# Chapter 2
# Background

## 2.1 VID Technology

In general, a fire VID system consists of video-based analytical algorithms that integrate cameras into advanced flame and smoke detection systems. The video image from an analog or digital camera is processed by proprietary software to determine if smoke or flame from a fire is identified in the video. The detection algorithms use different techniques to identify the flame and smoke characteristics and can be based on spectral, spatial or temporal properties; these include assessing changes in brightness, contrast, edge content, motion, dynamic frequencies, and pattern and color matching. As an active area of research, there are multiple VID systems in development. However, there are only about five systems that are commercially available. The capabilities of these systems vary from being able to detect only flame or smoke to being able to detect both as well as providing motion detection and other surveillance/security features.

Smoke VID systems require a minimum amount of light for effective detection performance and most will not work in the dark. However, capabilities vary between systems. In general, low light cameras can enhance performance and some systems have been developed to operate in the dark using IR illuminators and IR sensitive cameras [e.g. 3, 4]. Flame VID systems can operate effectively in dark or lit spaces and some systems will have enhanced sensitivity to flaming fires in the dark.

There are two basic architectures utilized by VID systems. Due to limitations of video processing technologies, the initial systems consisted of multiple cameras (usually a maximum of eight) each with an analog cable connection back to a central processing unit that executes all video capture and alarm algorithms (Fig. 2.1). The processing unit typically has relay contact outputs and the ability to send various alarm signals to standard fire alarm control units. Depending on the manufacturer, systems can also record still shots or video clips associated with alarm events and can provide instantaneous video display to a monitor.

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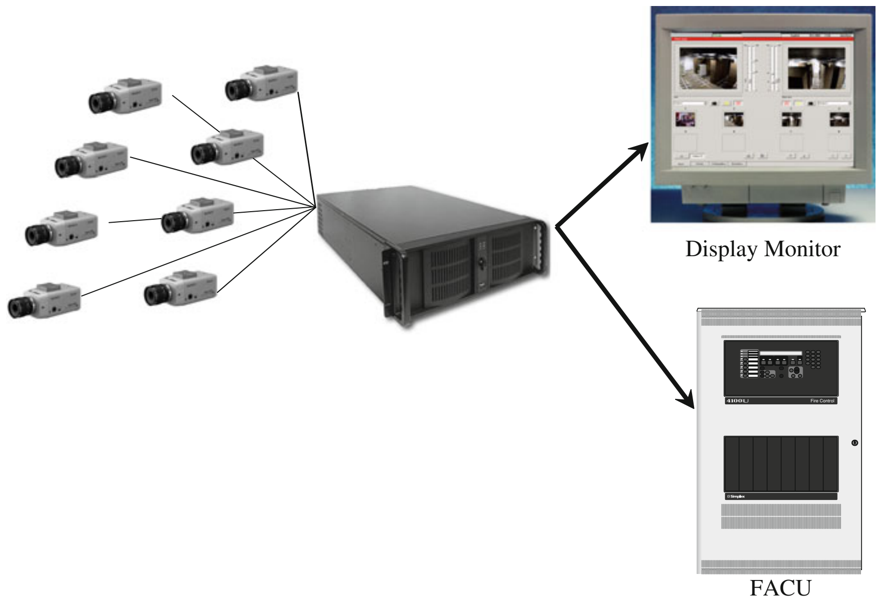


**Fig. 2.1** VID system with CCTV cameras individually processed by a central control unit that runs the alarm algorithms

Advancement in technologies has allowed the second type of architecture where both the video processing and alarm algorithm execution are performed at the camera in a single, spot-type device (Fig. 2.2), just like a typical optical flame detector. These fire detectors can have onboard storage of video and can be integrated on a closed-circuit system with an additional central processing unit, or it can be integrated as a spot detector on a standard fire alarm system. These devices can also be monitored remotely via network or internet connections. Video events of alarm conditions can be archived for each device and can be displayed automatically to monitors for instantaneous viewing.

As noted, commercially available systems range in capabilities. They also vary considerably in their setup and manner of use. Some systems have little or no user definable settings and are almost plug-and-play, and some systems require a trained manufacturer's representative to customize the system to the application. Once setup, there is little maintenance required of a VID system. Similar to any field of view detector, the primary issue is keeping the optical windows clean and the camera position fixed and unobstructed. Most systems monitor the video image, such as low or exceedingly high light levels, video loss, significant image changes, or obscured camera images, and provide a warning if the image quality is degrading or not sufficient for proper detection performance. Currently, VID systems can be tested/checked in one of three ways: (1) using a target smoke or fire source, (2) feeding the system a pre-recorded image of a flame or smoke event, or (3) using a product-specific electronic device that directs a pre-set "light" signal to the VID detector.

**Fig. 2.2** Example of a spot-type flame VID device with camera and alarm processing in unit (courtesy of Micropack)

VID systems provide unique advantages in a wide range of applications. One advantage these systems offer is the ability to protect a larger area, while still achieving fast detection. This is particularly true for smoke VID systems compared to spot or beam smoke detectors. In many large facilities with excessive ceiling heights, designers find it impractical to use conventional smoke detection devices. VID systems are able to detect smoke or flame anywhere within the field of view of the camera; where as conventional smoke detectors require smoke to migrate to the detector. VID systems can also be used for outdoor applications, such as train stations and off-shore oil platforms.

The ability to use the basic hardware of the VID system (i.e., the cameras and wiring) for multiple purposes is one of the advantages of this technology. Integrating video-based fire detection with video surveillance inherently minimizes certain installation, maintenance and service costs and can increase system availability due to more frequent use of and attention to the video equipment. Providing fire protection for historic buildings poses many challenges to not disturb the historic features of the structure. Running wire and mounting devices of typical fire alarm systems is just not possible in many of these applications for both aesthetic and practical installation reasons. Many museums and historic buildings already have surveillance cameras installed, which makes the use of VID systems attractive.

Another advantage of VID systems is the ability to have live video immediately available upon detecting a pre-alarm or an alarm condition. Immediate situational awareness allows monitoring personnel to easily view the protected area to determine the extent of the fire and to more accurately identify the location. Archiving of still and video images associated with alarm conditions also provides a means of assessing the cause of incidents and also provides a basis for changes in the detection system if the event was a false/nuisance alarm.

## 2.2 Codes and Standards

The National Fire Alarm Code, NFPA 72-2007, recognizes the use of flame and smoke VID systems. Per the Code, the installation of these systems requires a performance-based design. There are no prescriptive siting requirements. Flame VID systems are classified as radiant energy sensing fire detectors and are treated similar to optical flame detectors. Due to the variability of VID system capabilities and the differences in alarm algorithm technologies,

NFPA 72 requires that the systems be inspected, tested, and maintained in accordance with the manufacturer's published instructions. Appendix A contains excerpts from NFPA 72-2007 that apply to fire VID systems.

Currently, there are no systems that are UL listed, and there is no UL standard that specifically addresses VID systems. Four systems have been FM approved. These include a system that detects only smoke, one that detects only flame and two that detect both. The systems have been approved to meet the requirements of FM Standard 3260, Radiant Energy Sensing Fire Detectors for Automatic Fire Alarm Signaling [6], and UL 268, Smoke Detectors for Fire Alarm Signaling Systems [7].

FM 3260 establishes guidelines for testing detectors per manufacturer-specified sensitivities (i.e., fuel, size, distance and response time). It also requires that the detector sensitivity be established for one or more of the fires below[1]:

- $0.3 \times 0.3$ m ($12 \times 12$ in.) n-Heptane pan fire $\sim$126 kW
- $0.3 \times 0.3$ m ($12 \times 12$ in.) alcohol pan fire $\sim$27 kW
- $0.3 \times 0.3$ m ($12 \times 12$ in.) JP4 jet fuel fire $\sim$146 kW
- 127 mm (5 in.) propane flame from a 0.53 mm (0.021 in) orifice $\sim$0.32 kW

Typically, the detector is shielded from the ignition and shuttered once the fire is stabilized. This technique provides more consistency/repeatability in the sensitivity fires. The fires are conducted in large open spaces. If conducted outside, tests are only performed under good weather conditions (i.e., clear, blue sky days). There are no prescribed conditions for indoor tests, but light levels are measured

[1] HRR values calculated from empirical data presented by Babrauskas [8].

and documented as part of the approval. Overall, the FM approval is a verification of performance for the tested conditions only.

UL 268 specifies various flaming and smoldering type fires to be conducted in a room that is 10.9 by 6.7 by 3.1 m (36 by 22 by 10 foot high). All of the fires are small. They include pyrolizing wood, a 15.2 by 15.2 cm (6 by 6 in.) wood crib fire, a shredded paper fire, and a 15.8 cm (6.25 in.) diameter pan toluene/heptane fire.

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