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Mobile Healthcare Management System for Diabetes

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***Abstract*— In recent year, the users of smart mobiles increased rapidly, and Onset of diabetes in our daily lives dramatically and thus it became like flu disease for these reasons, we want to build a smart mobile application to help diabetics manage and control their diabetes, and make a self-evaluation by inputting the results of their blood glucose, blood pressure, height, weight, diseases and other variables. There is no need for the patients to be guessing for 3 or 4 months what their A1C results will be[2]. The application will predict HbA1c from daily checking blood sugar levels with a blood sugar monitor, to remove anxiety of the unknown, and help to have a better control of the ups and downs in blood sugar. Control and remind time to take blood sugar tests, medications, make exercise and diet. Store all data taken from inputs, generate graphs for the outputs, and share it with doctors by email, or simply print it. The application is connected with online feeds and brochures about the latest diabetes news, articles, and advises will be delivered right to the mobile between the patients hands.**

Keywords- (Mobile healthcare, Diabetics, Diabetes Self-Management , Mobile Phones , mhealth)

I. INTRODUCTION

More than 200 million people suffer from diabetes worldwide, Onset of diabetes in our daily lives dramatically and thus it became like flu disease and other diseases[1], We want to develop and enhance on patients services in health control management[1] . By producing mobile application for Diabetics on smart mobiles because, In recent year the subscribers of smart mobiles increased rapidly and easy to use for them, this field in m-health research and diabetics have self management on their health the prevention for them better than cure [2],[3].

Diabetes mellitus, or simply diabetes, is a group of metabolic diseases in which a person has high blood sugar Diabetes mellitus, or simply diabetes, is a group of metabolic diseases in which a person has high blood sugar[4], either because the pancreas does not produce enough insulin, or because cells do not respond to the insulin that is produced . There are three main types of diabetes mellitus (DM). Type 1 DM results from the body's failure to produce insulin, and presently requires the person to inject insulin or wear an insulin pump. This form was previously referred to as "insulin-dependent diabetes mellitus[4]. Type 2 DM results from insulin resistance, a condition in which cells fail to use insulin properly, sometimes combined with an absolute insulin deficiency. This form was previously referred to as non insulin-dependent diabetes mellitus[4]. The third main form, gestational diabetes occurs when pregnant women without a previous diagnosis of diabetes develop a high blood glucose level[4]. we want to focus on type 2 of diabetes self management. The Mobile Applications for Diabetes give you a full suite of useful tools in one easy-to-access location. These tools can help you better manage your diabetes and gain the confidence to make healthy, lasting changes in your life[5].

In this paper presents prototype for mobile application which is being design to give many services to diabetics to control and manage on their health ,give them awareness discussion guide to connect them in electronic and fast ways to the doctors by generate graphs and reports sending them by emails any time and store their data to get history files to diabetics. figure1 describe basic structure of our system.

Figure1: Basic structure of the system

II. BACKGROUND

We found several works in the literature that attempted to build Diabetics mobile application; the Mobile App for Diabetes from Vree [6], brought to you by Merck Tracking, nutrition, exercise, and more-all at your fingertips The

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Mobile Application for Diabetes from Vree gives you a full suite of useful tools in one easy-to-access location. These tools can help you better manage your diabetes and gain the confidence to make healthy, lasting changes in your life.
Likewise, DiabetesHealth [6], Diabetes Health Mobile gives you access to the top news articles and blogs posted to our website. You can read articles from our main Top News and Blogs section as well as other categories, including: Type 1, Type2, Pre-Diabetes, Kids and Teens, or Professionals. Cellnovo's Mobile Diabetes Management System [6],
People living with diabetes have a new mobile tool to aid with managing their disease. Recently, Cellnovo announced CE Mark approval for its mobile diabetes management system, Cellnovo The ability to see real-time data of patients who may be hundreds of miles away provides the opportunity to redefine our care model. Diabetes Pilot[6] is software that makes managing diabetes easier. Diabetes Pilot takes the place of traditional paper logbooks, Every feature in Diabetes Pilot is designed to be fast and easy to use. The software is designed and supported by people with diabetes who actually use the software.
Although these works have achieved limited services in diabetes mobile applications , but they suffer from , flexibility, complexity, scalability, and adaptability, we will show that our system is more flexible, and can give more services and monitor on patients health and connect them to doctors any time quickly by electronic tools and possible. In addition, we can claim that our system scales up very well as it grows in size since it puts little processing overhead due to its modular and database driven mechanism, and it is open source application.

III. ANALYSIS

Since diabetes is of one the most diseases spread in the world, 200 million of people suffer from diabetics ,after research and made many interviews with many doctors and patients to analysis our system to satisfy the optimal result, we intended to build the smart and management mobile system help and aware those who have diabetes. we aggregate data and analysis it to get right result and equations[7].

A. INTERVIEWS AND RESEARCH

We made many interviews with Doctors who treats diabetics and asked them a lot of questions to have accuracy information and knowledge about diabetes[8]. The most important questions were; What is diabetes? And what are its types? What are the differences between type1 and type2? What is the main information that is taken from the patient? How do we calculate the Body Mass Index (BMI)? What is the normal range for BMI? What tests do the patient need so Doctor can start with the treatment and help him with tracking the diabetes? What is Fasting Blood Sugar (FBS) test? What is its normal range? What is Random Blood Sugar (RBS) test? What is its normal range? What is glycated hemoglobin HbA1c (A1c) test? What is its normal range? How is blood pressure related to diabetes? What are the risks factors for diabetics? How do you determine diets for your patients? How should a diabetic patient take care of himself? Are there any other specific services you wish to have in a mobile application that could help you treating the patient? Or help the patient to control himself? and also We also interviewed patients who have diabetes and asked them many questions to get right analysis some of the important questions; Do you make blood sugar tests daily? Do you visit your doctor periodically? Or wait until you have complications then you go to the doctor? Are there any features you would wish to have in our application that could help you managing and controlling your diabetes?
and we make several research to get many accuracy information, We looked up the web for the diabetes disease, and collected many papers and researches that where done on the diabetes, and the relation between HbA1c(A1c) and the FBS RBS. And how can we predict A1c from FBS and RBS. Researches show that if we can control A1c and that in every percentage decrease (e.g. from 9% to 8%) in A1c, there is 25% reduction in death related to diabetes. Also we reduce the complications[3].
Finally, conclusion after the interviews and researches: Most of the patients wait until some complication happens then they go to the doctor, Not all the patients take daily blood test and tell doctors about it and this causes a delay in the treatment and controlling over diabetes, Predicting the A1c by a weekly result from daily tests of blood sugar can help the patient have more control on himself and give him awareness to possibly reduce complication and by this the patient can have longer life. after these deep analysis we reach to the functional and non-functional requirements for our system .

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B. Equations

- BMI: Body Mass Index is a measure of body fat based on height and weight that applies to adult men and women[4].

$$BMI = Mass\ (kg) / (High\ (m))^2$$

Status	BMI Records
Underweight	Below 18.5
Normal	18.5–24.9
Overweight	25.0–29.9
Obesity	30.0 and Above

TABLE1: BMI Results

BMI is a useful measure of overweight and obesity. BMI is an estimate of body fat and a good gauge of your risk for diseases that can occur with more body fat. High BMI means higher risk for certain

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diseases such as heart disease, high blood pressure, type 2 diabetes. BMI helps doctors with determining how much medication to give, and how would the diet be, to control weight and reduce possible complications and risks[9][3].

- FBS: Fasting blood sugar measures blood glucose after patient has not eaten for at least 8 hours. Fasting blood glucose tests are done to detect the risk of diabetes and prediabetes when glucose levels do not exceed 140.2-hour postprandial blood sugar measures blood glucose exactly 2 hours after you start eating a meal[4].
- RBS: Random blood sugar measures blood glucose regardless of when you last ate. Several random measurements may be taken throughout the day. Both 2-hour after eating test and RBS should be less than 180. Anything above this is too high[7].
- HbA1c or (A1c): measures how much sugar (glucose) is stuck to red blood cells. This test can be used to diagnose diabetes. It also shows how well diabetes has been controlled in the last 2 to 3 months and whether the patient diabetes medicine needs to be changed. The result of A1c test can be used to estimate your average blood sugar level[5].
- A1c: normal range is between 4.5% and 6.5%, diabetics should try to control their high A1c and try to reduce it as much as they can. How to predict A1C results; By using self-monitoring blood glucose results: Average all your blood sugar check results each week The ranges in the table below are the ones established by the American Diabetes Association (ADA). Find out if your laboratory's A1C is different from this one and use it to revise this table. According to ADA and to doctors, the non-diabetic range is 4-5 to 6.5% [6].

Average Glucose (mg/dl)	Predicted A1C %
<100	<6.5
100 – 120	6.5 – 7.0
121 – 140	7.0 – 7.5
141 – 160	7.5 – 8.0
161 – 180	8.0 – 8.5
>180	>8.5

TABLE2: AIC Results

- Graphs Equations(4):
  - Weights/Time: shows the change of weight through.
  - Pressure/Time: shows the change of pressure through time.
  - Fasting Blood Sugar (FBS)/Time: the change in FBS through time.
  - Random Blood Sugar (RBS)/Time: the change in RBS through time.
  - Body Mass Index (BMI)/Time: the change in BMI through time.\
  - HbA1c/Time: the change in HbA1c through time.
  - All graphs combined: shows all weight, pressure, FBS, RBS, BMI, and HbA1c in one graph each one with different color.

C. System Functional Requierments

after deep research to analysis data that we collect it from various recourses we reach to these system functions that give the diabetics self management to their health and give right results these Functional Requirements are:

- Self-Evaluation: Self evaluation means that the application makes an evaluation of the patient's current state based on the data input by him, and by calculations made on these inputs the application analyzes and compares data and gives back a result of the state, if it is stable or not? is the patient within the normal range? Or is he in danger and should contact a doctor immediately?
- Record your daily measurements: Is where the patient inputs his data like: Blood sugar level, change in weight, blood pressure, medications, meals, insulin, diseases, and any other notes he wants to write it into the application and the asymptotes appear like (Dizziness, Blurred Vision ,Frequent Urination, Unusual Thirst, Recurring Skin, Itchy Skin, Weight Loss ,Extreme Hunger, Dry Mouth, Leg Pain) . This is important to keep track of the patient's state to have better control on the diabetes and get reports and graphs to manage their health[3].
- Generate Graphs: This function generates visual graphs of all the data given by the patient and calculated automatically by the application or self evaluation outcome, for each input and outcome along with a timeline of the patient recordings, figure2 give you full description one example for a patient's graph example.

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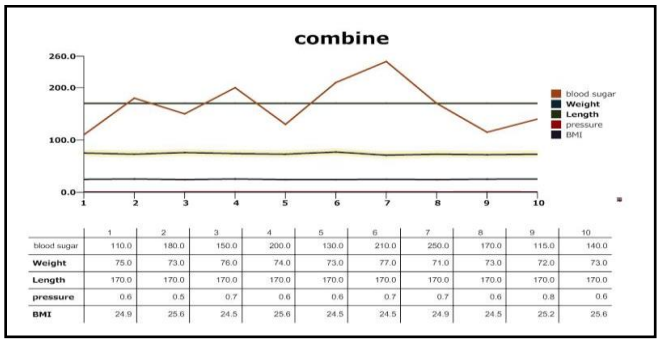

	1	2	3	4	5	6	7	8	9	10
blood sugar	110.0	180.0	150.0	200.0	130.0	210.0	250.0	170.0	115.0	140.0
Weight	75.0	73.0	76.0	74.0	73.0	77.0	71.0	73.0	72.0	73.0
Length	170.0	170.0	170.0	170.0	170.0	170.0	170.0	170.0	170.0	170.0
pressure	0.6	0.5	0.7	0.6	0.6	0.7	0.7	0.6	0.8	0.6
BMI	24.9	25.6	24.5	25.6	24.5	24.5	24.9	24.5	25.2	25.6

Figure2: All Graphs Combined Example

- Generate Reports: A detailed daily, weekly, monthly, or any period of time report is generated for the sum of all the data and outcomes from the patient history, prepared and ready for sending by email or be printed or viewed on the mobile itself(8).
- Doctor Decision Guide: The frequent question that may be asked and its answers, and here the patient can ask any question about diabetes or about his state, advices, nutrition... Etc.
- Nitration and Exercise Tracking: Tracks the carbohydrate, calories, fat, protein, fiber, sodium, cholesterol and other nutrients in the foods that you eat. Diabetes Pilot has an integrated food database with information on thousands of foods, including hundreds of fast foods.

- Diabetes Learning Recourses and Guide : All recent news and medication for diabetes, the newest updates in the way of treating diabetes and tips of how to manage of diabetes to avoid future complication, and give full awareness about the disease to the patient and a lot more, figure3 show you the system functions and services.

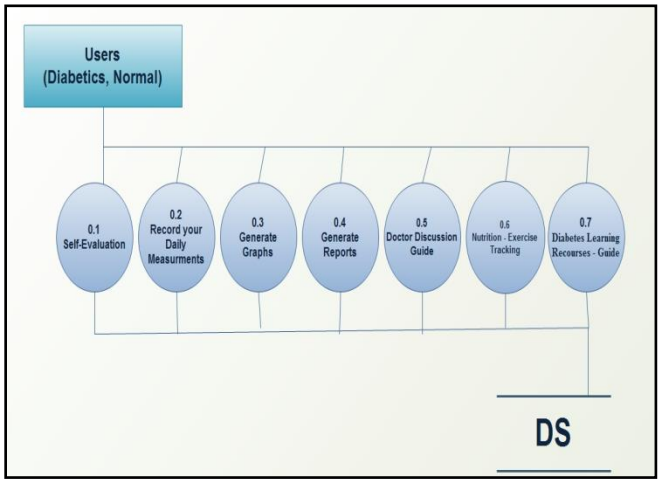

Figure3: System functions and Services

D. System Functional Requierments

- Scalability: ability of a system a growing amount of records.
- Availability :our system available any time
- Usability :easy to use it has user guide facility
- Secure : no one can access to your files and privacy information.

IV. SYTEM DESIGN AND INTERFACE

After the text edit has been completed, the paper is ready for the template. Duplicate the template file by using the Save As command, and use the naming convention prescribed by your conference for the name of your paper. In this newly created file, highlight all of the contents and import your prepared text file. You are now ready to style your paper.

A. Database Design and ER-Diagram

The database is a core component in our system. It will store all the records of the diabetics and their classifications and show the relations between entities of our system . The database consists of 11 tables representing the following entities: **Patients, Doctors, Symptoms , Exercise , Nutrition , Nutrition_ Reminder , Exercise_ Reminder, Daily records, Predicted A1C, Medication_ Reminder and Medication.** Figure4 show you the ER-Diagram for our system and entities relationship .

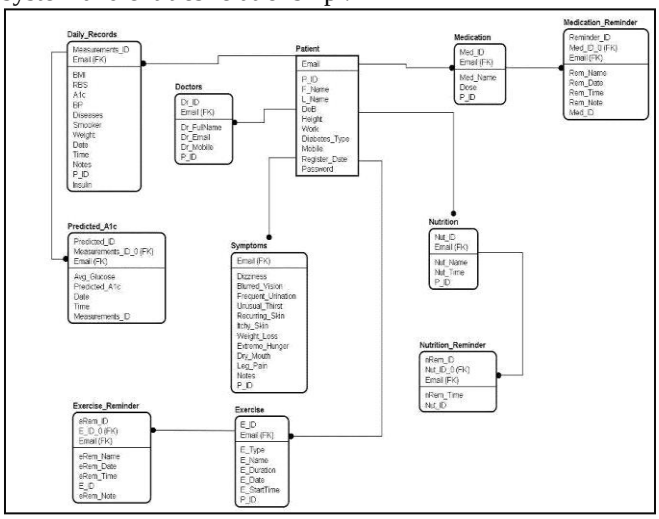

Figure4: ER-Daigram of our system

B. Object Oriented Design

We follow the object oriented design to build our system relations and operation for all the entities classes of our system to show you how the system interactive and operations between the components of the system figure 5 show you the use case diagrams that give you defining interactions between a role and a system, to achieve a goal. The actor can be a normal human or diabetics .

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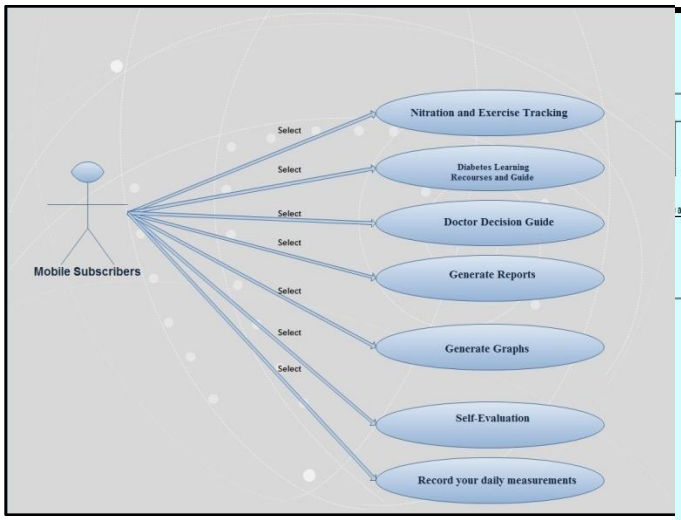

Figure5: Use case Diagram of the system

figure 6 give you the sequence diagram of our system that shows you how processes operate with one another and in what order. and shows object interactions arranged in time sequence. It depicts the objects and classes involved in the scenario and the sequence of messages exchanged between the objects needed to carry out the functionality of the scenario of our system.

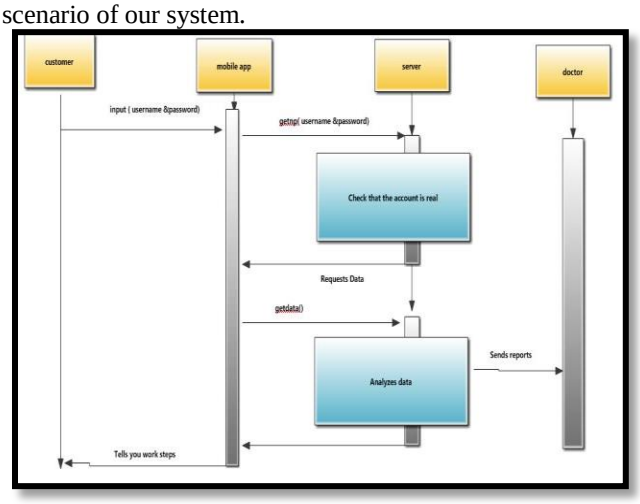

Figure6: Sequence Diagram of the system

figure 13 give you class diagram of our system that describes to you the structure of our system by showing the system's classes, their attributes, operations (or methods), and the relationships among the classes.

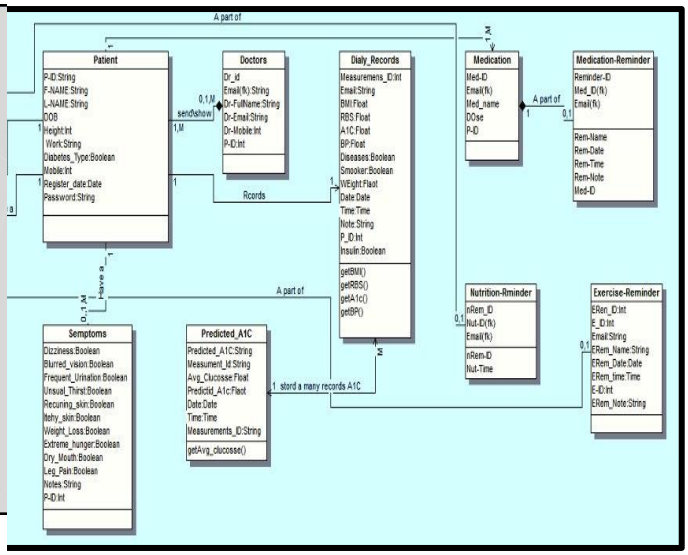

Figure7: Class Daigram of our System

C. User Inteface Design

We designed the system to be efficient and user-friendly, and to give the users all the services for our system , Our system provides guidelines and documentation for the user to make him/her use the system in the most effective way. figure7 give you the sequence menus for our system interface

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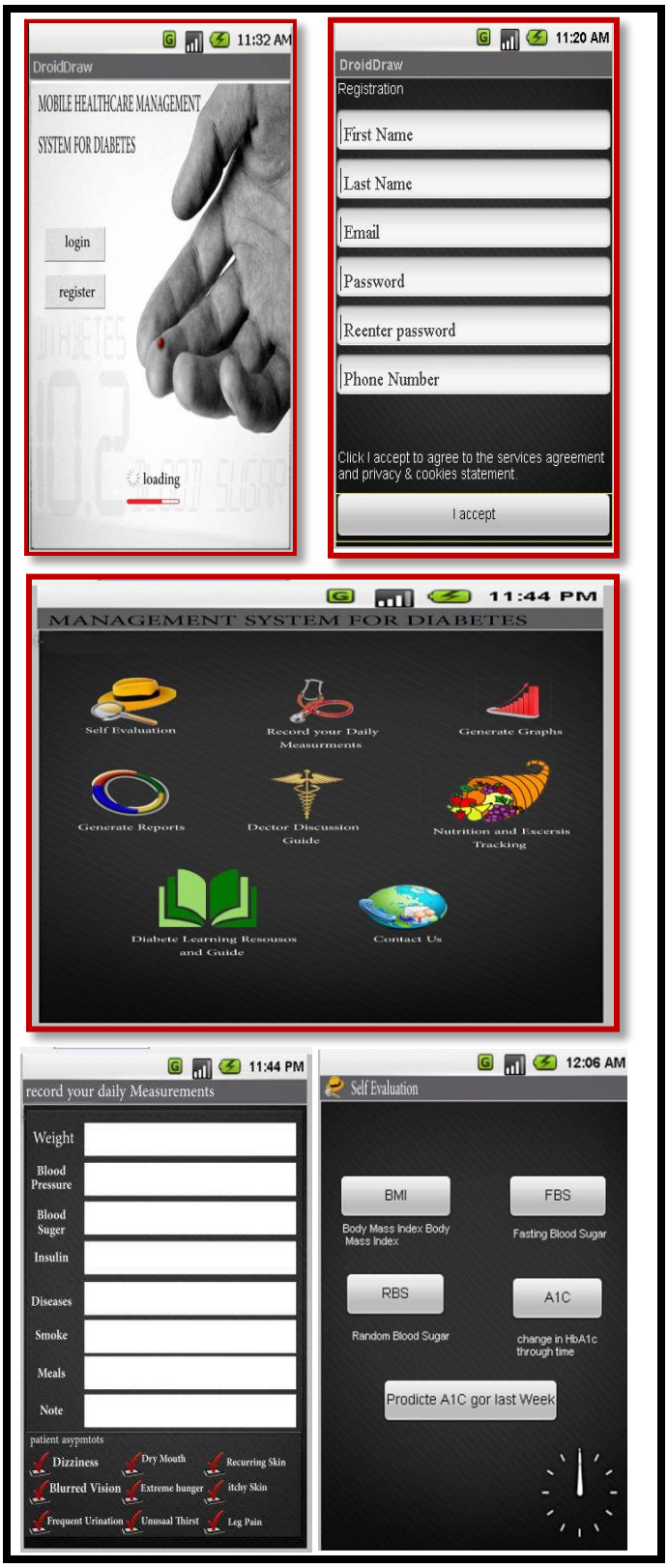

Figure8: User Interface of our System

V. SYSTEM IMPLEMENTATION

We have used (Eclipse "Programming language) to build our system which gave it several advantages; for example, Eclipse SDK is free and open source software (although it is incompatible with the GNU General Public License and we want to build an application that runs on android environment and also The Eclipse Platform uses plug-ins to provide all functionality within and on top of the runtime system, and it's a lightweight software component framework, Eclipse supports development for Tomcat, GlassFish and many other servers and we implement the algorithm and the equations on our system by this strong language and give the results and status for the patients (10)

ACKNOWLEDGMENT AND FUTURE WORK

Mobile apps have changed the world in just a few years. specially medical mobile applications In this paper we presents prototype for mobile application which is being design to give many services to diabetics to control and manage on their health ,give them awareness discussion guide to connect them in electronic and fast ways to the doctors by generate graphs and reports sending them by emails any time and store their data to get history files to diabetics. in future work we want to develop our system to give diabetics healthy eating what should they eat, monitor on their health , Find fitness activities diabetics can integrate into their lifestyle and stick with[9].

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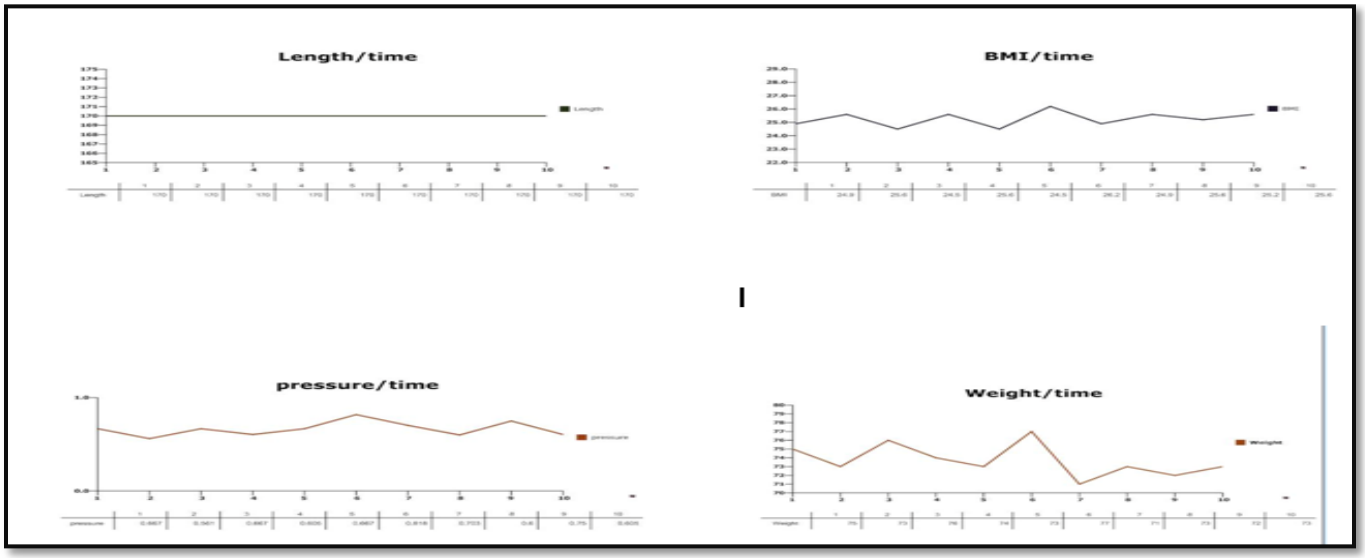

Figure9: System Graphs.