An Automated Wound Detection System

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Abstract. A crucial measurement for the injury evaluation measure is assessing and following injury size. Great area and size assessments can help you choose the right treatment for you. Typically, laboratory wound healing plans include a series of photographs taken at regular intervals that show the wounded area and the healing interaction in a guinea pig, usually a mouse. These images are then examined in person to determine crucial measurements relevant to the research, such as wound size progression. Nonetheless, this task is time-consuming and exhausting; additionally, defining the injury edge can be abstract and move from one person to the next, even among experts. Furthermore, as our understanding of the recuperating interaction grows, we need to track these important factors effectively and precisely for high throughput (for instance, over the enormous scope and long haul tests). Following that, in this study, a calculation was created using Python in an OpenCV-based picture investigation pipeline using image processing techniques such as segmentation and classification, to allow non-uniform injury pictures and concentrating relevant data such as the area of premium, the injury only picture yields, and wound fringe size after some time measurements. To acquire acceptable results, camera positioning and distance from the wounds that need to be photographed are critical. In this case, ultrasonic sensors in the camera system are required to ensure that images are taken at a consistent distance. Because the injury space is properly created, appropriate recuperation procedures are addressed. Image processing using Python provided results in terms of area and estimated chemicals to deliver in the right amounts. In this way, wound healing can be tracked, and appropriate drug doses may be given based on the size of the wound. Furthermore, the wound healing trend can be easily assessed.

Keywords python, OpenCV, image processing, wound, segmentation

INTRODUCTION

The work aims is to introduce a robotized calculation that can assist in determining a conclusion for patients with difficult-to-recovery wounds, allowing for quicker treatment decisions. A manual visual assessment, generally undertaken when making a decision, will be reproduced using picture information. The image data included computerized photographs taken with portable and advanced cameras (Nilsson & Velic, 2018).

Wounds progress when the quantity of damaging tissues increases. The intermittent fraction of the space covered by the injury is the traditional technique of assessing damage mending status. This technique takes a long time to complete, and re-evaluation is inconvenient. Essentially, contact procedures and non-contact tactics can be delegated for mending the status of the ailment. The purpose of this examination is to carefully assess the injury's healing status (Kumar & Reddy, 2014). Skin wounds, whether small or chronic, can last for a variety of times. However, the recovery period cannot be accurately predicted because mending is influenced by different aspects such as age, nutrition, drug, and environmental conditions. Regardless of these factors, wound trademark has a role in the mending process. Injury size, wound type, inner and exterior injury climate, internal heat level, body oxygenation, wound hydration, and contamination is all wound properties. As a result, observing wound healing necessitated careful consideration of wound characteristics. Even though the clinical consideration space contains a variety of applications for detecting and detecting illnesses, the injury care sector requires capable strategies and distinguishing systems for identifying wound biomarkers such as temperature, circulatory strain, oxygen, and infection status using biosensors.

In this study, we propose a physical issue treatment plan based on a biosensor-based identifying structure to check basic biomarkers, which are considered critical injury ascribes, such as internal temperature and body oxygenation, and design a fluffy deriving system to predict their effect on injury hydration, and finally recommend essential exercises to aid recovery (Sattar et al., 2019). An accurate and thorough injury assessment is a critical component of optimal injury management. A physical issue assessment has two major purposes: 1) to choose reality to predict the expected speed of wound recovery and cultivate a comprehensive plan of care, and 2) to serve as a strong outcome measure that can be used to assess the reasonableness of a given physical issue treatment program. The assessment of wound degree is a vital limit that should be related to a physical issue evaluation. Wound importance (, surface district length, width, and volume) are among the approaches for determining injury magnitude developed and supported (Kumar & Reddy, 2014).

Continuous changes in the surface area of the wound are directly proportional to its healing process. These sudden changes though they are directly proportional, normal human interaction cannot easily and efficiently follow procedures efficiently. As it stands, health practitioners mostly use measuring tape to estimate the size of the wound Wang, C. et al.2015.

Measuring tape had been used in determining measurements of wounds though the process is slow, tiresome, and inefficient. Recent technologies have been in cooperated in tracking wound healing by monitoring the size of the wound Wu, W, et al, 2019. The persistent use of try and error methods in healthcare services is a cause for concern as they need to develop a better or optimized system to assist in the determination of wound size Budman J, et al, 2015.

Biomedical sensors especially micro-electro-mechanical systems (MEMS) based have been used in tracking wound infections over some time so that proper medication can be applied. This approach helps to shorten the healing process since every stage is monitored concerning desired wound conditions and time for healing Salvo, P, et al, 2015. Mobile devices have been implemented in wound detection though in low complexity operations since mobile devices have low memory. The wounded area can be calculated using machine vision techniques Pires, I.M. and Garcia, N.M, 2017.

Mobile phones have recently gained popularity as they are now implemented in image capturing and processing of wounds. This has reduced exposure to infection and the challenge of expenses in acquiring hardware. Liu C, et al, 2019. In the previous decade, the use of artificial intelligence has spread across a wide range of industries, including medical services. For example, AI computations have been successfully used to detect of skin cancer in photographs, demonstrating its potential for use in twisted therapy by grouping wound photographs (Nilsson & Velic, 2018). In addition to reducing patient distress, an AI-based solution for wound picture categorization could reduce wound treatment costs (Nilsson & Velic, 2018). These methods have been considered. Furthermore, while each technique for determining wound size has its advantages and disadvantages, those used to determine wound surface region, rather than wound profundity or volume, are typically considered accurate and reliable. A comparison of a few different strategies for evaluating wound surface regions has also been done, while sound system photographic judgments are generally accurate, the use of an injury followed by a simple acetic acid derivation or estimations based on length/width estimations are considered reliable and simple to use (Kumar & Reddy, 2014).

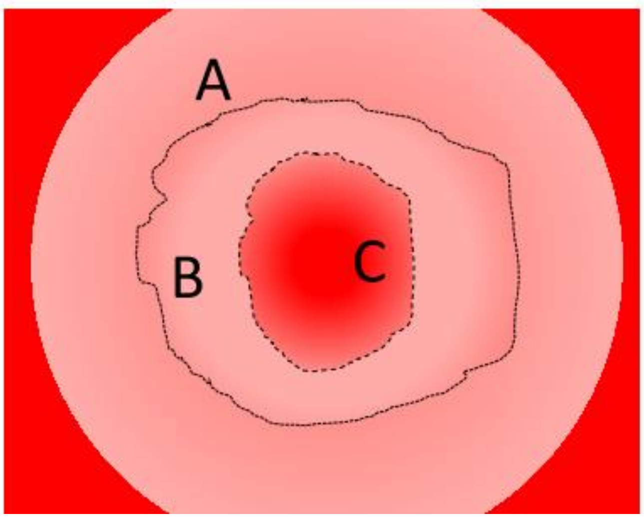

FIGURE 1. Different wound areas based on cartoon images: "Region A," shows normal skin. "Region B," shows the regeneration of the epidermis. "Region C," shows the wound center.(Jafari et al., 2020)

"A clinical photograph can transmit a huge amount of information to a prosperity capability than conceptual depictions, which are accessible to disarray (Kumar & Reddy, 2014)," Hughes explains. Photo evidence was critical in one specific scenario for obtaining clinical reimbursement for a patient. To aid the physician with wound retouching documentation, a couple of new robotized and electronic innovations have been produced that capture and separate visual photos of meticulous wounds. Furthermore, visual images of wounds could be used to communicate information about the patching state to a remote location for physical issue care (Kumar & Reddy, 2014). Presenting a customized gadget for determination might bring down costs significantly increase patients' quality of life just as an early and appropriate conclusion could bring down costs for wound consideration (Nilsson & Velic, 2018).

TABLE 1. Doctor's opinion for clinical validation (Chakraborty, 2019)

	Naked eye assessment by Doctor	**Automated Wound Tissue**

				Characterization
Wound images	**Tissue Type**	**Color**	**% of Tissue**	
1st	*Granulation*	*Red*	*40*	*58.39*
	Slough	*Yellow*	*46*	*41.61*
	Necrotic	*Black*	*14*	*0*
2nd	*Granulation*	*Red*	*85*	*93.42*
	Slough	*Yellow*	*10.5*	*4.52*
	Necrotic	*Black*	*4.5*	*2.07*

When comparing these two methodologies, the expert concludes that the AI collaboration provides a more precise degree of distinct tissues. When employing a wireless, the consequences are easily recognized, and the output can be expected to be even more successfully, unequivocally, and quickly (Chakraborty, 2019). The evaluation of diligent damage tissue representation employing unmistakable AI methodologies resulted in a precise examination of ulcer phases. The electronic clinical continuous injury picture, as well as the level of necrotic, sloughing, and granulation tissue, is superior to the ulcer's chosen, independent eye examination (Chakraborty, 2019).

Investigate late wound evaluation approaches that could prompt a start-to-finish response for a tailored wound checkup. Furthermore, the system should be able to organize the various tissue types discovered on the injury surface and, as a result, generate assessments such as injury estimations, the degree of perceived tissues that prompts a recovery appraisal, and treatment suggestions. Marijanovi (Marijanovi, 2020). In addition, the structure inspection might result in a 3D diversion of the injury, which could be used for additional assessment and follow-up connections during evaluations. To get outstanding results in the stages of damage division and tissue representation. Preprocessing of data is common in most exams. In this discipline, information is usually visual, such as wound photos that are sometimes compared to profundity pictures. Preprocessing usually entails noise removal, hiding now and then to remove picture encoding curios, reflections, and other artifacts, and improving division or wound identification phases (Marijanovi, 2020). Choosing the best shade space is usually part of the preprocessing process. HSV is the standard option, with CIELab being the second most widely used. HSV has been demonstrated in a variety of domains, including twisted research. Analysts have demonstrated that these shading spaces such as YCbCr and YDbDr are particularly ideal for distinguishing wound and non-injury picture regions. (Marijanovi, 2020).

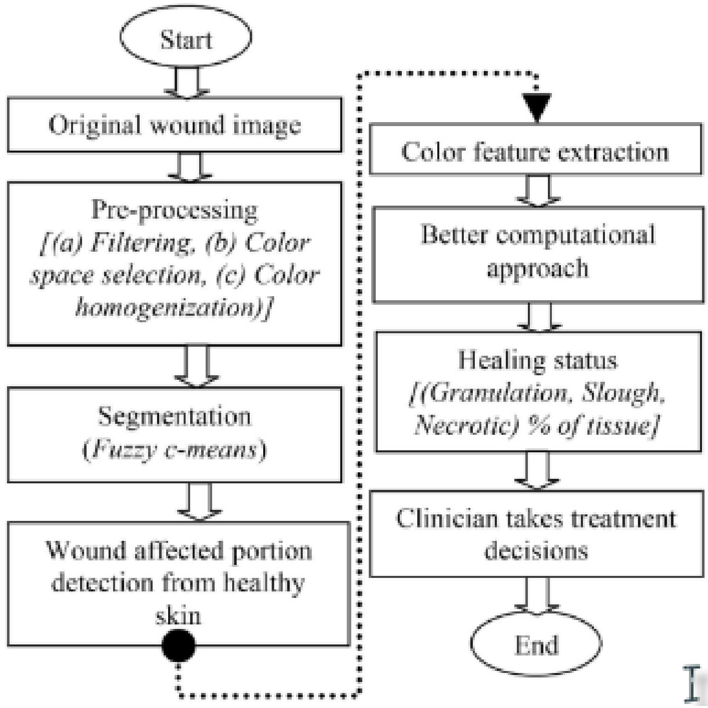

FIGURE 2. Automated wound healing procedure (Chakraborty, 2019)

METHODOLOGY

According to a new study of home medical services offices in the United States, 75 percent of them have an injury photo as part of their record system. In addition, several distributions show how to carry out an injury evaluation advocate employing twisted photographs to detect wound conditions. Using wound pictures has several advantages, including the fact that the physician does not have to contact the injury. Photographs capture the real portions of the ulcer, which are identical to the type of tissue seen in the injury bed (Kumar & Reddy, 2014). The advancement of a device that is advised to assist clinical staff in injury detection is described in this study. A mechanized computation that can determine how to recognize wounds in computerized images is the specific arrangement introduced. This section will discuss wound therapy today, with a focusing on possible improvements (Nilsson & Velic, 2018).

AUTOMATIC MEASUREMENTS

Having the injury pictures distinguished and divided appropriately, different examinations are performed to extricate significant data. Here, we determined the injury region and wound conclusion rate.

WOUND AREA CALCULATION

Wound region estimation was performed utilizing the accompanying condition:

$$A_u = An_i \times R, \quad (1)$$

Au is the obscure injured space of interest, Ain is the known inward ring region, and R is the proportion of the injured region to internal ring pixels (Jafari et al., 2020).Wound Closure Calculation Wound conclusion rate computation was performed utilizing the accompanying condition:

$$Cp\ = (\frac{Ai}{Ao} \times 100\ , \qquad (2)$$

where C_p is the injury conclusion rate, A_o is the injured region at day 0, and Ai is the injury space at the day I. Day 0 size is viewed as a 0% conclusion, an expansion/decline in the size is considered bad/positive rate change, and the 100% conclusion implies the injury is shut (Jafari et al., 2020).

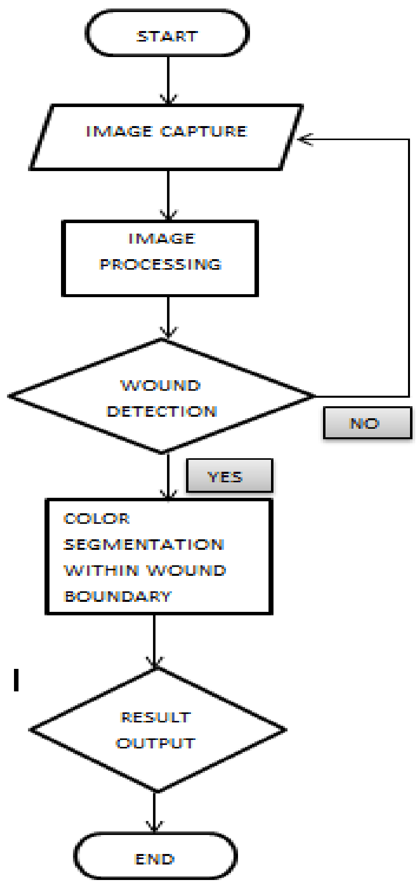

FIGURE 3. Python OpenCV flow chart

Python OpenCV has been applied in wound detection to acquire an area bounded by the rectangle. The wound area can vary depending on the distance between the camera and the wound. With this relation, the correct area of different types and sizes of wounds can be detected using a reference distance. The author and creator of your article PDF, you have the most intimate knowledge of *exactly* what the PDF should display. We ask all authors to carefully check their article PDF prior to submission. Perform visual inspections to detect subtle font errors and ensure that all fonts are embedded. With the wide range of tools and software that authors use to create PDFs, and the number of devices and platforms that readers use to view/print them, font embedding by authors is not only "nice-to-have"; it is *essential*.

CAMERA SETUP IN CAPTURING IMAGES

Camera setup for maintaining uniform distance for precision and accuracy to be effective. Varying distances of the camera from the images result in different readings of the wound's length, width, and area.

CONDITION 1: WOUND VERY FAR FROM THE CAMERA

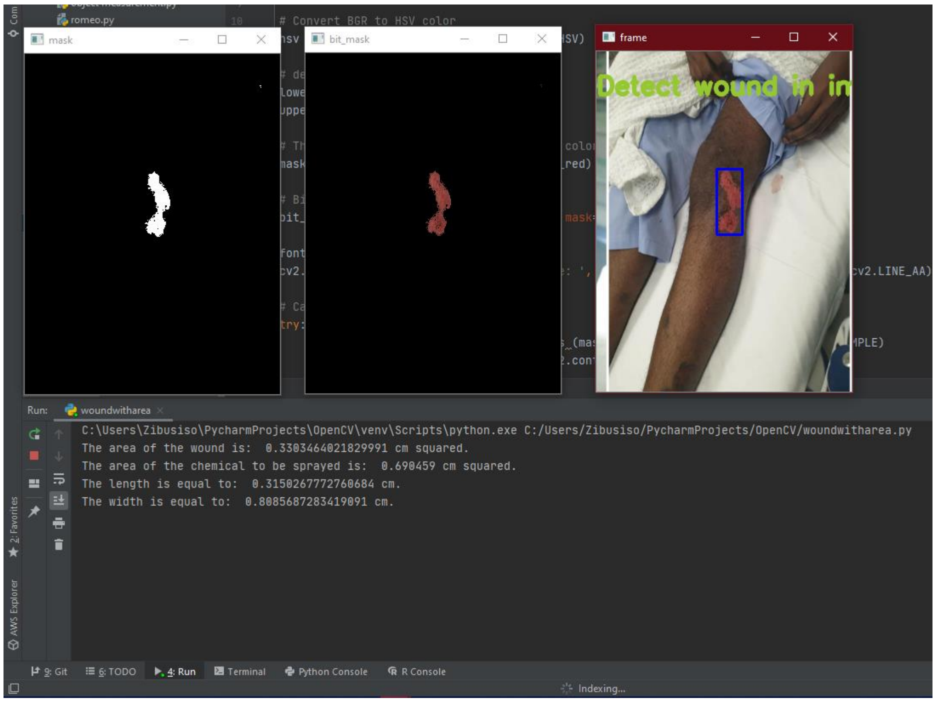

FIGURE 4. Wound very far from camera

The area of the wound is: 0.3303464021829991 cm squared.

The area of the chemical to be sprayed is: 0.690459 cm squared.

The length is equal to: 0.3150267772760684 cm.

The width is equal to: 0.8085687283419091 cm.

CONDITION 2: WOUND CLOSE TO CAMERA

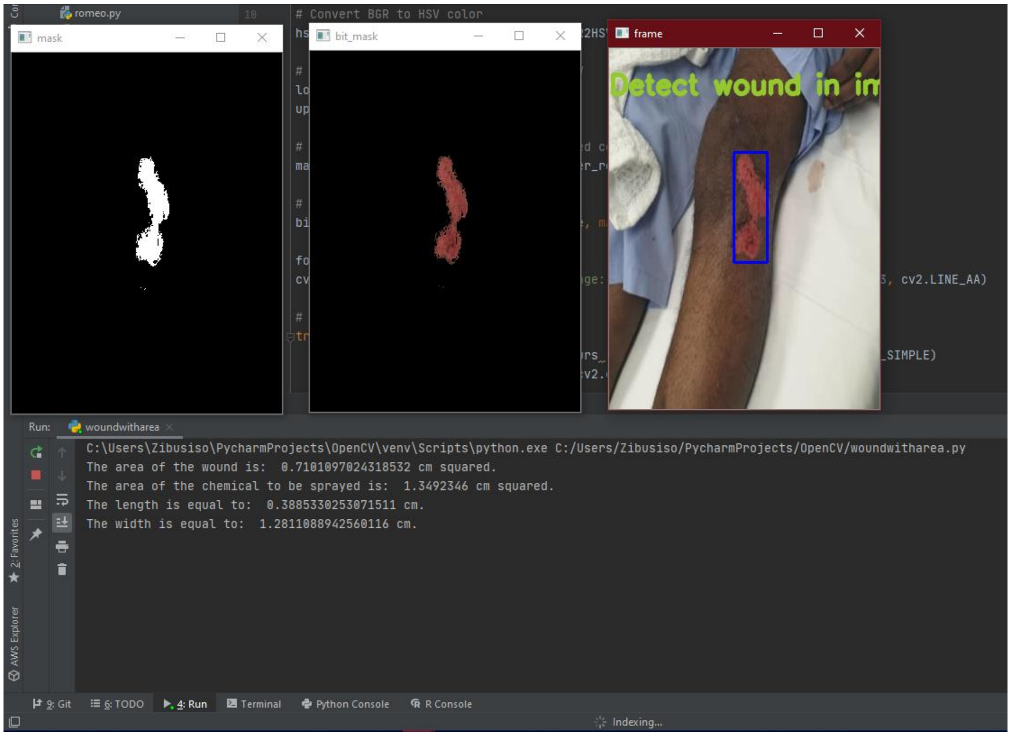

FIGURE 5. Wound close to camera

The area of the wound is: 0.7101097024318532 cm squared.
The area of the chemical to be sprayed is: 1.3492346 cm squared.
The length is equal to: 0.3885330253071511 cm.
The width is equal to: 1.2811088942560116 cm.

CONDITION 3: WOUND VERY CLOSE TO CAMERA

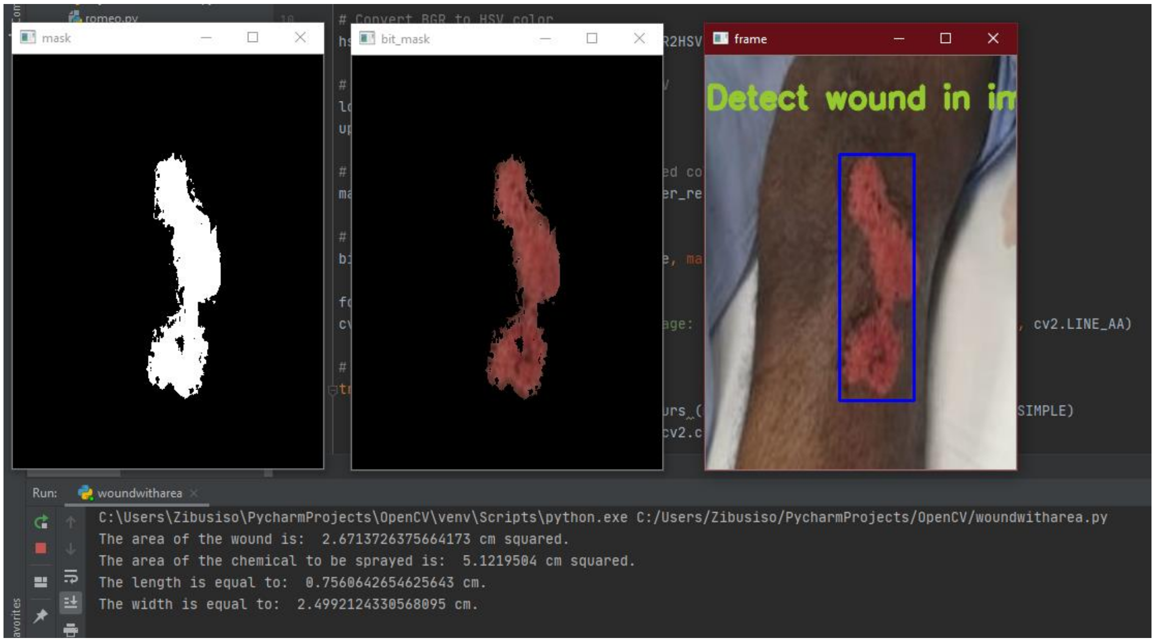

FIGURE 6. Wound close to camera

The area of the wound is: 2.6713726375664173 cm squared.

The area of the chemical to be sprayed is: 5.1219504 cm squared.

The length is equal to: 0.7560642654625643 cm.

The width is equal to: 2.4992124330568095 cm.

As shown by the results from each test, the wound area and the bounding box are different concerning the distance between the wound and the camera. As the wound gets closer, the area increases. Using a reference distance of 0.3m between the camera as the wound, precise areas of the wounds can be detected.

PYTHON OPENCV ALGORITHM

- The program identifies the wound by selectively using a certain range of HSV values
- The image is converted into black and white
- The extreme coordinates of the contour determine the position of the corners of the rectangle
- A rectangle is bound around the wound to identify the wound

RESULTS

Machine vision is very important when it comes to analysis and interpretation of various images. Here, as a solution, an image analysis. An algorithm has been developed using Python OpenCV software to ensure robustness, efficiency, and a low-cost and easy to-use method for wound detection.

PYTHON OPENCV OUTPUT

The Python OpenCV simulated the analysis and detection of a wound in an image. The simulated output is obtained by processing a captured image and analyzing the HSV range of colors that match a wound's colors. There are different stages of the simulated results, and they are (i) Masking the image to get only red colors that match a wound (ii) Converting the image to black and white (iii) Showing the detected wound in the image.

STEPS USED IN PYTHON

Code for processing images has to follow steps which are shown below.

a. Enter the image location and image type
b. Load the image
c. Read the image
d. Convert BGR to HSV scheme
e. Define the range of wound red color in HSV
f. Converting the image to black and white (convert grayscale)
g. Threshold the HSV image to get only red colors that match with wound colors (masking the image to get only red colors that match the wound)
h. Calculating percentage area

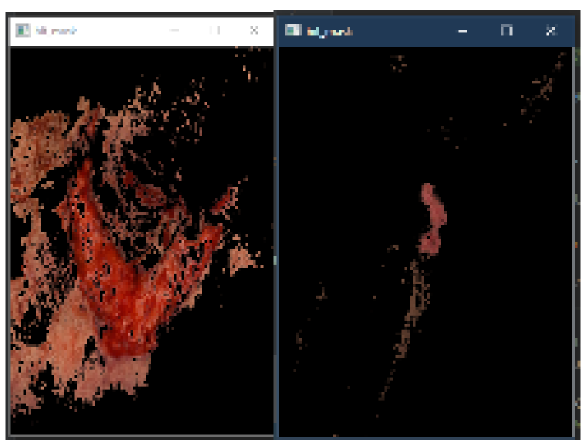

FIGURE 7. Masking the image to get only red colors that match a wound

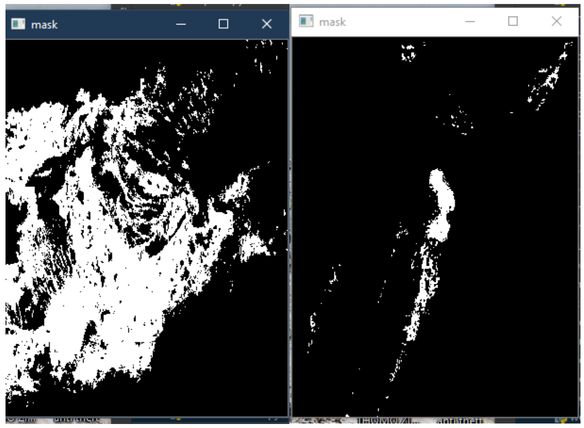

FIGURE 8. Converting the image to black and white

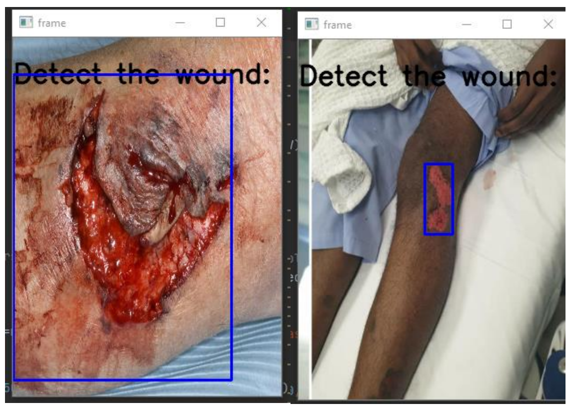

FIGURE 9. Showing the detected wound in the image

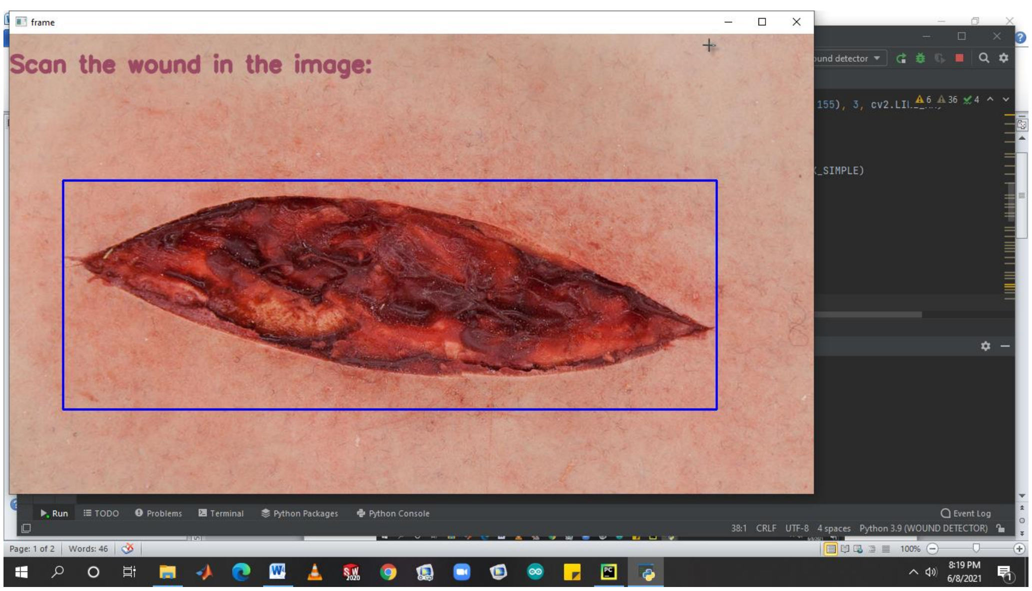

FIGURE 10. Masked image

CONCLUSION

Using Python in OpenCV software, it managed to carryout image processing to conclude in the wound area. This feedback can help the health practitioners know which step is taken to dress the wound to avoid infections. The calculated area indicates the area covered with the wound, thereby helping monitor the healing process. Different wound images gave different values of calculated areas, thus managed to give different values of calculated areas thus, determining the amount of medication needed. This also helps to track the healing process if it is doing well. The images can also be used to identify if there are any infections. This paper revealed the importance of wound detection as an eye-opener for medication procedures within a safe period.

RECOMMENDATIONS

There is a need to consider detecting wounds based on video feedback rather than photo image to implement both image processing and video processing. There is also a need to consider the average depth of the wound so that area wounds can be estimated to trigger supply gel chemical for stopping bleeding.

IMPLICATIONS

. This system to operate well requires maintaining the same distance from different wounds to give precise results. In addition, the system of this nature needs to interface with wireless technology so that feedback can be provided instantly.

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