LITERATURE SURVEY

AI-BASED LOCALIZATION AND CLASSIFICATION OF SKIN DISEASE WITH ERYTHEMA

DOMAIN: Artificial Intelligence

TEAM ID: PNT2022TMID03793

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PAPER 1: Deep Learning in Skin Disease Image Recognition: A Review

PUBLICATION YEAR: 11 November 2020

AUTHOR NAME: LING-FANG LI1 , XU WANG1 , WEI-JIAN HU 1 , NEAL N. XIONG 2 , (Senior Member, IEEE), YONG-XING DU 1 , AND BAO-SHAN LI1.

JOUNAL NAME: IEEE ACCESS (https://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=6287639)

SUMMARY:

The application of deep learning methods to diagnose diseases has become a new research topic in the medical field. In the field of medicine, skin disease is one of the most common diseases, and its visual representation is more prominent compared with the other types of diseases. Accordingly, the use of deep learning methods for skin disease image recognition is of great significance and has attracted the attention of researchers. In this study, we review 45 research efforts on the identification of skin disease by using deep learning technology since 2016. We analyze these studies from the aspects of disease type, data set, data processing technology, data augmentation technology, model for skin disease image recognition, deep learning framework, evaluation indicators, and model performance. Moreover, we summarize the traditional and machine learning-based skin disease diagnosis and treatment methods. We also analyze the current progress in this field and predict four directions that may become the research topic in the future. Our results show that the skin disease image recognition method based on deep learning is better than those of

dermatologists and other computer-aided treatment methods in skin disease diagnosis, especially the multi deep learning model fusion method has the best recognition effect.

CONCLUSION:

Forty-five relevant papers have been identified to obtain their concerns about the areas and skin disease types. These papers are utilized as basis to study the used data source, the preprocessing and data expansion techniques, the technical details of the models, and the performance indicators' overall performance. Deep learning models AlexNet, VGG, GoogleNet, and ResNet are widely used in skin disease recognition. Researchers often use the multimodel fusion technology to improve the performance of models. In future work, we plan to apply the concepts and best practices of deep learning described in this survey to other medical fields that have not fully utilized this technology. This survey aims to encourage many researchers to conduct deep learning experiments and apply the model of deep learning in the field of computer vision involving medicine, thereby achieving smart and convenient development for the medical industry.

PAPER 2: Progressive Transfer Learning and Adversarial Domain Adaptation for Cross-Domain Skin Disease Classification

PUBLICATION YEAR: MAY 2020

AUTHOR NAME: Yanyang Gu?, Zongyuan Ge?*, Member, IEEE, C. Paul Bonnington, Senior Member, IEEE, and Jun Zhou*, Senior Member, IEEE

JOURNAL NAME: IEEE JOURNAL OF BIOMEDICAL AND HEALTH INFOMATICS

SUMMARY:

Deep learning has been used to analyze and diagnose various skin diseases through medical imaging. However, recent researches show that a well trained deep learning model may not generalize well to data from different cohorts due to domain shift. Simple data fusion techniques such as combining disease samples from different data sources are not effective to solve this problem. In this paper, we present two methods for a novel task of cross-domain skin disease recognition. Starting from a fully supervised deep convolutional neural network classifier pre-trained on ImageNet, we explore a two-step progressive transfer learning technique by fine-tuning the network on two skin disease datasets. We then propose to adopt adversarial learning as a domain adaptation technique to perform invariant attribute translation from source to target domain in order to improve the recognition performance. In order to evaluate these two methods, we analyze generalization capability of the trained model on melanoma detection, cancer detection and cross-modality learning tasks on two skin image datasets collected from different clinical settings and cohorts with different disease distributions. The experiments prove the effectiveness of our method in solving the domain shift problem.

CONCLUSION:

In this work, they quantitatively validate the model generalization for different datasets from two perspectives. One is applying parameter-based progressive transfer learning to share transferable knowledge from task-different source domain and task-same but dataset-different intermediate domain with target domain. In the second method, we generalize the model for different datasets by integrating images from other datasets after translating with cycle consistent generative networks (Cycle-GAN). In this way, the model can be generalized for dataset-different domain as well as modality-different domain. Our experiments show the improvements for both overall multi-class classification accuracy and binary classification accuracy on both source domain datasets and target domain datasets. The improvement in binary classification is especially outstanding, which, in real cases, is more expected as the missing rate of melanoma shall be lowered. In the future, to further improve the classification performance, an algorithm can be developed that may contain discriminant features from both the training sets. The fusion could be developed by constructing a hybrid training parameter set from the two training set parameters which were extracted on individual data sets. Although this work applies domain adaptation to skin disease imaging dataset augmentation, we believe this scheme may inspire more studies on applications that lack training data, especially in general medical imaging applications

PAPER 3: Self-Paced Balance Learning for Clinical Skin Disease Recognition

PUBLICATION YEAR: August 2020

AUTHOR NAME: Jufeng Yang, Xiaoping Wu, Jie Liang, Xiaoxiao Sun, Ming-Ming Cheng, Paul L. Rosin, and Liang Wang

JOURNAL NAME: IEEE TRANSACTIONS ON NEURAL NETWORKS AND LEARNING SYSTEMS

SUMMARY:

Class imbalance is a challenging problem in many classification tasks. It induces biased classification results for minority classes that contain less training samples than others. Most existing approaches aim to remedy the imbalanced number of instances among categories by resampling the majority and minority classes accordingly. However, the imbalanced level of difficulty of recognizing different categories is also crucial, especially for distinguishing samples with many classes. For example, in the task of clinical skin disease recognition, several rare diseases have a small number of training samples, but they are easy to diagnose because of their distinct visual properties. On the other hand, some common skin diseases, e.g., eczema, are hard to recognize due to the lack of special symptoms. To address this problem, we propose a self-paced balance learning (SPBL) algorithm in this paper. Specifically, we introduce a comprehensive metric termed the complexity of image category that is a combination of both sample number and recognition difficulty. First, the complexity is initialized using the model of the first pace, where the pace indicates one iteration in the self-paced learning paradigm. We then assign each class a penalty weight that is larger for more complex categories and smaller for easier ones, after which the curriculum is reconstructed by rearranging the training samples. Consequently, the model can iteratively

learn discriminative representations via balancing the complexity in each pace. Experimental results on the SD-198 and SD-260 benchmark data sets demonstrate that the proposed SPBL algorithm performs favorably against the state-of-the-art methods. We also demonstrate the effectiveness of the SPBL algorithm's generalization capacity on various tasks, such as indoor scene image recognition and object classification.

CONCLUSION:

In this paper, they address the class imbalance issue and propose a novel SPBL algorithm that is trained using samples from easy to hard. They also propose a novel insight that in real-world applications, the class imbalance problem is not only due to the imbalanced distribution of class sizes but also the imbalanced recognition difficulty. Inspired by that, we propose both the PWU and CR strategies that ensure that the model learns a comprehensively balanced representation in each SPL procedure. They conduct experiments on two imbalanced data sets about clinical skin disease recognition tasks and several other imbalanced problems. The results indicate that both components of the proposed algorithm are effective and demonstrate the advantage of the SPBL against the state-of-the-art methods.

PAPER 4: A Visually Interpretable Deep Learning Framework for Histopathological Image-Based Skin Cancer Diagnosis

PUBLICATION YEAR: MAY 2021

AUTHOR NAME: Shancheng Jiang, Huichuan Li, and Zhi Jin , Member, IEEE

JOURNAL NAME: IEEE JOURNAL OF BIOMEDICAL AND HEALTH INFORMATICS

SUMMARY:

Owing to the high incidence rate and the severe impact of skin cancer, the precise diagnosis of malignant skin tumors is a significant goal, especially considering treatment is normally effective if the tumor is detected early. Limited published histopathological image sets and the lack of an intuitive correspondence between the features of lesion areas and a certain type of skin cancer pose a challenge to the establishment of high-quality and interpretable computer-aided diagnostic (CAD) systems. To solve this problem, a light-weight attention mechanismbased deep learning framework, namely, DRANet, is proposed to differentiate 11 types of skin diseases based on a real histopathological image set collected by us during the last 10 years. The CAD system can output not only the name of a certain disease but also a visualized diagnostic report showing possible areas related to the disease. The experimental results demonstrate that the DRANet obtains significantly better performance than baseline models (i.e., InceptionV3, ResNet50, VGG16, and VGG19) with comparable parameter size and competitive accuracy with fewer model parameters. Visualized results produced by the hidden layers of the DRANet actually highlight part of the class-specific regions of diagnostic points and are valuable for decision making in the diagnosis of skin diseases

CONCLUSION:

In this study, they propose a novel deep learning-based CAD system for skin cancer diagnosis. The output of this system is not only the label of a certain disease but also a visualized diagnostic report showing possible areas related to the disease, which can be considered as diagnostic points. The visualized diagnostic report is generated by the attention mechanism embedded at the upper part of our deep structure, and the whole framework is trained with only classification labels in an end-to-end way. The Spatial Attention-Oriented mask branch helps the Trunk branch to capture regions of interest related to the target label, and the Channel Attention-Oriented mask branch is able to model interdependencies between the channels of feature maps from the trunk branch in a computationally efficient way while enhancing the representational power of the trunk branch throughout every SEA module. To further enhance the model adaptability for different settings of the training batch size and the configuration of hardware, we introduce FRN layers for eliminating the dependence between samples or channels of the same sample. In the case study, all comparative experiments are conducted with a real histopathological image set that was collected and maintained by us during the last 10 years. Results validate the positive effects of the combination of two mask branches in the SEA module and the robustness of the FRN layers on a smallscale training set. Our DRANet achieves significantly better performance than baseline well-known image classification models with comparable parameter size and competitive accuracy with fewer parameters and smaller computational complexity. With light model size and relatively cheap computational costs, our DRANet can be deployed on common PCs or even a tiny mobile chip that might be embedded in medical image equipment. Visualized results generated by the CAM module actually highlight part of the class-specific regions of the diagnostic points, and they are valuable for decision making in the diagnosis of skin diseases.

PAPER 5: Necrolytic migratory erythema is an important visual cutaneous clue of glucagonoma

PUBLICATION YEAR: August 2022

AUTHOR NAME: Wei Li1,6, XueYang1,6, Yuan Deng2 , Yina Jiang2 , Guiping Xu3 , Enxiao Li4 , YinyingWu4 , Juan Ren5 , Zhenhua Ma1 , Shunbin Dong1 , Liang Han1 , Qingyong Ma1 , ZhengWu1* & ZhengWang1*

JOURNAL NAME: www.nature.com/scientificreports

SUMMARY:

Erythema is an extremely rare and slow-growing functional pancreatic neuroendocrine tumor arising from islet alpha cells in the tail of the pancreas. It usually presents with glucagonoma syndrome associated with characteristic clinical symptoms, including necrolytic migratory erythema (NME), diabetes mellitus (DM), stomatitis, anemia, deep vein thrombosis (DVT), weight loss, diarrhea and other symptoms. With the exception of NME, other clinical manifestations are nonspecific, which accounts for the delay in diagnosis in most cases and also for the fact that at least 50% of cases already have metastatic disease at the time of diagnosis. NME is observed in approximately 70–90% of patients diagnosed with glucagonoma. This rash is usually widespread, and the major sites of involvement are the

perioral region, trunk, extremities and perineum. The distinguishing feature of NME is annular erythematous plaques with central bullous, ulcerative lesions surrounded by brown pigment, which are usually pruritic and painful. The histological features of this skin lesion include parakeratosis, hyperkeratosis, spongiosis of the epidermis with necrolysis, loss of the granular layer, vacuolization of keratinocytes, and perivascular and interstitial inflammation. This paper summarizes the clinical characteristics of seven typical patients with glucagonoma followed at our hospital during the past 10 years. Our cumulative experiences (including diagnosis and treatment) may help clinicians to better recognize, diagnose and treat glucagonoma.

This study was approved by the Ethics Committee of the First Affiliated Hospital of Xi'an Jiao tong University and the study was conducted in accordance with the approved guidelines. Informed consent was obtained from all subjects and/or their legal guardian(s). We reviewed the database and collected seven cases of glucagonoma in the past 10 years. Patients with clinical presentations of skin manifestation (the skin rash is characterized by an intense erythematous lesion, which shows superficial epidermal necrosis and spreads in a centrifugal pattern), glucagonoma syndrome, elevated plasma glucagon, and a pathological diagnosis of pancreatic islet cell tumor were included in this cohort. The medical records of the included patients were reviewed. Tumor diameters were obtained from CT scan measurements. Follow-up data, including patients' follow-up status, symptoms (skin rash), recovery and administration of other therapies, were acquired from hospital medical records or by phone interviews with the patients, relatives, or general
practitioners.

CONCLUSION:

Surgical removal is considered to be the only definitive and curative treatment for pancreatic glucagonoma and NME7 . Optional operations included simple enucleation (< 2 cm) with peripancreatic lymph dissection, pancreaticoduodenectomy with peripancreatic lymph dissection, distal pancreatectomy with peripancreatic lymph dissection and splenectomy. However, more than half of all glucagonomas present with metastatic disease, most commonly liver metastasis. It has been reported that synchronous resection of pancreatic neuroendocrine tumors and liver metastasis (more than 30% of the liver tissue retained) provides a more favorable outcome. Liver transplantation may be considered as a potential therapeutic approach for unresectable hepatic metastases arising from pancreatic glucagonoma20. TACE might also be a safe therapeutic approach for liver metastasis arising from NETs because of the highly vascular and blood supply that primarily derives from the hepatic artery21. In addition, RFA is usually performed in combination with surgery, which has certain advantages in removing isolated metastases22. Medical therapy for glucagonoma, including chemotherapeutics, somatostatin analogous, PRRT and molecular targeted drugs, are also effective in controlling clinical symptoms and tumour growth7,16.

In conclusion, erythema is a rare type of functional NET. Since NME might be the only clue for the early detection of this tumour, it is very important to correctly diagnose NME in a timely manner Currently, surgical intervention is the only definitive treatment for this disease. Medical therapy is effective for symptom control and metastatic disease management.