

PNWD-SA-9523

Millimeter-wave Advanced Imaging Technology

2011 Joint AAPM/COMP Meeting – Vancouver, Canada



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Outline


- Introduction
- Background on Millimeter-wave Imaging of Humans
- Millimeter-wave Security Scanner
- Millimeter-wave Safety Standards
- Future Checkpoint Improvements
- Standoff Detection
- Health Applications
- Conclusions

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Explosives Detection Applications



Security Checkpoints



Standoff detection of person-borne IEDs

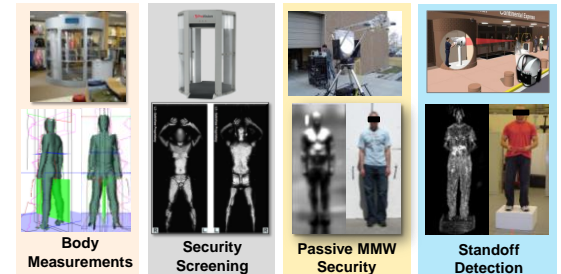


Integrated tri-portal concept

mmWave whole-body imager
Metal detector
Shoe scanner

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Millimeter-wave Imaging of Humans

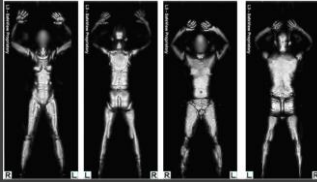


Body Measurements Security Screening Passive MMW Security Standoff Detection

RF	Microwave	Millimeter-Wave	Sub-mm / Terahertz
300 MHz	3 GHz	30 GHz	300 GHz
Frequency			

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Worldwide Deployment mmW AIT



http://www.tsa.gov/approach/tech/imaging_technology.shtm

Holographic Imaging

How It Works



Courtesy of L-3 Communications

L-3 ProVision®

Active Millimeter Wave Portal

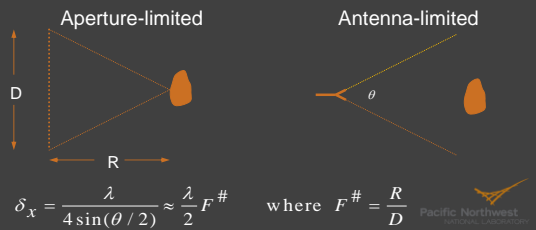
- Walk-through – stop 2 seconds
- Detects metals, and non-metals
 - Metals, ceramics, wood, plastic, etc.
 - Liquids and gels
 - Paper and coin currency
- Safe radio waves
 - Max. Peak EIRP: -11.6 dBm
 - 10,000 times lower power than a phone
- Fast: 200 – 400 people per hour
- Operational Frequency: 24.25 – 30 GHz
- Two Vertical Antenna Arrays
 - 384 elements per array (2 x 192)
 - One for front, one for back



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Image Resolution

- Image resolution is determined by the wavelength and the angular extent of the illumination
- The angular extent can be limited by the size of the aperture (aperture limited), or by the beamwidth of the antenna (antenna limited)



Range Resolution

- Range resolution is determined by the bandwidth of the system

$$\delta_r = \frac{c}{2B}$$

- For example, a bandwidth of 10 GHz (e.g. 90-100 GHz operation) results in a range resolution of 1.5 cm



Millimeter-wave Safety Standards

IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz, IEEE Std C95.1™-2005, Table 9.

Frequency Range (GHz)	RMS power density (S) (W/m ²)	Averaging time (min)
5 – 30	10	30 – 5
30 – 100	10	5 – 2.81
100 – 300	10 - 100	2.81 – 0.17

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Equivalent Isotropically Radiated Power

- EIRP is the amount of power that a theoretical isotropic antenna would emit to produce the peak power density observed in the direction of the maximum antenna gain*
- 11.6dBm[†] = ~0.00007 W emitted at the array output

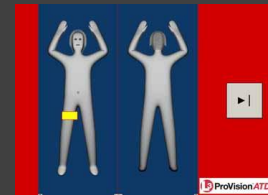
Distance	Power Density mmW AIT (W/m ²)	IEEE Standard (W/m ²)
0.25 m	0.000089	10
0.50 m	0.000025	10
0.75 m	0.000011	10

* http://en.wikipedia.org/wiki/Equivalent_isotropically_radiated_power

† Telephone discussion with L-3 engineer – Scott Trospen

Next-generation system

L-3 (TSA)



ProVision ATD (automatic target detection)

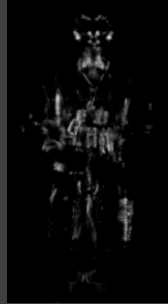
- Detects items on body
- Displays location on avatar

Addresses major TSA concern: *privacy issues!*

Future Checkpoint



40 – 60 GHz
V=Transmit
V=Receive

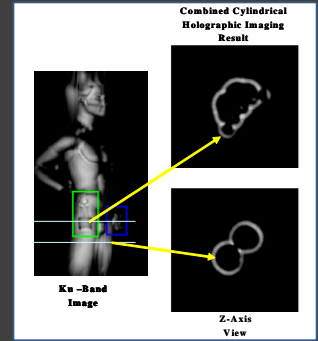


40 – 60 GHz
V=Transmit
H= Receive

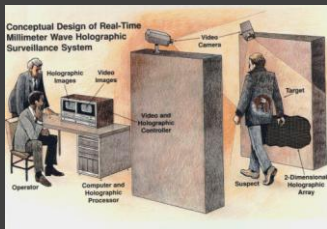
Combined Cylindrical Algorithm



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Future Walkthrough System



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Standoff Detection



340 – 360 GHz @ 5 m



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Licensed Application

Apparel, health & fitness markets

Unique People
People Magazine
Special Double Issue
June 27, 2011
Circulation: 3.75 million

my best fit
L-3 COMMUNICATIONS

SPECIAL AVIATION MEASUREMENTS

- Patented millimeter-wave imaging technology
- 100 degree wide-field view & full range of motion
- Measures 16 vital & 120 health & fitness metrics
- Designed for use by airport industry and airport
- 100 degree wide-field view & full range of motion
- Measures 16 vital & 120 health & fitness metrics

ADVANTAGES

- Speed
- Size
- High throughput
- Non-invasive
- Non-ionizing
- Non-contact
- Accommodates all body types
- Accommodates all ages
- Multiple platforms possible

OPERATIONAL BENEFITS

- High throughput
- Compact footprint for easy integration
- Customized for use in a variety of settings
- Non-invasive & non-contact
- Non-ionizing & non-contact

OPERATIONAL CONSIDERATIONS

- Compact footprint for easy integration
- Customized for use in a variety of settings
- Non-invasive & non-contact
- Non-ionizing & non-contact

F&D 100



Conclusions

- Millimeter-wave technology is suitable for detecting person-borne threats concealed in clothing
- Commercial available millimeter-wave imaging technology is well below recognized health safety standards
- Next generation mmW AIT will improve detection and privacy
- Submillimeter-wave technology ideal for standoff weapons detection
- Security body scanner technology adapted to apparel, health, and fitness markets

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Questions?



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