International Journal of Applied Engineering and Technology ISSN: 2277-212X
An Open Access, Online International Journal Available at http://www.cibtech.org/jet.htm
2022, Vol.12, pp.214-223/Sudha et al.
Research Article

REAL TIME DIABETIC FOOT ULCER PREDICTION AND MONITORING

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ABSTRACT
A more number of people are suffering due to Diabetic Foot Ulcer in this world. The wound image is captured by the high-quality camera, by using Android software to analyze the breadth and depth of the wound by using the Adaptive K-Means rule. Assessing Diabetic Foot Ulceration by ourselves is the way to save on travel costs and medical expenses. First, the image is converted into a standard form to assess the easy analysis. Then the images are pre-processed to get rid of noise by using Gaussian filter for masking and to protect the surrounding of the wound.

Keywords: *DFU, Adaptive K-Means Rule, Gaussian filter*

INTRODUCTION

Diabetic Foot Ulcers (DFUs) are common, costly, and take a toll on patients, families, and communities. It's calculable that at anybody time, DFUs have an effect on between three million to forty nine million folks worldwide. In Australia alone, each day, 50,000 folks suffer from a DFU, a thousand are hospitalized, twelve have Associate in Nursing amputation, and four die due to a DFU, resulting in Associate in Nursing calculable annual price of Aus $1.6 billion.

DFUs typically result from a mixture of Diabetes-related peripheral pathology (loss of protecting sensation yet as changes in gait) and mechanical pressures (from walking or external trauma). Once DFUs are sophisticated by peripheral artery illness and infection, they will take months or perhaps years to heal and sometimes result in hospitalization, amputation, and even death.

Additionally, DFUs impact the physical and mental quality of lifetime of patients and their partners and families, with patients oft describing a loss of independence over basic activities of living and an intermission to their sense of self as results of the ulceration. Best observe treatment of DFUs needs biweekly multidisciplinary team treatment in specialized clinics, with numerous clinicians operating along to produce effective clinical care.

However, this treatment additionally depends on self-care off from the clinic: patients ought to stop excessive wetness, modification wound dressings often, guarantee cleanliness, moisturize, check their feet to spot changes within the wound and any potential infection, and, maybe most significantly, adhere to sporting offloading devices the least bit times to alleviate mechanical pressures and defend the ulceration. These self-care practices are usually established in consultation between patients and multiple clinicians. Sadly, adherence to self-care practices has been found to be usually low.

Patients typically have a restricted understanding of polygenic disease, foot ulcers, and also the significance of self-care. What is more, many studies have shown that information alone isn't enough for folks to stick to new practices. Patients and their families additionally ought to have the power to enact care in terms of skills, time, finances, and resources. Additionally, and maybe most significantly, patients ought to be intended to enact self-care systematically over months of DFU treatment. sadly, several patients read self-care practices as an extra diminishment to their quality of life, like sporting Associate in Nursing offloading device the least bit times, whereas enhancements to their ulceration once adhering to the current care will be tough to notice on a day to day.

Hence, consultants suggest that new ways as required to assist encourage patients and have interaction

them in self-care off from the clinic. Mobile health apps hold nice promise for folks with polygenic disease; however few apps look for to interact folks in their DFU self-care. A range of apps for folks with polygenic disease are out there on the Google Play Store and also the Apple App Store.

These business apps give health data or enable chase of blood sugar levels, consumption habits, and physical activity, however they are doing not target DFU care. many apps are being developed to live DFU size, acknowledge signs of infection, establish spots wherever new DFUs are seemingly to develop, and assess patients remotely, however these apps are targeted at clinicians instead of patients. A notable exception is that the work by colleagues, WHO are operating toward a DFU observance tool for patients. However, their tool depends on a near-infrared light-weight attachment to the movable that limits accessibility for patients

We recently developed a mobile app image called Diabetic Foot Ulceration prediction, designed for patients to encourage and have interaction them in their self-care. Diabetic foot ulceration prediction encourages patients to use their own movable to require photos of their feet. The app applies novel visual analytics to those photos to extract DFU size data that lets patients and their carrier track their DFU healing progress.

What is more, Diabetic Foot Ulceration prediction highlights personal goals to assist encourage patients and provides reminders to enact care on a daily basis. The aim of this study was to gauge the usability Associate in nursing potential quality for promoting self-care of an interactive image of Diabetic Foot Ulceration prediction with folks with DFUs, supported a user-cantered approach.

LITERATURE SURVEY

Manu. G et .al.[2019] deals with diabetic wound image is captured and enforced with MATLAB package by victimization mean shift rule. The wound pictures are met metric and color it's used with simply identifies the healing standing of the wound. The sensible phone with camera is employed to capture the wound image and hold on in a picture capture box. The downside is just Nexus four robot sensible phones are used for particulars and no alternative sensible phones are used. Another downside is lack of tissue classification, quality and price is high.

Choi et.al [2020] deals with wound boundary and its determination by victimization mean shift rule .The healing standing wound is analyze by red, black and yellow colors. The wound pictures are captured with sensible phone. This methodology is to extend the wound healing standing and travel price is reduced. The downside is wound pictures aren't versatile.

Requence –Bueno et.al [2020] deals with wound image are captured and analyze robot sensible phone victimization mean shift and K- mean rule. This rule is employed as a high economical, correct wound boundary is detected the wound image segmentation. The healing standing and wound boundary is definitely settled with basic colors.

Ruiz Alzok et.al [2020] deals with wound image are capture the high resolution of camera to sensible phone, the injuries is analyze by victimization mean shift rule.

M. Goyal et.al [2019] deals with the app vocalize the phrases higher and lower. The steerage is predicated on image analysis through Open CV.

Jocher. G et.al [2020] deals with diabetic wound image are captured and it is segmented by distance regularized level set evolution (DRLSE) method. To analysis healing status and wound area are easily identified by using K-Mean shift Algorithm.

PROPOSED SYSTEM

The wound images are captured with high quality of digital camera and it is stored image capture box by implemented MATLAB software by using Mean Shift Algorithm. The image capture box is consider two block, one side is the foot is placed, the foot image are reflected to the inner side of the box. The reflected image is captured in the mobile phone. The mobile phone and PC are connected with Wi-Fi. Then the images are transfer to the PC and analysis of the foot wound. This algorithm is used only in limit applications. Nexus4 Android smart phone is only used in this algorithm and it is not used in different

type of smart phone.
The Foot Ulcer is captured by the different patients. So we are moving to this technology, to overcome the drawback of the previous system. The Diabetic Foot Wound is affected by more number of people in the world. So this technique is recovering the diabetic foot ulcer. The image is captured by camera. By using Android software the image is analysis by advanced algorithm of Adaptive K-mean algorithm. We can analyse the wound in depth and breadth. To analyze of the diabetic wound to known either critical or not. Then the wound is critical we can go and check the hospital, there is a not a necessary of visiting hospitals often. If it is severe wound visit hospital.
The image is analysis by Adaptive Mean Algorithm with used in wide range of application and accurate output. We are writes the coding by using Android to analysis the Diabetic Foot wound image. First the image is converted into the standard image because easy to analysis. Then the image is outline only the foot wound because unwanted area of the foot is not analyze. Then mask with unwanted area of the image is collected only the wound area, the Diabetic Foot wound image is convert to the RGB because the normal colour code is 0 to 256 pixels are analyze is complex so we converted to the RGB colour code is 256 to 256 pixels are easy to analyze.

METHODOLOGY

Diabetic foot ulcer prediction Prototype

The overall goal of Diabetic foot ulcer prediction is to be a mobile phone app that optimizes the engagement of people with DFUs in their self-care away from the clinic. Diabetic Foot Ulcer prediction was conceived by the research team based on their experience in the treatment and study of people with DFUs (JJvN and PAL) and in the design and implementation of mobile health technologies (BP and RB). The team developed multiple features within Diabetic Foot Ulcer prediction to engage people with DFUs, including the ability to visualize personal goals, self-monitor their DFU through ulcer photos and ulcer size information, a diary to foster reflection, and reminders to enact self-care.
The prototype presented in this study was the result of an iterative, user-centred design process. Prototyping software to generate interactive screen mock-ups to gather feedback from prospective users. On the basis of patient feedback, we refined the design and implemented a fully functioning Android app to demonstrate the feasibility of our approach.
The Android app was based on Java frameworks and open source computer vision library (OpenCV), a free real-time computer vision development library. A morphological watershed algorithm provided by OpenCV was used to segment the foot from the image background and then the ulcer from the foot. The app relied on a small (1 cm diameter) green sticker on the foot to provide a scale for calculating the ulcer wound size.
The mobile phone flash was used to control lighting during image capture, that is, to illuminate the foot and keep the background dark. The primary aim of this prototype and study was to demonstrate the feasibility of DFU monitoring to patients during an interview to obtain feedback on usability and potential usefulness.

***Goal Image**:*

An image below to visualize a goal a patient wishes to achieve when their DFU has healed. This feature was included because setting a realistic goal is typically one of the first steps in a therapy process to direct the treatment plan and to motivate patients to enact the plan. The aim of this feature was not to quantify goals set with clinicians but to provide motivation. By having this image on the home screen, patients would be reminded each time they opened the app of their long-term goal of trying to achieve healing in a positive way.
Participants in this study could change the goal image by clicking on the image itself. They could choose from several photos provided in the app such as to enjoy gardening or to play with grand children. Alternatively, they could set a personal photo taken through the mobile phone camera or transferred from another device.

FIGURE 1- Data set

Capture Foot Photo and Analyze Ulcer Size

Below Figure shows the 2 steps involved in the feature capturing photos of the foot and analysing ulcer size. First, patients need to take a photo of the whole foot. We expected that photos will usually be taken by a family member because even for healthy adults, it is difficult to take a photo of the plantar side of the foot.

For patients living on their own, we devised a voice assistance mechanism to help patients take photos without assistance from other people. People place the phone on the floor and hover their foot over the phone. The app guides the patient through voice feedback; specifically, the app vocalizes the phrases higher and lower. The guidance is based on image analysis through OpenCV. The app guides the patient to centre the foot over the camera at an appropriate distance and then automatically takes a photo without the patient having to touch the phone.

Finally, Diabetic Foot Ulcer prediction vocalizes image successfully captured to provide explicit feedback (Below Figure).Next, we developed a visual analytics feature (again based on OpenCV) to detect the Ulcer and calculate its size. To evaluate this feature, participants used a test image that had been uploaded to the phone (Below Figure).

To segment the ulcer and calculate its size, participants had to roughly draw on the image around the ulcer to denote skin tissue to the feature and then inside the ulcer using their finger on the screen of the phone to denote ulcer tissue (Below Figure). The last image in Below Figure shows how the visual analytics feature then automatically segments the Ulcer tissue from the foot image using an automated green line.

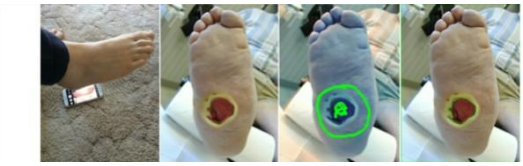

FIGURE 2: Localization of DFU

Photos can be captured with voice assistance. The analysis is based on circling around and inside the wound image to segment the Ulcer from the foot.

FIGURE 3: Patients can track the healing process in terms of wound size

Wound Progress

On the basis of the ulcer detected in the image, Diabetic Foot Ulcer prediction calculates the size of the ulcer as a proportion of the size of the foot and presents the progress through a graph (Above figure). Through this graph, patients can track their DFU healing process, which is often difficult to detect to the naked eye over weeks and months of the typical ulcer healing duration. This approach is inspired bypopular self-tracking, quantified self and personal informatics approaches, which argue that personal health data can foster personal reflection and behaviour change.

Although it often takes a long time to heal ulcers, prior research suggests that the progress (or lack thereof) during the first 4 weeks provides a clear indication as to whether the ulcer care is effective (>50% reduction in ulcer area in the first 4 weeks of care has been found to be a surrogate marker of effective DFU healing. Participants in this study could view the graph, which included the information generated by the researchers, as well as the information generated by the participants during their analysis of a test image.

Diary

The diary feature was incorporated to encourage reflection on self-care and well-being more broadly. Although we initially considered structured questions to help inform the therapy process, we eventually designed the diary in an open-ended manner so that patients can reflect on experiences that matter to them. Smiley faces were also added to let people add an entry quickly without having to type an entry (Below figure). Participants were asked to add a diary entry and to comment on what information they would diarize, if any.

Image Gallery

An image gallery allowed patients to review images and to see progress in the healing of their ulcer over time, in addition to the fore mentioned graphing of progress. This image gallery was separated from the image gallery on the phone because patients may not want their ulcer images alongside other personal photos. We added the gallery feature to let patients revisit their images and also so that they can show their images to carers and clinicians (Below Fig). Participants in this study could browse through a gallery that contained sample images provided by the research team.

FIGURE 4: Image gallery allowing patients, carers, and clinicians to review ulcers visually

Reminder Notifications

The app also provides patients with notifications to remind them to enact their dressing changes, take ulcer photos, or to make an appointment with their clinician. We added this feature because behaviour change theory suggests that even if people have sufficient knowledge and motivation, they may forget or run out of time and therefore need a reminder to enact behaviours. Reminders are implemented using a simple dialogue under settings, defining the intervals for reminding the patient to take photos and use

features in the app (Below fig).
Participants were asked to set the time for notifications, which prompted discussion about the potential usefulness of notifications and its contents. Furthermore, participants could view a sample notification on the Android lock screen that stated Time to check your foot, which they could double-tap to open Diabetic Foot Ulcer prediction.

Figure 5: App reminder configuration interface

Data Collection
We conducted a qualitative evaluation through semi structured interviews to explore how people with DFUs would use Diabetic Foot Ulcer prediction and to what extent the app could enhance their self-care practices. The interviews took place in a meeting room at the clinic where participants received their foot care and lasted 30 to 60 min per participant. Ethics approval was obtained from The Prince Charles Hospital's human research ethics committee (#17/QPCH/14).
The evaluation followed a standard procedure. First, a background interview was conducted to learn about their ulcer history, clinical care and self-care practices, and mobile phone usage. Second, we conducted observations of patients exploring each of the Diabetic Foot Ulcer prediction features. The participants were given a mobile phone with the Diabetic Foot Ulcer prediction prototype. They were instructed to think aloud to get a better understanding about their impressions of each feature, any questions or expectations that they may have, and whether they would try out this feature on their own phone.
Participants were free to try features in any order they wished, and questions were asked accordingly. Finally, through a semi structured interview, the participants were asked to compare and rate the features in terms of usefulness for their DFU care. These ratings were used as prompts to discuss how the app could be integrated with their self-care practices and the potential impact on improving their therapy process. Each evaluation was conducted by the same researcher (LSDS) and was audio-recorded and transcribed verbatim for later analysis.

Data Analysis
The data were analyzed qualitatively, following a thematic analysis approach. The authors browse through all transcripts and coded the information to spot the varied uses for every app feature still as areas for improvement. Knowledge was coded by the authors (BP, JJvN, and LSDS) through Saturate App, a Web-based tool for cooperative analysis.
In total, fifty four codes were generated concerning the prevailing movable practices, ninety seven codes concerning Diabetic foot lesion prediction options, and fifty seven codes concerning the potential use in existence. These codes were collated into five themes that describe existing care and movable practices and the way Diabetic Foot lesion prediction may support them, and that they area unit bestowed within the Results section.

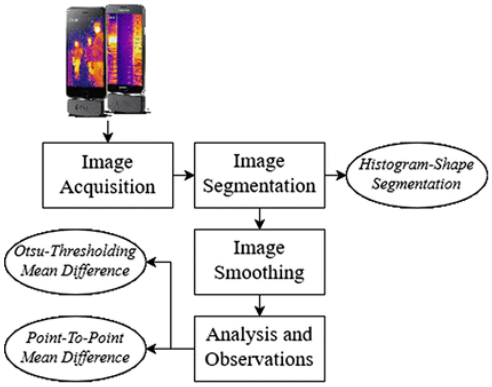

FIGURE 6: System Design

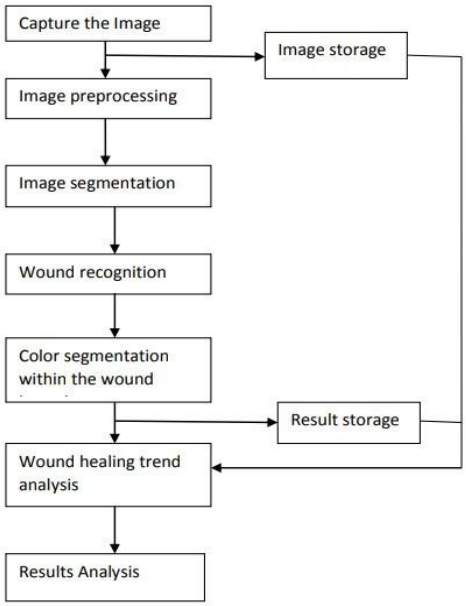

FIGURE 7: Data Flow Diagram

RESULTS AND ANALYSIS

This study showed that folks with DFUs understand a movable app like Diabetic Foot lesion prediction as helpful to have interaction them within the care of their ulcers. Despite technological advancements and despite the burden of the complication, movable apps area unit hardly employed by patients in their management or interference of DFUs.

Some pilot analysis during this space centered on movable apps that use thermal cameras hooked up to mobile phones to sight signs of Diabetic Ulcers too soon or to manage active ulcers in contrast to these apps, however, our style works with common place movable cameras, that makes it doubtless obtainable to anyone owning such a movable while not more value or work. Additionally, alternative apps area unit being developed chiefly to live DFU size, however these apps area unit targeted at clinicians treating patients instead of patients participating in their own care.

Our app differs by being patient-focused, as well as a patient-oriented style, involving patients from the beginning of the analysis, Associate in nursing planning to improve patients' motivation by developing an

app for them to use instead of keeping the app within the hands of the practitioner. Patients perceived the most {benefit of advantage of good thing concerning} Diabetic foot lesion prediction was its visual analytics feature that has objective knowledge about the dimensions of ulcers from photos of the foot. This data was seen as valuable as a result of patients usually cannot feel or see their lesion, and although they might see their lesion (on photos or in person), they might not sight if it absolutely was rising or deteriorating.

Additionally, the participants regarded {the data|the knowledge|the data} provided by the app as objective and therefore place a lot of religion during this information than in their own or their carrier's subjective accounts. Significantly, the app could address a scarcity of motivation by patients by showing them progress in their healing method. this could encourage patients and their carriers to continue self-care practices in a very consistent manner.

Many patients in our study already used movable photos (mostly taken by others) to examine their ulcers. though connected work shows that folks with polygenic disorder take photos of the food they need ingested and share them with dieticians, our study currently shows that several folks have additionally already adopted mobile phones to require pictures of the foot to share with relevant others (either clinicians or carriers). This additionally makes it a lot of probably that folks can use Diabetic Foot lesion prediction to require photos and track their healing method in real world.

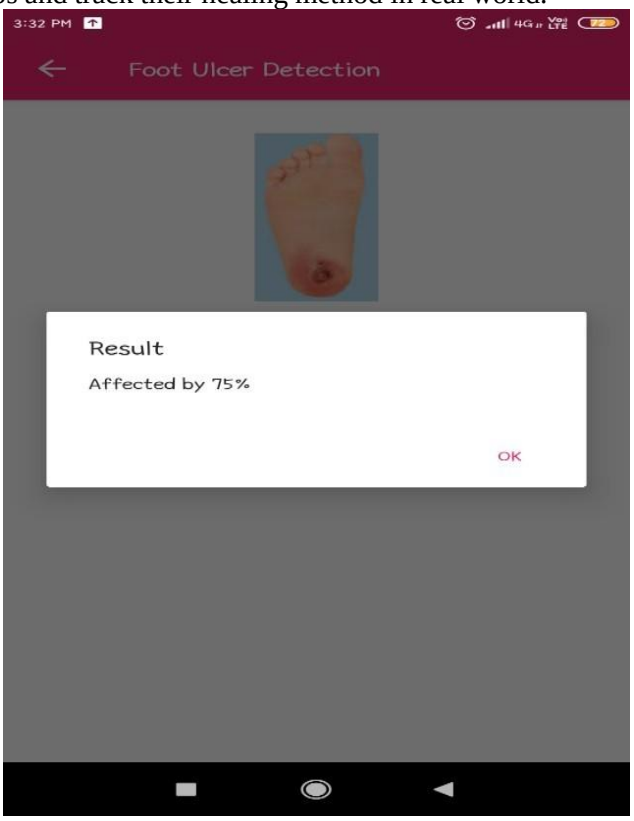

Figure: 8 Output

Although feedback on Diabetic Foot lesion prediction was for the most part positive, we tend to additionally known many challenges. First, victimization Associate in nursing app will represent further work for the patient and thereby will increase the already vital employment concerned in their lesion care and polygenic disorder management. Watching progress was seen as valuable; however participants additionally indicated that more reflection through goals and diaries won't be worthy enough to warrant the additional work.

Goal pictures were enclosed as a result of reflection on goals and progress knowledge will be empowering, because it helps make a case for the link to folks of however their care activities will impact their progress and ultimately their goal. Writing a diary was enclosed because it will facilitate folks to come back to terms with tough problems like the disruption caused by a DFU. However, the participants during this study were ambivalent concerning the goal and diary options. They might see potential edges, for instance, by providing a lot of careful data to their clinicians, however they additionally felt that the hassle wouldn't be even by these edges. In future iterations of Diabetic foot lesion prediction, we tend to suggest doubtless taking away these options and keeping the main target on self-tracking.

Second, many of us with DFUs notice movable apps tough to use. Though we tend to recruited solely movable home owners, several of them failed to use apps on their phone, and a few participants found apps inaccessible as a result of restricted vision and deftness. This finding is according to alternative studies of movable apps for folks with polygenic disorder. Despite increasing accessibility of polygenic disorder apps, they're usually not handy to support the wants of individuals with polygenic disorder, that is, for older adults.

In moving forward within the development of the app, we'll still explore more steerage within the image capture method, for instance, through voice help mechanisms or selfie sticks to manage distance and lighting between phone and therefore the foot, through boxes to rest the foot for image capture, or through consistent ghost outlines of the foot on the camera screen on every occasion a picture is taken to stay photos consistent in angle and distance.

We will additionally explore the employment of pill computers, which can offer grip and a bigger extent to create the app more accessible for folks with restricted vision and deftness. In exploring these choices, it's necessary to continue operating with folks with DFU of all ages and their carriers to make sure that the look permits them to simply browse and navigate data.

Finally, we tend to found that several participants needed to share their knowledge with their clinicians. This is often each a challenge and a chance. On one hand, the need to share data aligns with growing trends in digital and democratic health care, wherever patients progressively.

CONCLUSION

Diabetic foot lesion prediction, a mobile app that seeks to have interaction patients through goals, progress monitoring, and reminders, shows promising options to engage folks in DFU self-care. The patients in this study expressed positive views on Diabetic Foot Ulcer prediction. The options perceived most helpful were

(1) Taking photos of foot ulcers to assess healing and

(2) the flexibility to watch changes within the size of their ulcers through wound size information generated from such photos. a lot of work is required to boost the usability and accuracy of Diabetic foot lesion prediction, that is, by refinement the method of taking and analyzing wound photos.

This study enhances our understanding of opportunities and challenges for mobile health technologies, particularly through medical photography, to support folks with polygenic disorder and DFUs.

The findings open the door for additional work to develop Associate in nursing app that's correct, reliable, and simple to use in existence and to check it with folks with DFUs and their careers. The app given during this study works on common place mobile phones while not requiring a separate camera. With mobile phones turning into a lot of widely used among folks with polygenic disorder, Diabetic foot lesion prediction has the potential for widespread impact.

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