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Fence Disturbance Sensors

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Presentation Outline

- Types
  - Electro-mechanical
  - Strain sensitive cable
  - Geophone
  - Fiber Optic
- Testing
  - Over – by climbing
  - Through – by cutting
  - Vulnerability to Defeat
- Summary

Fence Sensors - Types

- **Electro-Mechanical** – sensing distributed along the fence
  - Mercury Switch: fence movement or shock breaks contacts
  - Mechanical Contact: fence movement or shock momentarily breaks the contact. Typically consists of a gold-plated ball sitting on electrical contacts.
  - Piezoelectric Crystals: flexing the fence generates a small voltage. Sensor alarms when voltage exceeds a pre-set threshold.

Fence Sensors - Types

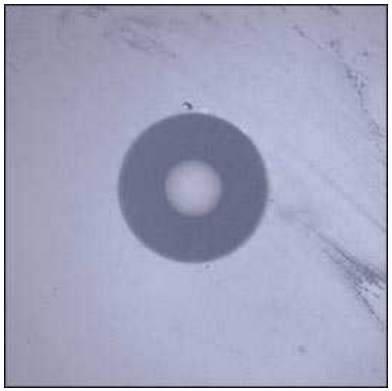
- **Strain-Sensitive Cables** – sensing is continuous along the length of a fence
  - wire movement through a magnetic field
  - slight frictional charges from different materials that make up the cable;
  - variations in position of wires inside the cable.
- Fence movement generates an electrical signal. Sensor alarms when voltage exceeds a pre-set threshold.

Fence Sensors - Types

- **Geophones - sensing distributed along the fence**
  - **Operate on the principle of electromagnetic induction.**
  - **Constructed of a coil of wire and a magnet.**
  - **Movement generates an electrical signal. Sensor alarms when voltage exceeds a pre-set threshold.**

Fence Sensors - Types

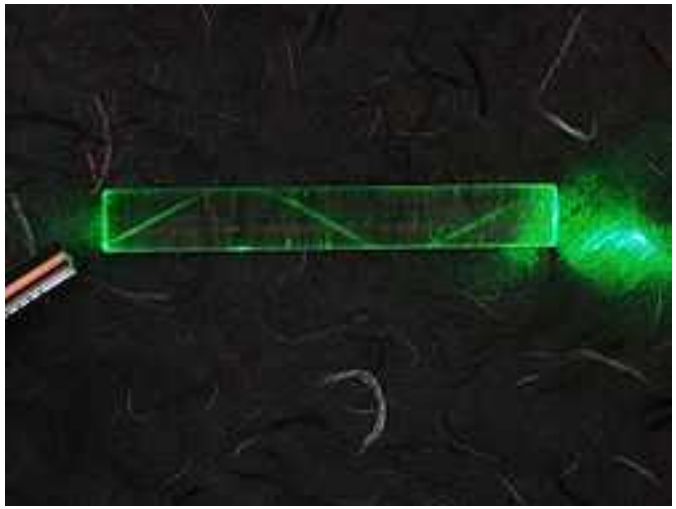
- **Fiber Optic Cables - sensing is continuous along the length of a fence**
- **Cables**
  - **Core – glass or plastic**
  - **Cladding - different refractive index than the core**



Fiber optic cable surrounded by cladding, magnified 400 times

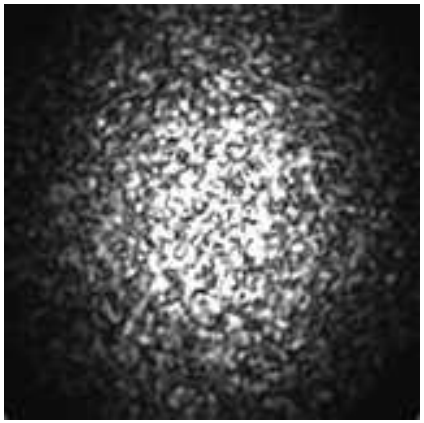
Fence Sensors - Types

- **Fiber Optic Cables - sensing method**
  - **Laser light is directed down the core; when the light hits the cladding,**
    - **Most of the light reflects (bounces) back into the core**
    - **Some of the light escapes the core**
  - **When a cable gets bent, more of the light escapes and the light is reflected differently.**
  - **Fence movement is detected when the fiber bends. Bends can be measured in several ways.**



Fence Sensors - Types

- **Fiber Optic Sensors**
  - **Microbend detection – detects change in amplitude of the light**
  - **Speckle Pattern Detection – detects "twinkling" when the speckle pattern changes**
  - **Interferometer Detection – detects change in phase between two light paths.**



Fence Sensor - Strengths/Weaknesses

- **Strengths**
  - **Low cost**
  - **Easy installation**
- **Weaknesses**
  - **Relatively high nuisance alarm rate (NAR) for some types (though this is usually a function of the fence and environment)**
  - **Requires a robust, well-installed fence where fabric moves very little**
  - **Vulnerable to a slow attack because of the counter and time window algorithm (logic)**
  - **Can not detect bridging**

Fence Sensor – Fence Installation

- Fence fabric, where used, should have proper tension
  - Use a “fish scale” and a ruler to test
  - Fabric should deflect no more than 2.5” (64mm) for a 30 pound (13.6 kg) pull centered between posts
- Fence Posts, and where applicable fence, need to be rigid
  - Use a “fish scale” and a ruler to test
  - Post should move no more than 1/2” (13mm) for a 50 pound (22.7 kg) pull applied 5’ (1.5 m) above the ground
- Avoid rattles
  - Ensure fence fabric ties or fence sections are installed securely
  - Do not mount signs on fence
  - Remove vegetation in contact with the fence

Fence Sensors - Tests

- Fence performance tests – two modes
  - Penetration through fence – Cut Test
  - Climbing over fence – Climb Test

- Other types of vulnerabilities to defeat need to be considered during design
- Each fence installation is unique. Tests should be run in-situ, for specific defeat criteria and specific scenario (to a specific DBT).

Climb test

- Define pass/fail criteria such as -

  A detection has occurred if the system alarms before the climber gets to the top of the fence

- Methods to test sensor's ability to detect a climb
  - Actual climbs best for performance testing
  - Some sensors – "signature" simulation may be appropriate for basic functional or operational testing
- Sensitivity varies across fence installation
  - Braced posts
  - Corner posts
  - Middle of fence fabric
- Slow, careful climbing is of most concern

Cut Test

- 10 to 12 cuts for man-sized opening, test to alarm
- Methods to sensor's ability to detect a series of cuts
  - Actual cut on sacrificial fence fabric
  - Cut on fabric ties (ties may be added for testing)
  - Simulated cuts – tapping
    - Spring-loaded cut simulator
    - Drop-hammer cut simulator
- Sensitivity varies across fence installation

Vulnerability to Defeat

- Damping of shock caused by cutting fence fabric
- Knowledge of event counter and time window logic
- Careful removal of sensor cable from fence
- Weather conditions
- Stealthy climbing
- Digging under fence
- Bridging over fence

Summary

- There are 4 general types of fence sensors. All require sturdy – rigid – fence construction for proper sensing and low nuisance alarm rate.
- There are two types of performance tests to run on fence sensors – Climb and Cut tests
- Actual climbing and cuts provide the best performance test data
- Vulnerability to Defeat mechanisms should be considered when designing a Physical Protection system using fence sensors

Questions?