Automated License Plate Reading – The Basics
Introduction

The purpose of this webinar is to introduce the basics of automated license plate reading technology to those unfamiliar with these systems and dispel myths and misconceptions. We will discuss; the technology’s history and maturation, basic operating principles, hardware components, software components, physical impacts, key metrics and performance evaluation methodologies.
Presenters

John Dalinsky

Technical expertise includes: tactical and commercial RF communications (terrestrial and satellite), remote surveillance, sensors, biometric, video surveillance, ground surveillance radar, automated traffic enforcement and command & control solutions, and over 12 years experience in the development of automated license plate capture solutions.

John has a 30+ years of experience as a successful sales and marketing Executive in the Business Development arena serving the Federal (Defense & LEA), State and Local Government markets.
Presenters

Juan A. Herrera, Ph.D.

Thirty years of practical experience in optical character recognition, machine vision, artificial intelligence, image processing, and pattern recognition. He is involved in the design and development of intelligent character recognition applications, real-time embedded systems, image processing hardware and software products, and the implementation of completely automated, turnkey solutions for security and traffic management applications.

Dr. Herrera was one of the original developers of Perceptics License Plate Reader system for which he was granted a U.S. patent in 1989.
What is ALPR

Automatic License Plate (or number plate) Reading (ALPR) is an established and proven technology that allows vehicles observed by cameras to have their vehicle license plates “read” using optical recognition software. ALPR cameras can check up to 3,600 license plates an hour on cars traveling in excess of 120 mph. When combined with other collection resources the resulting data obtained through ALPR becomes an extremely powerful tool for vehicle owner identification associated with toll collection and toll enforcement requirements.
Automated License Plate Number Reading (ALPR)

• **Definition**
  – A software/hardware solution that interprets alphanumeric characters from images and digitizes the information for transmission and application

• **Primary functionality**
  – Event recording (passive application)
    • Data placement for future action
  – Database matching (pro-active application)
    • Data match generates an event
Available Operating Platforms

• ALPR solutions are available in three basic platforms. These platforms include:
  – Mobile Platforms
    • Police Patrol Vehicle
  – Fixed Platforms
    • Gantry or Pole Mounted
  – Deployable Platforms
    • Tripods/Covert Deployments
    • Specialized Motor Vehicles/Trailers
Initial Development

- Developed by Cambridge University in the United Kingdom under contract to the Police Scientific Development Branch in response to IRA terrorism in 1976
  - Primary component of the “Ring of Steel” surrounding the City of London
- Theory if you cannot neutralize the weapon system neutralize the delivery system through vehicle interdiction prior to entry into the target area
Initial ALPR Deployment

- United Kingdom
  - Fixed System
    - Counter Terrorism
    - Congestion Charging
  - Centralized Technology Development
    - Recognized Standards
    - Recognized Performance Metrics
    - Privacy Controls

- United States
  - Mobile Systems
    - Law Enforcement
    - Tolling
  - Vendor Initiated Technology Development
    - No Standards
    - No Recognized Performance Metrics
    - No Privacy Controls
The 7 Basic Operating Principles

1. The vehicle and/or license plate is detected
2. License plate is located in the image(s)
3. Overview image is associated with license plate candidate
4. License plate characters are extracted from the background
5. Alphanumeric characters are identified (and confidence level computed)
6. License plate jurisdiction is determined (optional)
7. Processor transmits results to backend systems
Process Leading to Quality ALPR Performance

1. Vehicle Detected
2. Image Captured
3. Plate Candidates Identified
4. De-skew, Enhance, V&H Stroke Histograms
5. OCR to Produce Plate Text
6. Character Positions Found
7. Data Transmitted
8. Syntax Checked
9. State/Province Identified
10. Data Transmitted
Simple Concept, Complex Solutions

• Identify best hardware and software vendor with emphasis in the following areas as they pertain to your requirements:
  – Hardware (Triggering, Illumination, Optics, Processor)
  – Software (OCR)
  – Interface Capability (Communications)
  – Configuration Variation/One Size Fit All

• Identify best service provider
  – Installation & Post Sale Support
  – Experience

• Identify potential deployment process & quantify internal segments that may require investment
  – Illumination, Geography
Simple Concept, Complex Solutions

• ALPR that delivers high accuracy/high confidence reads:
  – Is not a hang it, point it, and leave it technology
    • Is an evolving solution subject to the evolutions of its operating environment
      – Requires a planned, strategic deployment by skilled personnel
      – Requires optimization by trained technicians
      – Requires regular “truthing” to accommodate “new” plates issues and other abnormalities
  – Work with an ALPR solution provider up front
    • There are elements that must be considered when designing and specifying an ALPR solution
Consideration: Plate Type

- Multi-Design
- Retro-Reflective
- Non-Retro-Reflective
- Reflective Coated
- Color Combinations
- Vanity Plates
- Apportioned Plates
Consideration: Triggering

- **Through Beams** – Passenger only vehicle’s and controlled traffic.
- **Laser Sensors** – No road construction is required for lasers and their accuracy is nearly 100%, however inclement weather can have a negative impact on their ability to perform consistently.
- **Video Analytics** – Video analytics is the least accurate triggering mechanism but has the benefit of not requiring any devices on the road surface, however you won’t know when a plate is not captured.
- **Loops** – With nearly 100% accuracy and impervious to weather, in-ground loops are the most accurate triggering device available. The downside of loops is they do require a lane closure and minor road construction to install them.
Consideration: Illumination

**Infrared:** Used when covertness is desired over accuracy. Cannot capture non-retro reflective plates or determine color.

**Visible/Near Invisible Light:** Used when high accuracy is desired or a need to capture non retro reflective plates and ascertain color.
Consideration: Camera

- Focus and Depth of Field
- Variable Shutter Speeds
- Resolution, Field of View, and Dynamic Range
- Video Manipulation Problems –
  - Camera Functions that Need to be Turned Off
- Light Filters
- All Weather Capabilities
- Intelligent Camera
  - Processing on the Camera/Remote Processing
Consideration: Software

Angles of Skew/Tilt/Rotation
Provides a flat visible surface for improved reading
Consideration Software

Syntax checking
Making sure the system is reading the plate!
Consideration: Processing Location

Roadside
- Real time processing
- Data and images reported direct to back office
- Not a single failure point
  - If the processor in the lane goes down, only a single lane becomes non-operational

Centralized
- Updates pushed to a single device
- In a multi-stage OCR configuration it can be used as a “verification” step to help reduce false positive results
- Offline OCR option allows more exhaustive image processing routines for analyzing the image
Consideration: Data Base Components

- ALPR camera image
- Captured plate patch image
- Plate #, Lane, Time & Date, GPS
- Account Information
- Driver Name, Account Number, Address, Phone Number
- Other lists
Common Factors that may Affect System Performance

- Lanes wider than 15 feet
- Inclement weather
- Vehicle sensors blocked by foreign objects
- Physical site constraints limiting hardware configuration
  - State local codes
- All can be compensated for in design if considered up front
Performance Evaluation

• Criteria for a non readable license plate:
  – Plate is missing
  – Plate is not in the field of view
  – Damaged
    • Portions missing and/or bent to the degree of changing the shape of the characters
  – Mounted inconsistent with the laws of the State
  – Obstructed
    • Any object that prevents the clear view and/or outline of the origin or registration numbers
Performance Evaluation

• **Vehicle detection rate**
  
  – # of vehicles detected divided by the actual # of vehicles multiplied by 100 equals the % of vehicles detected

• **Accuracy rate**
  
  – # of plates read divided by the number of readable plates multiplied by 100 equals the % of plate read accuracy

• **Confidence level**
  
  – Associated with each LPR result, there should be a measure proportional to the likelihood that the result is correct. This is called the **confidence level** of the result (typically in the range [0-100]).
  
  – In general, for any two confidence thresholds C1 and C2, where C1 > C2, the accuracy of results with confidence > C1 should be greater than or equal to the accuracy of results with confidence > C2.
  
  – In other words, the probability that a result with confidence > C1 is incorrect (error rate associated with C1) should be less than the error rate associated with a result with confidence > C2.
ALPR GOLDEN RULE #1

• No ALPR system will read 100% of the plates 100% of the time
ALPR Golden Rule #2

• When the confidence level increases...the error rate decreases.
ALPR GOLDEN RULE #3

• The key to good ALPR is a high accuracy rate and a high confidence level.
ALPR GOLDEN RULE #4

• Eradicating misreads and erroneous reads and maximizing accurate reads is the primary goal.
ALPR GOLDEN RULE #5

• The sooner you have a valid ALPR provider engaged with your design the greater the accuracy and confidence level will be.
Suggested Minimum Specifications

- A plate reading system should correctly identify ALL the alphanumeric characters on the plate AND the state/province/country of issue on at least 95% of all passenger vehicles that have a license plate that is undamaged and unobstructed.
- A plate reading system should generate confidence levels of 95% Read Rate with 95% confidence, 90% Read Rate with 97% confidence, 80% Read Rate with 99% confidence.
- A fixed plate reading system should be capable of reading both retro reflective and non-retro reflective license plates.
- A fixed plate reading system should be capable of operating 24/7 in all weather conditions.
- A fixed plate reading system should provide the same performance day or night even in the absence of supplemental ambient lighting.
- A fixed plate reading system should detect greater than 99% of vehicles, even with no plate present.
- A fixed plate reading system should be capable of capturing an image of the vehicle even if no plate is present.
- A fixed plate reading system should operate independent of vehicle speed and be capable of capturing vehicles at speeds up to 120 mph.
- A fixed plate reading system should have the option to provide an overview image of the vehicle (at minimum, color during the day, b/w during the night).
- A fixed plate reading system should provide a unique identification number, date and time stamp for each vehicle transaction.
- All roadside components of the fixed plate reading system should meet or extended operating temperature of -40°C to 70°C.
- A fixed plate reading system should be able to cover the full width of a standard lane (4.5m) with a single camera.
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• Please submit all questions via email to: Sharon.adair@tollinterop.org. Answers will be made available via email and the ATI website.