Autoscope RackVision Terra

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1.0 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 via processing of video images and 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, and incident management for expressways, arterial roadways, tunnels, and bridges, traffic data collection, traffic safety applications, and traffic control during road or intersection construction. The 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 170 input file rack standards.

The system architecture shall fully support Ethernet networking of system components through a variety of industry standard and commercially available infrastructures that are used in the traffic industry. The data communications shall support direct connect, [modem,] and multi-drop interconnects. Simple, standard Ethernet wiring shall be supported to minimize overall system cost and improve reliability, utilizing existing infrastructure and ease of system installation and maintenance. Both streaming video and data communications shall optionally be interconnected over long distances through fiber optic, microwave, or other commonly used digital communications transport configurations.

On the software application side of the network, the system shall be integrated through a client-server relationship. The client applications shall either be hosted on the same PC as the communications server or may be distributed over a local area network of PC's using the industry standard TCP/IP network protocol. Multiple client applications shall execute simultaneously on the same host or multiple hosts, depending on the network configuration. Additionally, a web-browser interface shall allow use of industry standard Internet web browsers to connect to MVP units for setup, maintenance, and playing digital streaming video.

1.1 System Hardware

The hardware shall consist of the following items:

Items to be provided by the system supplier:

a. One or more machine vision processor units with optional image sensors/cameras.
b. Optional interface cards for traffic signal control applications.
c. Optional notebook or desktop computers on which the system software runs (Supervisor computer).

Items to be provided by others:

a. Installation.
b. Interconnection cabling.

1.2 System Software

The MVP embedded software shall incorporate multiple applications that perform a variety of diagnostic, installation, fault tolerant operations, data communications, digital video streaming, and vehicle detection processing. The detection shall be reliable, consistent, and perform under all weather, lighting, and traffic congestion levels. An embedded web server shall permit standard internet browsers to connect and perform basic configuration, maintenance, and video streaming services.

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 MVP units, display basic information, and launch applications software to perform operations within that system of MVP's.

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- Configuration setup: Create and modify detector configurations to be executed on the MVP.
- Operation log: Retrieve, display, and save field hardware run-time operation logs of special events that have occurred.
- Software install: Reconfigure one or more MVP units with a newer release of embedded system software.
- Streaming video player: Play and record streaming video with flashing detector overlay.
- Data retrieval: Fetch once or poll for traffic data and alarms and store on PC storage media.
- Communications server: Provide fault-tolerant, real-time TCP/IP communications to / from all devices and client applications with full logging capability for systems integration.
- An optional software developer's kit (SDK) that provides necessary tools for software programmers to integrate the video detection system into the larger, traffic management system.

1.3 MVP Hardware

The MVP shall be shelf or rack mountable. Nominal outside dimensions excluding connectors shall not exceed 5.0 in. x 2.25 in. x 7 in. The MVP shall be capable of being mounted in a standard US loop detector amplifier card rack, or in an optional shelf-mounted enclosure. The MVP weight shall not exceed 0.9 lb. (0.04 kg).

2.0 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.

2.1 Real-Time Detectors

The MVP shall be capable of simultaneously processing information from one (1) CCTV video cameras or Hi-8, (or better), video tape players. The video shall be digitized and analyzed at a rate of 30 frames per second. Video input to the MVP shall be uncompressed, full motion analog video at 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: Count Detector, Presence Detector, Bicycle Detector, Speed Detector, Detector Function, Station Detector, Input Detector, Speed Alarm, Contrast Detector and Video Loss Arbitrator, Incident Detector

Multiple detector outputs can be combined together via OR, AND, NAND, NOR, and N of M logical functions. In addition, the MVP shall be able to 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, Type 9 (Moving Vehicle Detectors). Detectors shall accurately detect approaching, receding, speeding, or stopped vehicles in multiple traffic lanes via processing of video images, make the detections available to a variety of parallel or serial outputs that reflect the current real-time detector state, optionally provide detector outputs to a traffic controller or similar device in a parallel (contact closure) format and the MVP shall be able to detect the absence of a valid video signal on each image sensor input and upon detecting the absence of a valid video signal, the MVP shall place all detector outputs associated with the failed image sensor input on maximum recall.

The MVP shall also be able to detect when the quality of the video input from the image sensor is not sufficient to enable vehicle detection. (e.g., when environmental conditions obscure the sensor view.) Use of this video loss

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detection capability shall be selectable by the user. If a video loss failure is detected, the MVP shall place the detector outputs associated with the failed sensor on recall, maximum recall, or fixed time recall as selected by the user.

Once the MVP has been properly set up using the supervisor computer, it shall be possible to disconnect the supervisor computer. Thereafter, the MVP shall perform vehicle detection as a standalone unit.

2.3 Interval Traffic Data

The MVP shall count vehicles in real-time and compute the average of traffic parameters over user-defined time intervals (or time slices), as follows: Volume, Occupancy, Vehicle Classification, Flow Rate, Headway, Speed, Level of Service, Space Occupancy, Density.

The time-interval data shall be retained in non-volatile flash memory within the MVP for later transfer to the supervisor computer for analysis. The following time-intervals shall be supported: 10, 20, 30 seconds, 1, 5, 10, 15, 30, 60 minutes and by intersection cycle. In addition, "fill and stop" or circular buffer options shall be available for each detector that is storing data. Retrieval of data stored in the memory of the MVP shall be via a serial communications port using manufacturer provided software.

2.4 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 manufacturer of the MVP shall have a communications server software package available to allow the polling of the MVPs for data. This software shall be available in the form of a developer's kit and supplied when indicated by the project specification. The communications software shall be able to operate as a communications server under the Windows XP platform. The MVP shall provide 24 open collector TS1 outputs on the front connector and 4 jumper selectable outputs on the rear edge connector. The MVP shall provide 16 TS1 open collector inputs on the front connector. The MVP shall also offer 64 outputs and 32 inputs via TS2 SDLC port 1 connector also located on the front.

2.5 Detector Types

The MVP shall be able to be programmed with a variety of detector types that perform specific functions. The general functions performed by the detectors shall include: measuring vehicle speed and length and provide 5 classes of vehicles based on length; Perform traffic counts by user-specified time period and vehicle presence detection and Detect incident shock waves using either of the following alternative detection algorithms, both which have been widely deployed and proven effective: (1) AIDA (Autoscope Incident Detection Algorithm): (2) Dutch CL Incident Detection Algorithms. The video detection system shall support bicycle minimum green "bike min green" in applicable traffic controllers.

2.6 Detection Zone Placement

The video detection system shall provide flexible detection zone placement at any orientation within the field of view of the camera. Preferred detector configurations shall be to place detection zones across lanes of traffic for optimal count accuracy and to place detection zones parallel to lanes of traffic for optimal presence detection accuracy of moving or stopped vehicles. The system shall be capable of detecting both approaching and receding vehicles, with similar accuracies.

Detection zones shall be able to be overlapped for optimal road coverage. In addition, selective groups of detectors shall be able to be logically combined into a single output and further modified by using optional delay and extend timing and signal state inputs if available.

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 can occur when vehicles from a lane nearer to the camera obscure the view of the roadway of a lane further away from the camera.

2.7 Detection Zone Programming

Placement of detection zones shall be by means of a PC with a Windows XP, Vista or 7 operating system, a keyboard, and a mouse. The PC monitor shall be able to show the detection zones superimposed on images of traffic scenes.

The detection zones shall be created by using a mouse to draw detection zones on the PC monitor. Using the mouse and keyboard it shall be possible to place, size, and orient detection zones to provide optimal road coverage for vehicle detection. It shall be possible to download detector configurations from the PC to the MVP sensor and cabinet interface module, 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 disks or other removable storage media.

The supervisor computer's mouse and keyboard shall be used 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 sensor for different traffic applications or changes in installation site geometry or traffic rerouting.

2.8 Detection Zone Operation Verification

The MVP, real-time detection operation shall be verifiable through the following means: View the video output of the MVP, with overlaid detection zones, with any standard NTSC or RS-170 analog video display device (monitor). View assigned contact-closure pinouts from the unit front panel LED output display. An LED shall be ON when its assigned detector output or signal controller phase input is ON. An LED shall be OFF when its assigned detector or signal controller input is OFF. The MVP shall display 16 LED indicating local and external inputs, outputs, and phase colors selectable by rotary switch.

2.9 Providing Optimal Detection

The video detection system shall provide optimal detection of vehicle passage and presence when the camera is mounted 10 m (30 ft.) or higher above the roadway detection area, the MVP or camera is adjacent to the desired coverage area, and the distance to the farthest detection zone locations is not greater than 10 times the mounting height of the camera. The recommended deployment geometry for optimal detection requires that there be 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 be able to view either approaching or receding traffic or both in the same field of view. 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 adjusted to match the width of the road, shall be able to monitor a maximum of 6 to 8 traffic lanes simultaneously (field of view dependent).

2.10 Demand Presence Detection Performance

Using an installed camera that meets the optimal viewing specifications described above for intersection control traffic applications, the system shall be able to accurately provide 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, protected turning movements. Vehicle lane change anomalies will be excluded from the calculations. These performance specifications shall be achieved with a minimum of 2 presence detectors coupled with a single detector function (Type-9) to provide adequate road coverage to sample the random arrival patterns of vehicles at the stop line. The calculation of the demand presence error shall not include turning movements where vehicles do not pass through the presence detectors, or where they stop short or stop beyond the combined detection zones. Vehicle lane change anomalies will be excluded from the calculations.

2.11 Speed Detection Performance

The MVP shall accurately measure average (arithmetic mean) speed of multiple vehicles with more than 98% accuracy under all operating conditions for approaching and receding traffic. The average speed measurement shall include more than 10 vehicles in the sample to ensure statistical significance. Optimal speed detection performance requires the camera location to follow the specifications described above for count station traffic applications with the exception that the camera must be higher than 13 m (40) feet. The MVP shall accurately measure individual vehicle speeds with more than 95% accuracy under all operating conditions for vehicles approaching the camera (viewing the front end of vehicles), and 90% accuracy for vehicles receding from the camera (viewing the rear end of vehicles). These specifications shall apply to vehicles that travel through both the count and speed detector pair and shall not include partial detection situations created by lane-changing maneuvers. The MVP will not support local speed data output unless connected to a detector port master, or by being polled through the SDK (software developer's kit).

2.12 Video Processing

The analog video output shall provide graphics overlay that indicates the current real-time detector state. The MVP shall process a maximum of ninety-nine (99) virtual detection zones placed anywhere in the field of view. The MVP shall process a maximum of ninety-nine (99) detection zones from each camera being processed by the MVP. While not strictly a detector, an operator-defined label, visible in the processed video, shall be able to show a label identifying location of the camera field of view, various operational system parameters such as time of day, date, IP address, baud rate, processing load index, the state of any detector output, and the state of any detector interface card (detector port master) (if one is used).

Snapshot images shall be transferred using one of the following options: a. Uncompressed black and white bitmap, b. JPEG black and white image, c. Uncompressed color bitmap, d. JPEG color bitmap. The quality of snapshot images transferred shall be user selectable. It shall be possible to stream video from one or more MVP units. It shall be possible to save the streamed video files to a network computer hard drive. Video frame JPEG compression shall be capable of providing color image updates in as little as 2 seconds over typical phone modems connected at 56KB. The compressed video stream shall also contain the detector state information that can be overlaid on the video at the operator's request. A single workstation shall be able to access and view the compressed digital video stream.

2.13 MVP Environmental

The MVP shall be designed to operate reliably in the adverse environment found in the typical roadside traffic cabinet. It shall meet the environmental requirements set forth by the NEMA (National Electrical Manufacturers Association) TS1 and TS2 standards as well as the environmental requirements for Type 170 and Type 179 controllers. Operating temperature shall be from -34 C to +74 degrees C (-29 F to +165 F) at O% to 95% relative humidity, non-condensing. The use of fans within the MVP to meet these operating conditions shall not be acceptable.

2.14 Electrical

The MVP shall be powered by 12 or 24 volts 11 watts. 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. The manufacturer of the MVP shall have a Quality System that is ISO9001 registered. Written confirmation of the ISO9001 registration shall be available from the manufacturer prior to bid acceptance if requested. Communications shall be via RJ45 connector for Ethernet 10/100MB/s communications on the front of the unit. This port shall be able to download traffic data stored in non-volatile memory as well as the real-time detection information to show detector actuations. The MVP unit shall also include two (2) USB 2.0 connectors for USB mouse.

The MVP shall be equipped with one (1) NTSC composite video input, (color or monochrome), so that a signal from one (1) image sensor can be processed in real-time. The use of miniature video connectors shall not be acceptable. The MVP shall be equipped with a single composite video output. A BNC connector on the front of the MVP shall be used for video output. The MVP shall output standard NTSC or PAL video format via BNC connector at 1 Vpp. The MVP software shall be stored in flash memory within the MVP. This software shall be capable of being updated without the removal of modules or memory devices. The MVP software and/or the supervisor 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.

2.15 MVP Operations Log

The MVP shall maintain a non-volatile operations log, which minimally contains: revision numbers for the current MVP hardware and software components; title and comments for the detector configuration; date and time the last detector configuration was downloaded to the MVP; date and time 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. The MVP processor will reboot itself automatically when software or hardware functions are not operating properly.

3.0 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 sensor and its support hardware / software is a sophisticated leading-edge 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 is not an adequate substitute for practical classroom training and formal certification by an approved agency.

4.0 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 5 years shall be available. Ongoing software support by the supplier shall include software updates of the MVP sensor, modular cabinet interface unit, 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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