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Scorpion image segmentation system

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Abstract. Death as a result of scorpion sting has been a major public health problem in developing countries. Despite the high rate of death as a result of scorpion sting, little report exists in literature of intelligent device and system for automatic detection of scorpion. This paper proposed a digital image processing approach based on the floresencing characteristics of Scorpion under Ultra-violet (UV) light for automatic detection and identification of scorpion. The acquired UV-based images undergo pre-processing to equalize uneven illumination and colour space channel separation. The extracted channels are then segmented into two non-overlapping classes. It has been observed that simple thresholding of the green channel of the acquired RGB UV-based image is sufficient for segmenting Scorpion from other background components in the acquired image. Two approaches to image segmentation have also been proposed in this work, namely, the simple average segmentation technique and K-means image segmentation. The proposed algorithm has been tested on over 40 UV scorpion images obtained from different part of the world and results obtained show an average accuracy of 97.7% in correctly classifying the pixel into two non-overlapping clusters. The proposed [1]system will eliminate the problem associated with some of the existing manual approaches presently in use for scorpion detection.

1. Introduction

Scorpion envenomation has been a major public health problem around the world. Despite the high rate of death as a result of scorpion sting, the approaches of detection of this poisonous arthropod's have been of the medieval approach [1-6]. Available approaches to scorpion detection are crude and time consuming as it sometimes involves the presence of an investigator. Thus, new approach of detection using image processing is proposed in this work.

Scorpions are arthropods which are poisonous and found in several habitats, they are of the class Arachnida and of the order scorpiones [6]. They are nocturnal and feed at night on a variety of insects; scorpions sometimes used their venom for defence and predation [1].

Scorpions cuticle fluoresces a brilliant cyan-green under ultraviolet (UV) light. Scorpion investigators use this unique characteristic to sample these arthropods at night. Two molecules at their

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cuticles, beta-carboline and 4-methyl-7-hydroxycoumarin, is responsible for the fluorescence [4]. Their exoskeleton Fluoresces green when they are exposed to Ultraviolet light [4]. Figure 1a show scorpion under ultraviolet light while figure 1b show scorpion under natural light. The rest of this paper is organised as follows, section 2 is a review of scorpion detection technique, section 3 is the methodology, section 4 is the result and discussion of the results, section 5 of the work is the conclusion while the last part section 6 is acknowledgement.


(a)

(b)

Figure 1: (a) Scorpion under UV light. (b) Scorpion in Natural environment.

2. Review of scorpion detection technique

Scorpion detection technique sometimes referred to as scorpion sampling technique [8, 10] can be categorise into two, namely the unaided detection method and the aided detection method. The former method is further subdivided into Rock rolling, location burrowing detection technique, and peeling loose back of tree detection technique. The aided detection technique is subdivided into the use of ultraviolet flashlight and touch, and the use of pitfall traps [7, 10].

Rock rolling detection technique involves opening up rock and checking the presence of this arthropod's in there shelter under the rock [8]. The location of burrow detection method involves locating appropriate shelter under burrows and digging up the burrow for scorpion acquisition [10]. Figure 2a show scorpion burrow while Figure 2b show loose bark of tree where scorpions use as shelter.


(a)

(b)

Figure 2: (a) Scorpion Burrow. (b) Loose bark of tree.

The Peeling loose back of tree detection method involves peeling back of trees in the day time to search for scorpions [3]. The aforementioned methods are crude and time consuming, unreliable, and dangerous. Furthermore, if proper care is not taking the person carrying out the search might get sting by scorpion. The finding that scorpions florescence under ultraviolet wavelengths of black light has led to the use of ultraviolet light in the detection and study of scorpion [5], in this detection technique ultraviolet touch are used by investigator, who searches an area in the night for possibility of locating scorpion [8,9], Figure 3a show an investigator using UV light for scorpion detection.The use of UV is also time consuming and crude and involve the presence of a person for possible detection of this arthropods.

The pitfall detection technique involves setting pitfall traps for scorpion, by digging up ground surface for trap setting, covering and checking for possibility of catching scorpion; Figure 3b shows a pitfall trap.


(a)


(b)

Figure 3: (a) Scorpion fluorescence under UV light. (b) A pitfall trap.

Similarly this technique is not suitable for some environments and it is time consuming [8,10]. Hence the use of image processing technique has been proposed in this work as alternative detection technique.

One of the key features of the proposed technique is the colour segmentation approach. This involves analyzing the captured image using the RGB information. Hence detailed review of colour segmentation is undertaking in this section. In Colour-based segmentation of berlin edema from fundus image, using K-means clustering algorithm [11], the input image was sharpened using Laplacian filter mask of 3*3 matrix, then the image was pre-processed with Laplacian filter mask, K-means clustering was used for pixel based segmentation of the image, fifteen fundus images (768X576) resolution was used [11].

The detection of colour image, using saturation invariant in color image and hue invariant to detect edges and corner of the image was reported in [12], The dichromatic reflection model for colour mode analyses was use in getting the hue invariant, and the saturation invariant of the colour to detect the edges of the image. Extension of Haris detector in colour space to detect the corners of the colour image using invariant of hue and saturation [12]. Colour images were collected from Google image [12].

In lip tracking using local region based approach to tracking, [13] divide the local region based approach into lip colour extraction for the first lip frame and tracking of the lip frame after the colour extraction, the tracking algorithm uses a lip contour extraction for the first lip frame and a lip tracking in the second phase an illumination equalization was used to reduce the lighting asymmetry of the lip, it uses a 16point geometric deformable model to model lip shapes [13]. Two hundred (200) frontal face image from the CVL face database and five hundred (500) from the laboratory database was used in evaluating the performance of the system. The review of segmentation of images with multi-objectives using weighted formula approach and pareto approach was carried out in [14], approaches to multi-objective segmentation and image clustering was compare, using images from UCI repository and the brain web.

Improved thresholding-based segmentation under natural environment was proposed in [15]. Detailed investigation and comparison of three different techniques was done in the work. It was concluded that TsTN outperform other techniques due to uneven illumination in the acquired images. The use of color information for recognition and sorting of fruit was proposed in [16]. It was shown that the use of any of the three techniques proposed in the work is sufficient for identifying and classifying apple, Banana and Mango from an acquired image [16].

3. Methodology

The main stages used in the design of the algorithm is made up of two framework namely, image pre-processing and image segmentation. A General block diagram of this framework is shown in Figure 4.

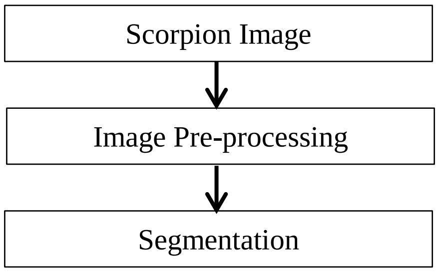

Figure 4: General block diagram of the framework

Based on Figure 4, two new approaches for Scorpion segmentation have been proposed in this work. The first method involve the block diagram shown in Figure 5. In this approach, the image pre-processing stage involves conversion of the image from RGB to YCbCr colour space to see which of the channels of the colour space provides a better quality image for segmentation.

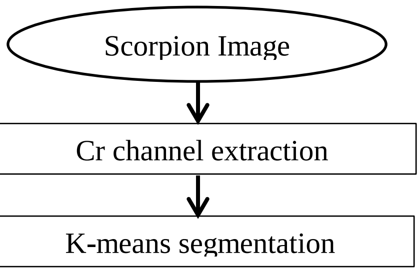

Figure 5: Block diagram of the K-means Segmentation approach

The input image was converted to the YCbCr colour image using the mathematical relation shown in equation (1):

$$\begin{bmatrix} Y \\ Cb \\ Cr \end{bmatrix} = \begin{bmatrix} 16 \\ 128 \\ 128 \end{bmatrix} + \begin{bmatrix} 0.25678824 & 0.50412941 & 0.09790588 \\ -0.1482229 & -0.29099279 & 0.43921569 \\ 0.43921569 & -0.36778831 & -0.07142737 \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix} \quad (1)$$

The K-means image segmentation is carried out using the mathematical relationship given as

$$L = \sum_{j=1}^{k} \sum_{i=1}^{n} a_{ij} \left\| x_i - \mu_j \right\|^2 \quad (2)$$

Where the given data points $n = (x_1, x_2 \ldots\ldots\ldots. x_n)$ and K is the number of clusters $K = (\mu_1, \mu_2, \ldots\ldots\ldots \mu_k)$.

The second technique involves the use of the block diagram shown in Figure 6. The green channel of the RGB scorpion image is extracted for further segmentation using simple averaging technique.

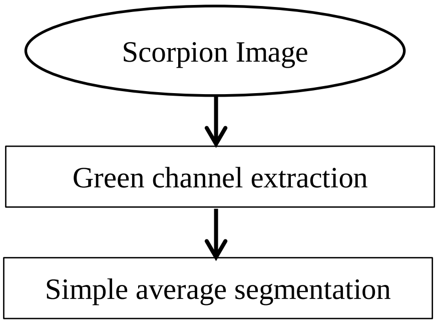

Figure 6: Block diagram of the simple Average Segmentation approach

The simple average thresholding invole the use of (3).

$$\bar{X} = \frac{\sum_i^m k_i}{m} \qquad (3)$$

Where $\bar{X}$ is the mean of the image, m is the total intensity value of foreground image, and k is the total intensity value of the foreground image.

$$g(x,y) = \begin{cases} 1 & if\ f(x,y) > T \\ 0 & if\ f(x,y) \leq T \end{cases} \qquad (4)$$

Where $g(x,y)$ and $f(x,y)$ are pixel value of binary image and the pixel value of the green channel image.

The green channel of the RGB image used for thresholding is expressed in equation (5) below

$$f(x,y) = I(x,y,2) \qquad (5)$$

$$where\ I(x,y,2) is\ the\ green\ channel\ of\ the\ original$$

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4. Results and discussions

Performance evaluations of the proposed methods were done using the receiver operating characteristics (ROC). Pixels will be classified into True Positive (TP), False Positive (FP), True Negative (TN) and False Negative (FN).

False positive are regarded as background pixels incorrectly classified as foreground pixels while TN are background pixels correctly classified as background pixels [17-19]. Furthermore, FN are foreground pixels that are incorrectly classified as background [17,18]. Similarly TP are foreground pixel that are correctly classified as foreground.

Performance evaluation of the system was done using true positive rate, true negative rate, false positive rate and false negative rate. Other performance metrics include:

TP: True Positive Detection; TN: True Negative Detection
FP: False Positive Detection; FN: False Negative Detection
MP: Missed Point; PR: Precision
FPR: False Positive Rate; TPR: True Positive Rate

SN: Sensitivity; Acc: Accuracy
SP: Specificity; ToC: Time of Completion
The TOC is a measure of the time taken for complete segmentation. Other metrics are defined as

$$PR = \frac{TP}{TP + FP}$$

$$FPR = \frac{FP}{N}$$

$$TPR = \frac{TP}{P}$$

$$SN = \frac{TP}{TP + FN}$$

$$SP = \frac{TN}{FP + TN}$$

$$Accuracy(ACC) = \frac{TP + TN}{P + N}$$

The ground truth segmented images was done using adobe Photoshop cs5 extended version 12.0.2x 32. The images were imported into the workspace and the quick selection tool was used to select the whole area of the image for segmentation. The result obtained from the application of K-means segmentation technique and simple average segmentation technique, are as shown in Table 1-2 below.

Table 1
The receiver operating characteristics (ROC) of the K-means segmentation technique.

Details	**ROC of the Cr channel**				
No	**ACC**	**PR**	**TPR**	**FPR**	**Toc**
Im1	0.9463	1.0000	0.9593	0	0.2537
Im2	0.9421	1.0000	0.8408	0	1.5554
Im3	0.9729	1.0000	0.9347	0	1.6154
Im4	0.9615	1.0000	0.9104	0	1.4102
Im5	0.9751	1.0000	0.9091	0	0.1237
Im6	0.9655	1.0000	0.9245	0	1.3812
Im7	0.9761	0.9978	0.9865	0.0005	1.3930
Im8	0.9566	1.0000	0.8784	0	2.0971
Im9	0.9864	1.0000	0.9920	0	1.5990
Im10	0.9826	1.0000	0.9913	0	1.6382

Table 2
The receiver operating characteristics (ROC) of the simple average segmentation technique.

Details	**ROC of the Green channel**				
No	**ACC**	**PR**	**TPR**	**FPR**	**Toc**
Im1	0.9658	1.0000	0.8270	0	0.0032
Im2	0.9513	1.0000	0.7445	0	0.0027
Im3	.9802	1.0000	0.8239	0	0.0029
Im4	0.9686	1.0000	0.8182	0	0.0030
Im5	0.9968	1.0000	0.8798	0	0.0002
Im6	0.9744	1.0000	0.8430	0	0.0027
Im7	0.9898	0.9996	0.9467	0.0001	0.0028

Im8	0.9627	1.0000	0.7775	0	0.0029
Im9	0.9940	1.0000	0.9575	0	0.0028
Im10	0.9884	1.0000	0.9233	0	0.0032

Results obtained as shown in Table 1-2. It shows that the accuracy value obtained in the Simple average segmentation technique of the green channel is better than that obtained from the K-means segmentation of the Chroma red channel. Furthermore, it was observed that the precision of the simple average segmentation technique is better than that obtained from the K-means segmentation technique. Similarly, it was observed that the time of completion of execution of the simple average segmentation technique is faster than K-means segmentation technique. Samples of resulting images are shown in Appendix I

5. Conclusions

Scorpion stings which are vital health issue that requires a considerable attention in minimizing the pain inflicted on victims and possibly avert death. A possible way of achieving this is the capability of being able to detect the presence of these arthropods earlier before it stings its victim. This paper proposed the use of digital image processing approach for the detection of scorpion. It has been shown that the simple averaging of the Green channel of the acquired RGB image is sufficient for segmenting the image from the background. Furthermore, the risk associated with the use of ultraviolet touch detection technique and pitfall trap which involves the presence of an investigator and also time consuming is being eliminated by the novel digital image processing approach proposed in this paper.

Acknowledgement

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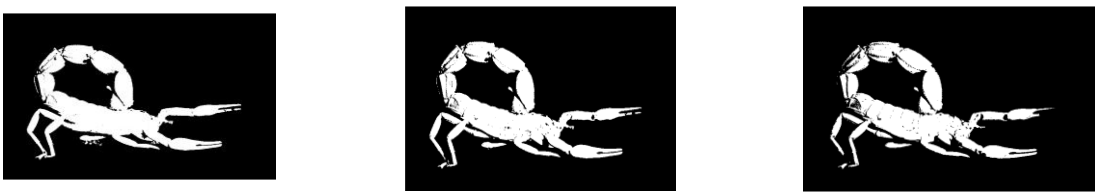
Appendix A.



a b c

Figure 7: (a) Ground truth (b) K-means Segmentation (c) Simple Average Segmentation

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