PlatePatrol

Crowdsourced Automatic License Plate Recognition (ALPR) Network

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The Challenges of Existing ALPR Systems

Limited coverage

High deployment cost

Less effective for urgent cases

WOSU 89.7 NPR News | July 31, 2023

Police LPR Unit, Lehigh County, PA

City of Traverse City, Michigan

The cost to implement a mobile Plate Recognition (LPR) on existing enforcement range from $50,000 to

Michigan investigated parking management

PA Turnpike

https://www.engadget.com/....26-amber-alert-explainer.html

"The LPR System Pays For Itself": An Interview With Detective Sal Aprile

Leonardo LPR Product News

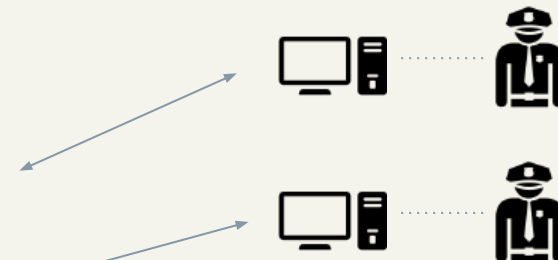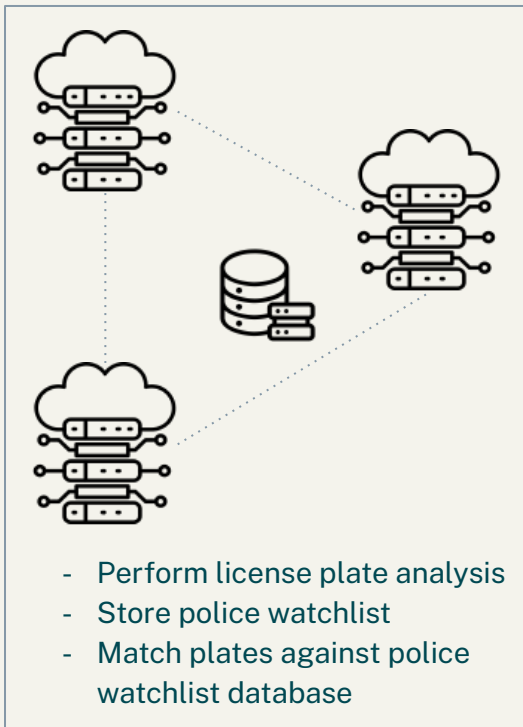# Our Solution: Crowdsourced ALPR Dash Cam Network

Enhanced Dash Cam System   ECE Areas: Software Systems, Hardware Systems   **Law Enforcement Portal**

Distributed Server System

Opt-in

- License plate data
- GPS coordinates
- Date & time

License plate watchlist

Matched license plate data
w/ GPS and time info

- Perform license plate analysis
- Store police watchlist
- Match plates against police
  watchlist database

Use Case Requirement

Dash Cam Requirements

Power: 12V DC

Weight: < 1.5lbs

Storage: Compatible with SD cards and supports loop recording

Hands-free operation

Privacy: Opt-in feature

Performance Metrics

ALPR Accuracy: ≥ 90% [1]

Capture-to-Alert Latency: < 1.1s [2]
Critical Path: Capture → Transfer → Process → Alert

Security: End-to-end encryption for all data transmission

Scalability: Support up to 314k [3] active dash cams

[1] Industry benchmark
[2] 1000ms Raspberry Pi to server transfer latency for 1080p30fps video + 100ms image processing latency (field testing) = 1.1s latency
[3] 6378.5k employed in PA * 68.7% of employee drive to work * 15% of drivers use dash cams * 47.7% of the dash cam market is advanced dash cam = 314k active advanced dash cams during peak hour in PA

Technical Challenges

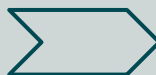| Challenges			Risk Mitigation
01	Ensuring license plates are legible in varying conditions		• Edge detection • Noise reduction • Motion stabilization • Adaptive preprocessing
02	Meeting the end to end latency requirement		• Offload heavy computation • Parallel processing with a network of servers
03	Managing real time data from high volume active cameras		• Load balancer • Simulate high traffic and resolve bottlenecks
04	Protecting user privacy while ensuring law enforcement access		• Data encryption • Opt-in • Clear user consent • Anonymous GPS locations • Data retention policy

Solution: Dashcam Hardware Choices

Storage Card

GPS

Wifi / Cellular

Board
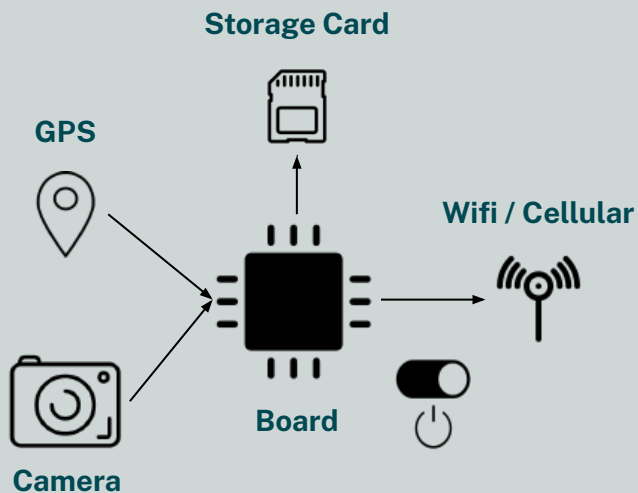
Camera

Edge Computing Devices

- RPi 4
- RPi 5 (AI support)

- Jetson Orin Nano

Camera Modules

- RPi Camera Module 3, 12MP
- RPi AI Camera, 12MP
- RPi High Quality Camera, 12MP
- RPi Global Shutter Camera, 1.6MP

- IMX219 Camera Module, 8MP

GPS Modules

- PA1616S for RPi

- GPS-18037 for Jetson

Solution: System and Webapp

License Plate Detection Model + OCR Model
- Finetune open source library (OpenALPR [1], FastALPR [2], EasyOCR [3], etc.)
- Training our own model w/ dataset (OpenALPR Benchmark [4], etc.)

Law Enforcement Web Portal
- Backend: RESTful APIs, WebSocket, microservices architecture
- Frontend: React

Database and Cloud Service
- NoSQL database (MongoDB etc.)
- AWS, GCP, Azure, etc.

Security
- End-to-end encryption for all data transmission

[1] https://www.openalpr.com/
[2] https://github.com/ankandrew/fast-alpr
[3] https://github.com/JaidedAI/EasyOCR
[4] https://github.com/openalpr/benchmarks/tree/master/endtoend/us

Testing

Dash Cam Unit Tests

Weight < 1.5lbs?

12V DC power supply compatible?

Footage loop recorded and stored in SD card?

Hands-free operation?

Opt-in feature?

Integration Tests

Capture-to-alert latency < 1.1s when connected?

Supports up to 314k active dash cams?

90%+ ALPR accuracy for human-visible plates?

Personal data securely encrypted?

Testing Milestones

Stage 1

Proof of concept testing

Stage 2

Basic dash cam functionality unit testing

Stage 3

Single stationary dash cam integration testing

Stage 4

Multiple dash cams field testing

Stage 5

Load testing

Day, sunny, correct identification

Night, blurry, correct identification

Night, glaring, incorrect identification

Day, tilted, correct identification

Day, rainy, incorrect identification

Division of Labor

Christine Li

- Distributed cloud infrastructure
- Distributed server API gateway
- Data transport

Vicky Liu

- Image processing pipeline (ML)
- Embedded dash cam
- Data transport

Andy Zhao

- Web app
- Embedded dash cam
- Data transport

Gantt Chart

Real-Time Coverage, Real-World Impact