Polaris
Sensor Technologies, Inc.

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www.polarissensor.com

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Company Information

- Founded 2003 as an Idea Factory
- Woman-owned, Small Business
- Located In High-tech Huntsville, Alabama
- Business Includes Military Government Contracting, Customer Solution Research And Development, And Launching Innovative Products To Commercialization
- Partnerships With Multi-national Corporations, Premiere Research Universities, National Laboratories, And Content Experts
- Over 30 Patents Submitted, Including International

Proven Experience Solution Experts

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Project Purpose

US Department of Transportation Small Business Innovative Research (SBIR) Solicitation:

"Similar to Red Light Running Cameras, this project would use pedestrian detection technology combined with automated enforcement technology to issue citations to vehicles that do not yield or stop for pedestrians at legal crossings."

Polaris awarded contract to develop system known as "Pedestrian Automated Enforcement Program"

- Combines radar and video to detect pedestrian right of way violations
- Phase 1 completed 2014
- Phase 2 in progress, to be completed in 2016

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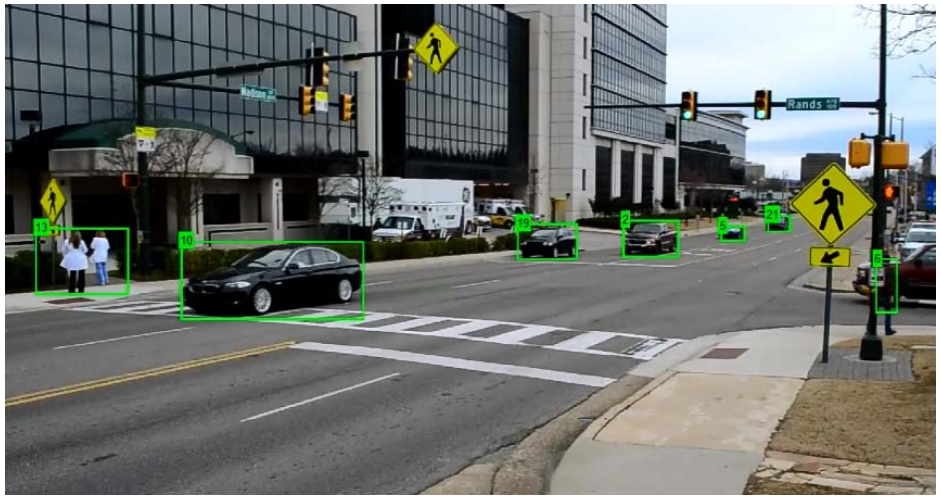
Approach

Detect vehicles and pedestrians, and apply traffic rules regarding pedestrian right of way to detect violators

- Automatically compute “normal” scene
  - “See between the crowd”
- Real-time detection of pedestrians, bikes, and vehicles (dynamic objects)
  - Use radar to detect and track vehicles, collecting speed and position information
  - Use video to detect and track pedestrians, bikes, and vehicles
- By tracking pedestrians and vehicles, dynamically detect when vehicles violate pedestrian right of way
  - Includes vehicle proximity to pedestrian, and traffic signal state when applicable



A challenge of any computer vision application is learning what part of the scene is of interest and what is background. Background changes depending on time of day and time of year. A method that continuously sees the background despite the dynamics is required.

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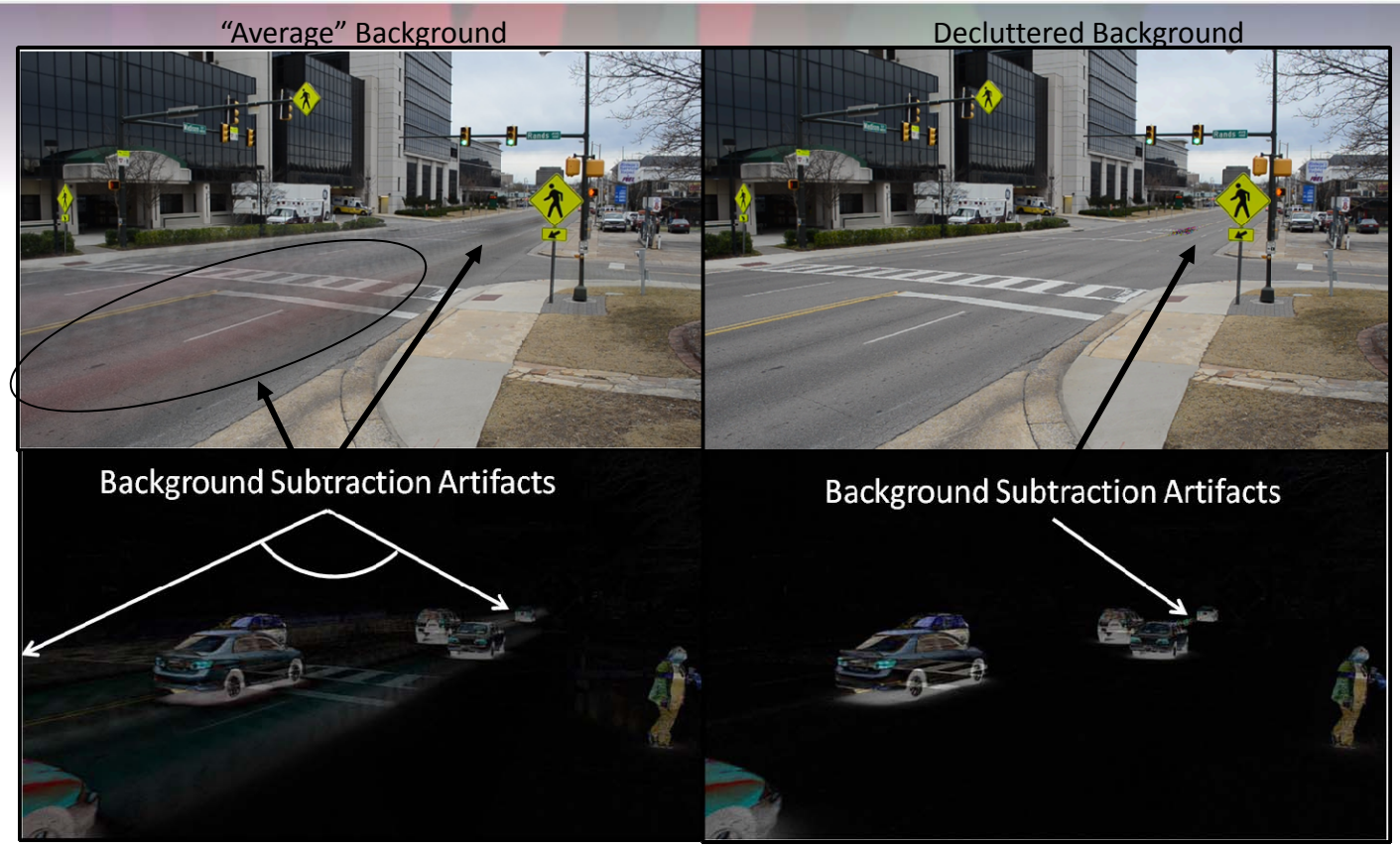
Phase I Results



Decluttered Background Image (right) – A new image processing algorithm developed to assist in tracking vehicles and pedestrians. Computed continually, allows effective tracking of vehicles and pedestrians by reduction of background image artifacts associated with scene dynamics, weather, time of day, and time of year change.

Top images show computed background scenes. Bottom images show what the system sees as differences from the computed background. The better the background representation the more clean the difference image and the better the system will function.

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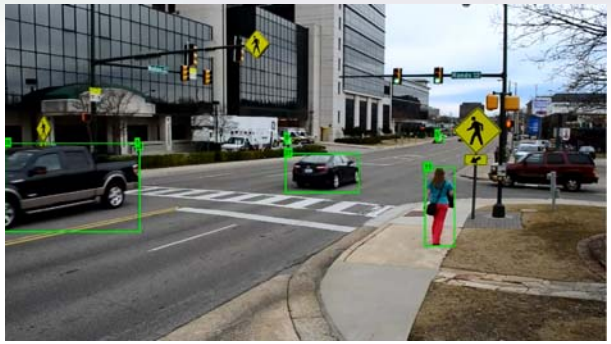
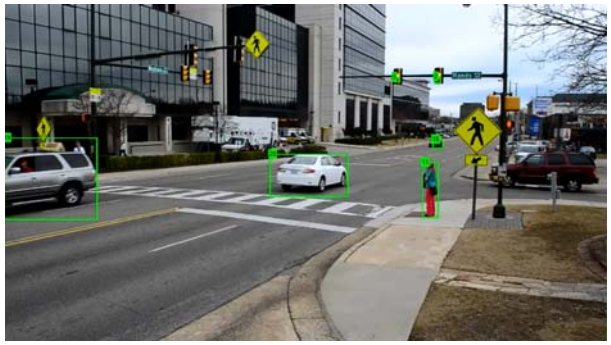
Phase I Results

Play Video 1

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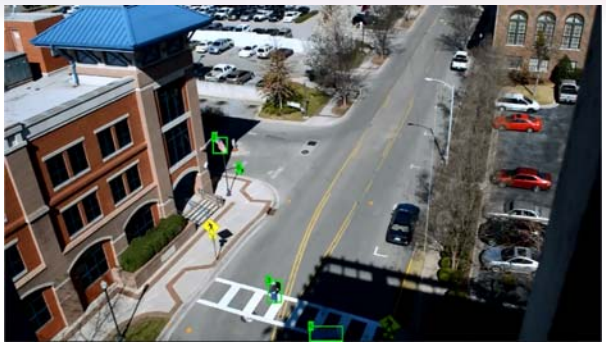
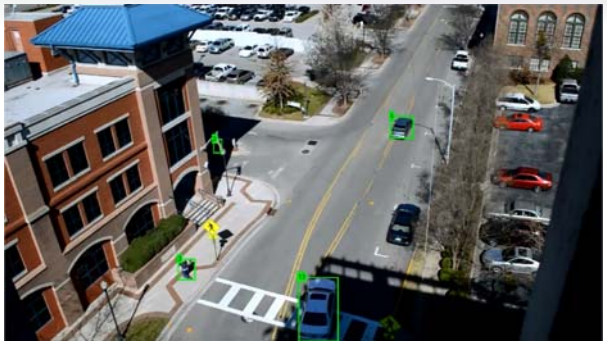
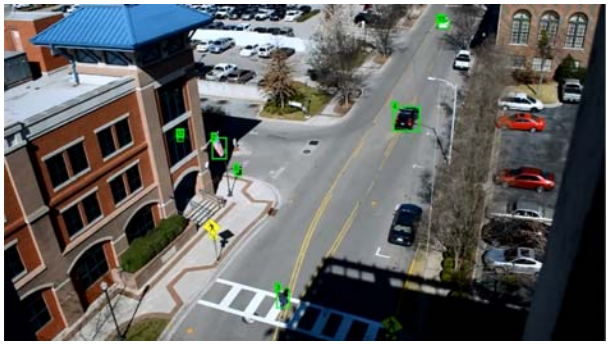
Phase I Results





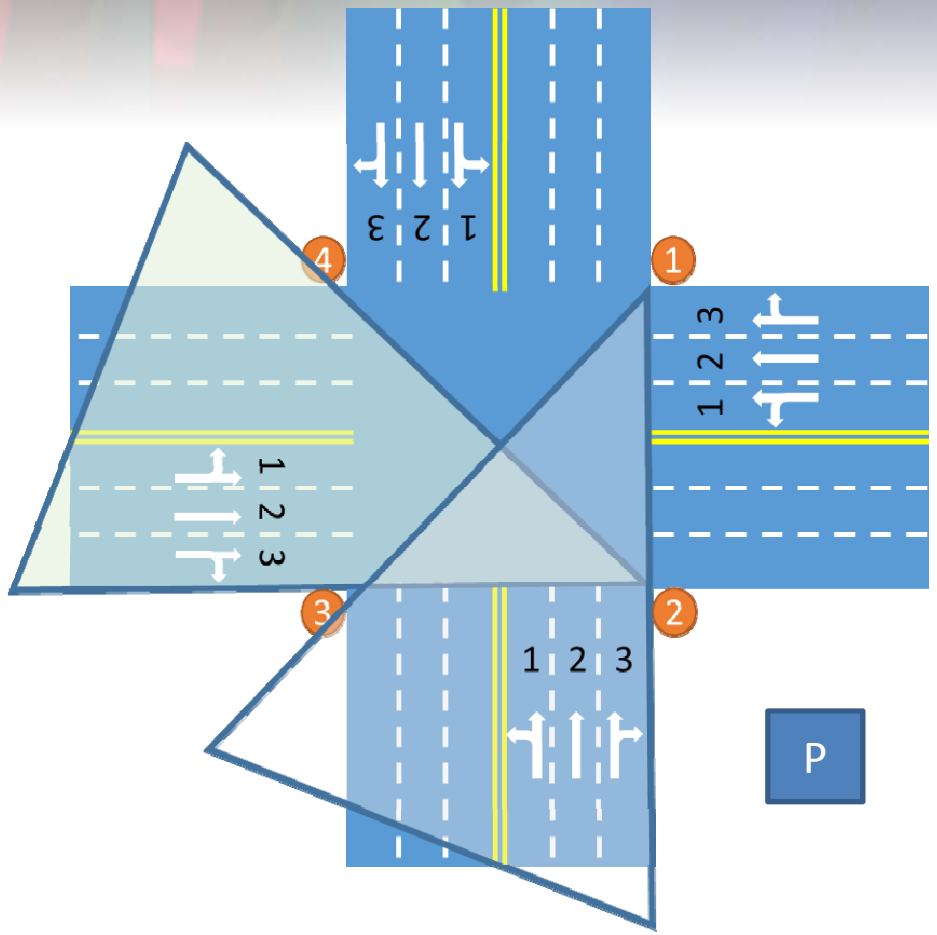


Play Video 2

System Design

KEY

- Sensor installation
- Sensor field of view
- System processor



Only 2 sensor coverages shown to simplify example.

Phase II Video Processing Work

HD Visible Camera | Intermediate Data: Differences in White

Play Video 3

Visible light camera systems can suffer from variations related to weather and lighting. Note: raw data on left, and intermediate data product on the right noting differences from computed background; difference data is input to the detection and tracking software, not a system output for human consumption.

Phase II Work: Thermal Infrared

VGA LWIR Camera

Intermediate Data:
Differences in White

Play Video 4

Infrared offers significant benefits over visible systems when operating in variable lighting conditions. Note lack of noise in difference image on right.

Thermal and Radar

Play Video 5

Combining radar and video provides visual detection with position and velocity information about each vehicle.

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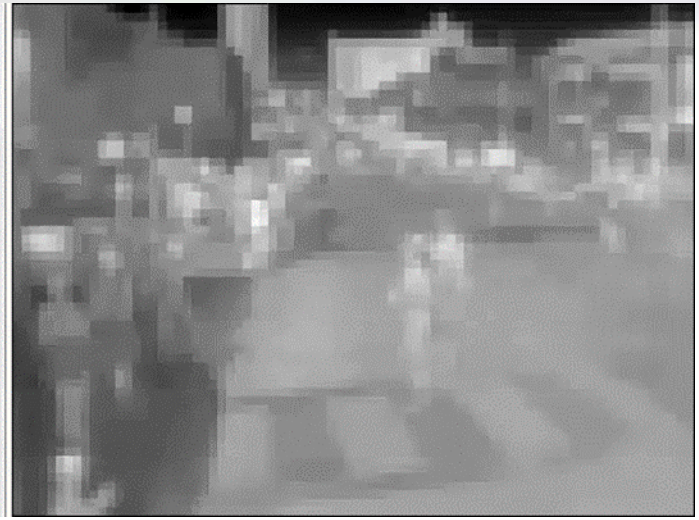
Cost Considerations

- Combining radar and thermal cameras can be costly
  - Thermal camera with VGA resolution cost between $5000 and $10,000
- Low cost systems can be more widely implemented, providing bigger impact on pedestrian safety
  - Low cost alternative must be considered
  - FLIR Lepton thermal camera provides 80x60 resolution thermal imagery at 9 Hz frame rate and costs around $300
- Image processing of Lepton imagery is possible on inexpensive processors
- Result is an inexpensive alternative to a high fidelity imaging system which can be used in conjunction with other sensors to provide the benefits of thermal imaging without the expense of higher resolution cameras

Example Thermal Imagery

FLIR Tau 640

FLIR Lepton



Play Video 6

Experiment comparing Tau 640 to Lepton. Field of view not the same, but center of field of view approximately aligned. Test shows Lepton offers potential for a low cost alternative to provide invariance to lighting anomalies.

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Current Project Status

- System design complete
  - Using radar designed for traffic applications combined with thermal and visible light cameras
    - Radar for detection of vehicles
    - Thermal for reliable detection and tracking of pedestrians
    - Visible for human consumable evidence
  - "System processor" collects data from all sensors, and computes a global picture of traffic and pedestrians
  - Rules applied as vehicles approach and move through "enforcement zones" where pedestrians have right of way
- Software development in progress
  - Focus on algorithmic implementations which allow for use on low cost hardware
- Testing to begin late spring 2016

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Component Capabilities

- Enforcement was primary goal of the SBIR project, but sensors have additional use beyond enforcement

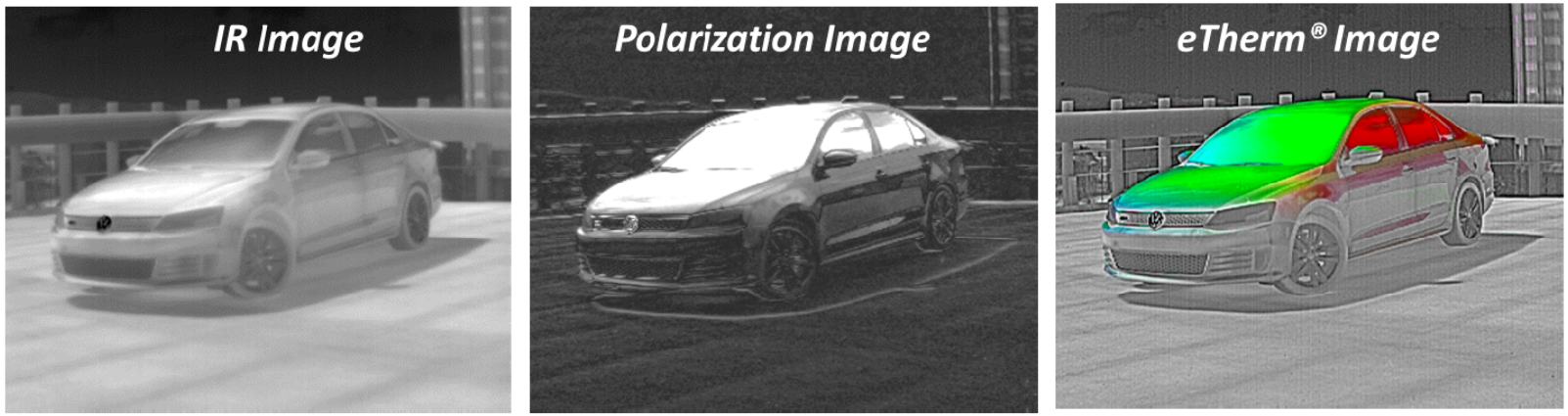
- Intelligent Transportation Systems (ITS) applications include Adaptive Traffic Control
  - City-wide adaptations
    - Because the system detects AND tracks vehicles, statistics could be computed providing traffic volume and pattern data to a centralized traffic control system
  - Local adaptations, i.e. at the intersection
    - If the system detects pedestrians lingering in crosswalk then the controller can be commanded to extend the amber
    - If the system detects vehicle unlikely to stop for amber then the controller can be commanded to extend the red clearance

- Traffic engineering applications include comprehensive traffic measurement and characterization, and automated pedestrian counting
  - Allows smaller communities without the budget for permanent installation of ITS equipment to do accurate and comprehensive engineering studies for improved design of intersections and crosswalks

Other Applicable Technologies

Polaris is also experimenting with additional technologies for traffic engineering

- Polaris Sensor Technologies Pyxis® combines thermal imagery and polarization to present eTherm® Imaging
- Offers potential to detect road edges, lanes, other hazards
- Provides information about shape and orientation



eTherm® Provides Superior Combination of Thermal and Polarized Imagery

eTherm® Highway Video

Standard Thermal

Pyxis® with eTherm®

Play Video 7

The Polaris Pyxis® with eTherm® allows for day or night detection of roadway surfaces, and provides shape and orientation information for objects in the scene.