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Computer Vision Based Identification of Dengue Mosquitoes from Images

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Abstract
The proposed work detects and identifies the Dengue mosquito from the images based on its descriptor values. Dengue mosquito is a carrier of dengue virus which causes the hemorrhagic fever. The image is identified as dengue or normal mosquito image. Further, the dengue mosquito image is identified for a male dengue mosquito or female dengue mosquito. The descriptor values of size, stripes on legs, slender body and color are extracted. The accuracy of identification of mosquito and other insects is found to be 98%. The accuracy of identification of dengue mosquito and other mosquito is found to be 97%. Similarly, accuracy of male and female mosquitoes is found to be 98.5%.

INTRODUCTION

Computer vision could be a field that has ways for effort, processing, analyzing, and understanding pictures and normally, high-dimensional knowledge from the $64000 world so as to provide numerical or symbolic data. The Indian Council of Medical Research the apex body in India for the formulation, coordination and promotion of biomedical research, is one of the oldest and largest medical research bodies in the world. AedesAegypti mosquito causes an illness such as severe-flue, blood vomiting, low blood pressure etc. These symptoms can lead to life threat. Till today, there is no specific medicine for the treatment of dengue. The World Health Organization (WHO) said that, dengue is the “fastest emerging arboviral infection” in the world. One study detects mosquito from its behavior, characteristics and territorial which the result could be important to fight against malaria, yet the study does not determine if the detected mosquito is an AedesAegypti which is a dengue carrier mosquito. In order to prevent the infection caused by dengue virus, different techniques to detect mosquitoes have been developed by Jahangir, Monnette Vessel and many others. To classify the various species of mosquitoes, different parameters such as size, shape, color, antennae, hind legs and the like are used.

Different images of mosquitoes and other insects

The images of mosquito are of two types namely, Dengue carrier mosquito AedesAegypti and non-dengue carrier mosquito. Fig 1(a) shows the images of dengue carrier mosquito and Fig 1(b) shows the images of non-dengue carrier mosquito.

Fig 1(a) *Different images of Aedes Aegypti mosquitoes.*

Fig 1(b) *Different images of Other mosquitoes.*

The images of other insects are also given as input and different images of insects is shown in Fig 1(c).

Fig 1(c) *Different images of other insects.*

Problem Statement

The work on identifying the mosquito and other insects is carried out. The work on vision based identification of dengue mosquito is not carried out. Hence, the work on *"**Computer Vision Based Identification of Dengue Mosquitoes from images**"* is proposed.

LITERATURE SURVEY

[Acevedo V, Amador M, Félix G, et al., 2017] introduced the operational features for controlling and preventing AedesAegypti. Dengue virus infect thousands of people every year and there is no cure for the disease therefore there is a need for minimizing AedesAegypti populations. Variety of control tools and approaches are introduced for trapping female dengue mosquitoes and their eggs. Hence, for the surveillance and control of AedesAegypti, the survey put forward the operational use of the Centers for Disease Control and Prevention Autocidal Gravid Ovitrap (CDC-AGOtrap).

[Harwood JF, et al., 2017] worked on controlling AedesAegypti in mysterious environment by using pesticides with ultra-low volume and mist blower. As AedesAegypti is a carrier of dengue virus, it gets involved in reproduction which would be difficult to control. The survey presents 3 spray techniques for controlling adult and premature AedesAegypti. For trapping adult mosquitoes and larvae, cages were planted in those mysterious locations.

[Kartzinel MA et al., 2017] introduced the operational aspects of "Testing of Visual and Chemical Attractants in Correlation with the Development and Field Evaluation of an Autodissemination Station for the Suppression of Aedesaegypti and Aedesalbopictus" in Florida. The efficacy of the ADS is likely to be strongly affected by the abundance of competing ovisites, the population dynamics, and climatic conditions.

[Kutateladze T, et. al., 2017] presented the updated record of AedesAlbopictus in Georgia. In August 2014, a survey was done on mosquitoes in Batumi, Georgia. After the survey, 32 species of AedesAlbopictus was reported as it was detected for the first time. The new checklist of the mosquitoes was provided in Georgia. That updated record contained AedesAlbopictus species.

[Fritzell C, et.al., 2017] held a survey with a group of 1472 students that made use of two-stage selection procedure with cluster sample for randomly choosing students. The survey permitted the students to take measures for preventing vector-borne diseases caused by Arbovirus. Using protective behaviors is a process that depends on several factors like sociocultural and cognitive factors.

[Crit Rev Microbiol, et al., 2017] proposed work on flavivirus Zika that appeared unexpectedly. Meantime people were not aware of the disease caused by the Flavivirus Zika but was only known to specialists. The group Flavivirus Zika comes from the family of Flaviviridae that were the cause for known diseases like the dengue, yellow fever, Japanese encephalitis. However, the group is also responsible for transmitting lesser known viruses which includes Wesselsbron, Ilheus, St. Louis encephalitis and Usutu viruses.

PROPOSED METHODOLOGY

A tree like structure given in Fig 3.1 shows the work to be carried out in the proposed work:

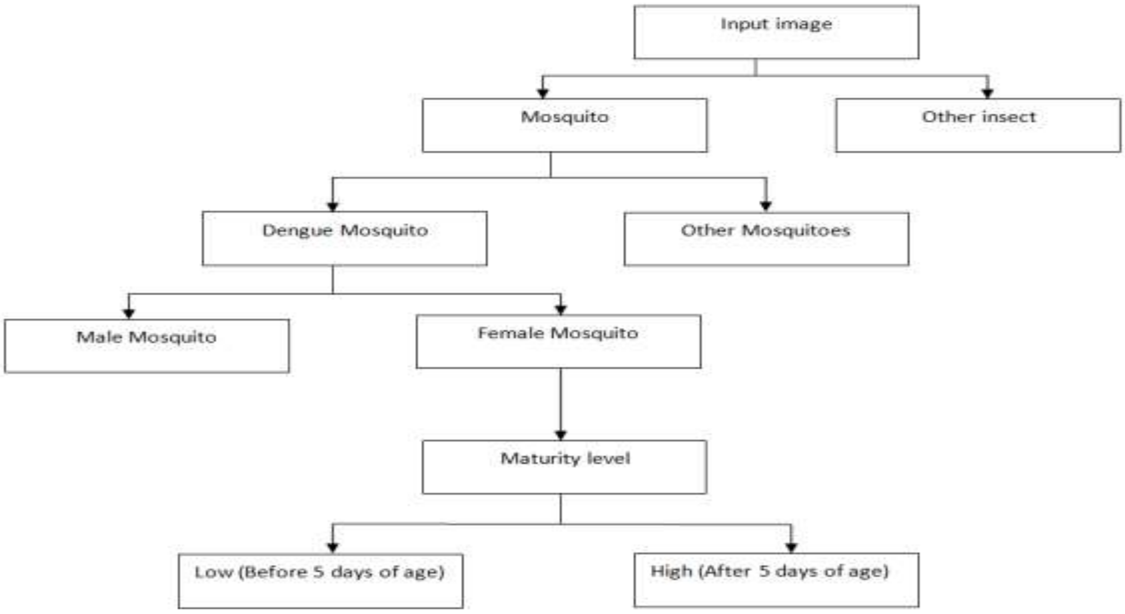

Fig 3.1: *Tree like structure showing the work to be carried out.*

Initially, the input image is identified as mosquito image or other insect image. In turn, the image is identified as dengue or normal mosquito image. Further, the dengue mosquito image is identified for a male dengue mosquito or female dengue mosquito. Also, the maturity level of female mosquito is predicted based on its life span.

Images of different types of flies are shown in Figure 3.2. Flies have large and moveable head with compound eyes that are often very large. Also, the legs of flies are thicker and shorter in length.

Fig 3.2 Images of Other insects.

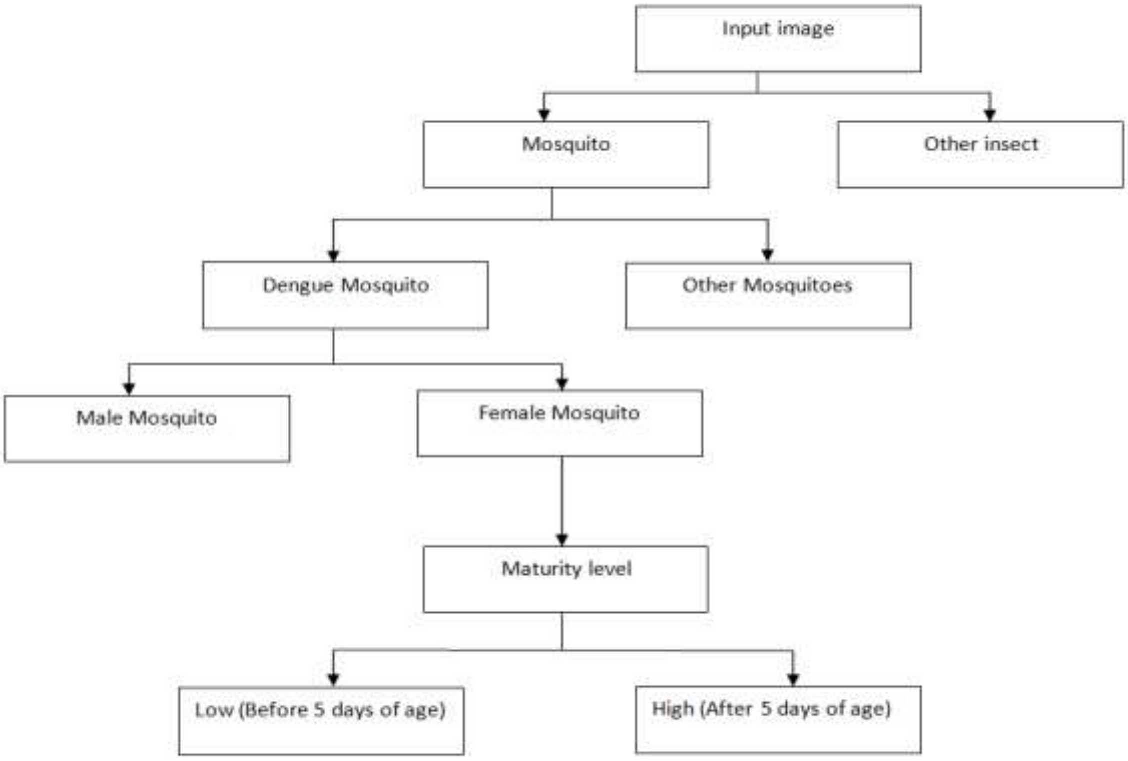

Fig 3.3 shows the images of different types of normal mosquitoes. Normal mosquitoes have slender body with long legs and relatively long antennae with many segments of similar shape and size.

***Fig 3.3** Images of Mosquitoes.*

Different images of dengue mosquitoes are shown in Fig 3.4. Dengue mosquitoes have more elongated legs, when compared with the normal mosquitoes and have minimum of two white stripes on their body and legs.

Images of Dengue mosquitoes.
Images of male and female dengue mosquitoes are shown in Fig 3.5. Males have more antennal flagellum, turning their antennae into a pair of bushy bottle brushes. Female don't have as many flagellum as male.

It is observed that, the visual features of insects, normal mosquitoes, male dengue mosquitoes and female dengue mosquitoes are different and unique. Hence, the mosquitoes can be identified easily using their unique visual characteristics.

Fig 3.5 *Images of male and female dengue mosquitoes.*

Phases used in the proposed work
Different phases used in the proposed work are shown in Fig 3.6.

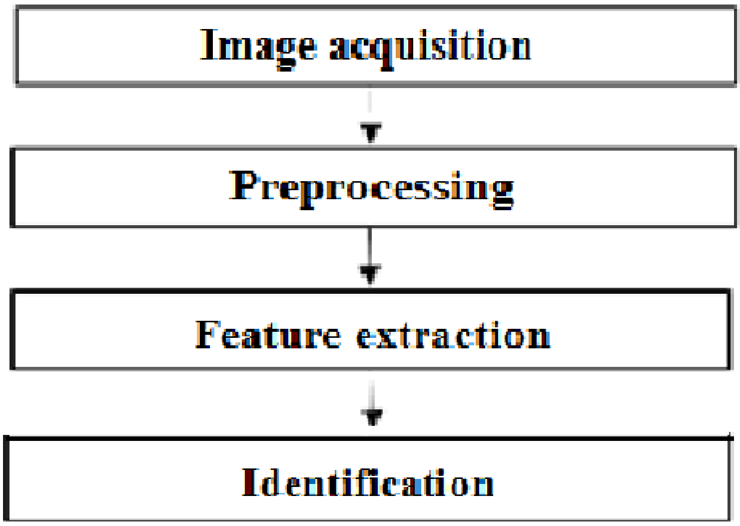

Fig 3.6 Phases used in the proposed work.

Image acquisition: In the first phase, the images of dengue mosquito, non-dengue mosquito and other insects have been acquired.These images are input images. The images of mosquitoes and other insects are given in Table 1. A total of 95 images of dengue mosquitoes are collected. Similarly, the image count of non-dengue mosquitoes is 114 and 40 respectively.

Table 1: *Table containing images of mosquitoes and other insects*

Name	No. of images
Dengue mosquito	95
Non-Dengue mosquito	114
Other insects	40

Pre-processing: In the second phase, the image is resized from its original size to 400x400 size. The original image is converted to grey scale shown in Fig 3.7.

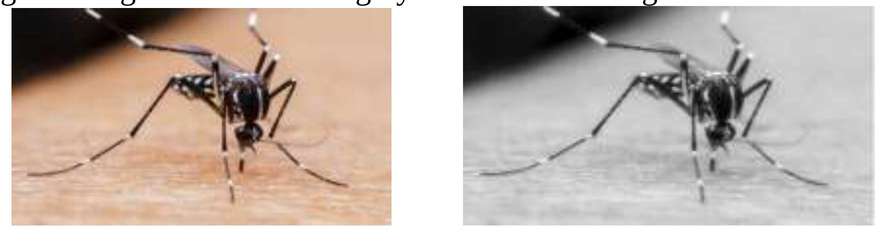

Fig 3.7 *Grey scaled image.*

If the image is noisy image or blurred image, it is eliminated and the image will be now noise free using Equalization Histogram as shown in Fig 3.8 and Fig 3.9.

Fig 3.8 *Noisy image*

Fig 3.9 *Cleared image.*

Feature extraction*:* After pre-processing phase, the descriptor values of length of the legs and body, shape of the body, area, perimeter, shape of the wings, color of the body and legs, slender body shape, compound eyes, structure of mid leg, hind leg, fore leg, femur, thorax etc are extracted. Considering a mosquito image as in Fig 3.10 and giving it as an input image to our system the key descriptor values are extracted as in Fig 3.11. Then the images from the train folder in Fig 3.12 which act as an ideal images, their descriptor values are extracted every time the program in executed. The key descriptor values of input and reference images are compared and number of similarities among them is counted in the variable count.

Fig 3.10 *Input image*

Fig 3.11 *Reference images*

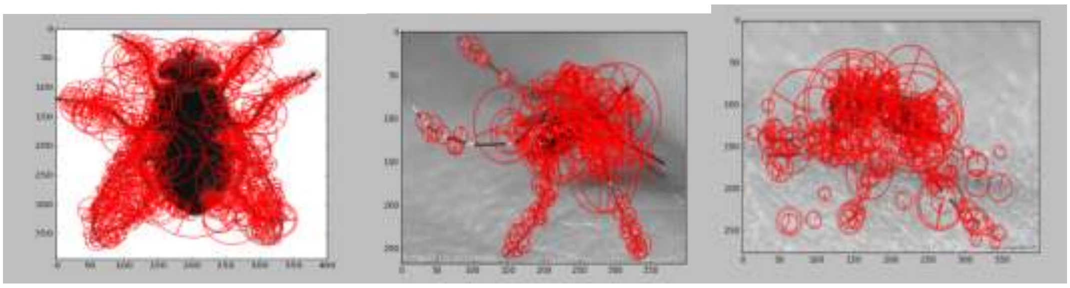

Fig 3.12 *Feature Extraction of the input image*

Identification: The input image is identified as mosquito image or other insect image. Further, the mosquito image is identified for dengue mosquito and non-dengue mosquito. The dengue mosquito is further identified as male and female. Finally, the maturity level of female dengue mosquito is predicted. The input image is matched with the ideal image of dengue mosquito, non-dengue mosquito and other insects for its descriptor values. The matched feature of input image with ideal image is shown in Fig 3.13

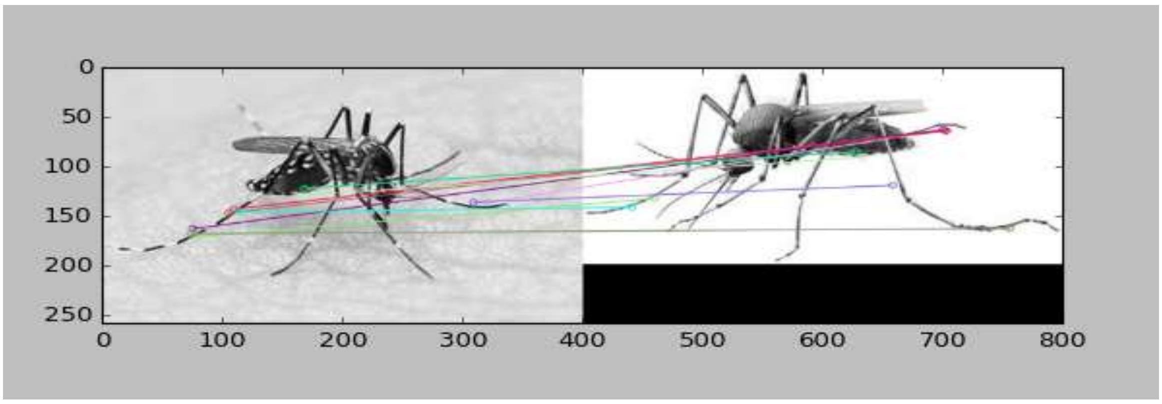

Fig 3.13 *Matching of input image and ideal image*

RESULTS AND DISCUSSIONS

Performance Matrices

The confusion matrix is shown in the Fig 4 which depict the accuracy carried out in the proposed work. The x-axis has the predicted label and the y-axis has the true label. The scale of values mentioned above specifies the accuracy rate. We have considered overall 131 images for testing. Among these 131 images 42 were of dengue mosquito, 30 were of non dengue mosquito and rest 59 were of other insects. The software was successful in identifying the input images with 100% accuracy and is shown in the confusion matrix.

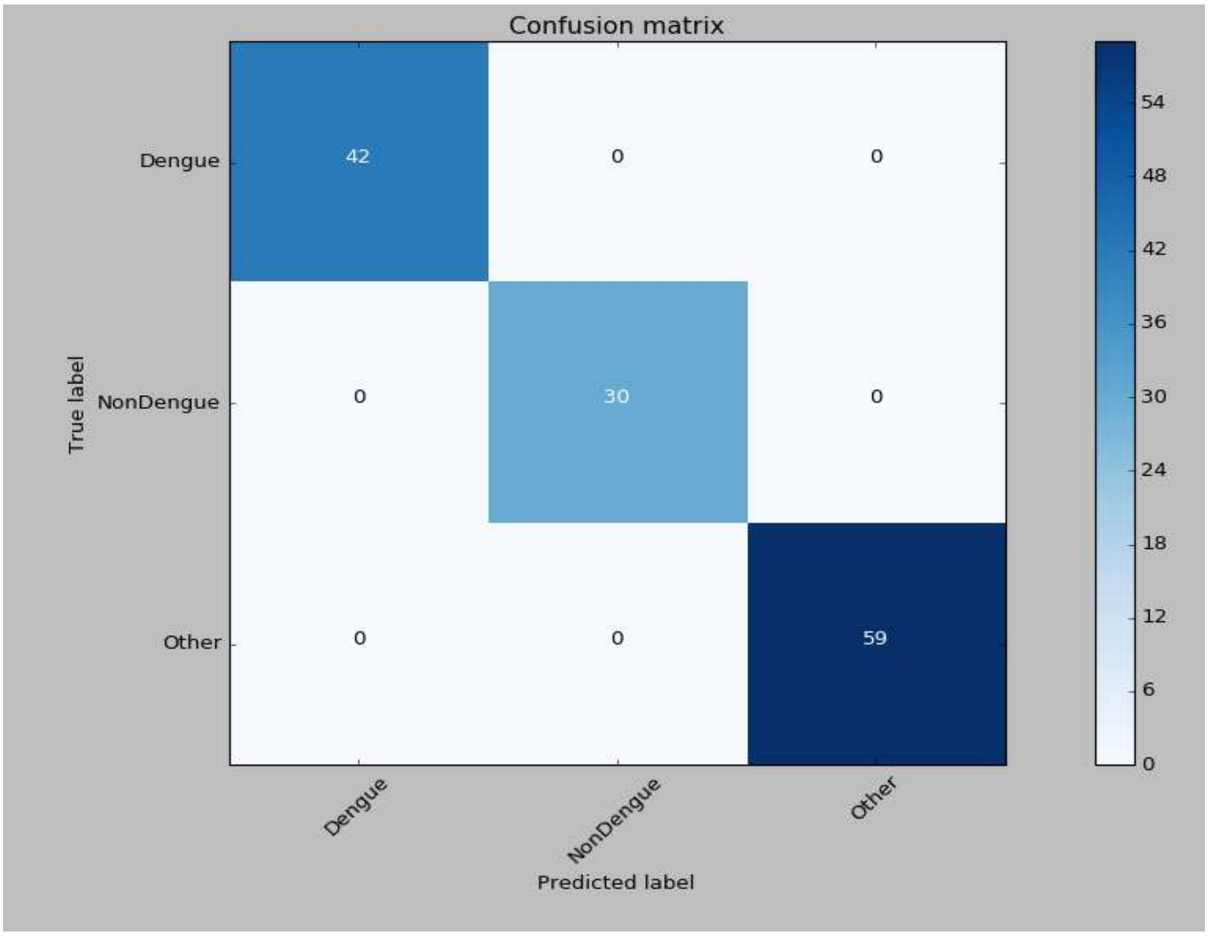

Fig 4 *Confusion Matrix*

Applications

- The developed software can be mounted to the drones which by themselves take a surveillance of area.
- This software can be mounted with the CCTV camera using microscopic lens which capture the smallest moving objects.
- This software can be mounted with a toy helicopter.
- This software can be used in homes using CCTV camera which helps to identify the mosquito and intimate family via messages or signals. Necessary precaution or action can be taken once it gets identified.

CONCLUSION

This software will keep people informed and aware of the areas where dengue mosquitoes are more prevalent. The proposed work aims to identify the mosquito carrying dengue virus so that, further preventive measures can be taken. The primary method of controlling Aedes Aegypti is by eliminating its habitats which is done by getting rid of open sources of water. The proposed work helps identify dengue mosquitoes, other mosquitoes and insects. The overall identification rate of 100% is achieved.

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