

LDART: A Large Scale Network of Embedded Systems for Laser Detection and Reciprocal Targeting

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I. LDART Application and Concept of Operations

LDART (Laser Detection And Reciprocal Targeting) is a novel military application developed by Honeywell under the DARPA NEST program¹. LDART provides battlefield situational awareness by detecting if a soldier or vehicle has been painted by a battlefield laser (target designator, range finder, etc.) and determines a precise position of the source (within $\pm 0.06^\circ$). It can also be configured to reciprocally designate an enemy laser source or communicate a combat ID to a friendly laser system. LDART, in addition to providing situational aware capabilities, allows the asset to take evasive action and possibly take offensive action against the enemy.

LDART can be used in three configurations. 1. LDART interfaced with a situation awareness system such as an Objective Force Warrior helmet mounted display or a vehicle cockpit display—the warrior would be warned almost instantly that he has been targeted and, shortly thereafter, be informed of the direction of the laser source. 2. LDART with a slave computer controlled designator to reciprocally target an OPFOR laser source. 3. LDART with embedded VCSEL (Vertical Cavity Surface Emitting Laser) elements to reciprocally target an OPFOR laser or send a coded friend-or-foe signal.

II. LDART Technology

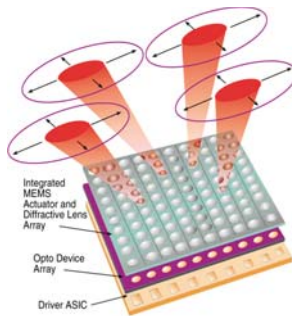


Figure 1: Micro Lens Array

It is envisioned that LDART will be deployed as a “patch” that can be placed on military assets. The LDART “patch” consists of a network of embedded systems that co-operatively recognize, locate, and respond to hostile or friendly lasers in the battlefield. LDART is based on a network of steer-able MEMS micro lenses, currently being developed by Honeywell under the DARPA STAB program, and is controlled by a computational and communications fabric.

An LDART “patch” consists of tens of thousands 1 mm^2 “cells” (See Figure 1). Each cell contains a single micro lens ($0.1\text{ mm}\varnothing$) that can be independently steered in 2-axes. Beneath each lens is a detector or emitter. Each cell also contains a small computational element that controls the lens, reads the detector or controls the emitter (See Figure 2). Each computational element is networked to its four nearest neighbors.

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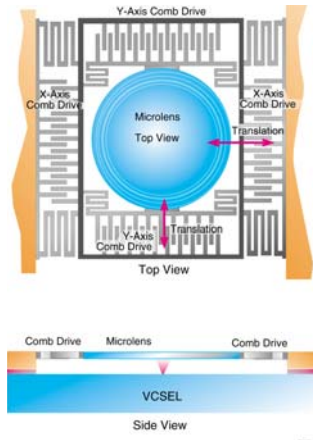


Figure 2: Micro Lens Details

Control of LDART is distributed among the computational elements. Each cell controls its own sensors and actuators, but many cells must cooperate to accurately locate incoming laser sources. During operation, nodes form dynamic groups that solve subtasks in the application: what nodes will track a target, what nodes should paint back and the handling of communications off “patch”. Control must also tolerate faults in individual nodes should the “patch” become partially damaged.

Advantages of the LDART design include (1) The large numbers of MEMS sensors (10^5) allows a single patch to cover a wide total field of view, (2) The simultaneous use of a large number of sensors mitigates error in position measurements, and (3) The tight coupling of sensor and data processing and the ability to communicate with other sensor/processor pairs enables these sensors to cooperatively identify, locate and respond to hostile or friendly battlefield lasers quickly in a changing battlefield.

III. LDART Development

The LDART MEMS hardware is currently under development. In the meanwhile, development of the distributed control for LDART is taking place on a macro platform that is, whenever possible, a faithful representation of the future MEMS system. The macro system has many advantages ranging from cost (ability to use many COTS parts) to easing experimental complexity (viewing platform at work with the naked eye).

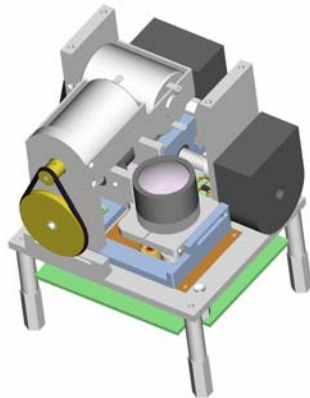


Figure 3: Macro Lens Assembly

The macro platform consists of a collection of 2-axis, lens translating stages, and an FPGA-based compute element. Each optical stage contains both a detector and an emitter so each stage can be used for either role in the macro system (See Figure 3). Despite the platforms larger size, there are still stringent mechanical requirements. In order to accurately find targets the lens positioning accuracy must be within $3\mu\text{m}$; however, it is important to maintain high speed movement to enable target tracking.

The compute element consists of a single FPGA (Altera APEX 20KE) that hosts a small 32-bit microprocessor and additional custom logic for low-level controls and remote circuit interfaces. This platform has two major advantages. (1) A port of μClinux from Microtronix allowed the use of a standard Linux development environment. (2) The FPGA made implementing hardware and software extremely fast and flexible by allowing easy trade-offs between hardware and software implementations of low-level controls. For example, low-level stage positioning controls are implemented in hardware on the FPGA while the distributed control algorithms are implemented in software.

IV. Status

Currently, the macro platform is a 3×3 array of optical stages able to detect a simulated battlefield laser and target it back. As the experimental platform continues to grow it is expected that a target will be accurately tracked, simulating the designation of a moving asset. Transition to the MEMS-based platform should begin the fourth quarter of this year.

Overall, the prolific use of battlefield laser systems necessitates a system that can quickly sense and react to these threats. The LDART system provides this unique and needed capability in a small form factor that can protect both soldier and vehicle on the new battlefield.