

## COLOURFUL FUTURE

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*Vehicle Detection – Improved Accuracy in Living Color*  
By Oran Ener, Richard Jacobson, and Dr. W.H. (Bill) Sowell  
Image Sensing Systems, Inc.

**The Desire-** Traffic engineers worldwide have been searching for a method to effectively “see” the complete traffic scene and perform not only cost effective loop emulation, but accurate automatic incident detection, queue length detection and traffic data collection since the first video vehicle detection system, Autoscope®, was first developed in 1984, and introduced commercially in 1989.

We are a generation greatly influenced by television, and we expect to see quality full color video not only for our recreational viewing, but also at work. Until today, all successful video detection systems strongly encouraged the use of monochrome, (black and white), video cameras for performing optimal video vehicle detection tasks, for a myriad of reasons- both economical and technical. While most video detection systems can operate at minimum “marginally” with color cameras, the added benefits that color cameras can provide were nullified, as the chromaticity, (color attributes), of the video images were removed prior to digitizing and image processing. Market leaders however continue to listen to their customers and reinvest in technology, research and development, seeking a cost effective means to provide clearly superior detection accuracy and image clarity with color cameras in challenging weather and lighting conditions.

**The Task-** The primary task of any video vehicle detection system is to make a clear distinction between the pixel fragment values belonging to roadways and to vehicles. In monochrome imagery, varying shades of gray represent all regions of the traffic video. It is possible that when using only monochrome video cameras, that the perceived shades of gray which represent a specific color of vehicle may appear visually in black and white, to be the same shade of gray represented by the pixel fragments of the roadway under a specific detection zone(s). The latest developments and incorporation of both temporal and spatial machine vision techniques have dramatically enhanced the detection accuracy of video vehicle detection systems. Autoscope Solo® Pro now feature enhanced image processing algorithms that derive additional information about the traffic scene by using the chromaticity of the video images derived from color cameras.

Typically over the course of a day, the gray scale value of pixels captured by video cameras can change from virtually white, in direct sunlight, to black at night. However, there is a far less probability that pixel fragments in the traffic environment will change to a unique and unmistakable shade of blue, green, or red. The use of color cameras for video vehicle detection can now resolve many routine anomalies found in early video vehicle detection systems, providing vehicle presence, count and speed accuracies in excess of 98 percent.

**Then-** In recent years, color video cameras cost as much as 75 percent more than monochrome cameras, and as with most traffic engineering projects, cost reduction measures have been the norm rather than the exception. Color cameras have for years suffered from a lack of sufficient low light sensitivity. Degradation in color traffic video imagery was manifested by increased image graininess as light levels decreased.

This increased graininess (or image noise) with color video cameras, was significant enough that most video detection systems found it difficult to estimate the pixel fragment values of the roadway and vehicles under low light conditions.

Adding color information to image processing effectively triples the amount of data that must be analyzed. If a single monochrome 512 by 512 traffic image is received from each of four cameras mounted at an intersection, this represents approximately one quarter of a megabyte of information that must be stored for each camera. If the image is color, this storage requirement then increases to  $\frac{3}{4}$  of a megabyte for each camera.

**Now-** Since the first Autoscope system was sold more than a decade ago, camera and processor technology has steadily advanced. Examining processing power, Moore's Law states that it doubles every 18 months. This equates to an available increase in processor speed by a factor of 64, which more than covers an effective transition from monochrome to color video detection cameras.

Autoscope systems already installed, and those to be installed in the future, will continue to perform accurately with monochrome cameras. Additional real-time traffic information and image detail can for the first time be derived from the use of color cameras- not to mention the enhanced visual benefits from being able to view real-time color video vehicle detection- either in the field or remotely via low-power microwave or compressed video over standard dial-up telephone lines. Surveillance and video detection are being merged into a single application for the benefit of the traffic engineer and the safety of the motoring public.

Accompanied by major improvements in processor technology, camera technology and the degree of integration with optics have dramatically improved since the early 1990's. It is now possible to obtain a color camera with a lens and associated zoom and focus control in a package which is smaller than that of the original monochrome cameras used for video vehicle detection as recently as 1998. The cost of color cameras is nearly equivalent to black and white cameras; yet provide better visualization even during periods with low light levels.

A monochrome picture is essentially two dimensional, offering width and height information. If all objects in the picture are the same shade of gray, differentiation from one another is impossible, and errors in vehicle presence, speed, lane occupancy, and queue length may be experienced.

When we actually utilize the chromaticity from a traffic video image, we can now add a new dimension of depth to the image. The image is now three-dimensional like, and it is possible to separate objects in the image that have the same gray scale level by examining their location and depth dimension. Improved separation of objects in the image and from the background reference image is important in providing enhanced detection accuracy and reliability over the broad range of challenging lighting and environmental conditions faced by modern video vehicle detection systems.

The addition of specialized algorithms to Autoscope Solo Pro improve vehicle detection and traffic data collection accuracy in the following areas:

- Stopped vehicle detection
- Queue length estimation
- Rejection and elimination of static and moving shadows
- Vehicle classification based on color
- Rejection of headlight reflections

Several new applications for video vehicle detection are under development, such as deriving individual travel times of vehicles. Keeping in mind our long-term goal of reducing traffic delays, travel time, congestion, fuel consumption, air pollution and enhancing motorist safety- video vehicle detection continues to evolve and play an even stronger role in typical as well as new and unique applications.

**Conclusion-** Video vehicle detection is now more cost effective, accurate and reliable than ever, outperforming inductive loops and other aboveground detection technologies under all weather and lighting conditions. For many years, video vehicle detection or machine vision has been incorrectly referred to as "simulated human vision". Now, with the addition of color and the added benefits it provides to enhancing system accuracy and reliability, the technology is one step closer to meeting the ideal of "human vision". The world is made up of color- not shades of gray, so why not benefit from the advances of technology?

## Pictures:

All photos are taken from Southern California intersections and a freeway using color video cameras for video vehicle detection and automatic incident detection applications.



