Generic Procurement Specification for a

Video Vehicle Detection System

For Road Traffic Applications

The Autoscope RackVision Pro 1 video vehicle detection system meets the attached specifications.

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683-10534-0418

1. Video Detection - General

This specification sets forth the minimum requirements for a real-time, wide area video vehicle detection system that monitors vehicles on a roadway by processing video images and that provides detector outputs to a traffic controller or similar device. This system shall be easily configurable and expandable to meet traffic management applications such as intersection control, traffic monitoring or surveillance, traffic safety applications, and traffic control during road or intersection construction. For example, it shall be possible to maintain semi- or fully-actuated detection at the stop line by lane or by phase, in the dilemma zone, or advanced extension detection while construction is underway.

A Mouse & Monitor interface feature shall allow use of industry standard USB mouse and analog video display to connect to the Machine Vision Processor (MVP) for setup, maintenance, and monitoring tasks. Additionally, an optional laptop or Netbook may use the USB interface for these same tasks, and other tasks including traffic data collection and the backup of the configuration in an operations log archive.

1.1 System Hardware

The machine vision system hardware shall consist of three components: 1) a color or monochrome video detection camera, 2) a modular, single video channel MVP unit for cabinet interface, and 3) a power and video interface panel. Additionally, an optional Personal Computer (PC) shall host the server and client applications to program and monitor the system components. The real-time performance shall be observed by viewing the video output from the sensor with overlaid flashing detectors to indicate the current detection state (on/off).

The MVP shall communicate detection events or alarms in the cabinet to the traffic controller or other device. Up to two (2) contact closure inputs and four (4) contact closure outputs shall be provided to a traffic signal controller and comply with the National Electrical Manufacturers Association (NEMA) type C or D detector rack or Caltrans TEES Input File standards. When connected to a Detector Port Master (DPM), the MVP may also receive DPM inputs and provide additional outputs to the traffic controller via the DPM contact-closure or SDLC outputs.

The interface panel shall provide video coax connections and termination points for three-wire power cables and optional two-wire zoom control that may be mounted on a pole or mast arm. It also provides for mechanical strain relief of these incoming cables to the cabinet. A junction box or splice point between the camera and the interface panel is permissible depending on local installation standards. The interface panel shall provide high-energy transient protection to protect other cabinet equipment from outside electrical surges.

The hardware shall consist of the following items to be provided by the system supplier:

a. One or more machine vision processor units with approved image sensor cameras and cabling
b. One interface panel (typical) and connecting coax cables to the MVP
c. Optional detector expansion cards for traffic signal control applications
d. Optional notebook or Netbook computers to run system software (a Supervisor computer)

Items to be provided by others:

a. Installation.
b. Interconnection branch cabling

1.2 System Software

A Mouse & Monitor interface feature uses industry standard USB mouse and analog video display to connect to the machine vision processor (MVP) for setup, maintenance, and monitoring tasks. Additionally, an optional laptop or

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Netbook may use the USB interface for these same tasks, and other tasks including traffic data collection and the backup of the configuration in an operations log archive.

The MVP's embedded software shall incorporate multiple applications that perform a variety of diagnostic, installation, fault tolerant operations, and vehicle detection processing. The detection shall be reliable, consistent, and perform under all weather, lighting, and traffic congestion levels.

There shall be a suite of client applications that reside on the host client-server PC. The applications shall execute under Microsoft Windows XP, Vista, or 7. Available client applications shall include:

- Master network browser: Learn a network of connected modular MVP units, display basic information, and launch other client applications to perform various operations.
- Configuration setup: Create and modify detector configurations to execute on the MVP.
- Operation log: Retrieve, display, and save field hardware run-time operation logs and special events that have occurred. This is also an archived backup of the entire configuration.
- Data Collection: Setup and retrieve traffic data from the MVP.
- Software install: Reconfigure one or more MVP units with a newer release of embedded system software.

1.3 MVP Hardware

The MVP shall be shelf or rack mountable. Nominal outside dimensions excluding connectors shall not exceed 4.5 in. (H) x 2.3 in. (W) x 7 in. (D) (11.4 cm x 5.7 cm x 17.8 cm) plus its handle. The MVP shall be capable of mounting in a standard detector card rack, or in an optional shelf-mounted enclosure. The MVP weight shall not exceed 0.5 lb. (0.2 kg).

2. Functional Capabilities

2.1 Functional Capabilities

The real-time, detection performance of the MVP shall be optimized to meet the detection objective of the traffic application. The detection objective determines the camera mounting location, the number of traffic lanes to monitor, sizing, placement, and orientation of vehicle detectors, whether traffic is approaching or receding from the camera's field of view, and how to minimize the effects of lane-changing maneuvers.

2.2 Real-Time Detectors

The MVP shall be capable of processing information from a CCTV video camera. The video will be digitized and analyzed at a rate of up to 30 frames per second. Video input to the MVP shall be uncompressed, full motion analog video at 25 or 30 frames per second.

Different detector types shall be selectable via software. All of the following Detector Types shall be supported for each camera input. Detector types shall include the following: Stop Line, Count, Presence, Speed, Detector Function, Station, and Label. The Stop Line detector can provide a large detection area during red for safety with various driver behaviors and then a small snappy detection output to the controller for efficiency of intersection control during green.

Multiple detector outputs can be combined together via OR, AND, NAND, NOR, and M of N logical functions. In addition, the MVP can condition the detector outputs based on the state of the associated traffic signals. All of the following detector output types shall be available: Type 0, Type 1, Type 2, Type 3, Type 4, Type 5, Type 6, Type 7, and Type 9 (Moving Vehicle).

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Detectors shall accurately detect approaching, receding, or stopped vehicles in multiple traffic lanes, and make the detections available to a variety of outputs that reflect the current real-time detector state.

The MVP will detect the absence of a valid video signal on the image sensor input and place all detector outputs associated with the failed image sensor input on maximum recall.

The MVP will also detect when the quality of the video input from the image sensor is not sufficient for robust vehicle detection (e.g., when environmental conditions obscure the sensor view). Actions for this video contrast loss capability shall be selectable by the user, including placing the detector outputs associated with the failed sensor on minimum recall, maximum recall, or fixed time recall.

A supervisor computer is not required for detector configuration or operation. When a computer is used for setup, monitoring, or troubleshooting, it shall be possible to disconnect the supervisor computer and the MVP shall perform vehicle detection as a standalone unit.

2.3 External Interface

It shall be possible for the MVP to output the detection signal directly to NEMA TS1, TS2, Type 170, Type 179, 2070, SCATS, and SCOOT controllers. It shall be possible to selectively disable and re-enable any or all of the detection outputs. The MVP shall provide four (4) open collector outputs on the front connector and four (4) jumper selectable outputs on the rear edge connector. The MVP shall provide two (2) open collector inputs on the front connector. When connected to a DPM, the MVP may also receive DPM inputs and provide additional outputs to the traffic controller via the DPM contact-closure or SDLC outputs.

A USB connection shall allow configuration and monitoring for the camera. The MVP's embedded software may be changed using a simple USB memory stick or with the optional laptop or Netbook computer.

2.4 Detection Zone Placement

The video detection system shall provide flexible detection zone placement at any orientation within the field of view of the camera to serve the detection objective. Traffic can flow through the scene vertically, horizontally, diagonally, or around a curve. The system shall be capable of detecting both approaching and receding vehicles, with similar accuracies.

Detection zones may overlap for optimal road coverage to serve the detection objective. In addition, selective groups of detectors may be combined logically into a single output and further modified with optional delay and extension timing and signal state inputs if available. The configuration shall support outputs by lane, by phase, and for advanced extension timings.

Optimal detection shall be achieved when the camera placement provides an unobstructed view of each traffic lane where vehicle detection is required. Obstruction of the view includes when vehicles from a lane closest to the camera obscure the view of the roadway of a lane further away from the camera. An application design guide and training shall be available to the engineer and technician.

2.5 Detection Zone Programming

Placement of detection zones shall be by means of a mouse and video monitor or with an optional personal computer with Windows XP, Vista, or 7 operating systems. A mouse draws detection zones on the monitor. Using the mouse or optional PC keyboard, it shall be possible to place, size, and orient detection zones for optimal road

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coverage for vehicle detection. It shall be possible to edit previously defined detector configurations to permit adjustment of the detection zone size and placement, to add detectors for additional traffic applications, or to reprogram the MVP for different traffic applications or changes in installation site geometry or traffic rerouting.

The optional PC shall allow backup of the entire configuration and archived operations log. It shall be possible to download detector configurations from the PC to the MVP, to retrieve the detector configuration that is currently running in the MVP sensor, and to back up detector configurations by saving them to the PC fixed disk or other removable storage media.

2.6 Detection Zone Operation Verification

Real-time detection operation shall be verifiable by viewing the video output of the MVP, with overlaid detection zones on any standard analog video display device (monitor) or on the optional supervisor computer. Front panel LED lights will show assigned contact-closure pin outs from the unit. An LED shall be ON when its assigned detector output is ON. An LED shall be OFF when its assigned detector is OFF. The MVP shall display four (4) local outputs.

2.7 Providing Optimal Detection

The video detection system shall provide optimal detection of vehicle passage and presence when camera is adjacent to the desired coverage area and mounted 10 m (30 ft) or higher above the roadway detection area. When in line with the left-turn thru-lane lane mark, the camera may be mounted on the signal mast arm. The farthest detection zone location shall not be greater than 10 times the mounting height of the camera above the zone. The recommended deployment geometry for optimal detection is an unobstructed view of each traveled lane where detection is required. The camera shall be provided by the same manufacturer as the MVP to maximize performance. The camera shall view either approaching or receding traffic. The preferred orientation for optimal detection shall be to view approaching traffic, since there are more high-contrast features on vehicles that are viewed from the front rather than the rear. The camera, when placed at a mounting height that minimizes vehicle image occlusion and the zoom lens aimed to match the detection area, shall be able to monitor a maximum of 6 to 8 traffic lanes simultaneously depending on the field of view.

2.8 Demand Presence Detection Performance

Using an installed camera that meets the optimal viewing specifications described above for intersection traffic control applications, the system shall be able to provide accurate demand presence detection. The demand presence accuracy shall be based on the ability to enable a protected turning movement on an intersection stop line, when a demand exists. The probability of not detecting a vehicle for demand presence shall be less than 1% error under all operating conditions. In the presence of artifact conditions, the MVP shall minimize extraneous (false) protected movement calls to less than 7%.

To ensure statistical significance, the demand presence accuracy and error shall be calculated over time intervals that contain a minimum of one hundred vehicles in each lane. The calculation of the demand presence error shall not include turning movements where vehicles do not pass through the detectors, or where they stop short or stop beyond the combined detection zones. Vehicle lane change anomalies will be excluded from the calculations.

2.9 Video Processing

The analog video output shall provide graphics overlays that indicate the current real-time detector state. The MVP shall process a maximum of ninety-nine (99) virtual objects or detection zones placed anywhere in the field of view of each camera. The user may hide some objects from the output view and display hidden objects while watching the output video. While not strictly a detector, an operator-defined label, visible in the video overlay, shall identify

the camera field of view, various operational system parameters such as time of day, date, processing load index, the state of any detector output, the traffic signal state, and the state of any detector interface card (detector port master if used).

Similarly, the video output may be viewed on a computer as streaming snapshots with flashing detectors.

Snapshot images shall be transferred using one of the following options: an uncompressed black and white bitmap, JPEG black and white image, uncompressed color bitmap, or JPEG color bitmap. The quality of snapshot images transferred shall be user selectable.

2.10 MVP Environmental

The MVP shall operate reliably in the adverse environment found in the typical roadside traffic cabinet. It shall meet the environmental requirements set forth by NEMA TS1 and TS2 standards and Caltrans TEES. Operating temperature shall be from -34 C to +74 degrees C (-29 F to +165 F) at 0% to 95% relative humidity, non-condensing.

2.11 Electrical

The MVP shall be powered by 12 or 24 volts at 11 watts maximum. The MVP shall include transient protection sufficient to meet the requirements set forth in the NEMA TS1 and TS2 standards. Power to the MVP shall be from the transient-protected side of cabinet power.

Communications shall be via a USB connector for each camera on the front of the unit for USB mouse, memory stick, or PC.

The MVP shall be equipped with a composite video input (color or monochrome), so that a signal from the image sensor can be processed in real-time. The MVP shall be equipped with a composite video output with BNC connector on the front of the MVP. The use of miniature video connectors shall not be acceptable. The MVP shall output standard NTSC or PAL video format at 1 Vpp.

The MVP software shall be stored in flash memory within the MVP. This software shall be capable of updating without the removal of modules or memory devices. The MVP software and/or the supervisor applications shall include diagnostic software to allow testing of the MVP functions. This shall include the capability to set and clear individual detector outputs and display the status of inputs to enable setup and troubleshooting in the field.

2.12 MVP Operations Log

The MVP shall maintain a non-volatile operations log to archive significant operational events and provide a complete backup of the configuration, which can be restored into a replacement unit in case of disaster. It minimally contains: revision numbers for the current MVP hardware and software components, title and comments for the detector configuration, date and time of the last detector configuration downloaded to the MVP, date and time of video connection or loss, date and time that the operations log was last cleared, date and time communications were opened or closed with the MVP; date and time of last power-up, and time-stamped, self-diagnosed, hardware and software errors that shall aid in system maintenance and troubleshooting. Optionally, the user may route other time-stamped events to the log. The MVP processor will reboot itself automatically when software or hardware functions are not operating properly and log these events.

2.13 Traffic Data Collection

The MVP will be capable of traffic data collection in real-time for immediate access or storage in non-volatile flash memory within the MVP for later retrieval. No additional hardware or software will be necessary. The manufacturer

will provide a method of estimating storage limits depending on the data types and time intervals selected before the oldest data is overwritten.

Traffic statistics shall include volume, occupancy, vehicle classification, flow rate, headway, speed, level of service, space occupancy, and density measures. The video system shall record traffic data and alarms by event or by multiple time intervals from 1 to 3600 seconds (1 hour) or for intersection monitoring by intersection cycle split for display, retrieval, and analysis. It will be possible to record the passage of individual actuations and signal changes for troubleshooting and maintenance.

3. Installation and Training

The supplier of the video detection system may supervise the installation and testing of the video detection system and computer equipment as required by the contracting agency.

Training is available to personnel of the contracting agency in the operation, set-up, and maintenance of the video detection system. The MVP and its support hardware/software are a sophisticated leading-edge traffic technology system. Proper instruction from certified instructors is recommended to ensure that the end user has complete competency in system operation. The User's Guide and Installation Manual are not adequate substitutes for practical classroom training and formal certification by an approved agency.

4. Warranty, Maintenance, and Support

For a minimum of three (3) years, the supplier shall warrant the video detection system. An option for additional year(s) warranty for up to six (6) years shall be available.

The manufacturer of the MVP shall have a Quality System that is ISO 9001 registered. Written confirmation of the ISO 9001 registration shall be available from the manufacturer prior to bid acceptance if requested.

The video vehicle detection system shall not require any special maintenance tasks beyond the usual preventive maintenance inspections typical for a traffic cabinet and intersection.

Ongoing software support by the supplier shall include software updates of the MVP and supervisor computer applications. These updates shall be provided free of charge during the warranty period. The supplier shall maintain a program for technical support and software updates following expiration of the warranty period. This program shall be available to the contracting agency in the form of a separate agreement for continuing support.

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