Journal of ICT Aplication and System (JICTAS)
Volume 3 Number 2, December 2024, pp. 33 ~46
ISSN: 2830-098X, DOI: 10.56313/jictas.v1i1.3i2

Systematic Literature Review: Advancements in Skin Cancer Diagnosis Using Convolutional Neural Networks and Dermatoscopic Imaging

Ahmad Muhajirin[1] , Achmad Alwi Hasibuan[2] , Aldi Antoni[3] , Ali Amran NST[4], Ns. Romy Wahyuny[5]
[1234]Informatics Engineering, University Pasir Pengaraian, Riau Indonesia
[5] Ilmu Kesehatan, University Pasir Pengaraian, Riau Indonesia

Article Info

Article history:

Received November 15 2024
Revised 10 Desember 2024
Accepted 28 Desember 2024

Keywords :

Skin Cancer, Convolutional Neural Network (CNN), Automated Diagnostic System, Dermatoscopic Images, Machine Learning

ABSTRACT

This study conducts a systematic literature review (SLR) to analyze the application of CNN in automated diagnostic systems for skin cancer using dermatoscopic images. The review examines methods, architectures, and datasets used in recent studies, focusing on their accuracy, efficiency, and limitations. It highlights the adoption of models such as GoogLeNet, ResNet-50, and YOLOv8, which have achieved accuracy levels exceeding 90%, demonstrating the capability of CNNs in distinguishing between benign and malignant lesions. The findings reveal that while CNNs offer high precision and recall, challenges remain in terms of overfitting, dataset diversity, and computational cost. This study underscores the need for larger and more balanced datasets, advanced augmentation techniques, and optimized architectures to enhance model generalizability. The research aims to contribute to the development of robust, efficient, and accessible AI-based diagnostic tools for early skin cancer detection, improving clinical decision-making and patient care.

Corresponding Author:

Ahmad Muhajirin
Informatics Engineering, University Pasir Pengaraian, Riau Indonesia
Email: achmadalwi42@gmail.com

1. INTRODUCTION

Skin, which covers almost the entire surface of the human body, is the largest external organ and serves to protect against various external hazards, including sunlight, dust, bacteria and viruses. In addition, as an internal component, the skin allows humans to sense environmental stimuli. However, its extreme position makes the skin vulnerable to various health problems, especially skin cancer. This type of cancer arises when skin cells change from a normal to a malignant state, leading to uncontrolled cell division and DNA damage. According to the International Agency for Research on Cancer's (IARC) 2018 Global Cancer Observatory, skin cancer is among the most common forms of cancer, with a significant number of cases reported globally. [1]

In this scenario, timely identification of skin cancer is crucial to improve treatment effectiveness and patient outcomes. Conventional diagnostic methods, such as biopsy, tend to be time-consuming,

expensive, and can cause discomfort for patients. As a result, there is an urgent demand for more effective alternative solutions...[2]

An innovative method being developed involves the application of artificial intelligence (AI), specifically in skin cancer image analysis. This research uses the GoogLeNet architecture that utilizes convolutional neural network (CNN) techniques. By incorporating the Inception module, this approach enhances image processing capabilities. This approach allows the execution of convolutional and fusion processes simultaneously, which reduces computation time while maintaining accuracy.[3]

The study listed deployed descriptions of 600 sensory pox beams published on the Kaggle.com construction. After enduring pre-processing as breaking the milestones of the posts and shrinking the mane noise exploring smoothing, the posts were classified into "benign" and "malignant" sensory pox species. The performance of the array was tested using the parameters of precision, recall, and F-1 value, and the results highlighted satisfactory accuracy (97.73%). [4]

Therefore, this determination is expected to contribute meaningfully to the discovery and categorization of healthy kintil cell tumors freshness scholars build earlier and accurate diagnosis. Innovations in this area have the potential to intensify the value of freshness preservation and intensify public awareness of the importance of early discovery.[5]

2. RELATED RESEARCH

In these articles, researchers examine data from previous studies as a point of comparison, either for shortcomings or strengths. Additionally, researchers sift through research journals for information regarding previous hypotheses connected to the topic to build a theoretical foundation for the science.

1. Cervical Cancer Classification Using Convolutional Neural Network (Alexnet) Model. In this study, the convolutional neural network model used is the AlexNet model which will be used to transform the input image into a disease label of cervical cancer.[6]
2. Detection and Classification of Blood Cancer Images Using Convolutional Neural Network (CNN) Method. Diagnosis of blood cancer starts with reading the microscopic image into the trained neural module for diagnosis. The trained Machine Learning module will give an output whether the sample is cancer or non-cancer based on the prediction value. For the training process, a dataset of 1000 images of cancer and non-cancer samples is used. The training dataset is used to train the machine learning module. It consists of cancer and non-cancer images labeled respectively.[7]
3. Skin Cancer Disease Detection System Using Convolutional Neural Network Architecture YOLOv8 Website Based. This research was prepared by including basic theories related to the scope of the available problems, including Skin Cancer, Machine Learning, Deep Learning, Convolutional Neural Network (CNN), You Only Look Once (YOLO), Confusion Matrix.[8]
4. Skin Cancer Early Detection Mobile Application Based on Image Processing. Pre-processing of skin image data is a very important task in CNN. Sometimes due to availability of less or small dataset the network becomes overfitted. In overfitting, CNN performs very well in training data but performs poorly in testing data. To reduce the problem of overfitting, data augmentation techniques have been applied using different CNN architectures that increase the size of the dataset and perform geometric transformation to the image dataset. Due to the rotation invariant characteristics of microscopic skin lesion images they are easily identified and analyzed by the pathologist. The pathologist examines these images from different orientations and angles without losing any variation or method of diagnosing.[9]
5. Skin Cancer Classification Based on Benign and Malignant Image Data Using Convolutional Neural Network. research to develop an accurate and reliable classification system to identify skin cancer types. In addition, the collected dataset provides a solid basis for analysis and evaluation, allowing researchers to measure model performance and identify potential limitations or challenges during the classification process. Therefore, the use of the Kaggle dataset is expected to help achieve the research goal of developing an effective classification solution for early detection of skin cancer.[10]
6. Classification of Skin Cancer in Dermatoscopy Images Using CNN. a This research will be carried out by implementing the Convolutional Neural Network method with the AlexNet architecture.[11]
7. Classification of Skin Cancer Pigment Images Using Convolutional Neural Network. researchers propose to classify skin cancer pigments using convolutional neural network algorithms. datasets obtained from the International Skin Imaging Collaboration (ISIC) 2018 with a total of 10015 images focusing on 2 categories namely Non-Melanocytic Malignant and Benign.[12]

8. Implementation of Convolutional Neural Network (CNN) Model on Skin Cancer Detection Application Using React Native Expo. Research on mobile applications to detect skin cancer has been done before. In the research conducted, successfully implemented the InceptionV3 architecture CNN model and converted it into TfLite form into a skin cancer detection mobile application. The application successfully detects skin cancer with Top-1 to Top-3 accuracy, namely 87.5%, 95.5%, and 97.4%. Another study conducted by Chaturvedi et al in 2021, successfully created a skin cancer classification system on the HAM10000 dataset using the MobileNet architecture. The system using the MobileNet architecture managed to get a total accuracy of 83.1%. In 2021, research conducted by Krohling, et al., successfully created a smartphone-based application to diagnose skin cancer using CNN with the ResNet50 architecture. The system managed to get an average accuracy of 85% and a recall of 96%.[13]
9. Implementation of Convolutional Neural Network (Resnet-50) Algorithm for Benign and Malignant Skin Cancer Classification. This research emphasizes on how to build a CNN model for classification and how to build a system for classification with Flask. This research does not focus on achieving the highest accuracy in classification, but rather on the process of creating and implementing models and systems that can function properly in the context of web applications.[14]
10. Modified Convolutional Neural Network GoogLeNet Architecture with Dull Razor Filtering for Skin Cancer Classification. This research uses the two dropout layers-CNN model, a deep learning and machine learning method to distinguish objects, including cancer types, including malignant or benign cancer [7]. The best accuracy obtained was 88.40%. Reference [8] utilized computer-aided diagnosis (CAD) to detect skin cancer based on ABCD rules, with the best accuracy result obtained was 92.00%.[15.

3. RESEARCH METHODS

a. Systematic Literature Review (SLR)

A systematic literature review (SLR) identifies, assesses and interprets all findings on the subject matter of the study examined to respond to a predetermined research question. An additional definition of SLR is a scientific study that compares or is supported by previous research and focuses on a specific subject.

b. Research Question

The specifics of the chosen topic are taken into account when formulating the research questions. The research questions of the study are listed below:

RQ1: What are the methods often used to design a web-based extracurricular management system in 2019-2024?

RQ2: What are the advantages and disadvantages of the web-based extracurricular management system based on the method used?

RQ3: Which research method has the best results in conducting a web-based extracurricular management system?

3.3 Search Process

Using Google Chrome and the website address https://scholar.google.com/, a search process was used to identify sources relating to the research question (RQ) and other relevant references.

1.1 Inclusion and Exclusion Criteria

This procedure is used to determine if the data collected is pertinent to the research. Studies will be selected if the criteria below are met:

a) The data used covers the years 2020 to 2024.
b) The data used was retrieved using the website URL https://scholar.google.com/.
c) The data used is limited to the Web-based Extracurricular Management System.

3.5Quality Assessment

The list of problem formulations serves as the basis for quality assessment, or QA. The quality assurance review stage should include all problem formulations. The information collected for this study will be assessed using the following criteria to measure quality..:

QA1: Was the literature published in 2020-2024?

QA2: Does the literature discuss the creation of a web-based extracurricular management system?

Each response listed below to the questions mentioned above will receive a score for each piece of literature.

Y (Yes) : in the case of literature that corresponds to the quality assessment question.

T (No) : in the case of literature that does not match the quality assessment question.

3.6Data Collection

This stage is the data collection stage when information is collected for this research. The following data collection steps were obtained using the source https://scholar.google.com/.

a) Access the web page https://scholar.google.com/.

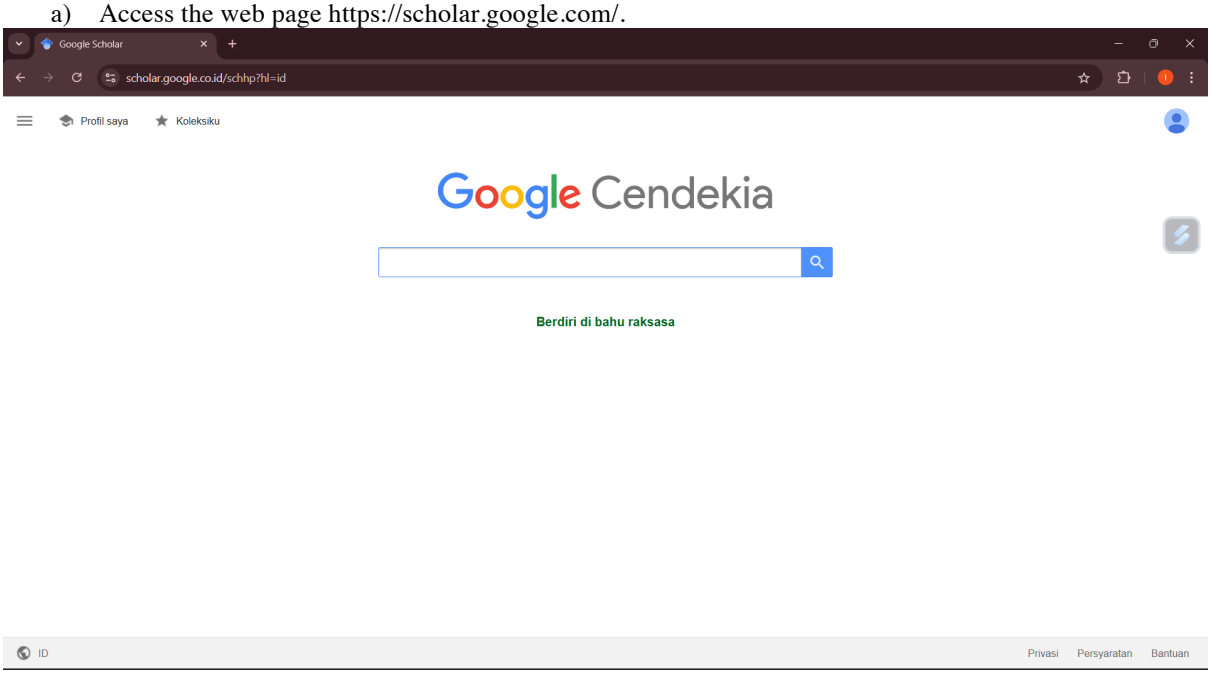

Figure 1. Open Browser Cendekia

b) Include the keyword "Web-based Extracurricular Management System" in the search column. On the left corner screen, Custom Range, enter 2019-2024 to identify the source year for retrieving relevant literature.

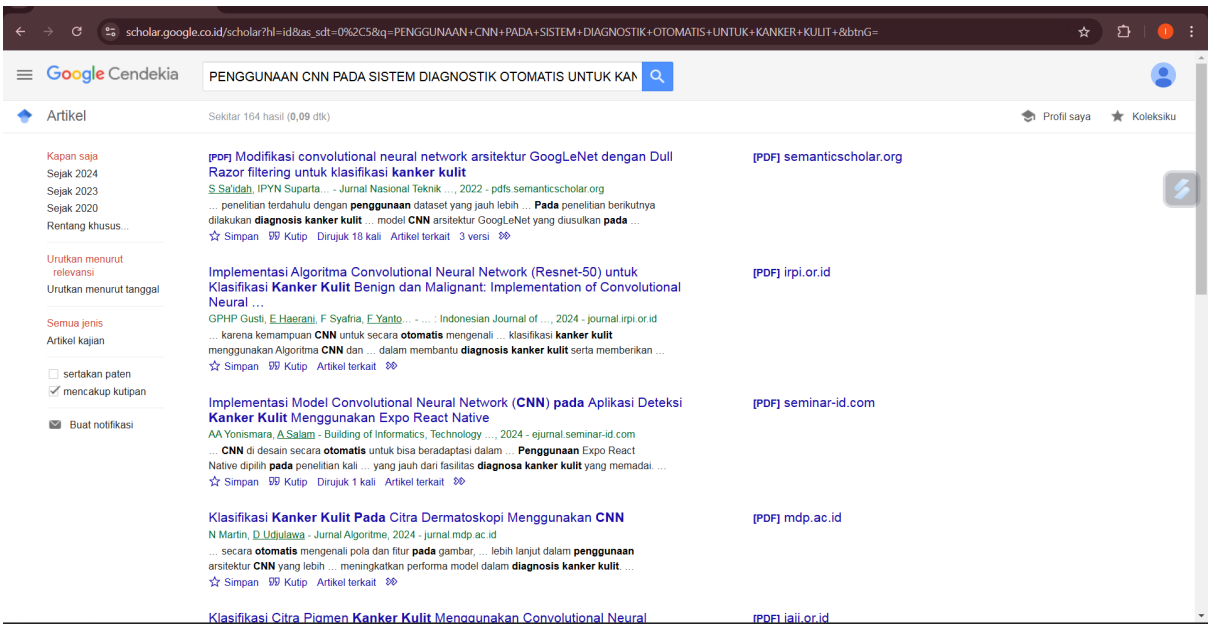

Figure 2. Search result of "Use of Cnn in Automatic Diagnostic System for Skin Cancer Based on Dermatoscopy Image" by year.

3.7 Data Analysis

Study questions (RQs) will be discussed at this point, along with the latest study results from 2019 to 2024.

4. RESULTS AND DISCUSSION

Search Process Results In the process of searching for relevant journals, the search results are shown in the flowchart below:

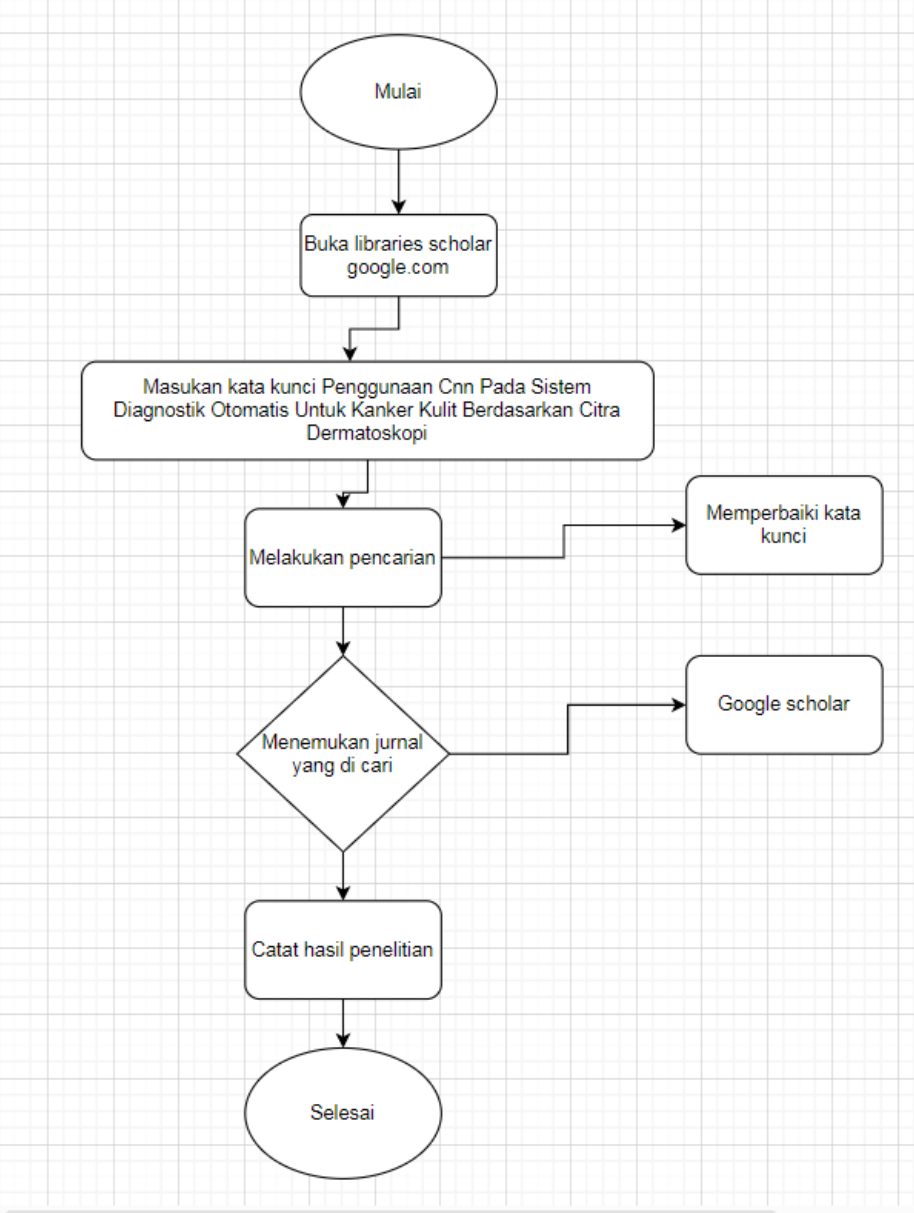

Figure 3. Flowchart of relevant journal search process

4.2 Quality Assessment Results

Parameters (inclusion and exclusion) will be used to select search results. At the search stage, the process generates many journals, then 10 journals are selected after the inclusion and exclusion stage. After that, data scanning will be performed. The next stage shows the results of the quality assessment of the journals that will be included in the study.

4.3 Quality Assessment (QA) Results

The results of the quality assessment will determine whether or not the journal is used in this study. The following figure is the result of the Quality Assessment

Table 1.1 Quality Assessment

No.	Author	Title	Year	QA1	QA2	Results
1	Habibullah, Akbar, Sandfreni.	Cervical Cancer Classification Using Convolutional Model Neural Network (Alexnet)	2019	Y	Y	✓
2	Sriyani Violina, Niken Rosiana, Damayanti, Iwa Ovyawan, Herlistiono.	Blood Cancer Image Detection and Classification Using Convolutional Neural Network (CNN) Method	2024	Y	Y	✓
3	Egga Naufal Daffa Tanadi, Dhian Satria Yudha Kartika, Abdul Rezha Efrat Najaf.	Skin Cancer Detection System Using Convolutional Neural Network Architecture YOLOv8 Based on Website	2024	Y	Y	✓
4	Fina Royana, Puput Yuniar, Maulida, Rully Nurul Hasanah, Sondari Setia Rahayu, Rasim.	Mobile Application for Early Detection of Skin Cancer Based on Image Processing	2021	Y	Y	✓
5	Findriyani, Rizal Adi Saputra.	Skin Cancer Classification Based on Benign and Malignant Image Data Using Convolutional Neural Network	2024	Y	Y	✓
6	Nicolas Martin, Daniel Udjulawa.	Classification of Skin Cancer in Dermatoscopy Images Using CNN	2024	Y	Y	✓
7	Luqman Hakim, Zamah Sari, Handhajani.	Skin Cancer Pigment Image Classification Using Convolutional Neural Network	2021	Y	Y	✓
8	Arvie Arvearie Yonismara, Abu Salam.	Implementation of Convolutional Neural Network (CNN) Model on Skin Cancer	2024	Y	Y	✓

.

		Detection Application Using React Native Expo				
9	Gogor Putra Hafi Puja Gusti, Elin Haerani, Fadhillah Syafria, Febi Yanto, Siska Kurnia Gusti	Implementation of Convolutional Neural Network (Resnet-50) Algorithm for Benign and Malignant Skin Cancer Classification	2024	Y	Y	✓
10	Sofia Sa'idah, I Putu Yowan Nugraha Suparta Efri Suhartono.	Modified Convolutional Neural Network GoogLeNet Architecture with Dull Razor Filtering for Skin Cancer Classification	2022	Y	Y	✓

4.4 Data Collection Results

After going through the inclusion and exclusion stage to get 10 journals, followed by the quality assessment stage, there are 10 journals that can be used for this research. The following figure will summarize the details of each journal.

Table 2. Data Collection Results

No.	Title	Author/year	Research method	Research Results
1	Cervical Cancer Classification Using Convolutional Model Neural Network (Alexnet)	Habibullah, Akbar, Sandfreni.	Convolutional Neural Network (CNN)	In this study, we have tested the performance of AlexNet convolutional neural network model on Intel & MobileODT Cervical Cancer Screening dataset. Of the 3 architectural models that have been tested, the AlexNet 2 model which has a double convolution layer in each block produces the best accuracy. This shows that the AlexNet model is able to classify cervical cancer cell images. Another parameter that also affects the accuracy of the AlexNet model is the iteration or epoch parameter. In addition, the larger the training data used, the accuracy results also tend to increase. The minibatch and learning

				rate parameters tend to have less effect on the accuracy of the AlexNet model. As for the input image resolution parameter, the accuracy results actually decrease where the computation time is also higher.[16]
2	Blood Cancer Image Detection and Classification Using Convolutional Neural Network (CNN) Method	Sriyani Violina, Niken Rosiana, Damayanti, Iwa Ovyawan, Herlistiono.	Convolutional Neural Network (CNN)	. Implementation of CNN to classify blood cancer and normal blood images using VGG-16 architecture. Based on image data classification is done in several stages. The first stage is by pre-processing the data, namely by resizing. The results obtained from the application of resize to speed up model computation. The CNN algorithm has several layers that are used for 2024. Journal of Information Technology and Computer Science (INTECOMS) 7(4): 1257-1264 feature learning and classification according to the VGG-16 architecture. This process is affected by the percentage of training data sharing, batchsize and dropout.[17]
3	Skin Cancer Detection System Using Convolutional Neural Network Architecture YOLOv8 Based on Website	Egga Naufal Daffa Tanadi, Dhian Satria Yudha Kartika, Abdul Rezha Efrat Najaf.	Convolutional Neural Network (CNN)	This research successfully implemented the YOLOv8 algorithm in a skin cancer detection system with satisfactory results. The model was able to detect seven types of skin cancer with 89% accuracy, 0.975 precision, and 0.969 recall. Evaluation using confusion matrix shows the model's ability to classify and detect with low error rate. The development of the web interface allows users to upload images and view detection results directly, making it easier for them to get information about possible skin diseases.

.

				The use of YOLOv8 enables fast and efficient real-time detection, very important in medical applications that require fast response and high accuracy. For future research, it is recommended to use a larger and more diverse dataset to improve generalization and detection accuracy on various skin conditions. Increasing the resolution of input images can help the model detect small features important in skin cancer identification. Development of additional features on the web interface, such as recommended medical measures based on the detection results, can increase the practical value of this system. Integration with electronic medical record (EMR) systems will help manage patient data and provide more comprehensive information to medical personnel. Clinical trials to test the reliability and effectiveness of the system in an actual medical environment are highly recommended to ensure practical and safe use in skin cancer diagnosis." [17].[17]
4	Mobile Application for Early Detection of Skin Cancer Based on Image Processing	Fina Royana, Puput Yuniar, Maulida, Rully Nurul Hasanah, Sondari Setia Rahayu, Rasim.	Convolutional Neural Network (CNN)	Compared to a similar application (skin lesion classification based on convolutional neural network architecture), the author's application has 9% better accuracy. Skin cancer detection (skin lesion classification based on convolutional neural network architecture) achieved an overall accuracy score of 88%

.

				(Saeed, 2021), while the author's application has 97% accuracy. This means the author's app has about 9% better accuracy in machine learning testing. However, this app requires expert physician intervention to identify the available features. In this study, to correctly classify and identify melanoma skin cancer, an efficient transfer learning-based approach is proposed by using the ResNetV2 model.[18]
5	Skin Cancer Classification Based on Benign and Malignant Image Data Using Convolutional Neural Network	Findriyani, Rizal Adi Saputra.	Convolutional Neural Network (CNN)	Excellent Model Performance: The accuracy rate of 99.01% shows that the model can classify skin cancer types (benign and malignant) very highly correctly on a test dataset that has never been seen before. This confirms the generalization ability of the model, i.e. the ability to provide good predictions on new data. 2. Prediction Reliability.[19]
6	Classification of Skin Cancer in Dermatoscopy Images Using CNN	Nicolas Martin, Daniel Udjulawa.	Convolutional Neural Network (CNN)	The results of this study emphasize the importance of selecting the amount of data and optimizing the parameters in the CNN model for skin cancer classification. This research opens up opportunities for further exploration in the use of more complex CNN architectures and testing with larger datasets to improve model performance in skin cancer diagnosis.[20]
7	Skin Cancer Pigment Image Classification Using Convolutional Neural Network	Luqman Hakim, Zamah Sari, Handhajani.	Convolutional Neural Network (CNN)	In all stages of the research that has been carried out, it can be concluded that the good or poor performance of the convolutional neural network model is caused by several influences such as the number of layers,

.

				increasing the size of the kernel_size in the input layer, the accuracy of data augmentation, data conditions, and data balance. What causes the model to have difficulty in classifying data is the condition of the data in one class that has several variations, this is because each class consists of a combination of several previous categories. Using the right augmentation technique is necessary to help increase the accuracy value. The number of datasets is very influential in the performance of the model built, the more data processed, the higher the accuracy of the model. In addition, the balance of data frequency in each class can also affect the accuracy of the model. A balanced dataset will increase the accuracy of the model. It can be seen that the proposed model on the classification of skin cancer pigments obtained an accuracy of 75%. with the highest precision and recall values found in the benign class, which are 0.80 and 0.82 respectively and the f1_score value of 0.81.[21]
8	Implementation of Convolutional Neural Network (CNN) Model in Skin Cancer Detection Application Using React Native Expo	Arvie Arvearie Yonismara, Abu Salam.	Convolutional Neural Network (CNN)	Performance testing of the CNN model used in this study is seen based on the confusion matrix that has been created. With the confusion matrix, researchers can evaluate the performance and accuracy of the model used in this study. In this research, confusion matrix is used as a reference to get the accuracy, recall,

.

				specificity, f1-score, and gmean values.
9	Implementation of Convolutional Neural Network (Resnet-50) Algorithm for Benign and Malignant Skin Cancer Classification	Gogor Putra Hafi Puja Gusti, Elin Haerani, Fadhillah Syafria, Febi Yanto, Siska Kurnia Gusti	Convolutional Neural Network (CNN)	The research reached its final stage with a conclusion that illustrated the results of meaningful achievements. In an effort to classify skin cancer images, the model utilizes the CNN Algorithm with a dataset from ISIC, focusing on two main classes, namely Benign and Malignant Cancer. The test results showed that the CNN model was able to properly classify the skin cancer types, providing satisfactory results. By summarizing the findings and analysis, the research conclusion provides a valuable final insight into the CNN model's ability to tackle the skin cancer classification task so that the results can make an important contribution in further understanding in the field of health and malignant.
10	Modified Convolutional Neural Network GoogLeNet Architecture with Dull Razor Filtering for Skin Cancer Classification	Sofia Sa'idah, I Putu Yowan Nugraha Suparta Efri Suhartono.	Convolutional Neural Network (CNN)	In this research, a system is designed to classify the types of benign skin cancer and malignant skin cancer. The skin cancer image data used is secondary data obtained from the web www.kaggle.com. A total of 660 data used are divided into 132 test data and 528 training data. By using the CNN method of GoogLeNet architecture, it can be concluded that the designed system is able to classify two types of skin cancer. The results obtained in this study are 97.73% accuracy and 1.7063 loss. For other parameters, such as f-1 score, recall, and precision, an average value of 0.98 was obtained. For further

				research, it is recommended that other deep learning methods be used, so that better accuracy is obtained in distinguishing benign and malignant skin cancer classes. In addition, implementation in the form of applications can also be done so that the detection of skin cancer types can be done in real-time.

4.5 Data Analysis Results

The results at this point will address the Research Question (RQ) and talk about the findings of the research conducted between 2019 and 2024.

RQ1: What are the methods that are often used to design a web-based extracurricular management system in 2019-2024?

Table 3. Pros and Cons of Methods

Methods	Pros	Disadvantages
Convolutional Neural Network (CNN)	• High Accuracy • Automatic Processing • Overfitting Reduction • Invariance to Translation • Automatic Feature Detection	• Big Data Needs • High Computation Cost • Long Training Time • Limitations of Interpretability • Noise Sensitivity

5. CONCLUSION

Skin cancer is a prevalent and potentially fatal condition where early detection is critical for effective treatment. This study systematically reviews the use of convolutional neural networks (CNN) in automated diagnostic systems for skin cancer, highlighting their ability to achieve high accuracy rates exceeding 97% in distinguishing benign from malignant cases using dermatoscopic images. Leveraging datasets such as ISIC and Kaggle, these models benefit from advanced architectures like GoogLeNet and ResNet-50, alongside data augmentation techniques to improve robustness. Despite challenges like high computational costs and the need for large, balanced datasets, CNN-based systems offer non-invasive, cost-effective, and efficient alternatives to traditional diagnostic methods. The findings emphasize the transformative potential of AI in revolutionizing skin cancer detection, supporting early diagnosis, and improving global patient outcomes

REFERENCES

[1.] B. Yanto, L. Fimawahib, A. Supriyanto, B. H. Hayadi, and R. R. Pratama, "Klasifikasi Tekstur Kematangan Buah Jeruk Manis Berdasarkan Tingkat Kecerahan Warna dengan Metode Deep Learning Convolutional Neural Network," Jurnal Inovtek Polbeng Seri Informatika, vol. 6, no. 2, pp. 259–268, 2021. [Online]. Available: https://jurnal.polbeng.ac.id/index.php/informatika/article/view/1351

[2.] B. Yanto, A. Lubis, B. H. Hayadi, and N. S. T. Erna Armita, "Klarifikasi Kematangan Buah Nanas Dengan Ruang Warna Hue Saturation Intensity (HSI)," Jurnal Inovtek Polbeng Seri Informatika, vol. 6, no. 1, pp. 135–146, 2021. [Online]. Available: https://jurnal.polbeng.ac.id/index.php/informatika/article/view/1351.

[3.] Lubis, I. Iskandar, and M. M. L. W. Panjaitan, "Implementation of KNN Methods and GLCM Extraction for Classification of Road Damage Level," IAIC Transactions on Sustainable Digital Innovation (ITSDI), vol. 4, no. 1, pp. 1–7, 2022. DOI: 10.34306/itsdi.v4i1.552.

[4.] Lubis and E. Prasiwiningrum, "Implementation of PageRank Algorithm for Visualization and Weighting of Keyword Networks in Scientific Papers," Journal of Applied Data Sciences, vol. 4, no. 4, pp. 382–391, 2023. DOI: 10.47738/jads.v4i4.203.

[5.] F. P. Loss et al., "Skin Cancer Diagnosis Using NIR Spectroscopy Data of Skin Lesions In Vivo Using Machine Learning Algorithms," arXiv preprint arXiv:2401.01200, 2024. [Online]. Available: https://arxiv.org/abs/2401.01200.

[6.] N. Kanwal et al., "Detection and Localization of Melanoma Skin Cancer in Histopathological Whole Slide Images," arXiv preprint arXiv:2302.03014, 2023. [Online]. Available: https://arxiv.org/abs/2302.03014.

[7.] J. G. M. Esgario and R. A. Krohling, "Beyond Visual Image: Automated Diagnosis of Pigmented Skin Lesions Combining Clinical Image Features with Patient Data," arXiv preprint arXiv:2201.10650, 2022. [Online]. Available: https://arxiv.org/abs/2201.10650.

[8.] S. S. Chaturvedi, K. Gupta, and P. S. Prasad, "Skin Lesion Analyser: An Efficient Seven-Way Multi-Class Skin Cancer Classification Using MobileNet," arXiv preprint arXiv:1907.03220, 2019. [Online]. Available: https://arxiv.org/abs/1907.03220.

[9.] R. Giusto and J. R. Martinez, "Cybersecurity Data Analytics: Trends and Perspectives," IEEE Security & Privacy, vol. 18, no. 3, pp. 45–52, 2020. DOI: 10.1109/MSEC.2020.2975070.

[10.] Z. Tariq, "Comparative Analysis of Visualization Tools for Big Data," IEEE Transactions on Big Data, vol. 7, no. 1, pp. 45–53, 2021. DOI: 10.1109/TBDATA.2021.3056403.

[11.] Chatterjee et al., "Real-Time Big Data Analytics for Cybersecurity Monitoring," Future Generation Computer Systems, vol. 79, pp. 30–45, 2018. DOI: 10.1016/j.future.2017.02.002.

[12.] S. Kumar and V. Sehgal, "Big Data Analytics for Cybersecurity," IEEE Access, vol. 7, pp. 143,299–143,307, 2019. DOI: 10.1109/ACCESS.2019.2944444.

[13.] Pakpahan, J. R. Sagala, R. Yesputra, A. Lubis, H. Saputra, and H. T. Sihotang, "Implementation of Certainty Factor Method for Diagnoses of Photocopy Machine Damage," Journal of Physics: Conference Series, vol. 1255, no. 1, p. 012059, 2019. DOI: 10.1088/1742-6596/1255/1/012059.

[14.] H. Hayadi, K. Rukun, R. E. Wulansari, T. Herawan, and D. Dahliusmanto, "Expert System of Quail Disease Diagnosis Using Forward Chaining Method," Indonesian Journal of Electrical Engineering and Computer Science, vol. 5, no. 1, pp. 207–214, 2017. DOI: 10.11591/ijeecs.v5.i1.pp207-214.

[15.] H. Hayadi, R. D. P. Permatasari, and K. Rukun, "Development of Digital Information Management Learning Media Based on Adobe Flash in Grade X of Digital Simulation Subject," Journal of Physics: Conference Series, vol. 1363, no. 1, p. 012066, 2019. DOI: 10.1088/1742-6596/1363/1/012066.

[16.] Bisong, Google BigQuery: Building Machine Learning and Deep Learning Models on Google Cloud Platform. New York: Springer, 2019. DOI: 10.1007/978-1-4842-4470-8_38.

[17.] H. Demirkan and D. Delen, "Leveraging Business Intelligence and Analytics for Enhancing Enterprise Performance," MIS Quarterly Executive, vol. 12, no. 4, pp. 19–29, 2013.

[18.] R. Sahtyawan, "Penerapan Zero Entry Hacking di dalam Security Misconfiguration pada VAPT," Journal of Information System Management (JOISM), vol. 1, no. 1, pp. 18–25, 2019. DOI: 10.24076/joism.2019v1i1.18.

[19.] Y. Talaoui, M. Kohtamäki, and R. Rajala, "Seeking 'strategy' in business intelligence literature: Theorizing BI as part of strategy research," Technology Innovation Management Review, vol. 10, no. 9, pp. 20–32, 2020. DOI: 10.22215/TIMREVIEW/1387.

BIOGRAPHIES OF AUTHORS (10 PT)

The recommended number of authors is at least 2. One of them as a corresponding author.

Please attach clear photo (3x4 cm) and vita. Example of biographies of authors:
