Pedestrian Infrastructure Data Collection using Ground-Level Video

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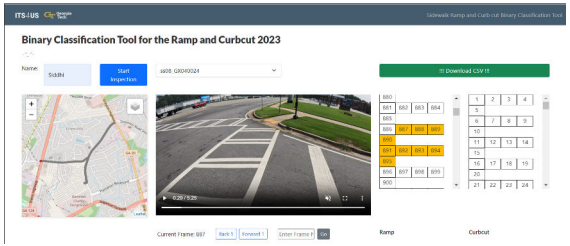
Outline

- Introduction
  - Pedestrian planning
  - Overview of project
  - The study area
- Project
  - Implementation steps
  - Vehicle collection and network creation
  - Wheelchair video collection
    - Deployments
    - Data analysis
    - Machine vision work
    - Results
- Conclusion
  - Future Works

Pedestrian Planning



- Accessible programs, policies, and services
- Inventory of assets
- ADA transition plans

Source: Georgia Tech Data Collection Team 2023-2024, City of Palo Alto, CA

Current State of Sidewalks

The Atlanta Journal-Constitution

METRO ATLANTA

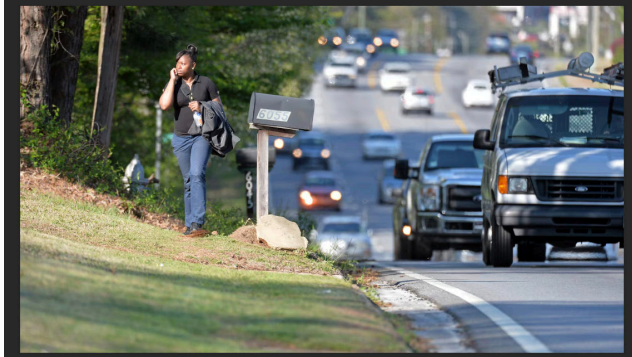
Gwinnett County and Snellville partner to work on sidewalk and water projects

The Snellville city council recently approved a $13,063,295 Fiscal Year 2021 balanced budget. (Courtesy City of Snellville)

Snellville is adding more than a mile of sidewalks at a cost of $1.9 million (January 2023)

The Atlanta Journal-Constitution

Gwinnett commission approves $1M for sidewalks around Highway 29



Alberta Watson walks along Lawrenceville Highway in Gwinnett County on April 9, 2014, one of several roads that could get sidewalks in the latest round of 2014 SPLOST funding. HYOSUB SHIN / HSHIN@AJC.COM

Connecting residential neighborhoods "Pedestrian safety and sidewalk connectivity are integral parts of a community" (Feb 2023)

- **January 2025: Gwinnett County SPLOST Tax Initiative for Transportation**
- **Enhances 1.78 miles of Peachtree Industrial Boulevard, including new sidewalks**

Source: AJC

Impedance and Routing

- **Wheelchair impedance**
  - Sidewalk presence
  - Pathway width
  - Level surfaces
  - Surface condition
  - Missing ramps
  - Etc.

- **Mobility mode routing:**
  - Infrastructure inventory, design, and condition data
  - Route impedance

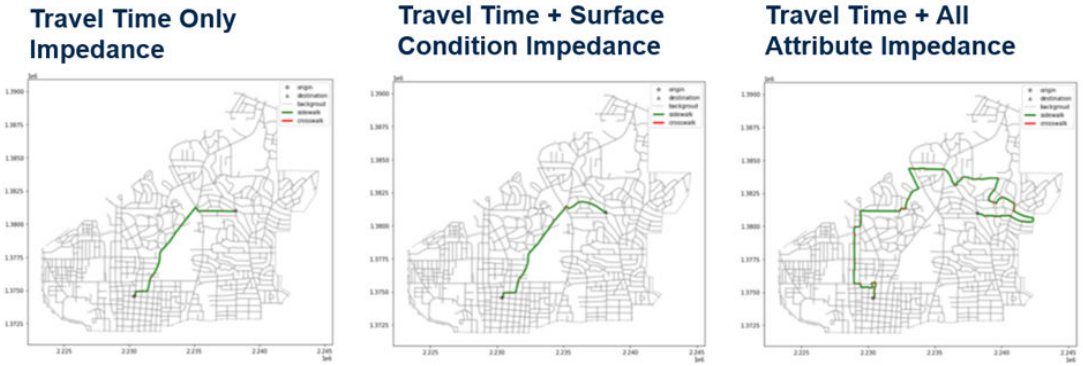
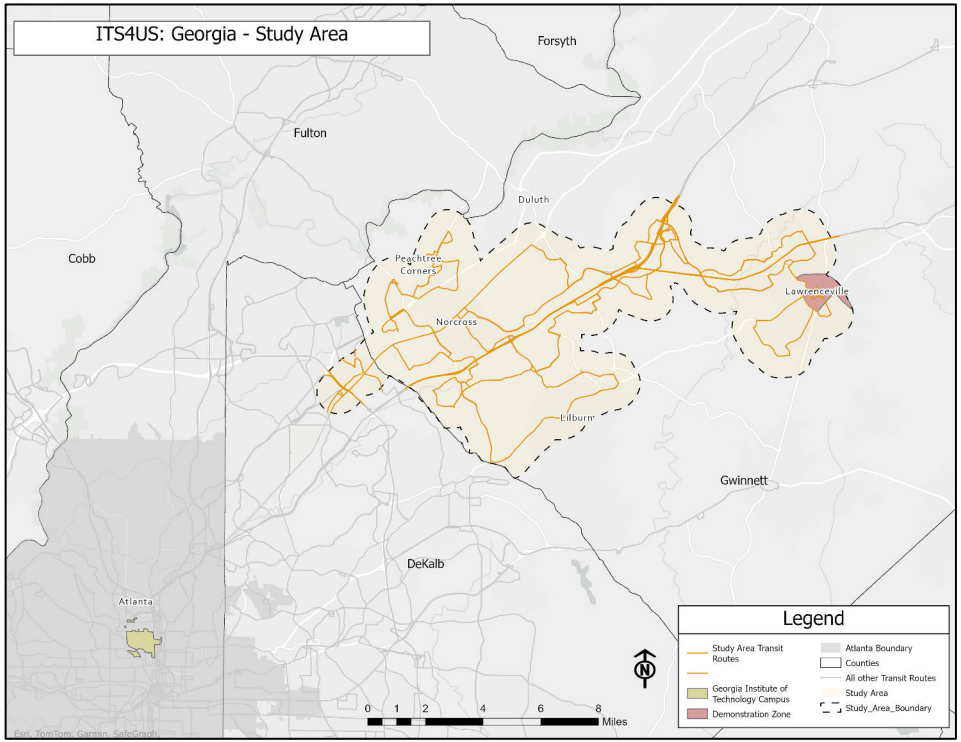


Image Credits: Guensler, Guin, Laval, Passmore, Sivakumar, Fan, and Lu

ADA Mobility Mode	Examples of Potential Impacts of Missing Curb Ramp on Impedance
No Disability	- potential trip hazard
Low Vision	- significant trip hazard
Manual Wheelchair	- forced to divert to the street - tip over hazard

Research Overview



Source: Georgia Tech Data Collection Team 2023-2024

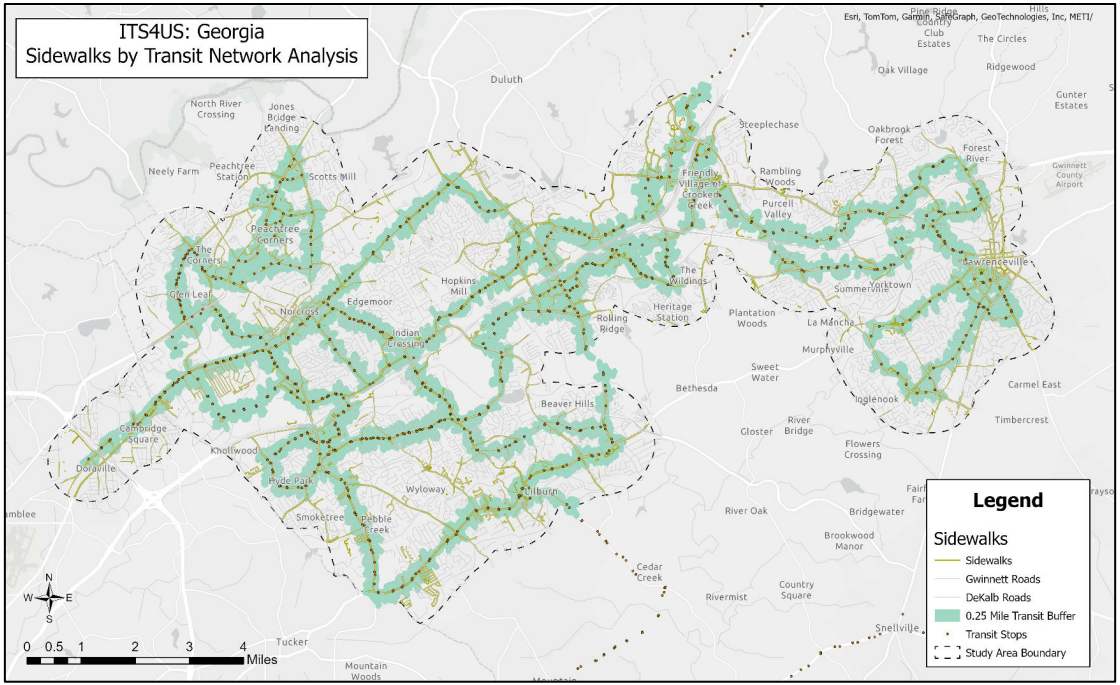
- **ITS4US Deployment Program Georgia DOT**
- **Develop a comprehensive pedestrian infrastructure network in the study area**
- **Graduate students and a team of ~50 undergraduate students for:**
  - **Field data collection**
  - **Spatial and network analysis**
  - **Machine vision**

ITS4US

GDOT Gwinnett ARC

Georgia Tech

Gwinnett County Study Area



- Gwinnett County, Georgia
- Over 500 miles of sidewalks
- Transit service area
  - Ride Gwinnett bus routes
  - Doraville MARTA station
- ~218 miles of sidewalk are walkable from transit stops

Source: Georgia Tech Data Collection Team 2023-2024

The Process

Vehicle Video Field Data Collectio

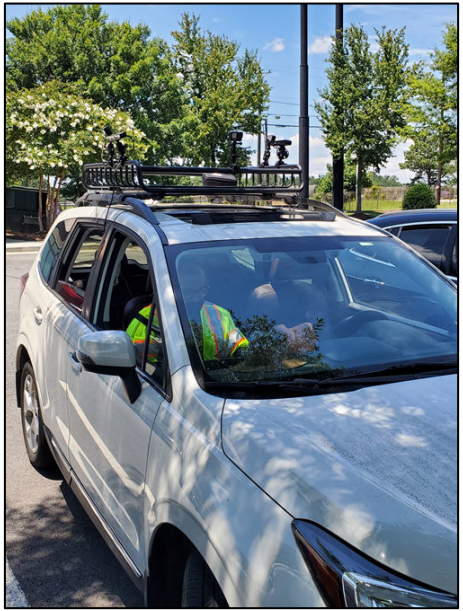
OSM Pedestrian Network Creation

Open Street Map

Wheelchair Video Field Data Collection

Machine Vision Review

Vehicle Video Data Collection
GoPro Cameras (Front and Both Sides)



Source: Georgia Tech Data Collection Team 2023-2024

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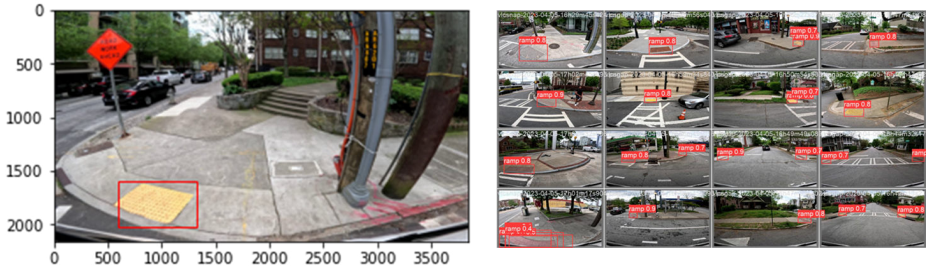
Vehicle Flythrough Data Collection

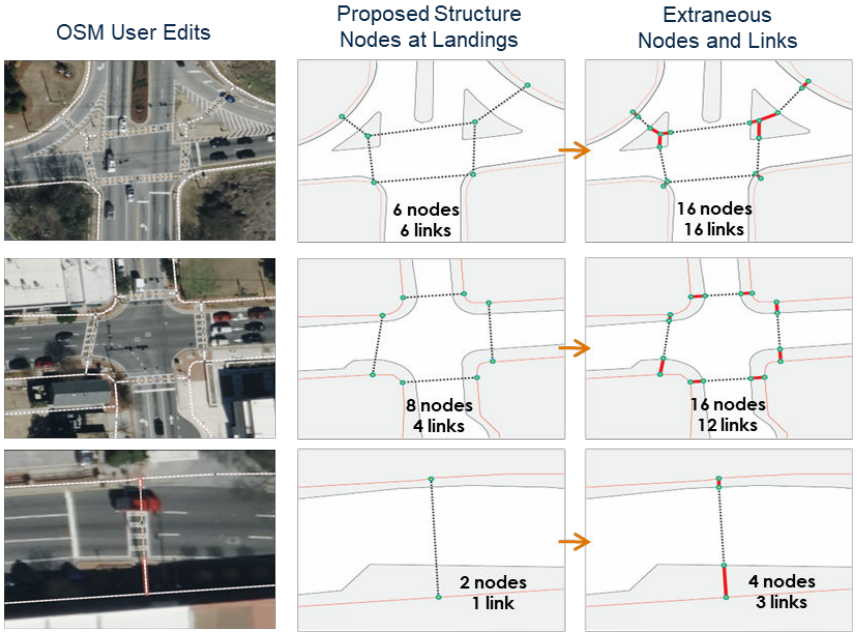


- Identify presence and absence of sidewalks
- GoPro cameras
  - Passenger-side
  - Driver-side
  - Front view
- Web-based flythrough
  - Log presence/absence
- Machine vision flythrough

Source: Georgia Tech Data Collection Team 2023-2024

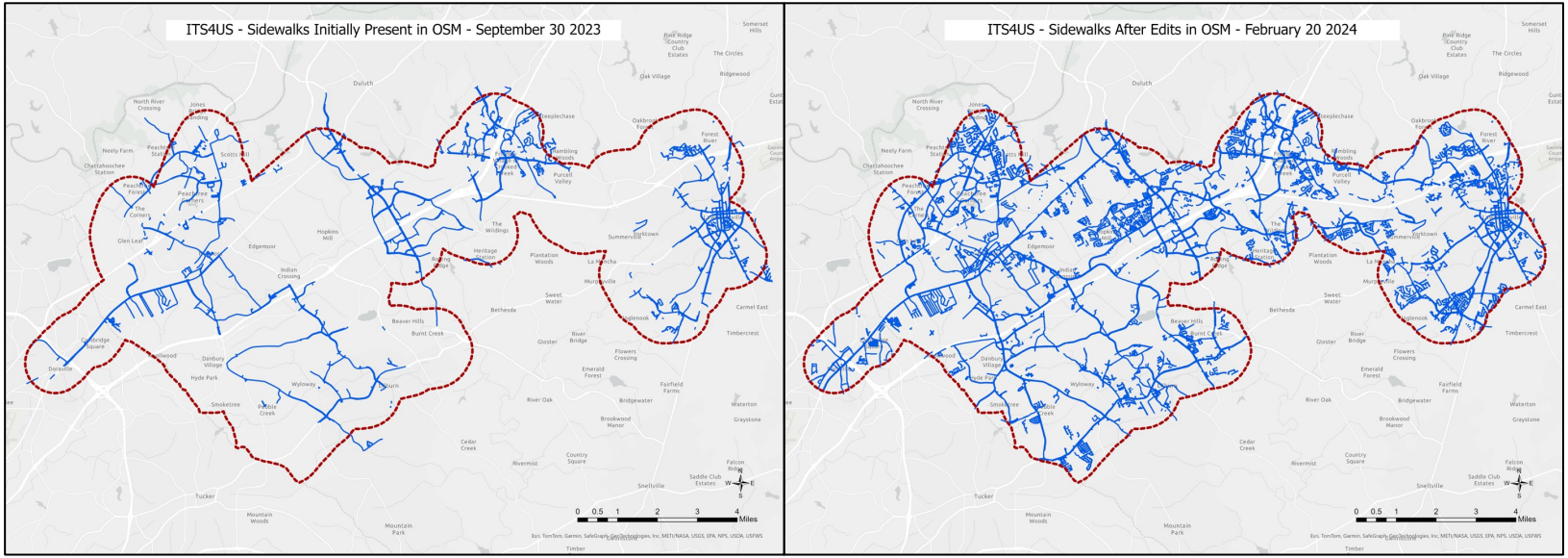
Pedestrian Network Creation in OSM

- Complete pedestrian network in OpenStreetMap (OSM)
- The team had to add more than 85% of sidewalks
- Link-and-node structure (more refined than ways)
  - Developed a unique mapping schema
- Lots of QA/QC required



Source: Georgia Tech Spatial and Network Analysis Team 2023-2024

Pedestrian Network Updates

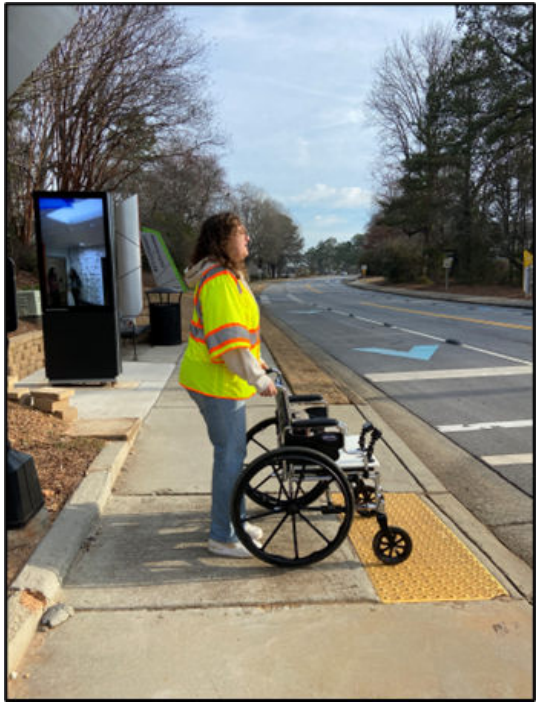


Identified 540 miles of sidewalks not in OSM (238% increase)

Source: Georgia Tech Spatial and Network Analysis Team 2023-2024

Wheelchair Video Data Collection Walking Speed (2-3 miles/hour)

Forward-facing and down-angled cameras



Source: Georgia Tech Data Collection Team 2023-2024

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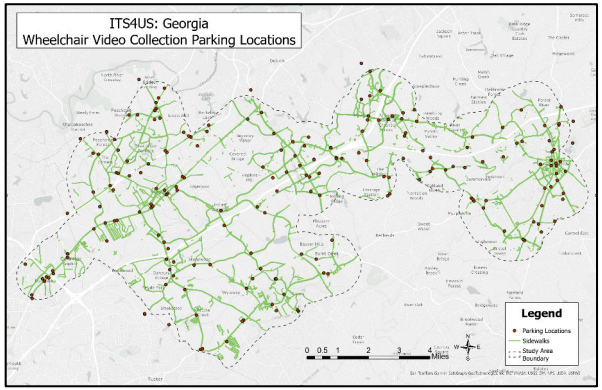
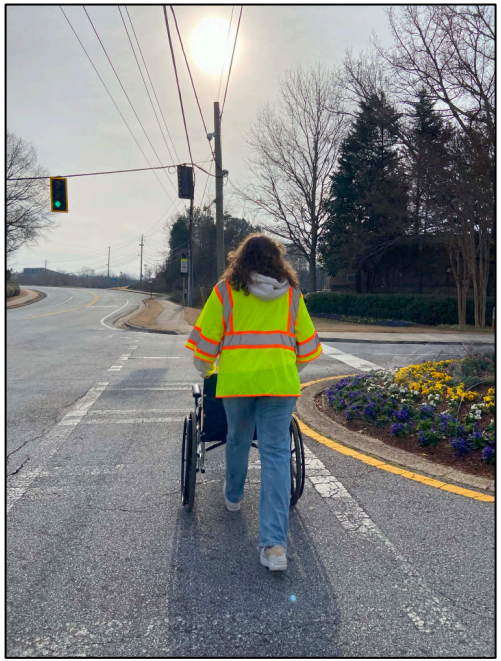
Data Collection Scheduling

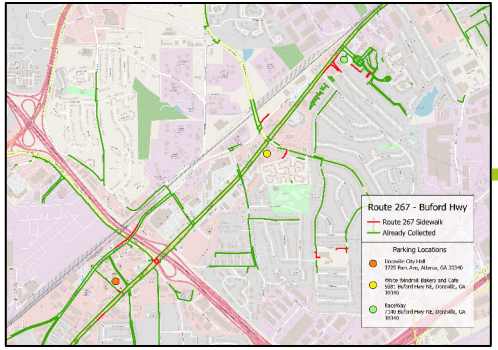




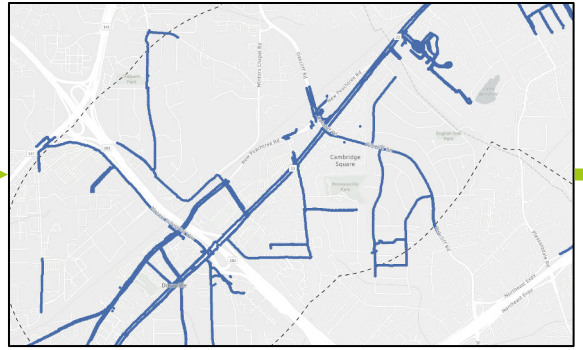
- Advanced MS Excel process
- Totals:
  - 284 successful deployments
  - ~10 months
  - 650 hours of Video

Source: Georgia Tech Data Collection Team 2023-2024

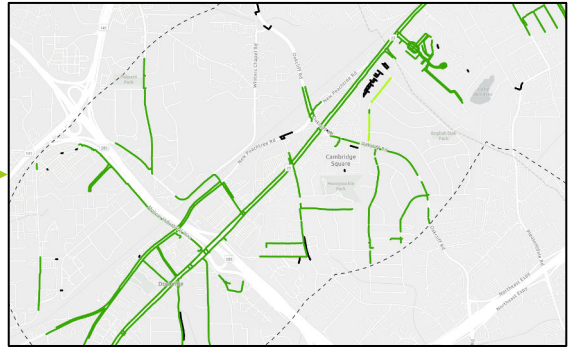
Wheelchair Video Routes and Data



➢ **Create data collection routes**
- **ArcGIS**
- **QGIS (open-sourced)**



➢ **Data plotted by point location (about 29 million camera frame points)**



➢ **Final network after collection**

Source: Georgia Tech Data Collection Team 2023-2024

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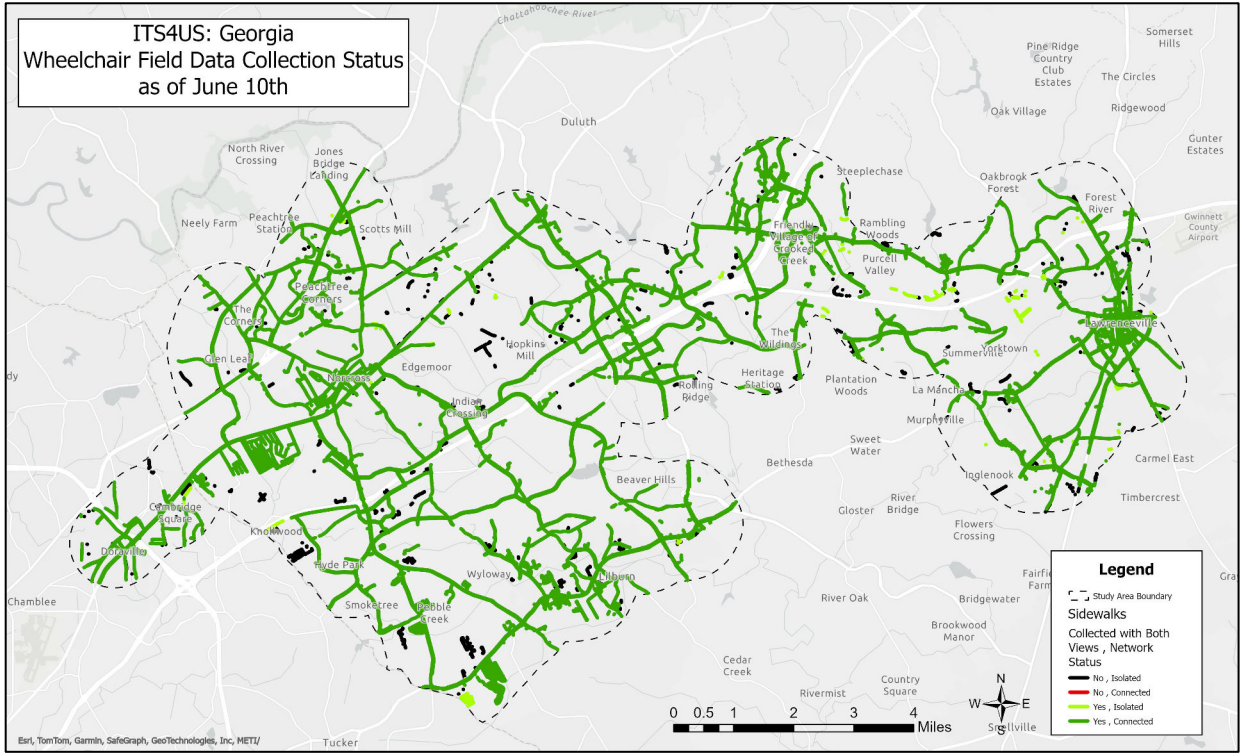
Wheelchair Video Data Collection in Gwinnett County

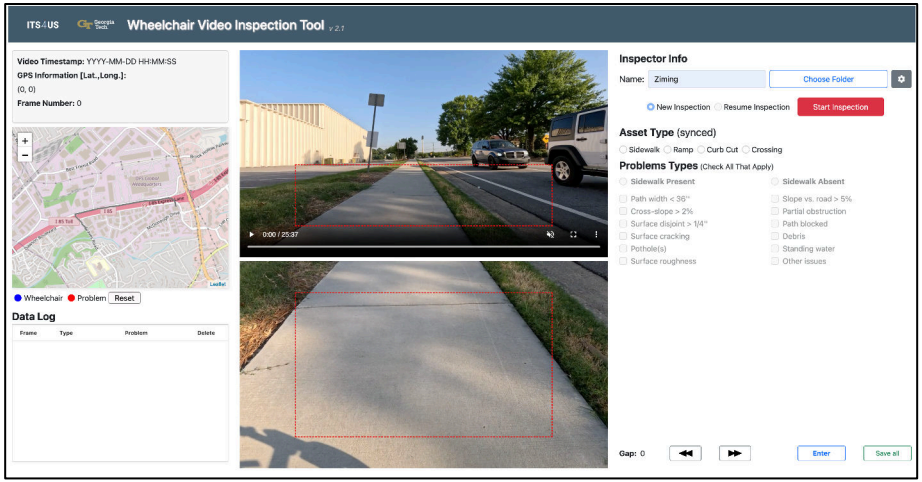


- ~1,200 total road miles
  - ~655 miles w/sidewalks
  - ~512 miles w/o sidewalks
  - Collected ~461 miles
- Protocols:
  - Safety
  - Routing
  - Intersection inspection
  - Etc.
- Full video archive
  - GoPros also collect vibration and gyro data

Source: Georgia Tech Data Collection Team 2023-2024

Video Inspections for Asset Defects
Sidewalks, Crossings, Curb Ramps, Curb Cuts

- Remote video inspection
  - Map location panel
  - Rolling video images
  - Inspection inputs
- Click image to pause video and document defect



Supported browsers include Chrome®, Edge®, and Firefox®

Video Inspectors can identify more than 90% of ADA issues, such as: width issues, obstructions, surface defects, changes in surface height >1/4”, cross-slope issues, debris, standing water, etc.

Source: Georgia Tech Data Collection Team 2023-2024

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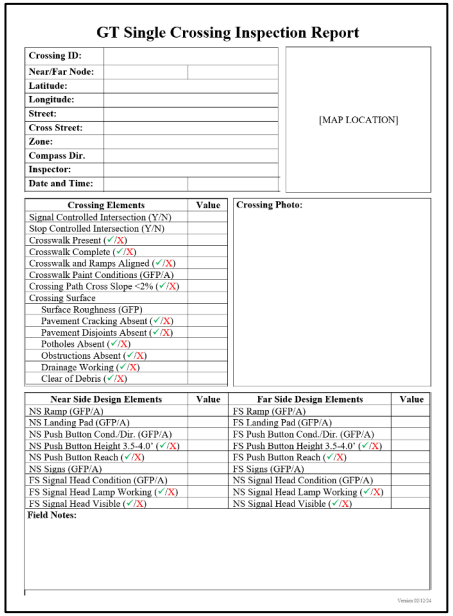
Manual Inspection of Asset Features for use in Technoeconomic Analyses



GT Single Crossing Inspection Report

Crossing ID:	[MAP LOCATION]
Near/Far Node:	
Latitude:	
Longitude:	
Street:	
Cross Street:	
Zone:	
Compass Dir.	
Inspector:	
Date and Time:	

Crossing Elements	Value
Signal Controlled Intersection (Y/N)	
Stop Controlled Intersection (Y/N)	
Crosswalk Present (✓/X)	
Crosswalk Complete (✓/X)	
Crosswalk and Ramps Aligned (✓/X)	
Crosswalk Paint Conditions (GFP/A)	
Crossing Path Cross Slope <2% (✓/X)	
Crossing Surface	
Surface Roughness (GFP)	
Pavement Cracking Absent (✓/X)	
Pavement Disjoints Absent (✓/X)	
Potholes Absent (✓/X)	
Obstructions Absent (✓/X)	
Drainage Working (✓/X)	
Clear of Debris (✓/X)	

Crossing Photo:

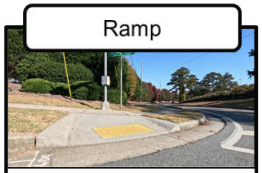
Near Side Design Elements	Value	Far Side Design Elements	Value
NS Ramp (GFP/A)		FS Ramp (GFP/A)	
NS Landing Pad (GFP/A)		FS Landing Pad (GFP/A)	
NS Push Button Cond./Dir. (GFP/A)		FS Push Button Cond./Dir. (GFP/A)	
NS Push Button Height 3.5-4.0' (✓/X)		FS Push Button Height 3.5-4.0' (✓/X)	
NS Push Button Reach (✓/X)		FS Push Button Reach (✓/X)	
NS Signs (GFP/A)		FS Signs (GFP/A)	
FS Signal Head Condition (GFP/A)		NS Signal Head Condition (GFP/A)	
FS Signal Head Lamp Working (✓/X)		NS Signal Head Lamp Working (✓/X)	
FS Signal Head Visible (✓/X)		NS Signal Head Visible (✓/X)	

Field Notes:

Version 03/12/24

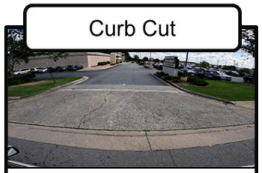
11 Defects
- ❑ Width
- ❑ Pothole
- ❑ Debris
- ❑ Roughness
- ❑ Blocked
- ❑ Standing water
- ❑ …

Sidewalk Surface



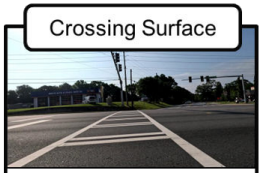
22 Defects
- ❑ Missing
- ❑ Slope
- ❑ Cross-slope
- ❑ Width
- ❑ Flare slope
- ❑ Landing Pad
- ❑ …

Ramp



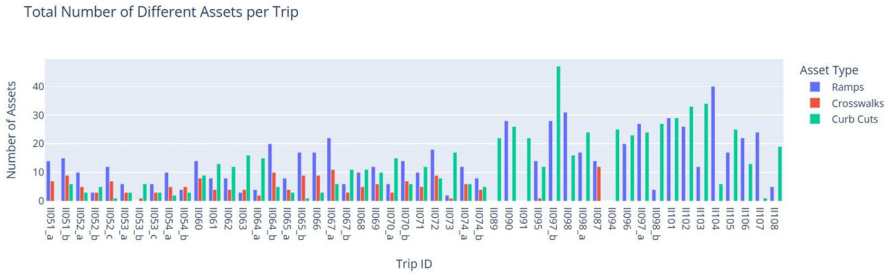
10 Defects
- ❑ Slope
- ❑ Cross-slope
- ❑ Flare slope
- ❑ Entry ramp slope
- ❑ Entry ramp cross-slope
- ❑ Depression sidewalk width
- ❑ …

Curb Cut



10 Defects
- ❑ Width
- ❑ Pothole
- ❑ Debris
- ❑ Roughness
- ❑ Slope
- ❑ Cross-slope
- ❑ …

Crossing Surface



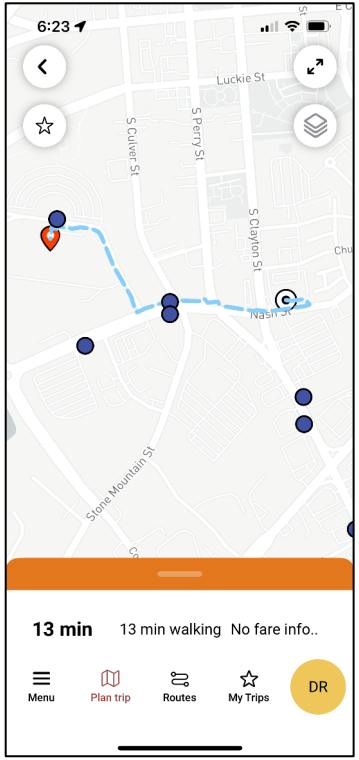
Source: Georgia Tech Data Collection Team 2023-2024

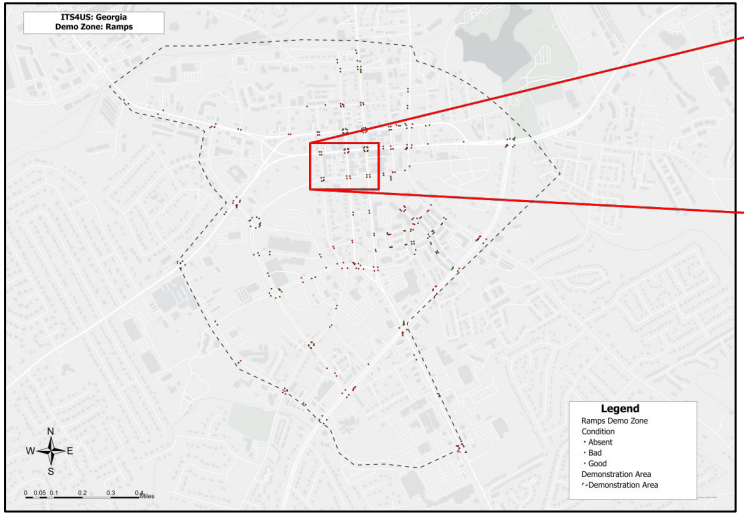
Wheelchair Video Playback Application

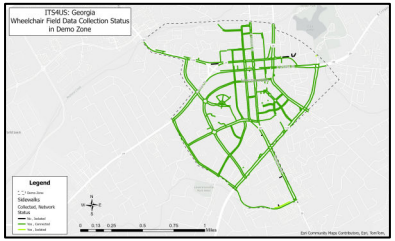
- Allows planners and engineers to view the video of their network
  - Verify problems identified by MV
  - Refine sidewalk repair cost estimates
  - Support analysis for pedestrian planning

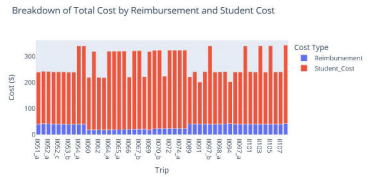
Source: Georgia Tech Data Collection Team 2023-2024

Results







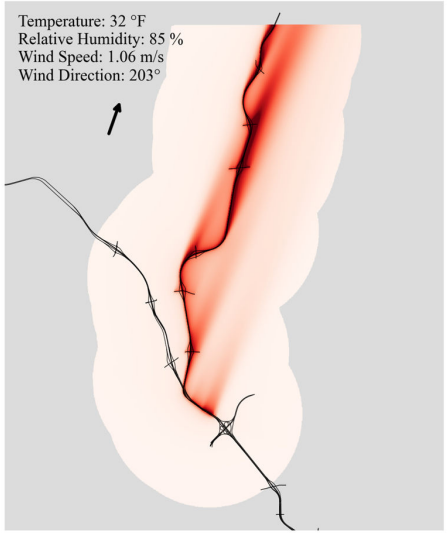


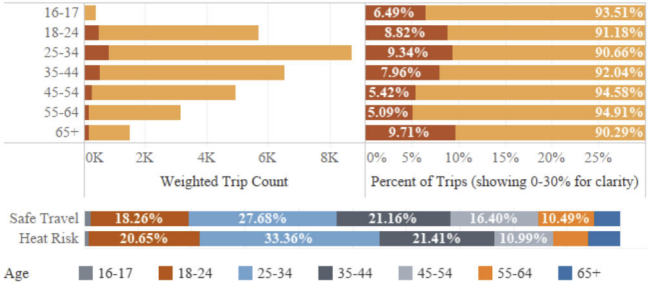
- Inventory of pedestrian assets in the study area
  - Impendence by link for routing
- Tech transfer to implement nationwide data collection with significant cost savings
- Video and MV data can support high-level research

Source: Georgia Mobility and Accessibility Planner (GMAP) Application – ICF, Georgia Tech Data Collection Team 2023-2024

More Analyses are in the Works

- Adoption of more advanced machine vision tools
- Incorporating TransitSim and SidewalkSim Python packages
  - Shortest path tools for mobility assessment
- Integrate exposure models for:
  - Heat risk assessment
  - Pollutant concentration health impact assessment

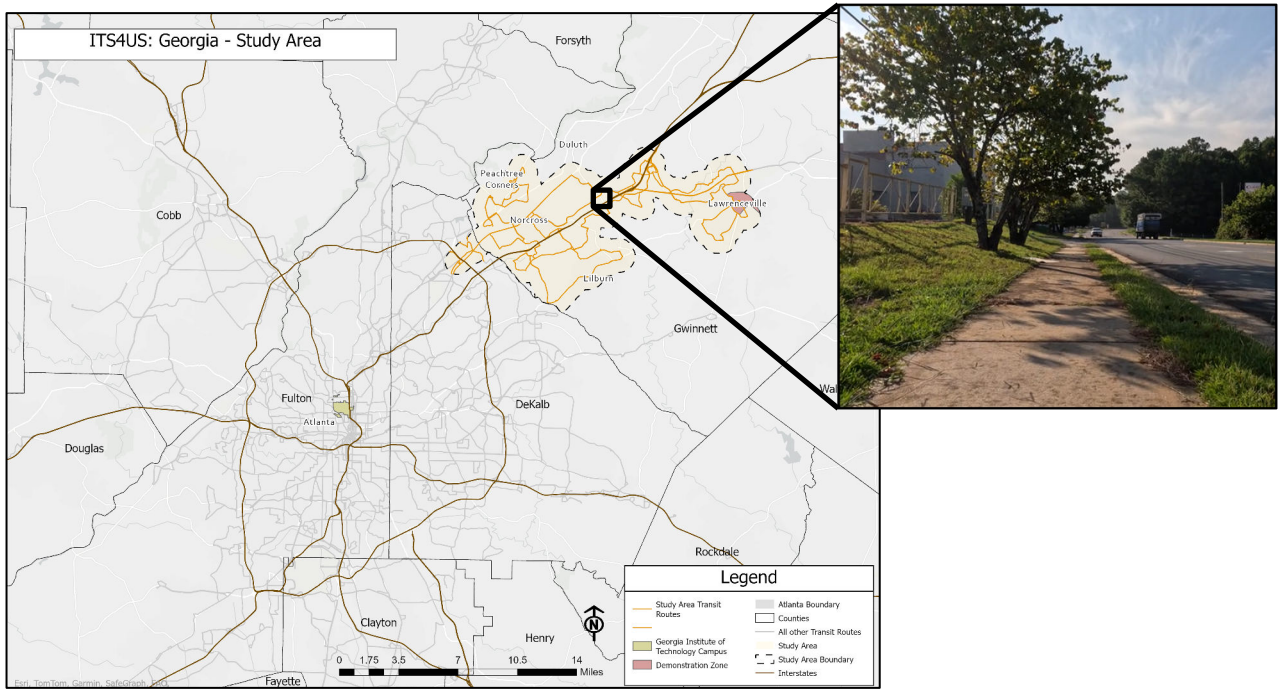




Source: H. Fan and H. Lu

What's Next…..

- Finalize reports
  - End of spring
- Commit code to Github
  - End of spring
- Seeking ongoing collaborations



Source: Georgia Tech Data Collection Team 2023-2024

Conclusions

- Inventory of sidewalks
- Machine vision processes
- Open-source technology
- Lower cost data collection
  - Video archives

Source: Georgia Tech Data Collection Team 2023-2024

Acknowledgements

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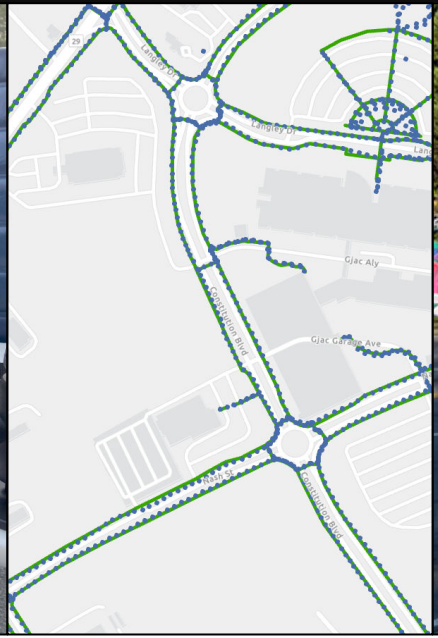
Questions?



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