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WOUND ASSESSMENT AND BLOOD SUGAR LEVEL MONITORING OF DIABETES PATINONS USING SMARTPHONE

Dhanapriya.M, Rajeswari.S, Gopirajan.P.V

Department of Information Technology, Karpaga Vinayaga College of Engineering and Technology
Asst.Prof, Department of Information Technology, Karpaga Vinayaga College of Engineering and Technology

rsdpriyait@gmail.com
gopirajan.kvcet@gmail.com

***Abstract*--Diabetic foot ulcers represent a significant health issue. Currently, clinicians and nurses mainly base their wound assessment on visual examination of wound size and healing status, while the patients themselves seldom have an opportunity to play an active role. Hence, amore quantitative and cost-effective examination method that enables the patients and their caregivers to take a more active role in daily wound care potentially can accelerate wound healing, save travel cost and reduce healthcare expenses. Considering the prevalence of smartphones with a high-resolution digital camera, assessing wounds by analyzing images of chronic foot ulcers is an attractive option. In this paper, we propose a novel wound image analysis system implemented solely on the Android smartphone. The wound image is captured by the camera on the smartphone with the assistance of an image capture box. After that, the smartphone performs wound segmentation by applying the accelerated mean-shift algorithm. Specifically, the outline of the foot is determined based on skin color, and the wound boundary is found using a simple connected region detection method. Within the wound boundary, the healing status is next assessed based on red–yellow–black color evaluation model. Moreover, the healing status is quantitatively assessed, based on trend analysis of time records for a given patient. Experimental results on wound images collected in UMASS—Memorial Health Center Wound Clinic (Worcester, MA) following an Institutional Review Board approved protocol show that our system can be efficiently used to analyze the wound healing status with promising accuracy.**

Keywords: Diabetic Foot ulcers, Smartphone, Accelerated Mean-shift algorithm, Wound boundary, Trend analysis and Accuracy.

I. INTRODUCTION

Beta cells situated inside of the human pancreas emit insulin, empowering the body to metabolize the glucose and keep up the centralization of blood glucose (BG) at a protected level about 70–120 mg/dL. Sort 1 Diabetes Mellitus (T1DM) is an immune system in which beta cell capacity is obliterated, bringing about the hoisted levels of glucose in the circulatory system [1]. Diligent high blood glucose (hyperglycemia) can prompt genuine long haul wellbeing conditions, for example, retinopathy, kidney infection, and neuropathy and now and again might bring about ketoacidosis (DKA) [2] with the danger of seizure and even causing death.

To achieve the capacity to metabolize glucose from supper starches or created by the liver, sort 1 diabetic must treat themselves every day with exogenous insulin either utilizing an insulin pump or through Multiple Daily Injections (MDI). Since insulin has the impact of bringing down glucose, over-conveyance of insulin represents a fleeting danger of hazardously low blood glucose (hypoglycemia), [3] which might bring about bewilderment, confusion, and in specific cases, trance like comma or death. Individuals with T1DM should explore a mind boggling optimization issue, much of the time measuring their blood glucose with a lancet and estimation strip and infusing an adequate level of insulin to keep their blood glucose inside of a sheltered limit. The affectability of the human metabolic framework to insulin fluctuates with the season of day, physical effort, illness and different elements, further entangling the procedure of keeping up the tight glycemic control [4].

Standard insulin treatment includes incessant estimation of blood glucose and manual infusions of long-acting insulin for benchmark needs and quick acting insulin at the dinner times [5]. Initially, the insulin pumps are presented in the 1960s which support basal conveyance through a customary implantation of fast acting insulin and physically seeked for boluses at the feast times. The modern pumps imbue the insulin into the subcutaneous tissue that brings about a type of insulin treatment known as Continuous Subcutaneous Insulin Infusion (CSII). In late years, this treatment has been improved with subcutaneous Continuous Glucose Monitors (CGM), which gives successive assessments of BG (commonly at regular intervals) by measuring glucose in the subcutaneous interstitial liquid that permits the patients to adjust their insulin measurement by watching glucose advancement and patterns [6].

The mechanized closed- control of blood glucose, known as the “Artificial Pancreas" (AP), guarantees to have a huge constructive effect on the wellbeing and lives of individuals with sort 1 diabetes. Frameworks, for example, the Biostator™ were presented and utilized as a part of the exerting so as to heal the center setting to keep up normoglycemia both positive (by means of glucose or glucagon) and negative (by means of insulin) control [1–5].

The implementation of these systems, however, requires considerable surgery. Thus, with the advent of minimally-invasive subcutaneous continuous glucose monitoring, increasing academic and industrial effort has been focused on the development of systems, using CGM coupled with an external insulin infusion pump and a control algorithm. In September 2006, the JDRF initiated the Artificial Pancreas Project and funded a consortium of centers to carry out CLC research. A number of inpatient studies followed, reporting encouraging results. During these studies, a regular computer or laptop was used as the main AP platform to run algorithms and communicate with CGM and pump devices. A comprehensive review of past and present progress, as well as ideas for future AP developments, is presented in recent Perspectives in Diabetes [29]. Following the multitude of successful in-clinic trials of CLC, the next logical step was the transition of CLC to ambulatory use. A major obstacle was the lack of a portable AP platform that was:

- Readily available at low-cost;
- Suitable for ambulatory use and computationally capable of running closed-loop control algorithms;
- Wirelessly connectable to CGM devices and insulin pumps; and
- Capable of broadband communication with a central location for data collection, remote monitoring and safety supervision.

The paper is organized into five sections. Section I portrays the significance of the diabetics study; Section II depicts overview of the Diabetic system; Section III portrays the novel solution for the Diabetic System. Section IV deals with the experimental design and results and at last concluded in Section V.

II. RELATED WORKS

There are many works related to maintenance of blood glucose level by patients themselves. Some of the works related to this project are discussed here.

a) Reducing the risks of wound consultation: Adding digital images to verbal reports by K.M [1[. Buckley et al, stated the study to analyze the impact of digital images on the assessment and recommendations of WOC nurse who was providing remote nurse-to-nurse consultations on home care patients with wounds. In a comparative study, information was gathered by home medical attendants from an instance of 43 grown-up patients with an aggregation of 89 wounds with different etiologies. To figure out the expansion of a computerized photo impacted the WOC attendant's evaluation and proposals, the WOC nurture initially finished an injury appraisal and suggestion structure in view of a verbal report from the home-medical attendant. The digital image of the wounds of WOC nurse and marks the wounds to an original assessment and management plan that includes the rationality of the changes.

b) The chronic wound: Impaired healing and solutions in the context of wound bed preparation by V. Falanga [2] states a different view of treating the diabetic's wounds. The term used to portray this new setting in which inability to recuperate is "wound bed planning". This term is changing the way of ceaseless injuries, and has permitted a constant injury to pick up the models of acute injury. In the view of wound bed planning, disabled healing and solutions for it are being tended in novel ways. In this report, we make utilization of the diabetic ulcer as a sample of a constant injury, and underscore the way of physiological standards, the cell and sub-atomic variations from the norm, and the arrangements offered by the new methodologies of quality treatment and immature microorganisms. The rising perspective is that interminable injuries are described by inhabitant cells that have experienced phenotypic changes that should be rectified for ideal recuperating to happen. We have built up in creature models and in people that foundational microorganisms can possibly achieve essential changes in the repair process and, at last, a "quantum" bounce in our therapeutic process.

c) Orchestrating wound healing: Assessing and preparing the wound bed by C. T. Hess and R.S. Kirsner stated an overview of the steps needed to prepare the wound bed for healing [3]. In the wake of perusing the article and taking the test, the member will have the capacity to: a) Depict the life systems and physiology of the skin. b) Portray the injury healing, the nearby and systemic variables that might hinder healing, and the parameters that survey the injury status. 3. Depict the progressions in the process to set up the injury bed for healing.

d) The effects of Tele-wound management on use of service and financial outcomes by R. S. Rees and N. Bashshur [4] states the impacts of a TeleWound program on the utilization of administration and financial related results among homebound patients with chronic injuries. The TeleWound program comprised of a Web-based transmission of computerized photos together with a clinical convention. It empowered homebound patients with interminable weight ulcers to be observed remotely by a plastic specialist. Ceaseless injuries are exceedingly predominant among chronically sick patients in the United States (U.S.). Around 5 million chronically sick patients in the U.S. have incessant injuries, and the total expense of their consideration surpasses $20 billion every year. Albeit 25% of home consideration referrals in the U.S. are for wounds, under 0.2% of the enlisted medical attendants in the U.S. are wound consideration guaranteed. This infers the larger part of patients with incessant injuries may not be accepting ideal consideration in their home surroundings. We estimated that TeleWound

administration would lessen visits to the Emergency Division (ED), hospitalization, length of stay, and visit sharpness. Subsequently, it would enhance financial related execution for the healing facility. An example of 19 patients getting this mediation was watched tentatively for a long time. This was coordinated to a chronicled control group of an extra 19 patients from doctor's facility records. Discoveries from the study uncovered that TeleWound patients had less ED visits, less hospitalizations, and shorter length of stay, when contrasted with the control bunch. In general, they hampered lower expense. TeleWound was observed to be a sound methodology to oversee weight ulcers at lower expense and potentially better results.

e) Combined machine learning with multi-view modeling for robust wound tissue assessment by H. Wannous et al [5]. It stated about the color images gained with a hand held computerized camera, a creative device for evaluating endless injuries has been produced. It consolidates both sorts of evaluation, shading examination and dimensional estimation of harmed tissues in an easy to use framework. Shading and surface descriptors have been extricated and chosen from an example database of twisted tissues, before the learning phase of a Support vector machine classifier with perceptron portion on four classifications of tissues. The outcome is a significative change in the speedy of the classification.

III. DECISION BASED DIABETIC DETECTION SYSTEM

The aim of decision based diabetic detection system is to permit the patients to be aware of the diabetic level and monitor their own health and also assist them to take care of their medication on time. The decision based diabetic detection system is categorized into seven modules, listed as:

- Medical User Module
- Register User
- Emergency Call
- Send Report
- View Report
- Settings
- Trusted Authority Module

a) Medical user: In this module, we add to the medicinal client modules, where the alternatives of medical client such as entering their qualities should be possible. In this module an application for Android smartphone is produced, to enlist the therapeutic client, then send and view their recuperate reports.

b) User Registration: The client is instigating to enlist with trusted authority to send the report and view analysis, on the season of enrolled client need to give their own data, for example, name, age, address, contact number, email id. Furthermore, username and password is generated to login and send the reports. User need to give the crisis contact number to call quickly in crisis circumstances.

c) Emergency call: The client can call the crisis number by squeezing a simple button, no compelling reason to open their dialer and entering the number or pursuit the contacts and call the number, the client is instigated to give the crisis number to call at the season of enrollment, that number is called when the client in crisis circumstance by pressing the simple button.

d) Send Report: Client intermittently sends their data (PHI, for example, Pulse rate, Blood sugar, and Blood weight and Body temperature to the Trusted Authority. The values are contrasted with edge limit and status is given as normal or emergency.

e) View Report: User can view the report sent to the Trusted Authority and the diagnosis received from the trusted authority, then they can do the need full based on the diagnosis.

f) Settings: User has the options to update their personal information, username, password and emergency number when they needed.

g) Trusted Authority: This module is developed as PHP project, Trusted Authority can login in the web application running in the server and review all medical user PHI reports, time of the report and status, and have the options to filter by the medical user name to view the particular medical user report, then sent the diagnosis to the medical user based on their PHI status to their Smartphone application. The user can receive the diagnosis as the email in the address given at the time of registration, and can receive the report in SMS to the given number.

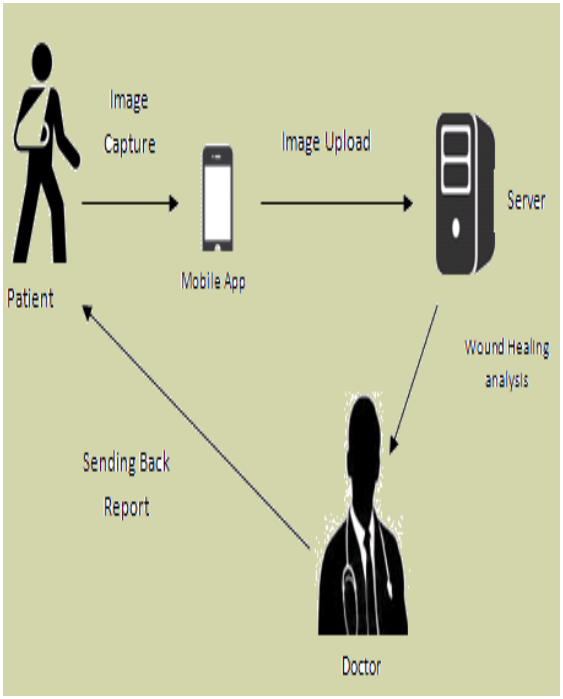


Fig.1. System Architecture

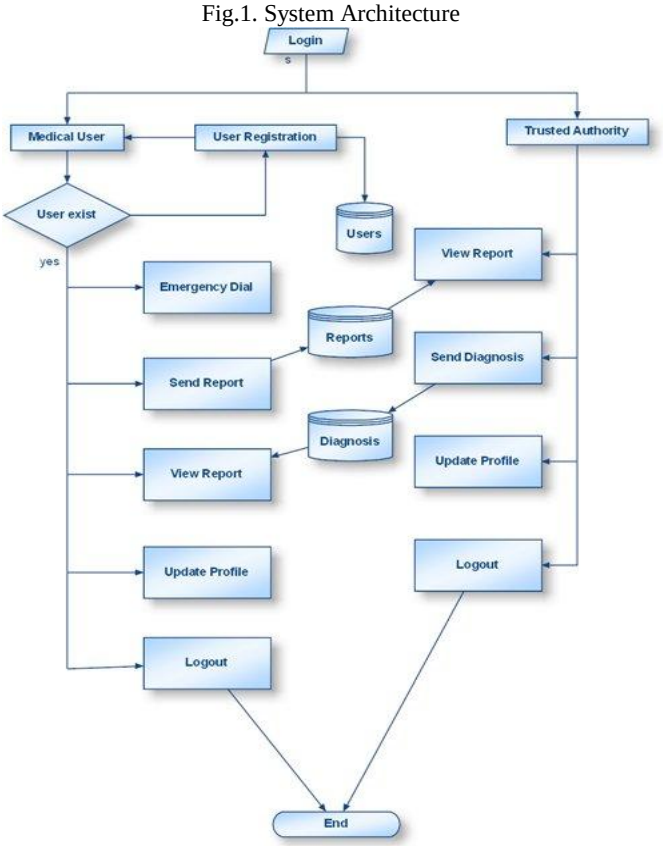


Fig.2. System Data Flow Diagram

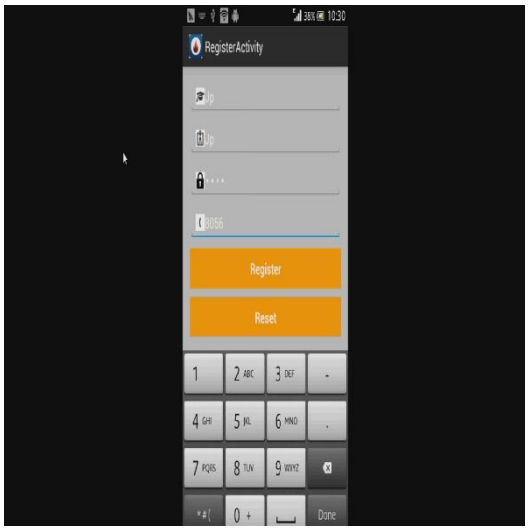
IV. EXPERIMENTAL DESIGNS

The system is implemented in Android and PHP. PHP is a server side web programming language. The components are described as follows:

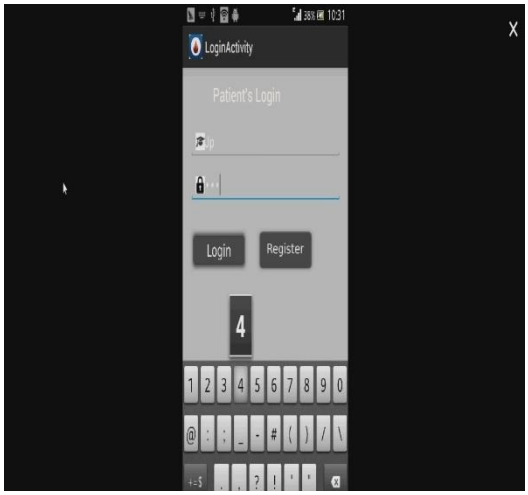
Mobile client Application: The user can access the system through a Mobile Application in Android OS interface, which has been implemented by using Android 2.3 and JSON is for transferring of data to the database server.

Database server: The database server mainly use for processing the JSON object and retrieve the complete information from client application and update with in data base tables using PHP scripts whenever communication occurs.

Knowledge base server: An Intelligent System. The KBserver includes all the facts on which inferences are derived. The knowledge-base contains rules with which the inference engine draws conclusions. These conclusions are the system's responses to the user's queries passes from mobile application through database server KBserver dynamically reading data from database server and according it produce results as well as it also shows the complete detail about the patient to doctor/expert so that he can provide suggestion or guideline for controlling diabetes.



a) XYZ



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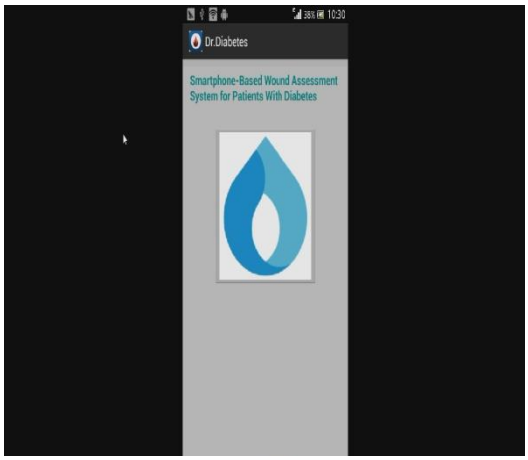
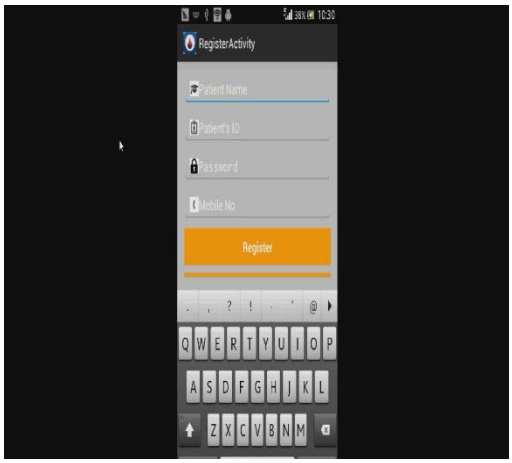


b) XYZ



d) XYZ

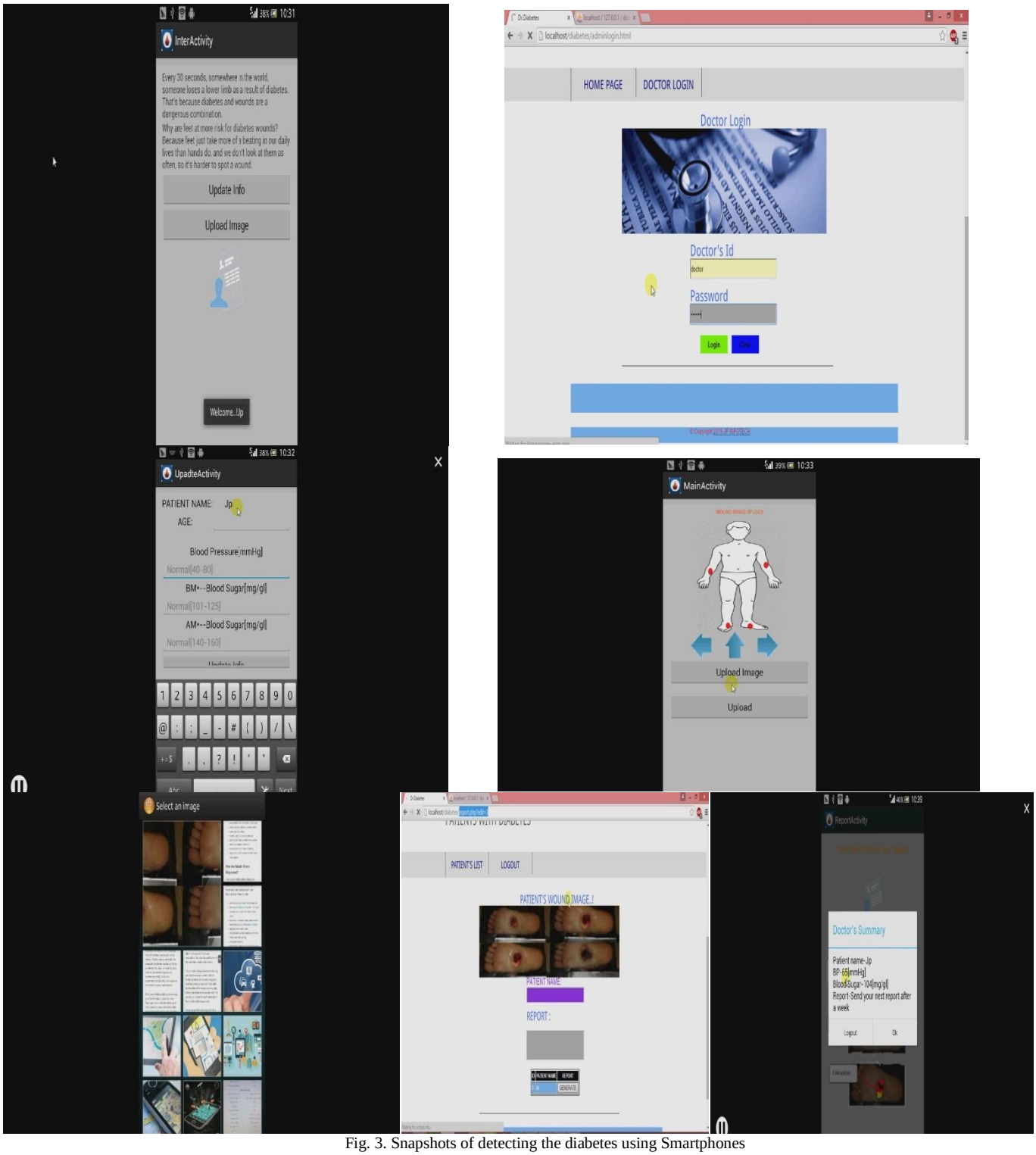


Fig. 3. Snapshots of detecting the diabetes using Smartphones

V. CONCLUSION

Several new innovation open up for creating portable healthcare frameworks which acknowledge the patient data on sake of patient itself or in vicinity of specialist that can permit to exchange this information remotely to enhance the diagnosis and treatment of diabetic diseases in a more realistic view. Complex mobile healthcare frameworks will positively emerge sooner rather than later. The objective of this paper is to actualize and plan a mobile healthcare services framework comprising of three sections: Recording the information from a patient progressively, an Android cell that advances the received information to a focal server and at last a server capable to store and examine that information by the expert's

system. It utilizes decision based way to deal with grouped information and forward binding inference strategy. If there should arise an occurrence of inference, the framework will get some information about the manifestations and risk variables to the master the framework. As per to the solution, the framework will make judgment about the likelihood of sickness, how much extreme it is similar to slight chance, moderate chance, high chance, high risk, diabetic or not.

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