Generic Procurement Specification for a Video Detection Solution for Roadway Applications

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Video Detection System

This specification sets forth the minimum requirements for a video detection system that detects vehicles, bicycles, and motorcycles on a roadway by processing video images, and that provides vehicle presence, traffic flow data, event alarms, and full-motion video for real-time traffic control and management systems.

1. System Hardware

The video detection system shall be comprised of two major hardware components: a video sensor and a communications interface panel. An optional wired input/output card shall be available for certain cabinet types.

1.1. Video Sensor

The video detection system shall include a video sensor that integrates a high-definition (HD) camera with an embedded processor for analyzing the video and performing detection.

1.1.1. Camera and Processor

1.1.1.1. The camera shall be a color CMOS imaging array.

1.1.1.2. The camera shall have HD resolution of at least 720p (1280x720 pixels).

1.1.1.3. The camera shall include a minimum 10X optical zoom.

1.1.1.3.1. It shall be possible to zoom the lens as required to satisfy across-the-intersection detection objectives, including stop line and advance detection.

1.1.1.3.2. It shall be possible to zoom the lens remotely from the TMC for temporary traffic surveillance operations or to inspect the cleanliness of the faceplate.

1.1.1.4. The camera shall have direct, real-time iris and shutter speed control by the integrated processor.

1.1.1.5. The processor shall support H.264 video compression for streaming output.

1.1.2. Video Sensor Enclosure Assembly

1.1.2.1. The camera and processor shall be housed in a sealed IP-67 enclosure.

1.1.2.1.1. The faceplate of the enclosure shall be glass and shall have hydrophilic coating on the exterior surface to reduce debris accumulation and maintenance.

1.1.2.1.2. The faceplate shall have a thermostatically-controlled indium tin oxide (ITO) heater applied directly on the interior surface to keep the faceplate clear of condensation, snow, ice and frost.

1.1.2.2. An adjustable aluminum visor shall shield the faceplate from the sun and extraneous light sources.

1.1.2.3. An integral aiming sight shall assist in aiming the camera for the detection objectives.

1.1.2.4. A removable rear cap and cable strain relief shall seal the power connection.

1.1.2.4.1. The rear cap shall be tethered to the enclosure to avoid dropping the cap during installation.

1.1.2.4.2. The rear cap shall be fastened to the body of the video sensor with a single, captive bolt.

1.1.2.5. The rear cap and enclosure shall include Gore breathers to equalize internal and external pressure while preventing moisture from entering the camera.

1.1.2.6. The sensor shall be self-supporting on manufacturer's mounting brackets for easier fastening during installation.

1.1.2.6.1. It shall be possible to rotate the field-of-view 360° without changing the angle of the visor.

1.1.3. Power and Communications

1.1.3.1. Power and communications for the video sensor shall be carried over a single three-conductor cable.

1.1.3.1.1. Termination of the three-conductor cable shall be inside the rear cap of the enclosure on a three-position, removable Phoenix terminal block. Each conductor shall be attached to the Phoenix plug via a screw connection.

1.1.3.2. The video sensor shall operate normally over an input voltage range of 89 to 265 VAC at 50 or 60 Hz.

1.1.3.3. Power consumption shall be no more than 16 watts typical.

1.1.3.4. No supplemental surge suppression shall be required outside the cabinet.

1.1.3.5. All communications to the video sensor shall be broadband-over-power via the same three-conductor cable that powers the unit. Coaxial cable shall not be required.

1.2. Communications Interface Panel

The video detection system shall include an interface panel in the traffic cabinet that manages communications between the video sensors, the traffic management center, a maintenance technician, and the traffic cabinet itself.

1.2.1. Video Sensor Connection

1.2.1.1. The communications interface panel shall provide 4 physical connection ports and allow for up to 2 sensors to be connected on each port, for a total of up to eight video sensors to be connected simultaneously.

1.2.1.1.1. A 3-pole terminal block, shall supply power and broadband-over-power communications to 1 or 2 sensors. If two sensors are connected on a port they shall be connected in parallel.

1.2.1.1.2. The broadband-over-power communications shall provide a throughput of 70 to 90 Mbps.

1.2.1.1.3. The broadband-over-power connection shall support at least 1,000 feet of cabling to the video sensor.

1.2.1.1.4. Each physical sensor port shall include a power switch controlling up to 2 sensors as well as an LED indicating status of power delivery on the port..

1.2.1.1.5. There shall be an LED for the first four sensors learned into the system to indicate the status of communications. The configuration software shall allow the user to see communication status of all sensors connected.

1.2.1.1.6. Each physical sensor port shall contain a resettable fuse.

1.2.1.1.7. Each physical sensor port shall provide high-energy transient protection.

1.2.2. Traffic Management Center (TMC) Communications

1.2.2.1. An Ethernet port shall be provided to connect to a remote Traffic Management Center (TMC).

1.2.2.1.1. The TMC connection shall support 10/100/1000 Mbps Ethernet communication.

1.2.2.1.2. The communications interface panel shall proxy all network requests that arrive on the TMC connection to avoid unwanted network traffic from reaching the broadband-over-power network between the communications interface panel and the video sensors.

1.2.2.1.3. All communications to the video detection system through the TMC connection shall be to a single IP address.

1.2.2.1.4. The system shall be able to provide Full HD quality video through it's WAN port for use in streaming video back to the TMC or any remote location.

1.2.3. Local User Communications

1.2.3.1. A wired Ethernet port shall be provided to connect the technician at the cabinet to the video detection system for setup and maintenance purposes.

1.2.3.1.1. The maintenance port shall support 10/100/1000 Mbps Ethernet communication.

1.2.3.1.2. All communications to the video detection system through the maintenance port shall be to a single IP address.

1.2.3.1.3. The maintenance port shall support DHCP to automatically assign an IP address to the user's computer.

1.2.3.2. An 802.11g Wi-Fi access point shall allow wireless connection to the video detection system at the cabinet for setup and maintenance purposes.

1.2.3.2.1. All communications to the video detection system through the Wi-Fi access point shall be to a single IP Address.

1.2.3.2.2. The Wi-Fi access point shall support DHCP to automatically assign an IP Address to the user's computer.

1.2.3.2.3. The Wi-Fi access point shall include a dipole, omnidirectional antenna.

1.2.3.2.4. A momentary pushbutton shall allow the user to turn the Wi-Fi access point on or off.

1.2.3.2.5. The Wi-Fi access point shall turn itself off automatically after a period of inactivity from connected devices.

1.2.3.2.6. An LED shall indicate when the Wi-Fi access point is enabled.

1.2.3.2.7. The Wi-Fi access point shall operate simultaneously with the wired maintenance port and with the TMC connection.

1.2.3.2.8. The WiFi access point shall require a password for connection by a user's computer. The default password shall be changeable.

1.2.4. Traffic Controller Connection

The communications interface panel shall provide one (1) connection to communicate to the traffic controller through the cabinet.

1.2.4.1. The traffic controller connection shall support a TS2 Type 1 compatible SDLC interface.

1.2.4.1.1. The traffic controller connector shall be a 15-pin female metal shell D sub-miniature type connector to support a standard NEMA TS2 or TEES SDLC cable.

1.2.4.1.2. The traffic controller connection shall support a protocol interface to SDLC-capable traffic controllers (NEMA or TEES).

1.2.4.1.3. The traffic controller connection shall support the NEMA TS2 SDLC protocol to include up to 64 detector outputs and 32 inputs.

1.2.4.2. The traffic controller connection shall be able to connect to a wired input/output card, which supports wired I/O in cabinets without a SDLC-capable controller.

1.2.4.2.1. The wired I/O data communications link shall support at least 24 outputs and 16 inputs.

1.2.4.3. It shall be possible to connect and use both SDLC communications and communication to the wired input/output card simultaneously.

1.2.5. USB Ports

1.2.5.1. The communications interface panel shall include two USB 2.0 ports.

1.2.5.1.1. If a communications interface panel fails to start and run due to a software or operating system failure, it shall be possible to reinstall all system and application software from a USB memory stick without necessitating removal of the communications interface panel from the cabinet.

1.2.5.1.2. Video recording of up to 2 cameras, or of 1 camera plus the quad view simultaneously, shall commence automatically when an appropriately configured USB memory stick is installed in either USB port.

1.2.6. Power

1.2.6.1. The communications interface panel shall accept input voltage in the range of 89-265 VAC, 50/60 Hz power from the transient-protected side of the cabinet.

1.2.6.2. The communications interface panel shall be protected by two slow blow fuses. Spares shall be attached to the panel.

1.3. Wired Input/Output Card

The video detection system shall support an optional wired input/output card that communicates with the communications interface panel for real-time detection states and other I/O to the traffic controller. The card may reside in a standard detector rack or shelf-mount enclosure with power module.

1.3.1. The optional wired input/output card shall comply with the form factor and electrical characteristics to plug directly into a NEMA type C or D detector rack or Caltrans TEES Input File.

1.3.1.1. The card shall occupy two slots of the detector rack.

1.3.1.2. The card shall provide four detector outputs on its rear-edge connector.

1.3.1.3. A front connector shall provide communication to the communications interface panel.

1.3.1.4. A front connector shall allow 16 inputs and 24 contact-closure detector outputs for wiring into the cabinet.

1.3.1.4.1. A front panel LED for each of the 16 inputs and 24 outputs shall indicate the state of the input or output.

1.3.1.5. The wired input/output card shall support optional expansion cards in other slots. Each expansion card shall support 4 outputs to the back edge of the card.

1.3.1.6. The wired input/output card shall support optional harnesses for connection to Input Files or C1, C4, C11, and C12 ports to support Type 170 or Type 2070 controllers.

2. System Software

The video detection system shall include management software for configuration, monitoring and data collection purposes.

2.1. Management Software

2.1.1. Management software shall be a Windows-based application.

2.1.1.1. The software shall be compatible with Windows 7 and Windows 10 operating systems (OS).

2.1.1.2. The software shall communicate with the video detection system via Ethernet.

2.1.2. The management software shall automatically determine all video sensors and communications interface panels available on the local network and populate a list of all devices.

2.1.3. The management software shall provide a means to add video sensors and communications interface panels on routed networks by the communications panel's WAN IP address.

2.1.4. The management software shall provide the user a means to name individual video sensors and communications interface panels.

2.1.5. The management software shall provide a means for the user to zoom the camera optics while viewing a live video stream.

2.1.6. The management software shall provide a means for the user to easily calibrate distances in the field of view so as to create a 3-dimensional mapping of the complete field of view.

2.1.7. The management software shall provide the user a means to create 4-sided detection zones in the field of view using either a still snapshot or live video.

2.1.7.1. The management software will overlay an outline of each detection zone over the background image.

2.1.7.2. It shall be possible for the user to place detection zones anywhere in the field of view for stop line detection and/or advance detection.

2.1.7.3. It shall be possible for the user to set the desired color of both the "on" and "off" states of the overlay for individual detection zones.

2.1.7.4. It shall be possible for the user to alter the size and shape of any previously created zone.

2.1.7.4.1. It shall be possible for the user to click and drag any of the 4 sides of a zone and the system will automatically scale the length of the side consistent with the 3-dimensional field of view.

2.1.7.4.2. It shall be possible for the user to move an entire zone without automatic rescaling.

2.1.7.5. It shall be possible for the user to create a new zone by selecting an existing zone and duplicating it on either left or right side, or specifying a new zone behind (for advance) with a specific length and distance back from selected zone.

2.1.7.6. It shall be possible for the user to easily rotate a zone by selecting any of its four corners and dragging to rotate it.

2.1.7.7. It shall be possible to easily flip the zone direction 180 degrees from its current orientation.

2.1.7.8. It shall be possible for the user to name each zone uniquely.

2.1.7.9. It shall be possible for the user to assign each zone to detect vehicles, to detect bicycles, or to detect both, and to specify different outputs for each type.

2.1.7.10. It shall be possible for a zone to have multiple output types (presence, pulse, snappy, speed threshold) on separate output channels.

2.1.7.11. It shall be possible for the user to specify the output of a zone as a presence, pulse, snappy (presence during red and pulse during green signal phase state) or speed threshold type output.

2.1.7.12. The pulse output shall be usable for both approaching and receding traffic.

2.1.7.13. The pulse output shall have a user programmable duration from 100 to 400 ms.

2.1.7.14. The speed threshold output shall be user programmable to output when the speed of a vehicle, or of the average of a specified number of vehicles is greater than, less than, between, or outside of a user specified speed threshold.

2.1.7.15. It shall be possible for the user to tie the presence outputs of multiple zones as well as signal phase state together with AND/OR Boolean logic.

2.1.7.16. It shall be possible for the user to assign the same output to multiple zones such that the output will be on if any of the zones are detecting a vehicle or bicycle.

2.1.7.17. It shall be possible for the user to assign a single zone to more than one output such that if a vehicle or bicycle is detected, all the assigned outputs shall be turned on.

2.1.7.18. The management software shall be capable of creating at least 99 detection zones per video sensor.

2.1.8. It shall be possible for the management software to retrieve all configuration parameters from video sensors or communications interface panels.

2.1.8.1. It shall be possible for the user to save all the settings for a video sensor or a communications interface panel to a laptop file.

2.1.8.2. The management software shall provide a means to read or import all the settings from a previously saved configuration file for a video sensor or a communications interface panel.

2.1.9. The management software shall be able to download a new version of the application software into a communications interface panel and its attached video sensors.

2.1.10. The management software shall provide a screen to monitor operation of a video sensor.

2.1.10.1. The monitoring screen shall include a live video stream from the video sensor with at least HD 1280x720 pixel resolution.

2.1.10.2. The monitoring screen shall show indications of detection in real time by changing the color of the detection zone.

2.1.10.3. It shall be possible for the user to configure different indications for vehicle detections vs. bicycle detections when both are configured for the same zone.

2.1.10.4. The monitoring screen shall include the following optional, configurable objects. It shall be possible for the user to size and position them anywhere on the screen and to change the color and size of text.

2.1.10.4.1. An indication of when either a zone or an output is on or off, along with a user-configurable name for that indicator, applicable to any zone or output type.

2.1.10.4.2. The current time in the video sensor.

2.1.10.4.3. A user-configurable title or name.

2.1.10.4.4. The version number of the video sensor software.

2.1.10.4.5. Configurable text as defined by the user.

2.1.10.5. Undo/Redo functions shall be available for operations during detection zone setup and programming.

2.1.10.6. It shall be possible for the user to turn the overlay graphics on or off with a single setting.

2.1.11. The management software shall provide a screen to monitor operation of the intersection with a quad-view video stream from the communications interface panel.

2.1.11.1. The quad-view video stream shall have a resolution of at least HD 1280x720 pixels, where each of the sensor videos comprising the quad-view shall be at least 640x360 pixels.

2.1.11.2. It shall be possible for the user to configure the order that the sensor videos appear in the quad-view.

2.1.11.3. The real-time quad-view video stream shall be capable of displaying the overlay graphics for all four sensors simultaneously.

2.1.12. While monitoring the video of a single video sensor or of the quad-view, it shall be possible for the user to request a "snapshot" or single-frame image to save to a named file on a laptop.

2.1.13. While monitoring the video of a single video sensor or of the quad-view, it shall be possible for the user to record a period of the video to save to a named file on a laptop.

3. System Functionality

The video detection system shall provide the following features and functionality.

3.1. Detection Performance

3.1.1. The video detection system shall detect the presence of vehicles in defined zones and turn on the assigned output when the vehicle is present in the zone.

3.1.1.1. Stop Line Detection

3.1.1.1.1. For detection zones placed at the stop line, the probability of not detecting the presence of a vehicle shall be 1% or less when aggregated over a 24-hour period (as stated in 3.1.2) when the video sensor is installed and configured properly.

3.1.1.1.2. For detection zones placed at the stop line, the probability of falsely detecting a vehicle that is not present shall be 3% or less when aggregated over a 24-hour period (as stated in 3.1.2) when the video sensor is installed and configured properly.

3.1.1.2. Advance Detection

3.1.1.2.1. It shall be possible to place advance detector zones such that the farthest point of the zone is up to 600 feet from the video sensor. Advance detector zone placement shall include 2-3 car lengths of field-of-view beyond the farthest point of the zone.

3.1.1.3. Receding Zones

3.1.1.3.1. The video detection system shall be capable of detecting receding vehicles in day or night conditions when the video sensor is installed and configured properly.

3.1.2. To ensure statistical significance for the above detection performance specifications, the data shall be collected over 24-hour time intervals (so as to avoid a single lighting condition) and will contain a minimum of one hundred (100) vehicles per lane. The calculations of detection performance will not include turning movements where vehicles do not pass through the detectors, vehicle lane-change anomalies, or where they stop short or stop beyond the combined detection zones.

3.2. Failsafe Mode

3.2.1. The video detection system shall provide three (3) failsafe options during optical contrast loss. The default shall be maximum recall. The end-user may also choose to use minimum recall or fixed recall in which a user-defined number of seconds may be implemented to hold call during green.

3.2.2. The video sensor shall continuously monitor the overall contrast in the video. If the overall contrast falls below a preset level (such as caused by dirty faceplate, severe glare, extreme fog, or temporary ice/snow on the faceplate), the sensor shall enable the chosen failsafe mode. When sufficient contrast is restored in the video, the sensor will exit the failsafe mode.

3.2.3. There shall be a setting within the configuration software that allows the user to adjust the sensitivity to contrast loss due to the above stated conditions.

3.2.4. The communications interface panel shall continuously monitor the connectivity status of the attached video sensors. If any video sensor goes offline due to either electrical failure or internal software failure, the communications interface panel shall enable the failsafe mode for that video sensor. If the video sensor comes back online, failsafe mode shall end.

3.3. Data Collection

3.3.1. The video detection system shall automatically collect and store traffic flow data in non-volatile memory for later retrieval and analysis. No additional hardware or software shall be necessary. Data functionality shall include the following:

3.3.1.1. Data shall be collected automatically for all zones created by the user once the learn period is complete and normal detection is active. No further setup shall be required.

3.3.1.2. Vehicle counts per zone.

3.3.1.3. Vehicle turning movements independent of zone.

3.3.1.4. Vehicle average speeds.

3.3.1.5. Vehicle lengths.

3.3.1.6. Detection statistics with the on/off timestamps when zones were activated.

3.3.1.7. Detection actuation statistics for whether a zone was triggered by a vehicle or a bicycle.

3.3.2. The management software shall be able to retrieve collected data over a specified period of time or for all currently stored data and save into a standard CSV file.

3.3.3. The sensor hardware shall include up to 8GB of memory storage capacity for data collection.

3.3.4. Data Download Types

3.3.4.1. Options shall be provided for downloaded data in the form of a .csv file for Raw data, Binned data, Detections and Zone Status as defined below:

3.3.4.1.1. Raw Data – Includes time stamped Zone statistics for vehicle or bike actuations and average speed as well as time stamped Exiting Vehicle Statistics which include volume, turning movement direction, speed and length for vehicles exiting each zone.

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3.3.4.1.2. Binned Data – Pre-binned data with bin time set by the user down to as little as 1-minute. Data shall include volume, occupancy, turning movement counts and speed for vehicles for each zone.

3.3.4.1.3. Detections – Date/time stamped data regarding vehicles exiting zones including type of object (vehicle or bike), speed, length and direction of movement (through, left, right).

3.3.4.1.4. Zone Status – Date/Time stamped indications of whether a vehicle or bicycle actuated a zone and the average speed of all objects in the zone.

3.3.5. Remote Data Interface

3.3.5.1. Data including counts, turning movements, speed and length, as well as zone names, sensor status, and video snapshots shall be available to remote systems via remote communication to the system using an Applications Programming Interface (API). This API shall consist of a set of GET commands embedded in HTTP protocol. The resulting data returned shall be in JSON format.

3.4. Operations Log

3.4.1. The communications interface panel and each video sensor shall maintain a time-stamped operations log of routine and special events in non-volatile memory for later retrieval and analysis.

3.5. Time Synchronization

3.5.1. The video detection system and management software shall provide three methods to synchronize the time of day clocks in the communication interface panel and the video sensors, as follows:

3.5.1.1. Manual time synchronization operation by the user, which sets the time to the current time on the laptop where the management software is running.

3.5.1.2. A configuration setting to allow the communications interface panel to automatically obtain time from the NEMA TS2 protocol on the SDLC channel and broadcast it to the video sensors.

3.5.1.3. A configuration setting to allow the communications interface panel to automatically obtain time from up to five Network Time Protocol (NTP) sources and broadcast it to the video sensors.

3.6. Video Streaming

3.6.1. In addition to the ability to view video streams in the management software, it shall be possible to view video from individual sensors or to view the quad-view from the communications interface panel using a third-party video player application on a tablet, smartphone or laptop computer.

3.6.2. Video bitrate is user-definable between 100 Kbps-5000 Kbps. The default shall be 2048 Kbps. All bitrates shall provide 30 fps.

4. Installation and Setup

The video detection system hardware shall be designed for flexible, fast and easy installation and setup.

4.1. It shall be possible to mount the video sensor on an intersection pole, mast arm, or luminaire arm.

4.2. No special tools or extra equipment, other than a laptop for configuration, will be required.

4.3. Once all hardware is installed, connected and functional, it shall be possible to configure the video detection system for a typical 4-approach, 8-phase intersection in 15 minutes or less.

5. Warranty, Service and Support

The video detection system shall be provided with the following warranty, service and support options.

5.1. Warranty

5.1.1. The manufacturer shall warrant the video detection system for a minimum of three (3) years. An option for up to six (6) years of warranty shall be available.

5.2. Service

5.2.1. Ongoing software support by the manufacturer will include software updates of the video sensor, communications interface panel, and management software. These updates will be provided free of charge during the warranty period. The manufacturer will maintain a program for technical support and software updates following expiration of the warranty period. This program will be available to the contracting agency in the form of a separate agreement for continuing support.

5.3. Support

5.3.1. A quick-start guide, installation guide, application notes, and other materials shall be available from the manufacturer to assist in product installation and setup for various applications. In addition, training online or in person shall be available.

5.3.2. Training shall be available to personnel of the contracting agency in application design, operation, setup, and maintenance of the video detection system.

5.3.3. Manufacturer shall provide a tech support website, support email address and a 1-800 number for technical support.

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