Cooperative Discrimination Sensor: Detecting and Tracking Human Activity

Current low-power intrusion-mitigation networks suffer from a variety of problems including short lifetimes, inadequate communication channel capacity, and weak on-board sensor processing. These networks have the ability to detect activity at each sensor, but often lack the ability to discriminate, due to complexities and inconsistencies in the sensors, environment, and potential targets. This can result in costly nuisance alarms and poor system reliability.

Our solution at LLNL is the reduction to practice of several existing micropower impulse radar technologies into a single cooperative discrimination sensor (CDS) system that can be networked to provide detection, tracking, and discrimination of human activity. A low-power network of these sensors is able to detect motion, track that motion through the monitoring region, and reliably determine if the dominant moving object was a human.

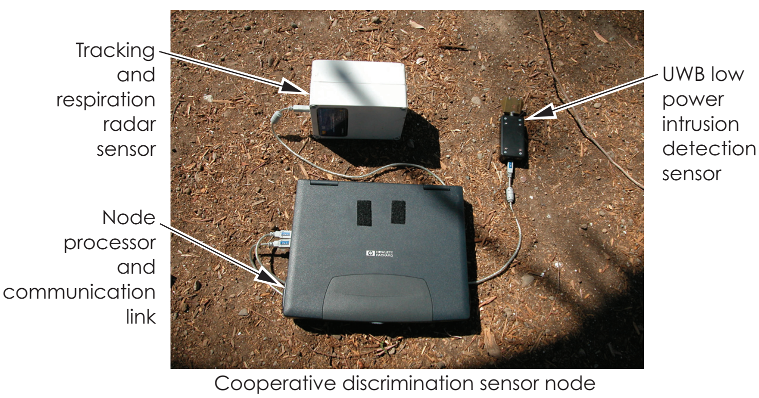

Figure 1. Basic CDS network node components.

Project Goals

We leveraged results from current radar projects to identify possible sensors for a detection, tracking, and discrimination platform. After extensive evaluation of current technologies and the specification of data-processing algorithms, we selected the sensor combination best suited to perform the required tasks.

We combined the sensors profiled in our first year to build multiple CDS nodes and integrate them into a three-node network. Once constructed, we implemented the previously identified algorithms in the specified network to

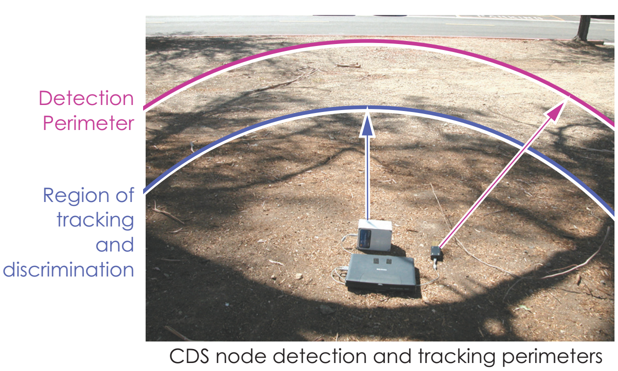

Figure 2. Deployed CDS node in operation.

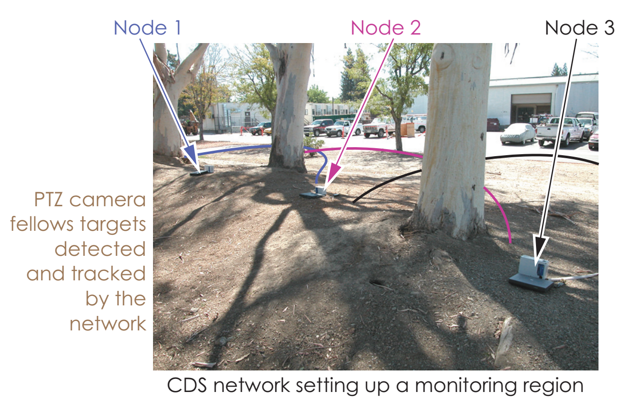

Figure 3. Multiple CDS nodes forming a network.

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produce a low-power intrusion-detection, tracking, and discrimination network. The network was then deployed in multiple scenarios for performance and capabilities evaluation.

Relevance to LLNL Mission

LLNL is gaining a multifunction, integrated radar sensor system that is capable of not only detection but also tracking and discrimination in a single package. This package can be used in a deployable perimeter security network, operating at power levels previously unattainable by conventional methods, thus opening up opportunities for large-sensor security networks for applications such as antiterrorism, border and battlefield monitoring, and facility monitoring.

FY2005 Accomplishments and Results

This year we combined the radars selected and evaluated in the earlier phase of the project into complete network nodes, as shown in Fig. 1. Each node consists of two ultra-wideband (UWB) radar units and a data processor/communications link. The first UWB radar is a low-power intrusion detection radar. It has a long sensing distance and operates with a very low power draw. This radar can monitor a bubble-shaped region around the CDS node and is used to sense when a potential target enters the area. It then turns on the other, more power-hungry radar and electronics as needed. The second radar is an UWB tracking radar capable of measuring the distance to potential targets within the detection region. When active, it constantly measures the distance from the node to the potential target as it moves through the detection region, in addition to monitoring the target's radar cross-section for discrimination information.

In a typical setup (Figs. 2 and 3), several nodes are deployed to monitor a large area or corridor. Once deployed, each node sets up and monitors its own detection and tracking perimeters. When a target is detected, each node sends its detection, tracking, and discrimination information to a central monitoring station. Then, that monitoring station intelligently combines the information from each node to perform discrimination and 2-D position mapping of the potential intruder.

The intruders are monitored as they pass through the detection region and, in the testbed system, a Pan, Tilt, Zoom (PTZ) camera was steered by the network's position estimates to follow the intruders for ground truth information.

The central monitoring station combines and displays all this information as shown in Fig. 4. A 2-D position plot shows the current location of the tracked intruder relative to the CDS nodes, and the PTZ camera video of the intruder is displayed next to the plot as they are tracked while moving through the network's coverage area. Testing and preliminary data analysis has shown this hardware/software system to be a robust intrusion-monitoring system that shows strong potential for numerous security applications.

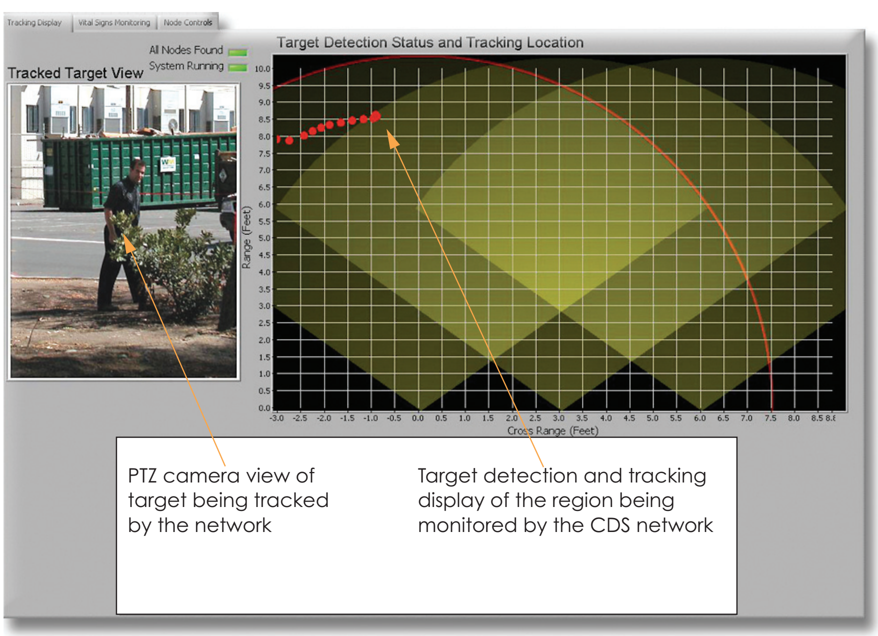

Figure 4. CDS monitoring station showing the tracking of a target.