Spontaneous Detection of Weapons in ATM Banks

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***Abstract* - Today's automatic visual surveillance is prime need for security while taking amount in ATM and this paper presents first step in the direction of automatic visual weapon detection and detection of hidden objects from tera hertzs images. And giving the alarm sounds to the customer and send the message to security guard and nearby police station using Internet of Things. The objective of our paper is to analysis the existing framework for visual and hidden weapon detection for automatic surveillance. Here automated Gun Detection System connected to CCTV camera is used to examine outside the ATM centre and detection of hidden weapons from tera hertzs images kept at the entrance of ATM centre. Both are used to avoid the criminal action.This framework exploits the color based segmentation to eliminate unrelated object from an image using k-mean clustering algorithm. Harris interest point detector and Fast Retina Keypoint (FREAK) are used to locate the weapons in the segmented images. And the hidden objects are detected from tera hertzs images by using three stages approaches. In the first stage, edge based segmentation is applied after smoothing the image using bilateral filter. In the next stage, transform invariant shape descriptors, Gabor and gray level co-occurrence (GLCM) texture features of interested object regions are computed. Finally, a Euclidean distance criterion is used for classification. For detecting the hidden objects from tera hertzs images detection rate and detection error are calculated. Experiment results are found to be promising performance of our system to detect a weapon with 1.04% detection error and 91.9% detection rate.**

Keywords: FREAK, GLCM and Internet of Things

I. INTRODUCTION

In the recent years, increased threats of criminal action have led to the development of many techniques for the detection of concealed weapons, explosives etc. They include metal detectors, X-ray scanners, and detection of explosive and are based on energetic radiation. From tera hertzs images, the Electromagnetic waves in tera hertzs frequencies have unique reflection and absorption properties and have characteristics signatures of tera hertzs wavelengths. They had reviewed various types of moments and moment-based invariants. They had studied the role for various image degradations and distortions that affects the shape descriptors for classification. They had reviewed numerical algorithms for moment computation in real applications. When any weapons are detected, a fire alarm rises and automatically closes the door. From this the customer can be safe inside the ATM center and person who had weapon will be kept outside the center. From automated Gun Detection System connected to CCTV camera, it raise an alarm signal if it detects gun in a frame extracted from video feed, after that CCTV operator can allocate his attention on the video scene and either acceptor discard that detection. So, GDS will provide great assistance to CCTV operator in long working hour as well as monitoring multiple video feeds concurrently on same. When detection of visual and hidden weapons either by using GDS or from tera hertzs images, it alert the customer by raising fire alarm and the signal from fire alarm is converted into message by connecting the fire alarm with INTEL Galileo Kit using Arduino software.

II. INTERNET OF THINGS

The Internet of things is the internetworking of physical devices, vehicles, buildings, and other items which is embedded with electronics, software, sensors, actuators, and network connectivity that enable these objects to collect and exchange data. In 2013 the Global Standards Initiative on Internet of Things defined the IoT as "the infrastructure of the information society." The IoT allows objects to be sensed and/or controlled remotely across existing network infrastructure, creating opportunities for more direct integration of the physical world into computer-based systems, and resulting in improved efficiency, accuracy and economic benefit. When IoT is augmented with sensors and actuators, the technology becomes an instance of the more general class of cyber-physical systems, which also encompasses technologies such as smart grids, smart homes, intelligent transportation and smart cities. Each thing is uniquely identifiable through its embedded computing system but is able to interoperate within the existing Internet infrastructure. Experts estimate that the IoT will consist of almost 50 billion objects by 2020[1][6].

III. TERA HERTZS IMAGE DETECTION

Due to noise and other variations, Images are processed to compensate for losses. Generally, objects are featured in images by its color, edge, and shape and texture information. Three main attributes of object are used to detect any hidden object at various spatial resolutions. First, the search image is divided into number of overlapping grids to reduce the missing probability. Both region-based and contour based shape descriptors are computed to distinguish shapes of different objects. Gobor[2], GLCM features are extracted as texture information to characterize objects. For robust detection, a combined feature vector of edge, shape and texture is employed. Euclidean distance classifier is used to calculate and compare text feature vector with feature vectors of the search image. Detection rate and detection error are measured against ground truth data to appraise the algorithm. Experiments are repeated both with combined and individual feature vector for gun, knife and needle images.

Shape descriptors

Shape descriptors are mathematical functions that are applied on images to produce numerical values which are processed to provide information about objects. There are two types of two dimensional shape descriptors such as region-based descriptors and contour-based descriptors which is used to characterize spatial distribution of pixel intensities, including pixels in boundary and transform invariant and robust to noise. Classification by using contour sequence moments comparatively good over area based moments. Shape descriptors F1, F2, F3 are calculated using equation1, 2, 3.

$F_1= (\mu_2)^{1/2}/m_1$------------------(1)

$F_2=\mu_3/ (\mu_2)^{3/2}$-------------------(2)

$F_3=\mu_4/ (\mu_2)^2$----------------------(3)

F_1, F2, F3 are shape descriptors region.

m_1 - first order moment.

μ_2, μ_3, μ_4 are second, third , fourth central order moments.

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Texture features

A Gray Level Co-Occurrence Matrix is a statistical method of examining texture that considers the spatial relationship of pixels in an image. The matrix element P(i, j | d, θ) is the relative frequency with which two pixels, separated by distance d, and in direction specified by the particular angle (θ). Here, gray level co-occurrence based texture features are computed in two steps. In the first step, pair wise spatial co-occurrences of pixels separated by a particular distance are charted by a gray level co-occurrence matrix (GLCM). Then using the GLCM, a set of texture features of interested object regions is computed. Here, entropy, correlation, energy, contrast and homogeneity features are computed. Energy content is computed using (4) and is the sum of squared elements in the GLCM. Entropy represents the randomness of intensity distribution and is computed using (5). Contrast is computed using (6) that presents the amount of local variation present in the image . Correlation reveals the linearity present in the image and is measured using (7). Homogeneity measures the closeness of the distribution of elements in the GLCM and is evaluated using (8).

$$Energy=\sum_{m=0}^{G-1}\sum_{n=0}^{G-1} P(m, n)^2 \text{ ---------------------------- } (4)$$

$$Entropy=\sum_{m=0}^{G-1}\sum_{n=0}^{G-1} P(m, n) \log P(m, n) \text{ --------------- } (5)$$

$$Contrast=1/ (G-1)^2\sum_{m=0}^{G-1}\sum_{n=0}^{G-1} (m-n)^2P(m, n) \text{ ------- } (6)$$

$$Correlation= (\sum_{m=0}^{G-1}\sum_{n=0}^{G-1} m*nP(m, n)-\mu_x, \mu_y)/\sigma_x \text{ -------- } (7)$$

$$\mu_x=\sum_{m=0}^{G-1}\sum_{n=0}^{G-1} m\, P(m, n)$$

$$\mu_y=\sum_{m=0}^{G-1}\sum_{n=0}^{G-1} n\, P(m, n)$$

$$\sigma_x = \sum_{m=0}^{G-1} (m-\mu_x)^2\sum_{n=0}^{G-1} P(m,n)$$

$$\sigma_y = \sum_{m=0}^{G-1} (m-\mu_y)^2\sum_{n=0}^{G-1} P(m,n)$$

$$Homogeneity=\sum_{m=0}^{G-1}\sum_{n=0}^{G-1} P(m, n)/ (1+|m-n|) \text{ ----------------------- } (8)$$

Gabor Features

Gabor filter is a linear filter used for edge detection. Frequency and orientation representations are similar to human visual system. They are most appropriate for texture representation and for object discrimination. Results of symmetric and asymmetric Gabor filter are combined in a single quantity, called Gabor-energy. The Gabor-energy is closely related to the local power spectrum and it is associated with a pixel in an image. Here, Gaussian window is used as a neighbourhood function. Transformation is applied on the image with different orientations and scales. The resultant magnitude represents the energy E(m, n) present in the image at different scales and is given(9). From the magnitude, homogenous texture σ_m is calculated using (10) and (11).

$$E(m, n) = \sum_{x}\sum_{y} |G_{m}(x, y)| \text{---------------} (9)$$

$m=0, 1, 2 ...M-1$

$n=0, 1, 2 ...N-1$

$$\mu_m = E(m, n)/P*Q \text{---------------------} (10)$$

$$\sigma_m = \sqrt{\sum_{x}\sum_{y}(|G_{m}(x, y)| - \mu_m)^2 / P*Q} \text{------} (11)$$

P*Q is image size

Algorithm

Read search image;
Img=imread ('humen.jpg');
Divide the image into overlapping sub images For each sub image,
Function[X1, map1] =edg(R, R1);
Compute edge features;
Function [X, map] =shape (RGB, RGB1);
Compute Shape descriptors;
Function[X1, map1] =txtre1 (R1, R2);
Compute GLCM feature edg (img, img1);
Shape (img, img1); txtre1 (img, img1);
Function gb=gabor_fn (sigma, theta, lambda,psi,gamma) Compute Gabor features;
Compute entropy features Compute a combined feature vector; Train for gun images;
Train for knife images;
Train for needle images;
Create a feature database;
Read test image (gun/ knife/needle) R=imread ('gun.jpg');
R2=imread ('1knife.jpg');
R3=imread (_needle.jpg‘); Create a test feature vector; Classify using Euclidean criteria

IV. AUTOMATED GUN DETECTION SYSTEM

An approach of visual gun detection is based on colour based segmentation using k-means clustering algorithm and interest point detector. Combination of Harris interest point detector and FREAK descriptor is used to recognize whether a given blob is gun or not. The algorithm of visual gun detection is given below.

Detection approach consists of several steps which will be discussed in following subsection.

System initialization loads the stored interest point descriptor of the gun that is used to measure the similarity score with extracted interest point features of blobs. The combination Harris interest point detector plus FREAK [1] is used for finding similarity.

Pre-processing steps involve removal of different noises from the image which arises during the acquisition or transmission of image. Colour based segmentation is performed to extract the colour related to gun, i.e. black if the gun is of black colour. It eliminates colour or objects which do not resemble gun. Colour based segmentation using k-means clustering13 is performed on image obtained from pre-processing to segment the image into different parts based on colour. k- means clustering algorithm.

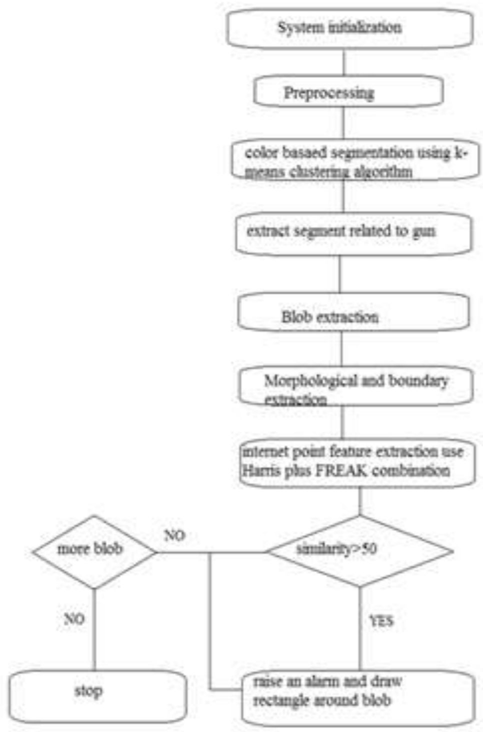

Fig.1 Image Preprocessing Steps

This step extracts a blob from the segmented image that is of area greater than 1000 pixels. Here we are extracting blob of area greater than 1000 because many blobs of small area arise during segmentation due to noises. A blob is a connected component of pixel where some properties are constant or varies lightly. Morphological closing is performed to eliminate the presence of small gaps in the blob. Morphological closing is achieved by erosion of image with structuring element followed by dilation with structuring element (eqn.1).Boundary is obtained by subtracting the result of erosion of image from the original image (eqn. 2).

$$Ic = (I \oplus SE) \theta SE \quad (1)$$

$$B = I - (I \theta SE) \quad (2)$$

Where I is the original image, Ic is the output of closing, SE is the structuring element, B represents the boundary of image. FREAK is a keypoint descriptor. It is inspired by the retina of human visual system. A retinal sampling pattern is used for the computation of cascade of binary strings by efficiently comparing image intensities. FREAK is very fast as well as accurate than other key point descriptors. It is motivated by the working of BRIEF and BRISK keypoint descriptors. The binary representation is used in order to perform dimensionality reduction. FREAK employs smoothing of the input image with Gaussian kernel for noise suppression. A binary descriptor F is constructed by thresholding the difference between pairs of receptive fields with their corresponding Gaussian kernel. F is a binary string formed by a sequence of one-bit Difference of Gaussians (DoG). An Oriented FAST and Rotated BRIEF (ORB) like algorithm are used to select the useful pairs in the receptive fields.

Matching has been performed to calculate the similarity score between the stored descriptor of gun and blob. Nearest neighbour ratio algorithm4 is used to calculate matching between two descriptors using sum of square difference (SSD) as metric.

$$SSD = \sum_{i=1}^{x} (x_i - y_i)^2$$

Where x and y are two feature vector.

EXPERIMENTAL RESULTS

When the person stands in the entrance of an ATM centre, Tetra Hertz Image scanner scans the person fully. If the person has weapons with him, immediately a fire alarm raises which leads to close an ATM centre door. Here, fire alarm connects to the Galileo kit and GSM module, using arduino software, when fire alarm blows, it send message to person," you should keep the weapons outside, else you won't be allowed inside an ATM centre". On entering an ATM centre, the door will be closed. After withdrawal of money, the door will open. The person can come out of an ATM centre. Secondly, CCTV will be fixed outside the ATM center. A Gun Detection System is inbuilt with CCTV camera. CCTV camera will continously sense the movements of the person. Work of an GDS is, when it finds person with weapon, an fire alarm starts sounding. Here, fire alarm is connected to the galileo kit and GSM module. Here the values are in digital.

Galileo kit senses the value from the fire alarm, When it reaches a limit, Galileo kit sends a message to the security guard and to nearby police station with the location of an ATM centre as,"Person stands with the weapon outside an ATM centre" and sends an alert message to the person who stands inside an ATM centre using GSM module.

V. CONCLUSION

When an images with hidden and visual weapons are found fire alarm raises and entrance door in an ATM centre will be closed and message will be automatically sent to the security guard and to nearby police station. This will prevent robbery in an ATM centre. Enabling intelligent devices to detect an object with various disturbances is not easy. Next Step is to further improve the techniques for low quality video surveillance.

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