Hamsu Kadriyan 19 Prosiding Inter

by Hamsu Kadriyan 19

Ear disease determination on computer-assisted outer and middle ear images

View the article online for updates and enhancements.

Ear disease determination on computer-assisted outer and middle ear images

H Kadriyan[1*], I G P S Wijaya[2], D Yudhanto[1], E A Yuliyani[1] and H Mulyana[2]

[1]Dept ENT-HN, Faculty of Medicine, University of Mataram, Mataram, Indonesia
[2]Dept Informatics Engineering, University of Mataram, Mataram, Indonesia

[*]Corresponding author: hamsu@unram.ac.id

Abstract. This paper proposes a method to determine the outer and middle ear disease from image files in computer data efficiently and developed the environment friendly unit. The proposed method starts its method by analyzing the accessed file. If a file is labeled as a file that needs to be classified, the proposed method collects the list of image files in the directory, then it starts to run CNN-based classification to determine the type of ear disease suffered by the patient based on the information contained in the input image. If an image file is detected as a certain outer and middle ear disease, that file will be given a label and its probability. The CNN engine work for classifying the input image captured by Endoscope Ear Cleaning Tool Kit. The classification machine was developed using 1800 images for 18 disease classes with each class having a sample of 100 to 105 sample images. The sample image was augmented from 900 patient data. The experimental result shows that the Ear Disease Determination on Computer-Assisted Outer and Middle Ear Images which is based on CNN has run properly which is indicated by 80% accuracy and potentially implemented for the rural health center facility.

1. Introduction

During the pandemic covid-19 in the world, several limitations and challenges are faces in health services. For instance, the obstacle to access secondary services, especially to the hospital and specialist. This condition was also affected by the central government policy on regional lockdown and the limitation on population movement between the region. [1] Fortunately, with the industrial revolution 4.0, the population was exposed by several new technologies in their daily life, including health services. [2]

In Indonesia, health service providers were spread all around the country, even the village, moreover, in the cities. The health services which is divided into primary (*Puskesmas*) and secondary (hospital) have been running well. On the primary health services, mainly operated by a general practitioner and other health workers such as nurses, pharmacist assistants, laboratory workers, etc. On the other hand, the specialist is the main services stakeholders in the hospital. [3]

General practitioner have competencies for managing 144 diseases, including the disease on the otorhinolaryngology (ORL) field.[4] However, a general practitioner in primary health care faces the obstacles of establishing the diagnosis on the ORL field since the limited number and frequency of case visit. Due to this problem, the competencies could be reduced and need to be refresh. According to this reason, the equipment and simple software are needed to simplify the diagnosis and treatment decision.

One of the technologies that can be used for refreshment and deciding diagnosis was the information technology. The development of an expert system on ORL disease using a forward chaining method as an inferential and web-based machine was published. On this approach, it started from entering the information

and then draw the conclusion, the searching methods by looking for the forward fact following the IF-THEN rules. On the other hand, the ORL diseases consist of 10 ear disease, 9 nose disease, and 9 throat diseases were preserved. All diseases consist of 57 symptoms. According to the accuracy test of the forward chaining methods was found 100%, where the data from the expert system were obtained from ORL experts to establish the disease through the symptoms. In this system, some symptoms were not understood by the public because they can't be seen or feel directly. [5]

The expert system can be combined with the electronic system. One of the common electronic systems is an integrated circuit with the raspberry-based. This circuit was used in several controlling systems of mechanical devices such as a robot, motor, IOT, and electronic key, etcetera. [6]

The related publication regarding information technology based on medical imaging to establish the outer and middle ear diseases is limited, hopefully, this study could be as one of the resources to develop the next technology in medical field, as well as an alternative methods for medical education learning. Moreover, this technology is friendly to environment.

2. Materials and methods

This research was implementation research which is used the previous informatics technology to establish the diagnosis of certain diseases based on the data of medical imaging. Medical imaging of the outer and middle ear will be segmented before classified because not all medical imaging has information about the outer and middle ear. To increase the accuracy, on classification process should insert the image that has the information regarding the outer and middle ear disease. The result of image segmentation will be used to develop the model of classification engine which is aided with learning engine type deep learning (DL). A deep learning-assisted classification engine model that fits the case of image classification of the outer and middle ear diseases should be tested through making a variation of several parameters, including the deep learning model, the number of the hidden layer, input layer model, etcetera[7–9]. Briefly, the outer and middle ear medical image segmentation system consists of color space transformation, filtering, erosion, thresholding, and labeling. The segmentation system must be able to work in real-time so that it can be implemented and integrated with an intelligent system. On the development of this engine, authors does not used any biochemical hazard. Finally, it is safe for the environment.

The outer and middle ear image classification engine model on this paper was designed independently, where the classification process ran only on the user's device (client-side only). An application developed by using a medical image classification engine that could classify a medical image of the outer ear and middle ear in realtime as well as off-line. The outer and middle ear medical image classification engine model was developed by using the Convolutional Neural Network (CNN) method, which was a supervised learning engine learning type with a specific architecture. In simple terms, the CNN model works with several stages where the input and output stages consist of several feature maps. Each stage consists of three stages, namely the convolution layer, the activation function layer, and the unification layer. The architecture of the Convolution Neural Network can be seen in Figure 1.
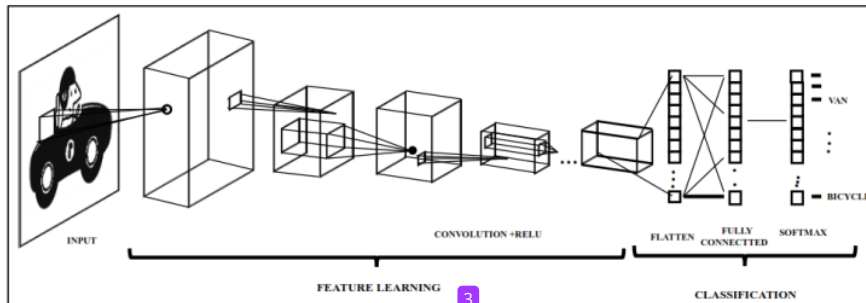
Figure 1. The architecture of the Convolution Neural Network.

Briefly, the model of the outer and middle ear medical image classification engine is shown in Figure 2, which consists of two main stages, the training stage, and the testing phase. The training stage is the step of searching for the CNN model and its parameters that correspond to the problem such as the classification of the outer and middle ear medical images. Meanwhile, the testing phase is the step to test the trained CNN model to determine its performance in the classification of the outer and middle ear medical images.
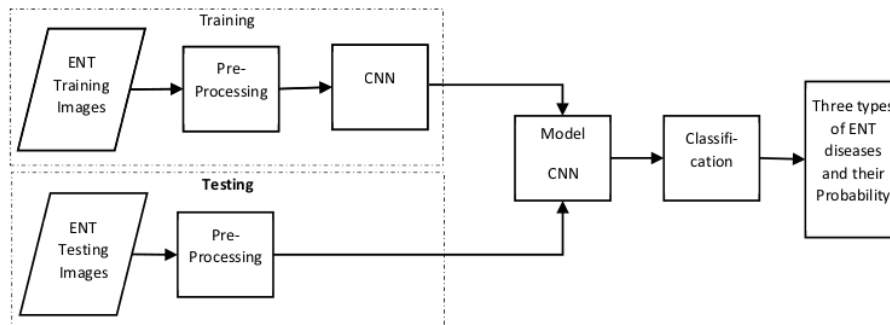

Figure 2. Block diagram of classification engine for the medical image of the outer and middle ear

Next step, in the medical image (the outer and middle ear) classification process, the system will perform a process similar to the training process in the form of information segmentation, which only contains information on outer and middle ear diseases. Then, this feature is projected into the supervised vector domain in the training process. The projection vector is calculated its similarity level through the previously-stored DL model. For the validation process, medical images of the outer and middle ear are needed, which are associated as healthy image training data to determine the threshold that determines whether the input image (query) is included in the trained data group or not.

To determine the performance of the medical image classification system that has been designed and implemented, the system will be tested using BlackBox and Whitebox methods. Blackbox testing is used to determine the functionality of the system, while the Whitebox is used to determine the performance of the proposed system with several test parameters, including the level of recognition accuracy, the error rate in the detection of negative data (false acceptance rate, FAR), and the error rate in the detection of positive

data (false rejection rate, FRR) and its derived parameters from confusion table model. In addition, the detection time (time needed to classify the input data) should be included as one of the important parameters.

If a file is labeled as a file that needs to be classified, the proposed method collects the list of image files in the directory, then it starts to run CNN based classification to determine type of ear disease suffered by the patient based on the information contained in the input image. If an image file is detected as a certain outer and middle ear disease, that file will be given a label and its probability. The CNN engine work for classifying the input image captured by Endoscope Ear Cleaning Tool Kit.

3. Results and discussion

The classification engine for outer and middle ear disease determination was developed using 1800 images for 18 disease classes with each class having a sample of 100 to 105 sample images. The sample image was augmented from 900 patient data. The experimental result show that the Ear Disease Determination on Computer-Assisted Outer and Middle Ear Images which is based CNN has run properly which indicated by 80% accuracy.

The classification engine model for the medical image of outer and middle ear with the above accuracy have a capacity to classify a group of data, then the images will be stored in one folder sequentially. An example of the performance of this classification engine for classification of 28 outer and middle ear images is shown in Figure 3. In addition, the single classification feature can be used to classify real-time images recorded from ENT image sensors/cameras. An example of the classification results of this feature is presented in Figure 3.
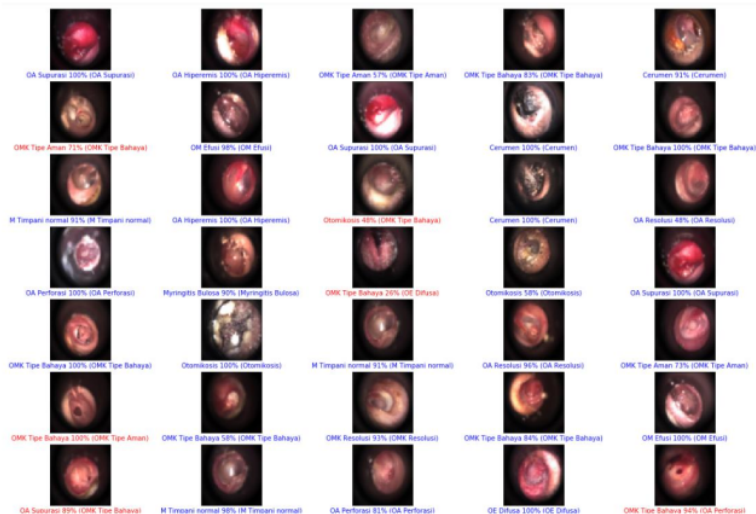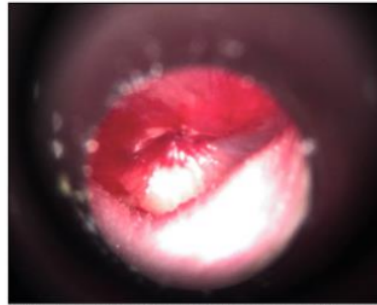

Figure 3. The result of classification by classification engine of outer and middle ear image for a grouping data. Outer ear disease such as cerumen, otomycosis, otitis externa (OE), and middle ear diseases such chronic otitis media (OMK), acute otitis mediawi (OA), efussion otitis media (OME) were documented.

Diklasifikasikan 1: OMA Supurasi, Prob. 100%, 2: OMA Hiperemis, Prob. 0%, 3: Tympanosklerotik, Prob. 0%

Figure 4. The result of real-time singe image classification by the classification engine for middle ear image with 3 probability diseases such as suppurative and hyperemic stage of acute otitis media (OMA), and tympanosclerotic.

An expert engine is an engine that has the capability to learning and improved their ability to perform certain tasks such as detection, recognition, and classification of objects/events. The concept of this engine is based on artificial intelligence systems such as naïve Bayes, LDA, Neural Networks, and even deep learning. Expert engine applications have been widely used such as facial recognition and electronic key control applications, [10] and pornographic image recognition. [11] An implementations of this system for recognition of pornographic or adult videos using a neural network (NN) and a convolutional neural network (CNN) reach an accuracy above 90%. [11], [12]

This expert engine can also be used as a learning simulator in medical education. Issenbert et al. (2005) in a systematic review published as Best Evidence in Medical Education (BEME), recommends that high-fidelity medical simulations are beneficial for learning if applied in the right conditions.[13]

With an accuracy of up to 80%, this feature can be utilized by primary health care centers (*Puskesmas*) that do not have otolaryngologist in analyzing ear, nose, and throat disorders. They could be aided to make a decision with the outcome whether the patient needs to be referred to an otolaryngologist or can be handled by the health personnel at the *Puskesmas*. This feature can also be used for learning in medical education for students at both the academic and professional stages.

If compared to similar studies, these results are quite encouraging. Barrera et al (2010) found the effectiveness of medical images for gastrointestinal diseases by 75%.[14] In skin diseases, the accuracy is 90%.[15] In rheumatic diseases, the accuracy ranges from 43-99%. [16] Based on those study, the system that the authors have built is quite reliable but of course, it remains need an improvement for the future.

4. Conclusion

This paper proposes an environment friendly computer-assisted outer and middle ear disease diagnosis system that can be implemented in primary health centers. The computer-assisted which is applied in this study is a disease classification model based on the information recorded in the image from the outer and middle ear examination results. This system has succeeded in providing an accuracy of 80%, which means this system has the potential to be developed for an expert system that can translate the expertise of a doctor into a computer system; furthermore, the treatment of a disease can be handled early from the public health center.

References

[1]   Muhammad Rosyidi R, Priyanto B, Putu Wisnu Wardhana D, Tsaniadi Prihastomo K and Kamil M 2020 *Interdiscip. Neurosurg. Adv. Tech. Case Manag.* **22** 100868

[2]   Kadriyan H 2019 (Mataram: Mataram University Press)

[3]   Mahendradhata Y, Trisnantoro L, Listyadewi S, Soewondo P, MArthias T, Harimurti P and Prawira J 2017 vol 7

[4]   Indonesia K K 2012

[5]   Verina W 2015 *J. Tek. Inform. Dan Sist. Inf.* **1** 123–38

[6]   Indra D, Tasmil T, Herman H, Mansyur S H and Alwi E I 2019 *J. Inf. Technol. Its Util.* **2** 1

[7]   Arimbawa I W A, Wijaya I G P S and Bintang I 2019 *2019 International Conference on Computer Engineering, Network, and Intelligent Multimedia (CENIM)* pp 1–6

[8]   Ding C, Bao T, Karmoshi S and Zhu M 2017 *2017 IEEE 9th International Conference on Communication Software and Networks (ICCSN)* pp 1157–61

[9]   Surinta O and Khamket T *2019 Joint International Conference on Digital Arts, Media and Technology with ECTI Northern Section Conference on Electrical, Electronics, Computer and Telecommunications Engineering (ECTI DAMT-NCON)* pp 150–4

[10]   Wijaya I G P S, Husodo A Y and Arimbawa I W A 2018 *Telkomnika (Telecommunication Comput. Electron. Control.* **16** 739–46

[11]   Wijaya I G P S, Widiartha I B K and Arjarwani S E 2015 *Telkomnika (Telecommunication Comput. Electron. Control.* **13** 985–95

[12]   Wehrmann J, Simões G S, Barros R C and Cavalcante V F 2018 *Neurocomputing* **272** 432–8

[13]   Issenberg S B and Scalese R J 2008 *Perspect. Biol. Med.* **51** 31–46

[14]   Abundez Barrera I, Rendón Lara E, Gutiérrez Estrada C and Díaz Zagal S 2010 *Lect. Notes Comput. Sci.* **6433** 144–52

[15]   J S G, M M B, Baarath S and Adarsh N 2020 *Int. J. Innov. Technol. Explor. Eng.* **9** 9–12

[16]   Alder H, Michel B A, Marx C, Tamborrini G, Langenegger T, Bruehlmann P, Steurer J and Wildi L M 2014 *Int. J. Rheumatol.* **2014**

Hamsu Kadriyan 19 Prosiding Inter

| 6 | Internet Source | <1% |

| 7 | Bhanu Pratap Singh, Nirvisha Singh. "A mobile app to make biometrics usage more secure", Institute of Electrical and Electronics Engineers (IEEE), 2020
Publication | <1% |

| 8 | repository.unair.ac.id
Internet Source | <1% |

| 9 | "Brain Informatics", Springer Science and Business Media LLC, 2020
Publication | <1% |

| 10 | Patricia Ohrmann. "Threat sensitivity as assessed by automatic amygdala response to fearful faces predicts speed of visual search for facial expression", Experimental Brain Research, 09/19/2007
Publication | <1% |

Exclude quotes	On	Exclude matches	Off
Exclude bibliography	On		