Computer Science

LOCATION ESTIMATION OF AN RF SOURCE

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Improvised Explosive Devices (IEDs) also known as roadside bombs, are explosives constructed from destructive, lethal, noxious, pyrotechnic, or incendiary chemicals that are used unconventionally as well as in military warfare. IEDs are 'home-made' devices built with the purposes of causing destruction to property and vehicles, killing, immobilization, or creating diversions. Typically, IEDs are constructed using household chemicals and/or military components, to form various combustible combinations. IEDs may be triggered remotely by radio signals sent from cell phones or other devices. An IED generally includes three major components. Of. The first component is an explosive charge that in some cases is boosted to improve the efficiency of the device. The remaining components include a detonator (usually an electrical device which emits a power signal) and an initiation system, which is a mechanism that initiates the electrical charge that sets off the device. Currently, IEDs are widely in use by guerrilla and other terrorist factions and account for a majority number of combat-related casualties worldwide particularly in Iraq and Afghanistan.

Our work focuses on IEDs activated using electronic devices. These devices emit a small power signal, which is often difficult to detect. As a radio signal travels through space, its power degrades naturally and also variably due to environmental factors. Given two receiver antennas at a fixed distance apart, the ratio of the power received for each antenna as defined: (Pr2 – Pr1)/Pr2 approaches zero as the radio source moves farther away. This is because the path-loss of a signal between the two antennas becomes less significant as the distance of the source increases. As an IED source becomes proximally farther the ratio will approach zero.

In this work, the experimental set up was done as part of a government BAA. The main purpose of our research was to determine a relationship between the ratio of the power received by the antennas and the distance to the IED. After analyzing our data, we found that the power received was significantly affected by the humidity in the air. Since signals do not degrade as much through very dry air than through humid air, data gathered on days with a high humidity resulted in lower power signals received at the same distances than on days with a lower humidity. By charting these differences we discovered that the relationship between humidity and signal power, with distance remaining constant, is non-linear. The further the signal source is from the receiver antenna, the more humidity degrades the signal.

Using a statistical data analyzer program, we were able to generate a surface that represents the relationship between the distance of the source of a transmitted signal as a function of humidity and the ratio of the power received by the two antennas. Using the difference in received signals of the two antennas from our setup eliminates the interference caused by environmental factors, producing more reliable data.

Future additions to this research could enable us to pinpoint the direction of the transmitting source. In addition, research into the environmental effects of patchy fog, rain, sunlight, or overall climate forecast/transmission media may serve as extremely valuable additions to our existing research.

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