International Journal of Electrical, Electronics and Computer Engineering **2**(2): 73-76(2013)

ISSN No. (Online): 2277-2626

Concealed Weapon Detection Using Millimeter Wave Technology and Image Fusion Algorithm

Vinkar Rao Dongre and Prof. M.P. Parsai

Department of Electronics & Communication Engineering,
Jabalpur Engineering College, Jabalpur, M.P., India

(Received 15 July, 2013 Accepted 17 September, 2013)

ABSTRACT: We have recently witnessed the bomb blast in Jammu which killed and left many injured, left the world in shell shock and Indians in terror. This situation is not limited in India but it can happen anywhere and an time in the world. The detection of weapon concealed underneath a person's clothing is an important obstacle to the improvement of security of the general public as well as safety of public asset like airport, railway station and building. It is desirable to detect concealed weapon from a standoff distance, when it is impossible to arrange the flow of people through a controlled procedure .The goal is the eventual deployment of automatic detection and recognition of concealed weapon. It is a technological challenge that requires innovative solution in sensor technology and image processing. A number of sensors based on different phenomenology as well as image processing support are being developed to observe objects underneath peoples' clothing. So fusion algorithm is proposed for early and automatic detection of weapon. The feasibility of the proposed fusion technique is demonstrated by some experimental results.

Keywords: Concealed weapon detection (CWD), Millimeter wave Image (MMW Image), Image Fusion, Wavelet Transform, Histogram.

I. INTRODUCTION

Concealed weapon detection (CWD) has been necessary as the concern about public safety increases. There have been a series of attacks dating back to March1993, the terrorist bomb, causing enormous loss of property and human lives. The public transportation system and gathering places attracted most of the interests from the terrorists because of its economic significance and the influence that the terrorists can exert through it.

In the US, the Transportation Security Administration (TSA) provided its National Research Council (NRC) with following statement of task:

1. Identify potential applications for technology in transportation security with a focus on likely threats;
2. Evaluate technology approaches to threat detection, effect mitigation, and consequence management.
3. Assess the need for research, development and deployment to enable implementation of new security technologies.

The introduction of computed tomography based on x-ray to the airport check in procedure for the passenger luggage has improved the security, however, for the passengers; security check still relies on the hand held and portal-style metal detectors assisted by human stop and search. There are drawbacks for this type of detectors, and the weaknesses can be exploited by the sophisticated terrorists. The public and authority call for complex and comprehensive security systems. A variety of approaches to concealed objects detection on the human body based on magnetic, acoustic or ultrasound, electromagnetic resonances based target recognition, and image processing technology technologies have been suggested and developed. In the image processing technology, image is acquired by the THz, infrared, x-ray and microwave or millimeter wave imaging system. Image acquired by these imaging system have noise. Denoising is applied to improve the quality of the acquired images and enhancement of the image. After denosing and enhancement, weapon detection technique is applied, and finally concealed weapon is detected.

II. LITERATURE REVIEW AND RELATED WORK

Mohamed Mansoor Roomi and R. Rajashankari in 2012 proposed a Detection of Concealed weapons in X-ray Images using Fuzzy K-NN. They provide an automatic method for detecting concealed weapons, typically a gun in the baggage by employing image segmentation method to extract the objects of interest from the image followed by applying feature extraction methods namely Shape context descriptor and Zernike moments. Finally the objects are classified using fuzzy K-NN as illicit or non-illicit object [1]. Zhuge and Yarovoy in 2011 proposed A Sparse Aperture MIMO-SAR-Based UWB Imaging System for Concealed Weapon Detection.

They have proposed a novel imaging system for CWD by combining the advantages of SAR, MIMO technology, and large operational bandwidth from the resolution requirements for CWD [2].

Sheeja Agustin. A, S. S. Vinsley and N. Krishnan in 2010 proposed a Image segmentation of concealed object by terahertz imaging. Multilevel thresholding method is applied to get initial segmentation of concealed objects in terahertz images. Then Gonzalez method and Gonzalez Improved methods are proposed to detect and segment concealed objects in terahertz images more correctly with specific shape [3]. Xilin Shen, with his colleagues in 2007 proposed a Detection and Segmentation of Concealed Objects in Terahertz Images. Terahertz imaging makes it possible to acquire images of objects concealed underneath clothing by measuring the radiometric temperatures of different objects on a human subject [4]. Bhavna Khajone, with her colleague in 2012 proposed a Concealed Weapon Detection Using Image Processing [5].

Zhiyun Xue in 2003 proposed a novel scheme for concealed weapon detection using colour image fusion [6]. Z .Y Xu, with his colleague proposed a new image algorithm combining Projection onto Convex Sets algorithm (POCS) and nonlinear extrapolation algorithm for improving millimetre wave images [7].

Timofey Savelyev, *et.al.* describes two approaches to short-range microwave imaging by means of ultra-wideband (UWB) technology. The first approach deal with synthetic aperture radar (SAR) that employs a transmit-receive antenna pair on mechanical scanner. The second one represents a multiple input multiple output (MIMO) antenna array that scans electronically in the horizontal plane and mechanically, installed on the scanner, in the vertical plane. The mechanical scanning in only one direction reduces significantly the measurement time [8]. Hua-Mei Chen with their colleagues in 2005 proposed Imaging For Concealed Weapon Detection [9].

D. Novak, in 2005 proposed a new scheme for concealed weapon detection. They proposed a new electromagnetic (EM) solution for concealed weapons detection at a distance. Their proposed approach exploits the fact that the weapons of interest for detection, whether they are a hand gun, knife, box cutter, etc, each have a unique set of EM characteristics. The particular novelty of their technical solution for concealed weapons detection at a distance lies in the use of millimetre wave signals over a wide frequency band (26–40GHz or Ka-band) to excite natural resonances in the weapon and create a unique spectral signature that can be used to characterize the object [10].

III. IMAGE FUSION

Image fusion is the process of combining relevant information from two or more images into a single image. The resulting image will be more informative than any of the input images. In remote sensing applications, the increasing availability of space borne sensors gives a motivation for different image fusion algorithms. Several situations in image processing require high spatial and high spectral resolution in a single image. Most of the available equipment is not capable of providing such data convincingly. The image fusion techniques allow the integration of different information sources. The fused image can have complementary spatial and spectral resolution characteristics. However, the standard image fusion techniques can distort the spectral information of the multispectral data while merging. Image fusion is a process of combining complementary information from multiple sensor images to generate a single image that contains a more accurate description of the scene than any of the individual images[11-13]. The objective of image fusion is to combine information from multiple images of the same scene. The result of image fusion is a new image which is more suitable for human and machine perception or further image processing tasks such as segmentation, feature extraction and object recognition [14]. Image fusion is a process of combining two or more images into an image. It can extract features from source images, and provide more information than one image. Multi-resolution analysis plays an important role in image processing, it provides a technique to decompose an image and extract information from coarse to fine scales [15]. A variety of image fusion techniques have been developed. They can be roughly divided into two groups, multi scale decomposition based (MDB) fusion methods and non-multi scale decomposition based (NMDB) fusion methods [16]. Typical Decomposition Based fusion methods include pyramid based methods, discrete wavelet transform based methods, and discrete wavelet frame transform based methods. Typical NMDB methods include adaptive weight averaging methods, neural network based methods, Markov random field based methods, and estimation theory based methods.

A. Application of image fusion – Application of image fusion are as follows

1. Image Classification
2. Aerial and Satellite imaging
3. Medical imaging
4. Robot vision
5. Concealed weapon detection
6. Multi-focus image fusion
7. Digital camera application
8. Battle field monitoring

IV. HISTOGRAM PROCESSING

Histograms are the basis for numerous spatial domain processing techniques. Histogram manipulation can be used effectively for image enhancement.

In addition to providing useful image statistics, the information inherent in histograms also is quite useful in other image processing applications, such as image compression and segmentation. Histograms are simple to calculate in software and also lend themselves to economic hardware implementations, thus making them a popular tool for real time image processing. In the dark image, the components of the histogram are concentrated on the low (dark) side of the gray scale. Similarly the components of the histogram of the bright image are toward the high side of the gray scale. An image with low contrast has a histogram that will be narrow and will be centered toward the middle of the gray scale. For a monochrome image this implies a dull, washed-out gray look. The components of the histogram in the high contrast image cover a broad range of the gray scale and further, the distribution of pixels is not too far from uniform, with very few vertical lines being much higher than the others. It is reasonable to conclude that an image, whose pixels tend to occupy the entire range of possible gray level and, in addition, tend to be distributed uniformly, will have an appearance of high contrast and will exhibit a large variety of gray tones. The net effect will be an image that shows a great deal of gray-level detail and has high dynamic range. It is possible to develop a transformation function that can automatically achieve this effect, based only on information available in the histogram of the input image [17].

V. PROPOSED METHOD

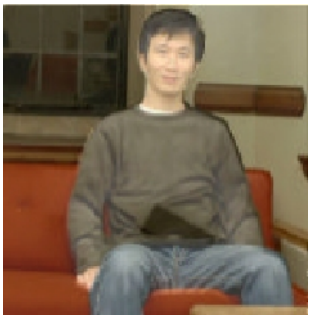
In proposed technique for concealed weapon detection in digital image processing, consider two types of input images 1.original image and 2.MMW image. Original image is nothing but that image is captured by the visual camera and MMW image is captured by the MMW imaging sensors. Since the human visual system is very sensitive to color this original image create a natural perception of an object to human vision, but not help so much in the detection of concealed weapon. For this consider the MMW image as second input for detecting CWD. Resize two input image since these two input image are taken from two different image sensing device so they are of different size. So we resize these two types of images because of the image fusion and other operation is not possible if the size is not same. Image fusion algorithm is applied on both these two input images. The image fusion algorithm is based on wavelet decomposition by haar transform. Fused image is obtained after apply the image fusion algorithm on the two input images. This fused image shows the concealed weapons.

VI. EXPRIMENTAL RESULT

ORIGIONAL VISUAL IMAGE

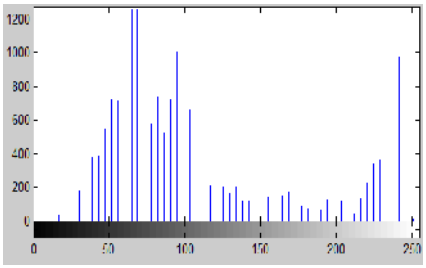
MMW IMAGE

CONCEALED WEAPON DETECTION



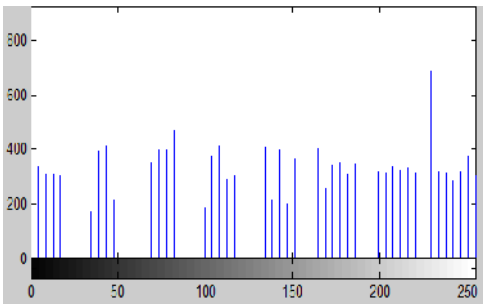
GRAY ORIGIONAL IMAGE

HISTOGRAM OF
GRAY ORIGIONAL IMAGE



ENHANCE CONTRAST USING
HISTOGRAM EQUALIZATION

HISTOGRAM ENHANCE
CONTRAST IMAGE



VII. CONCUSION

In this paper we have presented a new concealed weapons detection system based on MMW imaging system and fusion algorithm. We applied image Fusion algorithm based on wavelet decomposition method. For wavelet decomposition used the Haar transform. We have confirmed through a theoretical investigation and experiment that the proposed technique can detect a concealed weapon under a person's clothing.

REFERENCES

[1]. Dr. Mohamed Mansoor Roomi and R. Rajashankari, "Detection of concealed weapons in X-ray Images using Fuzzy K-NN", *International Journal of Computer Science*, Engineering and Information Technology (IJCSEIT), Vol**.2**, No.2, April 2012.

[2]. Xiaodong Zhuge and Alexander G. Yarovoy, A Sparse Aperture MIMO-SAR-Based UWB Imaging System for Concealed Weapon Detection. *IEEE Transaction on goscience and remote sensing* vol. **49**, no. 1, January 2011.

[3]. Sheeja Agustin. A,S.S. Vinsley and Dr. N. Krishnan, Image segmentation of concealed object by terahertz imaging, *IEEE International Conference on Computational Intelligence and Computing Research*, 2010.

[4] Xilin Shen, Charles Dietlein, "Detectio and Segmentation of Concealed Object in Terahertz Images'', *IEEE Transaction on Image Processing*, 2007.

[5]. Bhavna Khajone, V. K. Shandilya, "Concealed Weapon Detection Using Image Processing", *Iternational Journal of Scientific & Engineering Research*, Volume **3**, Issue 6, June-2012.

[6]. Zhiyun Xue, Rick S. Blum,"Concealed Weapon Detection Using Color Image Fusion", ISIF 2003.

[7]. Z.Y. Xu, W.BDou, Z.XCao, "A New Algorithm for Millimeter-Wave Imaging Processing", *IEEE-2008.*

[8]. Timofey Savelyev, Xiaodong Zhuge, Bill Yang, "Development of UWB Microwave Array Radar for Concealed Weapon Detection", *IEEE-2010*.

[9]. Hua-Mei Chen, Seungsin Lee, Raghuveer M. Rao, Mohamed-Adel Slamani, and Pramod K. Varshney Imaging For Concealed Weapon Detection IEEE Signal Processing Magazine, March 2005.

[10]. D. Novak, R. Waterhouse and A. Farnham, "Millimeter-wave Weapons Detection System", Proceedings of the *34th Applied Imagery and Pattern Recognition Workshop (AIPR05), IEEE*.

[11]. Z. Liu, K. Tsukada, K. Hanasaki, Y.K. Ho, Y.P. Dai, Image fusion by using steerable pyramid, *Pattern Recognit. Lett.* **22** (2001) 929–939.

[12]. G. Piella, A general framework for multiresolution image fusion: from pixels to regions, Report PNA-R0211, 31 May 2002.

[13]. P.J. Burt, R.J. Kolczynski, Enhanced image capture through fusion, in: Proceedings of the Fourth *International Conference on Computer Vision, Berlin*, Germany, 1993, pp. 173–182.

[14]. Gonzalo Pajares, Jesus Manuel de la Cruz A wavelet based image fusion tutorial Elesevier, 2004.

[15]. C.Y. Wen, J.K., "Chen Multi-resolution image fusion technique and its application to forensic science" ELSEVIER, November 2003.

[16]. Z. Xue, R. S. Blum, and Y. Li Fusion of Visual and IR Images for Concealed Weapon Detection ISIF, 2002.

[17]. Gonzalez, "Digital Image Processing," 2nd edition, pp. 88-89.