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Skinhealth, a mobile application for supporting Teledermatology: A case study in a rural area in Colombia

Juan Pablo Sáenz[1], Mónica Paola Novoa[2], Darío Correal[1], and Bell Raj Eapen[3]

[1] Systems and Computing Engineering Department. Universidad de los Andes, Bogotá, Colombia
{jp.saenz79,dcorreal}@uniandes.edu.co
[2] Fundación Universitaria de Ciencias de la Salud. Hospital San José. Bogotá, Colombia
mopanoca@hotmail.com
[3] Kaya Skin Clinic. Dubai, United Arab Emirates
bell.eapen@gmail.com

Summary. Background: The use of mobile applications in dermatology to support remote diagnosis is becoming more important each day, particularly in rural areas where dermatology services are commonly managed by healthcare personnel with no speciality training.
Objective: The aim of this study is to assess the reliability of mobile applications to support remote dermatological diagnosis, when used together with a dermatological ontology in underprivileged areas.
Methods: A mobile application that allows characterization of skin lesions was developed. The experiment was conducted in a remote area without access to a dermatologist. A total of 64 dermatological queries were recorded in the mobile application.
Results: The results showed that the probability of obtaining a correct diagnosis was between 64.4% and 85.6% and a confidence interval of 95%.
Conclusions: This study demonstrates the implementation of a Teledermatology strategy based on mobile applications and domain ontology-driven knowledge base to provide timely assistance to healthcare professionals. This approach was found to be pertinent in the Colombian rural context, particularly in forest regions where dermatology specialists are not available.

Key words: mHealth; Teledermatology; Remote Consultation; ONTODerm; Colombia; Latin America

1 Introduction

According to the Colombian Association of Dermatology, there were 1.25 dermatologists per 100,000 inhabitants in 2011, with a large number of them in larger and more densely populated cities (3 per 100,000 inhabitants), thus leaving rural areas without specialized dermatological care options. There, some complex

queries are sent to specialists through means such as email, and the answers may take several days to arrive.

Against this backdrop, mobile teledermatology is established as a technically feasible [1][2][3][4][5] and diagnostically reliable method of increasing access to dermatologic expertise in poorer regions of the world where access to computers with Internet is unreliable or insufficient.

In this paper, we present Skinhealth, a system that supports the diagnostic process of skin lesions by using ontology and knowledge base along with its integration with a mobile application. ONTODerm [6] is an ontology for dermatology that was originally designed for collaborative development by domain experts to analyse, modify and visualize the ontology in a convenient and accurate manner without the need of technical instructions.

Likewise, this paper reports the results of the first-time use of Skinhealth in a rural area in Colombia. The use of the application was made within the context of a program called Health Brigades in Colombia. Health brigades have been carried out since 2003 and are organized by the foundation "Alas Para la Gente" (Wings for the People) [7].

2 Skinhealth Overview

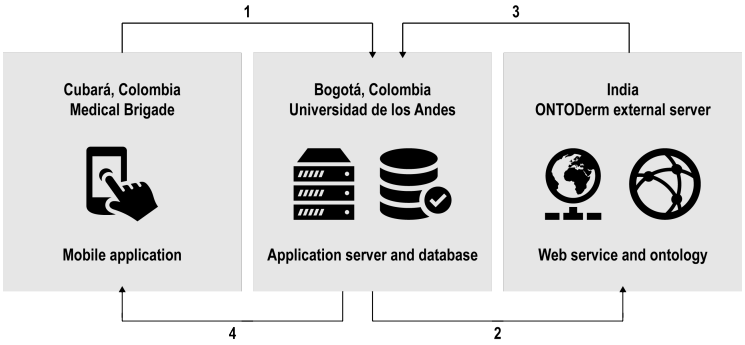

Fig. 1. Skinhealth overall perspective

To illustrate Skinhealth application, let us consider the process presented in Figure 1. In step one, the health care professional in a remote area uses Skinhealth to capture the information that corresponds to the parameters that describe the lesion. Skinhealth then connects to an application server located in the Systems and Computing Department (DSIC) of the Universidad de los Andes, in Bogotá, and transfers the information. In step two, the application server transfers the query to ONTODerm by using a web service hosted in an external server (gulfdoctor.net/dermbase). Once the external web service receives the request, it formulates a query that is sent to ONTODerm. In step three, the

web service returns eight differentials to the application server in Bogotá. In step four, the application server records the differentials for the query and sends them to the mobile application in the rural area. This information is used by the health care professional during the diagnosis process. Figure 2 presents the mobile application used by doctors.

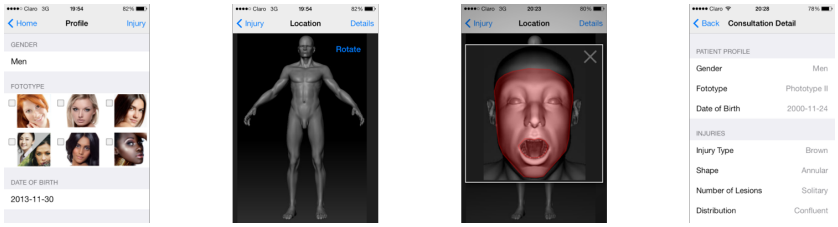

Fig. 2. Screenshots of the Skinhealth mobile application

3 Methods

To analyse the ability of Skinhealth and ONTODerm in supporting remote diagnosis of dermatological lesions, a health brigade conducted in a rural area in Colombia without immediate access to a dermatologist was selected as the scenario. The study population included all patients who attended the brigade without any exclusion criteria. The study was conducted in two stages. The first stage involved a general physician of the health brigade with no special training in dermatology and an assistant in charge of Skinhealth. The second stage is performed once the health brigade concludes. A dermatologist with broad experience in skin diseases examines the characterization of each query and compares this information with the diagnosis made by the general practitioner. The physician's diagnosis is marked accurate if it corresponded with the dermatologist's diagnosis.

4 Results

Phase 1 of this study was conducted in a Colombian municipality of Cubará, which has a population of 3,118 inhabitants; 1,551 women and 1,567 men, most of them belonging to the U'wa indigenous tribe. The nearest medical center with a dermatologist available is 166 kilometres away in the city of Cúcuta, at an eight-hour overland journey through a jungle area. During the three-day brigade, a totoal of 65 (7.26%) dermatology consultations were performed. A general physician attended dermatological visits between 8 a.m. and 5 p.m. Skinhealth was installed on a tablet with version 4.2 of the Android OS.

Phase 2 of the study took place in Bogotá, two weeks after the brigade. Coincidentally, the point estimate of the proportion of correct diagnoses in men and women was the same. It should be noted that the sample size for men is not large enough; thus, confidence intervals are very broad and do not provide accurate information. In contrast, confidence intervals for women are smaller and allow the formulation of more precise observations. Most skin lesions were identified in the face and hair, comprising 60% of total observations. Since the volume of pooled data was high, it was possible to separately analyse the queries of lesions on the face and the queries of lesions on the hair in order to determine the degree of accuracy in each case. The percentage of accurate queries in which the face was identified as the affected area was 96%.

5 Discussion

In the present study we proposed the integration of a mobile application and its respective connectivity and portability features with the ability of inference and learning of a dermatological ontology. We tried to ascertain the potential of this solution in dermatological diagnostic work carried out by general practitioners in rural and geographically marginalized municipalities where there are no specialists.

Besides assessing the accuracy of results, this study demonstrated the implementation of a different strategy of teledermatology that relies on mobile applications and domain ontology to immediately assist a general practitioner who answers dermatological consultations. This approach was found relevant in the Colombian context, particularly in geographically and economically marginalized regions. However, since the sample size is small, more studies would be necessary to validate the findings. The conclusions drawn in this paper do not represent a final validation of Skinhealth but a preliminary evaluation in order to determine its potential as a tool that can support medical staff in regions where there are not dermatology specialists.

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