Tele-Wound Monitoring through Smartphone

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Abstract - **This paper presents a system for acquiring, transmitting and monitoring chronic wound status from rural to good facility added clinics by easy-to-use interfacing in smart phone technologies. The aim of this paper is to give clinicians the possibility to monitor emergency home bound patients using Telemedicine fastly, accurately and precisely. Telemedical agent (TMA) can collect the wound data using high-resolution camera based smart phone and send it to the Telemedical hub (TMH) for better treatment consultation. The time and cost can be minimized and maintained e-prescription with respect to unique patient identification number (PIDNUM) in online wound database using this superior user friendly technique. The smart phone supported prototype system has been demonstrated with snapshots using very compatible and easy to integrate Hypertext preprocessor (PHP) and MySqL. The proposed system may facilitate better wound management and treatment.**

Index Terms - **Chronic wound image, Telemedicine, Medical Image Processing, Smart phone, Emergency Healthcare**

I. INTRODUCTION

Accessing timely chronic Tele-wound care is a major challenge for older adults. A Tele-wound care comprising transmission of wound images and a clinical protocol to home bound patients resulted in reductions of emergency visits, hospitalization, hospital utilization and cost [1]. Telemedicine [2] is an emerging field in advance communication systems and medical informatics, is able to deliver the healthcare data and sharing of medical expertise using wireless technologies (GSM/WLAN/SATELLITE/2G/3G/4G) in the span of teleoncology, telepathology, teleradiology, emergency healthcare and teledermatology. Today's remote people's are facing lot of problems on treatment like not available good clinicians and specialty care in rural area, provider shortages, patient can loses a day's wage, to pay for travel expenses, clinicians appointment is not readily guaranteed. Where as many cases are extremely trivial and of non emergency type. Therefore, clinicians charge a lot of money that's why Telemedicine have been taking a major breakthrough by providing fast and efficient diagnosis. And also maintaining e-prescription for referral cases, time and cost saved and clinicians can work from anywhere using smart phone. A handheld computing device like personal digital assistant (PDA) is used to monitoring patient's remotely [3]. Author [4]

discussed the implementation and use of an electronic medication management system (EMMS) using new technology to reduce the incidence of serious errors. The huge numbers of rural peoples in the world have been suffering with different types wound. However, due to the lack of trained clinicians, this adds up in suffering population. The huge improvement and development in mobile communication throughout the world reduce the problem up to some extent. Our medical experts with Telecommunication engineering are trying to mitigate these problems. The portable, handheld device like smart phone can be used to capturing high quality wound images and acquiring patient's demographic information and send it to TMH through secure, web based medium. The Telemedicine based wireless body area networks can be used for continuous remote patient monitoring [5] where wound image collected by high resolution camera based cell phone through image sensor. This paper also discussed about Electronic health records (EHR) services that are being used form maintain wound database and bridging geographical distances. Wound healing has been taken longer duration and regular check-up with certain interval is one of the big abstract to clinic, the TMA act as a major role on data collection from various Telemedicine centre's (TC).

Fig. 1: Different types of ulcers

The high featured smart phones like Xolo, APPLE, Nokia, SAMSUNG GALAXY TAB, Windows phone, BlackBerry, iOS, Canon, Adobe, ANDROID platforms can be used for sensing, acquiring the variety of medical data collection and monitoring applications. This paper deals a MySqL/PHP framework for acquiring, processing, analyzing and understanding chronic wound images. The several research articles designed metadata for dermatological imaging using ORACLE, SQL, XML, SAS8, PHPMYADMIN and MS ACCESS platform but these are licensed and cost effective. The Tele-wound application under Telemedicine approach should have a good user interface, easy to use, gives fast response, throughput, gives best performance in case of fault and error free. The different ulcerous cases can be transformed using MMS an email. Metadata can be defined as a structured information system that carries big strength of medical information. The chronic wound is mainly a wound that does not heal in an orderly set of stages and in a predictable amount of time. It mostly affect aged people, delayed skin re-growth, depression, slow older cell proliferation rate, social isolation, long term and costly treatment, they can't visit clinics frequently. There are four main types of chronic wounds like pressure ulcer, diabetic ulcer, venous ulcer and arterial or ischemic ulcer respectively. A wound consists of non-uniform mixture of red granulation tissue, yellow slough tissue and black necrotic tissue.

This paper has been organized is as follows. The importance of Telemedicine and mobile wound health monitoring systems are presented in section I, In section II, proposed model have been introduced, followed by section III discussed the operation of this model. In section IV, experimental results with screenshots have been demonstrated followed by section VII on concluding remarks.

II. PROPOSED SYSTEM MODEL

Our proposed scheme provides Telemedicine added chronic wound status monitoring system of remote patients with certain interval and also reduce the frequent clinic visits. Smart-phone enabled telemedicine service overcomes the shortcomings of computer based telemedicine like requirement not portable, wired service and constant electricity. Tele-monitoring provides to monitor the patient's vital signs regularly for reducing time and cost [6]. The good quality wounded image has been chosen in smart-phone by TMA from various TCs, form metadata and is sent to the TMH and stored in wound database with PIDNUM for monitoring the wound status problem remotely. The metadata can be extracted in TMH and then clinical information saved in global wound database and wound image goes to image processing toolbox for pre-processing, segmentation, feature extraction and classification

purpose and gives percentages of wounds. Based on this clinicians can be electronically prescribed medication. Wound images Fig. 2 depicts proposed Telemedicine based chronic wound monitoring system configuration. The different necessary attributes of this models has been discussed below:

(a) Patient's End – All patients are not conscious about their disease. They will require different treatment related information during and after the assessing and managing the chronic wound. The chronic wound affected patient are not willing to move from home, they needs remote care facility, make contact with TMA who are having inexpensive smart phone.
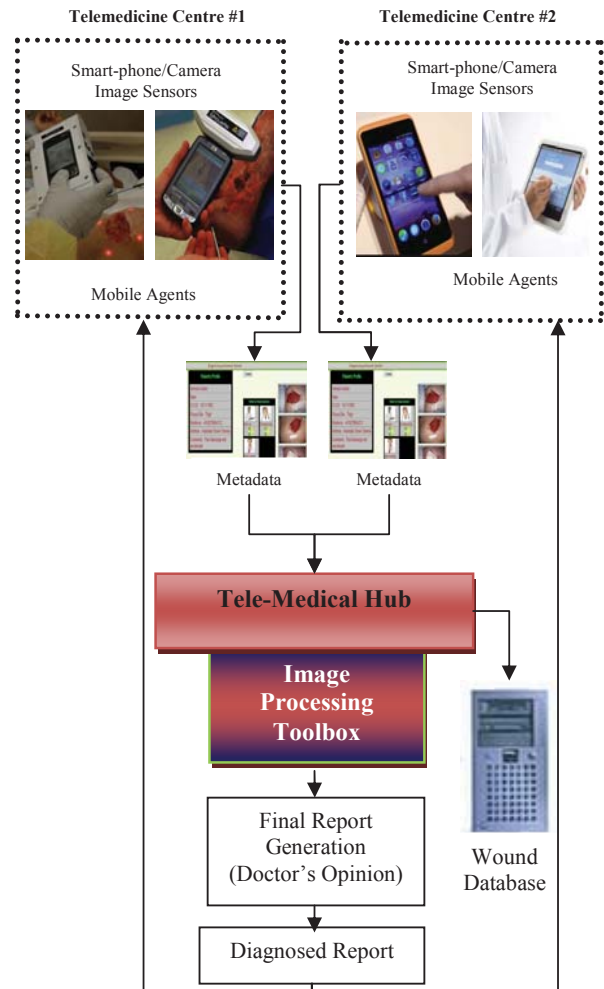

Fig. 2: Proposed wound monitoring system over Telemedicine Platform

(b) TMA – Agent is responsible for creating his account in the apps and feeds the form with relevant clinical information. TMA is putting image and clinical information as a metadata format in the apps that shown in Fig. 3.

(c) TC – The multiple number of TC's have to be set up in every populated rural area for providing specialist care. This centre's consist of preliminary treatment facility, local clinicians, agents, high technology added smart phone and necessary peripherals.

(d) Information Transmission Schemes – The metadata can be sent from rural to best clinics or clinicians through smart phones, the effective transmission schemes are essential. The quick and cost effective solutions like GSM and GPRS (data rate upto 40 kbit/s) is one of the best choices. The GPRS is gives good performance by having direct uploading capability and easily interfaced with modem and controller from patient's end to TMH in medical data transmission.

(e) TMH – This is the mainly centrally received, transmitted, monitored patient's status and managed all TC's. The best clinicians or clinics are associated with this section. The patient's can get optimal treatment from this TMH.

(f) Doctor's End – The clinicians keep on checking patient's profile for reports from patients. When clinicians logs in the apps and is redirected to patient's profile he finds that he has a case which asks for care and diagnosis. He clicks on the link on the arrived case which says "visit". The clinician having two options like he can go ahead and analyze the wound or can refer the report to other existing clinicians on the apps using PIDNUM. The clinicians regularly keep sending more intelligent and effective e-prescribed medication and wound status related feedback. It helps patients who are in remote areas and do not have access to expert care and advice.

(g) Wound Database - The patient and clinician is to be registered in the database. The database keeps the patients visiting status and clinicians given time and date subject to availability. The Medetec wound image database [7] consists of different types of wound images. There are no papers available on wound database; the global wound database is developed for particular wound related information storing, sharing and analyzing purpose that shown Table 1.

(h) Image Processing Toolbox – The Image processing toolbox (IPT) have been associated with TMH. When metadata received by TMH, the clinical information saved with PIDNUM in database and wound image goes to IPT for pre-processing, segmentation and classification of wound types.

(i) End-to-End Care Unit – This section started from patient's data acquision to clinician's feedback reception through TMA, TC, TMH.
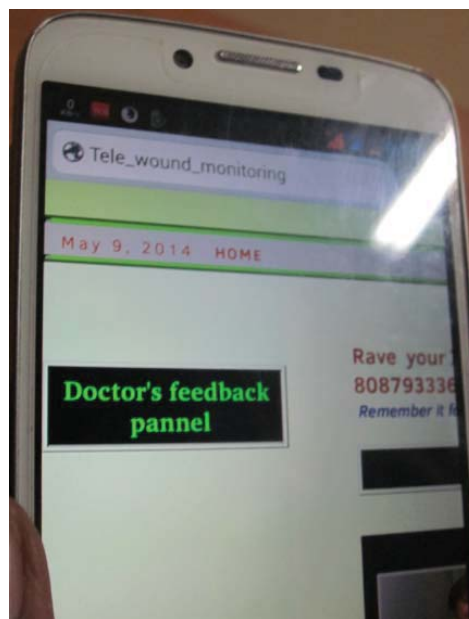

Fig. 3: TMA used Smart Phone

III. OPERATION

This developed prototype wound monitoring system allows clinicians to diagnose the progress of a wound timely. The wounded portion can be capture by smart phone and also TMA is able to collect patient's demographic information like name, age, PIDNUM, sex, address at time of diagnosis, current medication, , occupation, duration of disease, previous case history, diagnosis by doctor's, site of involvement, approximate size of wounds and parental history, finally makes a metadata format. This metadata can be embedded in JPEG format and transmitted globally using web application. This paper attempts very efficient tool using low, cost, open source and easy to access MySqL/PHP. The web application server runs on PHP program and metadata stored in MySqL database in TMH.

IV. EXPERIMENTAL RESULT

Our prototype system can be evaluate in terms of (a) **Timeliness** – patients can contact TMH in timely manner, (b) **Safety** – constantly getting optimal treatment facility in secure

PIDNUM – Patient ID Number, DOB – Date of Birth, WOS – Wound of Site

TABLE I
Wound Database

Name	PIDNUM	DOB	Address	Image	WOS	Contact No.	Comment	Seen
K. Mishra	20978	12.08.1960	Dumka	s.jpg	Ankle	+919908###	Bad pain	Yes
P. Bansal	66543	07.12.1967	Manisas	p.jpg	Hand	+918909###	Etching	Yes
H. Meena	98523	09.03.1956	Madhupur	6.jpg	Leg	+919452###	Pain	No
O. Sheela	96745	12.12.1962	Nikashi	gt.jpg	Hand	+919732###	Normal but developing wound	No
N. Kandar	12098	06.09.1970	Haripur	kl.jpg	Palm	+919123###	Not healed taken medication 15 days	Yes
S. Reddy	89540	03.04.1952	Kerol	o.jpg	Ankle	+919956###	Pain and etching	No
T. Jana	89723	01.02.1952	Pinduput	n.jpg	Leg	+917818###	Severe pain	Yes
H. Trivedi	10056	03.05.1965	Sibtala	t.jpg	Other	+919678###	Malignant Wound for 1 month	Yes

way over wireless communication technologies, (c) **Efficiency** – provide low cost optimal treatment facility over short time, (d) **Smooth Interaction** – effective communication between clinicians and patients are needed, (e) **Interoperability** – transferring medical information like patients records via web application over electronic media, (f) **Reuse** – can be used for other applications, (g) **Reliability** – precisely wound image processing is possible via web application in reliable way, (h) **Usability** – how easy it is for an patients to operate successfully, (i) **Scalability** – medical data can be stored in wound database, (j) **Wound Care Coordination** – provided very good coordination between TMA and TMH, (k) **Information Management** – electronically maintain patient's history with prescribed medication. The Fig. 4 deal with screenshot of TMA is taking patient's details and put into apps.
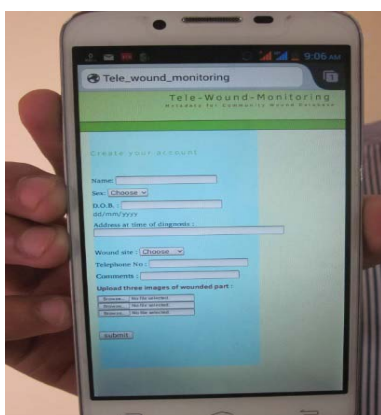

Fig. 4: Screenshots of Patient's clinical information entry page

Fig. 5 depicts the patient wounded portion has been captured by smart phone and patient can visit list of good clinicians that also available on smart interface in Fig. 6.
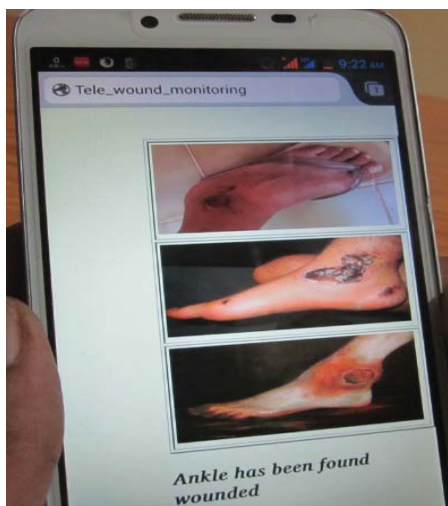

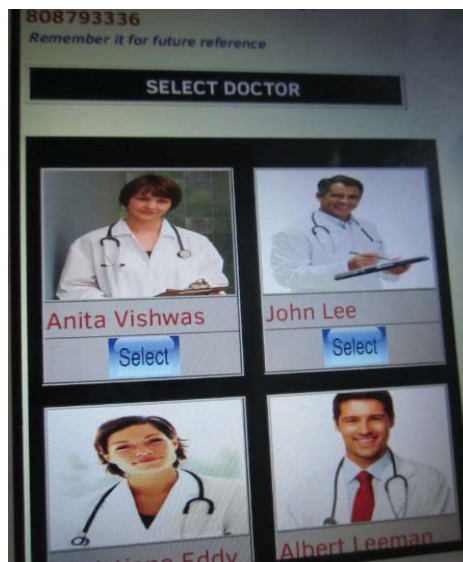Fig. 5: Screenshots of Patient's wounded image

Fig. 6: Screenshots of list of clinicians

In Fig. 8, Clinician is visited patient's wound history by giving unique PIDNUM and seen the wound status. Actually the redness is there in skin then this is first stage of ulcer or granulation, if yellow colored tissue is there then patient's have taken some medication, slightly repaired then this is known as slough and if wounded portion is mostly black colored then this is repaired necrotic. Clinicians prescribed based on the percentage of wound tissue. Fig. 7 is shown the wound image status with unique PIDNUM and clinician can prescribed.
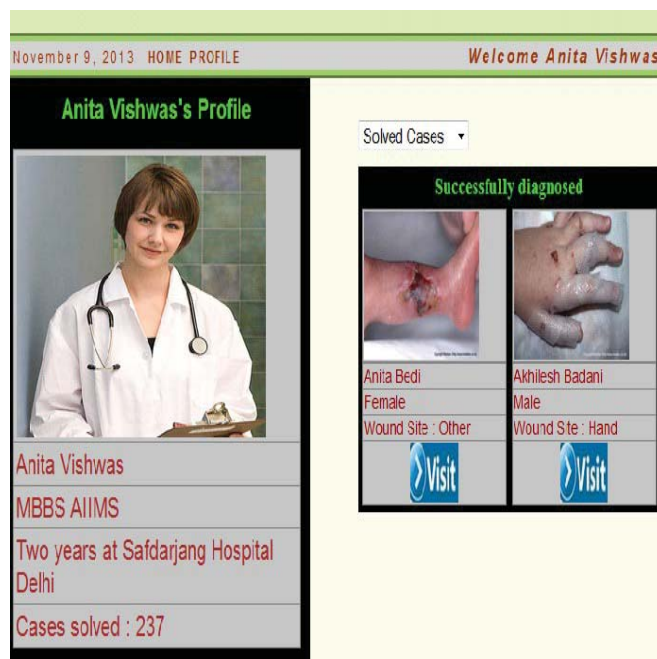

Fig. 7: Screenshots of Clinicians visited wound cases

V. CONCLUSION

In this paper, we present a remotely access chronic wound monitoring system, using portable and easy management tool like smart phone over a Telemedicine framework. Smart phone is storing metadata and send it to TMH via Internet/2G/3G/4G for diagnosis. The proposed approach gives the possibility of better quality treatment, more effective, scalable and precise evaluation. Wound database is maintaining e-prescription for future assistance. Clinician's gives valuable feedback after visiting wound image and patient's details through online medical report transfer at their clinic/home and even while on move, henceforth the less movement for patient and minimized costs. In future, the better authentication mechanism is required for sending the multiple numbers of patient's information through the transmission medium which gives the security to the patient. Availability of videoconferencing and Tele-wound monitoring in problem give more flexibility and improvement in rural remote care.

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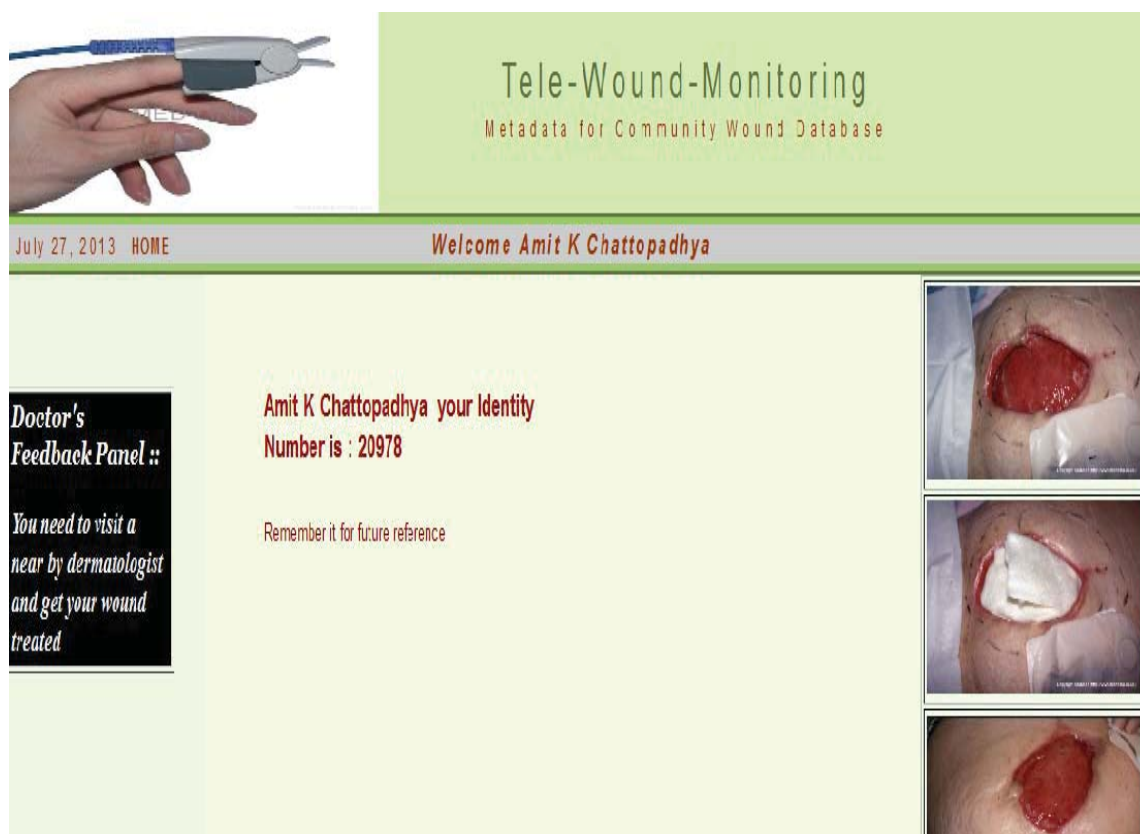[7] Medetec wound database: Available: http://www.medetec.co.uk/files/medetec_image_databases.html.

Fig. 8: Screenshots of patient treated with PIDNUM