Methods and Technologies for Pedestrian and Bicycle Volume Data Collection

NCHRP 7-19

NATMEC: Bike and Pedestrian Detection

July 1, 2014

Presentation Overview

- Introduction
- Guidebook Walkthrough
- Testing Approach and Findings
- Final Remarks

Project Purpose

- Address lack of pedestrian and bicycle volume data
  - Barrier to planning effective facilities
  - Standard procedures for vehicular data collection
- Assess variety of existing and new technologies and methods
- Develop guidance for practitioners

Guidebook Purpose

- Guidebook produced as a resource for practitioners
- Designed to help practitioners:
  - Understand the value of multimodal data
  - Develop a data collection plan
  - Identify and recommend data collection methods
  - Correct raw count data from a particular technology

Guidebook Organization

Quick Start Guide

1. Introduction
2. Non-Motorized Count Data Applications
3. Data Collection Planning and Implementation
4. Adjusting Count Data
5. Sensor Technology Toolbox

Appendices

Case Studies

Manual Pedestrian and Bicyclist Counts: Example Data Collector Instructions

Count Protocol Used for NCHRP Project 07-19

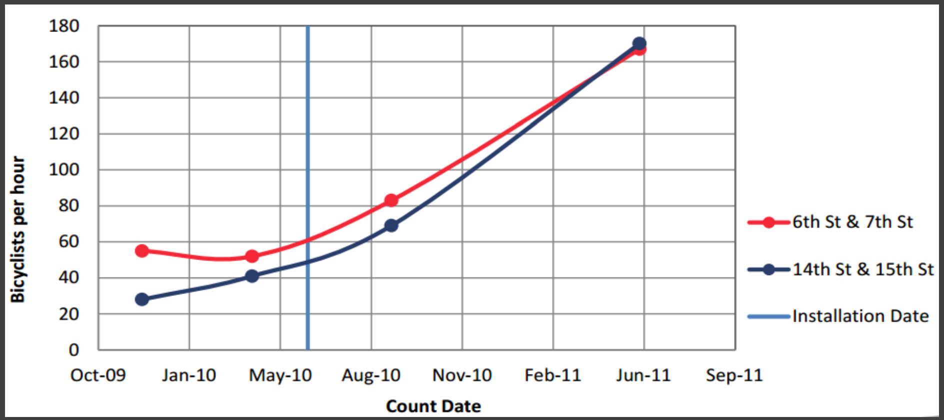
Appendix D. Day-of-Year Factoring Approach

2. Non-Motorized Count Applications

- Measuring facility usage
- Evaluating before-and-after data
- Monitoring travel patterns
- Safety analysis
- Project prioritization
- Multimodal modeling

For each application:
Details
Case Studies

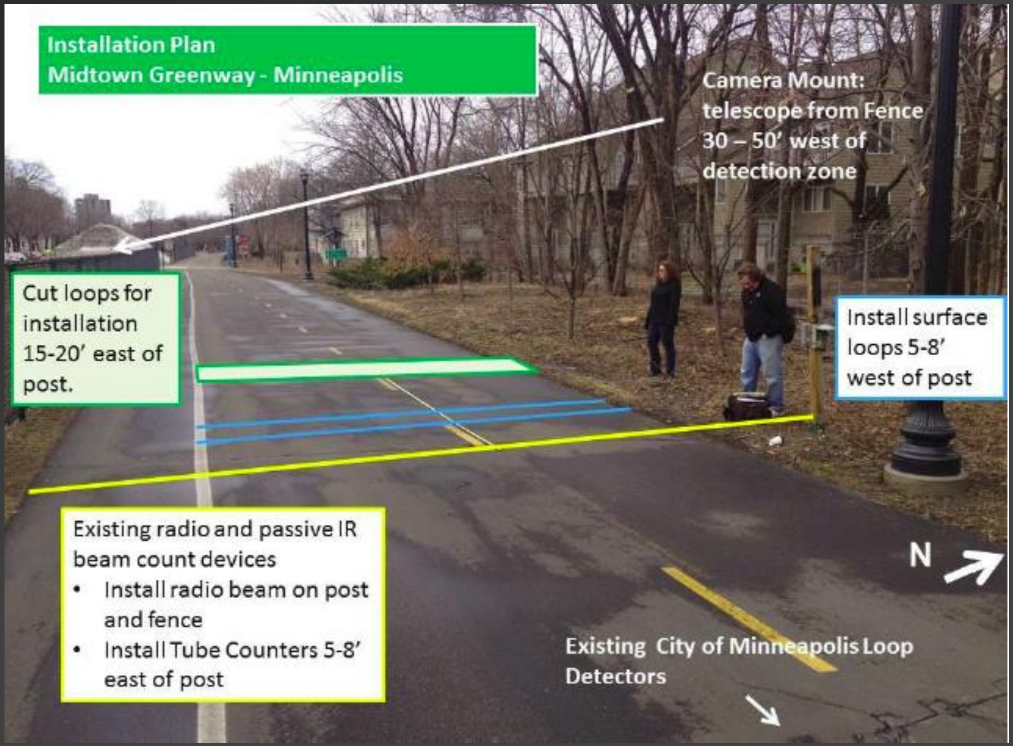
Before-and-After Bicycle Facility Usage – buffered bicycle lanes on Pennsylvania Avenue



Source: Kittelson & Associates, Portland State University, and Toole Design Group (2012)

3. Data Collection Planning & Implementation

- Covers:
  1. Planning the count program
  2. Implementing the count program
- Provides examples, detailed guidance, checklists



Source: Tony Hull, Toole Design Group.

4. Adjusting Count Data

- Sources of counter inaccuracy
- Measured counter accuracy
- Counter correction factors
- Expansion factors
- Examples applications

Occlusion error

5. Treatment Toolbox

- Description
- Typical application
- Level of effort
- Strengths
- Limitations
- Accuracy
- Usage

Sidebar with quick facts

PASSIVE INFRARED SUMMARY

Maximum user volume:
Provides consistent results up to 600 users per hour; counts can be corrected at higher volumes.

Detection zone width:
<20 feet

Typical count duration:
Can be used for both short-term counts and permanent installations

Typical equipment cost (2013):
$1,000–3,000

Relative preparation cost:
Medium (may require permitting)

Typical installation time:
<30 minutes for temporary installations, longer for permanent installations involving installing posts

Typical data collector training time:
<30 minutes

Relative hourly cost:
Low, equipment costs are spread over a large number of data-collection hours

Mobility:
Very good, equipment can be readily removed and taken to a new site

Testing Plan

- Focus on testing and evaluating commercially available automated technologies
- Assess **type** of technology as opposed to a specific product
- Cover a range of facility types, mix of traffic, and geographic locations
- Evaluate accuracy through the use of manual count video data reduction

Technologies and Site Locations

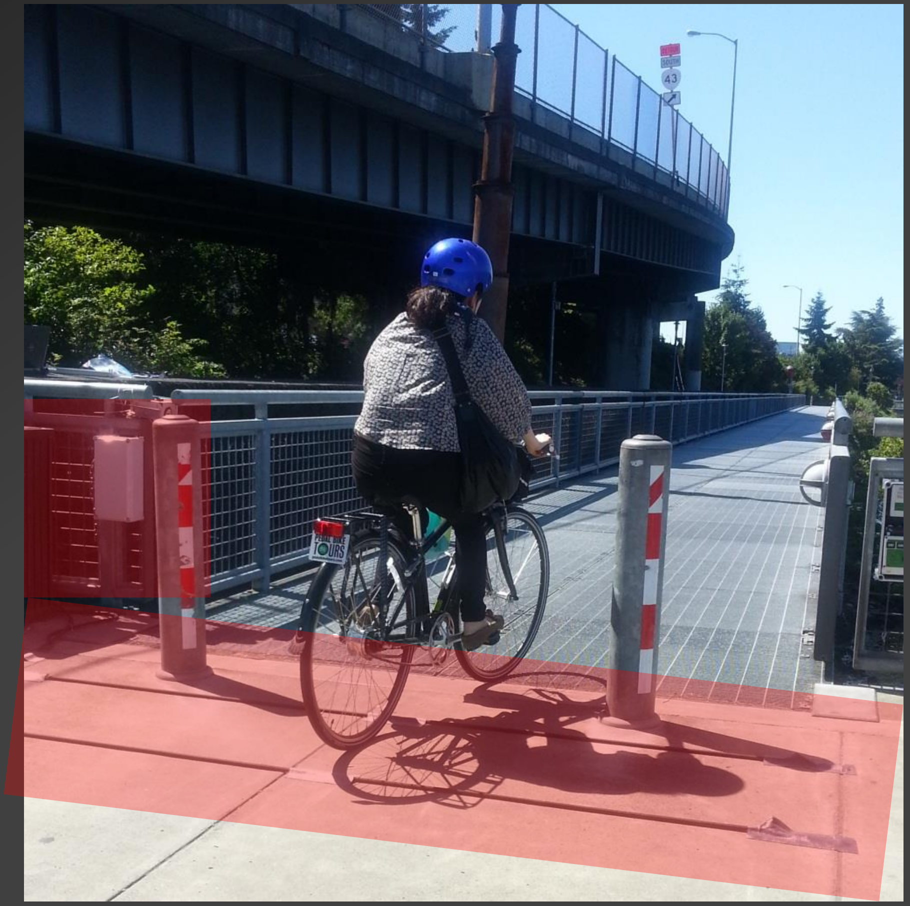
- Technologies
  - Passive infrared
  - Active infrared
  - Pneumatic tubes
  - Inductive loops
  - Piezoelectric
  - Radio beam
- Site Locations
  - Portland, OR
  - San Francisco, CA
  - Davis, CA
  - Berkeley, CA
  - Minneapolis, MN
  - Washington, D.C.
  - Arlington, VA
  - Montreal, Canada

Video Data Collection

- Camera installed with counters for ~5 days
- Second deployment targeting desired conditions
- ~3k hours of video collected

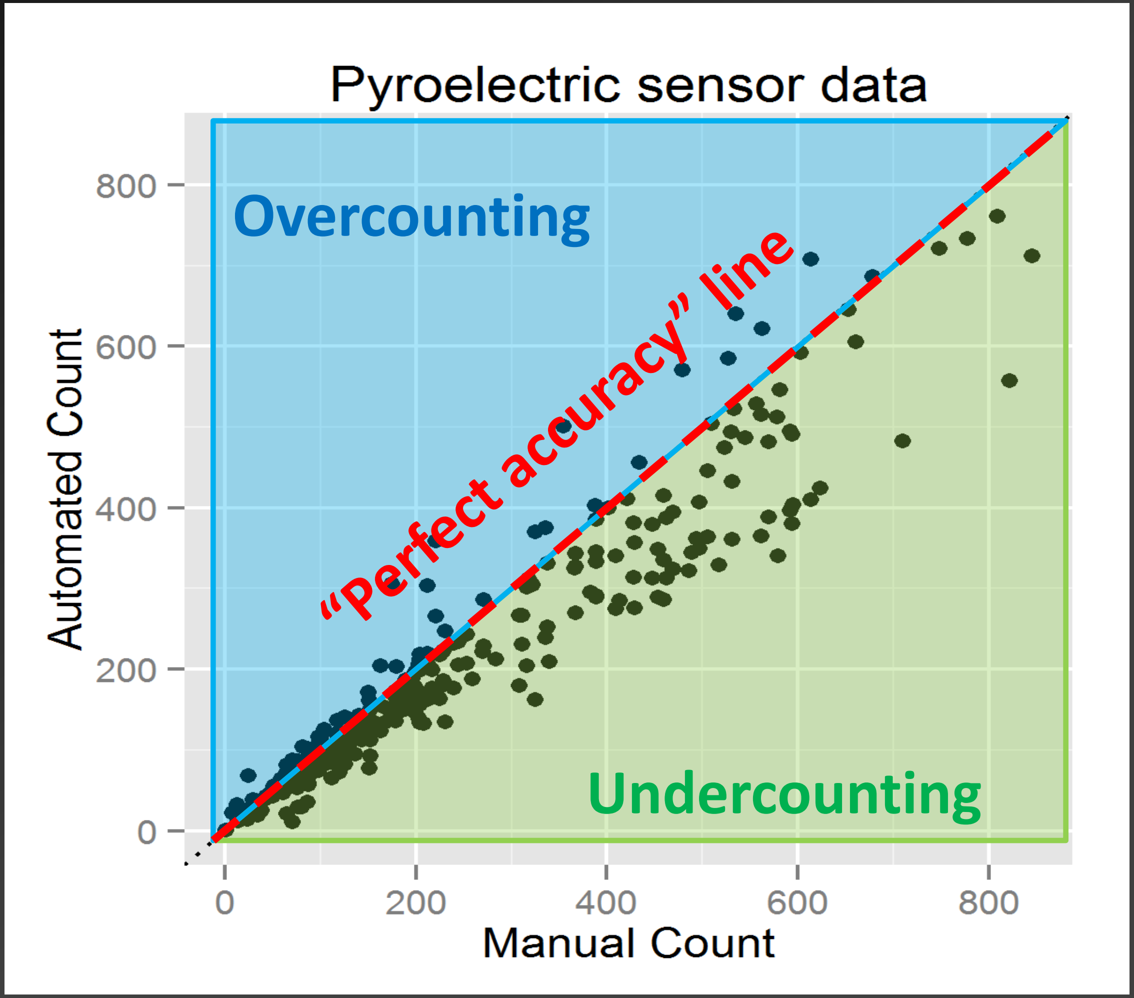
Example site: Portland, OR

- Eastbank Esplanade
- Multiuse path
- Tested:
  - –Passive Infrared
  - –Pneumatic Tubes
  - –Radio Beam



Source: Karla Kingsley, Kittelson & Associates, Inc.

Graphical Analysis



Accuracy Calculations

- $APD = \frac{1}{n}\sum_{t=1}^{n}\frac{A_t - M_t}{M_t}$
- $AAPD = \frac{1}{n}\sum_{t=1}^{n}\left|\frac{A_t - M_t}{M_t}\right|$
- $r = \frac{\sum_{t=1}^{n}(M_t - \bar{M})(A_t - \bar{A})}{\sqrt{\sum_{t=1}^{n}(M_t - \bar{M})^2}\sqrt{\sum_{t=1}^{n}(A_t - \bar{A})^2}}$

Where A_i is the automated count in period *i* and M_i is the manual count in period *i*

Passive Infrared (IR)

- Detect pedestrians and cyclists by infrared radiation (heat) patterns them emit
- Passive infrared sensor placed on one side of facility
- Widely used and tested

Source: Ciara Schlichting, Toole Design Group

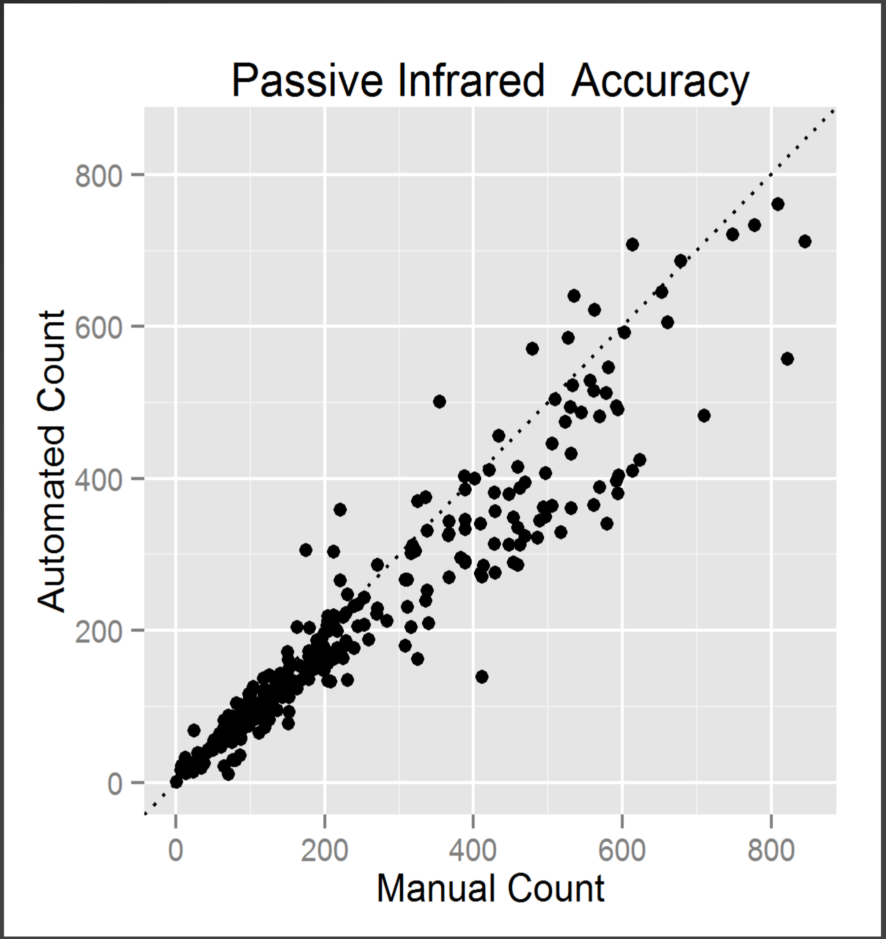
Passive Infrared

- Easy installation
- Mounts to existing pole/surface or in purpose-built pole
- Potential false detections from background
- Possible undercounting due to occlusion

Photo: Frank Proulx

Passive Infrared Findings

- APD = -8.75%, AAPD = 20.11%, r = 0.9502
- Differences between products
- Correction function could account for facility width
- Accuracy not affected by high temperatures



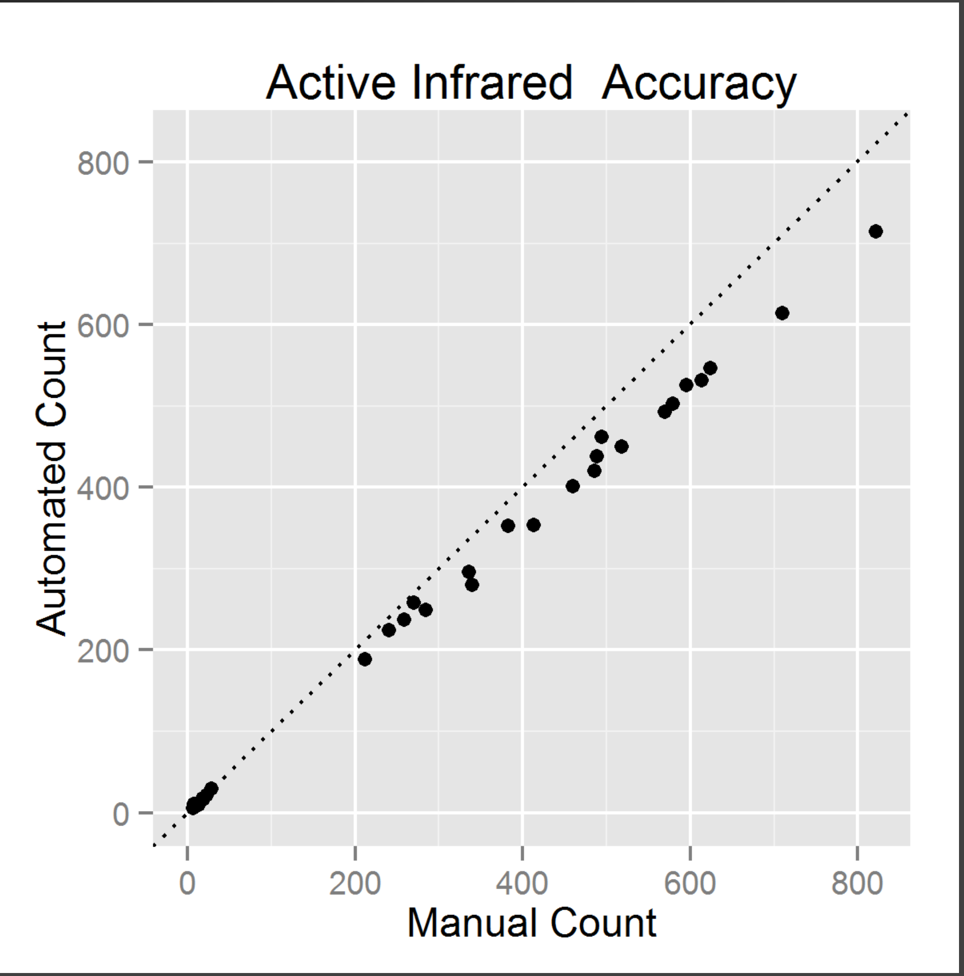
Active Infrared (IR)

- Transmitter and receiver with IR beam
- Counts caused by “breaking the beam”
- Moderately easy installation – requires aligning transmitter and receiver

Source: Steve Hankey, University of Minnesota

Active Infrared

- APD = -9.11%
- AAPD = 11.61%
- r = 0.9991
- Single device tested – accurate and highly precise



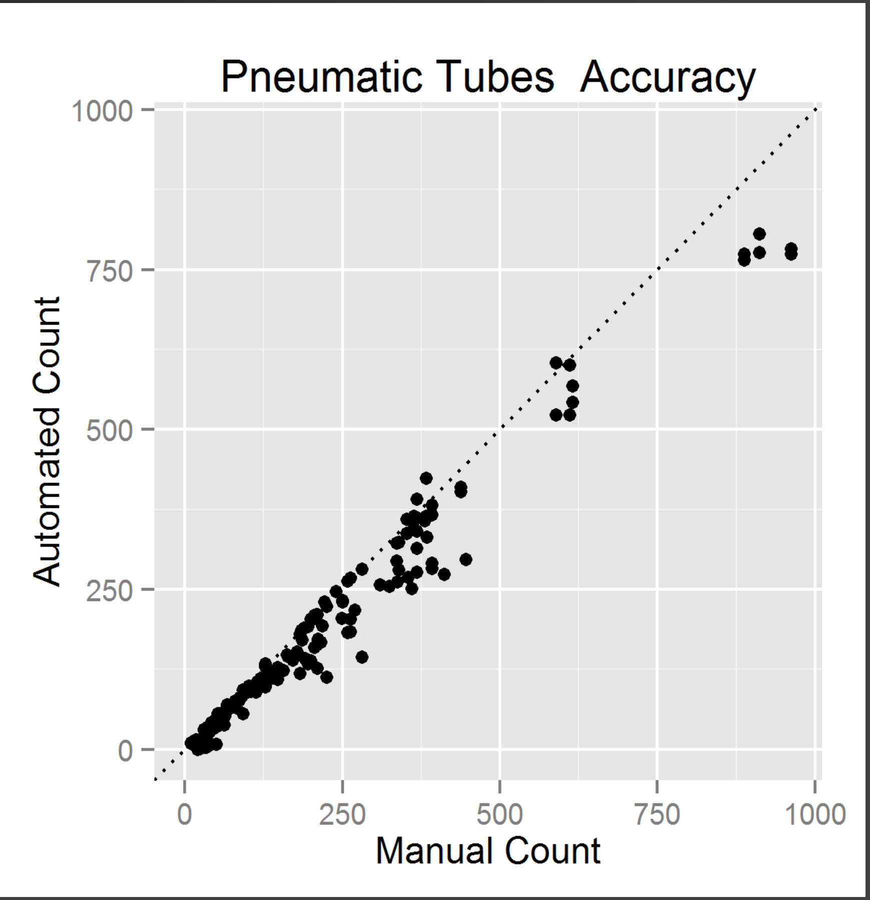
Pneumatic Tubes

- One or more tubes are stretched across roadway or path
- When a bicycle rides over tube, pulse of air passes through tube to detector

Source: Karla Kingsley, Kittelson & Associates, Inc.

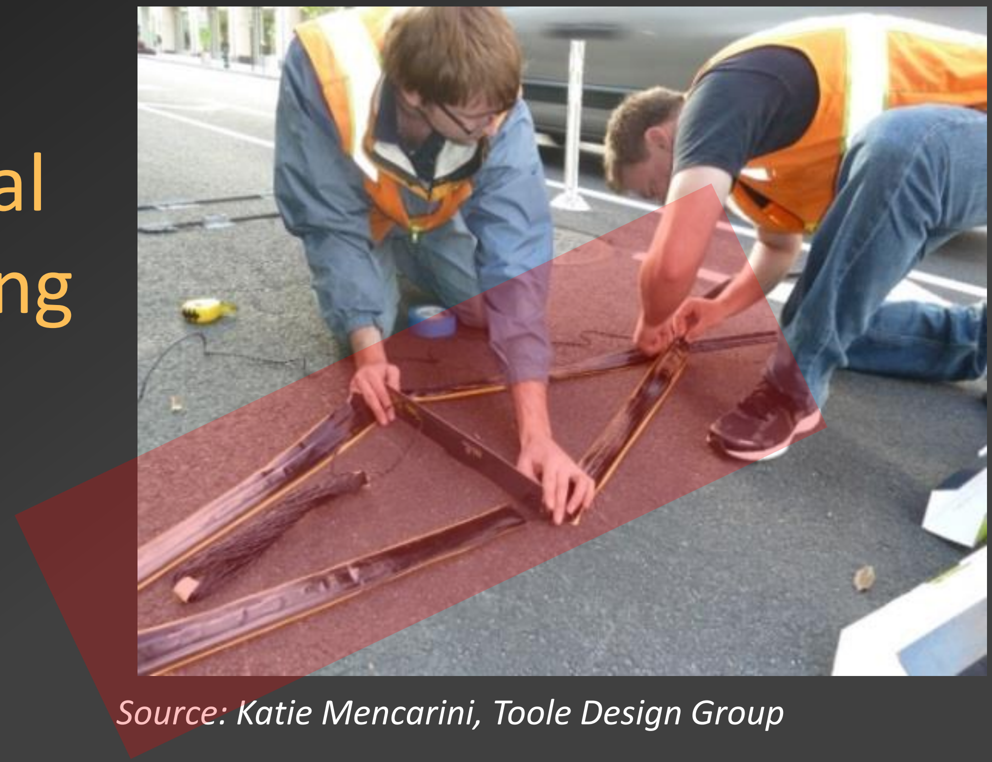
Pneumatic Tubes Findings

- APD = -17.89%, AAPD = 18.50%, r = 0.9864
- Strong site and device specific effects
- Accuracy rates not observed to decline with aging tubes
- Future research in mixed traffic settings



Inductive Loops

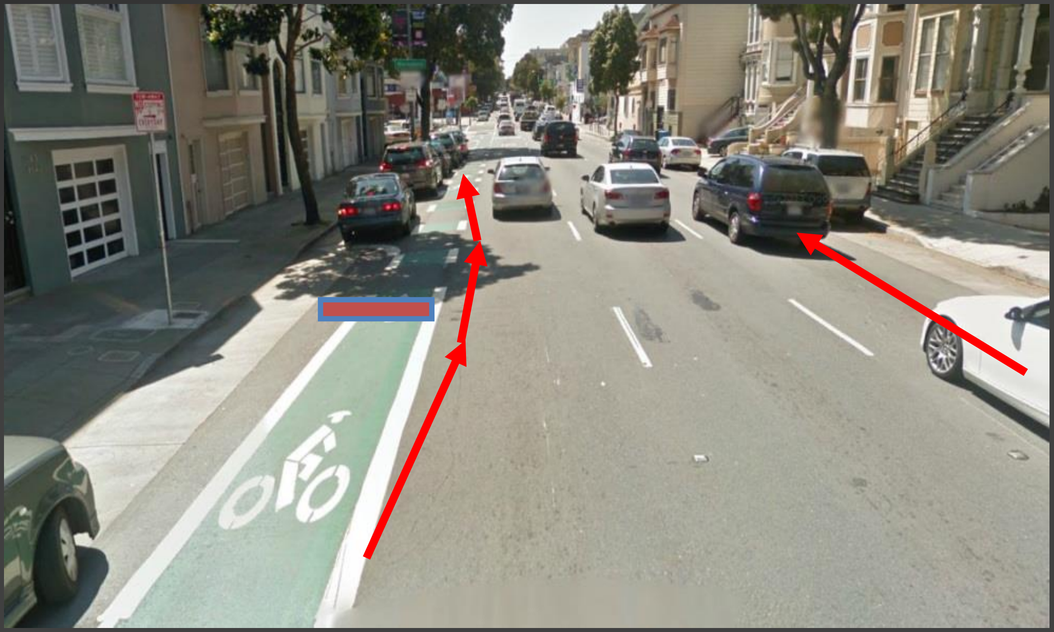
- Generate a magnetic field that detect metal parts of bicycle passing over loop
- In-pavement or temporary loops (on surface)



Source: Katie Mencarini, Toole Design Group

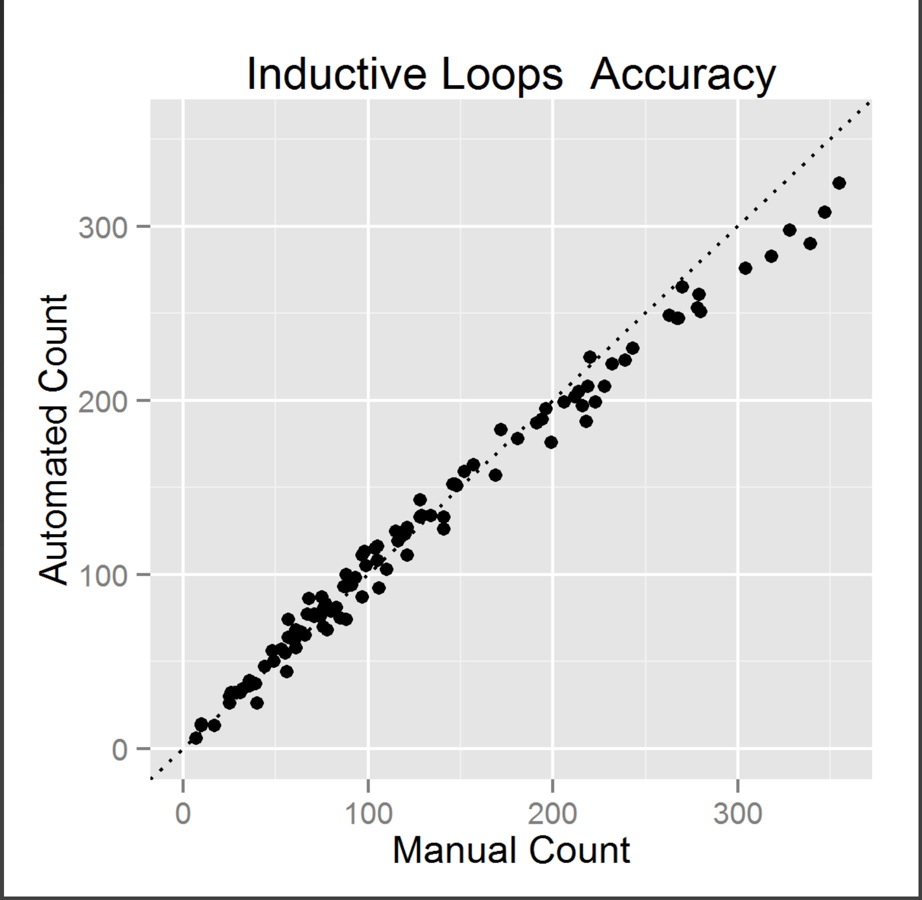
Inductive Loops

- Permanent (in ground) or temporary (on surface)
- Bypass errors
  - –Cyclists passing outside bike lane
  - –Loops leaving gaps in detection zone



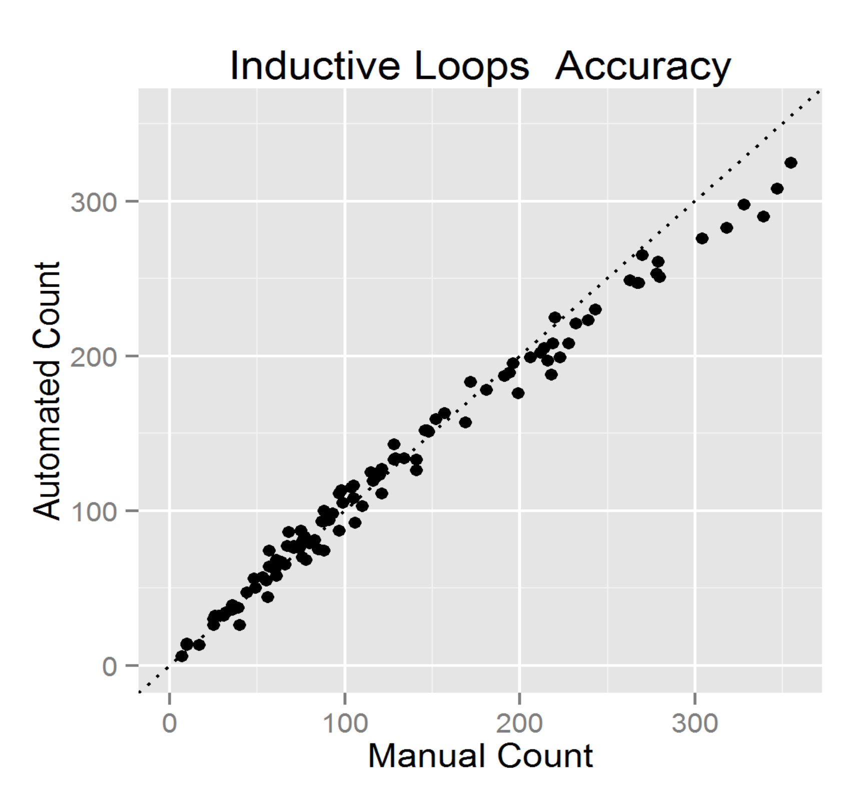
Inductive Loops

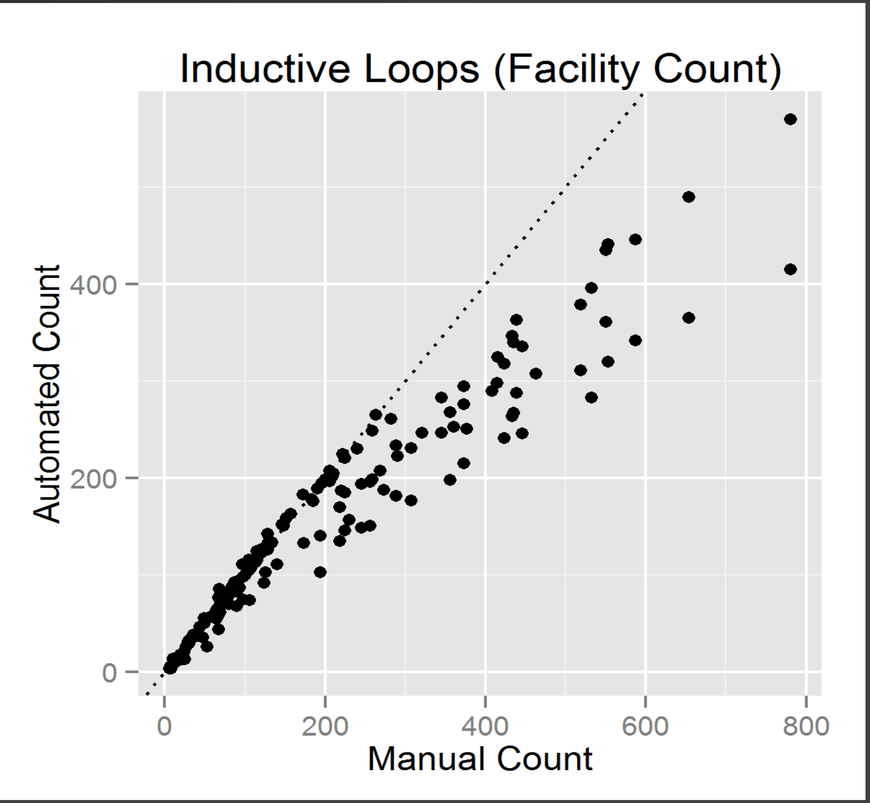
- APD = 0.55%, AAPD = 8.87%, r = 0.9938
- Errors with age of loops not detected
- Higher volumes slightly affect accuracy
- No substantial difference between permanent and temporary loops



Inductive Loops

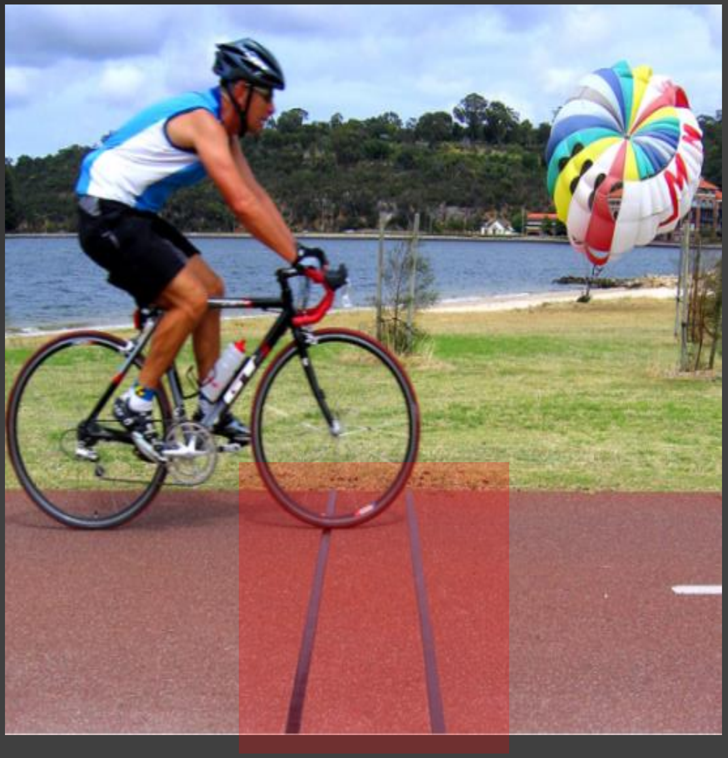
- Need to mitigate bypass errors





Piezoelectric Sensor

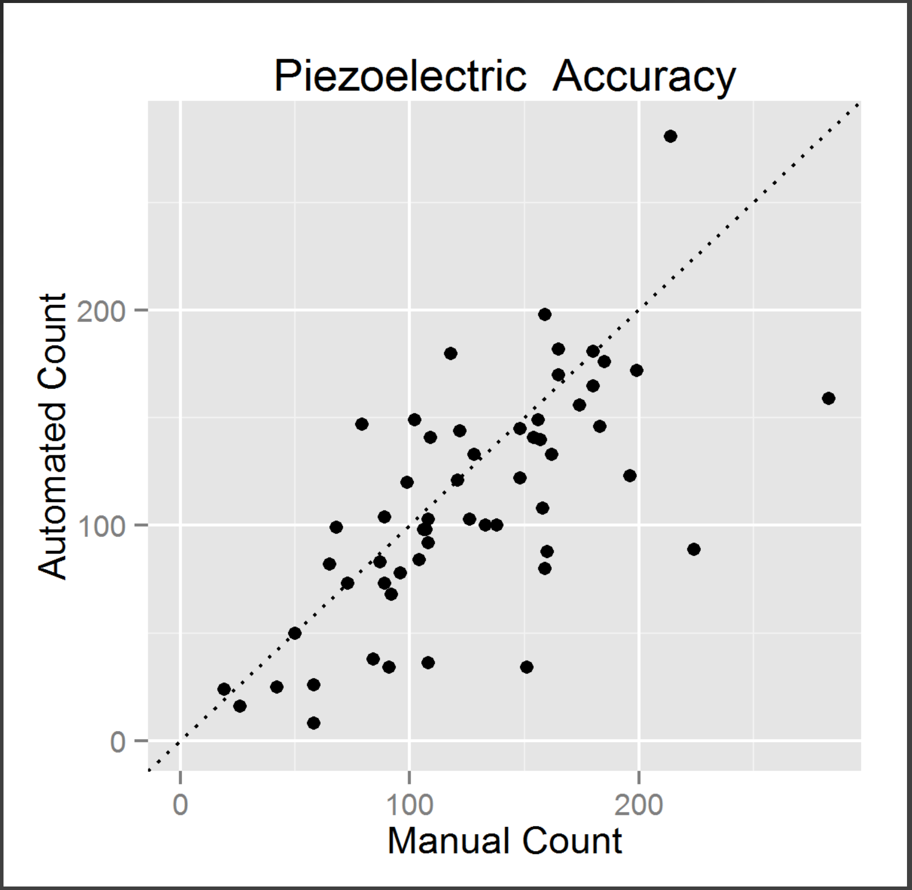
- Emit an electric signal when physically deformed to detect bicyclists
- Typically embedded in pavement across travel way



Source: MetroCount

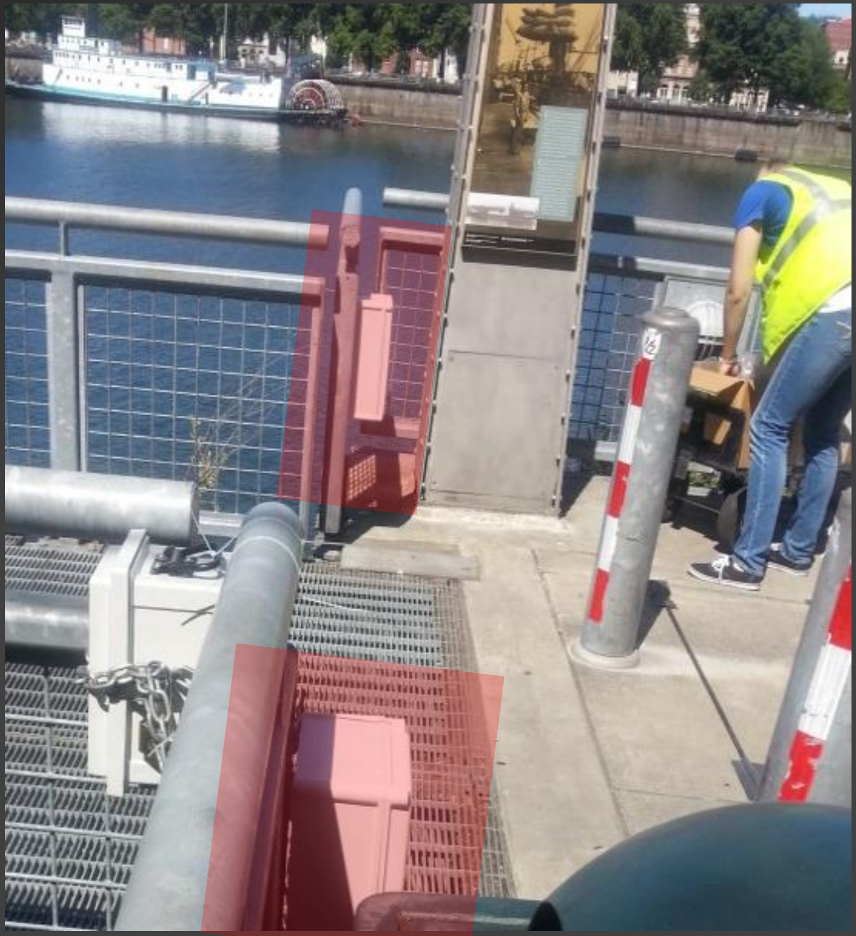
Piezoelectric Strips

- Tested one existing device, due to difficulties procuring equipment
- CAUTION – data from single device not installed by research team
- APD = -11.36%, AAPD = 26.60%, r = 0.691



Radio Beam

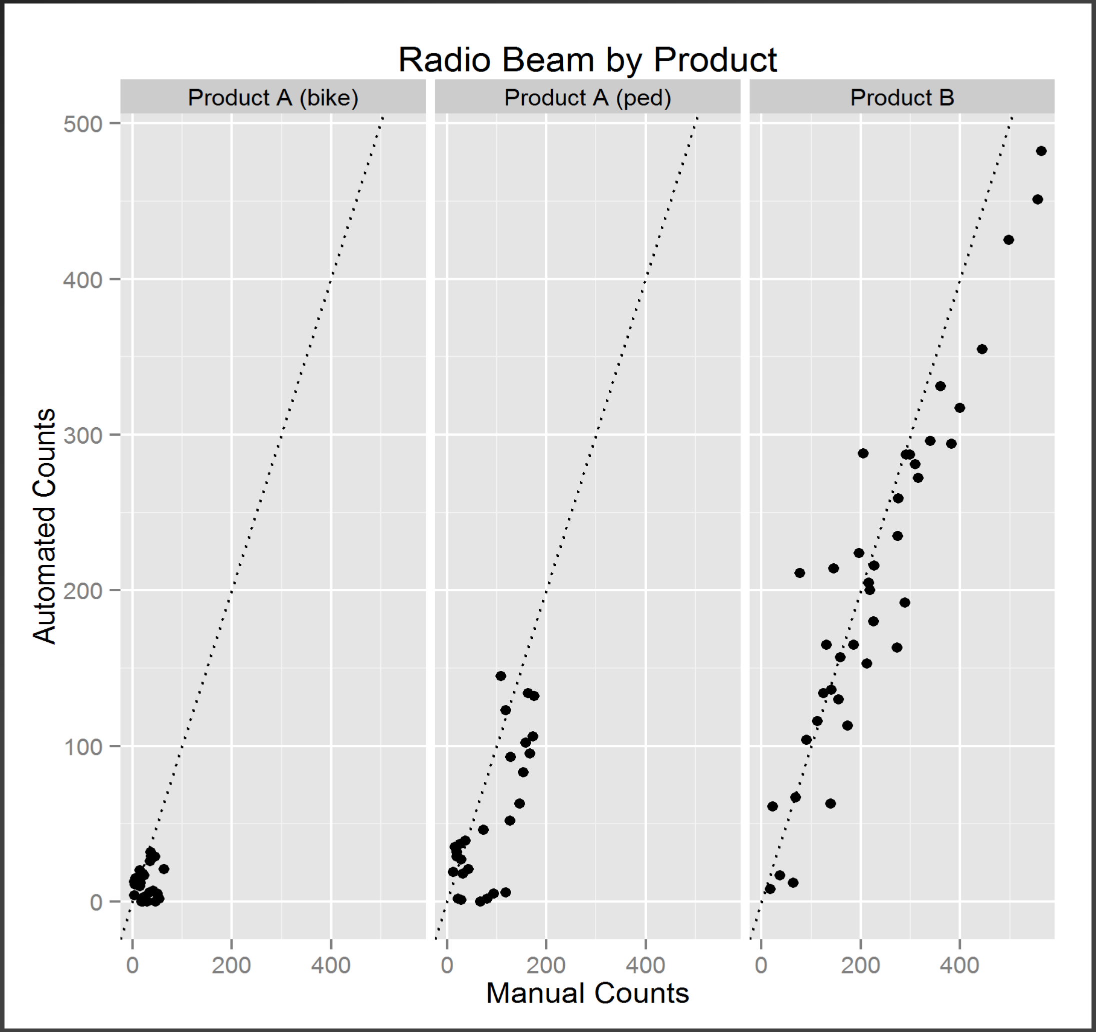
- Transmitter and receiver emit a radio signal that detect a user when the beam is broken
- Not previously tested in literature
- Some devices count bikes and peds separately



Source: Karla Kingsley, Kittelson & Associates, Inc.

Radio Beam

- Product B higher accuracy
- Product A – low precision and lower accuracy
- Occlusion errors



Recommendations for Practitioners

- Calibrate and conduct your own ground-truth count tests
- Consider approvals and site characteristics when selecting a count site

Suggested Research

- Additional testing of automated technologies
  - Technologies not tested or underrepresented
  - Additional sites and conditions
- Extrapolating short-duration counts to longer-duration counts
- Adjustment factors for environmental factors

Questions?

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