Detection and Tracking of the Human Hot Spot

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Abstract: This work presents an algorithm that receives as input a stream of thermal imaging detects heat sources present in them and classify them according to their mobility. After performing the experiment and given the results, it is concluded that the algorithm performed is able to discern and classify the different types of human bodies as long as you can provide a set of detection parameters adjusted to the situation, indoor or outdoor; and with one or more persons.

1 INTRODUCTION

Capturing images in the infrared spectrum and its subsequent processing is as diverse as the detection of forest fires (Liew et al., 2005) areas (Vodacek et al., 2005) applications of hot spots in electrical networks (Ishino, 2002) (possible indication of a short circuit, as it is shown in figure 1) of buried landmines (Carter et al., 1998; Azak et al., 2003) and focusing a bit on people, face recognition (Heo et al., 2005; Socolinsky & Selinger, 2004; Jiang et al., 2004) of facial expressions and gestures (Jiang et al., 2005) of positions (Iwasawa et al., 1998; Imai et al., 1993) or even biometric features such as the arrangement of veins in the hand (Lin and Fan, 2004).

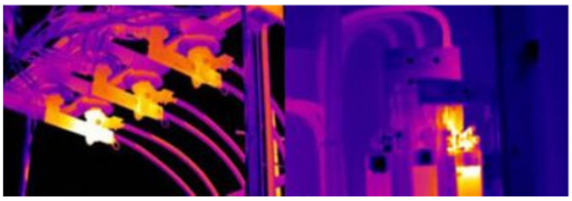

Figure 1: Hot spots in a grid.

Infrared detection supplements (and in some cases could replace) conventional video surveillance because, while relatively easy to hide in the eyes of others, not so much thermal radiation hide all bodies emit. As mentioned , the present design aims to design a system to detect heat sources in a scene and which is able to track the same, by means of a CCD camera operating in the IR band.

Although the heat source can be anything that is at a certain temperature, the application will be developed oriented to the detection and tracking of people, making it a system of monitoring and / or control regions.

A surveillance system of this type could be used to monitor the check-in counters at an airport, access to large areas like stadiums or shopping malls, parking for an office or a building block, the waiting section hospital emergency ... in general, all those places with large crowds.

In this project the development of an algorithm that, starting in the infrared spectrum captured scenes then rated heat sources present pursued. This classification is based on whether the foci remain in the same position and in the same way all the time or not.

2 USE OF THE THERMAL SENSOR

To capture thermal images and the construction of the database has been used a video camera company Guangzhou SAT Infrared Technology Co. (SATIR),

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SAT-280 model (see figure 2). This camera comes standard with features like interesting presentation profile or isothermal heat. It is capable of making measurements at specific points of the stage, designated by the user, or in areas of rectangular profile. However, regarding the development of the algorithm, only interested in the image.

Figure 2: Used IR camera and capture a person.

Regarding the capture settings , it was decided to establish an ambient temperature of 25°C and relative humidity was set at 0% because the idea was to study and common everyday situations. Since it is expected to find hot spots at different distances, about the parameter (default is 1 meter) was avoided. The emissivity of an object or surface is the ratio of thermal radiation that is capable of absorbing or emitting from that of a black body equal and varies between 0 and 1, the latter being the value for a perfect thermal emitter (Cromer, 1985). The human body has an emissivity of about 0.97 and does not change only the color of the skin. Under the conditions of employment provided, not some variation was observed in the imaging parameter to modify the emissivity so it was left to the default value, unity.

Presentation settings were used regularly the LEVEL and SPAN as the needs of the algorithm did not include regions of interest previously established. Neither wanted to do prior segmentation temperatures.

Table 1: Daytime measures, focus at 3 meters.

Distance (m)	Focus	LEVEL (ºC)	SPAN (ºC)	Comment
3	*	27	13	Acceptable
5	NO	27	13	Acceptable
8	NO	27	13	Confusion with ground
		30	13	Acceptable
10	NO	30	13	Acceptable
15	NO	30	13	Confusion with ground
		35	16	Acceptable

Before capturing images, tests were performed in an outdoor environment during the morning.

Table 2: Daytime measures, focus at 15 meters.

Distance (m)	Focus	LEVEL (ºC)	SPAN (ºC)	Comment
3	NO	30	13	Regular
5	YES	30	13	Acceptable
8	YES	30	13	Acceptable
10	YES	30	13	Acceptable
15	*	30	16	Acceptable
		35	16	Confusion with ground

And then tests were conducted in an indoor environment.

Table 3: Measures night, focus at 3 meters.

Distance (m)	Focus	LEVEL (ºC)	SPAN (ºC)	Comment
3	*	27	13	Confusion with ground
		30	13	Acceptable
5	NO	30	13	Acceptable
8	NO	30	13	Acceptable
10	NO	30	13	Acceptable
15	NO	30	16	Acceptable

Table 4: Measures night, focus at 15 meters.

Distance (m)	Focus	LEVEL (ºC)	SPAN (ºC)	Comment
3	NO	30	13	Acceptable
5	NO	30	13	Acceptable
8	YES	30	13	Acceptable
		27	13	Confusion with ground
10	YES	30	13	Acceptable
15	*	30	13	Acceptable
		27	13	Confusion with ground

Finally it was decided to perform detection based on the fact that the algorithm would be used in potentially changing scenes, that is, with hot spots appearing and disappearing of them, in the most general case. So to develop the algorithm is first recorded sequences of frames and then some videos. This has been referred to a frame sequence number of images relating to a scene. They are distinguished from the videos because the rate of frames per second in the sequence of frames is less than one. Based screening uptake levels of certain temperature and changing information between keyframes is showed when constructing an algorithm with satisfactory results. The camera has its own memory, but it could just shoot snapshots , so that it became necessary to connect the video output of the camera to a video capture card. The card used is a PCMCIA Card Imaging, Impex Inc., model VCE- B5A01 and is connected to a laptop Aspire 1600 Series, MS2135 model with Windows XP. The card software includes a simple program that can display the contents of the video input card. The captured video can be saved as sequences of frames or video file. In a line of work sequences of frames in which scenes were captured at a rate of frames per second less than unity, ie that passed between frames over a second were used, about a second and a half. These sequences, while useful to some extent, were eventually discarded and finally recorded a few videos in AVI format at a rate of 14 frames per second. Mainly due to disk space limitations, short sequences of less than one minute duration were recorded.

Eight thermal videos were recorded with the described capture device. Indoor and outdoor scenarios were used; and the focus goes in one motion. The main characteristics of each video are summarized in the following table 5.

The first column gives the name of the video in code, in the second column duration (time) is given in seconds and the third a brief description.

The videos were recorded during daylight hours. The camera was focused on objects eight to ten meters. The LEVEL and SPAN values were set to (L: 30, S: 13). The format is AVI videos, all have a rate of 14 frames per second and a size of 325 x 288 pixels.

Table 5: Description of the thermal videos.

Name	Time	Description
ip	9	Interior. A person sitting at a table.
ip2	24	Interior. A person sitting at a table, remains a few seconds and then it rises.
iev	51	Interior. A person crosses a corridor lit with fluorescent at different times.
ief	38	Interior. Two people stand before food machines. Extra people appear and disappear in the scene.
ep	29	Exterior. The scene is empty much of the time, except for one person that appears, remains static for a few seconds and then leaves.
eev	29	Exterior. Scene empty most of the time, except for one person who crosses a moderate speed.
eef	29	Exterior. A few people move to the back of the stage. Soon a person is in the foreground, is fixed a few seconds and then leaves.
eef2	29	Exterior. The scene is empty much of the time, except for one person that appears, remains static for a few seconds and then leaves.

3 DEVELOPMENT OF THE ALGORITHM

So then he decided to create a tool prior calibration.

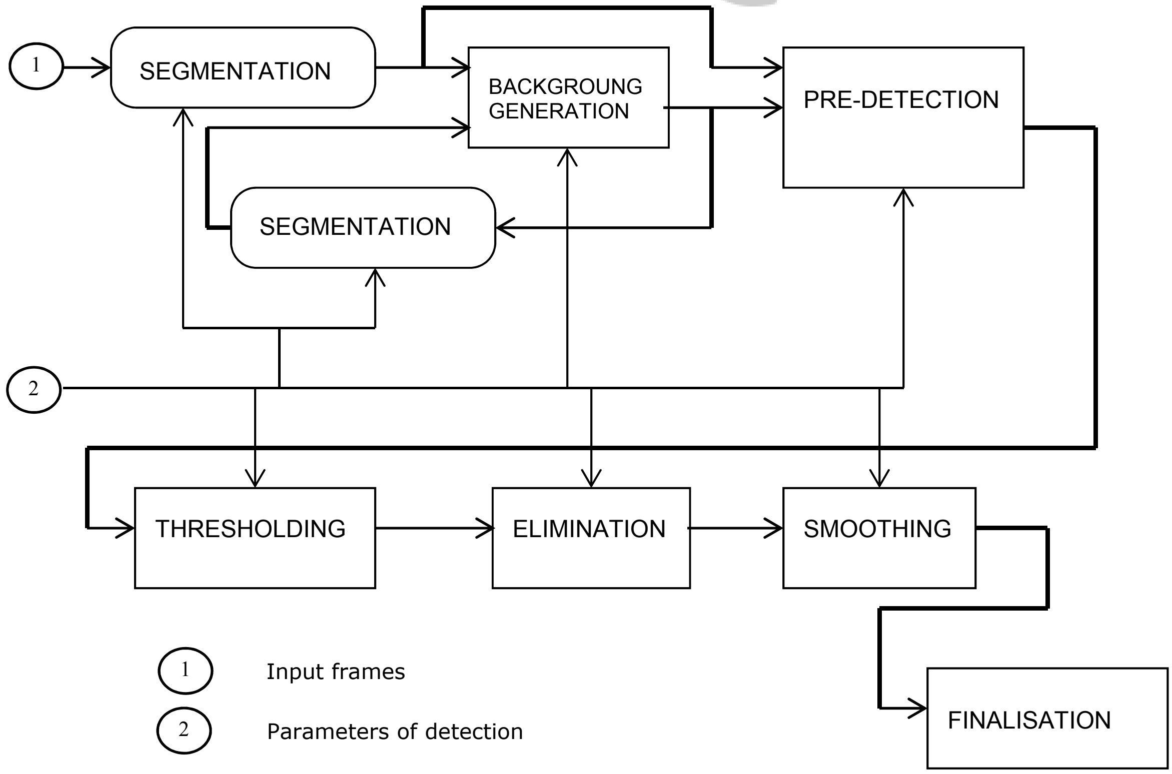
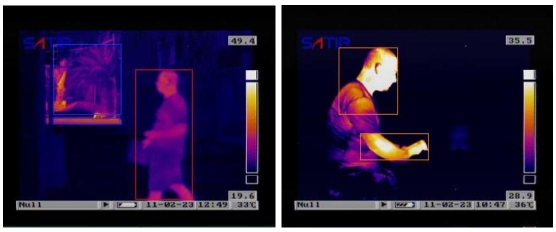


Figure 3: Functionality of the detector algorithm.

With this tool, the user designates (indirectly) the temperature ranges to be searched. Each user must analyze for your particular case scenario, choose as representative situation possible and take a thermal snapshot. With this calibration image, the user can develop a set of parameters that the detection algorithm used for detection. It is also possible (if the particular case requires) designate areas of no interest , regions where the algorithm simply discard the information collected.

With this tool calibration algorithm was practically finished and adopted the following structure, identical to the final version. The description of the subsystems is the following;

- Background generation: generates the background of the current detection information from the captured frame and the funds generated in previous detections.
- Segmentation: using generated parameters calibration algorithm to remove information considered irrelevant.
- Pre-detection: subtracts the background generated segmented frame and passes the result to grayscale.
- Thresholding: set an even clearer difference between lights and background.
- Elimination: performs a clean image, eliminating small and unimportant areas.
- Smoothing: recovers lost data or reconstructed in previous steps.
- Finalisation: classifies heat sources and found a box marked with different color depending on the type.



(a) Acceptable detection (b) Improving detection

Figure 4: Detection Effectiveness.

4 RESULTS

Detection is considered "acceptable" if the algorithm has been able to frame a person properly classify its evolution, while detection is called "improved" if the person framing elements are included scenario, if the figure of a person has been fragmented into more of a focus, or if its evolution has been misclassified.

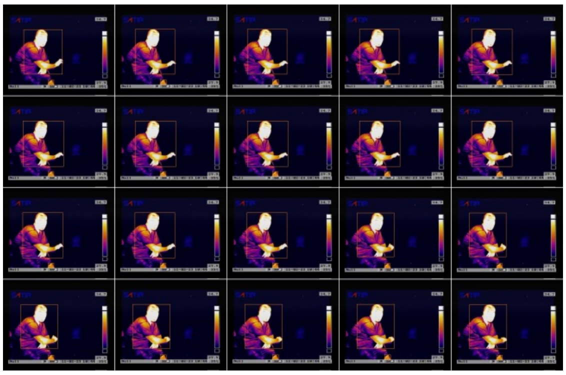


Figure 5: Detection of “ip”, frames 99-118.

Some examples for some of the different types of data recorded in Figures 5-8 are displayed.

Applying these criteria resulted in the videos, and the parameters of the our dataset the following table 6 is obtained.

For each video total detections in which people appear in the second column is specified. In the third column these detections are distinguished acceptable in the upper part and the bottom improvable. In the fourth column the percentage being relative to the total detections people.

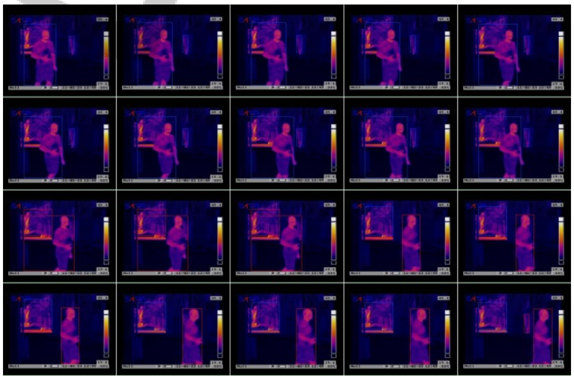


Figure 6: Detection of “eef2”, frames 390-409.

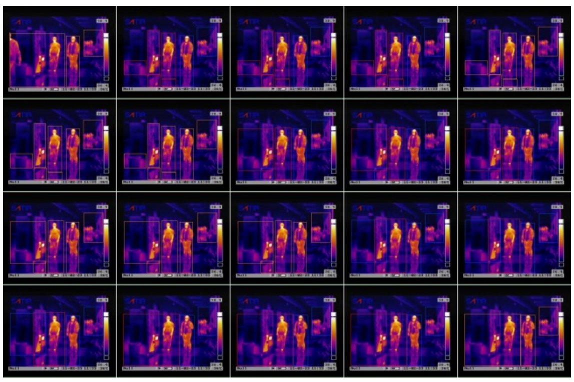


Figure 7: Detection of “ief”, frames 99-118.

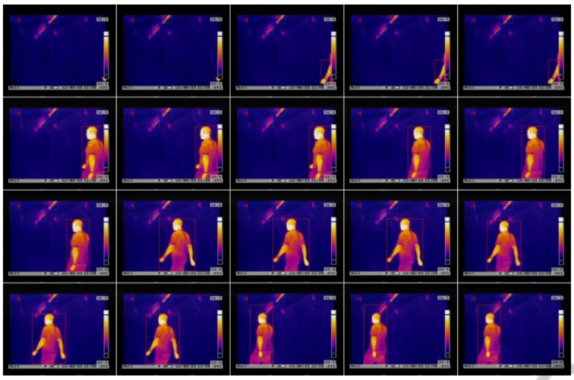


Figure 8: Detection of "iev", frames 158-177.

It is noted that these criteria, the algorithm does not seem particularly effective, but if, for example, is considered an acceptable detection to detect a person at different points, only for IP and IP2 videos would be 100% of detections.

Table 6: Accuracy on the person detection.

Type of video	Total	Acceptable / Improvable	Accuracy (%)
IP	33	20	60,61
		13	39,39
IP2	113	42	37,17
		71	62,83
IEV	86	38	44,18
		48	55,81
IEF	121	35	28,93
		86	71,07
EP	45	8	17,78
		37	82,22
EEV	12	12	100
		0	0
EEF	73	2	2,74
		71	97,26
EEF2	85	8	9,41
		77	90,59

5 DISCUSSION AND CONCLUSSIONS

This work has developed an algorithm detector heat sources. This algorithm needs the support of a calibration tool , which is a graphical user interface that generates some of the sensing parameters. To do this the user must use a fixed thermal image (photo), representative of the scenario in question. The sensing device consists of an infrared camera with its video output connected to the input of an acquisition card inserted into a computer. Recording in AVI format generated is input to the algorithm, which generates a video output with the same number of frames, and frames per second that the detected foci are framed by a rectangle. These boxes can be different colors and indicate the nature of the sources found. By default, the cuasidinámicos framed by orange lights, that is, those who are continuously detected in the scene and whose position and dimensions vary slightly over time. They are framed in blue static red lights and dynamic . When a scene foci appear and disappear continuously, are considered static those whose position and dimensions vary slightly detection in dynamic detection and those whose evolution is more noticeable.

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