public transit works and attempts to make it very efficient. We decided to work on prototyping the StreetCATS idea as the other solutions work around inconvenience and do not directly make the transit system more convenient. StreetCATS seemed to be a solution to many of the requirements identified earlier.

Instead of having fixed routes where buses can be on time, early, or late, in StreetCATS the bus routes alter according to demand, adjusted by an algorithm that determines what the best routes are based on the positions and destinations of the users at the moment. The system then sends the information to the user to let him choose out of the available options. Once the user chooses a particular transit plan for the indicated route, the system confirms and sends a message to the driver of the respective vehicle to pick up the passenger. The coverage of this service may be increased by operating vehicles based on regional usage patterns and by opening the system to private corporations like Flexcar or Zipcar [7] or even private

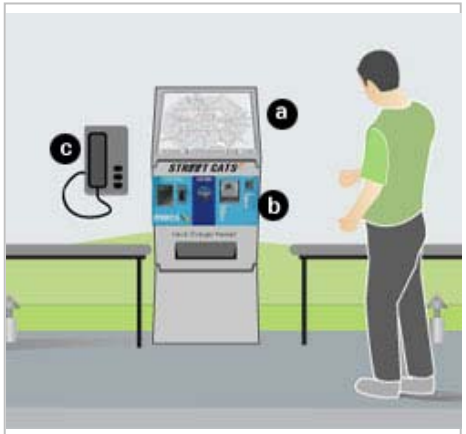

Figure3: Bus stops with proposed touch screen kiosks in the StreetCATS system (a) Map based application on touch screen interface (b) Ticketing / Bill payment slots (c) Phone for help/ emergencies/ connecting to IVRS.

The kiosks are of adjustable heights and have screens which can be tilted to facilitate users with various heights and preferences. For users with any kind of vision problems, we propose to have an auditory method of interaction as an alternative in the complete system. This method of interaction basically uses an IVRS. Users can use the phones located adjacent to the touch screens or can also use their mobiles to get connected to the IVRS and schedule a vehicle from their nearest bus stop. This can be a good alternative to the user group which is blind and some elderly who have vision problems/ disabilities. However, we have not gone in depth for this alternative method and did not prototype. The touch screen is the primary interface for most users, so we have chosen to focus on that and prototyped and tested the same.

taxi companies, thereby increasing the total number of vehicles in the public transportation system.

We expect the combination of efficient route scheduling and increasing the number of vehicles to lead to decreased wait times and travel times and make the entire transit system of the city more efficient.

The Street CATS provides flexibility, efficient use of existing resources, short wait times and travel times, higher coverage due to more vehicles being in the system, and gives the users feedback on bus arrival and travel times, which is entirely absent at most of the bus stops at the moment.

The Street CATS system includes a touch screen system which would be located in bus stops located all around the city (see Figure3) and an online system with similar features. We have designed the entire system architecture for the StreetCATS and prototyped the application for the touch screen system in Flash which demonstrates most of the proposed functions.

Touch Screen Kiosk

The StreetCATS touch screen systems have a zoomable map based interface. The user needs to zoom in to his destination using the controls adjoining the touch screen and click on it. The user can also enter his destination address (street no. and street name) using the on-screen keyboard function available at the bottom of the interface. Once the user selects a destination, the user's origin and destination are sent to the central server, which returns different optimized route plan options. The touch screen displays the following information about the suggested route plans: (1) estimated travel time (2) estimated pick-up time (3) Changes in the mode of transit (if any) (4) Fare. Once the user finds the above information acceptable and confirms to buy the ticket, he is prompted to either scan the breeze card (Travel pass for MARTA users) or pay bills. As soon as the user pays for the ticket, the MARTA central server sends a message to the driver of the chosen vehicle.

The user may also find destinations of various attractions and daily events going on in the city by clicking on the "view events and attractions" button (as shown in Figure4). Similarly, the user can know the location of various essential services like hospitals, shopping places, police stations, gas stations etc. The feature 'events & attractions' would be really helpful to people who are new to the city/ tourists and also keeps the local population updated with latest events going around in the city and allows them to book tickets and travel to those events. The 'services' feature would be useful for everyone in the community as it shows all the essential locations to which everyone can travel easily. In case that the user has a problem with using Street CAT application/ touch screen, we provided "HELP" menu.

System Architecture:

The System Architecture and backend of the system play a crucial role in StreetCATS. The backend route calculations must be fast and accurate in order for the system to succeed. The following is a sequence of actions that take place in the backend based on the user's inputs at the front end:

1. The user's input (selected destination) is transmitted wirelessly to the central MARTA server.

2. The MARTA server contains real time information of all the MARTA vehicles with the help of GPS tracking.

3. The MARTA server will check for vehicles operating near where the user will be traveling and will transfer information of the possible route plans.
4. When the user confirms the travel plan created by MARTA, the user is asked to pay the fare before the vehicle is actually scheduled to pick him up.
5. Once the user pays the fare, the system confirms his travel plan and sends this data to the vehicle.
6. The MARTA system gives a confirmatory note to the users that the vehicle they have chosen is on its way.

Evaluation

We evaluated our prototype using three techniques: cooperative evaluation, heuristic evaluation and written questionnaires. We did cooperative evaluation with 10 people who belong to the age group of 18-35 yrs from various nationalities. Five of them are new to Atlanta/US and five of them have stayed in Atlanta for more than 3-4 years. Participants were asked to perform three representative tasks with the touch screen interface: scheduling a StreetCAT to a specific destination using the map, using the on-screen keyboard, and finding attractions in the city. The tasks were chosen to test the full range of possible interactions with the system.

Users liked the idea of scheduling a transport whenever they want and liked being informed about the pick-up time, travel time and the most efficient plan to reach their destination, which reduced the anxiety regarding the next bus's arrival. 6 out of 10 participants liked the idea of finding destinations directly by zooming into maps as compared to searching a location through text entry. Users who were new to the city felt text entry was easy to find the destinations. Most users liked having both options depending on the situation.

Through heuristic evaluation by 4 HCI experts, we got a lot of insightful comments. They scored the interface very well in terms of Visibility, Consistency and Aesthetics but suggested some areas of improvement in terms of user control and interface design. From the responses of participants in the survey, we found that our prototype scored well in terms of ease of use, familiarity, and overall readability. Users had difficulty understanding some of the icons, particularly the attractions icons, and the route dialog. They also suggested different zoom controls and larger buttons.

We have incorporated the suggestions that were made and solved the other problems that were found in the finished prototype, shown in Figure 4. Though there were problems with the maps we used, as we were not focusing on map design, we haven't redesigned the city maps but this is something which needs to be implemented in the final system.

Conclusion

Improving the convenience, flexibility and accessibility of transit services is the key to attract people of Atlanta towards public transit. Our solution makes an attempt to use the power of technology to let the local public transit services operate more efficiently and at the same time meet users needs of transportation. By providing more accurate, real-time route and ridership information, our solution opens a platform for all the transit service providers to learn more about users' needs and design services accordingly. As it promotes the use of regular public transit as well as car-sharing initiatives like Flexcar, it helps in drastically reducing traffic congestion and air pollution.

Figure4:
Elements of the interface are as follows:
(a) Origin: the current location of the user
(b) The selected destination point: The user can click on the destination points (buttons) or can do text entry of the destination address using the on-screen key board function. The red dotted line shows its route.
(c) The on-screen keyboard: pops up when "Enter destination by text input" button is clicked.
(d) The information pop-up window: shows when a user selects a destination. It gives various available route plans that the user can avail in different tabs. The route plan which best matches with user's destination is shown in first tab. The second tab is the next best option. An individual taxi tab is always provided. In case the user is traveling in groups or for special purposes, he can schedule an individual taxi. Each route plan contains: 1) Estimated pickup time 2) Estimated travel time 3) Cost of travel.
(e) Time line: graphically represents the positions of the vehicle, user and destination in relation to time. This helps users in scanning the information fast.
(f) The control toolbar for the application: All the available options. Clicking on the "View events and attractions" button takes the user to a different screen which displays different events and attractions in the city. "View Services" option also works similarly. "Help" provides guidelines and information on using the application and about the StreetCATS service.

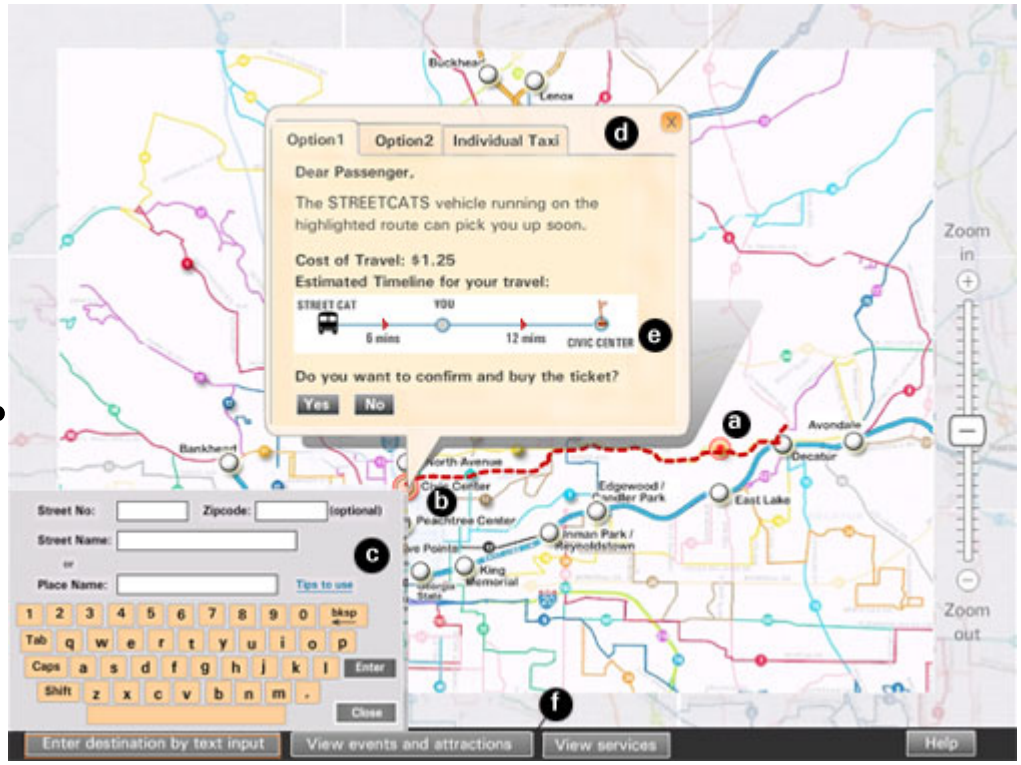

Figure4. A screenshot of the map based application on touch screen interface

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