SMART MARKERS FOR IN-DEPTH BATTLEFIELD INFORMATION: OPTICAL AND HYBRID COMMUNICATION

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ABSTRACT

Smart Markers create a battlefield communication network and collect and provide information needed for combat and other operations.

1. INTRODUCTION

The Assured Mobility objective of the Future Combat System requires that vehicles and personnel receive accurate, timely and detailed information. on position, battlefield hazards, friendly and hostile forces, mission and tactical requirements, and orders.

So that forces can be responsive, agile, and deployable in a wide variety of potentially hostile areas, while increasing survivability and reducing the vulnerability of individual soldiers, devices must be developed to carry out many mission functions. These devices should be capable of networking with each other as well as with other levels of communication: obtaining, storing and disseminating information in a secure, difficult-to-jam manner. The devices should be capable of housing a variety of sensors, which can obtain and quantify battlefield hazards. They should be light, inexpensive, low power consuming and able to be widely disseminated. Ideally, these devices can carry out many of the functions now performed by individual soldiers.

On a Phase II Plus Fast Track SBIR program managed by TACOM/TARDEC and supported by TACOM/ARDEC, Talking Lights LLC has developed prototype Smart Markers that address these needs.

2. MULTI-MISSION INFORMATION PLATFORM

The Smart Marker system has been developed within the framework of a highly extensible architecture that integrates a distributed information system with sensors, providing both real-time and historical battlefield information.

Each Smart Marker is a platform for sensors and provides a distributed interface for communication. Functions demonstrated for the Smart Marker Network include:

- Identifying members of the marker network which have become disabled or missing, thereby communicating battle damage, sabotage or infiltration.
- Having the network "heal" and resume function when a member is disabled or missing
- Sharing information among all members of the Smart Marker Network
- Collecting and continuously refining exact location through on-board GPS capability and providing location to users even if satellite signals are not available
- Accepting, storing and relaying messages from the command structure

Additional capabilities envisioned include:

- Seismic or other sensors to identify battle damage to structures like bridges and communicate this damage to users
- Seismic, acoustic and magnetic sensors for tracking and standoff detection.
- Chemical sensors to measure, quantify and track NBC hazards

3. SMART MARKERS

The markers are emplaced in the field and use optical infrared communication to establish a network that, for example, could be used to mark a cleared lane in a minefield. The markers remain dormant while collecting data until activated by friendly forces like a vehicle, or an individual soldier with a handheld computer. Information is then transmitted in a secure fashion.

These can be deployed in two form factors: implanted and ground level.

Figure 1 Implanted Marker

Figure 2 Ground-Level Marker

These markers can be deployed by a variety of methods including scattering by fixed-wing and rotary-wing aircraft, Volcano system, and artillery; emplacement by hand and by vehicle-mounted automated equipment; among others.

4. MARKER OPTICAL COMMUNICATIONS

The tactical advantages of optical communications include directed and controlled signal radiation, precise location of signal source, jam-proof, spoof resistance and covert capability. Our advances in receiver technology have enabled us to receive signals of order 1 part per million over the background and extract signals from a headlight with only 0.1% modulation depth.

We have developed two link-layer protocols: a CDMA (Carrier Detect Multiple Access) protocol that is an efficient derivative of 802.11, which is used for self-discovery and neighborhood registration. A real-time Tokened-Packet Datagram, which is self-routing and collisionless, is used to pass critical network and user information such as status—power, damage, security and tamper; marker position—GPS and relative topological quadrants; user—records, warnings, mailbox, and sensor information.

Limitations of optical communication include only line of sight capability and shot noise from ambient light. Ultimately the tradeoff is a fixed relation between range, power, data rate, and bit-error rate.

5. COMMUNICATING VEHICLE LIGHTS

The technology has also led to the development of a dual use capability for headlights and blackout lights on vehicles. These lights carry out their illumination function with no visible flicker but are also modulated to transmit secure information. The lights can communicate with Smart Markers and Smart Munitions like landmines and can, for example, provide a secure IFF (Identify Friend or Foe) signal. In this way, a minefield can be turned OFF for the safe passage of friendly vehicles and when all the vehicles have passed, turn the minefield back ON for the enemy using vehicle headlights or blackout lights as the communication medium.

6. CONTINUING WORK

Capabilities to be enhanced in continuing development will include increased range, increased bandwidth and data rate, increased data storage and networking capability, and hybrid networks with both optical and RF capability. Network and transport protocols need to be developed and integrated to allow wider area capability.

Miniature and ultra-low power designs are also under development.

Certain deployment methods such as aircraft and artillery require rigorous shock hardening.