APPLIED RESEARCH & PHOTONICS INC
http://arphotonics.net
Email: info@arphotonics.net

Applied Research & Photonics, Inc.
470 Friendship Road, Suite 10
Harrisburg, PA 17111, USA
Phone: +1-717-220-1003

Terahertz imaging system: TeraImager©

Introduction

The system is composed of three main components.

1. A terahertz (T-ray) source suitable for generating wide range terahertz radiation for illuminating the object interior
2. A camera system for capturing image on the surface and sub-surface
3. A computer with software for capturing and analyzing the images

Each of three components are described below.

1. Terahertz source

Applied Research & Photonics (ARP) uses its CW terahertz (T-ray) source for imaging applications. The source is a wide range broadband covering from ~0.1 THz to ~35 THz. Two T-ray sources were tested for both reflection and transmission imaging. A FLIR camera was used for testing of reflection imaging over a distance of ~10 ft. Example of imaging by this source with an in-house imaging demo is shown in Fig. 1–4. A metallic object hidden behind different fabric and cardboard was used for imaging demo. Normally, the object is not visible by the camera either in reflection or in transmission. But when the terahertz source is shined on it, the object becomes visible. This is because the T-rays penetrate the hiding layers, but are reflected back by the metallic object, allowing imaging in reflection. In transmission, the T-rays are stopped by the object but transmitted through the packaging materials, thus the image of its shape is formed.

As another example, a regular HB pencil line draw on an ordinary copy paper was imaged in transmission while covering the pencil line with layers of paper of the same type. Fig. 5 (a) shows the pencil line is not visible when covered by

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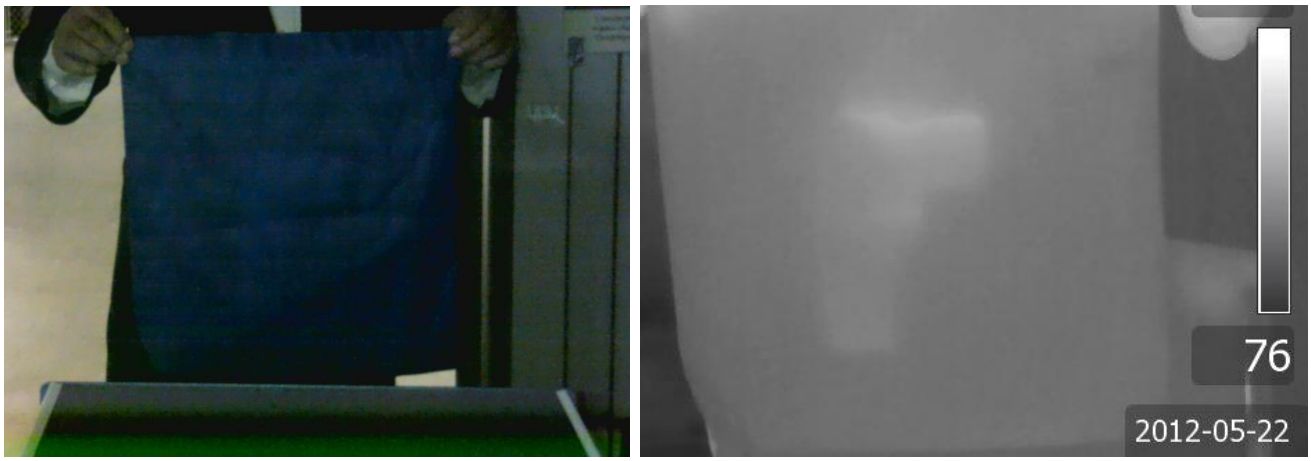

Fig. 1. A hidden metallic shape inside a bag (left) revealed with T-ray (right). Picture taken in reflection from ~10 feet away by FLIR camera. The T-ray source is a dendrimer based fixed power source ~10 mW, CW.

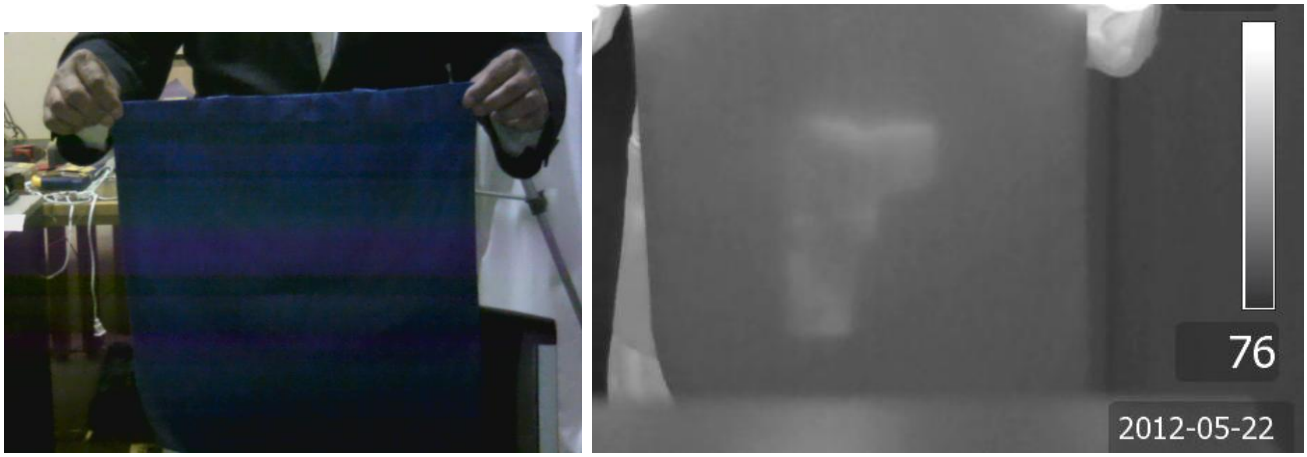

Fig. 2. The same hidden metallic shape as above inside a bag (left) revealed with T-ray (right). Picture taken in reflection from ~10 feet away by FLIR camera. The T-ray source is a dendrimer based tunable source pumped by fiber-coupled CW laser.

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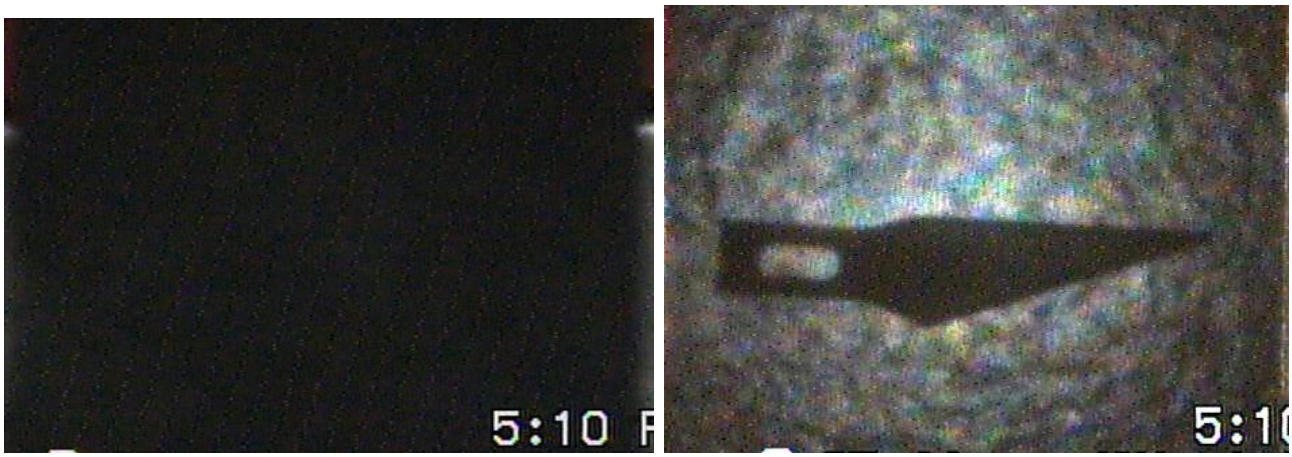

Fig. 3. A hidden blade behind a cardboard is revealed with the terahertz source. Picture was taken in transmission. Field of view is ~6" x 6" with distance between the camera and object ~1 ft.

Fig. 4. A metallic knife hidden behind a thick dark cloth is revealed by the terahertz beam. Picture was taken in transmission.

one layer of paper while the T-ray source is turned off. Fig. 5 (b) shows that the pencil line becomes visible through a layer of paper when the T-ray source is turned on. Fig 6 shows that the pencil line becomes visible by T-ray when it is covered by 3 layers of paper. This principle may be used to see the defects on a smaller scale object by focusing the imager on a tighter spot; the lower limit needs to be determined. While this is a rather crude demonstration, the

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imaging system may be optimized for the barrier layer defect or other kind of sub-surface defect detection.

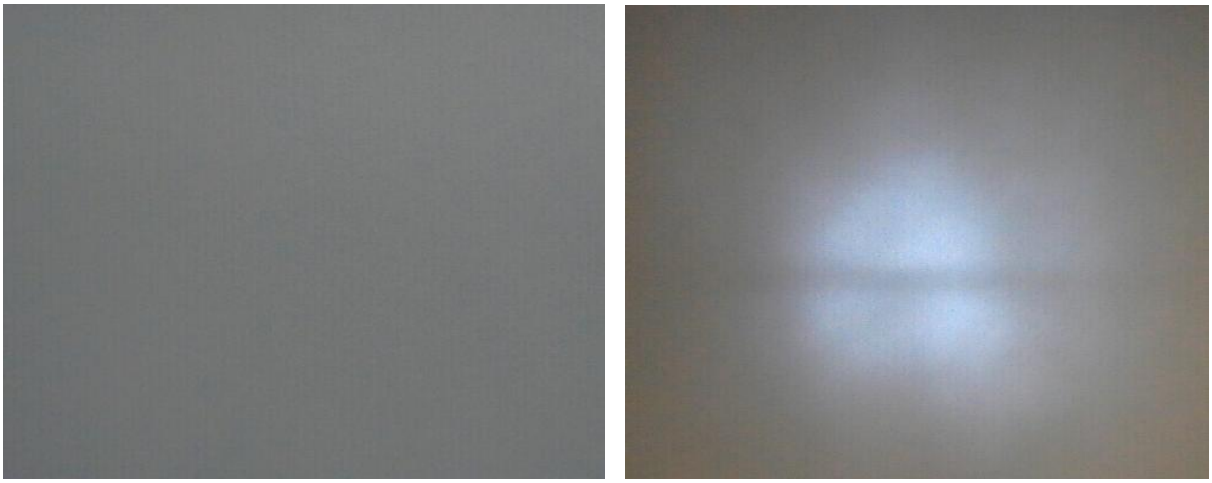

Fig. 5. Left: Camera looking at the paper layers, cannot see the pencil-line. Right: Pencil line seen through 1 layer paper with T-ray on.

Fig. 6. Pencil line seen through 3 layers paper with the help of T-ray source turned on.

2. Terahertz Camera System

The terahertz camera system has been developed by FLIR Systems (Nashua, NH 03063, USA) for surface imaging. The camera is being tested for detection

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of concealed weapons in conjunction with the T-ray source described above. This system will be mounted on a vehicle for remote monitoring and screening applications. Fig. 5 shows a concept picture of the camera. As shown on the right, the camera housing may accommodate two cameras; one terahertz camera for hidden gun detection and one regular camera for other objects. With ARP's terahertz source, it will be able to make terahertz imaging of concealed weapons, etc.

The field of view and the standoff distance may be adjusted by using a single or multiple sources. For a single source and for reflection imaging, the coverage area is ~ 1 sq. ft. at a distance ~10 ft. For transmission, the working distance is ~ 1 ft. with the field of view is ~ 6 sq. inch.

2.1. Special Features[1]

The terahertz camera has a number of useful features suitable for remote surveillance:

- 640 x 480 pixel IR resolution
- Fully programmable scan patterns, radar slew-to-cue, and slew-to-alarm functionality
- Built-in spot and area temperature measurement analysis functionality
- Extensive alarm functionality, controllable by the operator
- h.264, MPEG-4, and MJPEG streaming
- 100MB Ethernet supplies simultaneous analog and digital video at 30 Hz
- IP control: Integrate with any existing TCP/IP network and control over a PC.

[1] Specifications may change

- Multi-camera software: FLIR Sensors Manager allows users to manage and control a PT-Series camera in a TCP/IP network

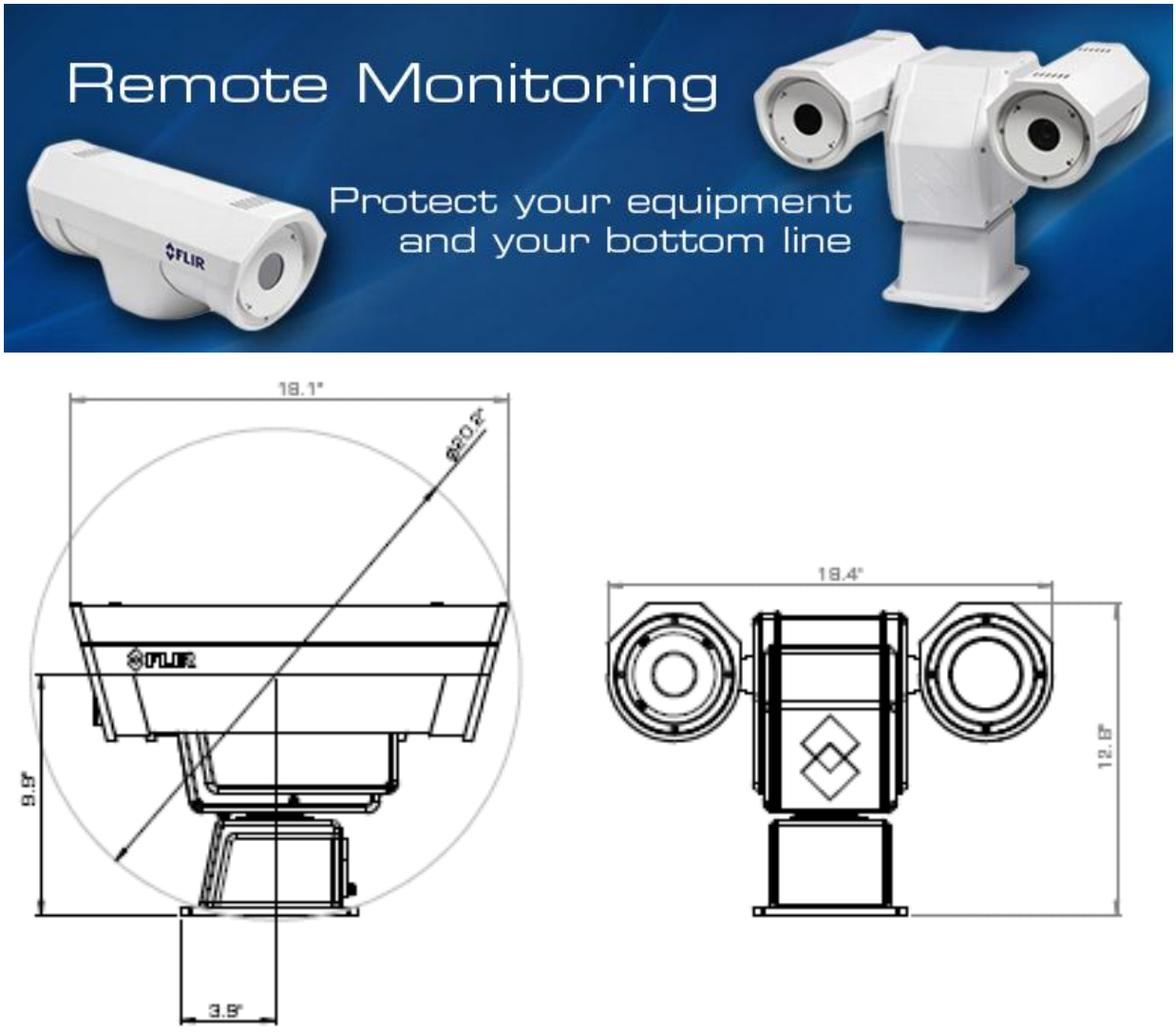

Fig. 5. Top: Camera housing for a single or double camera system. Bottom: Drawing of the camera housing for vehicle mounting.

3. Software

The software will be included as a utility CD or preinstalled on a computer.

Key Features of the software

- Setup of alarms and I/O configuration for digital out
- Setting of scheduled events and other e-mail options
- Setup and visualization of up to nine cameras for stand-alone applications, e.g., on-line monitoring and control
- Setup of synchronized signals for recording of image sequences in FLIR ResearchIR
- Draw a mask to cut out part of the image not to be analyzed
- Saving of images and image control

4. Pricing and delivery

ARP is inviting orders for this imaging system. For further information and placing order, please contact:

Anis Rahman, PhD
Chief Technology Officer
Applied Research & Photonics, Inc.
470 Friendship Road, Suite 10
Harrisburg, PA 17111
Phone: +1-717-623-8201 (Cell)
Fax: +1-717-566-1177
email: a.rahman@arphotonics.net
web: http://arphotonics.net