REAL TIME DECISION SUPPORT SYSTEM FOR DIABETES MANAGEMENT

نظام يدعم اتخاذ قرار فوري لإدارة مرض السكر

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ABSTRACT

Diabetes is one of the most prevalent chronic mellitus which occurs when blood glucose (sugar) increases more than normal. Diabetes management has been playing an important role on preventing or delaying occurrence of the life threatening diabetes complications. By providing a roaming operation environment, internet healthcare technologies can bring efficiencies and convenience to both diabetics and relative medics on diabetes management. The remote monitoring of patients is considered an important tool in facilitating improvements in diabetes care. The system will be focusing on diabetes which results from the body makes some insulin but cannot use it properly . The patients will have access into database to enter their medical readings and queries which related with their chronic illness and they will able to receive the latest developments and recommendations to take careful and follow the medical advice by practitioners. The system will gather their medicinal data and these data will be held on a database and the system will process these data to progress of the patients. It will allow the health care provider, to make a formed healthcare decision based on the collected data. The readings of diabetes and recommendations of treatments are sent to the patient and their general practitioners. This system will have the potential to reduce healthcare costs and increase patient program compliance. It is efficient to both patients and physicians. The aim of this paper is to build of a diabetes web-based management system. It will design and develop a generic framework of real time decision support healthcare system for monitoring diabetes management. Also it will have the potential to reduce healthcare costs and increase patient program compliance. It is efficient to both patients and physicians.

الخلاصة

مرض السكري هو أحد الأمراض المزمنة الأكثر شيوعا والذي يحدث عندما تزداد نسبة السكر في الدم عن معدلاتها الطبيعية. وقد لعبت أدارة مرض السكري دورا هاما في منع أو تأخير حدوث مضاعفات المرض التي تهدد الحياة وذلك من خلال توفير تكنولوجيات الرعاية الصحية عبرالإنترنت والتي بامكانها ان توفر الراحة والكفاءة لمرضى السكري ولمساعدي الطبيب المشرف على إدارة المرض. تعتبر مراقبة مرضى السكري عن بعد أداة مهمة في تحسين وتطوير رعاية هذا المرض. وان هذا النظام سيركز على مرض السكري من النوع الثاني الذي فيه يفرز الجسم بعض الأنسولين ولكن لا يتمكن من استخدامه بصورة صحيحة. وهذا النظام سيمكن مرضى السكري من الوصول إلى قاعدة البيانات لادخال قراءاتهم الطبية واستفساراتهم التي تتعلق بمرضهم المزمن وسيكونون قادرين على الحصول على اخر تطورات مرضهم لاتخاذ الحذر واتباع النصائح الطبية من قبل الممارسين. حيث سيقوم النظام بجمع البيانات الطبية لمرضى السكري (blood pressure, glucose and wieght) ومعالجتها في قاعدة بيانات النظام لتعرض للمرضى على شكل مخطط او جداول بقراءاتهم الطبية حسب التسلسل الزمني للادخال وسيمكن النظام مجهزي الرعاية الصحية من اتخاذ قرار يستند على البيانات التي تم جمعها من المرضى. وسيتم إرسال قراءات المرض وتوصيات المعالجة إلى المرضى والعاملين. ان الهدف من هذا التقرير هو بناء نظام يعتمد على شبكة الانترنت لإدارة مرض السكري. وهذا النظام سيصمم ويطور هيكلا أو اطار عاما يدعم نظام الرعاية الصحية على اتخاذ قرار فوري لمراقبة وادارة المرض.
هذا النظام سيوفر القدرة على خفض تكاليف الرعاية الصحية وزيادة التزام المريض ببرنامج المعالجة. أي انه فعال وكفوء لمرضى السكري واطبائهم .

Introduction

Diabetes mellitus is estimated as one of the major chronic diseases and a growing public health problem in the world. This disease increases a patient's risk of developing multiple health complications such as heart and kidney failures. However, these implications can be significantly reduced by controlling the blood glucose level. Recent research states that using new and emerging technologies in the areas of telecommunications, wireless networks and handheld computers, indicate a considerable qualitative and quantitative improvement can be achieved for the effective and timely diagnosis and treatment of diabetes patients specially in controlling the Glycemic and associated blood pressure levels, with a subsequent improvement in cost effectiveness and healthcare management. The system is to provide improved diabetes management system and to empower the diabetes patients through the internet. The aim fo this system is to design and to implement a generic framework of a real time decision support in healthcare for diabetes monitoring management system as shown in Fig.1. It will reflect the ongoing challenges of providing patients with better access to, and involvement in their own care. It is a design and build of a diabetes web-based management system. The system will gather medicinal data from patient. These data will be held on a database and the system will process the medical data to statistical data for progressing of the patients. It will allow the health care provider, to make an informed healthcare decision based on the collected data. The system will identify the blood sugar levels and blood pressure and manage the treatment by recommending and monitoring food consumption, physical activity, insulin dosage, etc., the readings of diabetes and recommendations of treatments are sent to the patient and their general practitioners; so that the patient can better manage their condition [1]. Also the sytem aims to test and evaluate the clinical database.

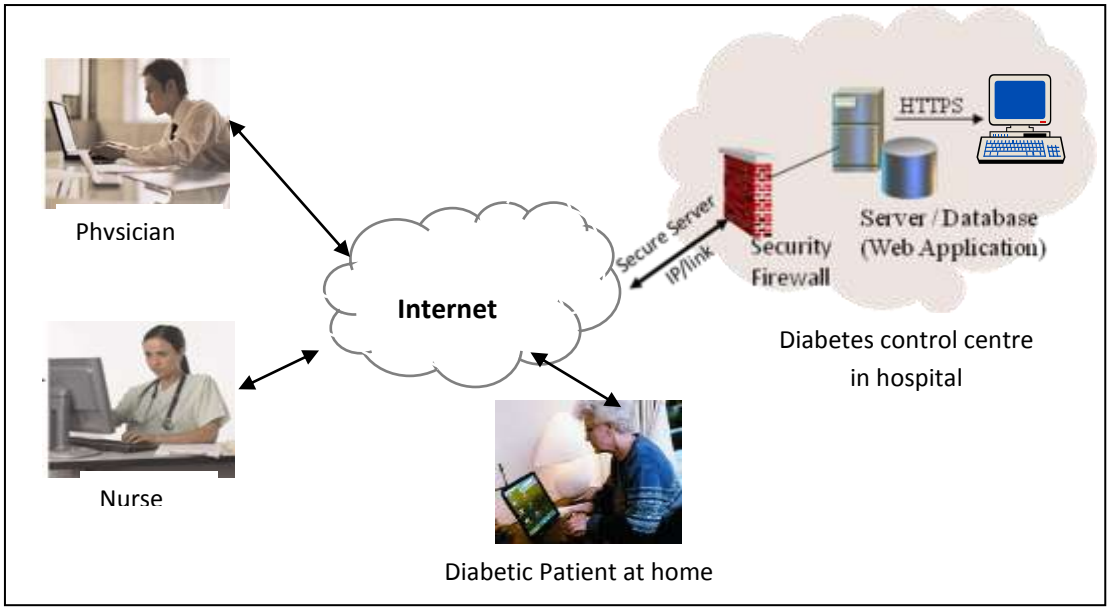

Figure 1: System architecture for diabetes management

System Scope

The scope of this system is to design a reliable and fully functional web-based diabetes monitoring system. There are two main types of users; the patient, and healthcare provider such as nurse, physician, admin, and technician as shown in Fig.2 The proposed system will allow the nurse to create/edit/update and search patients and any information associated to the patient. Each patient record will have an associated patient profile detailing the medical program the patient. The system should allow the nurse to add new sensor reading blood sugar to the system. It will hold information such as medical history, notes concerned with a patient held on the database. The patient will have access to the patient side of the system via the internet. Where there will be able to add their sensor reading to the system database. In addition, the patient will have the ability to review their past medical readings and receive the suggestion that been recommended by the nurse or physician by email. When the nurse creates new patient account, she will set a reference blood sugar values (high and low) to that patient and the time should the patient enter to the system, in order to compare it with the daily measurement of the blood sugar level and blood pressure, and representing these data in tables and statistically; if the ratio outside the limit, the system alert be email the nurse. Also the system will allow the nurse or physician to inform them whether no enter value of blood sugar of patient or it is bad (abnormal) and allow them to send their recommendations to patient email when there are abnormal readings. The system must have an admin user account. As an administrator will have full control over software maintenance and registered users.

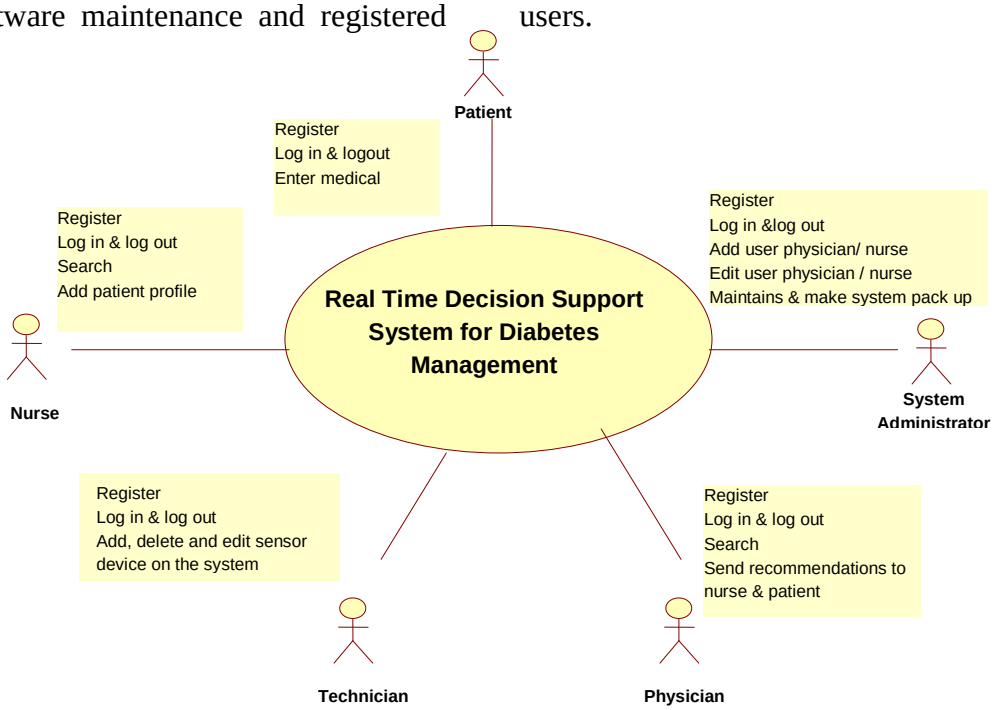

Figure 2: Scope of website develop for diabetes management

Method and System Analysis

To develop the prototype of diabetes system; it is important to attain details requirements from the stakeholder wich are physicians, nurses and patient/family involvement throght structured interview to understand the functional and non-functional requirements of system, identify the different users and their interaction which will be with the system and clarify anything ambiguous in the system.

The functional and non-functional requirements of the system were captured using the Volere requirement specification template. The Agile approach was chosen as the lifecycle in the development of diabetes management sytem, as shown in Fig. 3. To develop and fulfil the sytem objectives, we will use DSDM (Dynamic Systems Development Method) Atern which is development methodology originally based upon the Rapid Application Development Methodology, it is an iterative and incremental approach that emphasizes continuous user involvement and delivery of sytem s at the right time without any delay. In this approach each of time, cost and quality are fixed at the Foundations Phase while contingency is managed by varying the features to be delivered; contrary to the traditional approach, the feature content of the solution is fixed while time and cost are subject to variation. The diabetes system will be build modularly; the parts of the system will build first and then the system will be improved by adding new features.

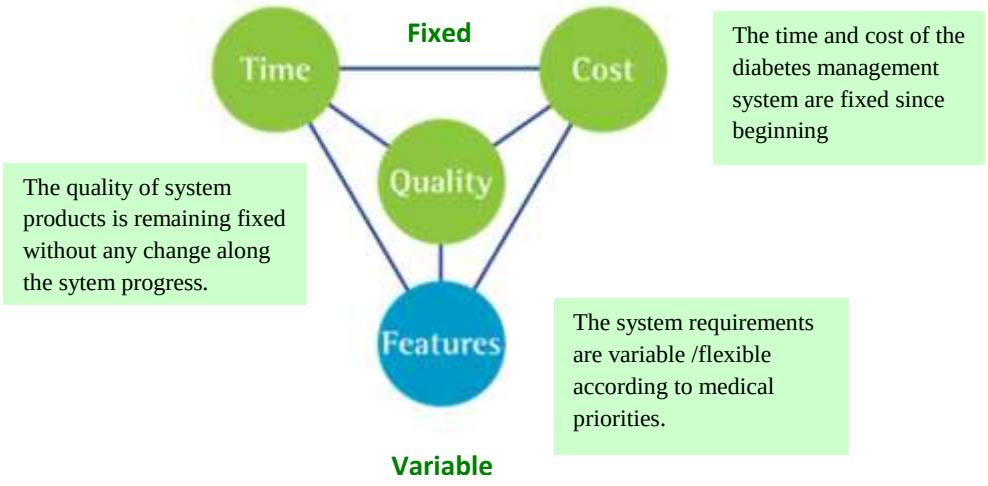

Figure 3: Atern approach for diabetes management

According to DSDM Atern, the diabetes management sytem will across within seven phases during its lifecycle as shown in Fig. 4:

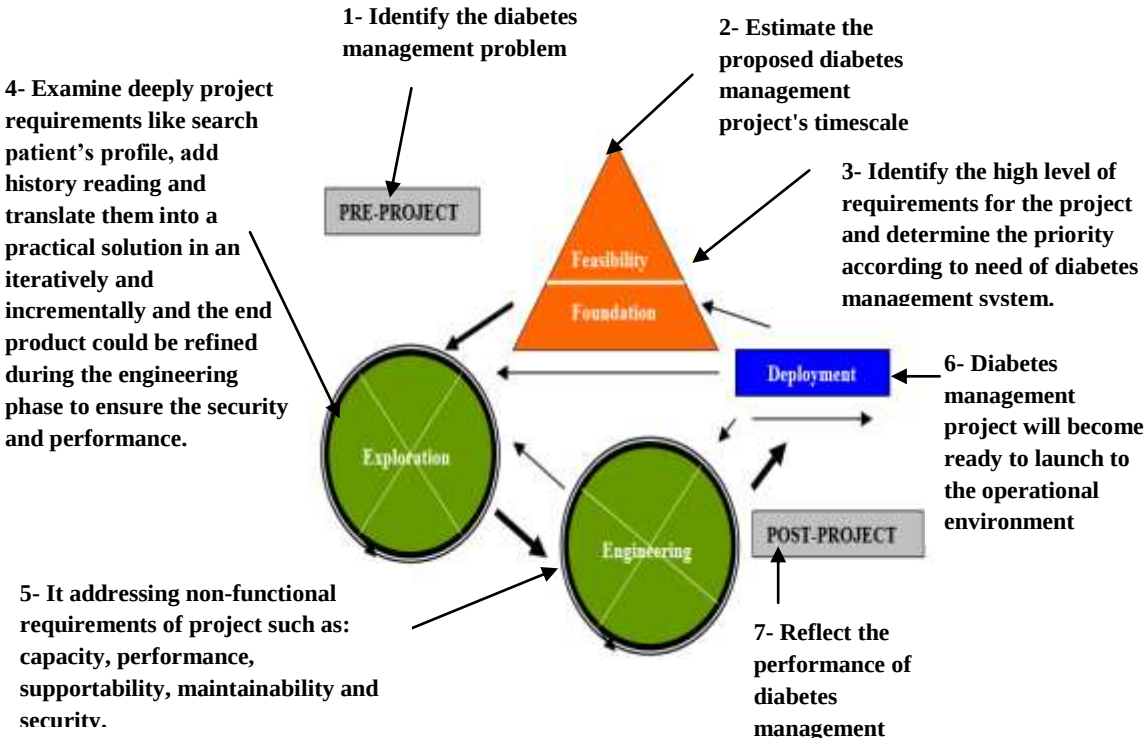

Figure 4: The system Lifecycle

Requirements and User Analysis

In diabetes management and decision support sytem , all requirements will prioritise according to their medical needs e.g. for viewing the physician's/nurse's recommendations and notes regarding to patient's history readings, it can view them on patient's profile without needing to send these comments to patient's email. These priorities defined before any work is started with reviews taken continuously as work is in progress. If a new requirement should arise or an unexpected turn happens, an evaluation must be made of how critical these new requirements are to the success of the current solution by using MoSCoW [2]. Throughout diabetes system, each requirement passes through four life-cycle stages as follows: Elicitation, Analysis, Validation and Management phase.

In web site of diabetes management system, five users were identified like: patient, physician, nurse, technical and admin. Table 1 in appendix A shows the role of one of actors in the system.

- **Output UML Sequence Diagrams**

Modelling and prototypes will be used to describe the functional requirements of the diabetes management system and the conditions for the proposed solution. Process models of diabetes management task designed by using the Unified Modelling Language (UML) as a process modelling technique for representing the using and impact of diabetes management system features within the monitoring. In the last stage, the software should be tested to know failures and faults throughout the development cycle before final release [4].

Use Cases Model also is used in this system to identify the diverse actors and on completion of this it is possible to establish the functional requirements of the final system. It allows the definition of the system's boundary, and the relationship between the system and outside of the system [5].

- **System Requirements**

Requirement is a service, feature or a function that the user desires the solution to perform or display. Diabetes system should meet both user and business needs. These requirements should be flexible according to the business needs. However there are two types of requirement in diabetes management system, functional requirements which is described as set of inputs, the behaviour, and outputs of the system, such as: Create patient account, create patient profile, edit patient profile, add reading, search user, add user, edit user, and send email, etc. Table2 in Appendix A illustrates one of the functional requirements of the diabetes management system.

Another type of system requirements is Non -functional requirements which are used to specify criteria that can be used to judge the operations of a system rather than specific behaviour. They describe what level, with what security, usability, Performance, reliability, maintainability and legislative [2]. Table 3 in Appendix A illustrates one of the Non-functional requirements of this system.

Method of Volere Requirements Specification was also is used in this system to detect the perfect medical requirements that match the connection to all components in the system, which causes the need for understanding and discovering requirements and connecting them to solutions. This consideration should be understandable by different users in this system [6]. Volere has three groups of interconnected components which are include the medical protocol knowledge requirement, the clinical requirements process and the healthcare provider requirements.

In addition Fit Criterion was used in the system to determine whether the medical information requirements were met and satisfied the healthcare needs in order to be more efficient and easy to use [7].

System Design

System design is the process of defining the diabetes management system architecture, medical components, functions modules, user interfaces, and medical data for a system to satisfy specified requirements. Its purpose is to create a technical solution which satisfies the system functional requirements [8].

A use case model is a description of a system's behaviour from a users' standpoint by using actions and reactions. It allows the definition of the system's boundary, and the relationship between the system and outside of the system [5]. It was used to identify the different actors and on completion of this. In diabetes management system, there are five actors in the use case diagram, and each actor has a particular role in this system. Use case model and use case text were used to design the system. Fig. 5 in Appendix B shows the diagram of use case models, five use case models were created in the diabetes management system can be found.

Use Case Specification

Use Case Specification/ text defines the actions flows which follow after the function has been triggered by the system user. It describes the functionality of the system counting event trigger and expected outputs. Many use cases found and a use case specification was draw up for each use case. Table 4 in Appendix A illustrates the detailed description of a Use Case Specification for one of the functional requirement.

The architecture of diabetes system design was determined by establishing the three tiers involved when designing web based system [9]. These tiers are Presentation Layer, Business Layer, and Data Layer. The interaction between the layers will be tasted to ensure all are communicating with each other.

- **Database design**

The clinical database design methodology is divided into three main phases; conceptual, logical and physical design [10].

The first step in the design methodology is the conceptual design; Fig. 6 in Appendix B shows the diagram that describes the relation and the connectivity between all components identified in the system.

The next step of design methodology is to produce a logical data model that driven by the conceptual data model based on the identified set of relations between classes. The logical data model consists of specified classes that will become tables, their attributes became fields, and the associations became relationships. Also it was essential to identify primary and foreign keys and any constraints to impose data integrity.

Then the final phase of the database design methodology is to translate the logical database design (the entities, attributes, relationships, and constraints) into a physical database which can be implemented using the target database management system (DBMS). The physical design will specify the system usability such as screen layout and patient menu structure.

In order to validate the derived relations to ensure are correctly structured and implemented, a technique of normalization is applied. This technique begins by examining the relationships (called functional dependencies) between attributes. This phase will produce the workable tables as shown in table 5 in Appendix A which will create SQL statements to be used in the database through implementation stage.

Since the database design have been finalize, the next step in the project is to design the user interface (UI) to enable the user to use the system. The diabetes management system is designed with a simple interface for user operation with the ability to use system in an increasingly dynamic fashion [11].

Implementation Tools and User Interface Design

The implementation process will conduct after the design specification. The implemented design tool of the system which includes the web design tools connected to database. The outlines of the tools used to implement the diabetes management system are: MySQL database was implemented in the design of the health information database, which supports large number of users' access, and (turned to optimise transaction processing for a fast and efficient processing of statement, whereas the database interface (presentation layer) was designed based on HTML and CSS. PHP also was used as a server side scripting to connect the user interface to the system provides a relevant management services to both patients and physicians. These tasks can be accessible by users through simple interfaces, such as:

1- Interface to login onto patient interface as shown in Fig. 7 in Appendix B.
2- Interface for re-entering the correct user name and password. Whereas the patient entered wrong user name or wrong password.
3- Interface to edit patient details as shown in Fig.8 in Appendix B.
4- Interface to confirm that the patient details have been successfully updated.
5- Interface to add the medical readings of the patient such as, blood pressure, glucose, and weight, as shown in Fig. 9 in Appendix B.
6- Interface to confirm that the added reading has been successfully.
7- Interface appears when the user adds new patient.
8- Interface appears when the system highlights the fields that required data input, in red colour during system validation.
9- Interface to add new data types to the diabetes management system database. Then these data are assigned to a sensor type as shown in Fig.10 in Appendix B.

Results

Results of system include the outputs from the implementation phase as follows:-

1- Showing the added new readings of blood pressure: After the patient login successfully. Fig. 11 in Appendix B shows the screen of the patient profile will appear. It will permit the patient to view their previous readings.
2- When the patient select sensor type" glucose" , and then press on "refresh" the screen will appear to show the history readings of glucose as shown in Fig. 12 in Appendix B.

3- When the patient select sensor type" weight" , and then press on "refresh" the screen will appear to show the history readings of weight as shown in Fig. 13 in Appendix B.
4- The Dashboard of a physician or a nurse as shown in Fig. 14 in Appendix B illustrates the list of patients associated to that physician or nurse logged in; the dashboard could filter the patients list. The system has two types of nurses associated to the patient, either visiting or individual nurse, therefore this page shows the option of filtering out the patient either located to visiting nurse mode or individual mode. However when the nurse selects the patient record from the list, this will be moving to the page of patient profile.

System Testing and Evaluation

To improve the quality of system products, serious tests conditions were taken from "Fit Criterion" and included in the section report which was defined in the volere requirements shell. The strategy of test involved two tests : Unit testing which is against the three tiers architecture of the system which includes: Data Layer, Business Layer and Presentation Layer; and system testing which is carried out to evaluate the diabetes management system's compliance with its specified requirements [12]. Also to validate the system requirements, we used scenario-based testing method to all functions involved in the diabetes management system in order to improve function implementation and linking. However, both the white box testing that requires, the tester will deal with the codes as knowledge of coding and logic is necessary i.e. internal working of the code; and the black box testing which focused on the testing for requirements and functionality of the work product/software application [15].

Heuristic evaluation method also is used to assess the design of diabetes management system as it is a fast and simple evaluation of a user interface design to other usability techniques [13, 14]. Performance usability tests in diabetes management system carried out to ensure that the objectives of usability were met. Throughout all phases of system testing, the same group of volunteers will be used for that. Table 6 in Appendix A shows the observation of heuristic evaluation used in the testing of diabetes management system, the rating system that used to rate the severity of usability problems, as follows:

0= there is no usability problems
1= surface problem only: if there is extra time in project, fixed it.
2= small usability problem: should be given low priority to fix.
3= major usability problem: it is essential to fix, therefore should be given high priority. Table 6 in Appendix A shows the observation of heuristic evaluation of the system. Usability testing technique also is used in the system to evaluate a medical product by testing it on real time [16].

User acceptance testing (UAT) considers the final step in diabetes management system before the end of application. The volunteers were divided into three groups: user interface (patient, nurse, and physician), technician interface and administrator interface). The numbers of different scenarios were tested by the volunteers were 17; and the results of this test based on a set of scenarios. The interface of patients will be basic and will include, view profile, change in information of profile, add readings and view diagnosis [17]. Tables 7, 8, 9 in

Appendix A show some of testing groups 1, 2, 3 users. And Table 10 shows the diabetes management system tested based on the defined requirement. However, after the 17 different tests were carried out to assess the usability of the user interface, we found the different activities were simple and easy, and mostly the system passed the usability test phase.

For Evaluation diabetes management system 30 tests of diabetes management system included 21 functional requirements and 9 non-functional requirements which have been carried out by the volunteers and after collecting their feedback; there were just 4 requirements failed due to some errors in coding such as: 1) The search for user failed. 2) The process of reminder failed to send. 3) Modify patient incorrect reading entered to the system failed. 4) Add users (Physician and nurse) failed as the system failed to create account. While 4 requirements were considered out of scope of the project, like: 1) The system cannot send a text message to the patient's mobile to remind them to take their medical reading at specific time, the system cannot backup the database regularly every 24 hours to prevent loss of data. 2) The system cannot add sensor device to the database. 3) The system cannot be compatible with multiple web browsers. In general the results which have been taken off carried out tests in this project were positive. The chart in Fig 17 illustrates the ratio of the conditions were passed the tests successfully.

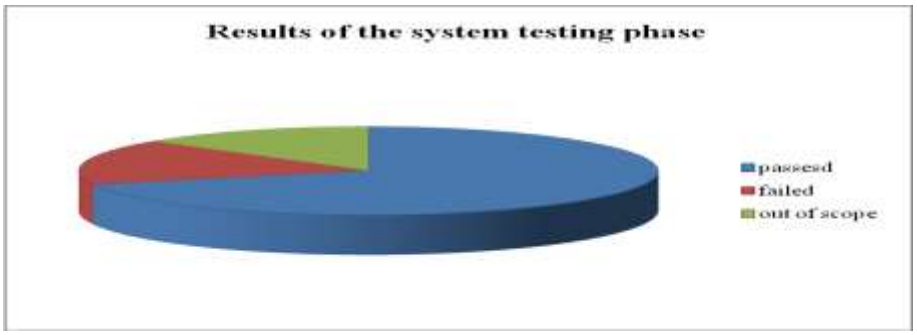

Figure 15: Results of the system testing phase

Conclusion

This research has been presented the design and implementation of real time decision support system for diabetes management care. The aim of this work was to provide a description to the basic building blocks involved in the internet diabetes disease management system. The diabetes management system was provided the patients with accurate and reliable ways of caring for themselves, outside a hospital or doctor's office. It will gather medicinal data from patient. These data will be held on a database and the system will process the medical data to statistical data for progressing of the patients. It will allow the health care provider to make an informed healthcare decision based on the collected data. The system will identify the blood sugar levels and blood pressure and manage the treatment by recommending and monitoring food consumption, physical activity, insulin dosage, etc., the readings of diabetes and recommendations of treatments are sent to the patient and their general practitioners; so that the patient can better manage their condition in the other words the patient can be the better self Management monitoring. It will also allow the health care provider detect and subsequently diagnose the problem earlier and avoiding problems later. This will also help the health care provider improve the care they provide to their patients.

Recommendations

After different tests which have been carried out in the diabetes management system, there were many recommendations to improve this system as the following:

1. Using some explanations with graph to aid understand/digest information.
2. The use of a simple instruction could improve navigation from one page to another.
3. To facilitate edit for the sensor type, the serial number of the medical device will need to be selected. Therefore, on selection this displays a drop down list of all the sensor types, with some instructions that would help to make this procedure clearer.
4. In the search process for a patient record and as the database grows in size, entry of more than one matching field is required, i.e. surname or post code. This will allow the search to be narrowed and prevent a larger search result.

Future work

For future improvements to the diabetes management system some functionalities requirement will add to the system such as:

1. Enhanced Multiple Chronic Disease Management.
2. Clinical Studies for Medical Validation of the system.
3. User activity logging and system recovery.
4. SMS Reminder.

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Appendix A

Table 1: Role of patient

Actor:	Patient	
Role:	The patient will access the site in order to enter personal health records. As well they will use it to add medical reading according to the schedule that has been setup by nurse to see the history records and comments.	
Characteristics:	Knowledge Domain	The patient will have a basic conceptual understanding of the system.
	Technician Expertise	A typical patient has simple technical skill. They will likely have experience in using the net and other application like word processing and email.
Activities:	✓ Input medical reading. ✓ Comment on any symptoms. ✓ Update personal information (i.e., address, mobile number).	

Table: 2 Functional requirements

Requirement ID: FR.1 **Title**: Add new Patient Account **Type**: Functional Requirement **Descriptions**: The system must permit the nurse to create new patient account. **Rationale**: The system enables the nurse to create new patient account which includes the entry of personal information e.g. name, address, and mobile phone. **Fit Criterion**: A sample of tests will be arranged. During the test a compression between the actual system record and expected result in order to check the system saved correctly.

Table 3: Non-Functional requirements

Requirement ID: NFR.1 **Title**: Performance (response time) **Type**: Non Functional Requirement **Description**: The system must have a fast reaction time to avoid the user from thinking, e.g. to record a new patient that must not take more than 5 seconds as well the patient must be able to view the results of history medical reading also within 5 seconds. **Rationale**: To make the system is more efficient and the user can do many tasks quickly. **Fit Criterion**: The admin performs a check with respect to the time of the tested function. Taking into consideration the response time spent to access on the system.

Table 4: Use Case Specification

Use Case Name: Add Patient Readings		
ID: 20		
Brief Decryption	The Patient tries to add a reading to the system database.	
Primary Actors	Patient	
Secondary Actors	Nurse, Physician	
Precondition	Login to the system.	
Description	step	Action
	1	When the patient selects add Readings from the menu, The use case will start.
	2	Add readings form will be loaded b system.
	3	The patient will enter the necessary fields.
	4	The patient will press on the submit button.
	5	The system will validate the inputted data.
	6	The system will add the new readings to the database.
	7	The system will inform the patient that the readings were successfully added to the system.
Priority	Must	
Performance	Response from system	
Channels to actors	Online	
Post Conditions	Successfully added the reading to the medical database.	
Alternative Flow	Entering Invalid Data.	

Table 5: Tables contents

No.	Table	Brief
1.	Patient Contact	It contains information related to the patients.
2.	Patient Details	It contains information related to the patients' personal details.
3.	Patient Profile	It contains information related to the patients' profile.
4.	User	It contains information related to health care workers.
5.	User Account	It contains information related to the user account details.
6.	User Assignment	It contains information related to health care workers of patient profile.
7.	Notes	It contains information related to the patients' notes.
8.	Treatment Notes	It contains information related to medical notes for a particular patient profile.
9.	Device	It contains information related to the sensor devices.
10.	Data Type	It contains information related to the various data types that build up a sensor type.
11.	Sensor Type	It contains information related to the sensor types.
12.	Sensor Assignment	It contains information related to the sensor type assignment to a patient profile.
13.	Weight	It contains information related to the weight readings taken from patients.
14.	Blood Pressure	It contains information related to the blood pressure readings taken from patients.

15.	Glucose	It contains information related to the glucose readings taken from patients.
16.	Reminder Scheduled	It contains information related to the schedule to remind the patient.
17.	Reading Range	It contains information relating range set to a particular sensor for patient.

Table 6: Observation of heuristic evaluation

No.	Observation	Notes	Rating
1	System status visibility	-Good user feedback after action. - System uses mandatory fields that have not been entered by the highlighted field.	0
2	User control and interface	-The menu permits the user to leap into a task very quickly with minimum number of clicks.	0
3	Prevention of error	-when error occurs, validation to promote user will be used.	0
4	Readability and view	-All buttons are clearly identifiable.	0
5	Flexibility and efficiency in using	-The menu permits flexibility.	0
6	Consistency and Standards	- Consistency of forms layouts. - Right positions of buttons location.	1
7	System and real world matching	- Use proper field names. - Use suitable graphic presentation. - Use of easy language that will be common to the user.	2
8	documentation and Help	- Availability of user manual.	3

Table 7: shows some of testing group 1 user (nurse, physician, and patient).

User	Activity	Level of Importance	Description	State	Notes
User-1	Login	High	The user can enter the system.	Pass	Access to the system when Successfully logged.
User-2	Create New Patient	High	The user can create a new patient account.	Pass	A feedback message appears shows “a new patient has been successfully added”.
User-3	Modify patient details	Medium	The user can update details on the patient’s profile such as address changes, Telephone No.	Pass	A feedback message appears shows “changes were made successfully”.

Table 8: shows some of testing group 2 Administrator

User	Activity	Importance	Description	State	Notes
Admin-1	Add new user	High	The administrator can add a new user	To be tested	A feedback message appears “a new user has been successfully added.
Admin-2	Update exiting user	Low	The administrator can update exiting user information.	To be tested	A feedback message appears “exiting user information has been successfully updated”.

Table 9: shows some of testing group 3 Technician

User	Activity	Level of Importance	Description	State	Notes
Techn.1	Add new sensor device	Low	The technician can add new sensor device to the system	To be tested	A feedback message appears" the new sensor device has been successfully added".
Techn.2	Delete sensor device	High	The technician can delete new sensor device	To be tested	A feedback message appears "sensor device has been successfully deleted".

Table 10: System Testing

Require ments	User	Level of Importa nce	Condition	Notes
FR-2	Nurse	High	The nurse should be able to create a new patient profile	When the validation is complete, the system notifies the patient that the record has been successfully added.
FR-7	Patient	Medium	The patient should be able to add their readings to the database.	This validation to ensure the correct medicinal information is inputted and to avoid inadequate information being entered
FR-9	Phys.	Medium	The physician should be able to add reminders	Reminder will be placed to the patient for a particular time to define when each reading must be taken.
FR-11	Admin.	Medium	The Admin. should be able create new accounts for users.	The system able to add relevant data for new account to the database tables.
FR-17	Technic ian	Low	The Techn. Should be able to add new sensor devices.	The system able to add relevant data for new sensor type to the database tables.
FR-21	User	Medium	The user should be able to view the medical readings which entered in a graph format.	The system able to present a graph generated to the data over a specified period.
NFR-3	Usa-bility	High	This system must be easy to navigate the required data with friendly interface.	The system provide friendly interface to be easy to navigate the medical data through it.
NFR-5	Comp-atibility	Medium	The system should be compatible with multiple web browsers.	The system was run with diverse browsers, like internet explorer, fire fox.

Appendix B

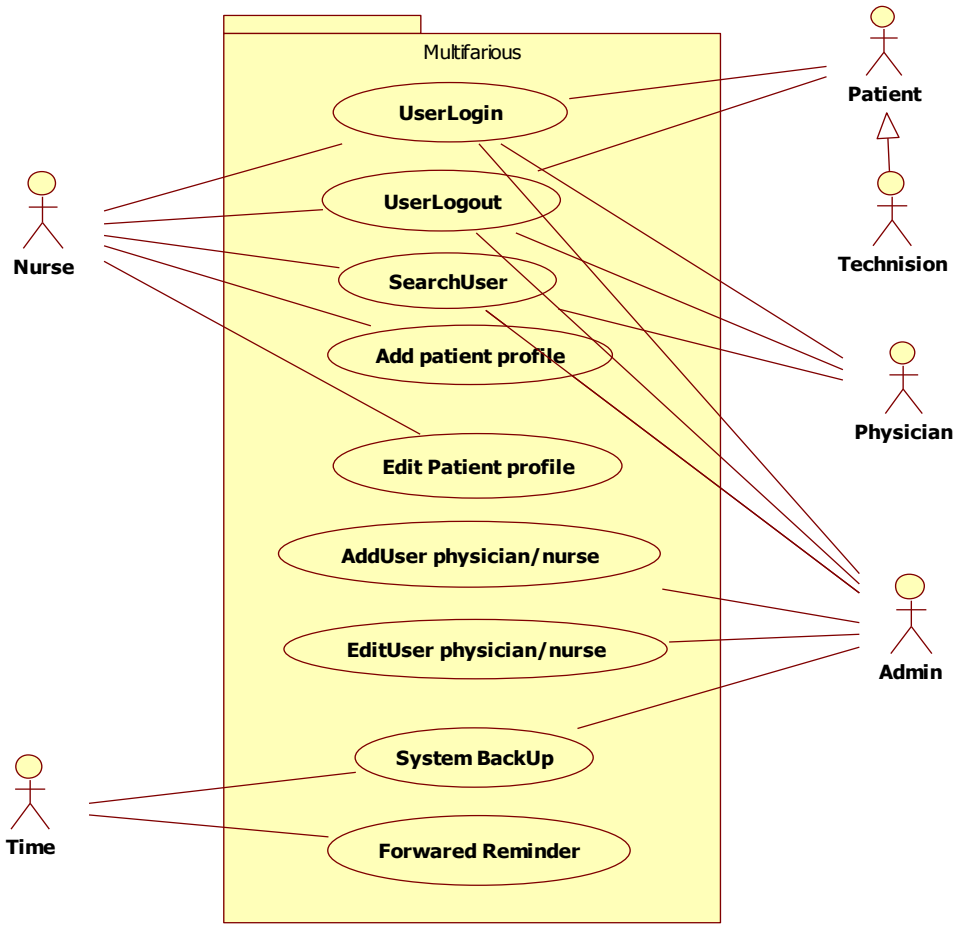

Figure 5: Use Cases Models

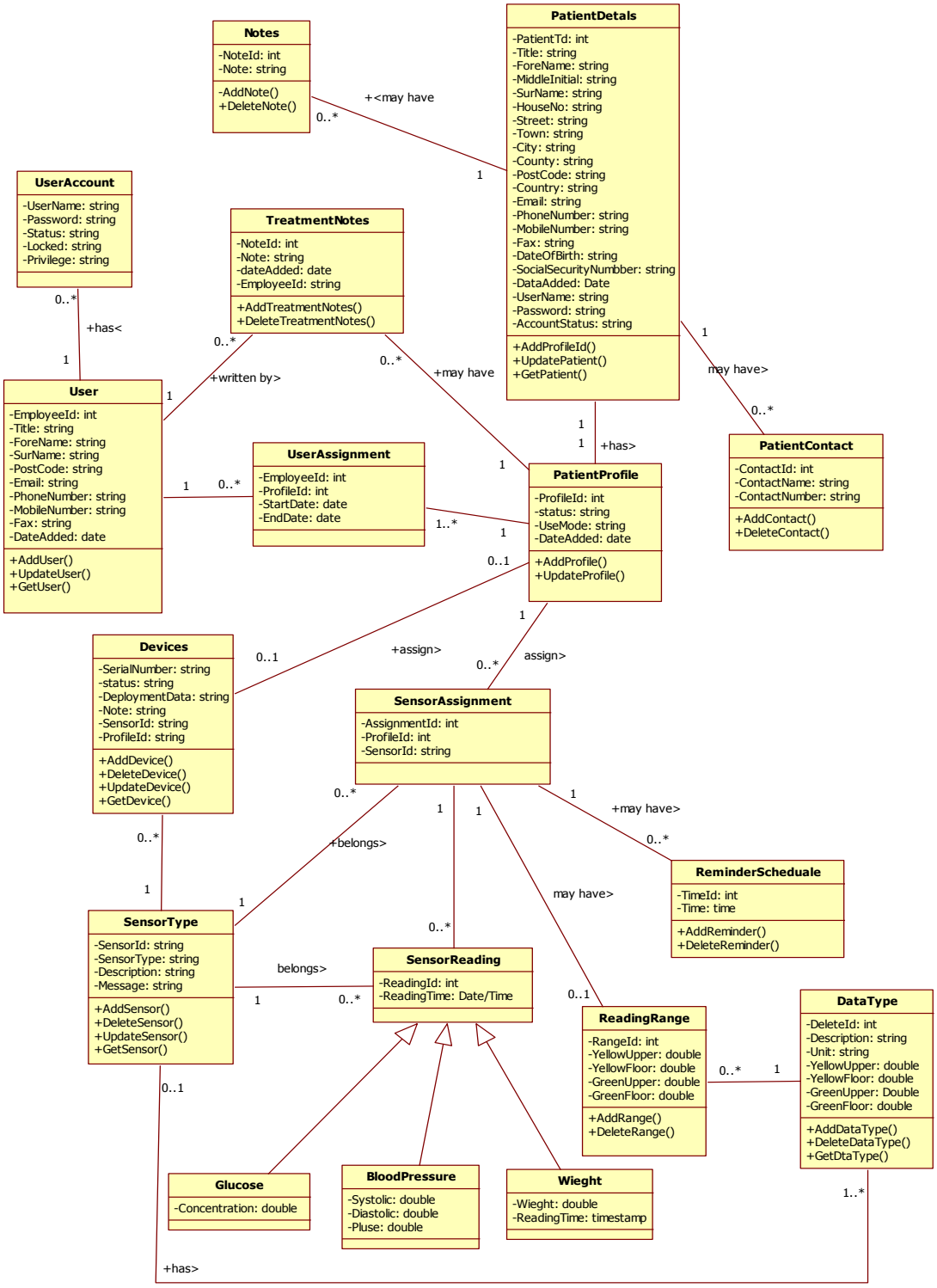

Figure 6: The conceptual design/class diagram shows the attributes with the associations between the classes

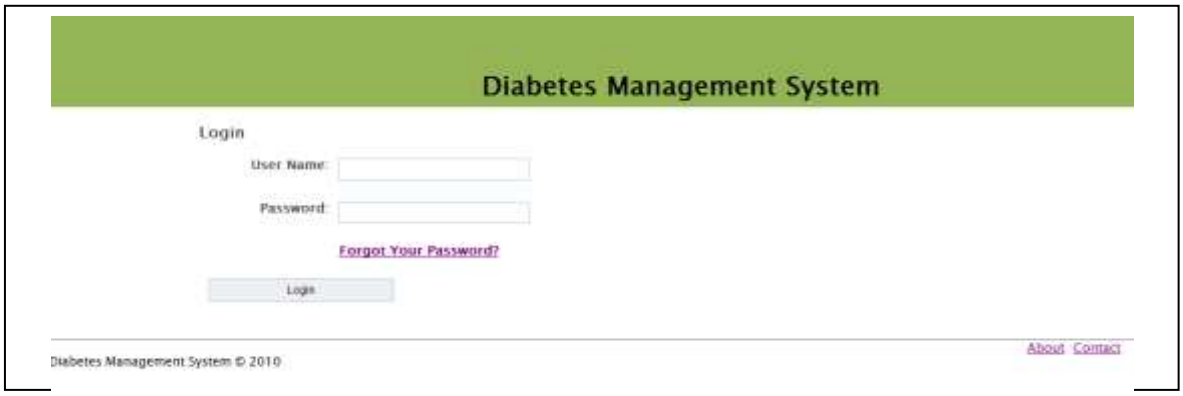

Figure 7: Used by patient to login to the system

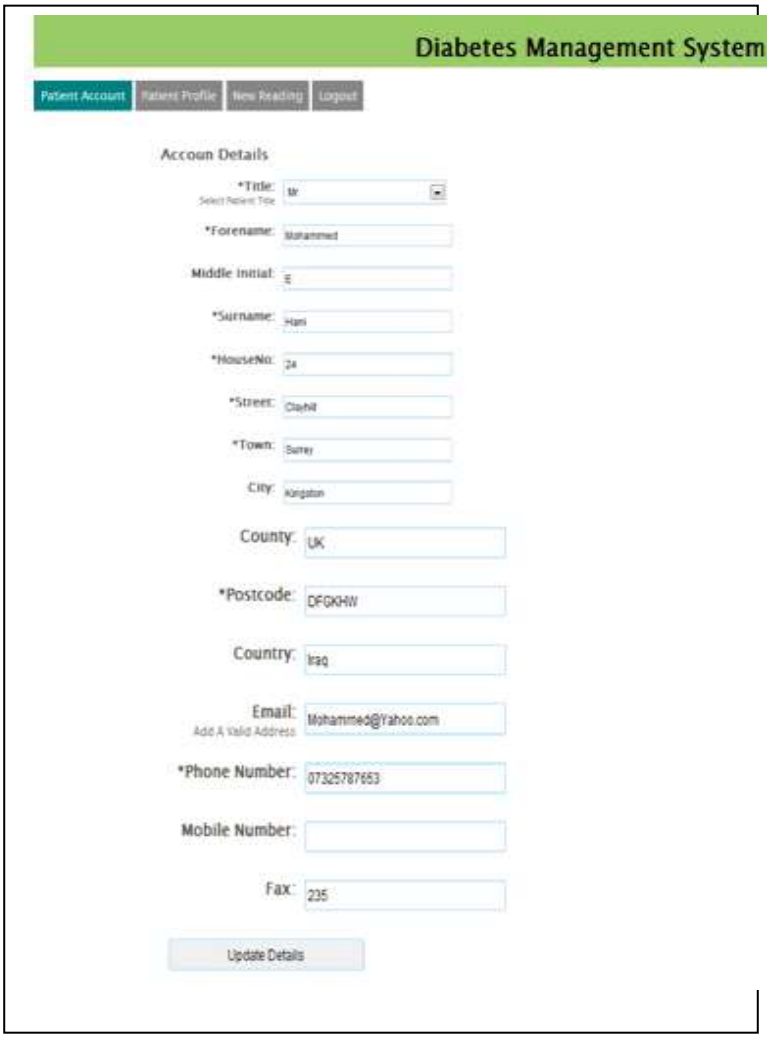

Figure 8: Updating the patient details

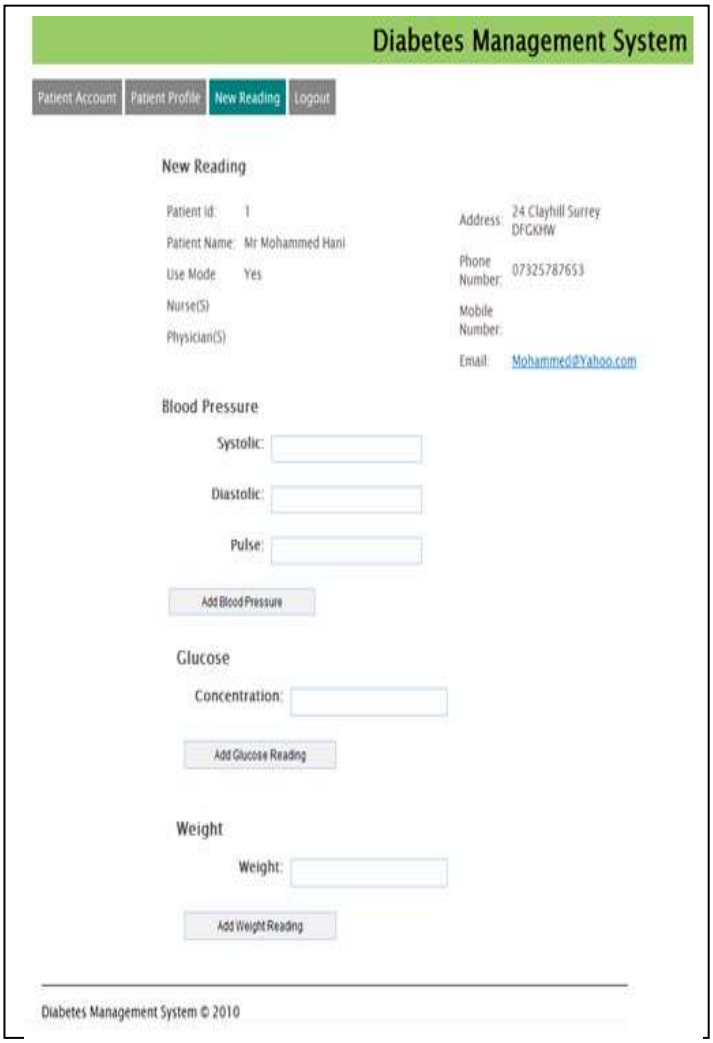

Figure 9: Patient Dashboard, for entering patients' medical readings

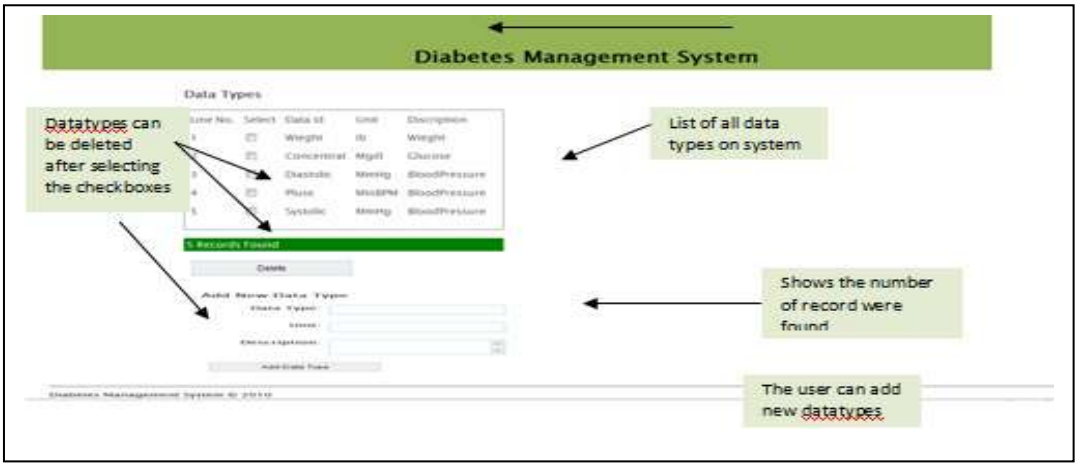

Figure 10: Adding new datatypes to the system

Figure 11: Showing the added new readings

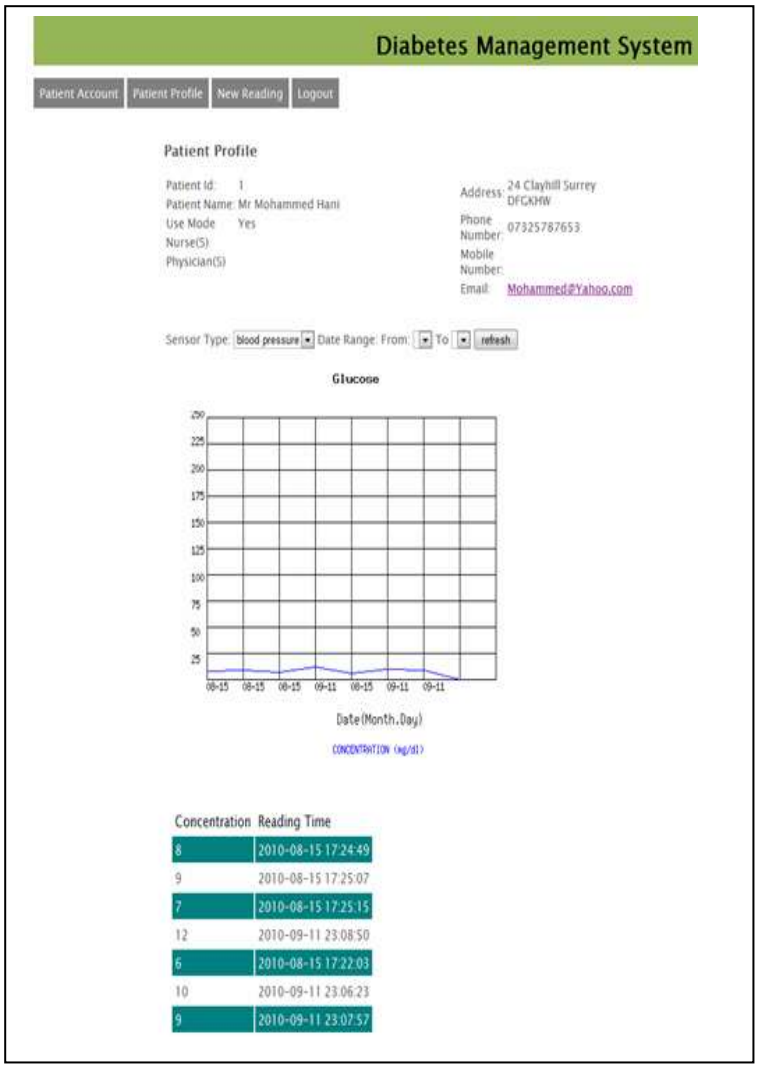

Figure 12: showing the glucose history readings

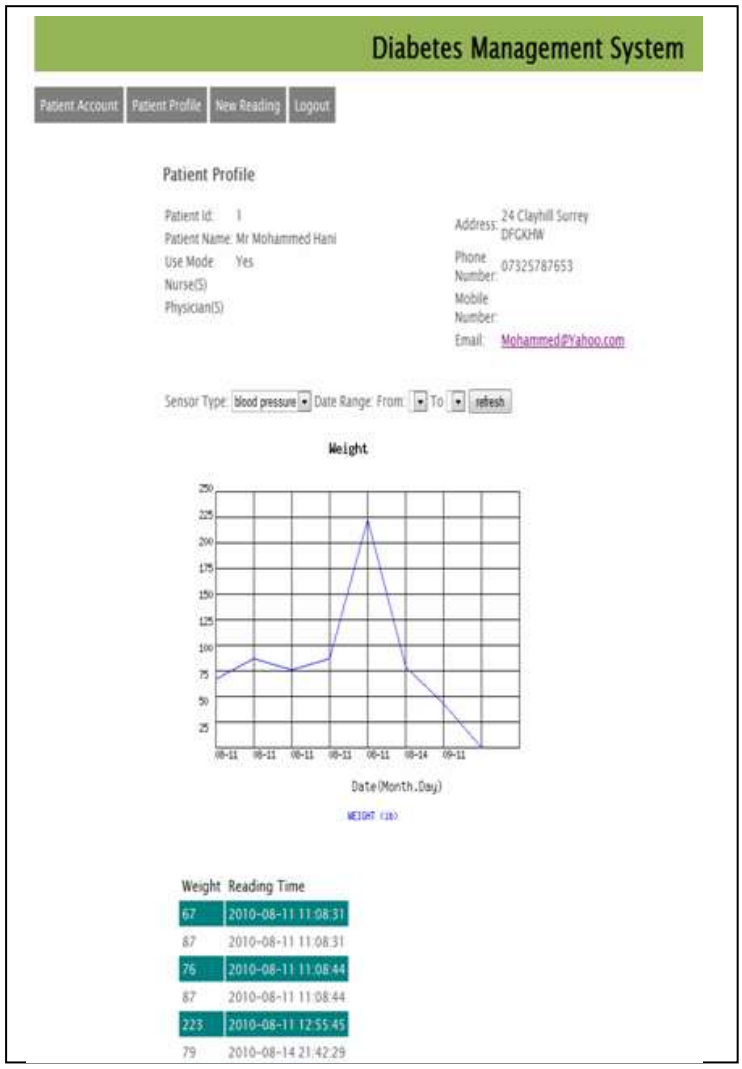

Figure 13: showing the weight history readings

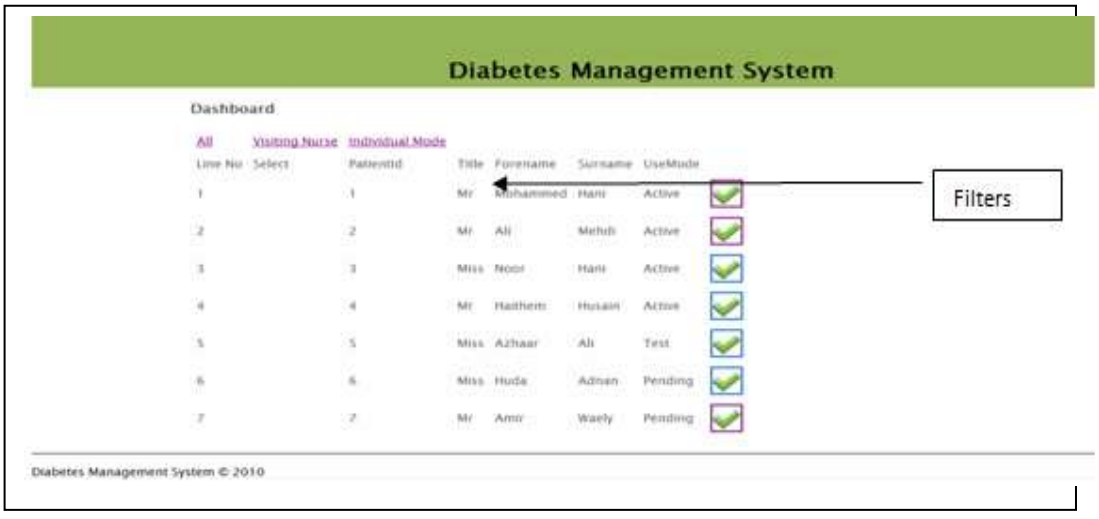

Figure 14: Showing the list of patients' records