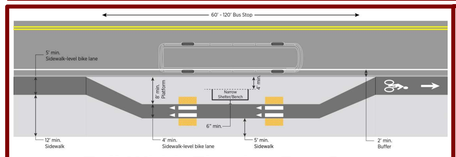
Accessible Bus Stop Design in the Presence of Bike Lanes

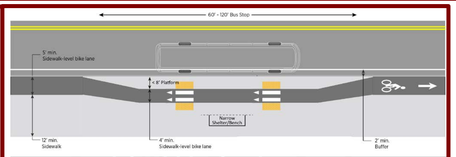
Yu-Min (Thomas) Yang [a], Dewan Tanvir Ahammed [a], Nathan David Obeng-Amoako[b], Dr. Eleni Christofa [a], Dr. Chengbo Ai [a], Dr. Peter Furth [b]

[a] Civil & Environmental Engineering, University of Massachusetts Amherst *[b] Civil & Environmental Engineering, Northeastern University*

Introduction



Full-Width Floating Bus Stop
Platform width ≥ 8 ft



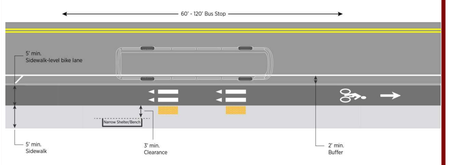
Partial-Width Floating Bus Stop
Platform width < 8 ft

Advantages

- Eliminates conflicts between buses & bikes
- Raised platform for riders to get on & off

Disadvantages

- Conflicts between bicyclists and bus riders
- Accessibility concerns



No Platform Floating Bus Stop
Bike lane adjacent to the curb

Research Objectives

- Investigate bus rider and bicyclist behavior and interactions when bicycle infrastructure is adjacent to floating bus stops.
- Propose design improvements and guidance to mitigate conflicts between bus riders of all abilities and bicyclists.

Methodology

Literature Review

- Design guidelines of floating bus stops in the United States and internationally.
- Research studies on bus stop accessibility and integration with bike lanes.

Focus Groups and Interviews

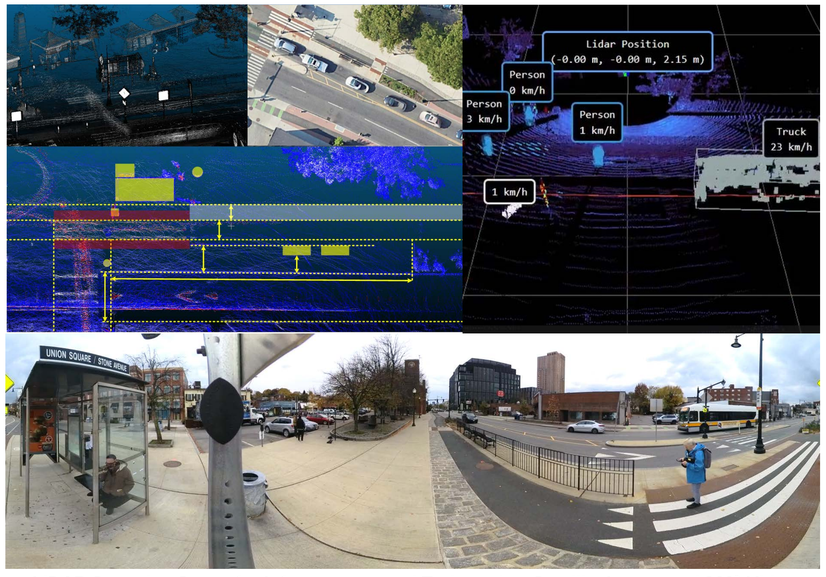
- Include visually impaired, hearing impaired, and individuals with mobility impairments.
- Professional community outreach (Association of Pedestrian and Bicycle Professionals).
- Cities that have integrated bus stops and bike infrastructure and developed design guidelines. (Amsterdam, Netherlands; Montreal & Toronto, Canada; Montgomery County, MD)

Inventory

- 56 bus stops in the MBTA region are inventoried through field investigation and Google Maps, Bing Maps, and Apple Maps.

Behavior and Conflict Analysis

- Five bus stops in the Boston area have been selected.
- Trajectory data and infrastructure information are collected by LiDAR.
- Interaction incidents between pedestrians and bicyclists are recorded by 360° video camera.



LiDAR Scanning Scene for Infrastructure and Trajectories, Satellite Image, and 360° Video Image at Somerville Ave. and Stone Ave., Somerville, MA

Literature Review, Focus Groups and Interviews

Design Guidelines

- Platform width: 8'-10'
- Min bike lane width: 4'-5'
- Accessible boarding area: 4'×4'-5'×8'
- BIKES YIELD TO PEDS sign
- Rails/Fences

Research Studies

- **Improve accessibility:** Barrier-free space, non-slip surfaces, well lit, ramps, shelter
- **Improve safety:** Separate bus, bike, and peds, bicycle speed management, provide clear view for bike and peds

Focus Groups

- 3 focus groups with 21 participants total
- Recommendations:
  - **Bike lane**: 1) speed mitigation: signage, raised bike lane, warning strips, pavement color and surface 2) separate cyclist and riders: by curb, fence, bollard blocking bicyclists
  - **Crosswalk**: improve visibility by pedestrian activated flashing lights, tactile pavement
  - **Fence**: detectable by riders using cane
  - **Shelter**: located to ensures enough space for wheelchair users
  - **Bus:** equip with stop signs as school buses, audible message
  - **Bus stop sign:** improve visibility by placing it closer to the shelter
  - **Education and Enforcement**

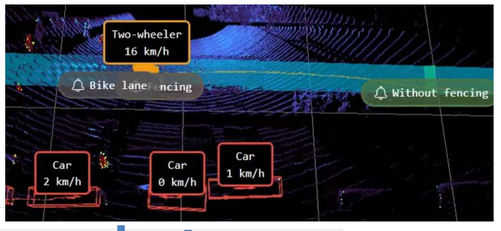
Professional Communities and City Interviews

- 5 responses from the professional community & 4 city interviews
- Recommendations:
  - **Bike lane**: 1) speed mitigation: raising, narrowing, rumble strips 2) separate cyclist and riders: lowering bike lane from sidewalks, half-dome 3) warning: marking and signage
  - **Crosswalk**: align with bus doors, tactile paving, guidance strips, detectable warning surfaces, signals
  - **Bus Stop Sign**: easily detected by locating it on the curb or next to the shelter
  - **Platform:** wider platforms (5'-8') by reducing bike lane width at limited space
  - **Shelter**: at all bus stops and on the platform
  - **Law**: bike should not pass the bus or approach closer than 2 m from the rear or front entrance or exit

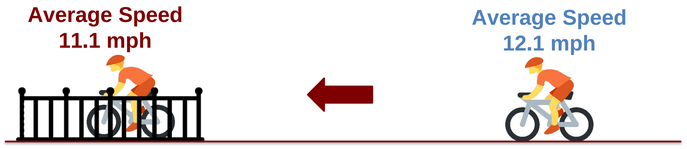
Behavior and Conflict Analysis

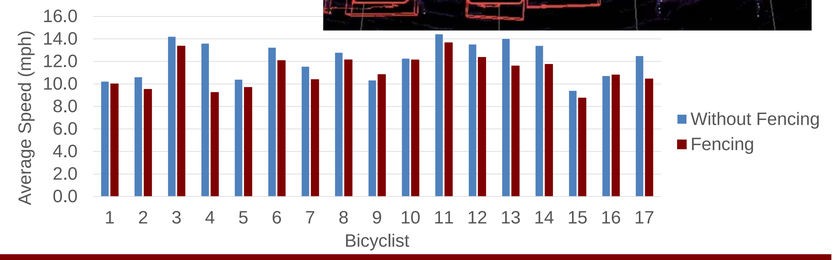
Trajectory Analysis

- Adjust the classification of road users
- Smooth the speed for each trajectory
- Determine area of interest



Does fencing or a shelter wall slow the cyclists?





Preliminary Design Recommendations

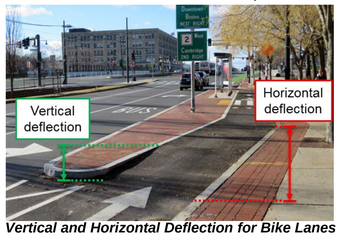
Safety Principles

- Maximize separation between bikes and peds
- Speed management and situational awareness for bikes

Stronger speed management strategies are needed when the separation is weak

Bike lanes

- **Speed Management and Situational Awareness**
  - Vertical/Horizontal deflection
  - Change in pavement surface
  - Create channelized spaces



Vertical and Horizontal Deflection for Bike Lanes in Boston, MA

YIELD TO PEDS Marking on Bike Lanes in Cambridge, MA

Bus Stop Types

- **Strong Preference for Full-width Platforms**
  - Narrow/Divert the adjacent bike lane
- **Stop Bikes when the Bus Door is Opened at No Platform Bus Stops**
  - Signage, markings, education

Wayfinding

- **Enhance Accessibility for All Users**
  - Align crosswalk, tactile pavement, and boarding area in a straight path
  - Mark the location of crosswalks by installing flexposts or secondary bus stop sign poles

Narrow/Diverting the Adjacent Bike Lane in Somerville, MA

Secondary Bus Stop Sign Pole in Silver Spring, MD

Channelized Space for Bike Lanes in Montgomery County, MD

Aligned Crosswalk & Boarding Area in Montgomery County, MD

Future Work

- Continue trajectory processing and analysis and cross-validation with video recordings.
- Recommendations for floating bus stop design will be finalized based on the results of the trajectory analysis.

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Contact

For more information, contact Yu-Min (Thomas) Yang: **yuminyang@umass.edu**