

2011 ITE Northeastern District Meeting

Motorcycle and Bicycle Detection Using Stereo and LWIR Cameras

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Presentation Outline

- **Problems and Existing Methods**
- **A New Multi-Sensor Platform**
- **Detection Algorithm Architecture**
- **System Prototype Development**
- **Current Status and Field Test Plan**

Problems and Existing Methods

Problems and Existing Methods

Although vehicle detection, classification, and characterization have been an area of active research for several decades, currently, there are only a few papers offering unique approaches for motorcycle detection and classification.

There are two primary issues related to this important research:

(1) How to detect motorcycles in a dynamic background involving moving vehicles, walking pedestrians, raining, snowing, etc?

(2) How to classify motorcycles into groups such as heavy touring-class motorcycles, light motorcycles, motor scooters, mopeds, tricycles and bicycles?

Problems and Existing Methods (cont'd)

Helmet Detection

It mainly searches the helmets to detect the motorcycles. However, detection of helmets alone is not sufficient to detect motorcycles due to limited camera resolution and skewed sphere shapes of helmets. The classification of motorcycles using visual length, width and pixel ratio also cannot effectively classify motorcycles.

Modeling and Background Subtraction

Methods such as background subtraction and vehicle modeling were reported. Although these methods are applicable for some vehicles and motorcycles, they are not robust enough for practical applications since background is highly dynamic and generic models for vehicles do not exist.

Problems and Existing Methods (cont'd)

Wheel Detection

A feature-based classifier was reported to distinguish bicycles from motorcycles. The algorithm extracts some visual features focusing on the wheel regions of the vehicles. It can only discriminate between motorcycles and bicycles, not their individual types. The camera also needs to be installed accurately to capture the wheels.

A New Multi-Sensor Platform

A New Multi-Sensor Platform

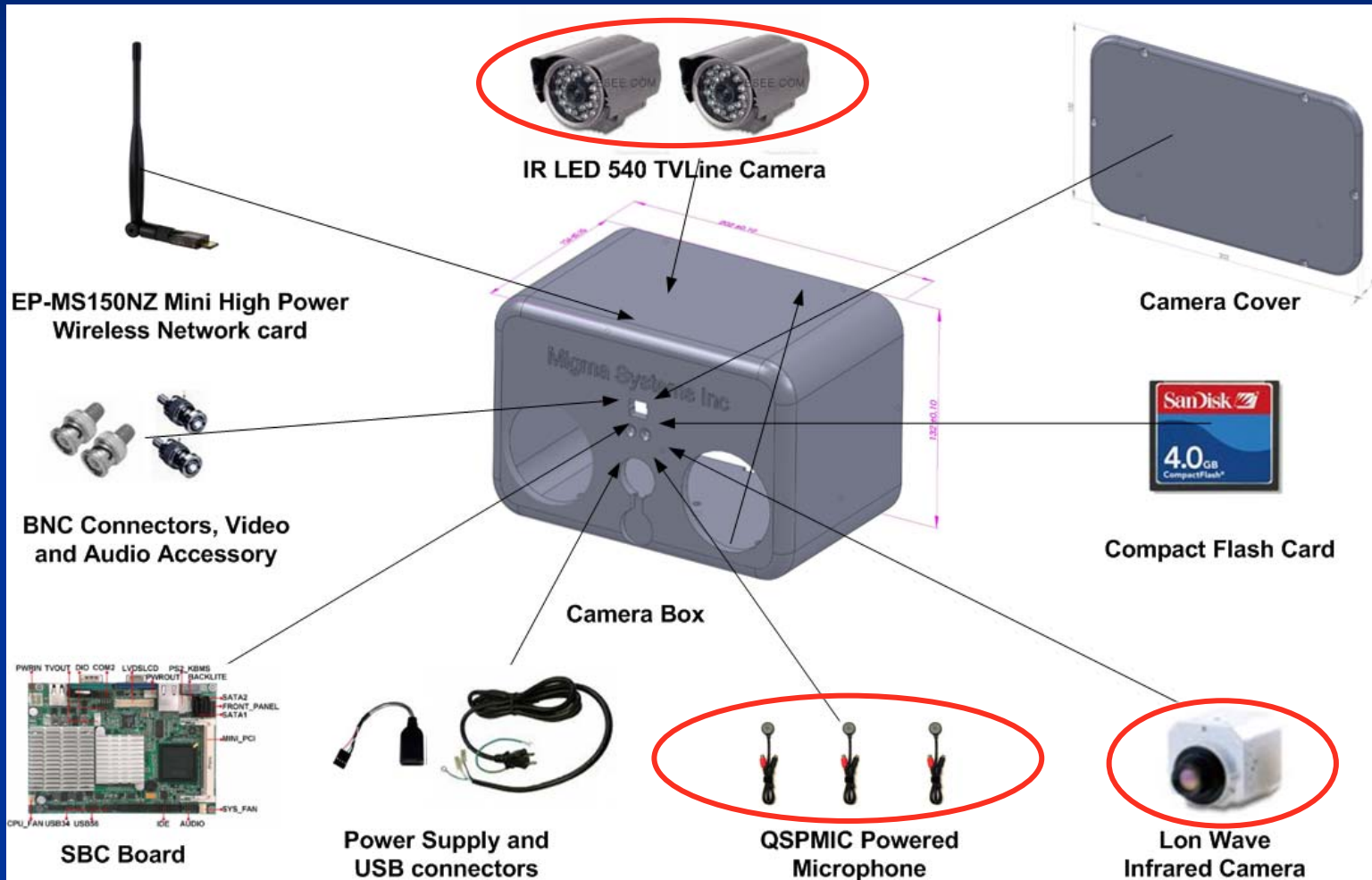
Working with FHWA, we have developed a new multi-sensor platform for

- ◆ detection bicycles
- ◆ detection and classification of motorcycles
 - heavy motorcycle
 - light motorcycle
 - scooter
 - moped

This detector is made of a suite of sensors including

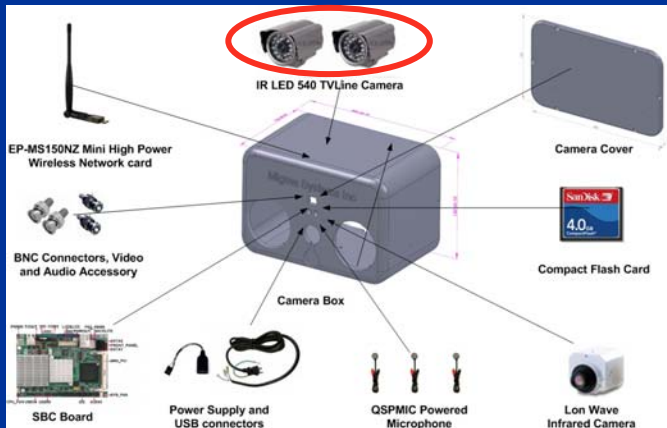
- ◆ stereo camera
- ◆ LWIR camera
- ◆ microphone array (three total)

A New Multi-Sensor Platform (cont'd)



A New Multi-Sensor Platform (cont'd)

Stereo Camera



This is the same stereo camera used in our current pedestrian detection products deployed at midblock crossings and street intersections:

MigmaMidblock™

MigmaIntersection™

MigmaWalktime™

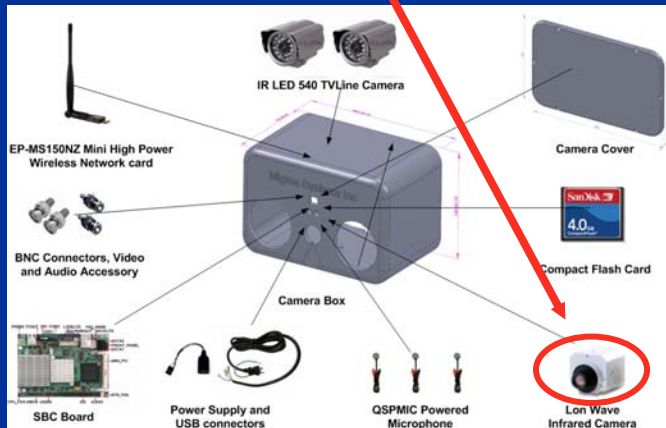
It is capable of discriminating human body and vehicle body through 3D feature detection and classification.

If we can detect the cyclist through his or her 3D body, we can infer the detection of motorcycle or bicycle he or she is riding on.

A New Multi-Sensor Platform (cont'd)

LWIR camera is used to detect motorcycles through their hot exhaust pipes.

LWIR Camera

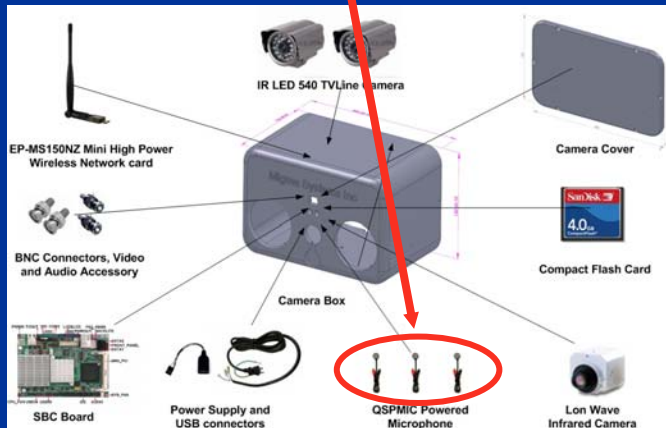


Bicycles show clear wheels in LWIR images.



A New Multi-Sensor Platform (cont'd)

Microphone Array



Microphones are used for the classification of heavy and light motorcycles, mopeds, and scooters.

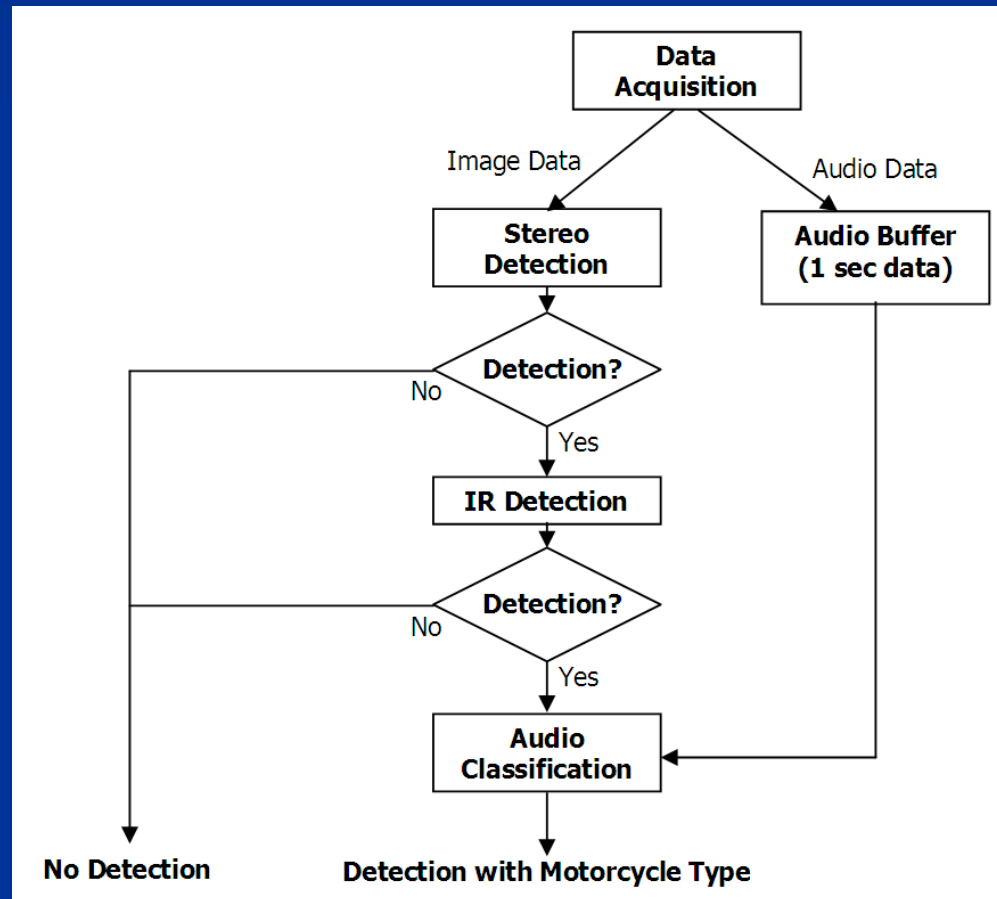
Three microphones are strategically placed on the enclosure to optimally reduce the background noises and enhance the classification accuracy.



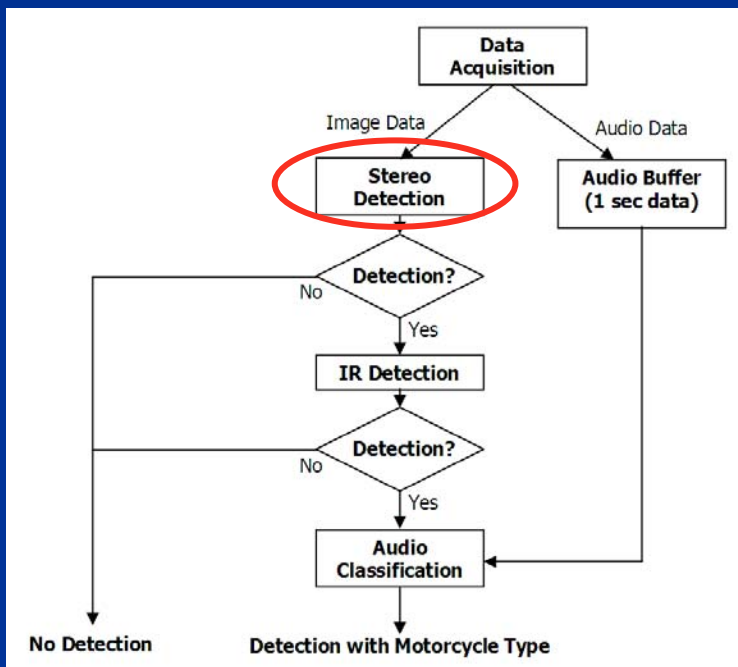
Detection Algorithm Architecture

Detection Algorithm Architecture

To fully utilize the sensor suite – stereo camera, LWIR camera and microphones, we use the layering approach and sensor fusion.



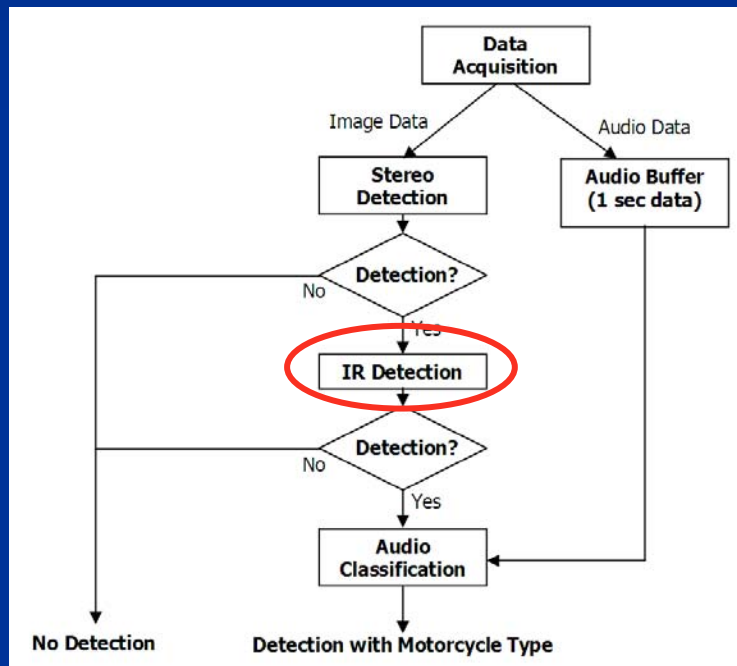
Detection Algorithm Architecture (cont'd)



Stereo camera is made of two high resolution CCD lenses. Instead of detecting the human bodies in the color images, it detects the cyclists in the disparity map extracted from the pair of color camera lenses in the stereo camera.



Detection Algorithm Architecture (cont'd)

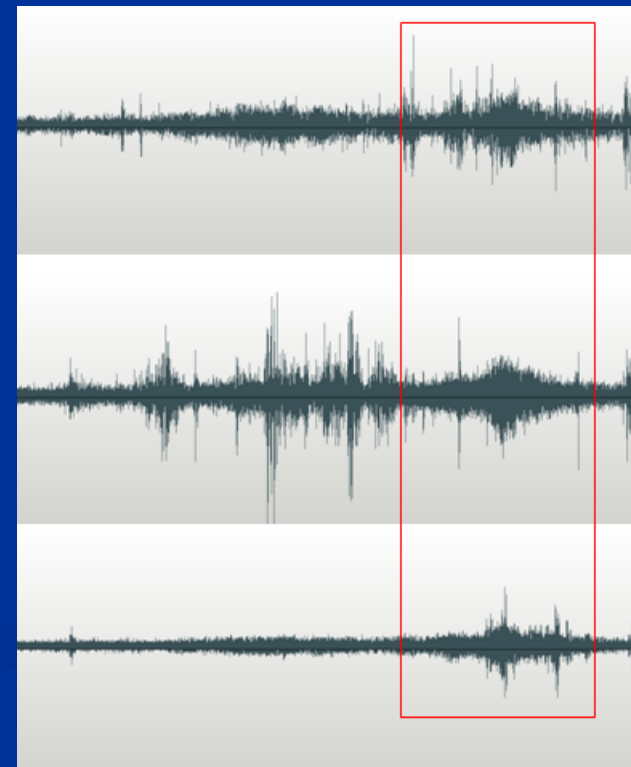
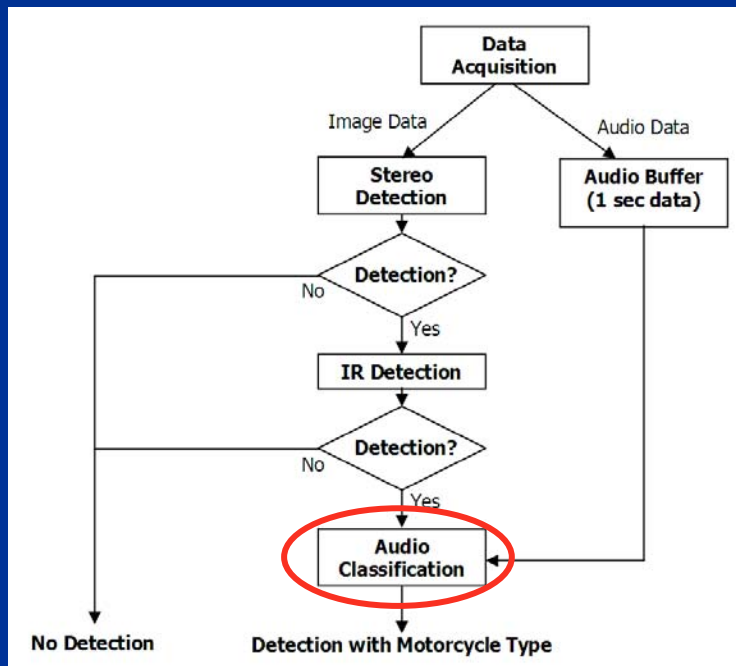


LWIR camera detects motorcycle and bicycle through their thermal signatures. Because of the temperature differences, both motorcycles and bicycles can be detected in the dynamic outdoor environment.



Detection Algorithm Architecture (cont'd)

Microphone array and its fusion are used for the motorcycle classification. Random noises such as the wind sound can be reduced through the sensor array fusion.

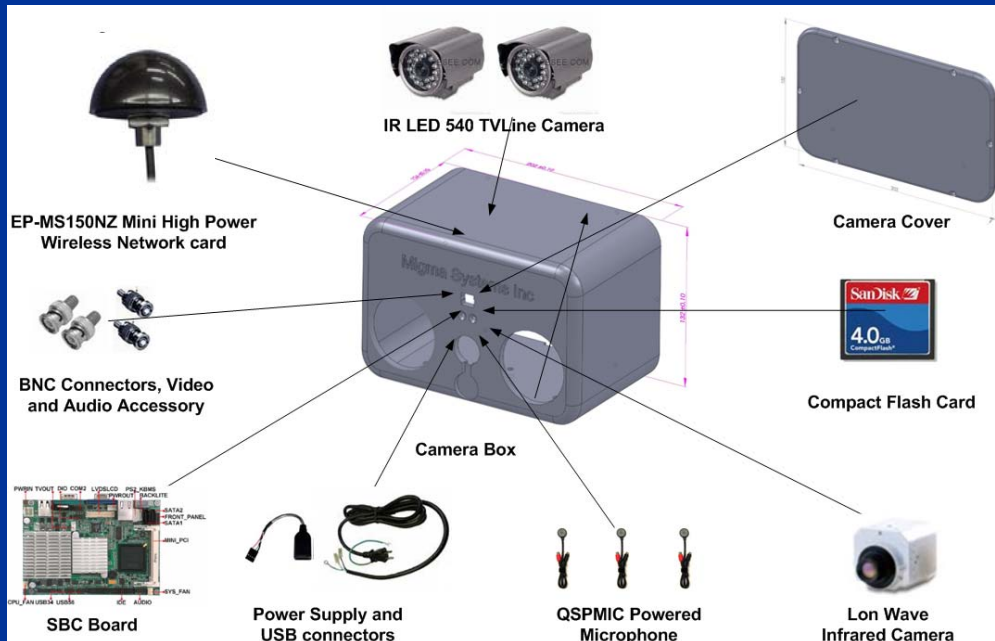


System Prototype Development

System Prototype Development

Standalone System

The detector has an embedded single board computer for the execution of detection algorithms and wireless communication.



System Prototype Development (cont'd)

Wireless Communication

This approach can significantly reduce the labor cost incurred during the installation. All detections are made locally in the single board computer.



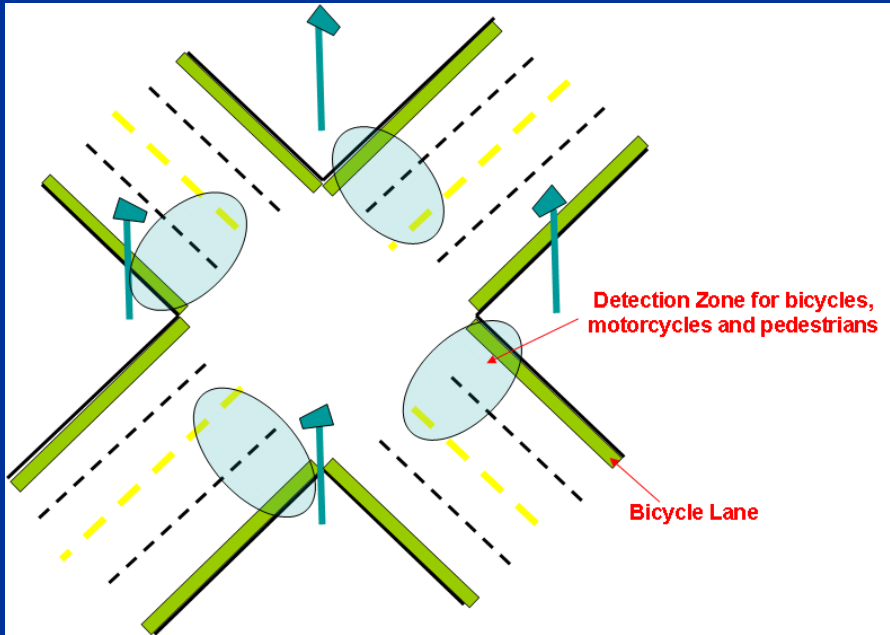
Traffic Controller



System Prototype Development (cont'd)

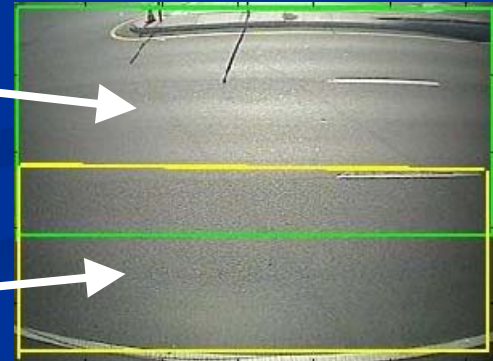
Two-Zone Detection

The image is divided into two zones – one for motorcycles and the other for bicycles. This approach can reduce the false calls related to the bicycle detection.



Motorcycle
Zone

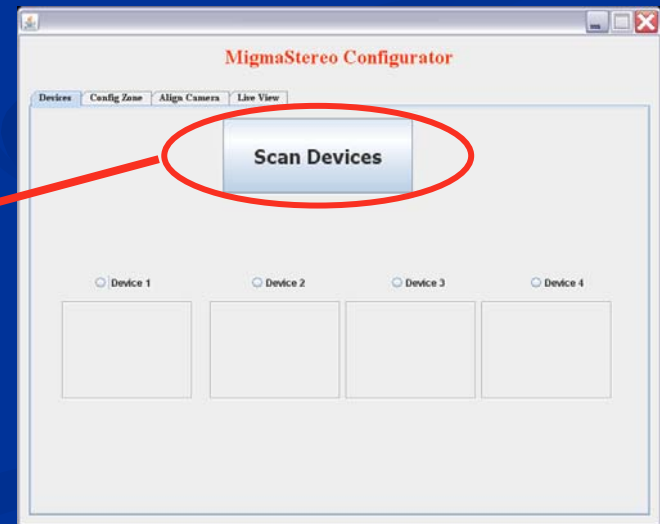
Bicycle
Zone



System Prototype Development (cont'd)

Remote Configuration

Each detector can be wirelessly connected at runtime remotely for configuration and diagnosis. It can scan multiple detectors and user can select individual detector.



Current Status

Current Status

A prototype system is deployed at an intersection of Rt. 1 in Walpole, MA.



This system can be used for data collection and operational test.

The detection results are wirelessly sent to the server located in our office. Configuration can be made inside our office as well.

Effort is being made to further improve the accuracy of both detection and classification.

We plan to conduct the field test soon for bicycle detection, and motorcycle detection and classification.

Thank You

Please stop by our booth to see our pedestrian detection products and their interface with APS pushbuttons.