VIDEO DETECTION
THE ATLANTA EXPERIENCE

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Imagine a system of technologies covering more than 60 miles (90 km) of freeway, over 300 cameras, more than 100 miles of fiber optics to facilitate communications, Changeable Message Signs (CMS), automatic radio transmitters, information kiosks, Internet access, and automatic incident management capable of detecting incidents and notifying DOT personnel within one minute.

This Advanced Traffic Management System (ATMS), conceived by the Georgia Department of Transportation (GDOT), exists today in Atlanta, Georgia--the largest integrated installation of these traffic technologies in the world today.

When fully integrated, machine vision technology will provide the data to better manage traffic in Atlanta and the surrounding communities. The Georgia Department of Transportation (GDOT) selected AutoscopeTM wide area vehicle video detection products developed by Image Sensing Systems, Inc. (ISS) of St. Paul, Minnesota and manufactured by Econolite Control Products Inc. (ECPI) of Anaheim, California. The ITS industry can learn much from this installation, from the various technologies themselves to the important lessons of integrating so many different technologies.

ATLANTA'S ATMS

Atlanta's new ATMS monitors the flow of traffic along Interstates 75 and 85 in real-time for advanced congestion and incident management and provides up-to-date traffic information to the traveling public in the greater area. The sponsoring agencies are GDOT, the Federal Highway Administration (FHWA), Federal Transit Authority (FTA), Metropolitan Atlanta Rapid Transit Authority (MARTA), the City of Atlanta, and five surrounding counties. The project not only helps promote more efficient transportation but also demonstrates U.S. transportation technologies to the world.

The Georgia DOT's Traffic Management Center (TMC) is the focal point of the ATMS, the Georgia ITS. Data flows into the TMC, and information flows out of the TMC to managing agencies and the public. Elements of the Intelligent Transportation Infrastructure (ITI) are the Freeway Management System, Incident Management System, and Traveler Information System. These systems monitor the flow of traffic along major highways in real-time and provide current traffic information to the traveling motorist in the greater Atlanta area.

The ITI provides a fiber optic backbone along one side of the I-75 and I-85 freeways. Detection and surveillance cameras at regular, closely-spaced intervals along each side of the freeway send video images along the backbone to hub buildings and then to the TMC. Often, the video image crosses the freeway to reach the backbone via real time radio transceivers.

GDOT choose the Autoscope wide area video vehicle detection system for a variety of reasons including minimizing lane closures during installation and any future maintenance activities. The Autoscope system provides average speeds, volumes, occupancy and stopped vehicle detection. Every 20 seconds, the Autoscope Scopeserver communication server polls each of the 57 Autoscope machine vision processors (MVP) for data from nearly 5000 detectors. The software then relays the data to GDOT's specially designed Count Station Data Acquisition System (CSDAS) database. The database provides real time traffic data access to all ATMS applications such as incident detection and driving display maps. Validation of this traffic data to the CSDAS is now underway. National Engineering Technology Corporation (NET) developed the CSDAS for GDOT.

Once the CSDAS receives the data, it looks for changes in the traffic data that indicate an incident. When detected, the software notifies operators at GDOT's TMC. The operator can then call up the nearest surveillance camera, determine the appropriate action, and dispatch resources.

Besides notifying the police or other emergency agencies, operators at the TMC can manually or automatically relay messages to the public through CMS, Highway Advisor Radio (HAR), and the Internet. The Atlanta World Wide Web page is a most interesting public notification method. With this useful tool, anyone with Internet access can download a color-coded map showing average speeds of the Atlanta Metropolitan freeway system. The CSDAS automatically updates this page (www.georgia-traveler.com/traffic/rttraff.htm).

KEY PLAYERS

A number of organizations helped GDOT make this system work. Traffic Products Inc. (TPI) provided the hardware and systems design for camera placement and Autoscope installation to GDOT. Autoscope installation tasks included mounting and aiming the Autoscope Image Sensors, installing and programming equipment in the hub buildings, and linking all components together with the TMC.

Key players included Alcatel Contracting (responsible for overall equipment installation), MilCom (responsible for much of the communications hardware), TPI, ECPI, and ISS. TRW Transportation Systems had system engineering responsibility for developing all aspects of the ATMS at the central Atlanta TMC. National Engineering Technology Corporation (NET) had engineering responsibility for the UNIX-based CSDAS software. JHK provided the central hardware including computers. In addition, a myriad of contractors and subcontractors worked on other sub-systems of the ATMS.

Each week during installation, a Working Group of company representatives, FHWA, and GDOT addressed problems, concerns and the necessary steps to complete the project. These management meetings adjusted the scope and pace of work, especially considering the forthcoming Olympics.

Incident Detection on over 60 miles of Interstate 75 and Interstate 85:

5,000 virtual detectors
316 Autoscope Image Sensors
57 Autoscope 2003 Machine Vision Processors
60 CCTV Surveillance Cameras
1 Helicopter Mounted Surveillance Camera
41 Changeable Message Signs
12 Highway Advisor Radio Transmitters
107 Radio Links for Video transmission
Over 100 Miles of Fiber Optic Cable

For example, the result of one of these meetings was to stop all efforts to get the incident detection system, which Autoscope was part of, up and running for the Olympics. This decision came about two weeks before the opening ceremonies as a result of ongoing problems encountered with the Scopeserver, the CSDAS software, and the communications link between the Autoscope units and the Scopeserver. It is important to note that the Autoscope units were fully operational during the Olympics.

MACHINE VISION PROCESSOR (MVP)

The Autoscope detection system uses virtual detectors drawn on a video image to collect traffic data. The key detectors for freeway applications count, measure speed, determine vehicle length, indicate stopped or wrong way vehicles, and accumulates traffic statistics for later retrieval by the central communications server.
The detectors are drawn on a live video image or a bitmap snapshot of the video image. You can easily size or move detectors for changing traffic patterns or optimizing performance.. This feature proved very beneficial and cost effective when GDOT added one additional lane and repositioned existing lanes early in the project. Adjusting the detector layout for optimal performance is an easy process for GDOT personnel and contractors when necessary.

Personnel in Atlanta can adjust the detector layout from a PC in the hub building or at the TMC. The PC also stores a backup copy of the detector file. Detector performance is visually verifiable by watching the detectors change color on the live video image on the PC screen.

FIBER OPTIC INFRASTRUCTURE

Fiber optic technology made it possible to transfer data and video from the many cameras to the hubs and the TMC. No other technology can move so much data and so many live video images with such quality and efficiency. Where fiber optics was not appropriate, a short radio link transmitted the video signal from about 30 percent of the cameras across the freeway to the fiber optic backbone.

Fiber provides the video and data communication links between each of nine hub buildings and the TMC. The hubs are small buildings that house four to 10 Autoscope MVPs and all the necessary communication hardware to the TMC.

To minimize communications channels, multidrop communications to the Autoscope MVPs at each hub were on one channel of multiport communications equipment from RAD Data Communications. The channel is multiplexed onto fiber to the Windows® NT 4.0 Autoscope Scopeserver communications server computer at the TMC.

The video signal from each of the 316 Autoscope cameras comes to the hubs using fiber with 60 radio transmitters on the front end of the video to "cross" the highway to the fiber optic trunk line. Once at the hub, the signal feeds the Autoscope MVP and is also muliplexed back to the TMC.

THE ROLE OF SCOPESERVER

As part of the ATMS project, ISS expanded the existing Autoscope communications server software, Scopeserver, to a 32-bit application for the Microsoft Windows NT operating system. ISS added TCP/IP communications to support platform independent client communications. For example, some ATMS software runs on a Sun Microsystems Solaris workstation with the UNIX operating system.

NET software engineers developed the CSDAS using the Scopeserver Developer's Kit for client-server communications support. This kit includes a Programmers Reference Manual, Scopeserver executable code, and sample application source code examples. The Scopeserver communications server runs on a Pentium P-133 with the Windows® NT 4.0 operating system. A Digi C/CON 16 port concentrator provides separate serial communication channels to each of the 9 hubs for the multidrop comm protocol. This concentrator is expandable to support a larger number of channels as the Atlanta ITI grows.

The Scopeserver can retrieve a basic data packet from 10 Autoscope units (57 cameras) from the largest hub, 'J', in just three seconds using a communication baud rate of 19,200 bps.

WHAT WE LEARNED

ISS, ECPI, and TPI learned valuable lessons from the largest freeway application of video detection in the world. During integration test of the Atlanta ITI, Scopeserver successfully integrated with the CSDAS and showed sufficient CPU and communications bandwidth to robustly support well over 100 Autoscope MVPs easily within the 20 second polling period.

Strong integration leadership is needed to synchronize the efforts of all contractors and subcontractors. It is important to budget enough resources for an integration plan to achieve its milestones. A smooth integration begins in the early phases of design and hardware selection.

Continuous and thorough inspection of installed equipment assured quality of execution to the design standards. When so many people are working on their piece of the pie, inspectors can help keep the integration process on track.

Continued design involvement and coordination among all of the equipment suppliers helped to achieve a robust integration of hardware and software. After the initial concept design, product specialists from the equipment manufacturers resolved issues in a timely manner while minimizing steps backwards.

SYSTEM BENEFITS

The major accomplishment of this project is the large deployment of new technologies, such as machine vision. Nowhere else has video detection data driven an automatic freeway incident detection system on this scale.

Automatic incident detection relieves the TMC operator from the drudgery of monitoring many surveillance cameras. An automatic system increases system reliability and efficiency because is never gets tired or loses focus.

The way data moved to the TMC and to the centralized automatic incident detection system. There are two parts to this achievement:

Data flows directly from the video detection system to a communications server at the TMC;

The centralized incident detection system employs a client-server network architecture for distributed processing and faster incident response.

In the first part, other systems use existing remote control units or controllers to convert vehicle detections from loops to a transmission to the TMC. Other systems apply the same strategy to video detection inputs and convert detector calls via a controller to a transmission to the TMC. In Atlanta, the data flows directly from the Autoscope MVP to a communications server at the TMC.

In the second part, other systems use one computer to communicate with the field and to process the data for incidents. The centralized incident detection program accesses the data from the communications server regularly, relieving the incident detection computer of the communications burden and increasing response time.

From a traffic management point-of-view, the ATMS allows extensive analysis of traffic data at a later time. The Autoscope MVP provides a variety of data: volume, occupancy, speed, vehicle classification, level-of-service, etc. The ATMS can archive this massive amount of data for later review. Traffic managers can later look for trends and periodic problems that only these detailed snapshots allow.

CONCLUSION

Bringing together many different technologies, including the Autoscope video detection system, meant overcoming integration challenges of both infrastructure and software. The benefits for Atlanta and the surrounding communities far exceed those of the centennial Olympic games themselves. Atlanta’s new ATMS will manage traffic in one of the fastest growing states in the country.

This is only a glimpse at the future potential of the Autoscope system and its benefits for the transportation industry as a whole. As this and other technologies improve and become more affordable and more accessible, ATMS systems such as Atlanta’s will become more common. The entire industry will benefit from the lessons learned.