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PIERS 2018 in Toyama, Japan, 1-4 August, 2018

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- PIERS Guidelines
- Paper Submission
- Session Organization
- Registration
- Locale&Hotel
- PIERS Exhibition
- PIERS Shortcourse
- PIERS Gallery
- PIERS2018 Organization
- PIERS2018 Sponsors
- Author Login
- Reviewer Login

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- PIERS2018 in Toyama
- PIERS2017 in Singapore
- PIERS2017 in St. Petersburg
- PIERS2016 in Shanghai
- PIERS2015 in Prague
- PIERS2014 in Guangzhou
- PIERS2013 in Stockholm
- PIERS2013 in Taipei
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- PIERS2012 in Kuala Lumpur
- PIERS2011 in Suzhou
- PIERS2011 in Marrakesh
- PIERS2010 in Cambridge
- PIERS2010 in Xi'an
- PIERS2009 in Moscow
- PIERS2009 in Beijing
- PIERS2008 in Cambridge
- PIERS2008 in Hangzhou
- PIERS2007 in Prague
- PIERS2007 in Beijing
- PIERS2006 in Tokyo
- PIERS2006 in Cambridge
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- PIERS2004 in Pisa
- PIERS2004 in Nanjing
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We are speaking the same language, Maxwell's Equations.
--- In memory of Jin Au Kong

The 40th PIERS in Toyama, JAPAN

1 - 4 August 2018 (From Wednesday to Saturday)

Venue: Toyama International Conference Center and ANA Crowne Plaza Toyama

Important Dates

- **1 April, 2018--- Extended Deadline of Abstract Submission [Submit] [Guidelines]**
- **1 May, 2018--- Pre-registration Deadline [Login First] [Instruction]**
- **5 May, 2018 --- Extended Paper Submission Deadline [Submit] [Guidelines]**
- **1 June, 2018 --- Preliminary Program available**
- **15 June, 2018 --- Advance Program available**
- **1 July, 2018 --- Final Program is available now** hot!

PIERS 2018 Toyama Program

- Final Program is available now. [download PDF version of final printed program]
- Proceedings (extended papers only) have been published on IEEE Xplore. hot!
- **Welcome Message by PIERS 2018 Toyama General Chair** is now available.
- **Install PIERS App into your mobile -** Installation Instructions
- **Program at a Glance**
  Please visit here at the local website, where the Program at a Glance is posted. You can easily have an idea about the entire program by taking a look at this webpage.
- **Opening Ceremony**
  Date and time: 16:00-16:40, Wednesday, August 1, 2018
  Venue: Toyama International Conference Center
  Please visit here for the program of the Opening Ceremony.
- **Symposium Banquet**
  Date and Time: 19:00-21:30, Friday, August 3, 2018
  Venue: ANA Crowne Plaza Toyama
  Please visit here for the program of the Symposium Banquet.
- **General Lectures**
  During PIERS 2018 Toyama, four General Lectures (GLs) by leading scientists in the electromagnetics community will be scheduled as plenary sessions. There are no other sessions running in parallel to these GLs, and all the PIERS 2018 Toyama participants are invited to join the GLs. Please visit the GL program at this webpage.
- **Pre-Conference Workshop**
  Prior to the Conference, a Workshop will be held on July 31, 2018, and all the registered PIERS 2018 Toyama participants are invited to attend the Workshop without extra fees nor advance reservation. Please plan on attending this Workshop! Please visit the Workshop schedule at this webpage.
- **Toyama City Fireworks Festival**
  The Toyama City Fireworks Festival will be held 19:45-20:30, August 1, 2018, right after the Symposium Reception. Please get out of the venue and enjoy Toyama's great summer event! Fireworks festivals held in Toyama in the past can be seen from this website.

PIERS 2018 Toyama

Progress In Electromagnetics Research Symposium

Program

August 1–4, 2018
Toyama, JAPAN

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PIERS 2018 TOYAMA TECHNICAL PROGRAM

Session 1A1
FocusSession.SC5: Remote Sensing for Hydrological Applications 1

Wednesday AM, August 1, 2018

Room T1

Organized by Jian-Cheng Shi, Hui Lu

Chaired by Jian-Cheng Shi, Hui Lu

08:30 Keynote — Fully Coherent Model for Layered Bicontinuous Medium Using Analytical Method of Feynman Diagram for Applications in Microwave Remote Sensing of Snow Cover
Jiyue Zhu (*University of Michigan*); *Leung Tsang* (*University of Michigan*); *Shurun Tan* (*University of Michigan*); *Son V. Nghiem* (*California Institute of Technology*);

09:00 Invited — Improving Snow Fraction Spatio-temporal Continuity Using a Combination of MODIS and Fengyun-2 Satellites over China
Lingmei Jiang (*Beijing Normal University*); *GongXue Wang* (*Beijing Normal University*); *Jian-Cheng Shi* (*Institute of Remote Sensing Applications, Chinese Academy of Sciences*);

09:20 Invited — Time-series Passive Microwave Observations Applied for Snow Estimation
Jinmei Pan (*Institute of Remote Sensing and Digital Earth, Chinese Academy of Science*); *Chuan Xiong* (*Institute of Remote Sensing and Digital Earth, Chinese Academy of Sciences*); *Jian-Cheng Shi* (*Institute of Remote Sensing Applications, Chinese Academy of Sciences*); *Deyuan Geng* (*Institute of Remote Sensing and Digital Earth, Chinese Academy of Science*); *Haokui Xu* (*University of Michigan*);

09:40 Invited — Time-series Ground Based X and Ku Band SAR Observation of Seasonal Snow: Modeling and Retrieval
Chuan Xiong (*Institute of Remote Sensing and Digital Earth, Chinese Academy of Sciences*); *Jiancheng Shi* (*Institute of Remote Sensing and Digital Earth, CAS*); *Jinmei Pan* (*Institute of Remote Sensing and Digital Earth, Chinese Academy of Science*); *Haokui Xu* (*Institute of Remote Sensing and Digital Earth, Chinese Academy of Science*); *Tianjie Zhao* (*Institute of Remote Sensing and Digital Earth, Chinese Academy of Science*); *Deyuan Geng* (*Institute of Remote Sensing and Digital Earth, Chinese Academy of Science*);

10:00 Invited — Measurement and Modeling of Multi-frequency Microwave Emission of Soil Freezing and Thawing Processes
Tianjie Zhao (*Jointly Sponsored by Institute of Remote Sensing and Digital Earth, Chinese Academy of Sciences*); *Jian-Cheng Shi* (*Institute of Remote Sensing Applications, Chinese Academy of Sciences*); *Shaojie Zhao* (*Beijing Normal University*); *Kun-Shan Chen* (*Institute of Remote Sensing and Digital Earth, Chinese Academy of Sciences*); *Pingkai Wang* (*Institute of Remote Sensing and Digital Earth, Chinese Academy of Sciences*); *Shangnan Li* (*Institute of Remote Sensing and Digital Earth, Chinese Academy of Sciences*); *Chuan Xiong* (*Institute of Remote Sensing and Digital Earth, Chinese Academy of Sciences*); *Qing Xiao* (*Institute of Remote Sensing and Digital Earth, Chinese Academy of Sciences*);

10:20 Z-R Relationships for Weather Radar in Indonesia from the Particle Size and Velocity (Parsivel) Optical Disdrometer
Marzuki (*Andalas University*); *Hiroyuki Hashiguchi* (*Kyoto University*); *Mutya Vonnisa* (*Andalas University*); *Harmadi* (*Andalas University*); *Muzirwan* (*National Institute of Aeronautics and Space*); *Sugeng Nugroho* (*Indonesian Agency for Meteorological, Climatological and Geophysics*); *Meri Yoseva* (*Andalas University*);

10:40 **Coffee Break**

16:40 Validating SMAP SSS with in Situ Data and Process Oriented Analysis
Wenqing Tang (California Institute of Technology); Simon H. Yueh (California Institute of Technology); Alexander G. Fore (California Institute of Technology); Akiko Hayashi (California Institute of Technology);

17:00 Accurate Surface Fields and Emissivities in Ocean Scattering and Emission Using Neighborhood Impedance Boundary Condition (NIBC) with Dense Grid in Surface Integral Equations
Yanlei Du (Institute of Remote Sensing and Digital Earth, Chinese Academy of Sciences); Tai Qiao (University of Michigan); Leung Tsang (University of Michigan); Xiao Feng Yang (Institute of Remote Sensing and Digital Earth, Chinese Academy of Sciences);

Session 3P1b
SC5: Inverse Scattering 1

Friday PM, August 3, 2018
Room T1

Organized by Motoyuki Sato, Toshifumi Moriyama
Chaired by Motoyuki Sato, Toshifumi Moriyama

17:20 Adaptive Array Radar Imaging of Moving Human Body for Measurement of Vital Signs
Takuya Sakamoto (University of Hyogo); Kentaro Konishi (University of Hyogo); Masashi Muragaki (Kyoto University); Shigeaki Okumura (Kyoto University); Toru Sato (Kyoto University);

17:40 Accuracy Enhanced Distorted Born Iterative Method with Envelope Based Boundary Extraction for Microwave Mammography
Shouhei Kidera (The University of Electro-Communications); Kazuki Noritake (The University of Electro-Communications);

18:00 Development of Microwave CT Mammography Device
Yoshio Nagayama (Nihon University); Tomoya Hanashima (Nihon University); Tomohiko Asai (Nihon University); Soichiro Yamaguchi (Nihon University); Toshifumi Moriyama (Nagasaki University); Toshiyuki Tanaka (Nagasaki University); Hayato Tsuchiya (Nihon University);

Session 3P2a
FocusSession.SC5: SAR Imaging and Applications

Friday PM, August 3, 2018
Room T2

Organized by Kun-Shan Chen, Toshifumi Moriyama
Chaired by Kun-Shan Chen, Toshifumi Moriyama

13:00 Invited Compound Scattering Matrix by Dipoles in the Range Direction
Yoshio Yamaguchi (Niigata University); Yoshihiro Yamazaki (Niigata University); Hiroyoshi Yamada (Niigata University);

13:20 An Experimental Assessment of Polarimetric L-band Backscattering Using GB-SAR Data
Sevket Demirci (Mersin University); Betul Yilmaz (Mersin University); Serhat Gokkan (Mersin University); Hakan Isiker (Mersin University); Caner Ozdemir (Mersin University);

13:40 RCS Characteristics Analysis of Trihedral Corner Reflector for Bistatic SAR Tandem Mode Radiometric Calibration
Qiaona Zheng (Institute of Electronics, Chinese Academy of Sciences); Jun Hong (Institute of Electronics, Chinese Academy of Science); Yu Wang (Institute of Electronics, Chinese Academy of Sciences);

14:00 Research on the Sparse Aperture Remote Imaging System Based on the Freeform
Quanying Wu (Suzhou University of Science and Technology); Junliu Fan (Suzhou University of Science and Technology); Baohua Chen (Suzhou University of Science and Technology);

14:20 Invited Airborne Single Pass X-band FMCW INSAR Instrument for the Accurate DEM Generation — Principle and Validation
Masanobu Shimada (Tokyo Denki University); Akira Nohmi (Alouette Technology); Hitoshi Nohmi (Alouette Technology); Mayumi Noguchi (The Geospatial Information Authority of Japan); Sho Takahashi (The Geospatial Information Authority of Japan);

14:40 Invited Integration of Heterogeneous InSAR Measurements for Mapping Complete and Accurate Three-dimensional Surface Displacements: A Case Study of 2016 Mw 7.8 Kaikōura Earthquake, New Zealand
Jun Hu (Central South University); J. H. Liu (Central South University); Lixin Wu (Northeastern University); Zhi-Wei Li (Central South University); Q. Sun (Hunan Normal University);

30 Detection of Small and Large Hidden Metallic Objects via Passive Millimeter Wave Imaging System with an Auto-segmentation Routine
Hakan Isiker (*Mersin University*); *Sevket Demirci* (*Mersin University*); *Betul Yilmaz* (*Mersin University*); *Serhat Gokkan* (*Mersin University*); *Caner Ozdemir* (*Mersin University*);

31 An Analysis of Relationship between Urban Heat Island in the Tropics in Extremely Hot Days with Land Use Using Landsat 8 Image — A Case Study in Hanoi Vietnam
Nguyen Thanh Hoan (*Institute of Geography, Vietnam Academy of Science and Technology*); *Tran Duy Phien* (*Institute of Geography, Vietnam Academy of Science and Technology*); *Dao Dinh Cham* (*Institute of Geography, Vietnam Academy of Science and Technology*);

32 Automatic Sport Fields Detection from China GF-1 Satellite Image Data via Improved SSD Model
Zhengchao Chen (*Institute of Remote Sensing and Digital Earth, CAS*); *Kaixuan Lu* (*Institute of Remote Sensing and Digital Earth, CAS*); *Xuan Yang* (*Institute of Remote Sensing and Digital Earth, CAS*); *Baipeng Li* (*Institute of Remote Sensing and Digital Earth, Chinese Academy of Sciences*); *Jianwei Gao* (*Institute of Remote Sensing and Digital Earth, Chinese Academy of Sciences*); *Mufeng Yao* (*Institute of Remote Sensing and Digital Earth, CAS*);

33 Impact of Usage of Multiple-satellite Sensors on Accuracy of Sea Surface Wind Data
Ayumi Koizumi (*Tokai University*); *Masahisa Kubota* (*Tokai University*); *Kunio Kutsuwada* (*Tokai University*);

34 Double Weighted Fourier Transform (DWFT) in Statistical Problems
Sergei I. Knizhin (*Irkutsk State University*); *Mikhail V. Tinin* (*Irkutsk State University*);

35 Experiment and FDTD Simulation of Antenna for the Microwave CT
Tomoya Hanashima (*Nihon University*); *Yoshio Nagayama* (*Nihon University*); *Tomohiko Asai* (*Nihon University*); *Toshifumi Moriyama* (*Nagasaki University*); *Toshiyuki Tanaka* (*Nagasaki University*); *Soichiro Yamaguchi* (*Nihon University*); *Hayato Tsuchiya* (*Nihon University*);

36 The Method of Adaptive Gaussian Decomposition Based Recognition and Extraction of Scattering Mechanisms
Xinyi He (*Science and Technology on Electromagnetic Scattering Laboratory*); *Pengcheng Gao* (*Science and Technology on Electromagnetic Scattering Laboratory*); *Wei Gao* (*Science and Technology on Electromagnetic Scattering Laboratory*); *Xiao Lin Mi* (*Science and Technology on Electromagnetic Scattering Laboratory*); *Yuan Zhang* (*Science and Technology on Electromagnetic Scattering Laboratory*);

37 Using Spectral Residual Method to Identification Buried Objects from GPR B-Scan Image
Yao Qin (*Henan University of Technology*); *Jing Wan* (*Henan University of Technology*); *Jieyi Yang* (*Henan University of Technology*); *Li Hong Qiao* (*Henan University of Technology*); *Chunhua Zhu* (*Henan University of Technology*); *Qifu Wang* (*Henan Academy of Science, Applied Physics Institute Co., Ltd*);

38 A Novel Encoding and Decoding Method for Packaging Goods Based on Grayscale-Information Matrix
Guo Chun Wan (*Tongji University*); *Wen Jing Liu* (*Tongji University*); *Jian Zhou* (*Tongji University*); *Mei Song Tong* (*Tongji University*);

39 Development of Middle-power W-band Gyrotron in IAP RAS
Mikhail Yu. Glyavin (*Federal State Budgetary Scientific Institution "Federal Research Center The Institute of Applied Physics of the Russian Academy of Sciences"*); *Mikhail D. Proyavin* (*Institute of Applied Physics of the Russian Academy of Sciences (IAP RAS)*); *Anton S. Sedov* (*Federal State Budgetary Scientific Institution "Federal Research Center The Institute of Applied Physics of the Russian Academy of Sciences"*); *Evgeni S. Semenov* (*Institute of Applied Physics of the Russian Academy of Sciences*); *Andrey S. Zuev* (*Federal Research Center "Institute of Applied Physics RAS"*); *Alexander I. Tsvetkov* (*Federal State Budgetary Scientific Institution "Federal Research Center The Institute of Applied Physics of the Russian Academy of Sciences"*);

40 Wavelength-dependent Terahertz Wave Modulation in Organic/Si Hybrid Structures
Joong Wook Lee (*Chonnam National University*);

41 Topological Propoties and Edge State in Parity-time Symmetrical Waveguide Array
Qi Dong Fu (*Shanghai Jiaotong University*);

14:20 Automatic Building Extraction Based on Deep Convolutional Neural Networks from High-resolution Remote Sensing Images
Jianwei Gao (Institute of Remote Sensing and Digital Earth, Chinese Academy of Sciences); Zhengchao Chen (Institute of Remote Sensing and Digital Earth, CAS); Xuan Yang (Institute of Remote Sensing and Digital Earth, CAS); Qun Ma (Institute of Remote Sensing and Digital Earth, Chinese Academy of Sciences); Baipeng Li (Institute of Remote Sensing and Digital Earth, Chinese Academy of Sciences);

14:40 Handheld Bistatic Subsurface Radar Using Accelerometer
Kazutaka Kikuta (Tohoku University); Motoyuki Sato (Tohoku University);

15:00 Investigation for the Measurement Accuracies of Silica Waveguide Sidewall Angles with Confocal Laser Scanning Microscope
Hongpeng Shang (Changchun University of Science and Technology); De Gui Sun (Changchun University of Science & Technology; University of Ottawa); Jinzhu Gao (Institute of Metal Research, Chinese Academy of Sciences); Peng Yu (Changchun University of Science & Technology); Qingyu Sun (Changchun University of Science and Technology); Peng Liu (University of Ottawa); Trevor J. Hall (University of Ottawa);

15:20 An Experimental Study of Foliage Penetrating Radar with Coherent Change Detection
Sevket Demirci (Mersin University); Betul Yilmaz (Mersin University); Hakan Isiker (Mersin University); Serhat Gokkan (Mersin University); Caner Ozdemir (Mersin University);

15:40 **Coffee Break**

Session 4P1b
Electromagnetic Modeling and Inversion and Applications

Saturday PM, August 4, 2018

Room T1

Organized by Jianhua Li, Ganquan Xie

Chaired by Shigu Cao, Ganquan Xie

16:00 Plane Wave Coupling to Overhead Lines over Stratified Earth
Zeyneb Belganche (Mohammed V University); Abderrahman Maaouni (Mohammed V University); Ahmed Mzerd (Mohammed V University); Ayoub Lahmidi (Universite Mohammed V);

16:20 Metasurface Design by Surrogate-assisted Optimization
Binbin Zhu (Kuang-Chi Institute of Advanced Technology); Yang Yang (Tsinghua University); Yiqi Liu (Kuang-Chi Institute of Advanced Technology); Xiao Guo (Kuang-Chi Institute of Advanced Technology); Ke Deng (Tsinghua University); Chunlin Ji (Kuang-Chi Institute of Advanced Technology);

16:40 Multiphysics Modeling for Ferroelectric Materials
Shigu Cao (Shenzhen Inequation Technology Co. Ltd.);

17:00 GL Full Wave Modeling and Ray Tracing Method for Cloak
Jianhua Li (GL Geophysical Laboratory); Lee Xie (GL Geophysical Laboratory); Feng Xie (GL Geophysical Laboratory); Ganquan Xie (GL Geophysical Laboratory);

17:20 r Can Be Negative in a New Negative World on Acoustic, EM, and Seismic Modeling and Inversion
Jianhua Li (GL Geophysical Laboratory); Feng Xie (GL Geophysical Laboratory); Lee Xie (GL Geophysical Laboratory); Ganquan Xie (GL Geophysical Laboratory);

17:40 A New GLHUANPII-3 Electromagnetic Invisible Cloak
Jianhua Li (GL Geophysical Laboratory); Feng Xie (GL Geophysical Laboratory); Lee Xie (GL Geophysical Laboratory); Ganquan Xie (GL Geophysical Laboratory);

Session 4P2a
SC5: Advances in PolSAR/PolInSAR Analysis and Applications

Saturday PM, August 4, 2018

Room T2

Organized by Hiroyoshi Yamada, Ryoichi Sato

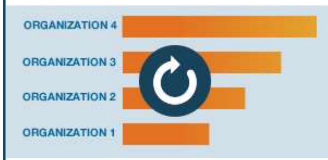
Chaired by Hiroyoshi Yamada, Ryoichi Sato

13:00 Detection of Landslides of the 2016 Kumamoto Earthquake by Using Two Single-pass Cross-track Interferometry Airborne SAR Data
Toshifumi Moriyama (Nagasaki University); Fumiaki Jitsufuji (Nagasaki University);

13:20 Monitoring Permafrost Environments with Polarimetric SAR and Optical Remote Sensing Data
Sang-Eun Park (Sejong University);

Detection of Small and Large Hidden Metallic Objects Via Passive Millimeter Wave Imaging System with an Auto-Segmentation Routine

5 Author(s) Hakan Işıker ; Şevket Demirci ; Betül Yılmaz ; Serhat Gokkan ; Caner Özd… **View All Authors**



1. Introduction
2. Auto-Segmentation Algorithm
3. Experimental Results
4. Conclusions

Authors

Figures

References

Keywords

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Abstract: In this study, we present Passive Millimeter Wave (PMMW) radiometric images for several concealed object experiments. PMMW is an imaging technique that is realized by col... **View more**

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Abstract:
In this study, we present Passive Millimeter Wave (PMMW) radiometric images for several concealed object experiments. PMMW is an imaging technique that is realized by collecting the existing cosmic background radiation (CBR) from the target and surrounding environment based on their temperatures and electromagnetic wave reflectivity. PMMW imaging, one of the detection and classifying methods for determining and localizing concealed objects in the cases where security is prioritized is presented without employing any active radiation and so preventing the human health. We present a detection algorithm based on the histogram of the raw data and applying an auto-segmentation routine to the data.

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Contents

SECTION 1.

Introduction

Detection of Small and Large Hidden Metallic Objects via Passive Millimeter Wave Imaging System with an Auto-segmentation Routine

Hakan Işıker[2], **Şevket Demirci**[1], **Betül Yılmaz**[1],
Serhat Gokkan[2], **and Caner Özdemir**[1]

[1]Department of Electrical and Electronics Engineering, Mersin University, Yenişehir, Mersin 33343, Turkey
[2]Vocational School of Technical Sciences, Mersin University, Mersin, Turkey

Abstract— In this study, we present Passive Millimeter Wave (PMMW) radiometric images for several concealed object experiments. PMMW is an imaging technique that is realized by collecting the existing cosmic background radiation (CBR) from the target and surrounding environment based on their temperatures and electromagnetic wave reflectivity. PMMW imaging, one of the detection and classifying methods for determining and localizing concealed objects in the cases where security is prioritized is presented without employing any active radiation and so preventing the human health. We present a detection algorithm based on the histogram of the raw data and applying an auto-segmentation routine to the data.

1. INTRODUCTION

PMMW imaging has become an important technology in a variety of applications ranging from airport traffic control under fog weather to the detection of oil spills in the ocean [1–3]. Among these applications, one of the important applications of PMMW imaging is doubtlessly the detection of concealed weapon in airports and other checkpoint sites [4, 5]. Studies show that microwave and millimeter wave radar technology provide a very important solution for the detection and visualization of dangerous objects (weapons, knives, explosives, etc.) well [6, 7]. Imaging in visible and infrared wavelength is easy, but it is impossible to spread in some situations such as smoke, fog, and rain environments. Radio frequencies can pass through opaque media but have poor angular resolution because they need sensors and large size antennas. Millimeter waves pass through most materials except metal and water (reflected by metals and absorbed by water), and especially by textiles, fabrics, paper, and so on. they pass directly. These waves are quite fit to use in imaging purpose. Although active systems in the millimeter wave band can be harmful to people around, passive systems using CBR radiation provide harmless detection and imaging of hidden weapons [8]. The reason for this is that the CBR receiver collects only the absorbed and scattered electromagnetic CBR radiation at the target. PMMW imaging technology generates images by using passive non-ionized radiation in millimeter wave bands with the help of a two-dimensional (2D) mechanism.

2. AUTO-SEGMENTATION ALGORITHM

The following algorithm based on auto-level thresholding and auto-segmentation routine is applied to detect and image any hidden objects beneath the clothing of human target. The steps of the algorithm are as follows: (i) First, the raw data is collected as a voltage amplitude in the two-dimensional spatial domain and then converted to gray-scale (0–255) $I(x, y)$ where x is the horizontal axis and y is the vertical axis. In this raw data image, metals and high dielectric materials appear as high reflection regions and are shown as hot (yellow) on the image. The human body, low reflective objects and background are treated as colder regions and are represented by the tones of blue on the image as low reflection regions. (ii) Next, we take the histogram of $I(x, y)$ to evaluate the distribution of the image intensity level. (iii) Subsequently, histogram values greater than or equal to 150 are assigned to variable A, and values greater than or equal to 200 are assigned to variable B. (iv) To find the decision ratio we use to separate images we calculate the value of B/A and store it in variable C. (v) If the value of C is between 0 and 0.3, it means that the hidden object is a small concealed target and will set T value to 150. (vi) If the value of C is between 0.3 and 0.5, it means that the hidden object is a big concealed target and will set T value to 200. (vii) If the value of C is between 0.5 and 1, it means that the no hidden object and will set T value to 150. (viii) Then, we take the values of the image matrix $I(x, y)$ greater than or equal to T to form new image matrix $R(x, y)$. (xi) To construct a border of the target we apply edge detection algorithm to $R(x, y)$. (x) Finally, we draw the concealed object outline $R(x, y)$ onto original image of $I(x, y)$.

3. EXPERIMENTAL RESULTS

Radiometric imaging system has been developed with components of dielectric lens, a low noise THz detector with pre-amplifier, a W-band horn antenna, a 2-dimensional (2D) scanner mechanism and a data acquisition card. The system is designed to collect CBR radiation around 100 GHz. In this study, two different passive radar experiments were performed for the following scenarios: (i) Model with a large metal concealed object and (ii) model with small concealed gun-like object. All experiments were performed at a distance of about 9 m from the lens of the PMMW imaging system. For the first measurement, we have utilized discrete data collection points 128 in the horizontal (x) and 64 in the vertical (y) directions with increments of 2.5 mm such that we have obtained 128×64 raw data matrix. The second measurement is also a 128×128 raw data image sized matrix. Each element in the resulting data matrix is a DC value corresponding to the radiometric total power gathered from spatial point of (x, y). The left-hand-side images in Fig. 1(a) and Fig. 2(a) represent the original raw images of model with big object and model with small object, respectively. The middle images in Fig. 1(a) and Fig. 2(a) were obtained from the original raw data which pixel values greater than the threshold value of 150. The right-hand-side images in Fig. 1(a) and Fig. 2(a) were constructed of the original raw data which pixel values from 150 to 255. The algorithm we propose needs to decide whether the threshold value should be 150 or 200. In order to be able to do this, we use the histogram of the raw data to calculate the required "C" ratio by applying the steps of the algorithm explained above. The "C" values of model with big object, and model with small object

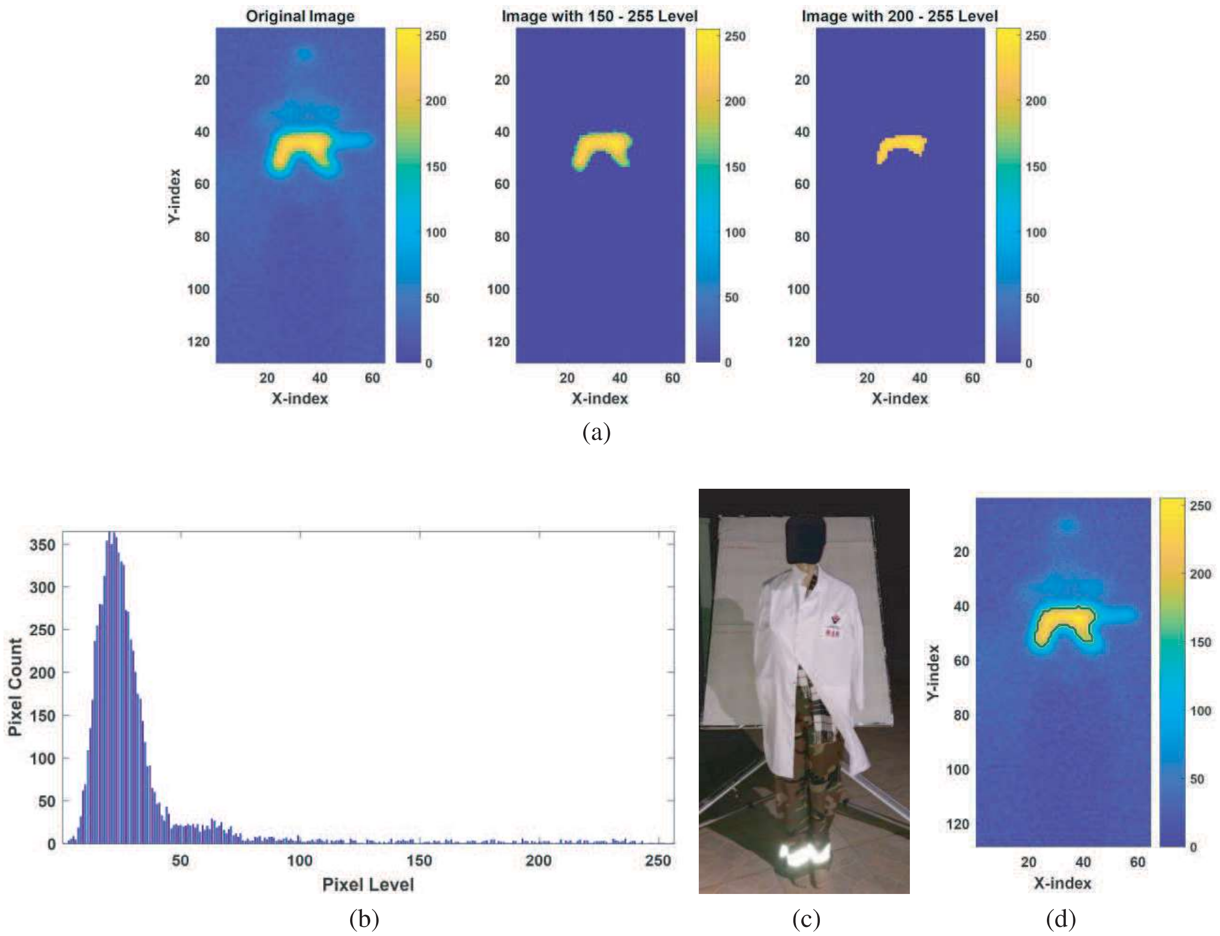

Figure 1: (a) Histogram for model with big concealed riffle-like object, (b) the original PMMW image and images with corresponding thresholded segmented image for $T = 150$, $T = 200$, (c) picture of model with concealed big metallic object, (d) edge detected final images obtained by the proposed algorithm.

experiments are 0.474 and 0.265, respectively. Thus, a threshold value of 150 for large objects and a threshold value of 200 for small objects are decided. From Fig. 1(a) and Fig. 2(a), it can be easily seen how the right decision is made. Pictures from these experiments are shown in Fig. 1(c) and Fig. 2(c), accordingly. Detected targets are successfully drawn on the raw image are shown in Fig. 1(d) and Fig. 2(d), respectively.

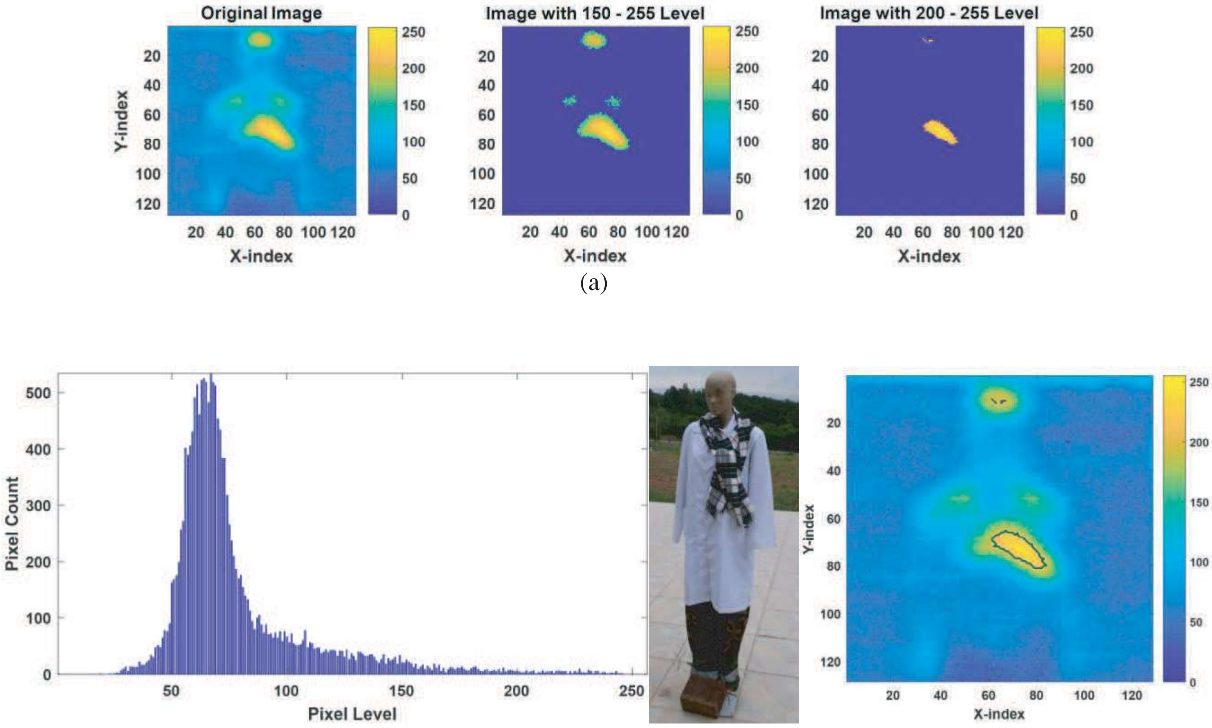

Figure 2: (a) Histogram for model with small concealed gun-like object, (b) the original PMMW image and images with corresponding thresholded segmented image for $T = 150$, $T = 200$, (c) picture of model with concealed small metallic object, (d) edge detected final images obtained by the proposed algorithm.

4. CONCLUSIONS

In this work, we have presented the passive radiometric images for several concealed object experiments. We have also developed an auto-classification algorithm for detecting and drawing the outline of concealed objects in different sizes. It has been shown that the existence and size of any hidden metal weapon can be determined by considering the ratio between histograms of two decisive threshold levels. We have provided experimental data to test the effectiveness and the validity of the proposed algorithm. Algorithm results and reconstructed final images show the success of the proposed technique.

ACKNOWLEDGMENT

This work was supported by Mersin University Scientific Research Unit under Project No. 2017-1-TP3-2129. We would like to thank İlhami Ünal, Mustafa Tekbaş and Mustafa Kılıç for their help during the experiments.

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