Detection of Electronically Initiated Explosive Devices

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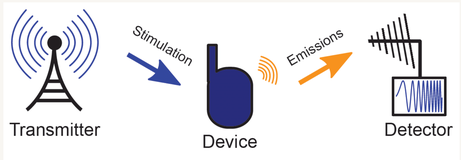
Abstract

Explosive devices are often triggered using electronics that emit electromagnetic energy when they are active, waiting for a trigger signal, and that are sensitive to strong electromagnetic fields. We are developing methods to detect, locate, and neutralize electronic triggers of explosive devices. The current ALERT effort is focused on detection and location of regenerative and superheterodyne receivers, the most common devices used to remotely initiate IEDs. Detection and location methods have been developed and are transitioning to commercial application.

Relevance

Detection of electronic triggers is challenging because unintended emissions are weak. Typical approaches passively detect the trigger by looking for emissions over a very narrow frequency range and comparing the result to a simple threshold or by actively using a very strong electromagnetic stimulation that is coupled to the device and then reradiated at a harmonic of the stimulation. Both approaches suffer from limited range and a high false alarm rate. Our unique approach uses a weak stimulation to modify the unintended emissions from the electronics in a predictable way. The advantage is that signals may be detected when they are far below the noise floor and false alarms are minimized, even when encountering a device for the first time.

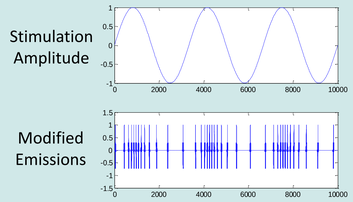
Technical Approach



- Radio receivers emit unintended RF signals that can be used to detect/identify electronic initiators
- A weak stimulation can improve detection:
  - Device reacts to transmitted stimulation signal
  - Stimulation changes the unintended emissions
  - Known emissions are easier to detect
  - Unique reaction of radio receivers reduce false alarms and allow detection at first encounter
- Missouri S&T patented technique

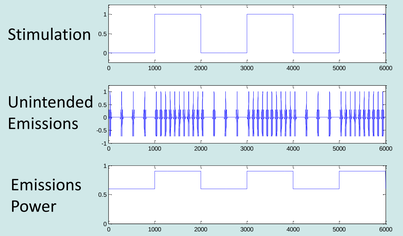
Regenerative receiver

Modified Emissions



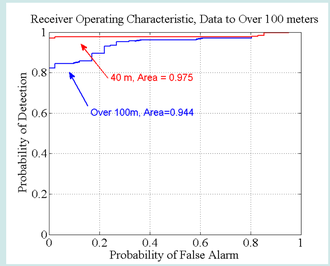
An amplitude modulated stimulation creates a frequency modulated response

Detection Approach



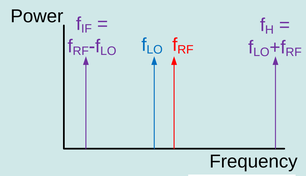
Modulating stimulation changes emissions power, which can be correlated with stimulation

Results

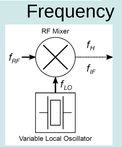


Superheterodyne receiver

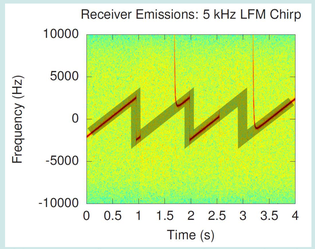
Modified Emissions



Stimulation signal is mixed up and down in frequency, but not at a harmonic

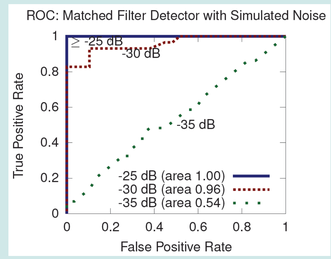


Detection Approach



A chirp at one frequency can be correlated to a response at another frequency.

Results



Accomplishments Through Current Year

- Experimentally determined how emissions from receivers can be modified with a weak stimulation
- Developed improved methods to detect regenerative and superheterodyne receivers
- Preliminary characterization of location techniques
- Developed relationship with small company looking to commercialize the technology

Future Work

Current work is focused on developing improved methods of locating the explosive by exploiting the change in unintended emissions with stimulation. Next year will focus on developing algorithms to detect/identify/locate digital devices like timers, passive IR detectors and (if time) on methods of determining device state.

Opportunities for Transition to Customer

Preparations are underway to commercialize algorithms in a hand-held device. Commercialization also planned for similar technology for detecting vehicles at remote border crossings .

Patent Submissions

- D. Beetner, A. Conrad, C. Stagner, et al, "Detecting Superheterodyne and Homodyne Receivers by Manipulating their Incidental RF Emissions with an External Stimulation," Oct. 27, 2009, U.S. Prov. Pat.No. 61/279,854.
- S. A. Seguin, D. G. Beetner, T. H. Hubing, "Electromagnetic Emissions Stimulation and Detection System," US. Patent no. 7,853,437, Dec. 14, 2010.

Publications Acknowledging DHS Support

- C. Stagner, A. Conrad, C. Osterwise, D. Beetner, S. Grant, "A practical superheterodyne receiver detector using stimulated emissions," IEEE Transactions on Instrumentation and Measurement, vol. 60(4), pp. 1461-8, 2011.
- S. Seguin, D. Beetner, T. Hubing, "Detection and Identification of Low-Cost RF Receivers Based on their Unintended Electromagnetic Emissions," IEEE Transactions on Electromagnetic Compatibility, submitted.
- S. Seguin, D. Beetner, T. Hubing, "Controlling Unintended Emissions from Regenerative Receivers to Improve Detection and Identification," IEEE Transaction on Electromagnetic Compatibility, submitted.
- S. Seguin, D. G. Beetner, T. Hubing, "Detection of Regenerative Receivers Based on the Modulation of their Unintended Electromagnetic Emissions," IEEE Transactions on Electromagnetic Compatibility, submitted.

Other References

- C. Osterwise, S. Grant, D. Beetner, "Reduction of Noise in Near-field Measurements," proc. of the 2010 IEEE Interntnl Symp. on Electromagnetic Compatibility, July 2010.
- D. Beetner, D. Carhoun, A. Conrad, S. Grant, C. Osterwise, J. Tichenor, "Verifying Neutralization of Electronically-Initiated Explosive Devices," 2009 MSS Battlefield Survivability and Discrimination conference, Feb., 2009.
- X. Dong, H. Weng, D. Beetner, T. Hubing, D. Wunsch, M. Noll, H. Goksu, and B. Moss, "Detection and Identification of Vehicles Based on Their Unintended Electromagnetic Emissions," IEEE Transactions on Electromagnetic Compatibility, 48(4), pp. 752-759, Nov. 2006.
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