Design and Deployment of Distributed Video Monitoring Systems

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Introduction

As the need to expand video monitoring from a single location to coverage across cities, states, or even countries the engineering approaches utilized in the past have become obsolete and require reevaluation. Distance and required functionality have driven the change in how video images are thought of and how they are handled. Another force changing the design paradigm is the interaction of humans with the generated video images; in today's environment of cost control and reduction the ability to set a person in front of a display is not always a viable option. This paper presents an overview of the Hurst approach to designing and deploying video monitoring systems.

Picture or Information

The first question that comes to the front in the design of a video monitoring system is "Is it a picture or is it information". Historically video images have been treated a picture that a designated person will act on in a real-time sense. The classic example of this approach is the security guard watching a bank of monitors and when an intruder is noted the police are called. While this stimulus-response approach can be effective its success demands an attentive person constantly watch all monitors. The best current example of this approach can best be shown by the monitoring systems utilized in Las Vegas casinos where an expert is assigned to a small number of monitors to watch for people cheating.

This approach to video monitoring is a picture-based approach. Even when video is recorded for later use it is treated as a picture. The limitation associated with this view is that there are no capabilities associated with the video image; in short it is not considered information. To consider video signals as information requires a change in the way design, installation, operation, and evaluation of the system is accomplished.

Who – What – Where – When – Why

Beginning with the conceptual design of a video monitoring system the designer is responsible for determining the information required from the system and how best to collect and distribute the required information. An easy design basis can be borrowed from the journalism profession, "Who – What – Where – When – Why".

Who – Who is the actual end user of the video information? Is the guard watching the monitor the end user or are there multiple people within the organization that will actually utilize the video information? Typically video information can meet the needs of multiple end users if during the design phase the functional requirements are fully identified and incorporated into the design. This approach reduces the overall cost to performance ratio of the system and often stimulates new uses for the information, further increasing overall system value.

What – What information is actually required in the video information? During the change from a picture to information the designer must identify what is actually needed and design accordingly. The starting point for answering "What" is through identification of the end users and functional requirements. Functional requirements should include definition of image detail, color, image retention, image distribution, or other physical issues. The greatest gain in this design phase is the avoidance of over designing the system. The classic example of the design errors eliminated in this phase is specification of a fully pan-tile-zoom camera with a 250mm zoom capability inside a room to watch a door that is six feet away. This example may seem extreme but almost any organization has this level of over design.

Where – Where is the video equipment deployed? Historically video cameras were installed and hard-wired with copper or optical conductors to a central location. Examples of this can be seen in many cities throughout the world where hundreds of miles of fiber optic cabling have been installed to provide traffic flow information. In reality this could be the correct solution if the designed installation of "Where" matched the functional analysis of "Why". The functional requirements should clearly define where video cameras are required and what information they should collect. Once this is set the locations will provide the input required to design the information network required to service the video information. This is actually the point where the distributive characteristics of the video information network are decided. The process of designing the video network is identical to the design of any communication network. Issues related to reliability, bandwidth, cost, and flexibility must all be considered to assure the final product meets all current needs and allows an identified degree of future expansion.

When – When is the information needed? This design aspect has two components. The first is when will the end user need this information, on an operational basis. Is the system monitored 24 hours a day or only when a problem is detected? Determination of when the video information will be used is a key point in determining what equipment is required as well as defining network capabilities.
Secondly is how long is the time period from design to implementation? As the complexity of video information systems increases they can rarely be deployed in

one project. Careful design of the implementation phasing is required to ensure that the functional requirements are implemented in the correct priority at the proper locations. The best approach for this is to utilize a risk based analysis. A summary of this method is to use a weighting method that takes all required locations and assigns a risk based weighting factor. After a weighting factor is assigned a secondary multiplier is assigned based on information network design requirements, in other words do I need this location to make the basic system work. The resultant rating number is sorted and assigned to phases. After the locations are phased a project schedule can be developed and implemented. Variants of this approach can be used successfully as long as a consistent analysis method is applied to the overall project.

Why – Why is the video information required? This is possibly the most important design question but is most often skipped. To ask "Why" is not directly related to the functional requirements but more closely related to how the video information is collected and handled. An example of "Why" considerations could be evidentiary rules in the location the system is being installed. An example of this would be the fact that in most states it is legal to record video information with no notification to the subjects being recorded; however, if audio is recorded it requires consent of the person being recorded or a judicial wiretap order. Does a regulatory body require the video information, if it is what requirements are in place for storage and authentication of the images? Why, is a hard question to answer in its entirety and is a critical part of the system design.

All five of these design questions must be completed and documented for a video information project to succeed. The risk of not competing all steps is a system that does not meet intended needs or one that is so expensive that it will not get built.

How To Do It

After the conceptual design phase is completed by answering "Who – What – Where – When – Why" the detailed physical design of the system can begin. For large systems cost usually demands that the video information be collected and stored in a distributive manner and called when needed. The risk analysis will determine where the initial centers should be established and how they should be connected to the end users.

Equipment for video information systems is available from hundreds of manufactures in all price ranges. Adhering to the functional requirements will determine what equipment level should be used. To assure that the final design progresses in an efficient manner a build from the bottom process identifying components should be implemented.

1. Imaging Components
   Based on functional requirements and physical locations select cameras and lenses that meet all requirements. To simplify maintenance and spare parts storage attempt to select a single camera manufacture. A key point to remember is that it is often less expensive to standardize on a camera

body and utilize lens design to provide specific requirements.

2. Ancillary Information
   During the determination of functional requirements other information such as alarm processing, thermal analysis, or image identification may have been identified. The equipment necessary to collect this information is selected and integrated into the camera design if necessary.

3. Information Collection
   In most video information system designs the image will be recorded for future use. There are two basic approaches to accomplishing this requirement analog or digital recording. Analog recording utilizes some form of tape or an optical disk system. While this is an old technology in some applications it can still be the right solution based on the functional requirements. Digital recording utilizes a computer to record information to disk. This technology has been available for about six years and has expanded the capabilities of video information systems many orders of magnitude. Like all computer-based systems a standard supplier should be selected to minimize the number of different platforms requiring maintenance and operator training. An important point to remember during this design evolution is that computers are a tool and a commodity.

4. Information Distribution
   To make video information useful it must get to the right people at the right time. The final destination for video information was determined during the conceptual design phase. In final design the decision on the display methodology and any analytical tools must be resolved. The prime concerns in this phase are the human factors associated with the information and the analysis applied to the information. Human factors design has to include ergonomics as well as performance. A single person can effectively watch four to six video monitors on a full time basis assuming there is an average activity level. Items that detract from this are image switching, the rapid changing from one view to another, complexity of the video image, and the quality of the image. If there is more information at a single point that this it is best to allow presorting of the images by the system. The easiest way to do this is to implement a view on alarm policy. Intermittent users should have viewing capabilities determined by the analytical requirements of the images they use. Where possible it is cost effective to utilize existing computer equipment to view images.

5. Information System
   The information system requirements for video are the same as any other information system. We have defined bandwidth, reliability, and other requirements now apply a system that matches those requirements. Direct cabling, private networks, and public networks can all be successfully

utilized by using careful design. Once again remembering that network systems are primarily a commodity and cost should be one of the major design concerns.

Summary

Video information systems have evolved from high-tech curiosities to off-the shelf reality. To implement a successful system sound engineering and financial principles must be applied as with any other process control system.