A Mobile Online Platform for Aged Men's Prostate Hypertrophy Monitoring Based on Linea Nigra Images Analysis

Mahugnon Géraud Azehoun-Pazou
National University of Science, Technology, Engineering and Mathematics, Benin
geraud.pazou@unstim.bj

Kokou Assogba
Laboratory of Electrotechnic, telecommunication and Applied Informatics, Benin
mkokouassogba@yahoo.fr

Hugues Adegbidi
Faculty of Health Sciences, University of Abomey-Calavi, 01 BP 526, Benin
adegbidih@yahoo.fr

Gloria Tognon Tchegnonsi
Tamakan Inc., 07 BP 265, Benin
tchegnonsigloria@gmail.com

Bickel Oloude
Tamakan Inc., 07 BP 265, Benin
bickeloloude@gmail.com

***Abstract*—Aged men generally have a hypertrophied prostate. This hypertrophy can evolve in cancer or can just be a benign hyperplasia. Some recent studies revealed that a linear hyperpigmentation of skin called Linea nigra (LN), can appear in men developing prostate cancer or benign prostatic hyperplasia. LN's prevalence is higher in the case of prostate cancer. It has been established that when a LN appears on someone's suprapubic region and has a length greater than ten centimeters, it indicates a metastasized or metastasizing tumor. Based on this, we developed in a previous work a method of LN segmentation. From segmented images, we can calculate descriptive values such as length, width, area, texture and color. These values are LN characteristics that can be used by specialists to make diagnosis. In this paper, we propose an implementation of those methods in an Android mobile application. The aim is to connect patients to their specialists for distant monitoring purpose based on images taken with their mobile phones. The specific architecture of the platform also helps in providing more precision in detection thanks to a deep learning program.**

Keywords— linea nigra images analysis; mobile application; aged persons distant health monitoring

I. INTRODUCTION

Usually found in pregnant women, the linea nigra (LN) is a linear hyperpigmentation of skin that appears between navel and suprapubic region. It sometimes appears in men of a certain age and non-pregnant women. Generally, LN is found on the abdomen of about 75% of women in pregnancy [1]. However, studies published in [2], [3] revealed that linea nigra is observed in men having prostate cancer or benign prostatic hyperplasia, Ly et al. (2013) proved that the prevalence is higher in the case of prostate cancer and concluded in [2] that an LN which is greater than ten centimeters indicates a metastatic tumor. From this conclusion, it appears that characterization of LN can be used as a non-invasive method to establish a differential diagnosis between the two types of prostatic tumors. This characterization can be done from images, thanks to image processing.

Medical images are one of the most widely used tools to better understand both normal and abnormal processes that affect health. In particular, image processing algorithms can provide quantification, accuracy, reliability and repeatability of measurements and analyzes by delegating tasks to computer. Because of that, development of computer aided diagnostic systems (CADS) is a research field of interest [4]. Their goal is to help physicians to make their decision through image analysis. Despite these advances, there are other challenges that dermatologist have to face. Indeed, in poor countries, there are very few specialists to cover a large population. This is the case in Mali where there is less than one dermatologist per million inhabitants. As a result, the country has to deal with a low level of competence in peripheral health structures. In such context, portable applications which are close to patients (including telemedicine, mainly tele-expertise) could be the solutions. Thanks to recent advances in ICT, it is possible for devices (mainly smart phones and tabs) integrating software and applications to be able to make decisions about a dermal disease based on images of pigmented disorders.

Recent advances in computing and Artificial Intelligence (AI) have had a huge impact on interpretation of medical images. However, since obtained results cannot be fully taken into account, it is essential to have final conclusions from doctors. It is for all these reasons and also in order to ensure a fast, cost-effective and remote consultation for everyone that we propose in this paper an online platform whose aim is to detect and to analyze pigmented disorders, while taking into account the expertise of distant specialists.

II. EASE OF USE

Using mathematics and technological advances, scientists created different applications to equip dermatologists. These applications also help to raise awareness and bring medical prowess closer to population. Among them, we can enumerate:

• A special skin cancer screening application developed by SkinVision that can be downloaded to smartphone [5]. It detects potentially suspicious moles and skin lesions and then records snapshots to detect abnormal changes. It allows photographing the suspect mole and then analyzes it in seconds using an algorithm that identifies any potentially abnormal growth. The application is the first comprehensive application

of skin cancer that has achieved European Certification (EC). It has been scientifically tested in 2013 by Munich University (LMU) Clinic, which is recognized as one of leading academic research institutions in Europe specialized in skin cancer. SkinVision's application is used by in many european countries

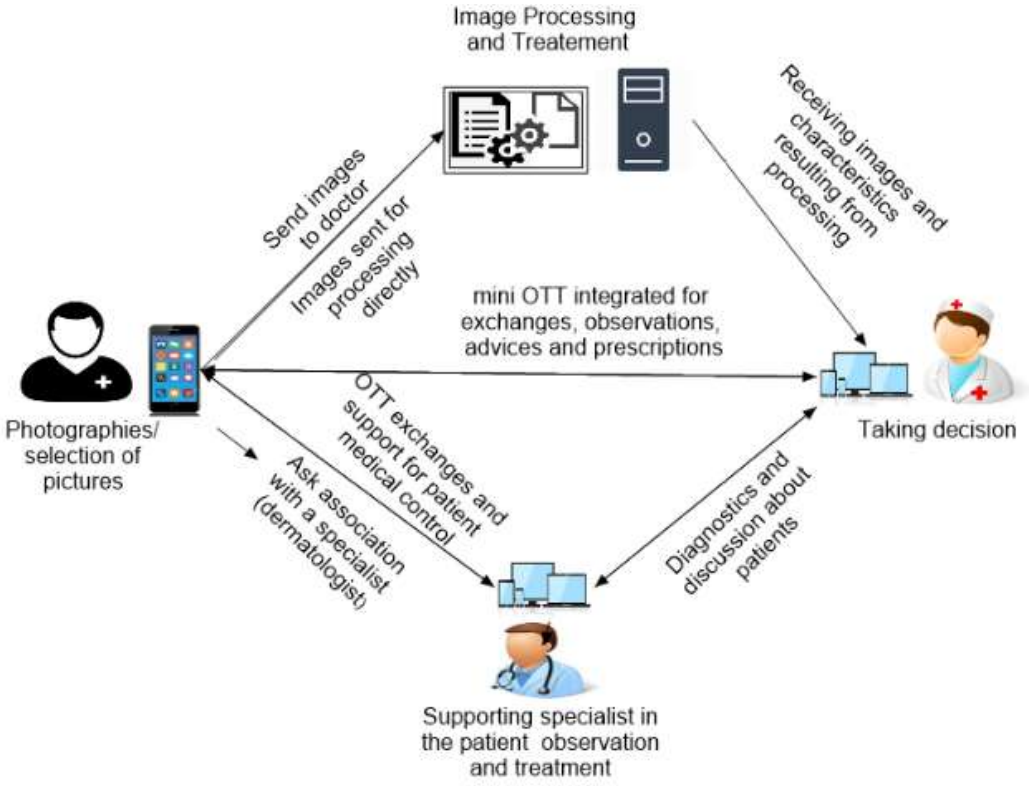

Fig 1. System architecture

• Maryam Sadeghi developed Molescope, an application that, using a smart phone connected to a mini-microscope, allows to take very precise images of spots and moles in order to detect possible malignant melanomas. [6]

• A team from University of Houston, USA, developed the DermoScreen application, an application capable of preventing skin cancer. By photographing a suspect lesion or mole with the phone, the software analyzes the risks whether it is cancer, with a success rate of 85%. [7]

III. MATERIAL AND METHODS

A. *Methodology*

Applications conception mostly for mobiles have become for some years accessible to the community; that is possible to the presence and availability of numerous modeling and programming tools. However, in the frame of medical applications pointed, it is generally professionals we meet. The conceptual phase stands for to take into account every features and mathematical treatments to do on the images for LN evolution detection. The database modeling is edited with UML. The development phase of platform must follow MCV for ease the application maintenance.

B. *Final users*

People involved in using the platform are:

- Sick people;
- Population;
- Dermatologists (doctor).
- Generalist doctors

C. *System architecture*

The system of LN detection application integrates in its functioning the mobile application associated with web interface for computers used by everybody as he is a doctor or patient (figure 1). The network cloud is made up by images processing and treatment algorithms implemented for LN evaluation.

D. *Networks architecture*

A mobile application running on smartphone and using the network connectivity for rural populations mostly need to be soft in its use. It means that processes and technologies used to develop and deploy application must not be smartphone chip gluttonous.

A*ccess to internet is generally difficult* in rural and remote places. At the first side, the coverage of terrestrial mobile networks is not enough because the mobile networks operators judge useless to densify with base stations or allocate a great bandwidth for a land where mobile traffic is not important. At the other side, the bandwidth and data rate put available are inappropriated for increasing rural needs. *In front of this fact, mobile API mustn't be greedy in chip capacities and data.*

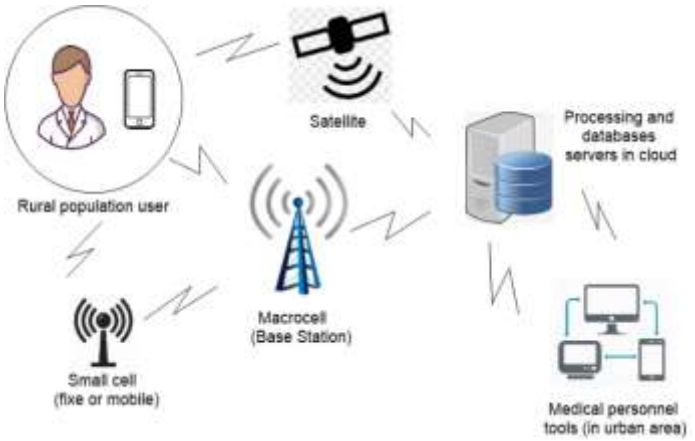

Fig 2: Rural scenario of application

E. General (standard) features

The mobile platform useful for remote people must integrate the basic functions like:

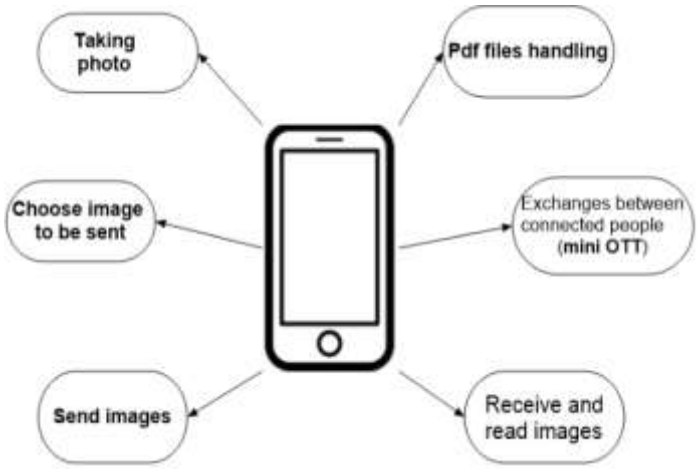

Fig 3: Basic mobile features

F. LN Application available features

The following features are available:

- Sick people (patients) can sign up (register) on the platform. They can register with a generalist ID associated or a dermatologist associated. The first doctor associated to one patient must validate the enrolment before the continuation (the patient will have access to health features).
- Medical personnel must sign up with mandatory informations useful to track their service states;
- The doctor treating a patient can add in need case till two specialists;
- Tchat OTT (mini OTT) module has two modes*: mode reserved* (discussion group for one treated patient doctors) and *mode open* (discussion group between doctors college and a patient).
- Patients can send LN images to the online platform from a mobile phone;
- As soon as an image is sent by a patient, his doctor is notified. From then on, doctor can connect to the platform and launch image analysis process;
- At the end of an analysis process, found characteristics can be used by specialists to make diagnosis.
- Sick patient receives advices and possibly prescriptions or an appointment for a thorough auscultation.

G. Technical choices

For technical choices, we bet on python technologies. Firstly, Python is multiplatform. Secondly, Python is one of best scripting languages with supported libraries in Image processing domain. The image processing module must be at the basis entirely in Python (opencv, numpy, matplotlib...). Thus, the details relative to mobile application using Python technologies are:

- Front-end: Kivy is the Python mobile API selected. Using Kivy, mobile application done can be distributed on PlayStore. The application can use also Android services (SMS, camera, mail and notifications system); and have access to most of the normal java API.

- Back-end: SL4A (Scripting Layer for Android). SL4A makes possible scripting languages to Android by using Python for complex processes.

- Web: The web interface accessible is guaranteed by Django utilization web version of application in order to allow to medical personnel to have flexibility in their technical works

H. Image processing module

The image processing module has been developed in python programming language based on LN's segmentation algorithm proposed in [9]. It consists of the following steps: conversion from color to grayscale based on Principal Component Analysis results; second step is contour initialization; in third step, contour evolves iteratively until it no longer changes.

Once LN images has been segmented, some characteristic values can be calculated. They are: length, width, ratio, area, and histogram of oriented gradients.

1) Length and Width

They are determined from two furthest points considering respectively X axis and Y axis.

2) Ratio

It is the ratio of width to length, gives an indication of the form of the pigmented disorder. Indeed, a ratio very close to zero indicates a very sharp LN. A value of ratio close to 0.5 indicates a LN more or less wide and / or not very long. A ratio close to 1 indicates a regular shape: circle or square.

3) Area

It corresponds to the total number of pixels that belong to segmented region.

4) Histogram of oriented gradients (HOG)

This descriptor calculates local histograms of the gradient orientation on a dense grid (evenly distributed areas) of the images. First proposed in [] the method has proven effectiveness for the detection of people.

IV. RESULTS

Fig4: Some LN segmentation results that Doctors can view

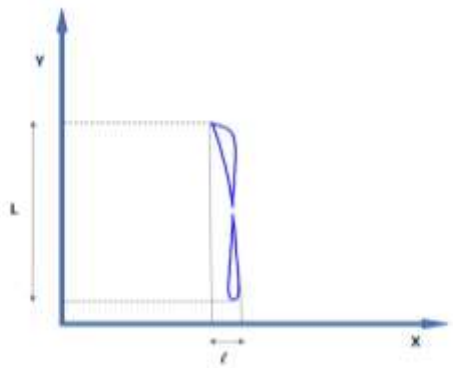

Fig5: Graph showing a segmented LN dimensions

Two segmentation results are shown in figure 4. Since it is important from clinical point of view to circumscribe the whole NL, we can conclude that our method is good. Considering the segmented LN of figure 5, the following characteristic values are calculated: Length = 365 pixels; Width = 50 pixels; Ratio = 0.137 and Area = 5191 pixels.

V. CONCLUSION

The development of a technology combining a large amount of information on skin disorders and the analysis of data calculated from images can increase the information available for Dermatologists. This motivated our research on the development of a platform to serve as a diagnostic aid system. The developed platform is suitable for elderly people whose mobility possibilities become reduced with advanced age. It is also very useful for people living in rural areas.

In future work, we should focus on automatic detection of probable or non-probable metastasis of a prostate tumor based on identified characteristics combined with results of biomedical analyzes and clinical symptoms.

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