Video Smoke Detection

Introduction

Camera based automatic fire detection is the latest technology to efficiently identify the presence of smoke or fire in areas previously deemed to be impractical for typical smoke detection. Traditional smoke and fire detection methods require the fire signatures such as smoke or heat to travel to the device; whereas, Video Smoke Detection (VSD) detects the fire at the source. Its ability to detect fire remains independent of architectural and environmental conditions that affect traditional detection methods.

Fire detectors and sensors are designed to look at one or more of the emissions from fire or the incipient stages of fire, most commonly smoke, followed by heat. In most typical commercial and industrial applications, these detection principles work very well. However, these traditional detection methods may not be able to provide adequate protection in unique structures and specialized facilities such as processing plants, tunnels, aircraft hangers, mass transit facilities, historic structures, or areas that are inaccessible or unsafe for spot-type detection. Based on the intended purpose of the building — the types of operations and processes it must contain — the design may not be conducive to detecting smoke or fire with standard detection methods. Features like vast open areas (atria, high ceilings) can severely diminish the effectiveness of spot-type smoke and heat detectors, as well as beam-type smoke detectors. VSD excels in all of these environments without any compromise to alarm response time. It can detect smoke and/or fire in any area visible to a standard video camera even through window or door glass.

Conditions Affecting Traditional Methods of Smoke Detection

Traditionally, automatic smoke detectors or sensors rely on smoke particles or heat signatures reaching the device before it can start the alarm/no-alarm decision-making process with the fire alarm control panel. This process can be affected by one or more of the following conditions:

1. Distance from Fire Source to Detector

Smoke and heat detectors are normally sited in a position that smoke/heat will travel to, typically the ceiling. The distance from the detector to any area on the floor is usually the maximum distance allowed in accordance with local or national fire codes. These codes are calculated from an acceptable time delay for the smoke to reach the detector from any area. Once the smoke reaches the detection point, it has to build up sufficient density to activate the detector. Even with the aspirating systems that draw the sampled air to the detector, the smoke still has to reach the sampling point, which would normally be placed in the same position as standard detectors.

2. Stratification

Smoke will rise because it is hotter than the surrounding air. As the smoke travels through the cooler air it will, in turn, cool down. Once the smoke approaches the same temperature as the air around it, the smoke will stop rising. This process is known as stratification. If the detectors are above this stratification level, then they will not detect the smoke until a significant amount of heat generated from the growing fire moves the stratification level higher and higher. This is the reason international standards will state a limitation on ceiling heights for certain types of smoke detectors. This can be as low as twenty feet for spot-type heat detectors, twenty-five feet for spot-type smoke detectors, or thirty feet for beam type smoke detectors.

3. Thermal Barriers

Heat rises. Therefore, the hottest air will be found at the highest point in the room. This will create a barrier of hot air which smoke will only penetrate if it has a higher temperature than this barrier. This is very evident in glass ceiling areas such as atria found in shopping malls and high rises.

4. Diffusion

As smoke rises it will tend to drift sideways as well as upwards. Therefore, the concentration of smoke will be lower as the smoke rises. Smoke sensors are designed to alarm when smoke levels reach a certain percent obscuration—a measurement dependent on the concentration of smoke at the detector's location. The more smoke diffuses, the longer it will take for the concentrations levels to reach the detector's alarm activation threshold.

5. Air Movement

Any air movement will take smoke away from the source of the fire. This is not a problem if you can predict the exact route of the air movement. In computer rooms, control rooms and clean rooms, this is usually known and detectors can be placed across air conditioning vents etc. There will, however, be the need for additional ceiling

detection after the airflow has stopped (e.g. air conditioning switched off) and the smoke takes its traditional vertical path toward the ceiling. Should the protected areas be external (or an area with similar environment such as an aircraft hanger that has large doors open), then there would be no predictable airflow.

Other At Source Detection Methods

Besides VSD, other at source type detectors are:

1. Thermal Imaging Cameras - These systems can detect changes in temperature by monitoring infrared emissions. They can be useful in a controlled environment where there are no other forms of unpredictable heat sources. They are impractical areas where heat sources such as people, cars and machinery are moving through the scene.

2. Image Processing of Heat Changes - These systems work by fitting a heat sensitive pad to known risk areas. These heat pads will change color or contrast with the increase in temperature. This change can then be monitored and processed via a thermal imaging camera.

3. Flame Detectors - The most popular at source fire detection systems in this category are flame detectors. The difficulty with flame detectors is that by the time flames appear to trigger the device into alarm, serious fire damage has occurred and will rapidly increase; also significant amounts of smoke may have been emitted causing serious risks to personal health.

Video Smoke Detection Principle of Operation

VSD, first developed in the late 1990s, is based on sophisticated computer analysis of the video image seen by a standard CCTV camera (sensor). Using advanced image-processing technology and extensive detection algorithms (and known false alarm phenomena), the VSD can automatically identify the distinct characteristics of smoke and flame patterns. The fire detection industry has an abundance of known smoke and flame phenomena, such as frequency of flicker, and all of these factors are built into the system to give an accurate decision on whether smoke and/or flames are present. The VSD system is so accurate in its analysis that it can differentiate between steam and smoke.

The VSD system uses standard CCTV cameras (back and white, color, infrared, existing or new) linked to a self contained processing system which is capable of recognizing small amounts of smoke and flame patterns within the video image and alerting the system operator both at the processor and by a variety of remote outputs.

The VSD system executes highly complex algorithms to process video information from up to eight cameras simultaneously. Under normal conditions with all eight cameras connected, the system achieves a 5Hz-frame rate for each channel.

The VSD system detects smoke and flame rapidly by looking for small areas of change within the image at the digitization stage and only passing these pixel changes to the main processor for further filtering.

The video information is passed through a series of filters that seek particular characteristics associated with smoke and flame behavior. Further analysis is then carried out on the relationships between the filtered characteristics to determine whether all the conditions have been met for the system to accurately predict the presence of smoke and/or flame.

The video hardware is designed to allow simultaneous real time digitizing of all eight images, which means that the system does not multiplex images and therefore no information is lost or delayed. All alarm condition images are log time and date stamped, and stored within the system's memory.

The system installer has the ability to vary the amount of smoke signal, and the length of time that the smoke exists before an alarm condition is raised to allow for situations where there may be background smoke present. The installer may also divide the video image into zones and program the system to alarm only if smoke and/or flame are present in two or more zones.

For even greater system performance, two camera images can be associated together so smoke and/or flame in one image is to be treated as a pre-alarm and smoke and/or flame in the second camera image triggers a full alarm.

To compensate for areas of the image that could prove troublesome such as reflective surfaces or smoke producing processes, the installer or system user has the ability to eliminate or mask parts of the image from detection on an individual pixel-by-pixel basis.

Benefits of Video Smoke Detection (VSD)

Quick Investigation and False Alarm Rejection

The ability of VSD to pinpoint the source of a fire on a camera monitor lets an operator or security staff view the area affected and assess the severity of the situation without delay. This can be done at a very early stage to allow the operator to view the camera image after a strobe or sounder is triggered locally and then take necessary action. The ultimate evacuation of the building can be delayed to allow an operator the time to verify and, if necessary, reject a false activation before the fire alarm is sounded.

Detection Not Affected by Ceiling Height

VSD is especially effective in areas with high ceilings such as atria, concert halls, railroad stations, etc. VSD cameras need only to be mounted to see above the risk area, and this location generally makes for ease of maintenance, initial camera mounting and commissioning.

Unrestricted Zoning

Similar to conventional fire detection systems, VSD uses zones of detection to locate and confirm the fire. VSD has the ability to freely move zones without having to rewire cameras. VSD zones are software driven and can be placed anywhere within the image or area of detection. For example, if an area being monitored contains an item which constitutes a high fire risk, such as a trashcan or telephone equipment, then a zone of detection can be placed directly above the high risk hazard. If equipment is then relocated, the zone can be easily moved to follow the equipment to its new position. This can be done quickly and easily by an operator though the VSD Systems Operating Terminal.

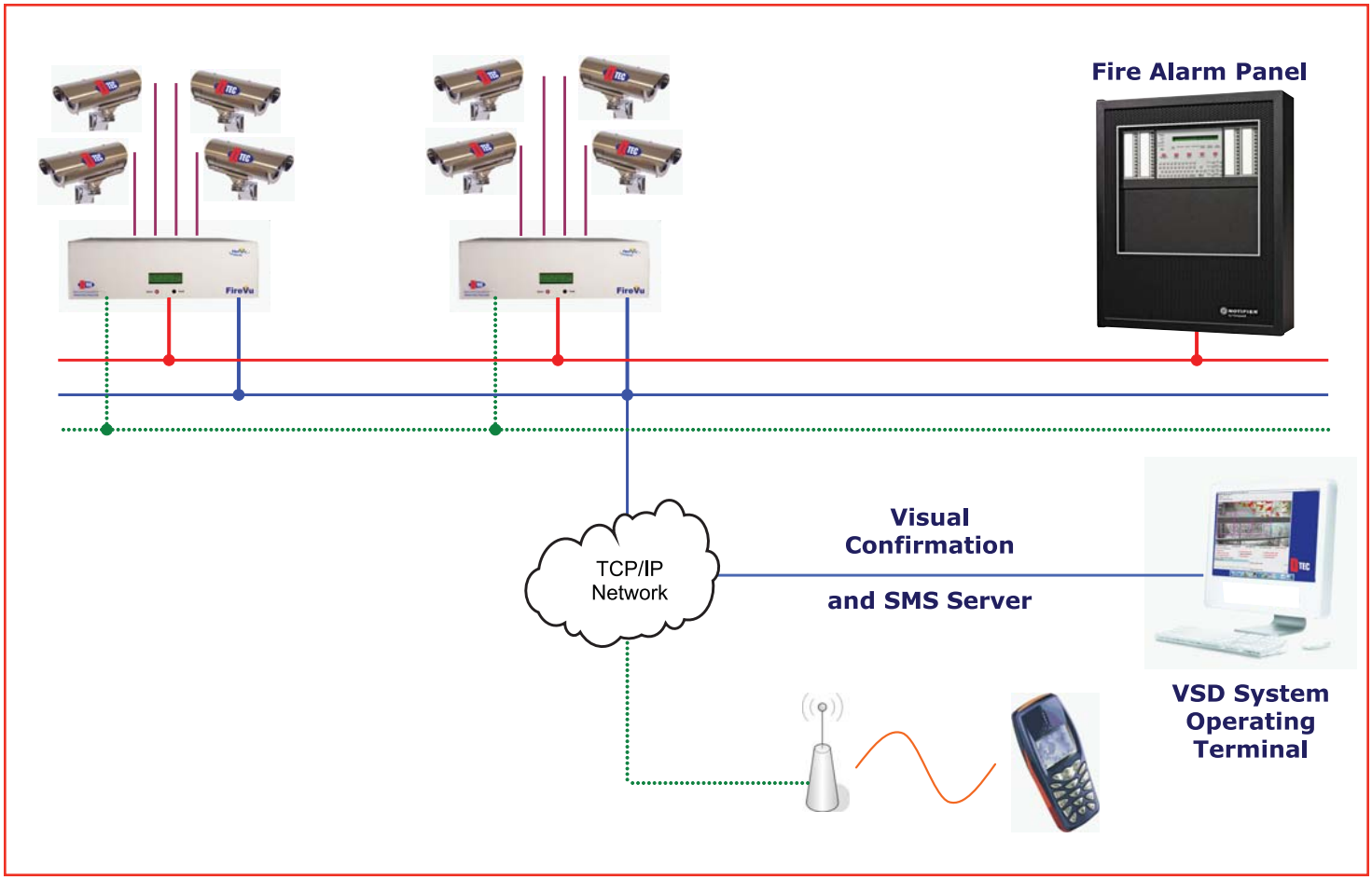
VSD will use any installed cameras for security monitoring as part of the VSD system. Sharing camera function is an excellent way to deliver the highest possible value to the facility owner. This does not require the need for additional wiring in the field and does not affect the installed cameras primary role of early smoke detection. Cameras installed primarily for VSD also can be used for security surveillance, item monitoring and non-motion detection.

System Architecture

The VSD system consists of an advanced embedded server designed to operate over an IP network. Using advanced, mathematical algorithms, it is capable of determining the presence of smoke within each of its four available analog camera inputs. Operators can be alerted via IP video events and/or locally via relay outputs to the fire alarm control panel. Each camera image can have up to 16 fully independent, configurable zones, allowing the user complete flexibility on setting up the areas to be protected with their required sensitivity levels. System configuration is carried out via a series of web pages using a web browser, while system monitoring and reviewing is carried out using the client software.

Conclusion

VSD systems detect smoke and fire at the source, and are not affected by environmental or architectural elements within a structure; e.g. atriums, ventilation systems, or large open areas. VSD systems can detect smoke and/or fire in any area visible to a standard video camera — even through glass — ensuring a fast response to incipient fire signatures in areas previously considered to be impractical or impossible to protect.



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