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Global Mobile Applications for Monitoring Health

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***Abstract*—The incentive of the mobile applications presented in this paper is the extensive spread of the mobile phone culture during the past decade. The first application is CalorieMeter, a calorie intake monitoring application. Cheer Up, the second application is based on self-help scientific methodologies for diagnosing possibilities of different kinds of depressions. Designs of both applications are based on the ideology of Mobile Phone Template applications. It supports easy transformation of a given application into other application domains and allows us gain natural language and regional languages independence, hence the global nature of our approach. Our applications have been developed for and tested on low- medium range of mobile phones.**

I. Introduction

MOBILE phone applications developed for the improvement of health of individuals capitalize the ubiquitous nature of mobile phones. Our first application, CalorieMeter concentrates on the improvement of the physical well-beingof an individual. The goal of this application is to motivate an individual to monitor his food and calorie intake so that he is able to meet his calorie needs without exceeding his permissible calorie amount for a particular day. The number of calories available for consumption per day is calculated using the Harris-Benedict equation [1]. We have created an intuitive and graphical interface to persuade users to use CalorieMeter regularly. This application as it is presented here targets English-literate users but its food choices can be conveniently adapted to any language and culture. The English texts in the language dependent screens (for example, user's profile) can be readily translated to any language we want to adapt the application to. The English texts can then be easily replaced by translations. All this is possible because the application design follows Template Ideology as defined in [2]. A template application is an application which can easily be modified from one domain to another.

The second application, Cheer Up is designed to help an individual to check the state of his mental health. Its goal is to help the user to become aware of his depressed state, if he is in one and to get a confirmation of his good mental status otherwise. We have created an appealing and enticing interface so the user can understand the flow of the application without any outside explanations. We believe that the intimacy and privacy of mobile phones will make people use the application and consequently help them overcome the stigma attached to depression. Eventually, they would seek a professional help, when needed. The application mainly targets teenagers who are regular cell phone users, might be depressed but otherwise would not seek help. We also show that application design follows Template Ideology.

A. Paper Organization

In section II, we present the physical health aid application, CalorieMeter. In section III, we present the mental health application, Cheer Up. For each application, we have described the application functionality, technical details, challenges and lessons learnt. In Section IV we show the working of the applications followed by the Template Ideology [2]. Section V is a conclusion of the paper.

II. CalorieMeter

CalorieMeter helps the user monitor his food and calorie intake. In this application, the user sets his profile, enters food consumed, and the application monitors and reports his caloric intake and balance. The application also suggests food items the user could consume while still remaining within the permitted calorie intake.

Four major factors motivated us to develop CalorieMeter. The first factor is the rising obesity throughout the world. WHO [5] projects that by 2015, approximately 2.3 billion adults will be overweight and more than 700 million will be obese. The second factor is the lack of awareness of the calorific value of food items amongst individuals. Another factor is the lack of awareness of the calorie needs of an individual and need of consumption of a balanced diet.

A. Application Functionality

On using the application for the first time, the user is prompted to set a profile. The *Profile* screen consists of a form like interface with fields for name, sex, birth date, height and weight. On saving the profile, the *Home* screen appears. The *Home* screen has four options: *Profile, Food Categories, Calorie Balance* and *What To Eat???*. All the options navigate to their respective screens.

On the *Food Categories* screen, the user selects the food category and a food item grid of the corresponding food category appears. The three food categories are *Fruits and Vegetables*, *Meats and Grains* and *Deserts and Soda*. Each category is represented as a 3X3 grid of food items. The background color of the selected food item in the grid changes dynamically according to the time of the day along with the audio pronunciation (Fig. 1(a)). On selecting the food item the user is navigated to the *Food Item Details*

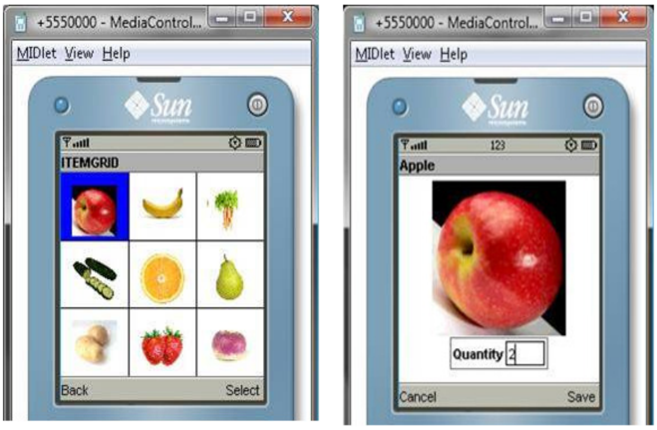


Fig 1. (a) Food Items Grid , (b) Food Item Details

screen (Fig. 1(b)). Quantity can be entered on the *Food Item Details* screen [for grains, 1 implies 100 grams]. On choosing *Save*, the calories for the food item are added to the already consumed calories of that particular day.

The *Calorie Balance* screen helps the user approximate his share of daily permitted calories consumed (as calculated for user profile by our algorithm) and left to be consumed through a pie chart. The red color fraction of the pie signifies calories consumed and the green portion of the pie signifies the calories available for the day (Fig. 2(a)).

The What To Eat??? button on the *Home* screen navigates the user to the *What To Eat???* Screen (Fig. 2(b)). This screen suggests intelligent and healthy food item suggestions to the user. The suggestions are displayed in the form of a grid. Any food item consumed from this grid assures that the user does not exceed the permitted calorie intake for that day.

The application also has additional alert messages displayed on the screen on occasions when the user does not eat or exceeds the calorie limit.

B. Key Features

CalorieMeter has attractive grid navigation with integrated audio support. The user can use the up, down, left and right buttons to navigate and select food items from the cells of the 3X3 grid. The name of the selected food item is pronounced in English, but that can be changed due to the template design to any other language. The application can also serve as language teaching tool in a case when user language is different than the language used in the application. Another feature is the dynamic resizing of images in the grid. Hence we store only one copy of the image. The application also implements an intelligent algorithm for suggestions of healthy food items that can be consumed to remain within the calorie limit.

C. Technical Details

CalorieMeter incorporates 27 .png images with 120X120 size and 27 .wav files in the application and supports low end mobile phones (CLDC, MIDP 1.0). It has been developed using J2SDK, Eclipse IDE, J2ME Wireless Toolkit and Eclipse ME, Eclipse plug-in to develop J2ME code.

We reuse our custom grid implementation code which is populated dynamically based on the food category chosen. Our custom method dynamically re-sizes the images to fit the grid irrespective of the mobile phone screen size. The widths and heights of the images initially 120X120 are divided by an integer factor which is incremented on iteration till the re-sized image fits perfectly in the grid. We also implemented a string tokenizer to parse the .txt files containing data about the food items. We used RecordStores to emulate RDBMS by creating separate RecordStores to store information related to User Profile, Food Categories, Food Items and Food Consumption. Since J2ME does not have a built in date type, we accept the birth date of the user and store it as month, date and year.

What To Eat??? screen considers calories consumed for the day and permissible calorific value for the day and outputs a grid of food items which can be consumed without exceeding the permissible calorie limit. The weight-age assigned to each category is the motivation factor as the output has more healthy options than unhealthy ones.

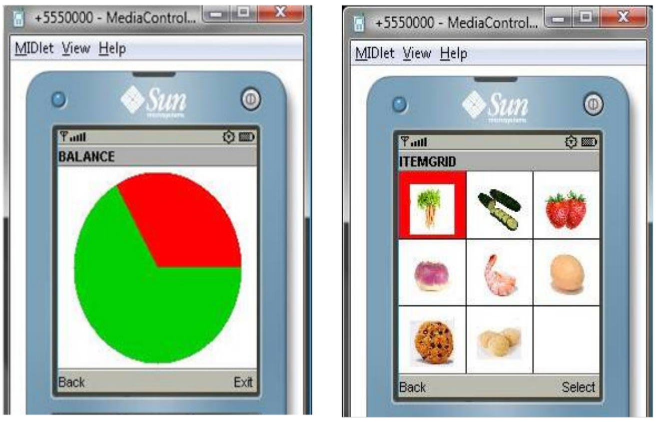


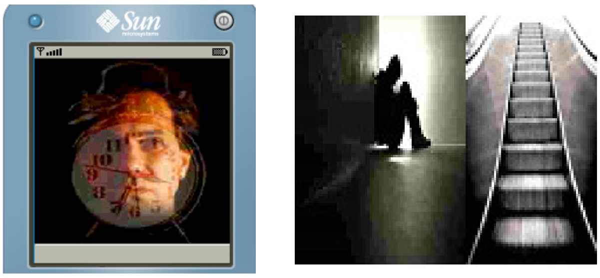
Fig 2. (a) Calorie Balance screen (b) What To Eat??? Screen

D. Challenges and Lessons Learned

The success of the application depended on the image size and clarity for easy comprehension by the user. Also, inclusion of packaged food items, platters and combos as food choices could increase the versatility of the application. This can be easily added during the customization. CalorieMeter can be also customized by adding/replacing picture set of food items according to the age groups and the regions, counties of users. Our application does not consider the frequencies of consumption of food items or the physical activities of the individual, but the template design allows and supports extensions.

E. Related Work and Comparison

This section describes a short comparison between prototypes of health applications deployed on technology platforms with consideration to type of architecture, motivational strategy employed and target audience. The applications we compare are PmEB [11], BALANCE [9], Heart Angel [10], FotoFit [7], and Wellness Diary [12]. PmEB [11] requires an internet enabled mobile phone whereas HeartAn-



DownloadCreate Chart 5. What do you think is this persons problem?

							answered question	71
							skipped question	0
	1	2	3	4	N/A	Rating Average		Response Count
Anxiety	15.9% (11)	24.6% (17)	**33.3% (23)**	21.7% (15)	4.3% (3)	2.64		69
Stress	10.0% (7)	15.7% (11)	**37.1% (26)**	34.3% (24)	2.9% (2)	2.99		70
Insomnia	11.4% (8)	**31.4% (22)**	24.3% (17)	24.3% (17)	8.6% (6)	2.67		70

Fig 3. (a) Sample Survey Picture (b) Sample Diagnose Image (c) Survey Results

gel [10] requires a Bluetooth enabled cell phone. All of them are standalone applications whereas PmEB [11] has client-server architecture. All the applications except PmEB [11] and Wellness Diary [12] require an external hardware device. For example Heart Angel [10] requires a heart rate monitoring hardware device. The motivational strategy in PmEB [11] and Wellness Diary [12] is control, in BALANCE [9] is challenge, in FotoFit [7] is competition and in HeartAngel [10] is encouragement. BALANCE [9], Heart Angel [10], Wellness Diary [12] target fitness enthusiasts, PmEB [11] targets obese mobile phone users and FotoFit [7] was developed for college students.

III. Cheer Up

Cheer Up is designed to evaluate the mental health of individuals by discovering if they are in a depressed state, categorize this state and send a warning to the user. It is an attempt to make Cognitive Behavioral Therapy (referred as CBT hereafter) [14] more accessible and personalized. We hope it would appeal to young people and make them aware that they might need to seek professional help.

A. Motivation

Depression is the single biggest cause of suicides in the world [22]. Most cases of depression go unnoticed, unreported and are aggravated due to lack of self-awareness, easily accessible psychiatric help or stigma associated with visiting a psychiatrist. The portable and personalized nature of mobile phones along with its ubiquitous nature might help to breach the gap between people who need professional help and those who eventually reach for it [15].

B. Requirements Elicitation

The foundation of Beck's cognitive theory of depression is a stress-diathesis model [13]. Persons may be vulnerable to depression because they have dysfunctional beliefs. These beliefs may remain latent for years, prior to and between depression pangs, but they can become primed by environmental stressors. The Cognitive Behavioral Therapy [13] aims at knowing how we think about ourselves and our surroundings and our emotional reactions to events occurring around us. By changing our thought process, we can change our emotional reactions which in turn can prove helpful in treating depression.

To feed our diagnosis algorithm with quantifiable associations between images & depression types, we conducted a survey of around 100 people in the age group of 20 – 30 (Fig. 3(a)). They were asked to rate the images on the scale of 1 to 5 where 5 indicated maximum association of the image with the type of depression. The entered weights were aggregated and the mean values were used to derive the probability of associations.

Based on the survey results we tabulate the mapping of each image to various types of depressions. This is stored in the configuration file and is used in the diagnosis algorithm.

C. Application Functionality

The *Home* screen consists of three options. The first option is *Diagnose* which is the key part of the application where user takes a self-diagnosis by responding, with numbers, to an adaptive display of images (Fig. 3(b)). The users' responses are used to predict their cause and degree of depression. These values are stored as user's profile in the record store until the user takes a new diagnosis. The user's predicted depression type and level is also used to assign a personalized set of therapy tasks like art therapy, cope, mood logs etc. The second option *To-Do* suggests ways to figure the type of depression discovered.

The *Help* button displays instructions on how to use the application. The *Diagnose* button starts a slide-show of images which evaluate the type of depression in the user. For each image, the user selects a number from 0-9 where a higher number indicates that the user can relate to the image to a higher extent (Fig. 2(b-c)). Once the slide-show is over, the results are displayed. Once the user completes the diagnosis, the user's profile is stored in the phone. On clicking on the *To-Do* button, the application launches a therapy task customized for the user based on the depression diagnosis. Scientific research proves the efficacy of art therapy in healing depression [23]. The tasks are usually timed and self-evaluated. Depending on the task image these may try to divert the user's mind, make him busy in a soothing hobby, or try to make him learn to cope with him causes of depression.

D. Technical Details

Extensibility was one of the primary goals in our design as we wanted to develop our application as a frame work for a generic family of applications that plays an interactive and adaptive sequence of images to gather up user responses and analyze them. This was made possible through an efficient object oriented design. The Diagnosis Algorithm multiplied the score entered by the user by the weights of various depression types. These weights were calculated as a result of the survey conducted by taking the weighted mean of the percentage of user responses. The sum of all results calculated to get the final result was then mapped to the various types of depressions.

We believe that the algorithm will be more accurate if the data obtained from the survey was actually obtained from real controlled clinical trials of patients suffering from depression. Our application is a proof of concept of a diagnostic tool. Our application can serve as a template for a real application. The diagnostic mobile based tool should be developed in collaboration with medical specialists and we plan to do so.

E. Related Work

There have been some innovative attempts at diagnosing and healing depression using computing technologies. They can be categorized into three major forms Internet Based CBT [19], Computer Based CBT [20], Mobile Based [16], [17], [18], and [21].

Mobile based depression therapy is a very new area and there are only few applications we came across. A disadvantage of these applications is that they require high end mobile phones and rely heavily on the use of the Internet.

In [16] the mobile phone acts as a patient terminal, mobile phone providers connect the patient to the Internet where the IIS web server stores the information. The patient receives an email with a link to interview page. The user selects a number which gives information about the degree of particular symptom.

In [17] the data is stored and can be accessed online through a mobile phone. This existing system contains a real-time advice function. Real time advice function implements an algorithm that is performed over the user responses to analyze the kind of depression he is in and provides encouraging or warning messages in order to boost his morale and take actions to perform better.

In [18] a mobile phone program monitors adolescents' mood, stress and coping behaviors with some specific aims. [21] presents a mobile application developed in Murdoch Children's Research Institute. This application is used to track young users' experiences of moods and stress levels. The authors have developed a real-time, youth-friendly mobile phone program based on momentary sampling (MS) with interactive monitoring programs that can be run on java-enabled MIDP 2.0 mobile phones. MS data may be recorded by calling participants on mobile phones and using automated interactive voice response systems or researcher-lead interviews.

IV. Template Ideology

CalorieMeter can be transformed into an application of another domain with minimal knowledge of programming in J2ME. Three types of changes are possible in the transformation. Firstly the user can change the set of food items displayed in our application. Secondly the weight-age of each category can be changed. Thirdly the categories can be changed. The only constraint is that the number of categories should remain three. However the user would have to clean and build the code and redeploy it as the .jar and .jad file would get modified.

A.CalorieMeter

For example the CalorieMeter might be transformed for use of university students in the USA. In this circumstance, the picture set should consist of fruit and vegetable salads, pizzas, burgers, soda available in the cafeteria. The steps to transform the application are as explained below in the following sentences. To change the set of images, the .png files in the pictures folder of the application source code should be replaced by the picture files of new food items. The size of image should be 120X120. To change the set of audio files, the .wav files should be replaced by the audio files of new food items. The average size of our .wav files was 90kb. Standard notations have been followed in the text files which have the information about the object items to be present in the grid. The following should be followed as standard in the text files. '#' is used as separator between each field on the same line. '?' is used as the end of line at the end of each description. Each text file is one single line. '?$' is used as end of file. For example Categorydefaultentries.txt is in the form of 1#Fruit#Fruit.png#50? Where category id is 1, category name is fruit, icon is fruit.png, weight is 50, weightage is 2, # is a separator between fields and ? is for end of line.

B.Cheer Up

To ensure consistent display of Cheer Up across different mobile phone devices, all images adapt to phone screen size. Data regarding depression types, diagnostic images, and therapy tasks can be added via the configuration files of the application. The application can used as a framework to design and develop applications which evaluate user responses and provide homework tasks in an adaptive manner. All text comes from text files which can be easily changed and translated.

V. Conclusion

In this paper we presented two mobile applications inspired by the globally pervasive nature of mobile phones. Our first application, CalorieMeter helped the user keep track of his calorie intake on a daily basis thereby helping him to maintain a check on the calorie intake in a healthy fashion. Our second application, Cheer Up is an initiative to help depressed individuals become aware of their condition and henceforth curb the stigma attached with seeking external medical help. Mobile phones prove to be an ideal platform for health applications as they are affordable, personalized and interactive. Template Ideology renders our applications independent of regional, language, age, educational and social barriers.

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