Image Processing Techniques in Localization of DFU

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Abstract:

For the detection and identification of diabetic foot ulcers (DFUs), there has been a significant amount of study using computer methodologies and technology; nevertheless, there are few systematic comparisons of cutting-edge deep learning techniques. Frameworks for object detection were used to solve this issue. A thorough dataset made up of 2,000 photos for training and 2,000 images for testing was made available to participants by DFUC2020. By contrasting the deep learning-based algorithms proposed by the winning teams, including

Faster R-CNN, three variations of Faster R-CNN, and an ensemble technique, YOLOv3 and YOLOv5, EfficientDiet, and a novel Cascade Attention Network, this paper summarises the results. We give a thorough explanation of the model architecture, training parameter values, and additional processes like pre-processing, data augmentation, and post-processing for each deep learning technique

We offer a detailed assessment of each technique. The number of photos available for training had to be increased with data

augmentation for each approach, and false positives had to be eliminated using post-processing. Deformable Convolution, a Faster R-CNN variation, delivered the greatest results, with an F1-Score of 0.9617 and a mean average precision (map) of 0.9565, recall:0.9670,accuracy:0,9510 Lastly, we show that the F1-Score can be improved using the ensemble method based on several deep learning techniques, but not the map. Convolutional neural network (CNN), deep learning, mobile net model, minutiae, ulcers in diabetic feet.
Keywords: Diabetic Foot, Ulcers, deep learning, convolutional neural network (CNN), Mobile net model, minutiae

INTRODUCTION

The International Diabetes Federation Saeedi et al. (2019) estimate that 463 million persons globally have diabetes in 2019. By 2045, this figure is projected to increase to 700 million. A diabetic person's lifetime risk of getting a diabetic foot ulcer is 34 percent. (DFU). In other words, 1 in 3 diabetics will experience a DFU at some point in their lives. Armstrong and others (2017). contamination of a DFU. frequently results in limb amputation, which significantly reduces the quality of life and life expectancy and causes severe morbidity and psychological suffering. The initial phase of a project on diabetic foot care is this research. In order to evaluate how well foot ulcers are healing, they must be periodically observed. Currently, this is done manually by clinicians. Several foot clinics photograph ulcers during initial assessment and follow-up evaluations to compare different stages of ulcer however these are frequently found in regular wound care data. It is imperative to create a technical solution capable of altering present screening procedures in order to potentially greatly minimise the demands on clinical time. The development of deep learning has made automated analysis of DFU possible. Deep learning needs enormous datasets, nevertheless, in order to provide outcomes that are comparable to those of human experts. Medical imaging researchers are now working alone, and the majority of their findings cannot be replicated.Yap et al. sought to close the gap and encourage data sharing between researchers and physicians. The diabetic foot ulcer problems were suggested by Yap et al. (2020c,b). The state-of-the-art computer techniques for DFU detection are reviewed, along with the publicly accessible datasets. Popular object detection frameworks on DFU detection are thoroughly evaluated, and an ensemble method and Cascade Attention DetNet are suggested. Deep learning algorithms trained on the DFUC2020 dataset are also thoroughly evaluated.

LITERATURE SURVEY

Ulceration of the foot in diabetes-William J Jeffcoate Ulceration of the foot in diabetes is common and disabling and frequently leads to amputation of the leg. Mortality is high and healed ulcers often recur. The pathogenesis of foot ulceration is complex, clinical presentation variable, and management requires early expert assessment. Interventions should be directed at infection, peripheral ischaemia, and abnormal pressure loading caused by peripheral neuropathy and limited joint mobility. Despite treatment, ulcers readily become chronic wounds. Diabetic foot ulcers have been neglected in health-care research and planning, and clinical practice is based more on opinion than scientific fact.19 Furthermore, the pathological processes are poorly understood and poorly taught and communication between the many specialties involved is disjointed and insensitive to the needs of patients.

2.2 Diabetic foot ulcer detection using deep learning approaches-Puneeth,Gettha Deep learning (DL) classification methods for tackling classification issues in medical imaging is strongly dependent on feature selection and extraction techniques that are sensitive to shapes, sizes, and colors. In previous studies, using machine learning and convolutional neural network techniques, the researchers obtained high accuracy in detecting DFUs.34 Although much research has been

done but still not yet across multiple functions which might be in the real world. Proper diagnosis and management of DFUs ensure a better prognosis. Diabetic foot management is based on vascular resection procedures, infection treatment, and wound removal. The treatment and type of apparel present differ on the condition and wound type on the foot. DFU challenge is a sequence of scholastic challenges facing DFU care-related activities to work comprehensive comparisons of detection, segmentation, and classification methods and assess the state-of-the-art with potential applications.

2.3 Treatment for Cavanagh,Benjamin diabetic foot ulcers- Peter People with diabetes develop foot ulcers because of neuropathy (sensory, motor, and autonomic deficits), ischaemia, or both. The initiating injury may be from acute mechanical or thermal trauma or from repetitively or continuously applied mechanical stress. Patients with clinically significant limb ischaemia should be assessed by a vascular surgeon to determine the need for angioplasty, stenting, or femorodistal bypass. When infection complicates a foot ulcer, the combination can be limb or life-threatening. Infection is defined clinically, but wound cultures reveal the causative pathogens. Tissue specimens are strongly preferred to wound swabs for wound cultures. Antimicrobial therapy should be guided by culture results and should aim to cure the infection, not to heal the wound. Alleviation of the mechanical load on ulcers (off-loading) should always be a part of treatment. Neuropathic ulcers typically heal in 6 weeks with total contact casting, because it effectively relieves pressure at the ulcer site and enforces patient compliance. The success of other approaches to off-loading similarly depends on the patients' adherence to the effectiveness of pressure relief. Surgery to heal ulcers and prevent recurrence can include tenotomy, tendon lengthening, reconstruction, or removal of bony prominences. However, these procedures may result in secondary ulceration and other complications. Ulcer recurrence rates are high, but appropriate education

for patients,9 the provision of posthealing footwear, and regular foot care can reduce rates of re-ulceration.

2.4 Etiology Of dFu-Leila Yazdanpanah, Morteza Nasiri, and Sara Adarvish, Recent studies have indicated multiple risk factors associated with the development of DFU . These risk factors are as follows: gender (male), duration of diabetes longer than 10 years, advanced age of patients, high Body Mass Index, and other comorbidities such as retinopathy, diabetic peripheral neuropathy, peripheral vascular disease, glycated hemoglobin level (HbA1C), foot deformity, high plantar pressure, infections, and inappropriate foot self-care habits Although the literature has identified a number of diabetes related risk factors that contribute to lower-extremity ulceration and amputation, to date most DFU has been caused by ischemic, neuropathic or combined neuroischemic abnormalities. Pure ischemic ulcers probably represent only 10 percent of DFU and 90 percent are caused by neuropathy, alone or with ischemia. In recent years, the incidence of neuroischemic problems has increased and neuroischemic ulcers are the most common ulcers seen in most United Kingdom diabetic foot clinics40 In total, the most common pathway to develop foot problems in patients with diabetes is peripheral sensori-motor and autonomic neuropathy that leads to high foot pressure, foot deformities, and gait instability, which increases the risks of developing ulcers. Today, numerous investigations have shown that elevated plantar pressures are associated with foot ulceration. Additionally, it has been demonstrated that foot defor-mities and gait instability increases plantar pressure, which can result in foot ulceration

2.5 TheChallenge of Managing Diabetic Foot Ulcers- Ka-Kit Tsang, Enid Wai-Yung Kwong, Kevin Y Woo Diabetic foot ulcer (DFU) is the focus of the present review because of the high prevalence of the disease and the burden it places on the health system. It is estimated that diabetes affects 8.3 percent of the global population or 382 million people. This number continues to grow, making DFU a major public health problem. The cost of caring for people with diabetes is exorbitantly high, amounting to 174 billion dollars in the United States in 2007, of which foot ulceration accounted for 24 percent to 31 percent Stockl et al. revealed that the average cost per DFU episode was 13,179 dollars, and greater in the case of deep ulcers with coexisting infection and circulation problems (as evaluated using the Wagner classification system). Apart from the financial impact of DFU, patients with DFU experience many limitations in their physical, social, and vocational activities (especially those who are required to undergo an amputation), leading to poor health-related quality of life36

2.6 Semantic Segmentation of Diabetic Foot Ulcer Images: Dealing with Small Dataset in DL Approaches- Niri Rania, Hassan Douzi, Lucas Yves the use of imaging technology for automatic DFU/wound assessment and measurements has increased considerably to become a common practice. Following this trend, many research works have started to perform wound assessment in medical environment using imaging devices . The major advantages of using digital cameras or smartphones is that photography does not require contact with the skin and it also can help not only to measure the ulcer area but also to analysis the different types of tissue31 inside the wound bed. DFU assessment will be more objective, accurate and less time consuming for health professionals and patients. Therefore, these methods require the use of image processing and computer vision techniques for image analysis. Several approaches based on Machine Learning (ML) techniques have been experimented on wound and DFU segmentation Mainly, these works performed the segmentation task using traditional ML algorithms such as SVM classifiers after manual feature extraction.The majority of these methods require the extraction of texture and color descriptors from images such as HOG, SIFT, LBP etc. These descriptors may be affected by light conditions, image resolutions and also skin shape and shades. Thus, the traditional ML methods are not robust due to their reliance on the handcrafted extracted features.The number of samples in our database is limited and not sufficient to feed a deep learning neural network. Therefore, due to the small size of our database, data augmentation is required to increase the size of training set and to avoid overfitting . Different techniques have been used to randomly deform the input image and correspondent ground truth segmentation map. Each image was horizontally flipped, rotated, translated and zoomed27

2.7 The burden of diabetic foot ulcers- GayleE Reiber, BenjaminA Lipsky, and GaryW Gibbons. In deciding which among several therapeutic options to prescribe, a clinician should weigh the cost of each therapy against its potential for improving a patient's functional status and quality of life. Increasingly, clinicians and policymakers use health-related quality of life information for patient management, reimbursement, and policy decisions. Health-related quality of life is a multidimensional concept that includes aspects of survival; the effect of disease or impairment on social Foot ulcers are an expensive problem, and there has been increasing pressure for providers and payers to consider the economic aspects of foot ulcer care. In a study of patients with type 2 diabetes, "chronic skin ulcers"—a subset of all foot ulcers—accounted for 150millionofthe11.6 billion of direct patient care costs.15 Costs for peripheral neuropathy, peripheral vascular disease, or amputation were not similarly analyzed.Several approaches have been used to estimate the economic impact28

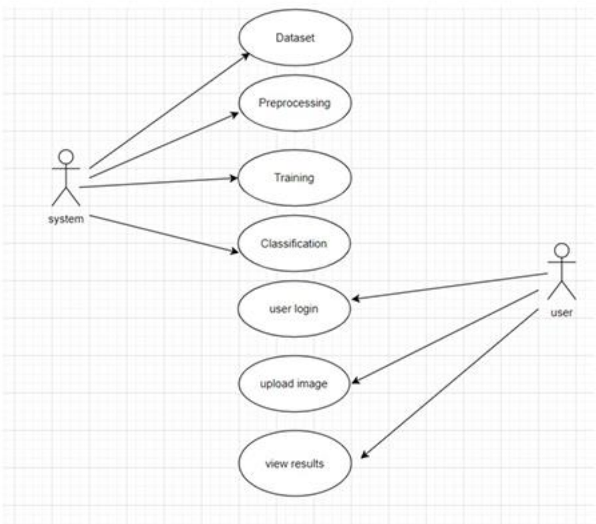
2.8 Data collection in dfu-Firomsa Bekele, Legese Chelkeba, Ginenus Fekad Data was collected using a questionnaire developed after reviewing different literatures and adopting it based on available data. One medical doctor, one nurse and one pharmacist were recruited as data collector and the data was supervised by another medical doctor. A pus swab was obtained from the ulcers before any ulcer cleaning and antibiotics given or debridement done to avoid contamination. The samples were delivered to the laboratory immediately and a thin smear was prepared on grease or oil-free slides. Appropriateness of antibiotics was identified based on standard guidelines of Infectious Diseases Society of America (IDSA)3 for diagnosis and treatment of diabetic foot infection , which is based on the most likely coverage of antibiotics for treatments of diabetic foot infection for identified gram stain and appropriateness of dosage regimens. Five percent of the sample was pre-tested to check the acceptability and consistency of data collection tool two weeks before the actual data collection. The patients were followed for consecutive three months with telephone interviews after patients were discharged from the hospital.

2.9 Assessment and Classification of dfa-Kleopatra Alexiadou and John Doupis Physical examination of the diabetic foot is based on assessment of the skin and of the vascular, neurological, and musculoskeletal systems.The dermatological examination includes a visual inspection of the skin of the legs and feet, particularly the dorsal, plantar, medial, lateral, and posterior surfaces, as well as a close examination of each toenail . Other observations to be noted include the presence of peeling skin and maceration or fissuring of the interdigital skin. The visual inspection may discover signs of autonomic neuropathy and sudomotor dysfunction . People with diabetes are at high risk of developing peripheral vascular disease; therefore, the palpation of pulses bilaterally in the dorsalis pedis, posterior tibial, popliteal, and superficial femoral arteries is necessary for assessment of the blood circulation in the lower limbs. Inadequate perfusion of a limb, due to peripheral vascular disease, may crucially affect the progress of the healing of an ulcer, often resulting in chronic unhealed ulcers that are susceptible to infection . A relatively simple method to confirm the clinical suspicion of arterial occlusive disease is to measure the resting systolic blood pressure in the ankles and arms.An ABI of less than 0.4 or an ankle systolic pressure of less than 50 mmHg represents advanced ischemia. The ABI correlates with clinical measures of lower extremity function, such as walking distance, velocity, balance, and overall physical activity. In addition, a low ABI has been associated with a higher risk of coronary heart disease, stroke, transient ischemic attack, progressive renal insufficiency, and all cause mortality . A potential limitation of the ABI is that calcified vessels may not compress normally, possibly resulting in falsely elevated Doppler signals. Thus, an ABI of over 1.3 is suggestive of calcified vessels. In such patients, an accurate pressure may be obtained by measuring the blood pressure in the toe and calculating the toe–brachial index. If ABIs are normal at rest but symptoms strongly suggest claudication, ABIs and segmental pressures should be obtained before and after exercise on a treadmill. This may unmask a hemodynamically significant stenosis that is subclinical at rest but significant on exertion.1

2.10 Growthfactors in the treatment of diabetic foot ulcers-SP Bennett, GD Griffiths, AM Schor, GP Lees The prevention of foot ulceration is clearly a prime goal. Accordingly, tight control of blood pressure and blood glucose levels, preventive podiatry and pressure relieving footwear are all important aspects of patient management. Frequent and regular assessment of the patient by a variety of healthcare workers is desirable. Once a wound has developed, current best practice involves wound assessment and classification into ischaemic, neuropathic or neuroischaemic ulcer types, offloading of pressure on the area, frequent debridement, dressings and management of infection. Surgeons will be involved in more radical debridements. More aggressive surgical treatment may be indicated for ulcers or infections that do not improve with good non-surgical treatment. Resection of infected bone may be part of a wider debridement back to healthy tissue. Vascular reconstruction is indicated in limbs with inadequate peripheral perfusion. This may involve angioplasty or surgical bypass. Revascularization techniques may involve outflow to distal calf or pedal vessels, as diabetic angiopathy typically affects the vessels around the trifurcation.4 Amputation may ultimately be necessary in patients with non-reconstructable vascular disease or extensive osteomyelitis. This may be a minor resection of a toe or forefoot if the peripheral circulation is sufficient to allow healing of the subsequent wound, but a major amputation may be required at below- or above-knee level. Recent introductions aimed at promoting wound healing include hyperbaric oxygen therapy and artificial skin grafting. In spite of these interventions, a cohort of patients with foot ulcers remains unresponsive to available conventional treatment; it is the needs of these patients that this review addresses.

2.11 The role of Deep Learning technology in the care of diabetic foot ulcers:- Joseph M Pappachan, Bill Cassidy, Cornelius James Fernandez Machine learning algorithms have been found to be very useful in detecting DFUs with high accuracy rates in previous studies. These algorithms are developed by using large datasets of images captured from the foot clinics. The development of computer-aided DFU diagnostic algorithms involves multiple stages such a pre-processing, feature extraction, detection, classification, and segmentation of DFUwounds. These tasks can be challenging in real-world settings due to the low quality of images from inadequate focusing, motion artifacts, inadequate lighting, and backlight, deformities in the foot/toes, size and shape of the ulcers (very small, very large and curved ulcers), and newly formed or early ulcers which are easily missed during the capture of photographs in foot clinics. The first and foremost step in the development of machine learning algorithms is the detection of DFUs from foot photographs. Further refinement of machine learning is currently being undertaken by incorporating the classification systems for DFUs, as in the real-world settings, to promote AI-based diagnostics and prognostication. Several manual DFU classification systems are currently used by foot care professionals such as Wagner, University of Texas, and SINBAD (Site, Ischaemia, Neuropathy, Bacterial infection, Area, and Depth) for DFU monitoring and management. These manual approaches may benefit from the automated processes afforded by AI.24 Development of deep learning AI algorithms requires large-scale datasets for automated DFU analysis to reproduce comparable results to those by experts. Researchers currently working in isolation may not achieve reproducible research outputs. Large DFU datasets used for training and validation by multiple professionals from different institutions across the globe should help to refine these pitfalls in machine learning algorithms for DFU classification and diagnosis. To enable innovation from clinicians and researchers, Yap et al[26] proposed the diabetic foot ulcer challenges by providing the publicly available datasets, for comprehensive evaluation of object detection frameworks on DFU detection using convolutional neural networks trained on the DFUC2020 datase

2.12 The development and healing of diabetic foot ulceration-Thanh Dinh, Francesco Tecilazich, Antonios Kafanas, John Doupis The main findings of the present prospective cohort study are that although neuropathy and vascular factors are associated with the development of DFUs, the main factors that are associated with failure to heal these ulcers are preexisting increased serum levels of inflammatory cytokines, MMP-9, and various growth factors. At the skin level, diabetes was associated with inflammation and increased expression of MMP-9 and PTP1B, factors that are associated with inflammation, can lead to resistance of the growth factor action, and may be responsible for the observed raised levels in the patients whose ulcers failed to heal. As would be expected, only neuropathic patients developed DFUs at a rate that was similar to the one predicted by previous prospective studies, indicating that the selected subjects were representative of the general diabetic population . It also is of interest that the forearm NARV was a risk factor,13 indicating the existence of more severe peripheral neuropathy that affected the c-nociceptive fibers of the upper extremity in the DFU group. In addition, both endotheliumdependent and-independent vasodilation in the macrocirculation were reduced in the patients who developed DFUs, indicating that the same vascular factors that are associated with excess cardiovascular mortality in diabetes also are involved in foot ulceration .



2.13 Foot ulcers in the diabetic patient, prevention and treatment-Stephanie C Wu, Vickie R Driver, James S Wrobe implemented a lower extremity disease management program consisting of screening and treatment protocols for the diabetic foot in a managed care organization and noted its effectiveness to reduce hospitalizations and amputations . Based on the presence or absence of diabetic neuropathy, peripheral vascular disease, foot deformities and pressures, as well as the history of lower extremity pathology, the authors stratified patients into low and high-risk groups, and implemented preventive or acute care protocols . They noted a 47.4 percent cw decrease in the incidence of amputations from 12.89 per 1000 diabetics per year to 6.18 (p ¡ 0.05), and a 37.8percent decrease in foot related hospital admissions, from 22.86 per 1000 members per year to 14.23 (37.8percent), after implementation of the disease management program.39 They further noted a 21.7 percent reduction in the average patient length of stay from 4.75 to 3.72 days (p lesser than 0.05), a 69.8 percent reduction in the number of skilled nursing facility admissions per 1000 members per year, and a 38.2 percent reduction in the average length of stay in a skilled nursing facility 8.72

2.14 Diabetic foot ulcer detection using deep learning approaches-

Tjokorda Gde Dalem Pemayun, Ridho M Naibaho, Diana Novitasar In deep learning, a model learns to carry out tasks directly from text , sound , or images and can occasionally perform with greater accuracy than a human. Deep learning is the key technology behind a lot of high-end advancements. It is providing outcomes that were not feasible in the past or even with conventional machine learning methods. The issue with the current models is that the depth, width, and resolution are interdependent, and their values fluctuate depending on the available resources. ConvNets are difficult to scale, hence most traditional methods scale them in one of these dimensions. the standard and novel hybrid CNN models and their salient features including the number of layers in the network, and the technique used to design the model. a deep convolutional neural network, and innovative architecture can enhance the extraction of key DFU properties. The width, depth, and resolution of the image had a role in the design of the solution. The compound scaling approach is used in this experiment and different scaling dimensions are not independent An overview of the various stages in the EfficientNet model. Increased network depth is crucial for higher-resolution images, as larger receptive fields can assist capture similar features that include more pixels in larger images. Accordingly, network width grows as resolution catches more fine-grained patterns in high resolution images with more pixels.25 These intuitions imply that scaling multiple dimensions requires coordination and balance rather than the more traditional single-dimension scaling. The compound scaling approach uniformly and logically scales the network's depth, width, and resolution using a compound coefficient

2.15 Assessment and treatment of diabetic foot ulcer-Fard, A Shojaie and Esmaelzadeh, M and Larijani

Foot ulcers are one of the main complications in diabetes mellitus, with a 15percent lifetime risk in all diabetic patients. The rate of lower extremity amputation among diabetic patients is 17–40 times higher than in non-diabetics. A critical triad of neuropathy, minor foot trauma and foot deformity was found in greater than 63 percent of diabetic foot ulcers (DFU). Peripheral vascular disease (PVD) has been identified in 30 percent of foot ulcers.14 We present a comprehensive assessment and the treatment of DFUs. We also want to notify physicians not to ignore foot assessment and examinations in patients with diabetes. Study conducted on pathogenesis and risk factors, assessment and physical examination, paraclinic assessment, treatment mortality and prevention.Appox 20 percent of hospital admissions among diabetic patients are the result of foot problems. Diabetic foot assessment should include dermatological, vascular, neurological and musculoskeletal systems notify physicians not to ignore foot assessment and examinations in patients with diabetes

2.16 Aseries of systematic reviews to inform a decision analysis for sampling and treating infected diabetic foot ulcers-Aziz Nather, Ng Yau Hong, Wong Keng Lin evidence on the performance of diagnostic tests used to identify infection in diabetic foot ulcers (DFUs) and of interventions to treat infected DFUs. To use estimates derived from the systematic reviews to create a decision analytic model in order to identify the most effective method of diagnosing and treating infection and to identify areas of research that would lead to large reductions in clinical uncertainty. Three studies that investigated the performance of diagnostic tests for infection on populations including people with DFUs found that there was no evidence that single items on a clinical examination checklist were reliable in identifying infection in DFUs, that wound swabs perform poorly against wound biopsies, and that semi-quantitative analysis of wound swabs may be a useful alternative to quantitative analysis. However, few people with DFUs were included, so it was not possible to tell whether diagnostic performance differs for DFUs relative to wounds of other aetiologies. Twenty-three studies investigated the effectiveness or cost-effectiveness of antimicrobial agents for DFUs. Eight studied intravenous antibiotics, five oral antibiotics,23 four different topical agents such as dressings, four subcutaneous granulocyte colony stimulating factor (G-CSF), one evaluated oral and topical Ayurvedic preparations and one compared topical sugar versus antibiotics versus standard care. The majority of trials were underpowered and were too dissimilar to be pooled.

2.17 Classification of diabetic foot ulcers-Lavery, Lawrence, Armstrong The decision to classify features of the ulcer alone as opposed to features of the limb or person depends heavily on the purpose of the classification. If for the purpose of note taking and sharing of clinical data then it may be sufficient to describe the lesion or ulcer or take a picture of it. If for prognosis or treatment decisions then features of the limb that could affect outcome 5-7, peripheral vascular disease, or that require a change in treatment plan, offloading for plantar neuropathic lesions, are also required. It is, as above, a requirement for clinical classification systems that they are inclusive, that is to say all lesions should be classifiable. Prior to choosing a particular classification system therefore, health care professionals must ensure that20it will capture the spectrum of presenting clinical disease that they feel is appropriate in their centre.system therefore, health care professionals must ensure that it will capture the spectrum of presenting clinical disease that they feel is appropriate in their centre. classification systems have been robustly validated within and between centres as above. In particular reassurance that a scoring system is meaningful, possible and robust in populations outside the region of the world that from which it was drawn is relatively rare. This is important as aetiological factors may differ between populations; for example arterial disease is relatively rare in developing countries compared to Europe and the United States. And bacterial infection may have a greater effect in countries where access to certain antibiotic protocols is less available. 2.18 Initial Outpatient Diabetic Foot Ulcers Infection Management Strategy and Hospitalization-SCHMIDT, BRIANMandARMSTRONG The objective was to evaluate the impact of the initial management strategies for DFU infections diagnosed at an outpatient multidisciplinary center. In 2019, people with newly diagnosed DFU infection were followed for duration of therapy to determine hospitalization rates within 30 days of diagnosis. Consecutive patients were stratified according to Infectious Disease Society of America infection severity. Demographic, socioeconomic, and antibiotic data was recorded. Among 147 persons treated for DFU infection, 59 percent infections were mild while 30 percent and 4 percent were moderate and severe, respectively. Empiric antibiotics, consisting of either a cephalosporin or penicillin (76percent) were prescribed for initial treatment in 116 individuals, and 66 percent of these had tissue cultures preceding the treatment. Despite initial management of outpatient infection, 42percent of the entire cohort required hospitalization within 30 days of diagnosis; 50 percent 38perent, and 12percent31 hospitalizations were mild, moderate, and severe infections, respectively. The percentage of hospitalizations which occurred in mild infection treated with only empiric antibiotic (58percent) was

1.5x greater than culture-directed antibiotic therapy (34 percent) despite similar empiric antibiosis. High rates of hospitalizations occurred in moderate (49percent) and severe DFU infection. Overall, there was a negative association between implementation of culture-directed antibiotic strategy and hospitalization, and increased hospitalizations with applying empiric therapy for mild DFU infection. These data strongly support the practice to obtain tissue culture regardless of DFU infection severity to guide further treatment, as it is negatively associated with hospitalization rates. It is therefore essential to ensure foot infection treatment involves culture-directed antibiotic therapy and is applied uniformly across infection severity.

2.19 Role of Technology for wound Care in Diabetic Foot-iswanathan,Mirshad Theburdenofdiabetic foot complications poses a severe challenge to the patient and the physician in terms of physical and socioeconomic constraints. The mortality rate is 2.5 times higher for patients with diabetic foot ulcers than for patients without DFU for five years, and it is two times higher at ten years. The ideal management37 of diabetic foot ulcers is debridement of the wound, management of any infection, revascularization procedures when indicated, and off-loading the ulcer. A framework for screening and early multifactorial interventions are required to control the disease progression, increasing life expectancy, and decrease the 26 CHAPTER2. LITERATURESTUDY economic burden on the individual as well as the society.

2.20 DFU-SIAM a Novel Diabetic Foot Ulcer Classification With Deep Learning-Toofanee, Mohammud Shaad Ally, Dowlut, Sabeena CNNis a deep learning algorithm that utilizes convolutional operations to identify patterns within data, specifically image and video data. The convolution operation involves the application of a filter to the input data, through a process of sliding the filter over the data and computing the dot product between the filter and input. This produces a feature map, which summarizes the presence of distinct features within the input data. It was introduced by Lecun et al. and has since achieved state-of-the-art performance in image classification task. CNN leverages the fact that nearby pixels are more strongly related than distant ones. It uses a special technique called convolution. CNN that takes in an input image, assigns importance, learnable weights, and biases to various aspects of the image. The convolutional layers, extract features from input data that are subjected to filters. This produces feature maps, which are passed into further processing layers. the authors focused on investigating various CNN-based deep learning architectures for binary classification. Specifically, they evaluated the performance of AlexNet, VGG16/19, GoogLeNet, ResNet50.101, MobileNet, SqueezeNet, and DenseNet. Employing a fine-tuning approach, the authors conducted experiments and assessed the accuracy of each architecture. Notably, the results revealed that ResNet50 exhibited the highest accuracy35 among all the tested architectures. It is important to note that although this research is recent, it lacked comprehensive information regarding the

Figure 3.17: abnormal image

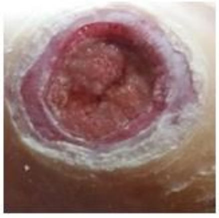


Figure 3.18: abnormal image 2

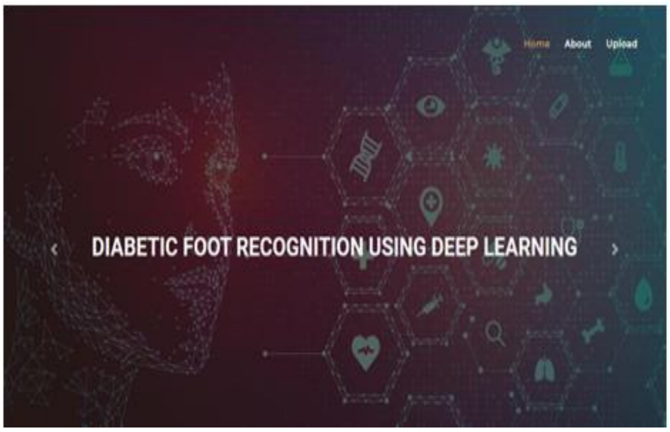
Figure 3.19: healthy image

Figure 3.20: healthy image 2

Result

Login page: here we will log in with the mail and password or you can sign up

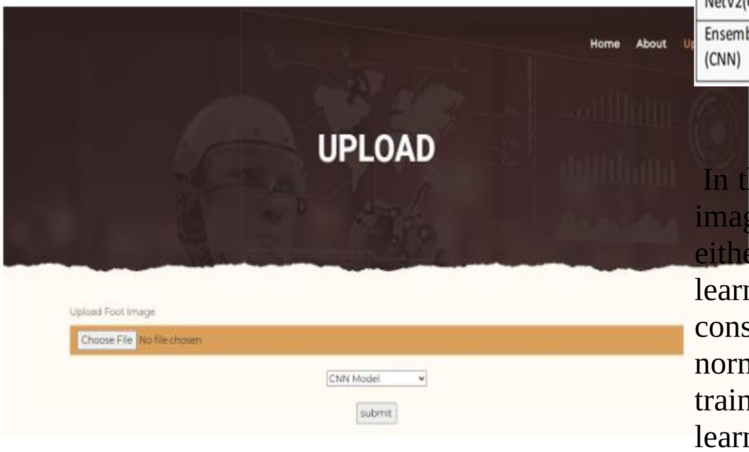
Figure 4.1: Login page Home: In our project, we are classifying the Diabetic foot ulcer and normal foot Image Classification, with the help of deep learning and Transfer learning.



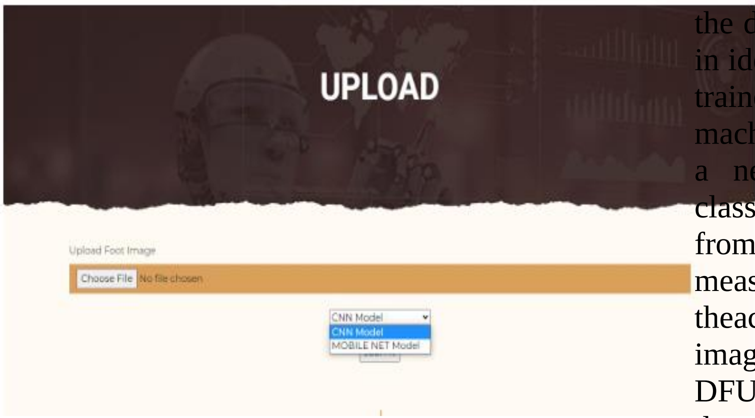
About: Here brief description of the project is given

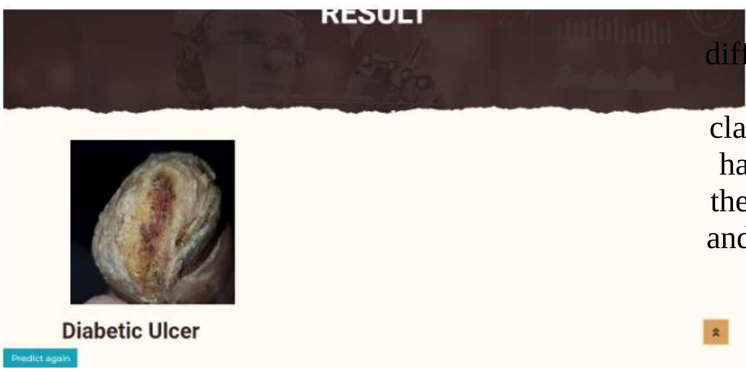
4.1 Testcases Figure

Upload Image with



model selection: Here the images can be uploaded those which are to be classified





Models	Accuracy	Recall	Precision	F1-Score	AUC score
BayesNet	0.639 ± 0.036	0.619 ± 0.018	0.653 ± 0.039	0.622 ± 0.079	0.643
Random forest	0.605 ± 0.025	0.608 ± 0.025	0.607 ± 0.037	0.606 ± 0.012	0.601
Multilayer	0.621 ± 0.026	0.680 ± 0.023	0.622 ± 0.057	0.627 ± 0.074	0.619
InceptionV3 (CNN)	0.662 ± 0.014	0.693 ± 0.038	0.653 ± 0.015	0.672 ± 0.019	0.662
ResNet50 (CNN)	0.673 ± 0.013	0.692 ± 0.051	0.668 ± 0.023	0.679 ± 0.019	0.673
InceptionRes NetV2(CNN)	0.676 ± 0.015	0.688 ± 0.052	0.672 ± 0.015	0.680 ± 0.024	0.678
Ensemble (CNN)	0.727 ± 0.025	0.709 ± 0.044	0.735 ± 0.036	0.722 ± 0.028	0.731

CONCLUSION:

In this project we have successfully classified the images of Diabetic foot ulcer and normal foot , are either matching with each other using the deep learning and Transfer learning. Here, we have considered the dataset of Diabetic foot ulcer and normal foot which will be of different types trained using CNN and Mobile net, transfer learning method. After the training we have tested by uploading the image and classified.

FUTURE WORK:

This can be utilized in future to classify and detect the different types of ulcers and make adifference in identifying and early treatment In this work, we trained various classifiers based on traditional machine learning algorithms, CNNs and proposed a new CNNarchitecture, mobileNet on DFU classification which discriminates the DFU skin from healthy skin. With high-performance measures in classification, mobile net allows theaccurate automated detection of DFU in foot images and makeit an innovative technique for DFU evaluation and medical treatment. For the detection of DFU, it is very important to understand the difference between DFUand healthy skin to know the features differences between these two classesin computer vision perspective. This work has potential for technology that may transform the detection and treatment ofdiabetic foot ulcers and lead to a paradigm shift in the clinical care of the diabetic foot

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