

## WHITE PAPER

# CamArray™

## DUAL-USE FOR VEHICLE CAMERAS: INDIVIDUAL AND PUBLIC SAFETY

### By:

Dr. Robert Finkelstein, President  
Robotic Technology Inc.  
Collegiate Professor  
Graduate School of Management and Technology  
University of Maryland University College  
BobF@RoboticTechnologyInc.com  
Office: 301-983-4194  
Cell: 301-980-8402

### And

Mr. D. Scott Watkins, CEO and President  
Mr. John Lamont, CTO  
CruiseCam International, Inc.  
Mobile Data Holdings, Ltd, HK  
Mobile Data Trust, LLC, USVI  
Cell: 248-709-2096

## PURPOSE

The **purpose** of this White Paper is to describe a **concept** in which proliferating automotive cameras, including those facing toward the rear (i.e., backup cameras) and forward, can be used for **public safety**. These cameras are increasingly available as **original equipment** or **after-market** systems. Our proposed **dual-use** application is in addition to the original intent of these systems – to provide individual safety.

**Backup cameras** currently aid drivers while moving in reverse, especially to provide safety for children behind the vehicle who are otherwise invisible to the driver. **Forward cameras** provide driver safety assistance such as collision and lane departure warning, automated headlight control, traffic sign recognition, and other assistance, while commercial and law enforcement vehicles use forward cameras to monitor and record incidents and accidents.

**Connected vehicle technology** (formerly known as IntelliDrive) being developed by the U.S. Department of Transportation (DOT) would serve as the means for using these cameras to **detect, identify, locate, and report fugitives, terrorists, and stolen vehicles**.

## BACKGROUND

### Backup Cameras

**Backup video** systems (original equipment and after-market) for vehicles, are becoming widely available. Many cars, including those that are lower-priced, are now being sold with the systems, and several electronics manufacturers competing in the after-market. The tiny cameras provide the driver with a view to the rear while backing up to help avoid hitting another car, an adult or child, a pet, or a hazard, such as a pole. The cameras are greatly superior to the acoustic ranging systems (sonar) which beep on detecting an object (some vehicles use both systems). Vehicles with a backup camera incorporated into a navigation system have the video image displayed on a dashboard screen, while an aftermarket system might be retrofitted with a rear-view mirror display.

The Secretary of Transportation, Ray LaHood, has proposed the mandatory installation of backup cameras in vehicles, to eliminate rearview blind spots and, in the process, decrease the likelihood of child-related tragedies. Because of the blind spot affecting even careful drivers, about 300 people are killed each year (half being children under age of 5), and many more injured, when a driver backs over them with a car. Even without a federal mandate, it is likely that **all vehicles will eventually be sold with backup cameras**.

### Forward Cameras

**Forward cameras**, both original equipment and after-market, are proliferating on vehicles. These cameras can provide a **spectrum of safety assistance** to drivers, depending on where they are mounted in the vehicle and the sensor processing that accompanies them. Their safety functions can include: collision warning; lane departure warning; automated headlight control; and traffic sign detection, recognition, and information. In addition, commercial and law enforcement vehicles use forward cameras to monitor and record incidents and accidents.

### Cameras for Reading License Plates

Cameras and accompanying software are also being used to read license plates for law enforcement in automated toll collection systems and other applications. Police in a number of jurisdictions are employing a growing network of **cameras (and associated software) for reading license plates**, which are transforming police investigations. Originally conceived as a **counter-terrorism tool**, the technology has been successful in **conventional criminal investigations**, such as finding suspects, fugitives, and stolen cars. For example, New York City has 238 license plate readers, of which 108 are at fixed locations and 130 are mobile, mounted on police cars. Additional cameras will be added to the system. Other cities, such as Philadelphia, are introducing the cameras as well.

## CONCEPT

Proliferating **rearward** and **forward vehicle cameras** can serve a **dual use** – for **reading license plates** and providing other vehicular information such as model, make, year, and color.

**Connected vehicle technology** and the **connected vehicle system** being developed by the DOT could serve as the means by which data collected from vehicle cameras are gathered and provided to law enforcement to be integrated with the traffic surveillance system, including governmental **license plate cameras**.

Vehicle cameras would provide in-vehicle information for **individual safety**, as is currently the case, but would also obtain imagery for **public safety**. To reduce the burden on communications between the vehicle and infrastructure, the imagery would be **analyzed onboard** the vehicle and the **compact data** of interest (e.g., license plate numbers and other vehicle and location information) would be stored in the vehicle. The stored data would then be transmitted to the infrastructure at the planned vehicle **data interrogation nodes** in the **connected vehicle system**. The data would be **sorted and analyzed** at the control center (or by intermediate processing nodes) and any hits would be transmitted to the appropriate law enforcement or national security agency.

Alternatively, a **general alert** for a suspect or fugitive vehicle could be sent, via the connected vehicle infrastructure. If a passing car were to detect and identify the fugitive vehicle, it could respond with an **emergency signal** (via the onboard “Mayday” communication system usually used for crashes) or specifically flag the information and transmit it at the first connected vehicle infrastructure node.

## Acceptance

The proposed system would **not add a significant privacy issue** to those already associated with the connected vehicle system. As is currently the case, a vehicle’s cameras would be viewing outside, **not inside**, the vehicle. They would be focused on license plates and the lower portion of other vehicles, **not drivers**. The public is already accustomed to being tracked via cell phones, GPS, street and traffic cameras, E-ZPass, and the Internet. The **benefits** for law enforcement and counter terrorism would outweigh any residual concerns.

## Technology

**Existing vehicle camera technology** might already be suitable to provide the data of interest, although a minimum sensor performance standard might be appropriate. New software would be needed to process the data on the vehicle and transmit it, using the onboard connected technology, to the forthcoming connected vehicle infrastructure. The effort involved would be a small part of the development and implementation of the connected vehicle system. There are no major technology gaps or basic discoveries needed; it is, fundamentally, a **system integration** project with **new software**.

A **small, pilot feasibility study**, examining the relevant technology and how it might be integrated into the connected vehicle system, should be performed while the technology and systems of interest are still **flexible and adaptable**: vehicle and license plate camera systems and the connected vehicle system.

**Technology issues** to be examined for the vehicle camera systems include camera field of view, resolution, software, data storage requirements, interface requirements, and operational analyses. The following are nominal **examples** of the technology issues:

**Field of View:** For example, the typical **existing** vehicle **backup camera** consists of a complementary metal-oxide semi-conductor (CMOS) with relatively low resolution (1.8-1.2mm) lens with a 110-180 degree field of view (FOV). A U.S. License plate would have to be within about 6 feet of an existing backup camera lens for a reasonable probability of recognition. Also, visual identification of the target vehicle by make, model, color, and identifying marks (dents, scratches, etc.) would be problematic at best. For the dual-use mission, backup cameras would need a **larger FOV** (or perhaps two fields of view).

**Resolution:** For example, **existing resolution** of backup cameras is typically 280–420 lines, while required resolution is about 540-600 lines. Otherwise, the software is extrapolating with a high margin of error.

**Software:** New software will be needed for **license plate reading, vehicle identification, and system control and communications**. The basic issues are accurate recognition from the video; storage time; data harvesting; comparison to a valid database; and the means used to notify and respond to authorities **accurately and efficiently**.

**Data Storage Requirements and Hardware:** Both onboard vehicle and central storage considerations include length of storage, uploading (time, priority, manual, automatic, scheduled), vehicle DVR accessibility when unoccupied, etc.), timeliness, accuracy, and compression method. **Data stored and uploaded** would have to include GPS, time, speed, video, DVR ID, subject vehicle database case ID, etc.

**Interface Requirements for Connected Vehicle System:** In addition to the vehicle DVR system, there will be a download/upload link to the agency managing the required data streaming, and the associated interface requirements are to be determined.

**Operational Analyses:** An operational analysis, including a system simulation, is needed to determine, for example, system cost/benefits, timeliness, and latency.

There are also **non-technology issues** to be examined, including:

**Legal Issues:** The potential legal issues for dual-use vehicle cameras are similar to those for **previous** (e.g., GPS, automated cruise control) and future (e.g., hands-free driving) **intelligent vehicle technology**. The public must be convinced that their **personal privacy** will not be significantly compromised in exchange for enhanced national security. The analysis of legal issues must encompass relevant federal, state, and local laws.

**Political Issues:** Federal, state, and local politicians must be convinced that the dual-use vehicle cameras will **increase national, state, and local security**, and that any concerns of their constituents will be ameliorated.

**Psycho-social issues:** The **privacy** issue is likely to be foremost and must be addressed. Other psycho-social issues might be the same as those associated with the **Connected Vehicle system**, regardless of dual-use cameras, e.g., individuals not wanting to be connected to a kind of social network. The recent rapid acceptance of **social media and social networks** by the vast majority, and the consequent public dissemination of previously private information, indicates that privacy issues are likely to be minimal. The public can be convinced that **increased personal and public safety** is worth any **tradeoffs** for dual-use cameras and the Connected Vehicle system.