Concealed Weapon Detection Using Image Processing

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Abstract **--In today's world, security forms an integral part in every aspect of life. The detection of weapons concealed underneath a person's clothing is very much important to the improvement of the security of the public places as well as the safety of public assets like airports, railway stations, etc. Manual screening procedures for detecting concealed weapons are common in controlled access settings like airport, entrance to sensitive buildings and public events. It is desirable sometimes to be able to detect concealed weapons from a standoff distance, especially when it's impossible to arrange the flow of people through a controlled procedure. People think bomb blasts cannot be predicted before handled. This paper shows you the technology which predicts the suicide bombers and explosion of weapons through Image Processing for Concealed Weapon Detection.**

Key Words **– concealed weapon detection, image fusion, IR, MMW.**

I. Introduction

A weapon is any object that can cause harm to another individual or group of individuals. This definition not only includes objects typically thought of as weapons, such as knives and firearms, but also explosives, chemicals, etc. so these harmful things need to be detect for securing public assets like airports and buildings etc. Already used manual screening procedure sometimes gives wrong alarm indications, and fails when the object is not in the range of security personnel as well as when it is impossible to manage the flow of people through a controlled procedure. It also disappoints us when we try to identify a person who is the victim of an accident in future. We have recently witnessed the series of bomb blasts in Mumbai, Delhi, etc. Bombs went off in buses and underground stations. And killed many and left many injured and left the world in shell shock and the Indians in terror. This situation is not limited to India but it can happen anywhere and anytime in the world. In all these cases CWD by scanning the images gives satisfactory results. But only single sensor technology cannot provide acceptable performance. Hence, we try to bring the eventual development of automatic detection and recognition of concealed weapons. It is a technological challenge that requires innovative solutions in sensor technologies and image processing. The problem also presents challenges in the legal arena; number of sensors based on different phenomenology as well as image processing support are being developed to observe objects underneath people's clothing. Now image fusion has been identified as a key technology to achieve improved CWD procedures. This paper is completely focused on fusing visual and the less cost IR images for CWD. Infrared images depend on the temperature distribution information of the target to form the image. Usually the theory is that the infrared radiation emitted by the human body is absorbed by clothing and then re-emitted by it. In IR image the background is almost black with little details due to high thermal emissivity of body. The weapon is darker than the surrounding body due to a temperature difference between it and the body (it is colder than the human body). The resolution in the visual image is very high than the IR image.

II. Imaging Sensors

These imaging sensors developed for CWD applications depending on their proximity, portability and if they use active or passive illuminations. The different types of imaging sensors for CWD are:

A. Infrared Imager

Infrared imager uses the temperature distribution information of the target to form the image. Generally, they are used for a variety of night-vision applications, such as viewing the vehicles and people. The basic theory is that the infrared radiation emitted by the human body is absorbed by clothing and then reemitted by it. Due to this, infrared radiation can be used to show the image of a concealed weapon only when the clothing is tight, thin, and stationary. For normally loose clothing, the emitted infrared radiation will be spread over a larger clothing area, thus decreasing the ability to view the image a weapon.

B. PMW Imaging Sensors

1) First Generation: When energy is emitted or reflected by the source then Passive millimeter wave (PMW) sensors measure the temperature. The output of the sensors is a function of the emissive of the objects in the MMW spectrum which is measured by receivers. Because of the high reflectivity and low emissive of objects like metallic guns, clothing penetration for concealed weapon detection is possible for MMW sensors. A visual image of a person wearing the heavy sweater that conceals two guns which is

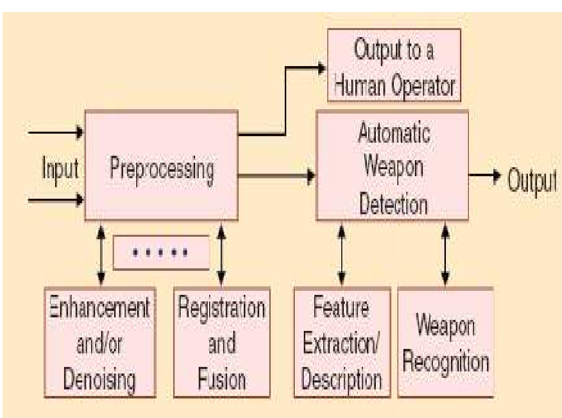
made up of metal and ceramics is shown in fig.1(a). By scanning a single detector across the object plane using a mechanical scanner Fig.1(b) was obtained. Both these firearms are clearly shown by radiometric image.

Fig. 1: (a). visible and (b). MMW Image of a Person Concealing 2 Guns Beneath a Heavy Sweater

2) Second Generation: The video-rate is (30 frames /s) for advanced MMW sensors in MMW cameras. Another camera is a 94-GHzradiometric pupil-plane imaging system that employs frequency scanning to achieve vertical resolution. And it uses the array of 32 individual waveguide antennas for horizontal resolution. And this system collects up to 30frames/s of MMW data.

3) CWD Through Image Fusion:More complete information can be obtained by fusing passive MMW image data and its corresponding infrared (IR) or electro optical (EO) image, furtherthis information can then be used to facilitate concealed weapon detection. The fusion of an IR image revealing concealed weapon and its corresponding MMW image is shown to facilitate extraction of the concealed weapon.

III. IMAGING PROCESSING



ARCHITECTURE

Fig. 2: An Imaging Processing Architecture Overview for CWD

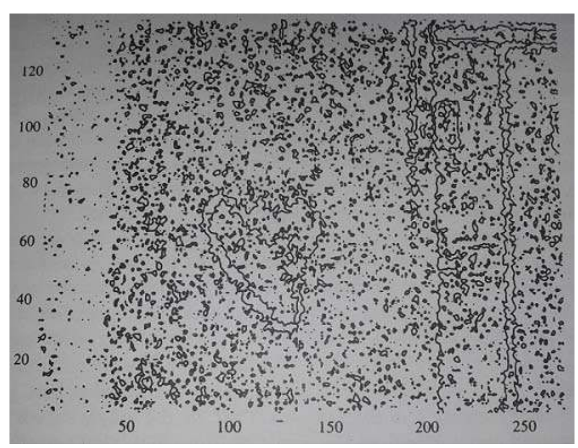
The image processing architecture for CWD is shown in Figure 2.Here the input can be multi sensor (i.e., MMW + EO, MMW + EO, or MMW + IR + EO) data or only the MMW data. Further, the blocks showing registration and fusion can be removed from Figure. At the output we may get several forms. The output can be as simple as a processed image/video sequence displayed on a screen; a cued display where potential concealed weapon types and locations are highlighted with associated confidence measures; a “no,” “yes,” or “maybe” indicator; or a combination of the above. Image processing procedures that have been investigated for CWD applications ranges from simple denoising to automatic pattern recognition.

IV. WAVELET APPROACHES FOR PREPROCESSING

It is desirable to preprocess those images or video data to maximize their exploitation, before the image or video sequence is presented to a human observer for the operator-assisted weapon detection or fed into an automatic weapon detection algorithm. In this section of preprocessing, it includes enhancement and filtering for the removal of wrinkles, shadows, and other artifacts. And when more than one sensor is used, the preprocessing must also include registration and fusion procedures.

A. IMAGE DENOISING& ENHANCEMENT THROUGH WAVELETS

The technique for simultaneous noise suppression and object enhancement of passive MMW video data is described here.This method relies on the fact that noise commonly manifests it as fine-grained structure shown in Fig.3 and the wavelet transform provides a scale-based decomposition. Mostly the noise tends to be represented by wavelet coefficients at the finer scales. Initially temporal de-noising is achieved by motion compensated



filtering, which estimates motion trajectory of each pixel by various Fig.3 Edge Extraction From Original Image

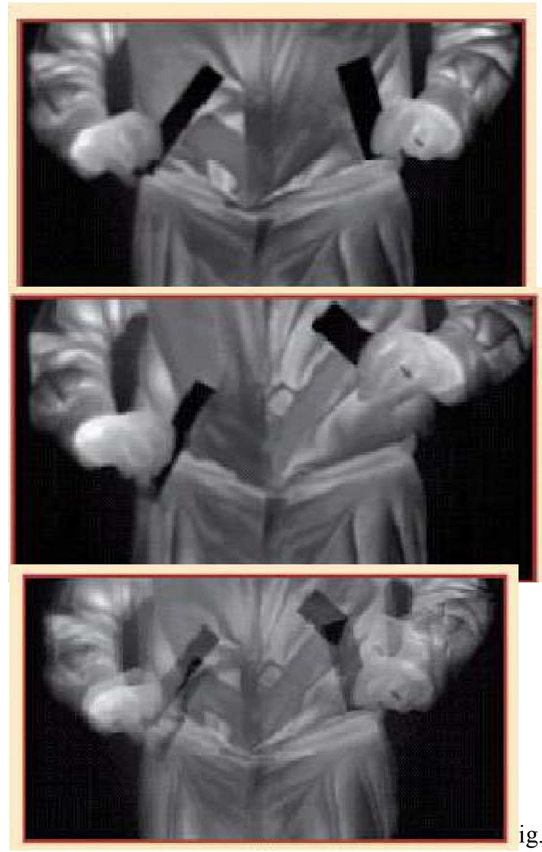
types of algorithms and then conducts a 1-D filtering alongthe trajectory. After performing this process, this reduces blurring effect that occurs when temporal filtering is performed without regard object motion between the frames.

B. Registration of Multi Sensor Images

Now we know that, making use of multiple sensors may increase the efficiency of a CWD system. So, the first step toward image fusion is a precise alignment of images (i.e. image registration). Even though MMW imagers penetrate clothing they do not provide the best picture due to their limited resolution. Whereas, Infrared (IR) sensors, provide well-resolve pictures with less capability for clothing penetration. Mixing both these technologies should provide a better way to display a well resolved image with a better view of a concealed weapon. But combination of IR and MMW image sensors requires the registration and fusion procedures. The registration procedure is based on the observation that the body shapes are well preserved in IR and MMW images. We first scale the IR image in accordance with some prior knowledge about the sensors. And then the body shapes are extracted from the backgrounds of the IR and MMW images. Finally, we apply correlation to the resulting binary images to determine the X and Y displacements.

C. Image decomposition

In the first step, an image pyramid is constructed for each source image by applying the wavelet transform to the source images. Due to this step, we get important details of the source images at different scales, which is useful for choosing the best fusion rules. Next step is using a feature Selection rule, a fused pyramid is formed for the composite image from the pyramid coefficients of the source images. One of the simplest feature selection rule is choosing the maximum of the two corresponding transform values. This allows the integration of details into one image from two or more images. And hence finally, the composite image is obtained by taking an inverse pyramid transform of the composite wavelet representation. The process can be applied to fusion of multiple source imagery. Thus, this type of method has been used to fuse IR and MMW images for CWD application. The first fusion example for CWD application is given in Fig. 4.



ig.4. (a) and (b) are original I R images (c) is fused image

V. Automatic weapon detection

After performing of the preprocessing, the images/video sequences can be fed into a weapon detection module or displayed for operator-assisted weapon detection for automated weapon detection. For this aim of detection, several steps are required, including object extraction, shape description, and weapon recognition.

VI. Segmentation for object extraction

Regardless of whether or not the image fusion step is involved, object extraction is an important step towards automatic recognition of a weapon. It is successfully used to extract the gun shape from the fused IR and MMW images. This can never be achieved using the original images alone. One segmented result from the fused IR and MMW image is shown in Figure 3.3.

VII. CONCLUSION

In this paper, the sensor technologies being investigated for the CWD application is briefly reviewed. Here, Imaging techniques based on a combination of sensor technologies and processing will potentially play a vital role in addressing the concealed weapon detection problem. Recent advances in MMW sensor technology have led to video-rate (30 frames/s) MMW cameras. However, MMW cameras alone cannot provide useful information about the detail and location of the individual being monitored. To enhance the practical values of passive MMW cameras, sensor fusion approaches using MMW and IR, or MMW and EO cameras are being described. By integrating the complementary information from different sensors, a more effective CWD system is expected. In the second part of this paper, a survey of the image processing techniques being developed to achieve this goal, is provided. Specifically, topics such as MMW image/ video enhancement, denoising, registration, fusion, decomposition, segmentation and recognition were discussed.

VIII. REFERENCES

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