FORESIGHT

Landmine Detection Systems

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GENERAL DYNAMICS
Canada

Figure 1. Remote Detection Vehicle (RDV)

Effective detection of anti-tank landmines is a problem for land forces worldwide, especially in areas where a clear route is needed for the safe passage of convoys and reinforcement of peacekeeping forces. General Dynamics Canada Ltd.'s integrated landmine detection system, FORESIGHT, provides an innovative and successful solution to these problems.

The FORESIGHT System is designed around a Remote Detection Vehicle (RDV) that has the ability to pass over pressure-activated mines and mark them for disposal. The system uses multiple sensors and data fuses the results to optimize the detection while minimizing the rate of false alarms. Using the RDV as a base (see Figure 1), the specific combination of vehicles and concept of operations can be tailored to the requirements of the user's specific objectives and environment. One configuration is to employ a three-vehicle system as shown in Figure 2. This configuration employs a lead Protection Vehicle that prepares the route and safe guards the system's detection components. Further protection is achieved through the low ground pressure of the detection vehicle so as to not initiate mines as it passes over and marks them. The two lead vehicles can be remote controlled from a command vehicle operating at a safe distance. Alternatively, depending on the customer's concept of operations, a manned, blast proof vehicle can be used. In some environments, such as route proving or peacekeeping operations, the protection vehicle might be eliminated.

Figure 2. System Configuration

Experience

FORESIGHT technology is based on the Improved Landmine Detection Program (ILDP), an Advanced Development Model conducted by Defence Research Development Canada (DRDC) Suffield and GD Canada to meet Canadian Forces' specifications and continued on the Improved Landmine Detection System (ILDS), a development and production program led by GD Canada. The project began in 1995 when DRDC Suffield contracted with GD Canada to assist in development of the ILDP. GD Canada has since gained a wealth of experience in its past and current work with Canadian, US, and UK governments.

In 2002 GD Canada delivered the Improved Landmine Detection System (ILDS) program to the Department of National Defence. GD Canada has the capability and license to apply this knowledge to address the demining needs of other customers. ILDS has been operationally deployed with the Canadian Forces.

Product

FORESIGHT is composed of a series of detection sensors that can be mounted on a variety of platform vehicles. The system features GD Canada's data-fusion technology to provide maximum confirmation of detection, while significantly reducing the incidence of false alarms. FORESIGHT consists of a Ground-Penetrating Radar (GPR), a Minimum Metal Detector (MMD), and Forward-Looking Infra-Red (FLIR) imager mounted on a tele-operated Remote Detection Vehicle (RDV). The Canadian forces version also utilizes a Thermal Neutron Activation (TNA) detector for target mine confirmation.

Ground-Penetrating Radar (GPR)

Buried mines are constructed from man made materials and these materials have a radar signature different from the signature of the surrounding soil. Because radar signals are reflected from buried objects, radar can be used in the detection of buried mines. FORESIGHT includes a ground-penetrating radar.

Minimum Metal Detector (MMD)

The MMD uses electromagnetic induction techniques to detect very small amounts of metal on or beneath the ground. FORESIGHT includes a vehicle-mounting arrangement that maintains a minimum separation distance between the MMD and metal objects, thereby maximizing the systems capability to find low metal content mines.

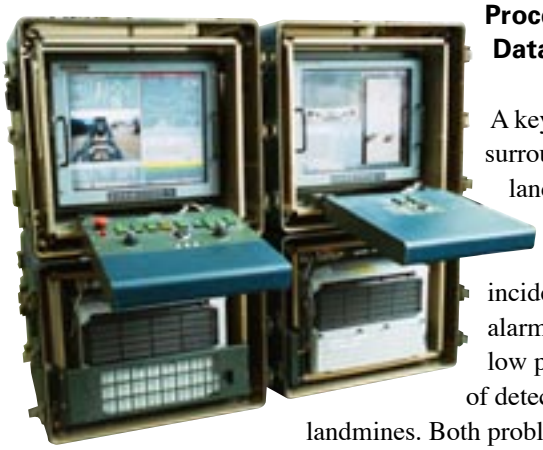
Forward-Looking Infra-Red (FLIR) Imager

The infra-red imager identifies potential mines due to the variations in ground thermal conductivity caused by the presence of a landmine. This can come from the mine itself or the act of burying the mine. A buried mine or disturbed soil has thermal properties that are different from those of the surrounding undisturbed soil. This difference in thermal properties presents itself as a small temperature variation that can be detected by an infra-red camera.

Thermal Neutron Activation (TNA) Detector

Once the other sensors on the FORESIGHT vehicle indicate the probable presence of a landmine, the role of the TNA sensor is to confirm its existence. FORESIGHT does this by measuring high-density emissions of nitrogen, which are unique to modern, high explosives.

Thermal Neutron Activation (TNA) Detector



Remote Control Consoles

Processing and Data Fusion

A key problem surrounding landmine detection technology is the high incidence of false alarms and the low probability of detecting actual landmines. Both problems result in costly and time-consuming efforts to unearth and positively identify suspected landmines. Data fusion is a key capability in accurately detecting mines and reducing the false alarm rate.

Each of the scanning sensors (GPR, MMD and IR) provides information relating to the presence (or absence) of physical properties that accompany the presence of landmines. As the system operates, each scanning sensor scans a different area of the path according to that sensor's position on the FORESIGHT vehicle. A detection in any sensor consists of positional information and a measure of the confidence that there is a mine-like object.

Before detection-level data fusion can be applied, all detections from the scanning system must be registered spatially in the same frame of reference. This means that highly accurate geometrical parameters and estimates of vehicle motion need to be provided by a navigation subsystem.

Once all detections are spatially registered in a common frame of reference, spatial correspondence algorithms are applied. Spatial correspondences are decisions derived by the system that relate individual detection events according to whether these events originated within the same local patch of ground, and hence, could have originated from a single landmine. If the overall confidence level for detection is significant, a position for placement of the confirmatory sensor is computed, and the system stops to use the confirmatory sensor.

Information provided by the confirmatory sensor is used in combination with scanning sensor information as a final fusion stage. This process results in an overall confidence level concerning the presence (or absence) of a landmine at that location. A significant confidence level results in the system declaring a detection, firing the marking system, and recording all relevant information concerning that detection.

Marking and positioning system integration

FORESIGHT's physical landmine-marking subsystem includes equipment used to mark mine locations and cleared lanes. The landmine-marking subsystem places a fixed volume of paint at confirmed mine locations.

Cost Effective Solution

The FORESIGHT System combines modern capabilities of multiple sensors, navigation systems, data fusion, and a purpose-built low ground pressure vehicle to maximize detection while minimizing the false alarm rate. The result is a safe, effective approach to route clearing.

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