

Step Up Life: A Context Aware Health Assistant

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ABSTRACT

A recent trend in the popular health news is, reporting the dangers of prolonged inactivity in one's daily routine. The claims are wide in variety and aggressive in nature, linking a sedentary lifestyle with obesity and shortened lifespans [25]. Rather than enforcing an individual to perform a physical exercise for a predefined interval of time, we propose a design, implementation, and evaluation of a context aware health assistant system (called Step Up Life) that encourages a user to adopt a healthy life style by performing simple, and contextually suitable physical exercises. Step Up Life is a smart phone application which provides physical activity reminders to the user considering the practical constraints of the user by exploiting the context information like the user location, personal preferences, calendar events, time of the day and the weather [9]. A fully functional implementation of Step Up Life is evaluated by user studies.

Categories and Subject Descriptors

H.1.2 [Information Systems]: User/Machine Systems—*human factors, Human information processing*.

General Terms

Algorithms, Design, Human Factors.

Keywords

Personal Health assistant, Context Aware Systems, Geographic Information Systems, Public Health, Environmental Monitoring, Individual Health, HealthGIS, Sensors

1. INTRODUCTION

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The World Health Organization (WHO) has predicted that by 2015, approximately 2.3 billion adults will be overweight and more than 700 million will be obese [25]. A dramatic increase in sedentary lifestyles has invited a wide variety of associated health problems, and an equal focus in combatting these risks with the conveniently available technology has proliferated. While popular fitness tracking apps like Nike+, FitBit, and Map My Run aim to encourage a more active lifestyle, the vast majority of these solutions are significantly wide in scope. These fitness-tracking apps track user activities and generate graphical reports to provide feedback to the user. Our approach is distinct from rest of the fitness tracking apps as we target the single most important aspect of a sedentary lifestyle - doing very brief physical activity after a prolonged interval of sitting-with a more personalized feedback loop through a smartphone's standard set of sensors.

In addition to promoting brief physical exercise after prolonged periods of inactivity, we are also undertaking a study in how users respond to differing kinds of reminders. Our “reminders” are represented in the form of haptic vibrations from the user’s smartphone, brief but noticeable in duration. We call these vibrations “nudges”, similar to an interpersonal interaction where one person nudges the other as a gentle reminder to perform a task. We seek to track a user’s response to varying amounts of nudges to perform brief physical activity. The timing, content, and nature of these nudges will be carefully considered and will likely be heavily overhauled multiple times during the course of the development of Step Up Life, as subtle changes in the way these nudges are communicated to a user can dramatically change the cognitive load and, ultimately, the overall user experience. We hypothesize that a brief, routine, and subtle approach to nudge a user to perform physical activity, and increasing the severity of these nudges if they are frequently ignored, will help significantly in establishing a habit of “taking a break” from prolonged inactivity, and encouragement of the nudges and a minimalist user interface will significantly increase the activity level of a user’s daily routine. The testing of our hypothesis is achievable because smartphones are easily capable of logging activity informa-

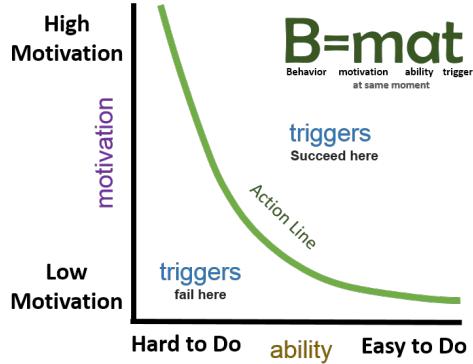


Figure 1: Fogg’s Behavior model [7]

tion such as accelerometer data, and user response. Based on this data, we can conduct user studies that confirm or refute the hypothesis of the overall user experience. We have performed the user study of our functional system and presented our methodology and findings in this document.

2. PRIOR WORK

Dr.BJ Fogg from Stanford’s Persuasive Technology Lab invented the behavior model [7] that shows there are three elements that have to converge at the same moment for a person to adopt a behavioral change. The three elements are motivation, ability and trigger. If the intended behavior does not occur, at least one of the three elements is missing.

In order to understand the significance of these elements, we have to go little deeper into the model. As per Fogg’s behavior model in Figure 1, we always aim to achieve the top right corner of the graph (high motivation, easy to do, a trigger in place). If the user has high motivation and low ability (difficult to do), what he will get is frustration. If it is low motivation, but easy to do (e.g. Turn off light), he will develop a sense of negligence towards the task. Authors have used theoretical models to understand the factors behind motivating individuals to adopt a behavior [23]. According to the Theory of Meaning Behavior (TMB), there are two incentives behind promoting behavioral change: internal and external motivators. Receiving external rewards for behavior like getting more game points for doing some physical activity can be thought of as an external motivator. On the other hand, internal motivators are the type of motivators that are internalized, for example feeling happy or satisfied after doing some work. Because TMB takes “emotional worldview” into consideration, it is considered a reliable theory behind predicting behaviors. Over the years, a new group of technology called persuasive technology started emerging that is primarily designed to change a person’s attitude or behavior. Various tools like pedometer, social interactions, and media would be used by persuasive technology to encourage individuals to adopt a behavior [8]. Various studies have shown that persuasive technology has deeper impact in promoting physical activity and healthy behavior [3]. Several studies have been done in the past and some have come up with the key design requirements of technologies as listed below that encourage physical activity:

1. Give users proper credit for activities,
2. Provide personal awareness of activity level,
3. Support social influence, and
4. Consider the practical constraints of user’s lifestyles.

Several mobile phone applications have been developed to encourage physical activity by various means such as games, exercise reminders, physical activity trackers, and friendly competitions. Studies have shown that competitions among friends provide higher motivation to perform physical activity. Applications like Fish N Step [15] have used friendly competitions to increase motivation by sharing the step count with users’ friends. Fish N Step also used a virtual aquarium with a fish being an avatar of the user. The appearance of the fish depends on the amount of physical activity performed by the user on that day. Fish N Step incorporated a friendly competition through a social aquarium where the users can add their friends and view their avatars. Sometimes friendly competition has shown to have a negative effect as participants overdo the physical activity to beat other participants in the competition, which is bad for user’s health.

2.1 Smartphone Applications

The market for smartphone exercise reminders and tracking applications has dramatically expanded in the recent years. Different applications function by reminding you to step away from your tasks and exercise for a brief period differently. Below we document several existing applications that can be considered similar in nature, and we describe how Step Up Life can better perform this task.

2.1.1 Move-Daily activity to stay healthy

Move iOS application [10] encourages users to perform small exercise tasks throughout a workday to encourage a healthy lifestyle. Although its goal is similar, its implementation is different from Step Up Life in that it provides no context for the reminders and uses the smartphone sensory data to create context of the timing and nature of said reminders. Its way of knowing that a user has performed the task is limited to an “honor system”, in which the user is asked to press a button confirming that the exercise has been completed.

2.1.2 Exercise Reminder

Exercise Reminder iOS [24] application is more directed towards reminding users to perform more rigorous workout routines. The nature of reminders is static, since the user is only able to set reminders for a specific time of the day for each day that this app is expected to be used. Its focus seems different from that of Step Up Life, since we focus on “nudging” a user to stand and perform a brief exercise after a prolonged period of sitting, rather than setting rigorous exercise schedules.

2.1.3 Health@Work

Health@Work iOS application [17] is similar to the above listed application “Move”. It is aimed towards the office worker demographic and consists mostly of static scheduling of brief exercise apps. As with the “Move” application,

this application also does not contextualize the reminders depending on the user activity, nor does it use smartphone sensors to objectively track changes in user activity over a prolonged period.

2.1.4 *ErgoMinder*

ErgoMinder iOS application [13] is identical to “Health@Work” in both scope and implementation. The only difference is it allows a user to customize suggested exercises towards a specific part of the body such as the neck, shoulders, or back. The drawbacks in static scheduling and lack of sensory documentation remain the same.

2.1.5 *FitBit*

FitBit iOS application [6] expands the boundary of fitness tracking by allowing a user to document sleep schedules, dietary habits, and exercise routines. As with many applications of this type, “FitBit” has a different scope of promoting fitness, and does not attempt to specifically encourage sedentary office workers to perform brief exercises in the same way that the previous applications and Step Up Life will focus on.

Not all of the apps and devices discussed above understand the context and alert the user. The most popular fitness applications are primarily activity trackers or static reminder apps, which aid in tracking how many calories users burn during the day or alerting users about their break time. All these apps and devices are targeted towards fitness conscious people who would like to keep themselves in shape. Our proposed application is for people who have a predominantly sedentary lifestyle and do not allocate time for physical exercise as part of their daily routine, but still wish to mitigate the high health risks associated with the sedentary working style for several hours in a day.

3. DESIGN PROCESS

3.1 Ethnographic Study

We conducted an ethnographic study focused on understanding the values, needs, and vocabulary to better understand the practices and life of our target users. We performed a specific type of ethnographic data gathering method called contextual inquiry. Contextual inquiry is all about going to the users’ environment, observing their real work, asking questions, and taking notes. It helped us to have a shared understanding of our target users’ environment and their practices. It also revealed some hidden aspects of their work that were implicit in the users’ understanding. The users for ethnographic study were selected from three target groups as listed below.

1. Students
2. Working Professionals
3. People who work from home

During the ethnographic study, we visited each user twice and a total of sixteen hours of ethnographic study was conducted. We went to their working/living environment, observed what they did, asked questions and made notes. The users’ information is listed in Table 1.

Table 1: Users’ information - Ethnographic study

User	Gender	Age-group	Occupation
User-1	Male	20-25	Student
User-2	Female	30-35	Work from home
User-3	Female	20-25	Working professional
User-4	Male	25-30	Working professional

Finally, we consolidated all the four observations from the three user groups, analyzed the data, and got some insights into their everyday activities. This study helped us to validate our findings from interviews and discover any fact if unrevealed during the interviews. The results from the ethnographic study highly correlate with the findings from interview. The following facts are exclusively discovered from ethnographic study:

- In general, people at the office do not take regular breaks.
- Everyone is aware of the importance of physical activity.
- Majority of users lacked motivation to do physical activity.
- Majority of users realize that a health assistant application would motivate them to do physical activity.
- Few users believe exercise reminders were useful in reminding them to do physical activity.
- Users in common prefer to do physical activity in the morning.
- Majority of the users wanted to know how much physical activity they performed in a day.
- When at the workplace, most users keep cell phones on their desk, but some keep them in drawers.
- Some spend hours together talking on phone, though the health assistant application identifies this as non-sedentary state, the user was actually sedentary while talking on phone.
- Some users go for a short walk, following their lunch. This is a way for them to relax and flex their muscles.
- Some users are totally unimpassioned towards fitness apps.
- Few users browse the internet to find about simple exercises that they can practice at workspace.
- Few users feel it is uncomfortable to exercise at workplace, because of their clothing and environment.
- Few users do not feel good about sharing their physical activity summary with their friends.
- Few users feel motivated when they compare their physical activity summary with the national average.
- Users in common did not seem to be excited about the food recommendations, because they do not want a mobile application to control their dietary habits.

3.2 Online Survey

To help acquire more general knowledge of fitness habits in the workplace, we conducted a user study answered via online questionnaire. We acquired information from 47 individuals, 23 of which were students, 23 working professionals, and one listed as “other”. Of this pool of participants, 17% classified their health in the past 30 days as “great”, 42% as “fairly well”, 35% as “not the best”, 4% as having active health-related issues, and 2% listed “other”. When asked about their working style, 88% of our participants described their day as “mostly sitting”, with 4% “standing”, 6% “walking”, and 2% “other”, with no users reporting their work involving physically demanding tasks. 63% reported that they do not take time out of their day for physical exercise, although 85% say they take “general breaks at the office”. These breaks include 38% chatting with co-workers, 42% “taking a short walk, 4% sit and relax and 13% list “other”. This indicates that while people do not currently take time out of their day to exercise regularly, there is clear interest in taking general breaks that mostly involve moving away from their desk.

However, most of our participants do not factor exercise, with 79% of them reporting that they do not consider exercise in their breaks. At the same time, however, most people realize the importance of physical activity to one’s health, with 83% reporting that they are “aware of the importance of physical activity”.

Finally, 71% of our participants expressed interest in physical activity throughout the day but lack motivation to do so, and 92% of them reported to have smart phones in their possession. This provides an opportunity for us to provide a smart phone application specifically focused on motivating these users. 65% of participants reported that they do respond to phone notifications instantly, although they are typically not engaged in mobile gaming, with only 46% reporting that they play games on their cell phone. While 58% believe that applications can or do have an active influence in their daily activities, only 13% reported that they use some kind of fitness tracker such as Fitbit or Jawbone. To further motivate the use of an health assistant application integrated into the smart phone itself, 56% reported only moderate interest in spending additional money for a separate fitness tracking device and a companion application, and 35% reported they have “no interest at all” in doing so. For those who used such a tracker in the past, 46% only used it for about a month before they discontinued, 4% used it for about 3 months before discontinuation, and 6% used it for more than 3 months before discontinuation. Only 8% still use their tracker regularly. When asked about their discontinuation in a free response question, the most common response was either “lazy” or “due to the lack of motivation”. In the general comments, overall users’ reception was positive towards performing simple exercises at workplaces, assisted by a cell phone application. While some users indicated that they would only find it useful as a motivational tool, others found the ability to track their movements and activity, to be very useful but had reservations about the cost of such a device and companion applications.

4. SYSTEM COMPONENTS

4.1 Accelerometer based activity recognition

With the advancement in technology, most of the modern day cell phones are equipped with various sensors. The combined information from all the sensors is comprehensive enough to understand the users’ context and activity in real-time. Of all the sensors available, Accelerometer sensor forms the prominent component of our application. An accelerometer is an electromechanical device that measures acceleration forces across three orthogonal axes. The acceleration forces could be static due to the gravity pull or dynamic due to the movement of the accelerometer in 3D space. Hence, an accelerometer sensor embedded in the cell phone of a user can provide accurate details about the user’s activity by change in the magnitude and direction of the accelerometer values. These readings can reasonably be translated to the specific types of user physical activity [16, 18, 2, 14]. Smartphones can easily log accelerometer data, and we can link this data to critical times during which we remind users to perform an exercise by taking a break from prolonged hours of sitting. By analyzing the accelerometer data, it is possible to more accurately identify when users actually perform these exercises when they are reminded to do so. This helps us to verify the user’s acceptance to perform an exercise with the user’s actual activity. Further this will in turn enable us to reach conclusions about any changes in user’s physical activity throughout the day, and validate whether the types and timing of reminders used are beneficial to the users.

4.2 Context awareness

Context awareness imparts an element of intelligence to the applications, causing their behavior to match the user expectations [5, 1]. The context aware abilities of Step Up Life allow it to be smart enough to provide timely and relevant feedback.

4.2.1 Age Group

Age group of the user helps the application to be considerate and precise in its exercise suggestions. As Step Up Life caters to users from all age groups, an exercise which is demanding and which requires complex movement of body parts may not suit an elderly user but it would be most beneficial for a youngster [12]. Hence based on the age group to which the user belongs to, the application makes intelligent suggestions on exercises.

4.2.2 Location

The location information of the user (GPS coordinates) helps the application decide whether or not to generate notifications as specific locations are tagged as Do Not Disturb zones by the user [4, 11]. For example, if a user is watching a movie in a theater, it is not appropriate to notify the user to take a walk. On the other hand, notifications would be acceptable if the user is in an office building, and has been in sedentary state for several hours. Step Up Life provides an interface to the user to add a particular location as Do Not Disturb zone. For example, a student using Step Up Life chooses not to be notified for long hours of sedentary state when at library. Hence, the student will add the current location (library) along with a name (tag) as the Do Not Disturb zone. Internally Step Up Life automatically retrieves the GPS coordinates of the current location and saves it by associating with the name tag provided by the user. After a location

has been added as Do Not Disturb zone, for each time the user is at that location, Step Up Life stops notifying the user for sedentary state.

4.2.3 Time of the day

Time of the day adds another dimension to the context awareness of the application by helping it to control the frequency of notifications on a typical working day of the user. Typically, working professionals tend to have longer sessions before taking a break during morning hours of work, and during these morning hours, Step Up Life will observe user's inactivity but will refrain from generating a notification, as the user likely doesn't want to be disturbed during these morning hours of higher productivity. Since the working style differs from one individual to other this feature is configurable.

4.2.4 Weather

The exercise suggestions can be made highly smart and precisely applicable to the context by considering the current weather conditions, before generating a notification. When Step Up Life identifies the sedentary state of the user, before generating a notification it queries for the current weather details. After receiving weather details, it chooses the most appropriate exercise for the user. For example, if the weather information reports that the condition outside is raining, high temperature or windy, Step Up Life prompts the user with exercises which can be performed indoors. On the contrary, if the weather conditions are favorable, Step Up Life suggests the user to go outside of the building and walk around or take a short.

4.2.5 Personal Calendar

Similar to the dynamic context information like GPS, time of the day, and weather, a personal calendar can also be exploited to either suppress or schedule a notification. Before generating a notification for prolonged sedentary state, Step Up Life queries for the calendar events of the user. For each time a calendar event is found, the application suppresses the notification. However it does not let the sedentary state go unnoticed, hence Step Up Life reschedules the notification for five minutes after the current meeting elapse time.

4.3 Notification/Feedback System

Notifications can be generated through multiple ways such as haptic vibrations, auditory feedback, and visual stimuli to name a few. We believe that notification through haptic vibrations is the best means of providing feedback to the user, since it is a simple and effective form of attracting a user's attention, and is silent enough not to disturb the nearby colleagues [22, 20, 19].

4.3.1 Haptic Vibration

When "Step Up Life" observes the state of prolonged inactivity of the user, it notifies the user along with an exercise suggestion by generating haptic vibrations using the cell phone vibration motor [21, 22]. The duration of the haptic vibration depends on the number of times the user has snoozed a notification.

4.4 Integration with Social Networks

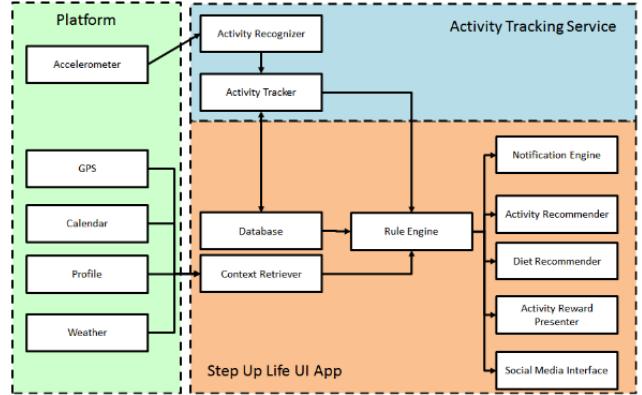


Figure 2: System Architecture

Experiments from social psychology indicate that, sharing information on personal accomplishments, with family and friends acts as a motivating factor for any of the task that the user is involved in. Building on these results, Step Up Life provides users an option to share statistics on social networks about the exercises performed, its complexity, number of hours exercised, calories burnt and many other statistics as accomplishments.

4.5 Dietary Suggestions

We originally planned to include a feature that provided users with abstract suggestions on what kind of food to avoid for the dinner based on the number of hours that the user has exercised and the complexity level of the exercises. The suggestions would be highly abstract as to what kind of food to avoid, rather being specific about the ingredients. For example, if the user has not exercised or not involved in physical activities up to an optimal level, the application will suggest avoiding fatty food. However, this feature was abandoned early in the concept phase due to its lack of focus pertaining to the main feature of exercise reminding.

5. IMPLEMENTATION

5.1 System Architecture

Step Up Life a mobile application is developed on an Android platform. The application has two components: a background service and the UI app. The service runs in the background and listens to accelerometer data. The background service receives a continuous stream of accelerometer data on which it runs decision tree based machine-learning algorithms to classify data as either an activity or sedentary state. The current scope of Step Up Life does not recognize the exact activity if the accelerometer data does not indicate a sedentary state.

The high level System Architecture consists of three main modules which are further composed of many sub-modules. A diagram outlining said sub modules are found in Figure 2.

5.1.1 Activity Tracking Service

One of the major tasks performed by Step Up Life is tracking the physical activity of the user. We recognize the activity

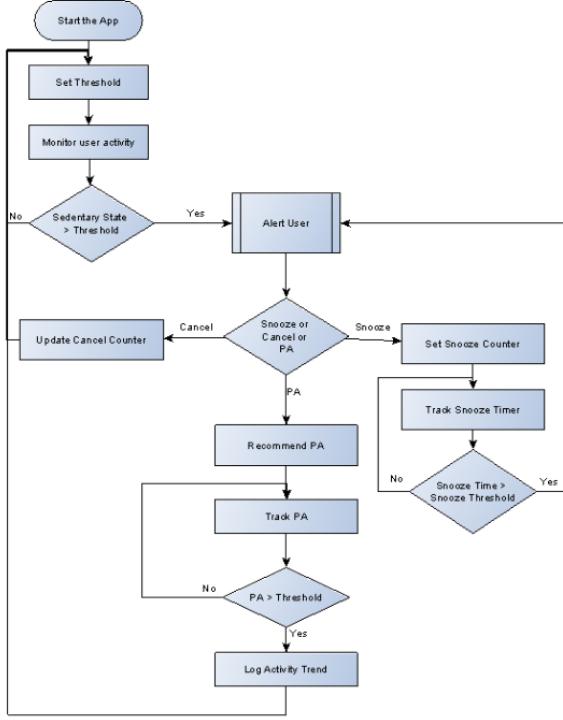


Figure 3: System State Diagram

performed by the user by using the accelerometer data embedded in the smartphone. The activity tracking has to happen all the time, like when the user is using the application or even when the application is running in the background. In order to run the tracking in background, we have implemented the activity tracking module as an android service, which will run even when the application UI is not shown to the user.

5.1.2 Step Up Life User Interface

The second important module of Step Up Life is the User Interface module. This module is an android front end interface to the application which will be used to collect all context information and alert the user based on the context aware rules. All the lo-fi prototypes designed and evaluated during the design phase are implemented in this module.

5.2 User Interaction Design

Having decided on a minimalist approach to the interface of Step Up Life, the application is implemented as a service. The application is built to have a UI centered on displaying positive feedback through visible rewards with intuitive animations to reflect users' accomplishments. Figure 3 describes the application state flowchart that identifies each state of the application interface. This is the state diagram of the overall application. The app maintains a threshold for idle time which varies throughout the day based on time of the day and how much activity has already been done. When the app starts, an initial threshold is set, and the monitoring of user activity commences.

A timer is initialized with the idle time threshold. In the

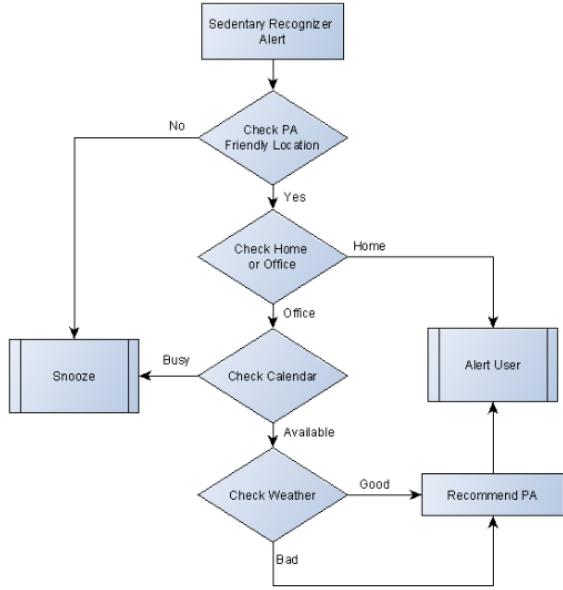


Figure 4: Notification State Diagram

event that the timer runs out, an alert is shown and activity monitoring is temporarily suspended. The alert screen allows the user to choose from the following options: do the suggested exercise, cancel, or snooze. After the user chooses to do the suggested exercise. A timer is initialized, the purpose of using a timer is to prevent the user from over-exercising. When the timer runs out, the user is notified to stop exercising. The user then acknowledges the notification, and the activity is logged. The idle-time threshold is then updated and the timer is reset, with the activity monitoring resumed.

If the user chooses to “snooze” on this exercise notification, a separate “snooze” timer is initialized and a snooze action is logged. Once this timer reaches zero, the user is then asked to exercise again. If the user chooses to cancel, the cancel action counter is updated and the idle time threshold is reset once again. Activity monitoring also is resumed.

Figure 4 shows a second state diagram outlining the notification and feedback system. Once Step Up Life is initialized, the application starts running in the background and tracks user activities. If the user is inactive for a pre-set duration of time, the application identifies this as the sedentary state and the Notification System of the application is activated. Before the Notification System generates a user notification, it checks for many contextual elements [9]. The notification system first checks if the user is in a location where he or she is able to exercise, a state that we call a “Friendly Location”. Examples of such locations include offices and homes, while “Non-friendly Locations” include public places like movie theaters, libraries, etc. We use smartphone’s GPS, Cell ID, and Wi-Fi details to identify the location of the user and once it finds that the user is in a friendly location, it proceeds to check the second contextual

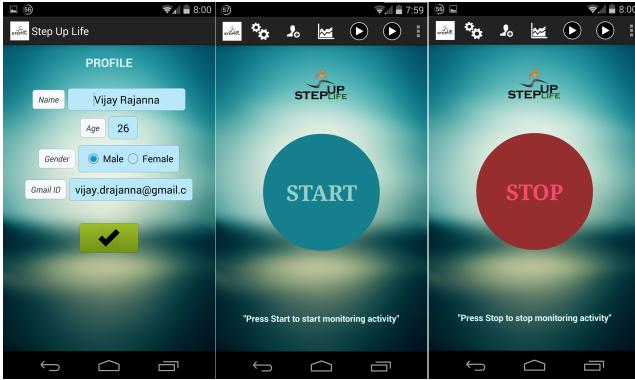


Figure 5: Step Up Life - Start Activity Tracking



Figure 6: Step Up Life- Sedentary State Notification, Reward, and Adding a Do Not Disturb Location.

element, the Calendar. The exception in this case is if the user is identified to be at home, the system will not check for other contextual elements, but will proceed with generating the notification. However, for any other “Friendly” location the system will check whether or not the user has any event planned at that particular time. If no event is found, the system will proceed with an exercise notification. To help the user take the most advantage of favorable weather conditions, the application checks for the current weather details and alters its exercise suggestions based on the information it retrieves. On a rainy day, for instance, the system will only suggest indoor exercises. Some important screens of the android application are given below.

6. EVALUATION

Step Up Life was evaluated in three phases.

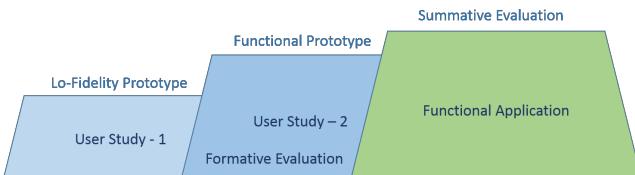


Figure 7: Step Up Life - Evaluation Phases

6.1 Evaluation based on Lo-Fidelity prototype

Evaluation based on Lo-Fidelity paper prototype proved most influential for Step Up Life since this phase introduced nearly 40% of changes in the aspects of the user experience, visibility, and mapping of various user interface controls. During the Lo-Fidelity prototype evaluation, users were presented with the simulation of real time scenarios like as if the user is working at office, or a student continuously studying for long hours and users were also presented with the corresponding user interface sketches of the application that matched the scenario. Further, users were asked to follow the instructions on the prototype screen and act accordingly. This study involved multiple users over a period of several hours but not greater than one day. We conducted semi-structured and unstructured interviews with the users to gather general feedback on the experience of using this application, and to provide them with an opportunity to suggest improvements or changes to the system. The UI sketches presented during user studies included Login Screen, User Profile Screen, Home Screen, Activity Trend Screen, and progress Screen.

Number of users: 04

Occupation:

Students, Working professionals, People working from home.

Summary

- Few participants seemed concerned about the privacy aspects when providing details for user profile. However they were convinced with our explanation of how the security aspects will be ensured.
- Some participants indicated that the users’ clothing would post limitations on the kind of exercise that they can perform. In addition, they suggested that users should be able to choose from a wide range of exercises.
- New feature requests received for “Canceling a notification” and “Snoozing a notification”.
- Feature to share statistics on the social networks was identified as most pertinent and highly motivating feature.
- The users seemed visibly surprised at how often regular exercise actually is in relation to the pace of a workday. Our assumption that most people leading a sedentary lifestyle simply do not realize how little exercise they perform is supported by the behaviors observed in this particular user study.
- Many users provided us with strong support for the “Tree Growing” metaphor that would grow a small sapling into a tree depending on how often the user accepts the notification and performs the exercise.
- Many users wanted better navigation between screens. We did not have a menu-bar to help the user navigate through the app with ease.
- Many users wanted to customize the app to their preferences like type of alert etc.

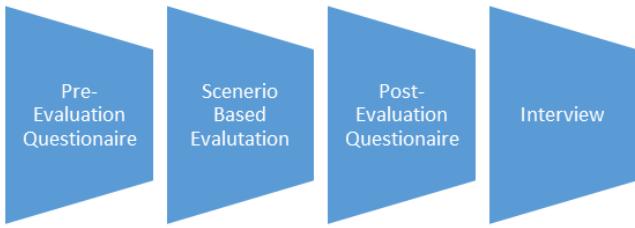


Figure 8: Step Up Life - Functional Prototype Evaluation

- The word “Step count” was confusing to many.
- Many users could not get the concept of reward by looking at the reward screen. In addition, we had to modify the “Activity Tracking” screen to make it more intuitive for the user.
- Many users wanted to set goal and start the day.
- The progress bar we had in the “Activity Tracking” screen to show the sedentary state was confusing.
- Most of the users did not like the food recommendation page.
- Almost every user liked the concept of calendar integration with the app.

6.2 Evaluation based on Functional Prototype

Evaluation based on functional prototype involved four phases.

During the functional prototype evaluation phase, Step Up Life was not functioning as a single system however each of the individual modules were working independently. Hence, the Functional Prototype Evaluation phase was a formative evaluation of the application. During the prototype evaluation participants were first briefed about the general functionalities of the application. We didn't explain each screen of the application because we wanted the users to find them by using the app, we then asked few demographic questions and asked them to perform a set of scenarios . After the users had performed all the scenarios, we asked the following set of questions to evaluate their user experience:

1. Were you able to perform all the scenarios?
2. Which of those scenarios you didn't complete?
3. Rate each of those scenarios on the scale of 1 to 10?
4. Could you find what you were looking for?
5. Was it easy to get to the tracking page?
6. Was anything too obtrusive?
7. Was anything too well hidden?
8. How useful are the app notifications?
9. Name three favorite things in this app?
10. Does the app motivate you to perform physical activity?

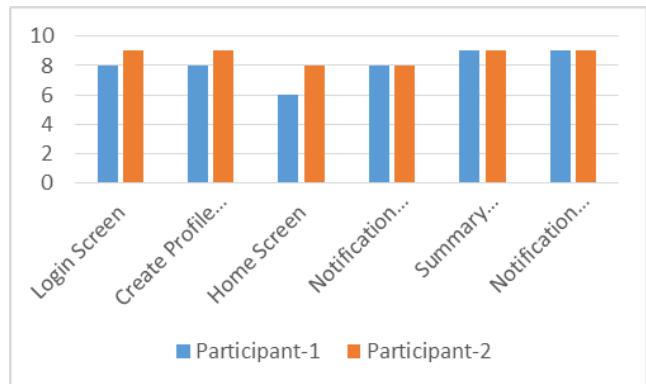


Figure 9: User Ratings for Each Functionality

From the interviews and post-evaluation questionnaire, we gathered each participant's impression about our system's usefulness and usability and suggestion for improvement. All our study was within subjects with different conditions. The independent variables were the individual screens implemented in the app, each serving different purpose. The dependent variable is the change in the user's mental behavior i.e., whether the app motivates them to perform physical activity. For instance, context based notification is an independent variable which influences the intended physical activity motivation. If the notifications were not proper, it might frustrate the user instead of encouraging him/her.

6.2.1 Quantitative Evaluation

Following the qualitative evaluation of the application users were asked to rate various application screens on a likert scale based on the usability aspects, visibility of the UI elements and mapping of interactions to the functionalities. The following graph was generated based on the quantitative evaluation.

With the quantitative user studies, we were able to assess the functionalities that addressed the users' needs and identified some flaws in our implementation.

6.2.2 Affordances/basis for interaction

The app was able to non-invasively prompt the user to perform exercise after a prolonged period of sitting. Interaction with the application itself is minimal, where the user is expected to confirm or decline the exercise and to check the statistical analysis at the end of every day. Users responded generally favorably to this approach in activity tracking and made multiple suggestions of their own, showcasing enthusiasm for the idea. The main affordance of interaction is in watching trees grow, and visualizing how much exercise the user has performed by noticing the tree's state. This functionality was not self-explanatory, but once explained the users were able to get the idea instantly. The affordance of progress-view used for sedentary state was not intuitive for the user.

6.2.3 Visibility

Only a single visibility issue was reported, as the users could not find the cancel counter on the home screen.

6.3 Summative Evaluation

Summative evaluation was performed using the fully functional Step Up Life Android application. The study included two users, both graduate students in their twenties. Listed below were the main considerations for the summative evaluation.

- Participants of summative evaluation had already been part of previous evaluations.
- Hence, the users knew well about the functionality of the application.
- User studies were conducted for nearly 1 hour with each user.
- During the user studies, there was minimal help from the developers and users were asked to use the application on their own.
- All the functionalities used by the user were observed and documented.
- Difficulties and conflicts of the users were resolved on the spot and also documented.
- User study was followed by a post evaluation questionnaire. From the summative evaluation, the following feedback is received on the user experience aspects of the application.

Profile Creation

- Both the users could easily understand the functionality.
- Issues were reported on interactions involving entering the text, as an “Enter” action was not moving the cursor to the next text box.
- They keyboard blocking few UI controls.

Home Screen

- User-2 misinterpreted start button to a video play button.
- Both mentioned that greeting messages are not required.

Notification Screen

- Both users found user experience intuitive.
- Users performed the exercises, tested snooze functionality.
- None cancelled the notification.

Summary Screen

- Users had no clue on how to get to the summary screen.

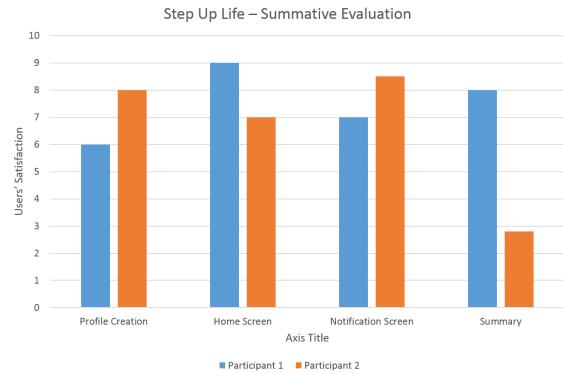


Figure 10: User Ratings for Each Functionality

- Found the information on summary screen sufficient

Both users highly recommended integration with social networks.

6.3.1 Quantitative Evaluation

Following the qualitative evaluation of the application users were asked to rate various application screens on a likert scale based on the usability aspects, visibility of the UI elements and mapping of the interactions to the functionalities. The following graph was generated based on the quantitative evaluation.

7. CONCLUSION

Recent health research has found surprising and highly concerning results pertaining to the health risks associated with sedentary lifestyle. The proliferation of “desk work” has exponentially increased in contemporary society, and the associated health risks are numerous and severe. We have developed a context aware health assistant aimed precisely at users who seek to curb the health hazards related to sedentary lifestyle, and we have identified numerous aspects of user psychology regarding action trigger and peak times to expect results. We sought to use the principles behind persuasive technology to help develop such a system. Results of these initial trials were positive. Nearly 80% of the users from three evaluation phases expressed enthusiastic interest in the concept behind this application, and were interested to know about the different ways that an application can tailor exercises to a user’s workday and other tangentially related factors. One user who is a student expressed concerns surrounding the privacy and usability aspects, especially with the fact that the user is expected to carry his or her smartphone to track this information at all times. This feedback helped to shape a strong direction in which improvements can be made in the future. Overall, the application was received generally well and the system operates within a relatively unpopulated subsection within the fitness domain that nevertheless is important to hundreds of millions of “desk workers” around the world.

8. FUTURE WORK

Although significant important milestones have been reached with this first iteration of the concept, observed areas of improvement from both the design and the evaluation phases

have been identified. During the application evaluation it was very apparent that the users didn't like to carry a cell phone with them all the time, they were not confirmable with keeping the cell phone in their pocket while performing exercises, and lastly even when they were at desk they tend to keep the cell phone on desk. These actions of the user impede the capabilities of the application from achieving high accuracy of activity tracking. Hence, we seek to further develop the application by integrating a wearable device with accelerometer capabilities, and which can stream the accelerometer data to a mobile device. Once implemented, this system will resolve the concerns regarding the accuracy of activity tracking. In addition, users will always welcome this hands free approach to activity tracking. Further, we would like to enhance the data gathering capability of this application. Specifically, we would like to record time data, in seconds, of instances such as time taken for the user to begin an exercise, and average time between an exercise reminder and the actual completion (including snooze time). Other useful information can include statistical analysis of times Snoozed or Canceled, and compare that against the time of the day, number of activities in calendar, or outside weather. This information can greatly aid us in identifications of specific behavioral patterns that can provide an insight into user experience, and help us understand how and why sedentary desk workers perform or choose to ignore physical activities.

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