Perimeter Security Fence Systems

Technology Considerations

Introduction

Perimeter Intrusion detection security systems are based on the core principle of establishing a steady background state and continuously monitoring to detect any change above or below a pre-determined threshold. Changes above or below these thresholds indicates that an intrusion has occurred. To accomplish this, many technologies have been developed and each offers a different method to protect a fence.

Perimeter security exists to deter, detect, assess, delay and respond to an attempted intrusion. When specifying a security technology system, each facility has unique characteristics and security requirements, and should be designed to suit the requirements of each site. Site layouts, facility building locations, the terrain and surrounding environment, the local weather conditions, the presence of trees or other natural or man-made surroundings, the condition of the fence, and the movement of vehicles in and out of the facility all must be considered.

Operational Requirements

Typical operational requirements for a fence protection system include:

- Detects intruders with high probability
- Performs with a low false/nuisance alarm rate
- Has the ability to protect perimeters of varying lengths
- Has linear characteristics (system sensitivity not distance dependent)
- Is able to withstand harsh/dangerous environments
- Is adaptable, tunable and can respond to environmental conditions

For high security facilities, there is a documented need for high probability of detection and low false/nuisance alarm rates, and it mandates the use of sensors that have tunable thresholds. These sensors use multiple criteria in conjunction with a tunable decision network to distinguish between environmental noise and intrusions. Without tunable thresholds, the sensor is unlikely to have the high sensitivity that is required to catch intruders, while keeping false/nuisance alarms sufficiently low.

The requirement for a system that can be tuned essentially rules out the use of sensors such as taut wire systems and other metallic or mechanical sensors, because the tuning of each of the system components distributed along the perimeter becomes a practical impossibility. This is especially true where the tuning requirements demand a level of sophistication beyond simple thresholds.

Perimeter sensors are, by their nature, spread out over large distances. Often mounted to fences, other times buried under the ground, in all cases they extend over hundreds, if not thousands of meters. This presents

another problem for metallic fence detection systems because lightning is more likely to strike somewhere along the perimeter. The threat of lightning strikes constitutes justifiable concern about metallic conducting cable sensors. Such sensors are not only susceptible to being destroyed by a lightning strike, they can also conduct high-voltage, high current surges into the area containing the analysis software/electronics, destroying the sensing electronics and possibly other un-related electronic modules as well. The cost of such mishaps is manifest in the replacement cost of the lost electronics modules, as well as the cost of re-deploying the sensor on the perimeter. While lightning surge protectors provide a degree of protection they also add cost and are not 100% effective. Other factors also make metallic conducting sensors problematic. Oscillating electric fields near conductors create induced currents by electro-magnetic induction. High oscillating fields are common, especially along the lengths of extended perimeters.

Another reason to avoid the use of metallic conducting sensors for perimeter sensors is the possibility of corrosion and failure over time. This is especially true in designs that have different metals touching each other, particularly in the presence of water. A final reason for rejecting metallic cable is the limited length of perimeter they can cover (due to resistive losses, dispersion, etc.). While this is a more serious problem for some metallic cable providers than for others, they all have much higher loss than fiber optic sensors.

The use of metallic vs. fiber-optic fence security

Today's perimeter security systems use many different sensing technologies. These include Radio Wave Disturbance Sensors, Sound Sensors, Electric Fences, Infrared Motion Detectors, Taut Wire systems and so forth.

Fiber optic fence security systems use light rather than electricity to detect intruders. During operation, light pulses are transmitted through fiber optic cable, which is typically installed on existing perimeter fencing. These light pulses are continually monitored for any change in light pattern or optical power, as may occur when the fiber is physically disturbed during an intrusion attempt. High security fiber-optic systems monitor the small changes in the light signal and detect any movement, vibration or pressure that occurs along a protection zone.

When compared to other types of security systems, Fiber Optic fence systems offer many advantages over other sensing technologies:

- Immunity to electromagnetic interference (EMI) - Compared to electronic, microwave, and electric field sensors, fiber optic sensors are not subject to interference from EMI.
- Safe for all environments - Fiber optic sensing cable does not carry or conduct electricity; it is safe for use around fuels, gases and combustible materials.
- Exceptional range - Fiber optic monitoring systems operate over far greater range than electronic sensing systems.
- Low incident of nuisance alarms - Fiber optic fence systems are not subject to interference due to small animals, adverse weather, changing light conditions, EMI, and so forth.

- Cost effective - Fiber optic sensing cable is easily incorporated into all types of existing fences and walls. The cable can also be mounted on posts as a stand-alone system. Fiber optic sensors typically do not require electrical power in the field.

Long distributed sensors that use metallic conducting cable are unsatisfactory because of:

1. Susceptibility to lightning strikes and subsequent damage to the sensor and associated/nearby electronics
2. Susceptibility to noise from induced currents resulting from nearby oscillating electric fields
3. High attenuation loss, resulting in limited range
4. Radio Frequency Interference (RFI) that creates problems for the system

In addition to metallic sensors, we should also eliminate optical mesh perimeter sensors as a viable solution because of their poor sensitivity and the comparative ease with which such sensors are defeated. Fiber optic meshes have an additional problem; it's comparatively easy to tell if you've set off an alarm. That's because the fiber responds only to tight bending (enough to cause a measurable loss in signal) and/or breaking. For example, reliably detecting a bend in single mode fiber (carrying light at 1310 nm) might require bending it to a radius tighter than about 1.5 cm, over 180 degrees. Yet the cable in fiber-optic mesh sensors can easily be handled without exceeding this bend radius, making it simple for intruders to work on the sensor while using specialized tools to separate the mesh at the nodes, and then simply walking through the sensing net, knowing that (unless they break the cable) they have not tripped an alarm.

Perimeters are seldom straight, with an un-obstructed view of the entire length. Often there are adjoining structures near the perimeter, on both the outside and inside, that create shadow regions for point sensors. Sometimes these structures are outside the perimeter, but they enclose people or machinery that might set off sensors, such as microwave, that can sense movement through walls.

Some metallic conducting systems, like ported coax, have such high attenuation that they cannot be used effectively beyond a few hundred meters.

The Principal Drawback of ported coax is that it is subject to interference by sources of electromagnetic interference (EMI). This type of system should not be used at electrical substations, around large electrical equipment, etc.

Other Shortcomings include:

- Very high component / installation costs
- Nearby metallic objects, including metal fences, can interfere with performance
- Sites with heavy snowfall are prone to unreliable detection
- Standing water over buried cables can generate nuisance alarms
- Limited calibration capability to eliminate nuisance alarms

In the domain of wire-based security systems, another system alternative is a metallic system called the “Shaker Fence”. This type of system is promoted as a multidirectional vibration sensor cable solution, responding to vibrations caused by intrusion attempts. Since it is a wire-based system, it is subject to EMI and RFI interference, and it is also known to be subject to corrosion. A review of solutions of this type reveals no reference to nuisance alarm discrimination and no built-in ability to discriminate false alarms from actual intruders.

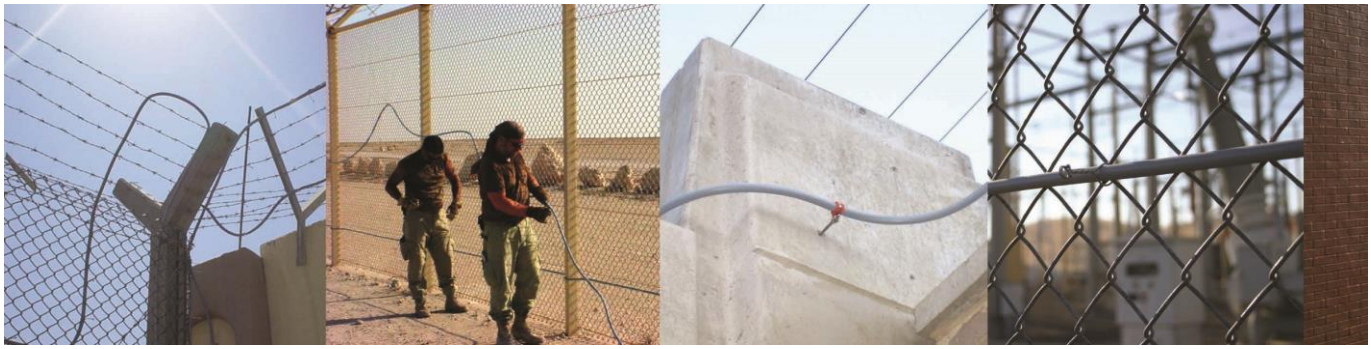
Another type of perimeter security technology is the electric fence. The primary function of an electric fence is protection, and it offers very few additional levels of sophistication or enhanced integration capabilities. It is designed to keep away unwanted visitors, prevent trespassing and secure buildings located in isolated or remote areas. At the same time, electric fences can be a real danger for people, wildlife or pets. Insurance companies disapprove of this type of fence as they claim that it can cause serious injuries. If an intruder tries to enter the property and gets hurt because of the fence, the organization may be sued.

In addition to the disadvantages described in this document with metallic fence systems, electric fences offer additional disadvantages:

- They are not suitable in places where they are likely to be overgrown with plants or trees
- The systems require visible or audible warnings indicating that a dangerous security system is in place
- Mechanical control may be required to control leakage due to vegetation
- Although modern energizers can maintain voltages in conditions where there is high leakage, they are not as efficient when the affected fence is several kilometers in length
- It is necessary to regularly check fence lines to make sure the fence is working properly
- Installation teams require special training
- Insurance costs are higher due to additional liability concerns

CONCLUSION

Fiber-optic sensors are an outstanding technology for perimeter security, but as we've seen, every project requires its own design considerations and determined intruders can defeat even the best of them. This is why highly secure perimeter security systems always use layered sensor systems based on varied sensing phenomenology. The original perimeter sensor, the sentry, illustrates this important principle. Imagine you're a sentry, posted on a critical perimeter with the task of catching intruders. As you scan from your post, you see something suspicious and out of the ordinary. You may do a double take, training your eye on the spot, but you'd probably also strain your ears to see if they confirmed the oddity. You'd respond in a similar manner if you heard something that startled you – turning your head to get visual confirmation of whatever made "that noise." These are two examples of ways evolution has designed organisms with layered, complimentary sensing mechanisms; eyes for visual sensing, ears for acoustic sensing, smell for chemical sensing. In addition to reducing the rate of false alarms, redundant systems also improve the probability that at least one of the sensors will catch any given intruder. It's why organizations like The U.S. Air Force use multiple sensors for critical measurement.



For more information on using fiber-optic perimeter protection systems please contact Fiber SenSys' sales or technical support team directly at +1-503-692-4430 or by email at info@fibersensys.com.

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