Online Support System for Diabetes Management

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ABSTRACT
Diabetes Mellitus requires regular monitoring to effectively reduce the risk of complications and improve the quality of life of the patient. The management of chronic diseases such as diabetes plays an important role in their prevention. Information and Communication Technology (ICT) plays an important role in general healthcare delivery and management, and the use of online systems in the monitoring of patients is considered an important tool in facilitating improvements in diabetes care; hence, a design of an online support system was done for diabetes management. This paper presents the development of an online support system for diabetes management which allows a diabetes patient to provide detailed information regarding treatment regimens such as blood glucose level at regular intervals, blood pressure level, and the food intake among others. The scheduler module of the system uses a flexible scheduler algorithm based on the First-come-First Serve basis. The system was designed using HTML, CSS, PHP and MySQL.

General Terms
Online Support System, Health Care Delivery and Management

Keywords
ICT, Diabetes Mellitus, Online Support Systems, Patients, Doctors.

1. INTRODUCTION
Over the years, diabetes mellitus (DM) has been one of the diseases that have continued to affect a larger population of the world because of its chronic nature which causes metabolic disorder in any age group and causes a high level of glucose in the blood[1,9]. However, quite a number of patients with this condition manage to live healthy thereafter while the inability to manage the condition has led to the death of many.

Diabetes mellitus can be of three types, which are: Type I, known as Insulin-Dependent Diabetes Mellitus, Type II, known as Non-Insulin-Dependent Diabetes Mellitus, and Gestational Diabetes mellitus. The most common of the types are the Type I and Type II. The Type I diabetes mellitus is usually as a result of the inability of the pancreas to produce insulin because the Insulin producing cell (b-cell) has been damaged, while the Type II diabetes mellitus occurs when enough insulin is made by the pancreas, but not effectively utilized. [12]

Diabetes cannot be cured especially in the case of Type I, making it difficult to control but can be managed. One of the ways to approach the latter can be achieved by effective healthcare management and regular checking of the blood sugar level of the patient, the blood pressure, carrying out of physical exercises, diet control and monitoring, glycemic level monitoring, strong adherence to drug regimens, etc must be monitored by a medical personnel to give useful advice and necessary treatment to the patient. Failure to effectively take note and monitor the above parameters can lead to complications such as cataract, hypertension, kidney related problems, death and many more [2, 8].

Traditional ways of monitoring which involves face-to-face contact between patients and diabetes coach, medical nutrition therapist or doctors had been in use over the years until the emergence of Information and Communication Technology (ICT) which has helped in introducing different kinds of monitoring systems. Traditional monitoring can be costly and time consuming in the situation where the patient have to travel over a long distance to meet a medical practitioner, and as a result, many patients wait to be attended to. The consequence may include but not limited to; inefficiency of the medical practitioner as a result of stress and fatigue, inadequate record keeping due to improper handling of medical records and large size of papers used for documentation. However, the development that has been experienced in the field of ICT and health over the years can assist in developing a remote patient monitoring system [5].

This paper proposes a system that allows the diabetes patient to provide detailed information about blood glucose level at regular intervals, blood pressure level, the food intake, the level of exercise carried out by the patient, and other necessary information pertaining to the well-being of the patient. The system reminds patients when to use their drugs and as well when next to meet the doctor in case there is need for such.

This paper is divided into five sections. The first section provided a brief introduction to diabetes and the need for motoring it. Related works were reviewed in the second section. The methodology deployed in the development of the system was described in the third section, section four presented the research results and section five concluded the work.

2. RELATED WORK
[7] Developed a blood sugar management system. The system makes use of the internet and Short Messaging System (SMS) as a medium of managing the blood sugar level of a diabetes patient. The system was able to reduce the social economic burden placed on diabetes patient thereby encouraging a self-based diabetes management. The system allows patients to send self-monitored blood glucose level using cellular phone via SMS to the health care providers who then goes through the message sent and sends back recommendations, dosage adjustment, correction of life style and other necessary information to the patient via the same means as feedback.

Also, [13] proposed a mobile-based phone SMS-based system for self-management of diabetes. The system was designed to

be a companion of patients with diabetes for a long time allowing patients and physicians to communicate via SMS at regular intervals. The patients then sends their insulin measurements and other required information to the physician while the physician respond via the same channel to motivate, give recommendation and remind the patient of their next appointment. The reminder may not be efficient if the physician has a lot of patient to be attended to.

[11] designed and implemented an expert system capable of storing clinical data such as blood sugar measurement, insulin injection doses, hypoglycemic events, dietary intake and exercise activity in diabetes management among others. The stored records allow the doctors to monitor their patients remotely and to advice the patients about insulin dose. In addition, the system gives recommendations to the patients about insulin dose adjustment based on the records and the intelligence built into the system.

A Personal Digital Assistant (PDA) based Personal Diabetes Management System (PDMS) was developed in the integrated environment of Visual Studio.NET 2003 by [10]. The system consists of four main menus to manage personal information, diet, exercise, and blood glucose. It gives quantitative health indices, such as BMI (body mass index) and diabetes index, based on personal physical information, pedigree, and living habits. PDMS is capable of predicting change of the body weight serving as a reminder to patients on the importance of the diabetes management.

[14] developed a knowledge-based diagnosis and management system for diabetes mellitus. The system was developed to reduce the cost of automated medical intelligence system that helps in self-diagnosis, treatment and management of diabetes. It was implemented through a web-based technique that enables functionality in offline and online mode with a convenient user interface. The system analyzes the patient's data inputted into the system and consequently, decisions regarding diagnosis, prevention and treatment of patients are made based on the intelligence built into the system.

An automated android application for the management of diabetes with hypertension was developed by [1]. The system has two options: one is diagnosis and management of diabetes; another is the stored report lookup. In the diagnosis and management option, the system takes user input data such as blood glucose level, blood pressure and cholesterol level for the diagnosis and management. In the stored report lookup option, the system helps in displaying a patient's report based on previous data inputted into the system.

[6] compared the use of a two way SMS cell phone messaging with e-mail reminders that are directed at encouraging blood glucose monitoring. The system designed for the work allows patients to customize their schedule for reminder messages. The work concluded that cell phone text messaging to promote blood glucose monitoring is a viable and acceptable option for diabetes patients.

Despite the development of the above systems, little or no attention has been given to reminding diabetes patients when and how to use their drugs, that is, drug regimes, to take measurement of their blood sugar parameters and send it to the doctor, reminding patients about appointment with their doctor(s) and vice versa. Hence, the development of this system.

3. THE PROPOSED SYSTEM

The proposed system is a web application with three-tier distributed architecture. There is a database server for information storage, a middleware application and a client side application. The web application allows medical practitioners which may include doctors, nurses, etc. and patients to be registered. The doctor and patients are matched and based on the information provided, the patient, gets an Identity Tag (username) as well as a password that will be used to access the system. The same process applies to the medical practitioners as depicted in figure 1. The patient and doctor can use either a phone or a computer to access the webpages. The webpages are well outlined with responsive feature for ease of use.

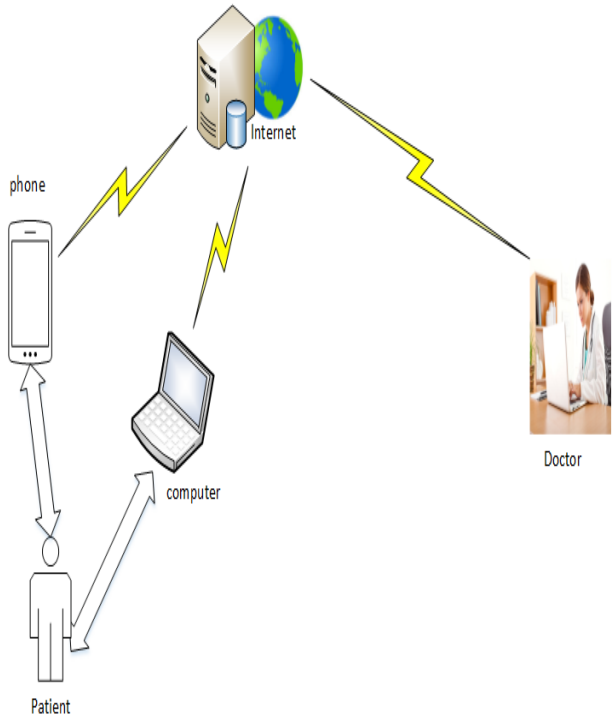

Figure 1: Conceptual Framework of the proposed system

A patient is expected to take measurements of blood glucose level, blood pressure using necessary and appropriate gadget, food intake, and other parameters at a specific interval each day and send them to the doctor. Afterwards, the doctor is notified and the data are uploaded to the database of available records that belongs to the patient. The reminder module of the system as captured in figure 2 reminds the patient when it is about 30minutes to the period of taking the measurement through the use of SMS using the SMS gateway on the need to take the measurements in other not to forget based on the regimes fixed by the doctor. However, the system can be altered based on extreme cases and severity of the patient. SMS is also used to remind the patient about the next meeting with the physician a day before the set date.

The system then processes all the records sent by patients into a more useable form and notifies the doctor whenever a new message comes in for his appropriate decision and attention.

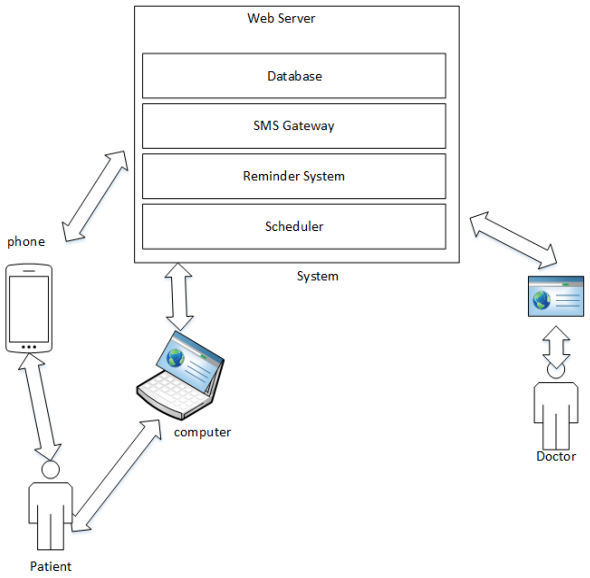

Figure 2: Architectural Framework of the proposed system

The scheduler module of the system uses a flexible scheduler algorithm based on the First-come-First Serve (FCFS) basis and the criticality of patient's case as stated by the physician in order to schedule the time to meet the patient. The schedule is then approved by the doctor before it is sent to all patients concerned. The system reminds the patient about appointments with the doctor a day before through SMS using the Reminder System module and the SMS gateway module of the system.

The system also provides a platform for the doctor and patient to chat in real-time which serves as a means of having interaction with the doctor without having to be physically present at the hospital.

4. DESIGN AND IMPLEMENTATION

The proposed system was designed and implemented using Hyper Text Markup Language (HTML), Cascading Stylesheets (CSS) and JavaScript for the front end, Hypertext Preprocessor (PHP) was used for the server side scripting to connect the user interface to the system which provides relevant management services to the different users of the system. The features of the system are accessible to users through simple interfaces. Figure 3 shows the welcome page that is accessed when the website is logged on to. The system administrator, patients and doctors can log in to their respective accounts through this page.

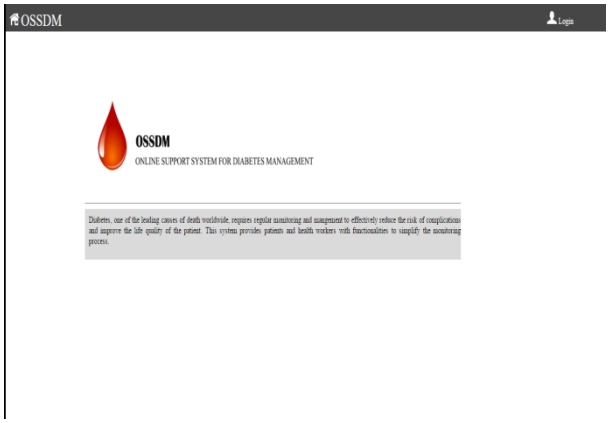

Figure 3: welcome page

Figure 4: Log in page

Figure 4 shows the login page for all the users and allows all registered users to login with their username and passwords. Figures 5 to 7 shows the experimental results. Figure 5 is the recording of blood glucose page which allows patient to be able to store their blood glucose readings and also contains the chat screen and a manual on how to record the blood glucose readings.

Figure 6 illustrates the calorie calculator page allowing patients to calculate the amount of calories needed to maintain a certain weight, while Figure 7 shows the chat page that allows patients to communicate with the doctors in real-time.

Furthermore, Figure 8 shows the scheduling page that enables the doctor to either accept or decline already scheduled appointments booked by the patients.

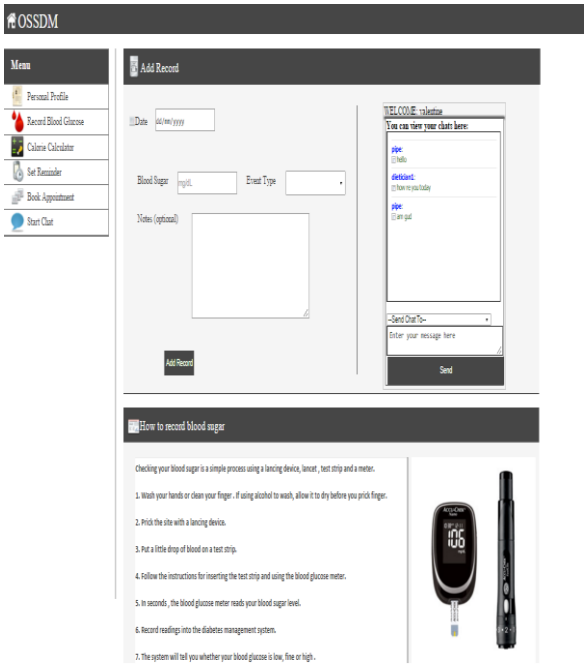

Figure 5: Record Blood Glucose Page

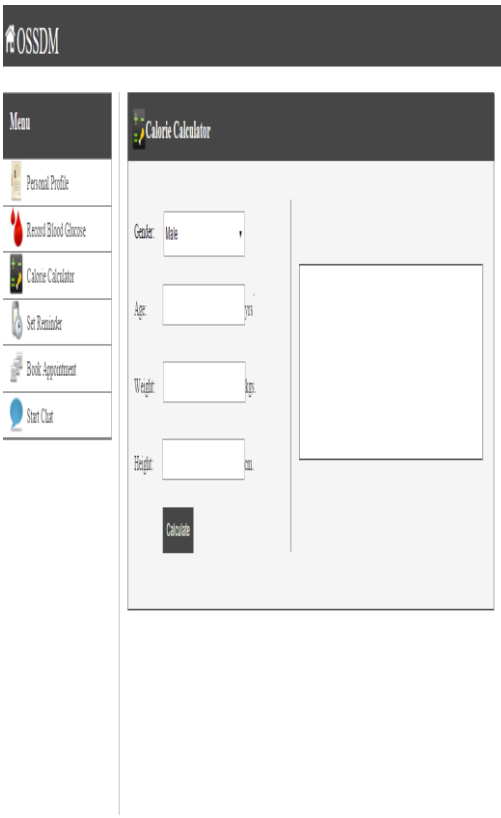

Figure 6: Calorie Calculator Page

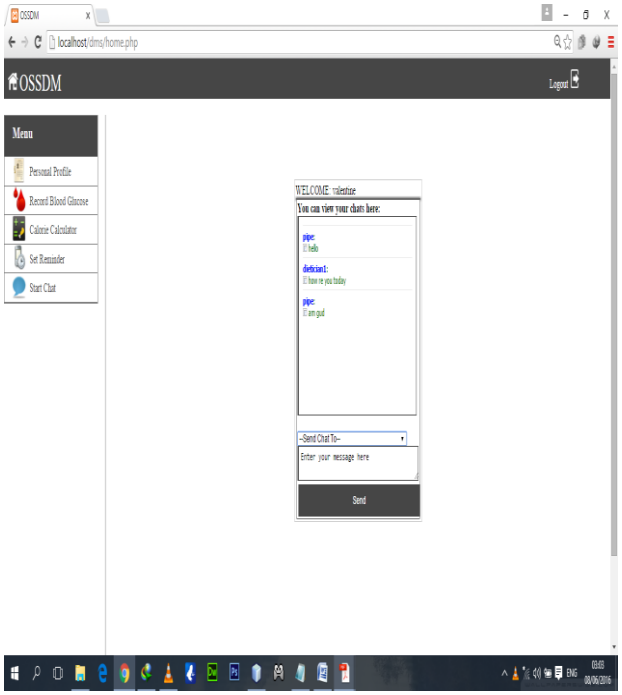

Figure 7: Chat Page

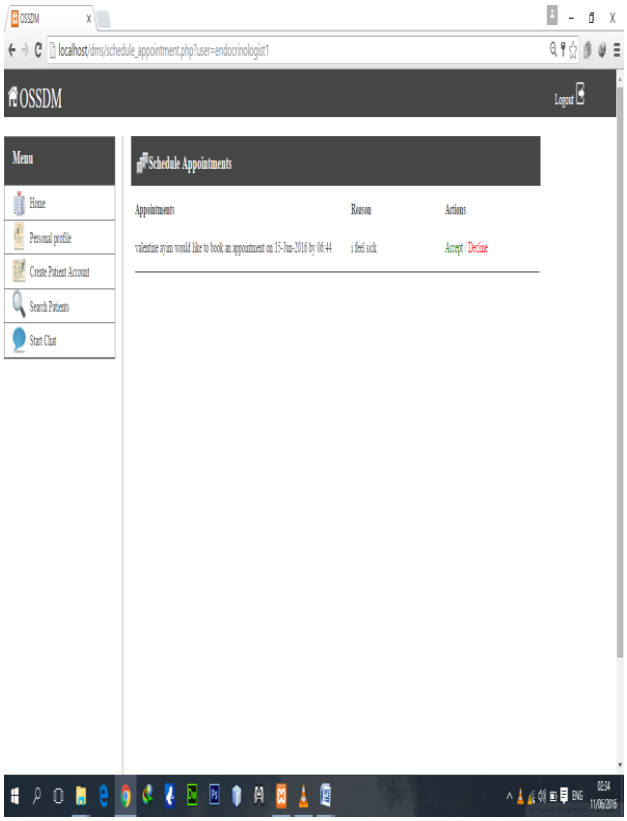

Figure 8: Scheduler

The proposed system allows diabetes patient to provide detailed information remotely about blood glucose level at regular intervals, blood pressure level, the food intake, the level of exercise carried out by the patient, and other necessary information pertaining to the well-being of the patient without getting to see the doctor. The system reminds patients when to use their drugs and inform accordingly when next to meet the doctor when necessary. Figure 9 is the use

case diagram that represents the actions performed by the users of the system while Table 1 further shows a comparison between the existing systems and the proposed system.

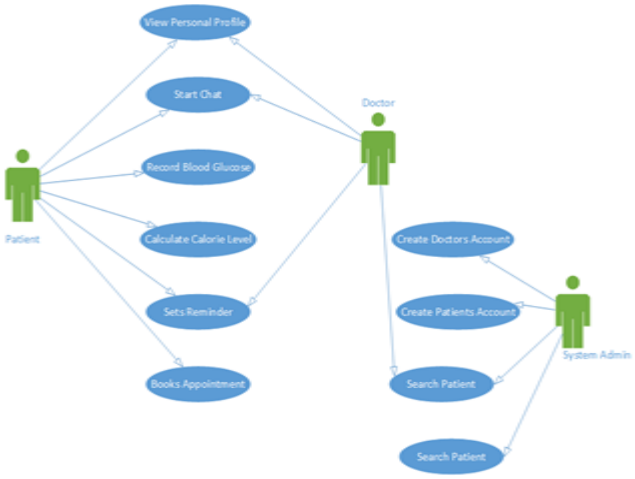

Figure 9: Use-case diagram

Table 1: Comparison of the existing systems and the proposed system

Properties	Record Management	Record Documentation	Record Duplication	Notification	Reminder (drug regimen and meeting)	Real time chatting	Effective Scheduling
Face-to-face	poor	poor	yes	no	no	no	No
SMS [7] [11]	fair	fair	yes	no	no	no	No
Existing Systems[1][10]	good	good	no	yes	no	yes	No
Proposed System	good	good	no	yes	yes	yes	Yes

5. CONCLUSION AND FUTURE WORK

The primary objective of the Online Support System for Diabetes Management designed was to create a diabetes monitoring system for diabetes patients which serves as an adjunct to the health care needs of the patient, and a monitoring tool for the health workers. Also, it is important to note that the target users are diabetes patients and the interface designed in this work was appropriate for their use. The proposed online support system for Diabetes Management accomplished all of these objectives but is limited to being a web application. Users who cannot access the web on a regular basis must have an alternative way. However, further work is recommended on developing a mobile-based Online Support System for Diabetes Management that can be synchronized with the data on the web application. Consequently, intelligence can be built into future systems to assist doctors in decision making and big data analytics is recommended to aid in predicting what may happen next based on the available records of patients over time.

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