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Automatic Intrusion Recognition and Tracking for Security Systems

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ABSTRACT: This paper is an assay to develop a system which is completely independent and it will automatically recognize, track intrusion for security system. There are some untoward environmental conditions where Human Soldiers find it hard to fight this system can also works in those conditions. Intrusion should not be present in Entry-Restricted areas such as Line of Control. This set up will be placed at some suitable spot from which it can capture a complete view of line of control with a camera. The system has a battery powered computer installed on it which will analyze the captured images from camera. It will find out and then recognize the object. This is done by comparing the features of detected object with features of the objects which are stored in database. The object will get tracked to find its velocity if match is found in the features, and get bombarded with bullets and bombs until object gets destroyed completely. Thus without imperiling a valuable life of Human Soldier safety and very tight security can be provided. For the implementation point of view the system is kept as simple as possible. Due to the low execution time of the system and Simplicity of algorithm ensures real time operation of system and low implementation cost.

KEYWORDS: object tracking, object recognition, shape description, color detection**.**

I.INTRODUCTION

For detecting intrusions, tracking it this system is proposed. This set up will be placed at some suitable spot from which it can capture a complete view of line of control with a camera. In this system a high resolution camera, image processing hardware, microcontroller, two servo motors and other supplementary hardware and mechanisms are provided. Camera is used to capture the images after some predefined interval of time then these images are provided to Image Processing hardware. Then every captured image will be processed by image processing hardware for detecting intrusion. It will extract the features of that intruding object if intrusion is detected and compare that features with features of objects stored in database. The objects those are to be destroyed are collected in the database.

Object is said to be recognized if match between intruding object and one of the objects from database is found. Then to calculate its velocity of motion, system will track that object. The system will need this velocity information to destroy that object, and for that it decide the angle and time instant at which projectile is to be launched at object. In the form of x-y co-ordinate, the position of the intruding object is taken out and given to microcontroller. To position the cannon it will control the angle of rotation of two Servo Motors aiming at the intruding object. At the end cannon will get fired.

II.MATERIALS AND METHODS

A. CAMERA

Depending upon the requirement of system camera with different resolution and color depth can be used. System has camera fixed on it and once background image is captured should not move from its place; otherwise as subtraction is calculated to detect query object it will unfavorably affect accuracy of the system.

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B. IMAGE PROCESSING HARDWARE

A Image Processing hardware is used as a computer. Via USB port camera and pc are connected. This hardware process the image captured by camera and result of this is given to Microcontroller. The angle of rotation for motor is used for positioning of cannon which are done by the microcontroller.

C. IMAGE PROCESSING SOFTWARE

Shape and color are the prominent features of the object, when an object is seen form long distance and these features distinguish it from its background and other shape. Hence for identification, the peripheral shape and color are considered, at the time of calculating features of the object.The program for this system is run using Image Processing Toolbox in Matlab7.2 software.

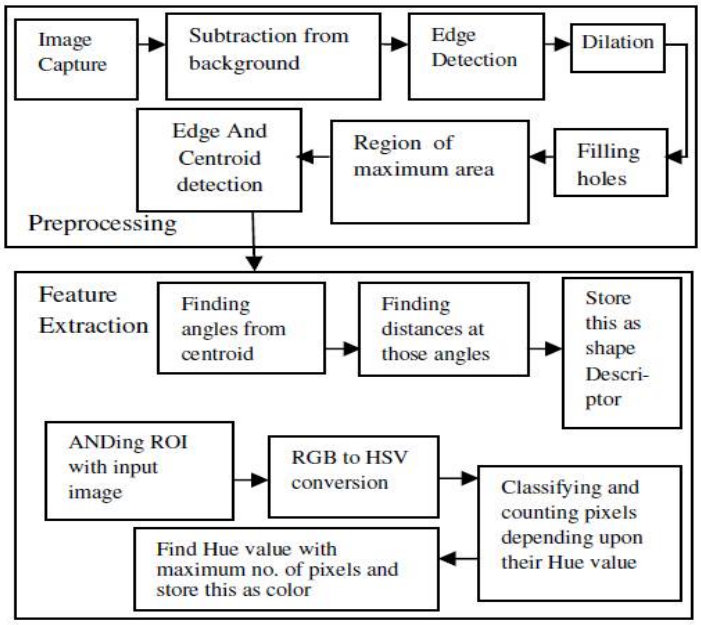

Figure.1 Block diagram of Image Processing software

1. Preprocessing

After installing camera at its place background image has to be captured and once background is captured camera shouldn't move. Background and current image captured from camera is used to find out intrusion and for that subtraction is carried out between these two images. Previously taken background image and current image which is taken from camera will have none difference and subtraction result will comes out none if there is no intrusion. But if some object has presented in the scene then subtraction between that two images will be the query object itself and is none, as in previous case.

As exterior edges of object are clearly invisible therefore result of subtraction is unsuitable for extraction of features. This is the image which is obtained from inversing the subtraction result which shows above mentioned problem. So before feature extraction this subtraction result has to be preprocessed. Subtraction result is also a color image as subtraction is obtained subtracting color images, so it is converted into image which is binary one. For edge detection of the object canny edge detection is the method which is operated on Binary Image depending upon threshold chosen adaptively. To increase overall accuracy correct choice of threshold is important which will lead to proper edge detection. At this stage problem of unclear and broken boundary is present, with the proper mask the image is dilated to connect these broken edges to remove this problem. Here, instead of white region related to the query object we have various undesired white regions other in the image. Illumination variations, small changes in the background at the time of obtaining images, camera impurities will result into unwanted white regions. The attributes of the unwanted region is

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used over here; their area is always less than intruding object. So only maximum area of white region is kept which gives out the intruding object.Canny edge detection method is used for detection of edges. This edge belongs to boundary of intruding object. Here there is presence of error introduced because of operation of dilation. So depending upon size of object; mask for the dilation operation is adaptively chosen and after this process image with detected edges is suitable for detection of shape.

2. Feature extraction:

2. A Shape description:

Distances of all the points on its boundary from some reference point is nothing but Shape of an object. Centroid (center of mass) of an object is the reference point which is unchanged though object is rotated. Centroid is the center of circle and centroid has equal distances from all points. Likewise we can obtain descriptors of shape if we calculate distances of some points on the object's boundary. For this section it is assumed those points on the boundary of the object which are differ by 10 degrees angle and all then all angles are calculated from object centroid.

Hence total 36 distances results into to 36 various angles detached by 10 degrees are obtained. In order to increase accuracy this angle of separation can be reduced. But as the angle separation is reduced, number of readings will increase which ultimately increases time required for computation. So there is tread off between capability of system to work in real time and its accuracy.To allow scale invariance, normalization of the data isdone. Object seen from different distances will vary in sizes but not in their shape. Comparisons between objects those are present at many distances from camera; normalization will enables it. By dividing all 36 readings of distance by longest farness reading normalization is carried out. This gives out 36 shape descriptors readings to range from 0 to1.

Shape descriptors acquired above can also be made rotation invariant and circular shifting of readings can be executed for this. Using this property objects having different rotational orientation can be compared. Thus this system is rotation and scale invariable. Descriptor of shape of the object is obtained in this way.

2. B Color detection:

Gross features of the object are taken into consideration instead of fine details. When some objects are observed from long distance, the color which is covering most of the area of that object is considered, and it is said that object is of that color in case object is having different colors on its different parts. To search the hue of the object, image acquired from camera is logically ANDed with image which is made with preprocessing. And then resulting image is converted into HSV. Color information of HSV image is in its hue plane only. Values of color plane are between 0 and 1. And color is detected with the help of these values. And in this way second important feature of the objects that is its color is detected.

On database images acquiring of color and shape is also done. If there is any suitability atmen one of the object within the database and intruding object then object is said to be found and then before bullet is fired towards it, for finding its velocity object is tracked. Size of object and its distance from camera is calculated and stored in database. By using formulagivenbelow the distance of intruding object from camera can be obtained

$$\text{distance} = \frac{\text{distance of database object} * \text{intruding object's size}}{\text{Size of database object}}$$

By calculating distance covered by the object in two following frames obtained by camera and time period difference atween two frames, the velocity of intruding object can be calculated. This allows system to compute angle for launch of projectile and time when projectile has to be fired. Two servo motors are taken; one is used for motion of cannon in X-direction also other for Y-direction which together decides angle of projection. Angle of rotation of servo motor can be varied by making a change in width of PWM signal which is given at servomotor. 89v51RD2 microcontroller is used which has inbuilt PWM module in it.

III. RESULTS

For the proposed system, the experimental results are carried out by applying the input to our system. The experimentation is done over the MATLAB 2013a toolbox. The pre-processing is done on input image. In pre-

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processing convert image which is suitable for further processing. This includes image resize, image dilation erosion etc. The inbuilt MATLAB function such as imread, imresize are used to read image and to resize into required format respectively. Object segmentation is performed for the input image using canny and morphology segmentation method. After segmentation, defected feature are extracted by shape extraction and color detection method. This method of feature extraction provides more accuracy than any other extraction method.

The databases of 7 different images are used for training and testing set. Some of them contain object and some doesn't have an objects. The experimentation is done over the MATLAB 2013a toolbox. There are inbuilt commands in MATLAB to read image, for image preprocessing and for image segmentation. We need to develop some functions for feature extraction and for color detection. The output MATLAB windows to show the result of detection are given below.The results are taken for the methods. Let's see how the system is able to detect the objects. Consider one object from the database, after selecting this image in training mode; calculate shape description features and color of that image. Then store those results in database. Output on matlab window for selection of image and features results are given below:-

Fig 5.1 Database Object Input image

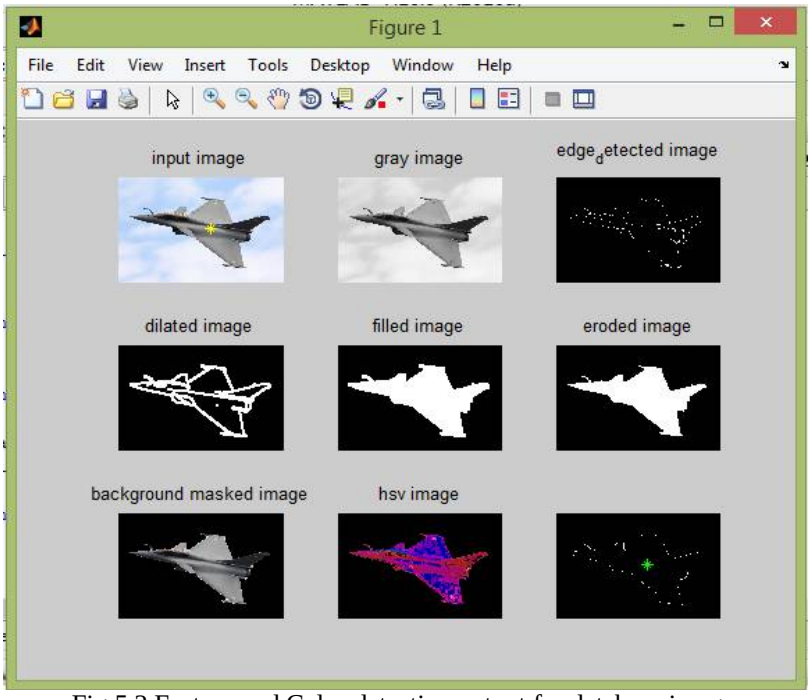

Fig 5.2 Feature and Color detection output for database image

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Extracted 36 Features for Database Image:-

0.560332017083254	0.541375956593857	0.526840626842317	0.462586660148849
0.559538036002030	0.716712163368083	0.627265879184737	0.556550518910535
0.360917304395904	0.303543658699918	0.266393945435503	0.245642676095824
0.234152854731530	0.227532606194409	0.226749695980807	
0.237849799902690	0.287251880728018	0.385126309748004	0.493688843460942 1
0.575170816942951	0.522040422098841	0.344160783798274	0.330571062878662
0.329358448412526	0.336783188065583	0.354391356448790	0.413610377390979
0.415179400262757	0.427784226272684		
0.380247052310313	0.342477360972063	0.320204246111397	0.310243610009115
0.308897254994491	0.713814147358308		

Now consider another image for testing and calculate both color and shape features for that image. Then after comparing those features with the features of image which is selected in training mode we get the result. For that calculate percent of match from the shape and color match. As a example let us consider 3 different cases.

CASE 1:- Object With No match.

Input Image:-

Fig 5.3 Input Test object 1

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Output Image:-

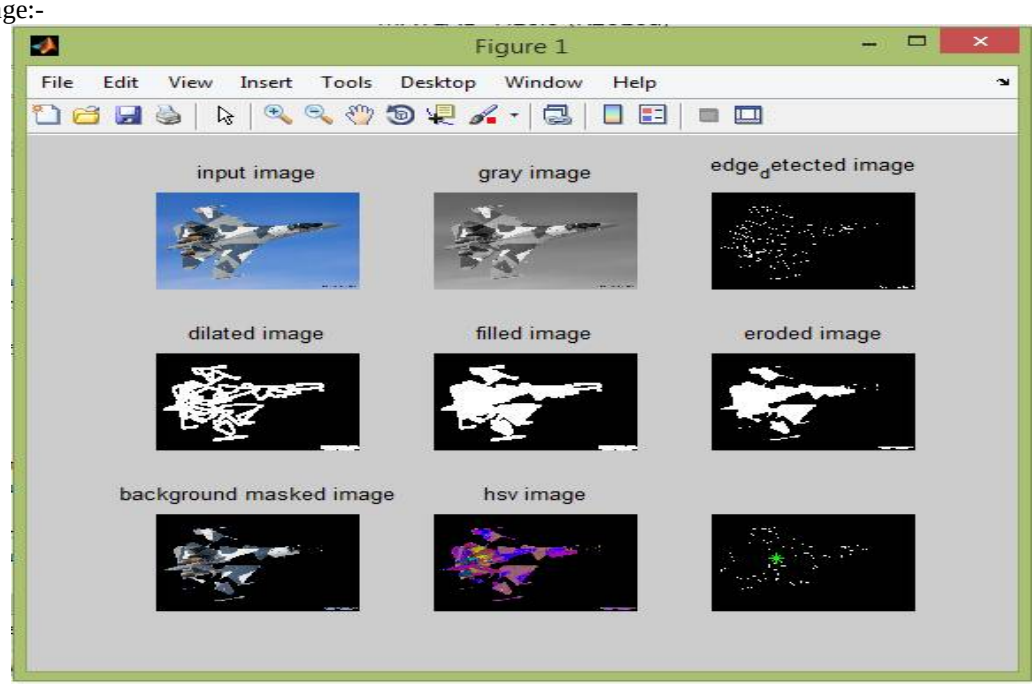

Fig 5.4 Output of test object 1

Percent match = 8.3333

36 Features for this image:-

0.718228376135520	0.158379578059924	0.676485459646402
0.655640708879314	0.661211248311013	0.792236718478984
0.725219201248156	0.612058273013411	0.457528451235520
0.526714245732769	0.378943753453842	0.524399306354944
0.826890093539965	1	0.923503700793313
0.838258069193207	0.786456786820005	0.782534057125821
0.766058783814317	0.828208915595772	0.849368611298256
0.711847778471750	0.504222491186515	0.327915851330136
0.251596206759946	0.215680980302943	0.207650841824681
0.311117046537777	0.310886930347611	0.314377900843481
0.330362004306858	0.360158922276082	0.396118359239492
0.626360967223376	0.868284671608983	0.247870772471093

So from the above results it is clearly seen that the object is not match with database object.

CASE 2:- Object With perfect match.

Input Image:-

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Fig 5.5 Test Object Input image 2

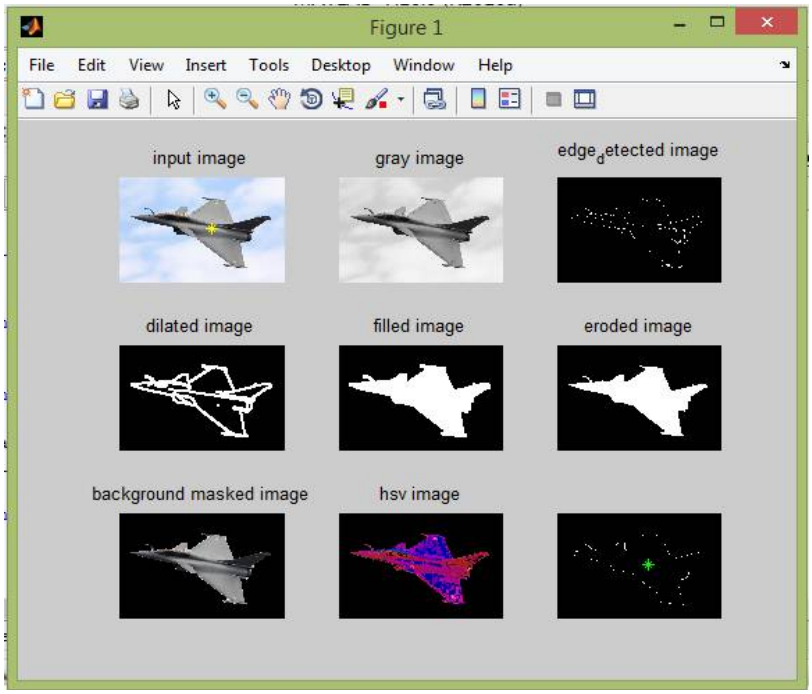

Fig 5.6 Feature and Color detection output for Test image 2

Percent match 100%

Extracted 36 Features for Database Image:-

0.560332017083254	0.541375956593857	0.526840626842317	0.462586660148849
0.559538036002030	0.716712163368083	0.627265879184737	0.556550518910535
0.360917304395904	0.303543658699918	0.266393945435503	0.245642676095824
0.234152854731530	0.227532606194409	0.226749695980807	

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0.237849799902690 0.287251880728018 0.385126309748004 0.493688843460942 1
0.575170816942951 0.522040422098841 0.344160783798274 0.330571062878662
0.329358448412526 0.336783188065583 0.354391356448790 0.413610377390979
0.415179400262757 0.427784226272684
0.380247052310313 0.342477360972063 0.320204246111397 0.310243610009115
0.308897254994491 0.713814147358308

From the above result of features it is seen that the object is perfectly match with database object

CASE 3:- Object With partial match

Input Image:-

Fig 5.7 Test Object Input image 3

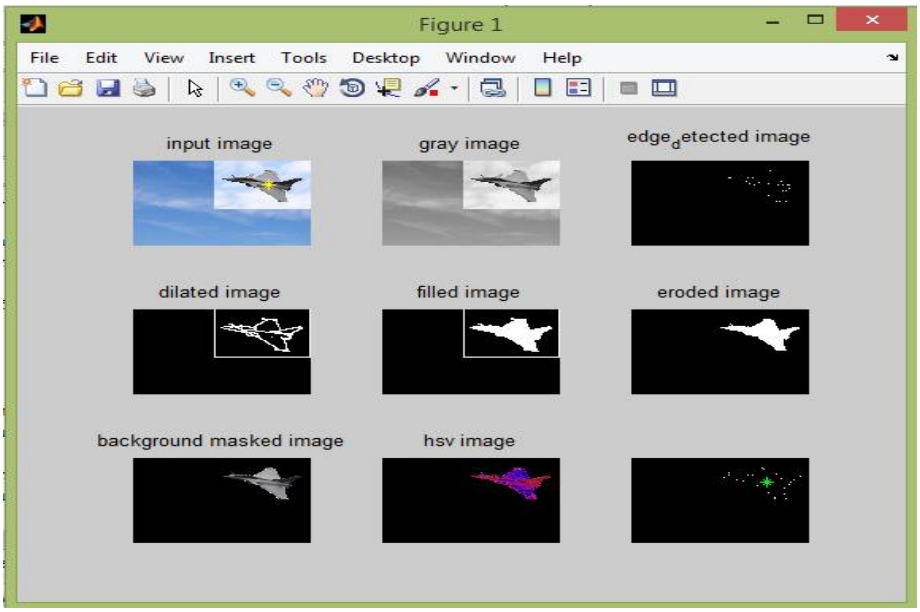

Fig 5.8 Feature and Color detection output for Test image 3

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Percent match =97.2222
Similarly 36 Extracted features for test image, from the above result of features it is seen that the object is partially match with database object.
7 different objects were stored in database. Out of total 80 trials, system correctly recognized, tracked and destroyed intruding objects in more than 74 trials. This brings 94% accuracy. For shape description, total 36 distances corresponding to 36 angles were calculated. If total 32 distance readings of intruding object and database object are matched then object is said to be recognized. If number of readings used for shape description is increased, then it drastically improves accuracy. More readings are taken, more accurately shape of the object can be described. If number of readings taken is doubled it increases total execution time.

IV. CONCLUSION

The system proposed in this paper is very useful for military applications where it is needed to detect and track the intruding object in the area under surveillance. A simple system is implemented which automatically detects and tracks the intruding object. This system avoids need of appointing human soldiers in entry restricted area where a very tight security is needed. Thus, precious life of human soldiers is taken care of. Simplicity of algorithm ensures operation of system in near real-time because of low execution time it is nearly 140ms and the greater accuracy of this system makes it better than other system. Simplicity also ensures low implementation cost.

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