Center for Urban Transportation Research

College of Engineering
University of South Florida
Tampa, FL
CUTR’s Research Program

- 100+ active research projects
- $8+ million in annual research
- 45 full-time research faculty
- 20+ student researchers
CUTR’s Multimodal Focus

Centers/Institutes
- National Center for Transit Research
- National Bus Rapid Transit Institute

Programs
- Transportation Demand Management
- Transit Management & Innovation
- Transit Training and Technical Assistance
- ITS, Traffic Operations & Safety
- Planning and Corridor Management
- Transportation Program Evaluation & Economic Analysis
- Mobility Policy

www.cutr.usf.edu
Today’s Presenters

Nevine Georggi
Research Associate

Sean Barbeau
Research Associate
Location-Aware Information Systems

A Case Study Utilizing GPS-enabled Cell Phones to Assist Riders with Special Needs

The Travel Assistance Device

Presented by
Sean Barbeau and Nevine Georggi
Center for Urban Transportation Research (CUTR)
University of South Florida (USF)
Overview

- Overview of Location-Aware Information Systems (LAIS)
- Role of LAIS for Travel Training
- Travel Assistance Device (TAD)
- Impact of TAD on Users
- Accomplishments/Next Steps
Opportunities

Proliferation of cell phones
- 61% penetration of the world’s population (4.1 billion)
- 93% penetration of U.S. (292.8 million) (Jun. 10) [1][2]
- 50% U.S. penetration of smartphones by 2010[4]
- 23% of U.S. Households are Wireless–Only (Dec. 09) [3]
- E-911 mandate for locating cell phones

- Smart devices can be linked to other systems:
  - Internet
  - Computer
  - Car
  - Hands-free

- Public no longer just users, but contributors:
  - Wikipedia
  - MySpace
  - YouTube
  - OpenStreetMap

Mobile Technology

“Smart” phones are now capable of many “computer” functions
- Email, text messaging, social networking
- Playing and recording sounds, video
- “Apps” - Most are programmable using languages such as Java
- Navigation

Many methods of human interface on cell phone
- Visual (text, images, and video)
- Sounds
- Touch (i.e. haptics, or vibration feedback)
Information Age Driven by Communication

- **Satellite**
  - Coverage at world level
  - Streaming download fast, upload slow
  - Expensive for dedicated communications
  - Typical consumer uses: GPS, Satellite TV

- **Cellular networks**
  - Coverage at city level (most urban and suburban areas)
  - AT&T, Sprint-Nextel, Verizon, T-Mobile, etc.
  - Subscription required
  - 4G broadband networks now emerging (e.g. WiMax, LTE)

- **Wi-Fi**
  - Coverage at building level
  - Many access points are free
  - Not the best for connection while in motion
Global Positioning System (GPS)

- Device uses broadcast satellite signals to determine its current location
- Accurate up to 3-5 meters
- Small enough to manufacture as a “chip” inside phone
- Assisted GPS (aGPS) uses data provided by the cellular network to reduce time-to-first-fix
- High-sensitivity GPS can even provide indoor (but less accurate) fixes
Location Based Services (LBS)

- Driving directions, “Friend Finder”, or other services that use the knowledge of your current position
- GPS is used

LBS Applications know:

- Where you are (Latitude & Longitude)
- How fast you are moving
- What direction you are traveling

Only with your permission
Survey Question

- What type of cell phone do you have?
Travel Assistance Device (TAD)

TAD is a navigation software that uses GPS-enabled mobile phones to assist transit riders.
The TAD Team

- Funded by FDOT and USDOT, TRB
- Team members
  - Sean Barbeau, Phil Winters, and Nevine Georggi, CUTR, USF
  - Miguel Labrador and Rafael Perez, Computer Science & Engineering, USF
  - Mark Sheppard, Hillsborough Area Regional Transit (HART) Travel Trainer
  - Gigi Gonzalez, Special Education Facilitator for STAGES program at USF
  - Amy Datz, FDOT Project Manager
  - Harvey Berlin, TRB TCRP IDEA Project Manager
Travel Training

. . . the Challenges . . . the Victories
Skills Needed to Travel Independently

1. Leave the place of origin and arrive at the bus stop on time.
2. Demonstrate appropriate street crossing skills.
3. Travel to and from the bus stop using his/her route of choice.
4. Stand at the bus stop or terminal in an appropriate place.
5. Look in the direction of bus travel.
6. Carry a bus pass and take out the correct fee.
7. Identify the correct bus (through number, color, style, inquiry).
8. Signal to the driver the desire to board.
9. Board the front entrance in consecutive turn.
10. Show the driver the bus pass or transfer and deposit the correct fare in the box.
11. Communicate any special needs to the driver.
12. Know how to board the lift and be secure.
13. Ask the driver for a bus transfer, if needed.
14. Select a seat or a proper place to stand.
15. Watch for landmarks.
16. Obey the rules of the bus and exhibit appropriate bus behavior.
17. Recognize a landmark near the desired bus stop.
18. Signal for exiting at the proper time.
19. Exit the bus through the proper door.
20. Travel to any necessary transfer points or destinations through the most direct or the safest route.
21. Dial or ask for assistance when utilizing the phone.
22. Respond and act correctly in emergency situations.
23. Read the bus schedule and/or find routes.

Source: Curriculum to Introduce Travel Training to Staff Who Work with People with Disabilities. The Kennedy Center, Inc., for Easter Seals/PROJECT ACTION, 1993
The Challenges . . .

- Transportation is essential for independent living
- Individuals with mental/cognitive disabilities (14.2M Americans, 6.9% of pop.)\textsuperscript{1} often have problems with quick actions required by transit
- Paratransit is expensive $27.90 per unlinked passenger trip (bus) versus $3.20 per unlinked passenger trip (demand responsive) and can be restrictive to riders

\textsuperscript{1} - National Institute on Disability and Rehabilitation Research. “Survey of Income and Program Participation (SIPP)”, 1997.
The Challenges . . .

- Personalized attention is required to introduce riders to fixed transit (Travel Trainers/Instructors)
- Travel training has shown success and cost savings, but even after training many riders with cognitive disabilities still need to be prompted to initiate stops
- Need a method of remote “coaching” for riders
TAD is the Answer

- Develop first navigation software for public transportation using GPS-enabled mobile phones
  - Alert user when to get off the bus with audio, visual, and tactile prompts
  - Target simplicity, with cognitively disabled in mind
TAD Web Page – Create Trips

Create New Trip

1. Select agency:
   Hillsborough Area Regional Transit
2. Select bus route:
   Route 6
3. Select trip day:
   Wednesday
4. Select trip time:
   Hour: 11 am  Minutes: 34
5. Select trip:
   trip: 0
6. Choose segment starting bus stop by clicking in the map.
7. Choose segment ending bus stop by clicking in the map.
8. Enter segment name:

Enter trip name:

Work to Home

Create Segment

Save Trip

Done
Transit Rider Selects Trip That Was Planned On Website
TAD Cell Phone Application

- While waiting for bus, rider sees estimated time until arrival and headsign for bus (vibration alert w/ 5 min. left)
– When the vehicle is within ~2 minutes of arrival, "NOW ARRIVING..." shows, with vibration alert
TAD Cell Phone Application

On Bus...

Then the user hears: “Get Ready!”
Pull the Cord Now!
(+Sound and Vibration)

Then: “Pull the Cord Now!”
TAD Web Page – Real-time Tracking

Real-time Tracking View of Riders

Transit Rider: Test1 User1
Phone Number: 555-555-555

Call
Text Message

List of Transit Riders:
- Test1 User1: Active
- Test2 User2: Inactive

Create a New Trip
Edit an Existing Trip

To create a new trip:
1. Select a transit rider.
2a. Click on create new trip.
2b. Click on edit trip.
TAD – Nuts and Bolts

[Diagram showing the architecture of the TAD system with various tiers and components, including User Interface Client Tier, WEB SERVICES, SERVLETS, TAD GIS DATABASE, and Legend with icons for HTTP, JAX-RPC, AJAX, JDBC, and UDP.]
Complexities to overcome...

- Complex software system
- GPS is very dynamic
- Testing in the field is different from lab!

Technology

- Multiple organizations
- Testing with special population
- Restricted Access to GPS on new Cell Phones
- Updating bus route information

Institutional
Challenge: GPS is very dynamic...
Challenge: Bus Stop Location Accuracy

Errors in bus stop inventory location vs. true geographic location
Google Transit provides free trip planning tool to agencies

Agency has incentive to post schedule updates to a webpage so Google can update their system

Over 128 agencies in U.S. are on Google Transit

TAD system can grab the same updates and use them!

This feature also allows adding new agencies to TAD with the click of a button!
With GPS, uncertainty of true position exists

- Calculated Position
- Possible True Position

Uncertainty Radius

2nd-to-last Stop

Destination Stop
Lessons Learned

- Problems arise when alert radius and uncertainty overlap when bus stops are close.

Diagram:
- 2nd-to-last Stop
- Destination Stop
Lessons Learned

- When alert radius is big, can cause unpredictable results for certain route configurations.
Lessons Learned

- CUTR’s algorithm based on circles surrounding 2nd-to-last stop

Diagram:
- 2nd-to-last Stop
- Destination Stop
Lessons Learned

- Detects user passing 2nd-to-last stop
Lessons Learned

- Create Bus Stop Management Tool
Lessons Learned

- Human Factors – Investigate Bluetooth or wired Headset
  - Privacy for Individual
  - Easier to hear over noise on bus
Evaluation of TAD with Users

ARICA BOLECHALA
USF FLORIDA MENTAL HEALTH INSTITUTE
Evaluated the effectiveness of TAD on bus riding behavior of individuals with disabilities
A behavioral analysis experiment was conducted to determine TAD’s effectiveness as prompting tool for intellectually disabled

- Teamed with USF Florida Mental Health Institute
- Observe # of successes to request stop and exit the bus at the proper time with and without TAD
- 3 individuals with moderate mental retardation on HART buses
- Safety measures in place if rider failed to exit the bus
- ABAB research design:
  - A = Baseline (i.e., no TAD prompts)
  - B = Intervention (i.e., TAD prompted the rider to “Get Ready” and “Pull the Cord Now”)

Evaluation of TAD with Users
• Target Behaviors:
  1. The participant must pull the bus cord signaling the appropriate stop
  2. The participant will exit the bus at the appropriate stop.
Results

- Same results across 33 trials with 3 users:
  1. The individual could not request a stop or get off the bus at the correct location without TAD
  2. When provided TAD, each user requested their stop and exited the bus at the correct location.

- Future studies will look at larger and more diverse populations
  - Elderly
  - Individuals with dementia
  - Individuals with sight-impairment
  - Individuals with traumatic brain injuries (TBI)
TAD Deployment

Technical test deployments to 5 other Florida agencies that provide General Transit Feed Specification (GTFS) data
TAD Deployment

- Deployment of TAD to additional transit agencies
  - Miami-Dade Transit (MDT)
  - Pinellas Suncoast Transit Authority (PSTA)
  - Sarasota County Area Transit (SCAT)
  - Broward County Transit (BCT)

- Using agency GTFS data and off-the-shelf GPS-enabled cell phones, the features of TAD were replicated at each agency

- Travel trainers will aid the TAD deployment process to agencies
  - If no travel trainers, other champions would likely be needed
TAD and AVL

TRB INNOVATIONS DESERVING EXPLORATORY ANALYSIS (IDEA) PROJECT
TAD INTERFACE WITH AVL SYSTEM
Provides new services based on real-time bus location
TAD Website showing live bus locations
Estimated Arrival While User Waits at Stop

– All other TAD features, including tell rider when to get off the bus, do NOT require AVL
USF has partnered with Dajuta (www.dajuta.com) to offer TAD as a commercial service to transit agencies and riders who need it.

Ideas
- Utilize in paratransit environment
- Utilize for tourists or novel transit rider
- . . . . Share your ideas.

Current Projects
- Dynamic Travel Information - Personalized and Delivered to Your Cell Phone
- Enabling Cost-Effective Multimodal Trip Planners through Open Transit Data
Contact Information

SEAN BARBEAU
BARBEAU@CUTR.USF.EDU

NEVINE GEORGGI
GEORGGI@CUTR.USF.EDU

USF’s Location-Aware Information Systems Lab
http://www.locationaware.usf.edu