Fast Image Reconstruction

Over the last decade, LLNL has become a world leader in the application of microwave radar imaging techniques to NDE problems.

The challenge lies in the real-time processing of the raw data. Past systems have relied on collecting the data and conducting off-line postprocessing to achieve the desired effect. There is a need to be able to perform these evaluations at a faster, closer-to-real-time rate. The small form factor of the micropower-impulse radar (MIR) sensors, coupled with fast imaging techniques would provide a valuable tool in the nondestructive characterization of structures, materials, and personnel. The advent of FPGAs, CPLDs, fast programmable microcontrollers, DSP cores, and current innovations in parallel programming afford us the opportunity to work with a small platform capable of conducting image-reconstruction techniques at the rate of 4 fps.

Project Goals

This project will reduce to practice a small, flexible, computationally efficient platform to carry out image reconstruction of a radar-analyzed scene at the rate of 4 fps, based on real-time raw microwave radar input.

Relevance to LLNL Mission

This problem is of interest to LLNL because it affords a new modality with which to inspect and characterize structures, materials, and personnel. Additionally, such a platform could be used for image reconstruction of other modalities, such as ultrasound.

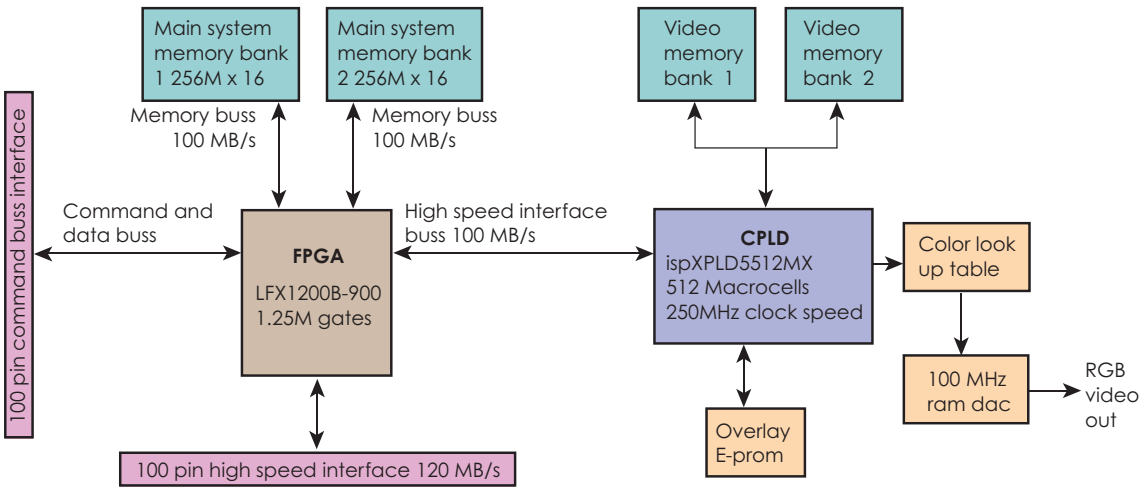

Figure 1. Block diagram of the imaging board. The system contains dual gate arrays: a 1.1-million gate FPGA capable of processing the 48-bit image channel, running at 80 MB/s, and a 512-macrocell CPLD used for image formatting and display. A proprietary video interface bus between the two gate arrays is capable of running at 100 MB/s. The system memory consists of 512 MB of main memory divided into two banks. For communication, there is a 100-pin high-speed video bus, a 100-pin general communication/control bus, a USB2 bus, a high-speed RS232 bus and a standard video display connector. Video imaging formats include 1024 x 768 at 70 fps and 640 x 480 at 60 fps, with 24-bit color.

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This effort will enhance the technology base of engineering at LLNL in the areas of computational systems, radar/ultrasound imaging, and NDE.

FY2005 Accomplishments and Results

For FY2005, deliverables included a prototype image reconstruction board and identification of an algorithm for image reconstruction of microwave radar scenes. Both these goals were achieved and exceeded. A finalized PC board was constructed and loaded with the necessary algorithms to perform 4-fps image reconstructions.

A block diagram (Fig.1) outlines the functionality of the imaging board and specifies the components. The hardware, in conjunction with the identified and implemented reconstruction algorithms, permits real-time visualization of radar data in a format that is intuitive to an untrained observer. As an example, Figs. 2 and 3 contrast four frames of real-time raw data with reconstructed data at a rate of 4 fps.

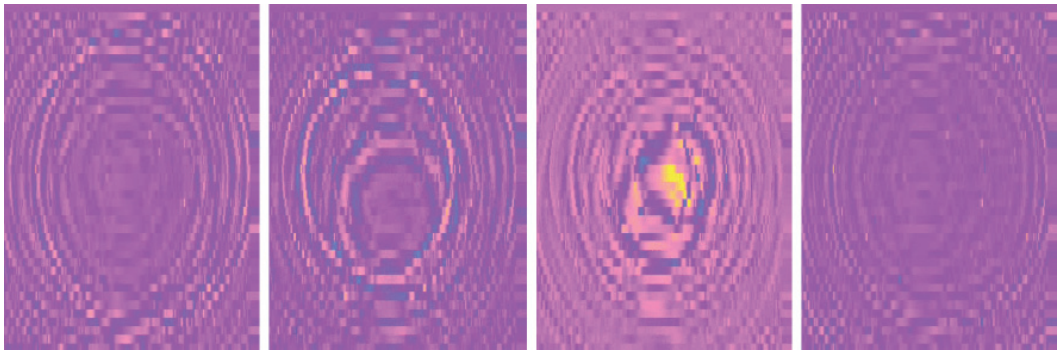

Figure 2. Raw radar data.

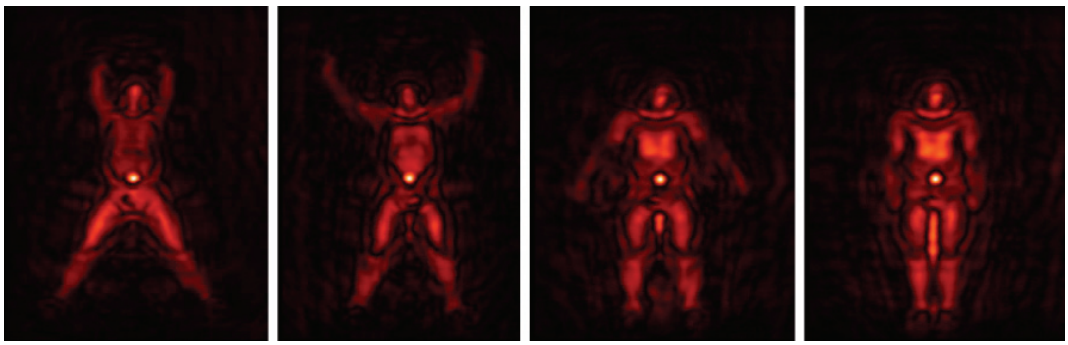

Figure 3. Reconstructed radar data.