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Mobile Application for Recognition of Arachnids' Bites: An Approach based on Ambient Intelligence

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Abstract. In various regions of the world, the bite or sting of a spider is crucial, especially in children. This problem can produce in some cases, benign symptoms where they do not need medical treatment, others, usually present complications due to scratching and with this cause a superinfection in the lesion. These accidents require treatments to prevent death, amputations or permanent sequelae. Likewise, the impact of sequelae and deaths represent a high burden on health, society and economy. For this problem, currently, a recognition system has not been developed to help address this problem. On the other hand, the objective of this paper is that, with Ambient Intelligence, it is allowed through telemetry and knowledge management systems can be supported in a remote diagnosis that affects the improvement of the diagnosis made and its potential long-term use for a substantial improvement of the patient, generating recommendations, through a mobile application that is connected to a center of specialties, near the City of Misantla.

Keywords: Ambient intelligence, bite spider, arachnid poison, telemetry, remote diagnosis, intelligent system.

1 Introduction

In Mexico, there are approximately 50 families comprising 5,579 arachnid species, but of these only a dozen of the families Theriidae and Loxoscelidae, with the genera

Latrodectus and Loxosceles cause problems for humans [1]. There are 100 species of violinist spiders worldwide, and the most toxic are found on the American continent, especially in South America and are called Loxosceles reclusa, Laeta, Boneti. It is commonly known as a violinist, brown, brown spider, among others. Its habitat is dark temperate, moist and poorly ventilated places, such as sheds, wooden warehouses and warehouses [2]. Spiders are invertebrates of the arachnid family, such as ticks and scorpions. They are characterized by being carnivorous (even cannibals) and hunting characters, since they only eat live prey, that is, insects that hunt, since they do not eat the dead ones. All spiders have small poisonous glands, with more or less poison to kill their prey [3].

The spiders, in order to kill their prey, inject the venom through their chelicerae, two appendices with a powerful musculature and a sharp distal nail that nail the prey. The venom comes from a poisonous gland located in the cephalic zone, which drains directly to the chelicerae through ducts [4]. The spiders of the genus Loxosceles are characterized by being not very aggressive, since they only bite when provoked. They are nocturnal and hide in dark places where they wait for the prey to jump over, since they make little use of the spider web.

1.1 Spider Bite

Most bites by spiders are resolved without complications, when a timely intervention is made on them. However, in local loxosis by recluse spider, the necrosis of the skin can be serious and requires an exhaustive management of the wound, until surgical treatments and depending on the affected member. Therefore, it is impossible to know what kind of spider the aggressor has been, at the moment when it bites. As well as identifying the place to which they should turn, that is, a center of specialty where they attend this type of emergency.

Ambient intelligence is a multidisciplinary approach that aims to improve the way environments and people interact with each other. Make the places where they live and work are more beneficial for people. The main peculiarity of the technological development of digital environments is that they can produce a reinforcement and even an amplification effect of the cognitive abilities of people. In this sense, we can speak of the existence of a specific type of intelligence: ambient intelligence [5]. And, everything that requires a clinical and diagnostic model falls within the ambient intelligence. Since spider bites are analyzed with a medical database.

It is known that spiders respond to a wide variety of ambient conditions and can be indicators of plant associations and habitat disturbances [7]. Therefore, the objective of this paper is to develop a mobile application that recognize arachnid bites to optimize medical diagnostic processes in children and generate recommendations to channel the patient to a specialty center closest, in case of presenting this problem.

In addition, we need to reduce the risk of death in infants, which has been reflected in the center of Veracruz, Mexico, caused by arachnid.

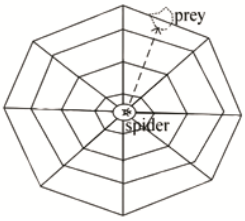

Fig. 1. Spider prey sketch.

Spiders have been a source of intrigue and fear for humans for centuries, and there are numerous myths about the medical effects of spiders. Many people believe that the bites of several species of spiders cause necrotic ulceration, despite the evidence that most suspected cases of necrotic arachnoidism are caused by something other than a spider bite. Latrodectism and loxoscelism are the most important clinical syndromes resulting from the spider bite. Latrodectism results from the bites of widow spiders (Latrodectus spp) and causes local, regional or generalized pain associated with non-specific symptoms and autonomic effects. Loxoscelism is caused by Loxosceles spp, and the cutaneous form manifests as pain and erythema that can develop into a necrotic ulcer.

Systemic loxoscelism is characterized by intravascular hemolysis and occasional renal failure. Antivenoms are an important treatment for spider poisoning, but they have been less successful than those for snake poisoning, with concerns about their effectiveness for both latrodectism and loxoscelism [8]. The bite of an arachnid can have great complications, such as necrosis. This is the degeneration of a tissue by the death of its cells. This mortality is produced by the action of a harmful agent that generates an irreparable injury. On the other hand, we find the one that is produced as a result of a series of changes in the cell that is the one that, by itself, decides that it has to die. This is a main element in the investigation. Therefore, it is essential that when a person presents this problem of arachnid bite, it is urgently addressed since otherwise it could result in deat in it, if not treated immediately.

1.1 Spider Web Definitions

Definitions of the spider web. In nature [9], the spider is based on the great network for the life of its prey. In most cases, the cobweb structure is approximated as a potential center of symmetry (see Fig. 1).

The cobweb, consists mainly of three parts, namely the center point, the radius and the spiral silk thread. The radiation that comes out of the center of the silk is called convergence (ray), used as a spider's web, the silk spiral thread of the ray is called chord (spiral). Through the web, spiders can feel the vibration to determine if there are prey and their net position. Each ray of the web will transmit the vibrations to the center of the web, so the spiders will usually remain in the center waiting for information.

Differences between dangerous and non-dangerous spider webs:

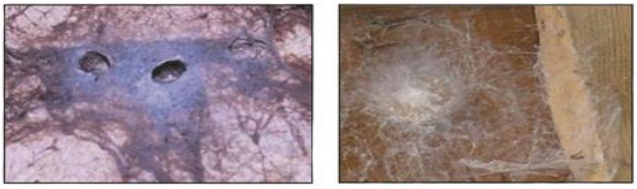

Fig. 2. Loxosceles fabrics. Irregular, cottony, compact, with apparent disorganization.

Fig. 3. In general, they are regular, organized, symmetrical and demarcated.

a) Dangerous spider webs, Fig. 2.
b) Non-dangerous spider webs, Fig. 3.

Spider Morphology

As well as insects, spiders and other arachnids have two main parts in their body. The anterior part of your body is the cephalothorax or prosoma. The dorsal part of the cephalothorax is called the carapace, the ventral part is known as the sternum. The back of the body is called abdomen or opisthosoma. The body is divided into 2 regions or labels: the prosoma (previous) and the opisthosoma (posterior to), joined by a structure called pedicel, which can be a marked constriction in some arachnids (union caulogaster, for example, spiders and amblipigids), or a wide union of both labels (hologaster union, for example, scorpions and opiliones).

The prosoma has 6 pairs of appendages: chelicerae (2-3 segments), pedipalps (maximum 6 segments) and 4 pairs of ambulatory legs (7 segments that can be subdivided or merged depending on order). The dorsal part of the prosoma is usually covered by a shield or carapace, which lacks antennas and where the ocelli are found, which can be from scratch in the case of troglobian species or that inhabit caves, 2, 4, 6 and even 8 ocelos, always in even numbers. The opisthosoma may or may not be segmented and generally lacks segmented appendices (or are highly modified); In addition, in this region are the reproductive and respiratory structures [10].

2 Analysis of Related Works

Experts from the Arachnology Laboratory of the Center for Parasitological and Vector Studies [11], created a digital system that allows users to take pictures with their mobile devices and identify the different species of arachnids and scorpions, and in turn, identify arachnid species that pose some kind of risk to human health as well as harmless ones. Sergio Rodriguez Gil, one of the creators of the application that goes by

Table 1. Degree of poisoning from arachnid bite.

Degree of intoxication	Clinical picture
Grade I / mild	Pain in injury site, in lumbosacral region, abdomen. Asthenia, adynamia, diaphoresis, sialorrhea, hyperreflexia.
Grade II / moderate	Accentuated dyspnea, epiphora, headache, spasm, contracture or muscle rigidity, priapism.
Grade III / severe	Accentuated miosis, mydriasis, trismus, heart rhythm disorders, bronchospasm.

name: Is it a spider or a scorpion? This is a tool created in Argentina, which serves the community so that, on the one hand, it has enough information about these animals and can differentiate which are dangerous and, on the other, so that it is possible to report their presence more quickly.

This innovation is now available to download in different digital stores for devices with Android operating system. In addition, from the immediate service received by the community, the data collected by the application is configured as a great information base for future scientific work: "What users send allows mapping the zones of appearance and seasonal behaviors, and even giving a notion about the reactions generated by the presence of these species, the erroneous or accurate preconceptions that circulate about them in society" [12]. Its operation is very simple. The first thing the user must answer is whether the animal in question stung it or not. If the answer is affirmative, a notification arrives as a matter of urgency and the first recommendation is that you approach the closest attention center so as not to delay the attention.

Another spider identification assistant made for mobile devices, is called "Spidentify", created in Australia. This application was created by Minibeast Wildlife who reveals the mysteries of one of the most feared animal groups in Australia and places a lot of detailed information on 250 arachnid species. This tool identifies detailed information about each spider, including an instantly accessible bite danger classification. Useful pop-up windows explain technical words in a simple language. Users in this application can browse the field guide by category, including habitats and families. Search the place to show any species in the application, search terms in the glossary or find closely related species. The complementary content explains the spider's anatomy, dispels myths, answers common questions and more [13].

3 Recognition of Arachnid Bites

3.1 Epidemiology, Diagnosis and Prevention

The epidemiology of a spider bite depends on the interaction between the spider and humans, the ecology of the spider and the ambient. The distribution of spiders of medical importance is the most important factor in the identification of where clinically

important arachnidism occurs throughout the world and is analyzed for each of the spider groups [14].

The diagnosis of spider bite [15], is usually clinical, and the defined bites must be based on a clear history of a spider that bites the person and is then identified.

3.2 Treatment

Antivenoms are an important therapeutic intervention for poisoning syndromes, and antivenoms exist for many groups of spiders [5]. However, antivenoms have been less successful in the treatment of arachnidism than those of snake or scorpion poisoning. The use of antivenom is based on clinical experience, which has led to discrepancies in the proportion of patients treated. For example, in Brazil, antivenom is rarely used to treat Phoneutria poisoning despite substantial and distressing effects, but it is widely used to treat Loxosceles poisoning, although in theory it is unlikely to be effective [6].

Although Loxosceles antivenom is used in South America and is an effective invitator, the delay in clinical presentation and the irreversible nature of skin necrosis mean that this laboratory finding does not translate into effective treatment [16]. In contrast, antivenom for tissue poisoning in the form of a funnel fabric is highly effective and can save lives because early and inverse neurotoxic effects can be administered [5].

3.3 Methodological Proposal for the Recognition of an Arachnid Bite

According to the tests, the use of a mobile application is feasible, to identify the bite of a spider and to know which was the aggressor, using photographs in real time for the cases. This investigation tries to recommend the patient with said problem, to the place where it should be resorted in case of bite of a poisonous spider, to avoid the amputations or even the death of said spider in the case of some child.

Since, it is impossible to know what kind of spider the aggressor has been, when he bites and the idea of not knowing what species has been attacked in a person, is one of the main problems for this work. That is why with AmI, a series of tools to solve this problem arise, which in this case are technology, information, image processing, among others.

3.4 Design of the Mobile Application

The georeferencing of the location to identify the place that should be attended to avoid a tragedy, determining the correct center of specialties to treat the problem based on the arachnid bite, using a mobile application, which makes possible a decisive aspect where it is recommended catalyze the patient to the right place, at the right time.

Using a georeferencing model, it is possible to determine the precise location of the different places where medical care is carried out, so that, through the telemetry and knowledge management systems, a remote diagnosis for babies is admitted. they suffer the bite of a spider and that affects the improvement of the diagnosis made, as well as its potential long-term use for a substantial improvement of the patient (see Fig. 5).

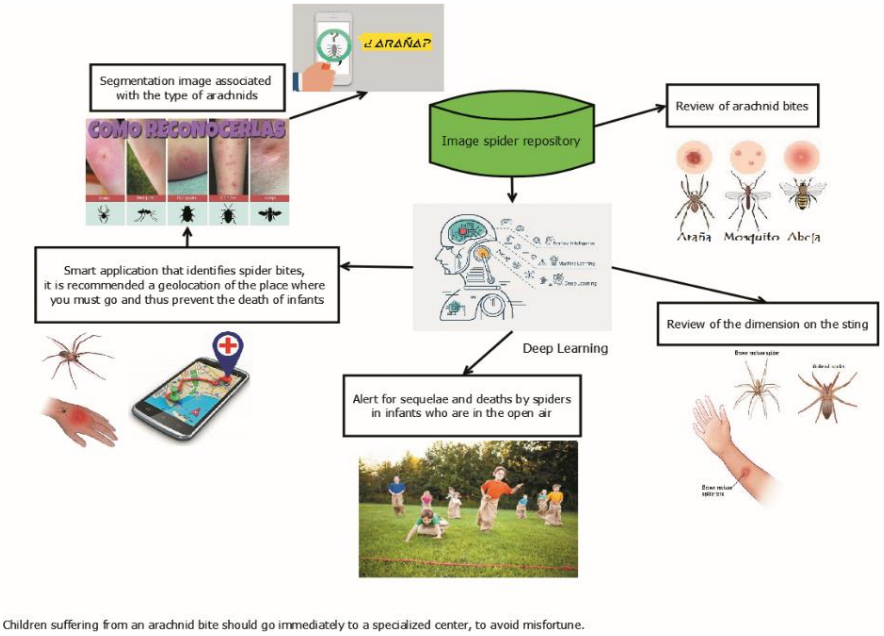

Fig. 4. Proposal of the model, associated with the investigation**.**

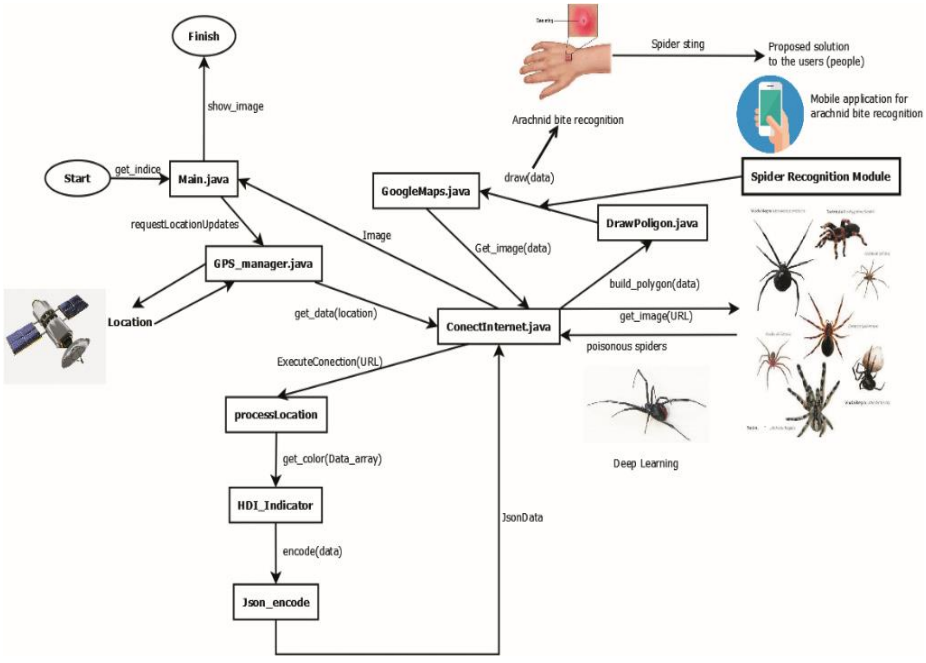

Fig. 5. Modular description of the components for the development of the mobile application.

Fig. 6. Identify the place to turn to in case of arachnid bite.

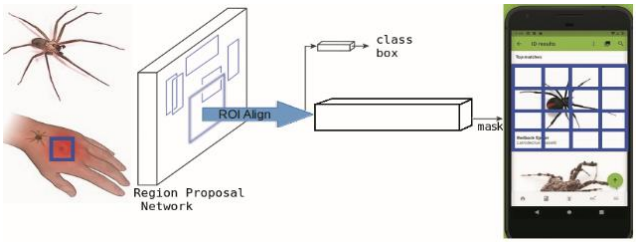

Fig. 7. Simplified diagram of the R-CNN mask network used for classification / segmentation of images. In the diagram, the network generates three types of output, the box where the arachnid is located, a binary mask that delimits the arachnid and the type (genre) of arachnids found.

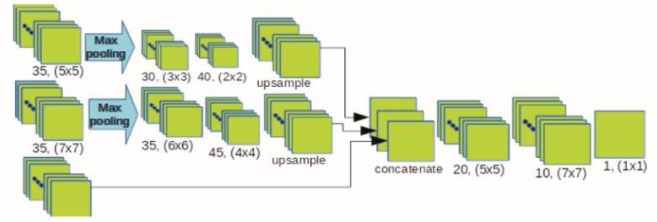

Fig. 8. The proposed architecture for the mask module. It consists of three channels of convolutional layers that are concatenated to have a good feature map with information at different scales.

3.5 Considerations of the Problems and their Impact on Society

According to [10] in the world there are about 5 million accidents per year of poisoned animals, of which between 50 and 75% require treatment to prevent death, amputations or permanent sequelae. The impact of the sequelae and deaths represent a high burden on health, social and economic.

Most of these problems caused by an arachnid bite are:

Fig. 8. Sample images of the input data. As can be seen, the bites can be similar and it is difficult to identify the type of arachnid that has been the aggressor.

- They produce similar benign symptoms.
- Some do not need medical treatment.
- Others, usually present complications, due to scratching, since there may be superinfection in the lesion.
- It is also possible to trigger serious reactions that can even compromise the life or amputation of a limb.
- It is impossible to know what type of spider the aggressor has been, at the time it bites.
- Identification of the place to be used, a center of specialties where they attend this type of emergency.

3.6 Spider Recognition Module

This module for the mobile application is shown in Fig. 7, which has an exchange with the image recognition of spiders and the rest of the data. To recognize the arachnid bite and identify it, this work requires a dataset that contains images of different types of arachnid species, as well as the different types of spider webs. The arachnid identification stage consists of a deep learning architecture. An input image of the sting and, subsequently, it is segmented into several groups which are then classified as the recognition of the arachnid type. The architecture is based on the regional convolutional mask neural network (RCNN) that extends RCNN by adding an object mask to the existing branch for recognition of the bounding box.

Mask R-CNN is an architecture of deep learning to solve the segmentation of instances, it uses the module for the classification of R-CNN fast, but with an additional module to create masks. The R-CNN mask adopts an identical first stage of the region proposal network, however, it adds a binary mask for each stage to produce a binary mask from the input image. In this architecture, each module of the network has its own assigned loss, which allows the network to generate masks for each class without competition between classes. In Fig. 7, the architecture of the network is shown.

In this paper, a new architecture was proposed for the mask module in the R-CNN mask, since the network will only focus on the recognition of arachnids, simplifying the module so that it is easier to train and have less computational load.

The proposed architecture consists of three convolutional channels, where each channel aims to select different feature sizes: a large channel with 11x11 size cores, a medium size channel with 4x4 size output filter, and finally, a small size channel with 2x2 output filters. The outputs of the different channels are concatenated in a feature map that contains information at different scales of the input image, keep in mind that, for concatenation, the output of the medium and small channels is sampled so that the output of all three channels have the same size. Subsequently, the output is fed to a pair of convolution layers to recover the size of the original image and, finally, a convolution layer of filter size 1x1 to have a level image of gray with the masks of the spider regions. Each mask in the output image has a gray level that indicates the class of the region enclosing the mask [17]. And, the details of the described architecture (see Fig. 8).

In Fig. 8, several images used to train the network are shown. To increase the transmission speed to the server and reduce the computational cost, the input images were reduced to a fixed size of 128x128 pixels. This initial data set was processed with data augmentation techniques [18], to have a final data set of images; for this purpose, each image of the initial data set was processed with translations, rotations and scale changes. In addition, each image was manually segmented into the background and the different types of arachnids. The network became a medium error loss function, the implementation was programmed using the keras framework [19], on a computer with an Intel Core i5-4210U 2.40 GHz processor and a Nvidia GeForce GTX 840M graphics card (8GB of RAM).

In addition to this, it is convenient to indicate that the image recognition module is still being improved for its correct implementation in the cell phone, but due to the compact form of the architecture of this research, it is considered that it is very viable that it can be implemented. For any type of mobile with Android operating system.

To know the operation of the proposed model, the estimation of the bites by various types of arachnids is used, after that, the comparisons between the bites to determine by means of the type of spider web what the aggressor really was and based on this, recommend the patient a nearby specialty center.

These images were taken from a database, which has scientific names that are part of the following catalog of taxonomic authorities: CONABIO (Comp.). 2012. Catalog of taxonomic authorities of arachnids (Arachnida: Arthropoda) of Mexico. SNIB-CONABIO database. Mexico.

That includes information of the BK006 project. And, they were evaluated by the intelligent application through their representatives in the deep learning model. For the estimation of the matrix of the selection of identification of one type of arachnid, 30 executions of the experiment were carried out under the same conditions, and, for the group of finalist proposals, a design of experiments according to the attributes of each proposal to obtain a better estimate of the final classification.

An atmosphere capable of storing the data of each one of the stings in the people was developed, including the type of arachnid species that represents the sting, this, with the purpose of evaluating when taking an image from the application in real time and saying which it has been the arachnid bitten on the person. One of the most important characteristics observed in this work was the identification of the spider bite, not being able to distinguish which has been of the different existing species in the

Fig. 9. Results of the proposed network segmentation.

database, since some spider bites are similar to another type of species and that's where the confusion exists.

Structured scenes with agents cannot be reproduced in general, and only a moment is represented in the space and time of different societies. This is a unique and innovative form of adaptive behavior that solves a computational problem that does not try to group societies only with a factor associated with their external society, the treatment of a computational problem that involves a complex change between existing relationships. they can relate metaphorically to the knowledge of community behavior with respect to an optimization problem to culturally select similar societies and their arachnids, without being the same quadrant associated with similar ones.

The main experiment was to detail each one of the 5 different types of arachnids and their bites, this allowed to generate the best selection of each quadrant and its possible location in a Diorama associated with the arachnids, which was obtained after comparing the different similarities between the stings that you are leaving after attacking, and evaluate with the multiple coincidence model of each of them. The tool developed classified each of the spiders belonging to each quadrant. The design of the experiment consists of an orthogonal matrix test, with the interactions between the variables: emotional control, fighting ability, intelligence, agility, strength, resistance, social leadership and speed. These variables are studied in a range of emotions associated with the arachnid; another variable is the color of the spiders represented by numbers (0 to 256).

Metrics for the evaluation of segmentation are as follows.To measure network performance, we used the precision for the recognition module in R-CNN and for the segmentation mask stage using the Union Intersection (IoU), which is a common metric [20], used to evaluate the accuracy of the segmentation. This metric calculates the total number of pixels at the intersection between the set of predicted pixels (A_{pred}) and truth pixels in the ground (A_{GT}) for each class, and is divided by the number of pixels in its joint, as shown in equation 1:

$$IoU \frac{A_{pred} \cap A_{GT}}{A_{pred} \cup A_{GT}}. \tag{1}$$

3.7 Fragment of Code

Advancing and traversing the bounding boxes and the names tagged for each arachnid and drawing them in the output image for viewing purposes. Example:

Algorithm 1. Example of a program when performing image classification, object detection, semantic segmentation and instance segmentation. Performing the segmentation of instances with Mask R-CNN.

```
1 # loop over the recognized spider
2 for ((top, right, bottom, left), name) in zip (boxes, names):
3         # draw the predicted spider name on the image
4         cv2.rectangle(image, (left, top), (right, bottom), (0, 255, 0), 2
5         y = top - 15 if top - 15 > 15 else top + 15
6         cv2.putText(image, name, (left, y), cv2.FONT_HERSHEY_SIMPLEX,
7 0.75, (0, 255, 0), 2)
8 # show the output image
9 cv2.imshow("Image", image)
  cv2.waitKey(0)
```

In this code fragment, the for cycle begins to traverse the bounding boxes of the different types of detected arachnids and the predicted names. To create an iterable object that can easily be traversed values, we call zip (tables, names), which results in tuples from which you can extract the coordinates and the name of the box.

The coordinates of the box are used to draw a green rectangle in the line of code 4. The coordinates are also used to calculate where the text should be drawn for the name of the arachnid (line 5), followed by placing the text of the name in the image (lines 6). If the spider bounding box is at the top of the image, we must move the text below the top of the box (handled on line 5), otherwise the text would be cut. Finally, proceed to show the image until a key is pressed (lines 8 and 9).

4 Results

For the image data set, all noise was eliminated to maintain only the areas of interest necessary, that is, the background was removed to only appreciate either the spider, its spider web and the spider bite. Finally, each image was homologous to the same size and, therefore, correct processing was applied.

One of the most relevant aspects of this research is that if it detects the type of arachnid in time, the patient can be cataloged to a specialty center where it is attended to avoid death. And taking into account that the death of infants can be reduced, this proposed mobile application for Android operating systems arises. The output of the segmentation on the arachnid bites and the combination with the sorting output is shown (see Fig. 10).

The prediction of future events is a difficult task to perform, since it requires extensive multivariate analysis, and it is also impossible to do it in several subjects [20]. There are several methods that have been used as an auxiliary tool for the construction

of estimation models. In this case, in the review of the literature, it has been detected that there are not enough antecedents in the area. In this work, the use of ubiquitous calculus, image processing and deep inclinations combine to predict behavior in an evaluation of the bite by a child arachnid from ambient intelligence.

The approach proposes a model that includes two main characteristics: the identification of the arachnid bite and to recognize the type of arachnids by their characteristics, in this case identify which, without margin of error by means of its web. The model incorporates basic information on the various types of arachnids from an arachnid repository, which was obtained from CONABIO.

5 Conclusions and Future Research

In Mexico, currently, they have not done a job like that is presented above. In addition, the great contribution of this article are the techniques of image pre-processing and machine learning for the case study and incorporating the three data sets into one.

The animals are characterized by possessing venom glands and specialized structures for inoculant tales. In Mexico, there is a large number of poisonous species and it is located in two biogeographical zones. When having an accident with any of these animals, you should go to the doctor, to avoid serious consequences or death.
According to the experiment, it is confirmed that it is possible to implement a technological platform for the recognition of arachnid bites in real time, using a mobile device that captures the part of the bite. This application is able to identify which was the arachnid attacked in a person and based on it, act immediately avoiding a misfortune in the affected party.

It is recommended that the intelligent tool be adapted to the people who are with this problem and thus be catalyzed in an efficient way as far as the displacement, to a nearby center of specialties. It is expected that the mobile application will be developed not only for Android operating systems, but also for iOS devices and, be cross-platform.

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