Development of Automatic Wound Healing Level Detection System based on Convolutional Neural Network

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Abstract

Wound is an unpleasant experience caused by tissue damage. The wound healing level is subjective, where each individual has a different perspective the level wound healing response, sometimes difficult to determine only by visual eyes and can only be felt by the individual without being felt by others. Therefore, the wound healing level determined the treatment by medical personnel to the patient. This could lead to non-standard handling of patients in medical treatment. The automatic stand- alone system for healing wound level detection based on wound image recognition is developed. The system determines patient wound level detector based on wound image recognition. The level of the wound is detected based on wound image procession technique and Convolution Neural Network (CNN). The system is working properly, since it resulting the training and testing accuracy of 67% and 55%, respectively.

Keywords
Wound healing level; wound level detector; Automated stand- alone embedded system; wound image technique; Convolution Neural Network;

1. Introduction

Wounds, defined as discontinuity of the body's tissues, because of physical, mechanical, chemical and thermal cautions. Wounds, both open wounds and closed wounds, are one of the most common problems that occur in daily in outdoor or indoors emergency state. Handling wounds is a skill that must be mastered by a medical personnel (Arisanty, 2011). The main goal of wound care is to get a fast healing function, infection prevention and avoid trauma of the patience. Therefore, wound healing plays important rule in the overall treatment to the patient. however, fault detection in the healing wound level identification can causing error treatment to the patience (Ariningrum & Subandono, 2018).

There are many works has been done in wound healing level detection. The researcher develop wound Detection with the color sensor and the Arduino (Herza, Ari D, & Arizki P, 2018). Other researcher Kuman and Reddy (Kumar, K & Reddy, B, 2014) analyze the wound healing level, based on Support Vector Machine (SVM), K-Nearest Neighbors and Wound Image Analysis Classifier (WIAC). It is prove that WIAC is lead among others method to identify the level of wound healing. However, this method still could not perform the percentage identification accuracy. On other side, Sattar and colleges (Sattar et al., 2019), has establish wound level identification based on IoT, so the wound level identification could identify from distance. Anisuzzaman and colleges do the assessment of the wound level identification based on Neural network method (Anisuzzaman et al., 2020).

In this work, the automatic stand-alone system for wound healing level detection based on the wound image identification system is developed. The wound healing image recognition system is based on intelligent system

neural network. The convolution neural network (CNN), which is a relatively popular artificial intelligent, are introduced and proposed for the wound level identification system. CNN is simple and very powerful method. CNN work based on Neural Network principle (Herdianto, Jonathan, Astuti, Puji, & Yuli Astuti Andriatin, 2020). The proposed intelligent system-based image capture identification system used LabelImg as input. The effectiveness of the proposed system is evaluated experimentally. The results show that the proposed technique has produced the better training and testing accuracy.

2. Proposed System

This work considers two main works, which consist of automatic stand-alone wound healing level detection system and wound healing level identification based on the wound-image. Automatic wound healing level identification based on computer and electrical design, which have two main functions, there are an automatic wound healing level identification and perform the decision healing level after identification. Furthermore, the healing level identification system based on image processing and artificial intelligence. Figure 1 shows a flow chart of automatic full detection wound image identification system.

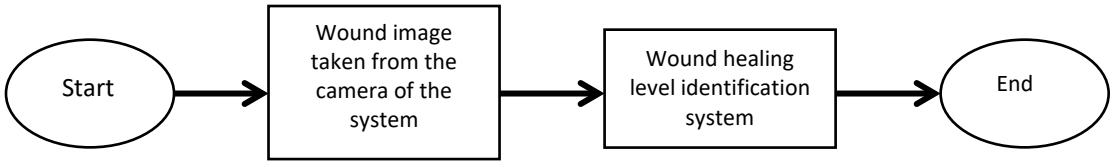


Figure1. Flowchart wound healing level identification based on the wound-image.

These systems have two main parts, namely hardware and software part, respectively. The hardware part consists of electrical parts, has two main functions, taking the reference data and perform the wound healing level identification based on wound-image.

As discussed previously, the hardware part which consists of electrical component, as part of the stand alone wound image capturing system, consists of main parts, namely Casing, Camera, Main Camera Holder, Raspberry Pi, PCB, Cooling Fan, Button and LCD.

There are two types of systems used to carry out two different tasks. For wound image capturing systems, buttons for taking pictures of subjects represent wound healing levels that have been adjusted to the healing level scale. The first stage of data collection is input is done when the subject image is taken with a button that is in accordance with the level of . Second, the system will store images that have been taken into the automatic healing level of the wound based intelligent systems. Finally, the system will flash the notification in the form of an LCD to inform that process of taking patient picture is successful, as shown in Figure 2. This system uses the Raspberry Pi as the main component and the camera as a supporting component for taking pictures, as well as buttons and LCDs to display the output.

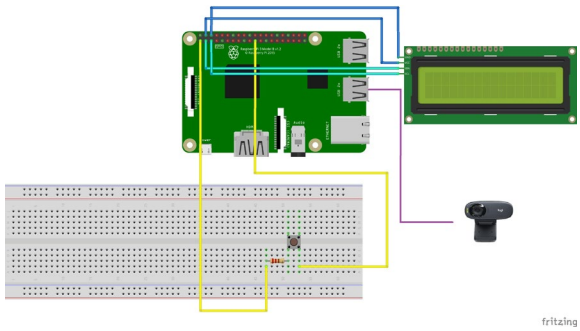


Figure 2. Embedded system for taking the picture of the patient

Figure 3 shows the proposed of the wound-healing level identification of the patient. The system basically consists of three main components, namely image processing, data selection, and identification system. Image processing is used to obtain images using the data based and testing using the camera, data transferred to the computer and processed in order to obtain LabelImg. The processing results in the form of XML file which convert to the form of CSV. The data is then used as input to the identification process in the training phases. There are two important phase identification system, training phase and testing phase, respectively. In the training phase the data is applied to train the system, finding the model each of the expression data patterns. The model testing based on the testing data that captured in real time. Single shot detector (SSD) is applied as identification system to obtain the healing level of the person.

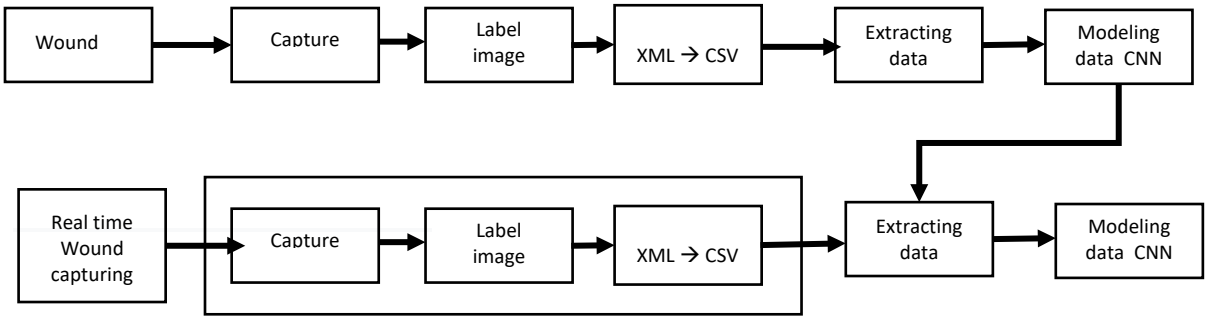


Figure 3. Block diagram of wound healing level identification based on the wound-image system

Single Shot Detector (SSD) applied one shot to detect multiple objects in the picture using multi box. The system is faster in the algorithm when detecting objects and with a high degree of accuracy. High speed and high accuracy SSD in using images with relatively low resolution caused by several things such as convolutional filters, which are increasingly reduced to predict which objects are in which category(Shi, Bao, & Tan, 2019).

SSD accuracy is achieved by using several boxes with size and aspect ratio for the detection of different objects. This makes the system apply some of the filter area ratios to several feature layers at the final stage of the system which helps in making detection at various scales.

SSD has a basic network called VGG-16 which is accepted by conventional multi box layers. The basic network VGG-16 is a standard convolutional neural network (CNN) architecture for the classification of high-quality images but without a final classification layer(Xie, Han, Liao, & Shi, 2017)(Arge & Mage, 2015) . VGG-16 is used for feature extraction.

The following will discuss about the architecture of the SSD listed in Figure 8 below. SSD consists of two main networks, basic network to detect the feature and additional Convolutional Layers to detect objects, respectively, as shown in Figure 4.

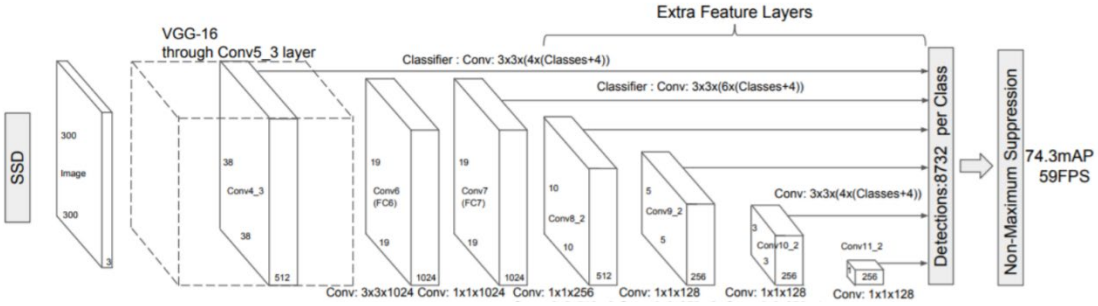


Figure 4. SSD architecture

3. Experimental Result

In order to evaluate the effectiveness of the proposed Automatic Wound Healing Level identification system based on the wound image detection system. The proposed system is installed at simulation system equipment. In this proposes system, the wound image is considered, the wound of the person captured using the camera. The wound image is processed in a computer in order to have the characteristic each of the level of the wound healing. The wound healing level, namely level 1, level 2, and level 3 are used in the experiment.

3.1 Experiment Setup

In this experiment, 3 levels (grouping) were used for the types of wound healing level detection used, namely level 1, 2, and 3. Each level has 27 sample photos, which makes the total of three levels are 81 photos. 72 photos and 9 photos are used as training and testing data, respectively. Logitech C310 used as camera to capture the wound. Because of the type of the camera, the image has problems because of camera resolution need the support the performance of this work.

In the testing phase, the system will run in real-time where the image will be processed directly when the tool is instructed to identify the healing level of the patient's wound. For more detailed ways of working can be seen through Figure 5 below. The laptop used to run this system uses the Nvidia GTX 960m as its graphics processor and has 16 GB of random access memory (RAM).

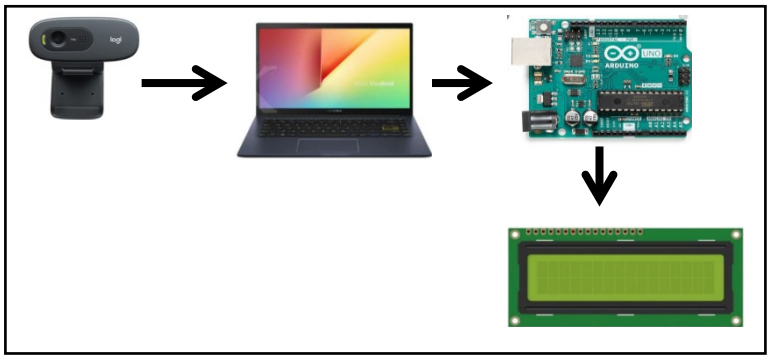
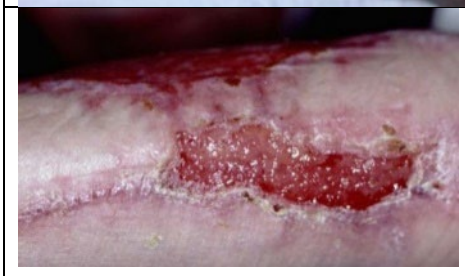


Figure 5. Identification System when testing using a laptop

3.2 Experiment Result and Discussion

The results of the training are then tested using wound image and show that the accuracy obtained is above 67% per level. Figure 6 below shows the test results of the above training. The experiment was carried out based on three levels of healing level wound. It applied photos, a total of three levels of expression from different the wound image, different subjects, different lighting, different background photos and different sexes of the subject. The all of these differences are used to support accurate results in recognizing every expression of the subject that will exist later in the field. SSD method is applied to extract the photos before used as input to the identification system. The size of the photos is also reduced to support the training phase performance and faster identification.

	Level 3
	Level 3
	Level 2
	Level 2
	Level 1

	Level 1

Figure 6. Identification result of real time detection

From the results of trials that have been conducted, it can be concluded that the SSD system can detect each level well with an accuracy level above 55%. Accuracy can also be affected by lighting, subject distance from the camera and many other things. If there is more than one subject in the shooting area, other subjects will be detected as well, so it is highly recommended that there are no more than 1 subject in one shooting area. Poor lighting can also cause a system failure to see the subject in front of the camera. There are also conditions where the hair covering the face is too much so that the identification value becomes less accurate plus the lack of training data that uses subjects with front hair that is too long to narrow the face identification area. The SSD method is proven to have a high identification speed and is fast, aside from the reason that the SSD method can be used on raspberries but also has a weakness where more than one result can be detected on one image. The testing image for levels 1, 2 and 3 have a similar tendency so that sometimes the tool identifies 3 levels at once as in Figure 5. Therefore, it takes photo samples for very diverse training and longer training time to produce smaller errors and maximum identification results.

4. Conclusion

The process of wound healing level identification based on the wound image is discussed in this work. At this time, the process of identify of the healing level is still done manually, which requires a not standard of the medicine to do the task and errors can occur due to the level of the .

With this identification system for wound healing identification based on the wound image detection system, it can reduce the occurrence of errors when give the treatment to the patient, making it easier to identify the level of the wound healing and speeding up the time in the process identification.

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Biographies

Michael Ethan, final year student from BINUS ASO School of Engineering, Bina Nusantara University, in 2020 majoring in Automotive and Robotics Program, and Currently he is planning for pursuing his master degree. His research mainly based on intelligent system, data base, and embedded system.

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