

# DIABETES MELLITUS COMPENSATION USING MOBILE TECHNOLOGY

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## Abstract

We are working on system for diabetes mellitus compensation - Mobiab project. The whole system is designed as client-server with mobile application and web portal. The application can collect data about patient's caloric intake and expenditure, can communicate via Bluetooth with glucose meter, tonometer and scales. The application is using gamification principles for patient's positive motivation. The web portal gives physicians way to supervise their patients. The Mabiab project is almost prepared for pilot testing and after successful test also for clinical study.

## Keywords

diabetes mellitus, Android, caloric intake and expenditure, monitoring, gamification, Bluetooth accessories

## Introduction

Currently, according to International Diabetes Federation, an estimated 381 million people had diabetes. This number is estimated to almost double by 2030. More than 800 thousand people (more than 8.7 % population) had diabetes in the Czech Republic, more than 25 million people (12.3 %) in the USA. Treatment of diabetes and its complications is estimated to cost almost 10 % of total expenditure on health in the Czech Republic. Most of this money goes for treatment of complications.

We would like to prevent complications of diabetes in our project Mabiab [1]. We are working on complex system, which contains mobile application for patients with Android phones and web portal for patients and their physicians. All measured data are stored on server and immediately are available for patient's physician. The mobile application can communicate via Bluetooth with the glucose meter, pressure gauge and kitchen scales for easier or automatic entering values.

## Architecture

### System Architecture

The system is designed as a client-server, all data are stored online on our server. The client is then a web portal or a mobile application that receives data from the server by sending specific requests that the server

process and returns the requested data (Fig. 1). The mobile application has advantage in Bluetooth accessories – currently the blood glucose meter and the kitchen scales (prototype), the tonometer and the scales in future.

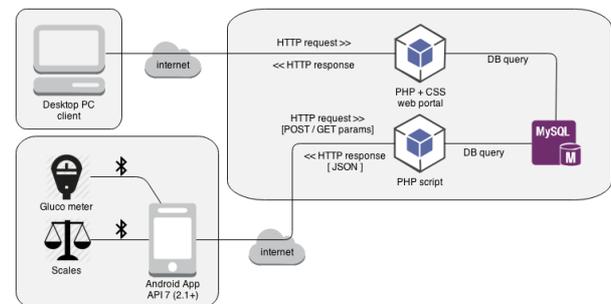


Fig. 1: The scheme of system architecture. It shows server side and clients – web portal and mobile application.

### Web Portal

Web portal is designed primary for physician, who can easily check their patients and send them message (recommendations, compliment or complaint) throw communication module. The Figure 2 shows output of patient for one day in synoptic charts.

Also patients can log into the portal and view their entered data and results.

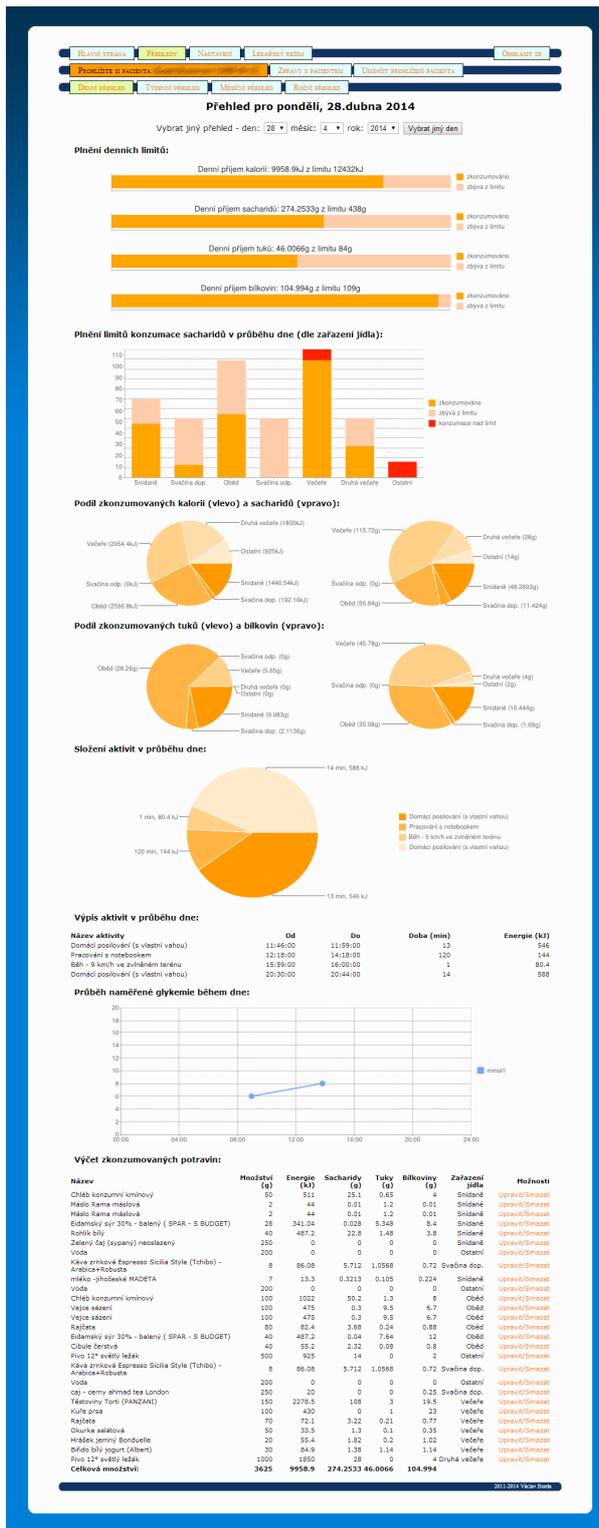


Fig. 2: Webpage screenshot of whole patient's day. From top it shows: filling daily income limits, sugar consumption limits, distribution of consumption within the day, done activities with time and caloric expenditure, glycemic progression in day and list of consumed food with caloric values.

## Android Application

The mobile application is developed through individual modules, which are themselves nearly independent. This approach has several advantages. The application can be easily extended of other functionality, or built an application with the use of only certain modules in the future (Fig. 3). Currently, we are working on two new modules. The first is education module, which provides basic information about diabetes mellitus and its compensation. The second is pressure module which allows enter data about blood pressure and pulse. Furthermore Bluetooth communication with tonometer has been also implemented.

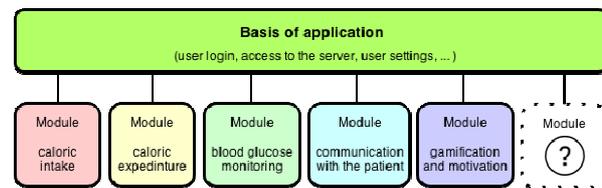


Fig. 3: The scheme of mobile application. It allows simple expansion of additional functions.

## System Functions

### Bluetooth Accessories

We are working on further modules that allow Bluetooth communication with other devices such as kitchen scales, glucose meter or tonometer. The goal is to facilitate the patients to use mobile applications to the use of these devices (e.g. glucose meter). They can easily get the results of the measured data through a mobile application and also share these results with their doctor. Currently, there is necessary patient interaction – it is needed to select which values will be saved. This strategy allows patient to select one value from multiple measures in short time. For older patients can be this step in future skipped – all measured values will be immediately saved to database after measure.

At this moment application supports Fora Diamond Mini DM30 glucose meter and prototype of kitchen scales.

### Caloric Intake and Expenditure

This module allows patient to enter consumed food and done activities (caloric expenditure). Our database contains more than 6000 of actual Czech food entries and more than 400 activities. The English food database is more modest covering 2000 entries.

The entering of values is very simple. Patient searches food by name or its part, enter date, time and

amount of consumption, selects part of day, when was food consumed (e.g. breakfast) and save it. The most consumed food can be labeled as favorite for easier entering. The caloric expenditure works very similar. Patient select done activity and duration and then saves it.

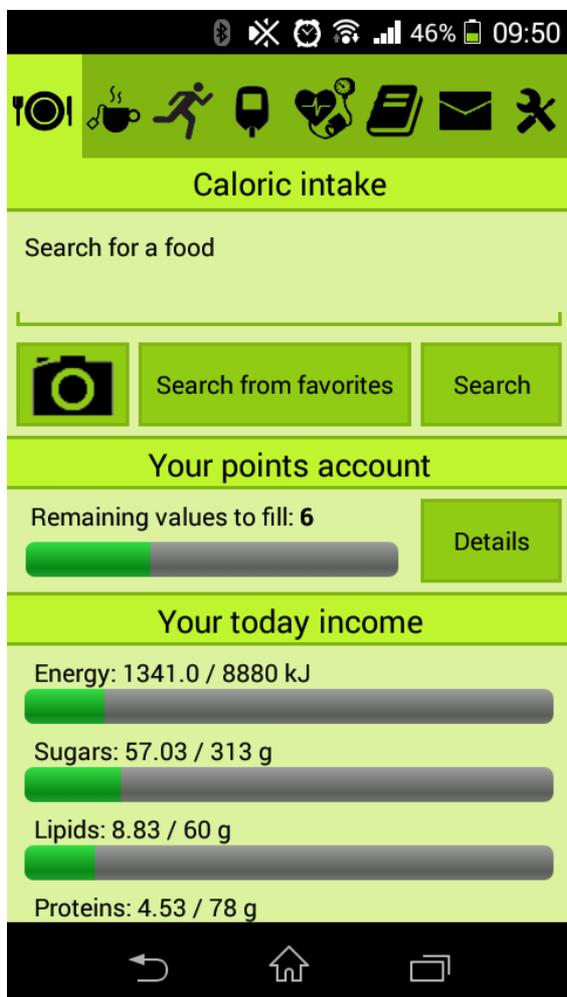


Fig. 4: Main screen of mobile application. It shows food search, gamification module and daily limits.

### Patient's Motivation and Gamification

It well know that patients forget to enter values and they have not good motivation for entering consumed food, done activities and other values [2]. Therefore we decided to implement a several motivation features.

The first one is a simple reminder system. This module check at specified time if expected values were entered. For example in the morning system check if breakfast was entered and in negative case ask patient for complete entries.

The second is a gamification system. Patient gets for each entry specific amount of points and for continuous entering gains bonus points. These points can be changed for real gifts (e.g. blood glucose test strips) or

virtual accessories for animated Avatar. Avatar means desktop widget with some animal, which represents patient's personification – like Tamagotchi in 90's. Patient feeds this animal through entering values of food which he ate. Avatar has wishes – wants do some activities or tells to patient that he is hungry.



Fig. 5: The avatar – dog with bow. Patient can click on the bubble for view whole text: "I just finished the activity Jogging – 8km/h".

The third system is the support of social networks. Patient can share his achieved results with other patients to private group on Facebook. This should motivate the others to get better results, like Endomondo sports tracker or PatientsLikeMe [3].

### Patient's Education

Currently we are working on education module, which provides to patient basic information about diabetes mellitus and its compensation. This module works like wiki - information are linked with cross-references. It contains chapters about diabetes and its symptoms, treatment, acute and chronic complications and prevention.

## Conclusion

The project can improve life quality of diabetes patients, prevent diabetes complications and reduce spending money on treatment. Patients can simply record food intake, executed physical activity, measured glucose blood level and blood pressure. All entries can be supervised by a patient's physician.

The Mobiab project was tested for functionality and usability in beta testing with 10 users. The application is also downloadable on Google Play (currently only Czech version, but we are intensively working on update, which will be also in English with English food database) and we have over 900 downloads and over 150 signed users since last year. Mobiab project is almost prepared for pilot testing and after successful test also for clinical study.

## Acknowledgement

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