Review Article

Medical & Clinical Research

Biometrics based Mobile Reminder for Mental Health Disorders

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Abstract

Assistive mobile technologies are highly demanded in order to reduce care givers effort with low cost/free programs. In this context, and due to the aging/ mental health disorders, memory loss and the change in the interaction between cognitive disability and mental health conditions, using mobile mental health assistive applications would improve the employees' performance. Hence, assistive mobile technology can be used to support people with mental health conditions to stay in their jobs and improve their productivity, in addition to assist remembering daily activities, order and organize them according to place and emotions. Emotion detection based mobile technologies are recently considered a revolution in building assistive mobile applications. This article introduces a Bio-reminder mobile application that will remind the person with his/her tasks based on matching with their biometrics associated with the given task. Biometrics includes heart rate monitoring measured by biosensors. In this paper, the proposed mobile application uses Fitbit to measure heart rate, calories burned in addition to GPS to report the location

Keywords: Assistive Mobile Application, Biosensor Data, Biometrics, Biosensors, Mental Health Problems.

Introduction

Recall that mobile devices now are widely used because of the availability anytime anywhere, in addition to the effect of a busy lifestyle, full schedules on human mental memory loss; one might experience problems remembering time and location for the tasks. Recent work in the field of assistive technologies reported the importance of using the assistive technologies inclusion in overcoming the memory problems in education, disabilities, epilepsy (non-motor seizure cases) and health care services [1-5].

Among mobile assistive technologies are the most commonly used reminder applications. Mobile assistive technologies are not only used for remembering the tasks, but also for task planning. Nevertheless, majority of assistive mobile technologies lack the consideration of the mental health conditions and/or the user's biometrics associated with the task. Furthermore, emotion detection assistive technologies including emotions readers were only limited to diagnostics uses not to users themselves and in a commercial product that is associated with an application this user uses. Emotion detection assistive technologies such as brain signals readers, skin temperature devices are now available to assess the usability efficiency of the assistive applications. The Q Sensor; shown in (Figure 2), provides records for stress and frustration levels throughout the day. Currently those records allow doctors detect changes of reactions in an objective way to see and communicate what might be causing stress for a person.

Figure 1: Bio-sensing of wearer's emotions with Fitbit Surge watch

Figure 2: Bio-sensing of wearer's emotion with QSensor

Figure 3: How do Biometrics template is prepared?

Fitbit watch Called Fitbit Surge, **(Figure 1)** that has biosensors to detect Steps, Calories, Distance, Auto Sleep Detection & Tracking Auto Exercise Recognition Continuous Heart Rate Text Notifications GPS Tracking Hourly Activity & Stationary Time [6]. In this article, a study aims at studying and developing a reminder mobile application by using Fitbit watch as emotions reader to detect and store these readings along with a given task name and location in order to create the template [13]; (**Figure 3**), of biometrics for this task and hence send the notification when similar biometrics and location are met.

Background

In the world of internet of things, mobile applications witnesses ongoing rapid changes with the deployment of new technologies. This brought up introduction of many varieties of devices and applications. Among these applications are reminder applications. For example, there exist many applications for IOS devices that provide the service of alarm/reminder Apple Reminders app, Do! Application. However, none of them was focusing on building a reminder that used a biometric data, i.e. none of these applications takes biometric in consideration, where biometric data uses body characteristics, which include heart rate monitoring, calories burned and well serves the nowadays trending smart technologies and internet of things, Phone Gap and Fitbit [7].

Reminders in Health Care Services

Recent published studies show how the technology transformed the health care [8, 9]. In the past they have a lot of healthcare error but in the mid of the 2000s the came up with some technology to improve the error correction, some of these technologies is to access their health records & medical information. Since this technology can be used by personal computer or cell phones to help them easily accessed their records. In agreement with Pew Research Center's (2014) about mobile technology, it shows the evidence of American adults 90% have cell phones and 58% have smartphones related to January 2014. Smart phones even can provide International Classification of Diseases coding information [7].

There are different types of reminders, the alternative types that helps for scheduled health service and any other appointments encounters to help all segments of the society on fulfilled or rescheduled appointments. The commonly known simple reminders are very helpful for attending appointments [8]. Many studies presented the results of investigating the effect of using reminders applications in health care services as it increasingly improves the attendance of appointments [9]. A study was conducted Department of Nursing Science, University of Turku, Turku, Finland (2014). Sample size studied was 60, and the study result was in favor to the use of technology in health care services.

The study claimed that the main reason that most patients not attend their appointments is forgetfulness referencing to that between 8% and 44.8% they did not attend their appointments. The same study claimed that 80–90% of patients have strongly agree with receiving a reminder to remind them to young people attending their appointments, referencing to that 56.3%, agree with letter reminders, then (26.0%) agree with telephone reminders and lastly 17.7% SMS reminders. Apart from age and gender, reminders applications efficiency sometimes depends on other factors such as mobility and the availability of the application to check the reminders.

Despite the fact that simple reminders provide alarms based on location and time for appointments are very helpful for normal people who are suffering from forgetfulness to attend their appointments, there are people with some mental health disorders and simple reminders would cause discomfort to the user.

Biometrics

The International Standards Organization provides the following definition for biometrics: "automated recognition of individuals based on their biological and behavioral characteristics. Biometrics covers a variety of technologies by automated recognition which can be used in any application to identify and authenticate the users via there physiological features or their behavior. This technology uses the user physiological features like: temperature, face, heart rate, hand, DNA, and the user's behavior like his/her: voice, signature, and way of speaking or typing rhythm [10-12].

Biometrics is used in most restricted applications that require accurate identification of an individual. It is seeking to improve accuracy and verification by combining it with other tools to insure the security of the critical system. Biometric system components are: Sensor which is used to collect the data and convert it to digital format, Signal processing algorithm which is used to perform quality control activities. Matching algorithm is used to compare the new biometric template to one or older templates in the data storage, and Decision process is using the results from matching components to make the system-level decision [12-14].

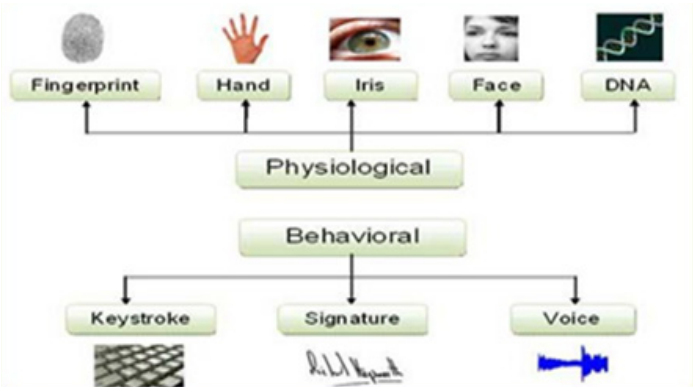

Figure 4: Biometrics Characteristic

Proposed Model

Proposes Architecture

This section describes the bio-reminder model and associated technologies. The proposed model adapted sociotechnical analysis approach along with use Phonegap to develop the application, which uses HTML based iPhone application development. Structured analysis is an organized method of systems analysis that makes use of graphical diagrams to develop and present system specifications to users in a way that makes them clear and easy to understand.

The diagrams explain the steps that need to occur and the data that is needed to meet the design requirements of the system. Benefits of using structured analysis are: improving maintainability, reduce the risk of over-run, this includes both time and budget.

The proposed model aims to be the solution for people who want to organize their to-do-list tasks by managing memory problems within the busy schedules as it alerts users based on their location and offers many features to the users with Google Maps' APIs such as providing the path, distance and the area maps. In addition, the application would offer the user an option to choose a distance that he/she wishes to be reminded before reaching the indicated location.

(Figure 5) below shows the sociotechnical design model since we are looking forward to having maximum availability of services that the system provides, high level of security, reliability, ease of access since we need the system work in specific time, so we need very fast response and exact action in specific time with high efficiency. In Social Technology Design model, it has four layers.

Interface, layer which is the link between the user and application/ process layer, in the second layer, which is process layer here is core, layer where happen the fusion, filter and decision making algorithms. The third layer which is database on local storage it the layer that is connecting process with Fit bit layer .in last layer there is Fit bit layer where we collect biometrics data and time and location and heart rate.

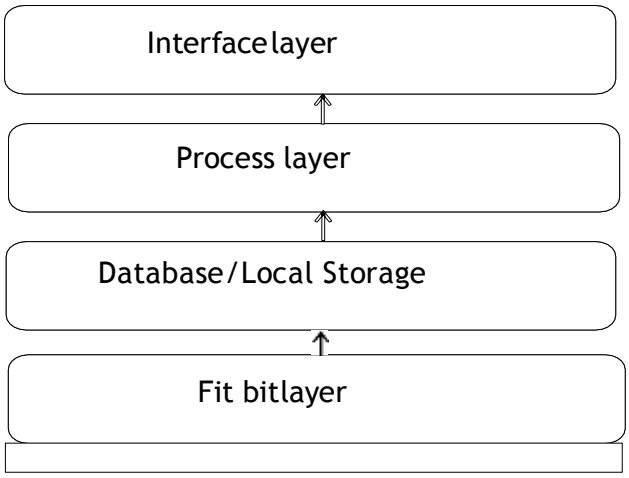

Figure 5: Sociotechnical System Architecture one word

Approach

The proposed approach uses the cosine similarity and Euclidean similarity based classification for each biometric modality match individually. The Cosine Similarity is calculated according to the following equation.

$$\text{similarity} = \cos(\theta) = \frac{A \cdot B}{\|A\|\|B\|} = \frac{\sum_{i=1}^{n} A_i \times B_i}{\sqrt{\sum_{i=1}^{n} (A_i)^2} \times \sqrt{\sum_{i=1}^{n} (B_i)^2}}$$

The second classifier is Euclidean Similarity is calculated according to the following equation

$$\mathrm{d}(\mathbf{p}, \mathbf{q}) = \mathrm{d}(\mathbf{q}, \mathbf{p}) = \sqrt{(q_1 - p_1)^2 + (q_2 - p_2)^2 + \cdots + (q_n - p_n)^2}$$

$$= \sqrt{\sum_{i=1}^{n} (q_i - p_i)^2}.$$

The classifier computed the threshold for each subject using the training pattern features and the input data, the average threshold were then computed from the five training pattern and saved as stored threshold. The template is then created for each trait.

Using multiple biometric traits together to identify or recognize a human/ human state requires a fusion technique that depends on the specific level of fusion [5, 12, 15, 16]. Fusion is the process of combining two or more biometric modalities. The fusion in this work is the decision level based fusion were each biometric subsystem completes autonomously the processes of feature extraction, matching, and recognition and gives a weight for the decision produced for each biometric trait using partitions of the biometrics template (the partition related to the given trait) rather than entire template.

The decisions resulted from the two unimodal biometrics are combined, commonly known as fusion process; Figure 6. Fusion methods presented in [2, 4, 9, 11, 17, 18], usually uses equal weights

for each single biometric trait, heart beat rate and temperature traits both have the same weight as we have the task GPS location is weighted equally with each of both traits [19].

The fusion is considered:

a. Accept if the classifiers weighted sum from two classifiers is equal to or greater than 0.800.
b. Reject if the classifiers weighted sum from two classifiers is equal to is less than 0.200

In our experimentation we set α to 0.8 for the heart rate modality and $1 - \alpha = 0.2$ for the temperature modality.

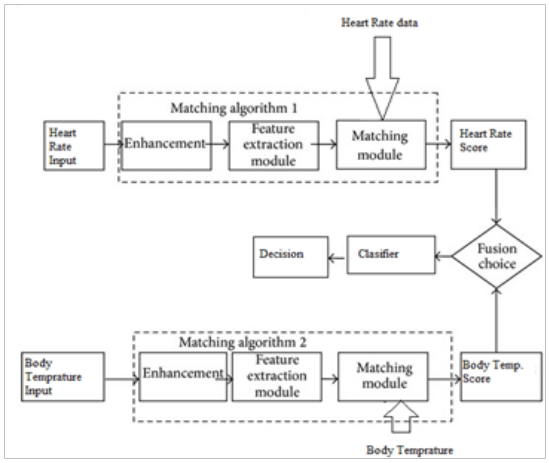

Figure 6: Multimodal bio-reminder application: process flow

Experimentation Design Experimentation Results & Evaluation

The experiment was designed to consider a group of 40 people from different ages, but nearly half of them 22 – 20 years with different work places and responsibilities (students, teachers, administration, housekeepers). The subjects were asked to follow a scenario, hence a form with 8 questions provided for each user in order to gather and investigate users' feedback. The false reminder rate FRR is 11% and true reminders rate TRR is 89%. Both rate is consider excellent over five iterations for all subjects (**Table 1**).

Table 1: Summary of Results for 40 subjects: True Reminder Rate (TRR) and False Reminder Rate(FRR)

Subject Type	One task Reminder		Sequence of Tasks Reminders	
Sequence of Tasks Re-minders	TRR (α)	FRR (1- α)	TRR (α)	FRR (1- α)
Students	100%	0%	82%	18%
Elderly	97%	3%	80%	20%
Administra-tion employee	97%	3%	100%	0%
House keeper	89%	11%	74%	26%

In addition, a three criteria evaluation test was run in order to measure the satisfaction level to the users to include: ease of use, complexity and learnability, speed of system response and reliability, (**Table 2**). Subjects were asked to perform certain tasks and the time spent on each task were reported.

Table 2: Measuring user satisfaction

	Time on Task	
Task	**Maximum in second**	**Minimum in**
Go to home page	6s	2.3s
Insert new task	55s	17s
Deal with fit bit to send bio-metrics	10s	6s
Edit task	35s	14.45s
Delete task	6s	2s
Modify setting	8s	3s
Add task	5.37s	3.36s
Edit task	0.98s	0.87s
Get current location	3.5s	2s
Change setting	6.65s	4.22s
View profile	7.31s	4.56s
View favorite place	2.6s	2.2s

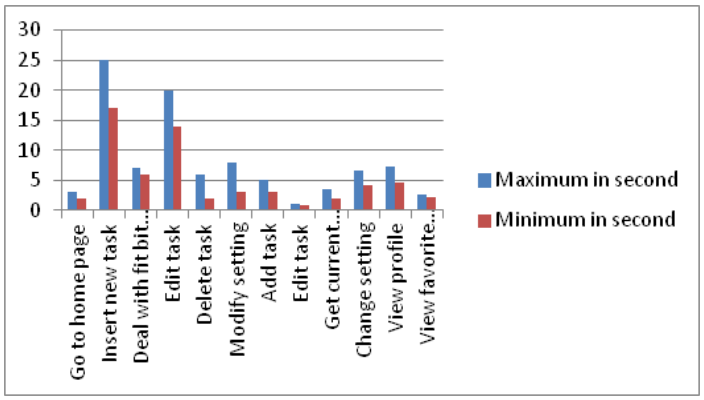

Figure 7: Measuring user satisfaction

Conclusion

Through this project, we present what we achieved and what is the impact of creating a reminder application that connects biometrics measures and tasks based on location. The proposed bio-reminder mobile application; using Fitbit integration, overcomes the simple reminder applications problems for people with the mental health problems. The application has many advantages, especially if you are one of our target groups such as people with Alzheimer's, disability. The bio-reminder would help disabled to in their work and remind them with locations, time, changes in heart rate, their mood, favorite places and less favorite places without assistance from other people. The elderly people with memory problems need a simple visualization program depends on the GPS, time, change in heart rate or mood change to alert them of their dates or daily hospital appointments.

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