A Hybrid Model for Usability of Mobile Applications

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Abstract

The success of mobile applications depends upon its usability. Of all the non-functional requirements, usability dimension is the foremost requirement for mobile applications. The usability of mobile applications should be high so that users can interact with them easily. There have been many models proposed that help developers make mobile applications more usable. But they did not address all the issues. In our paper, we propose a framework which is hybrid of multiple models including ISO, Moe, Voelle, Nielsen Zhang, and PACMAD models. In this paper, we also introduce a novel feature "Waste-app" for efficient utilization of memory. It automatically cleans up cache and the apps that have been in use for a long time. The proposed methodology shows that inclusion of this new feature and the new hybrid model gives better results in usability aspects.

Keywords: Mobile applications, usability, Waste-app.

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1. Introduction

The vast and increasing number of mobile applications in the marketplace have opened many challenges for the developers in terms of usability aspects. It has become important to introduce such usability guidelines and standards that should be followed while designing mobile applications. Lot of research have been done to devise these guidelines for android applications. Research has been performed in two major scenarios (i) laboratory studies and (ii) field studies. Laboratory studies are performed under controlled scenarios where the test subject is observed using installed cameras. The test subject is the given mobile application. While in use, its actions are recorded. Laboratory tests lack real time problems that a user can face. Field study on the other hand is built to test in real time scenario where analyst or investigator is responsible to observe the test subject. Several usability frameworks were developed in the past. Most of them were mobile models similar to or inspired from Moe, Nielsen Zhang, and Schneiderman models.

2. Related Work

The increasing trend in mobile applications for performing routine tasks has given developers a new direction to design mobile applications under some standards. To study and create these standards a proportion of research has been performed for many years. This research was mainly performed in two types of environments: (i) Field study and (ii) Laboratory study. In Field study, users are observed while they are interacting with the application whereas laboratory study is performed in a controlled environment.

Jailani [1] et al, proposed analysis of seven different models for providing usability guidelines. This model showed that thirteen parameters were important to consider while designing mobile applications. The thirteen parameters were: (i) effectiveness (ii) efficiency (iii) satisfaction (iv) ability to learn (v) get attention of consumers (vi) presentations (vii) human-computer interaction (viii) navigation and (ix) data obtained from the map (x) mobile context (xi) security and (xii) assistance. Following these thirteen parameters mobile guidelines were proposed for developers while developing a mobile application. Fernandaz et al. [2] presented mobile usability framework to provide ease to the analysts and developers while designing an application. The framework was presented for the Android platform. The goal was to identify possible usability problems while designing an application. The task to identify problems was grouped into four phases: (i) preparation (ii) collection (iii) extraction and (iv) analysis.

The preparation phase enabled logging information by setting up the application prototypes for evaluating the usability. The collection phase ensured proper collection of the necessary data. The extraction phase was responsible for extracting the logged data. The analysis phase analyzes the processed information that which part of the system the users had difficulty interacting with. This [2],emphasized the importance of tools usage for APIs to make simpler developer's tasks. Hussain [3] proposed a technique based on Goal, Question Metric approach for measuring usability of mobile applications. The objective of the study was to validate the metrics by means of several methods. The results from the study helped in making new validation model for usability guidelines. Moritz et al. [4] proposed an efficient and economical usability testing method. Combination of user centered method was promoted to focus mainly on user-based factors i.e. emotions, cognitive and emotional aspects. The model was achieved by the usability evaluation that consisted of two evaluation methods. These methods were categorized into analytical (expert-oriented) and empirical methods (user-oriented). The empirical method was promoted because mobile applications are user dependent. User based evaluation was performed that included usability, cognitive and emotional factors with respect to the user. Then think-aloud test combined with field study were performed. In this phase, the investigator stands at the test subject and observes his actions. Three types of emotional behaviors were considered in this phase. First the blood pressure and heart rate of the test subject is measured. Second is the self-disclosure of the test subject with the help of questionnaires or rating scale. Last is the gestures movement of the test subject by the investigator. Under consideration of the following parameters usability guideline were modelled.

Jesper et al. [5] presented six techniques for usability measurement of mobile applications in laboratory environment. These six techniques were based on two categories. In the first category, test subjects were required to walk while using the mobile phone. Second category test subjects were required to use a mobile system while driving a car simulator. This simulator-based technique was able to collect data quantitatively and qualitatively. Results were gathered by evaluating the mobile applications usability in different scenarios and new guidelines were proposed. These guidelines were divided into three categories of critical, serious, and cosmetic problems.

Dalbir et al. [6] addressed the isolation issue of usability guidelines for mobile applications. A model was devised that comprised of four factors. These four factors were, (i) environment (ii) user (iii) technology and (iv) task/activity. The model consisted of 10 dimensions that were synthesized and prioritized based on importance towards designing usability guidelines. It also included four contextual factors. Fatih et al. [7] presented a critical analysis of existing state-of-the-art usability evaluation models for mobile applications. Mobile usability guidelines were proposed under laboratory experimentation, field studies and hands-on measurement. It was concluded that laboratory studies were more expensive compared to field studies. It also concluded no evaluation studies were performed for IOS applications. It was suggested to apply a hybrid of both studies to obtain better results. Alexander et al. [7] have designed, built, and validated a personalized lung function monitoring device that utilizes smart phone and tablet technology to create a convenient, reliable, and user-friendly system. The portable external mobile device accessory collects spirometry, peak expiratory flow, exhaled nitric oxide, carbon monoxide, and oxygen concentration information from patients after two breath maneuvers. They have also developed a software application that records and stores the gathered test information and e-mails the results to a physician. Telemetric capabilities help physicians to track asthma symptoms and lung function over time, which allows physicians the opportunity to make appropriate changes in a patient’s medication regimen more quickly. Ljilja et al. [8] describe usability studies and redesign of the remote patient monitoring (RPM) mobile application UI for older adults, refined RPM mobile app interface using the UD approach, and a set of inclusive design guidelines that reconcile inconsistencies between design guidelines and UD principles. Vassilis et al. [9] proposed a system that consisted of smartphone (referred as Mobile Base Unit) and wearable sensors. These sensors were responsible for calculating parameters like heart rate, BP, breathing rate and skin temperature within the patient’s environment. The sensors were connected to the smartphone’s Bluetooth. If any problems like slow heartbeat rate is detected by the smart phone, a message alert is sent to the patient. This output was then delivered to the two groups. The first group involves the Medical Center (MC) operators, who receive the generated notifications, evaluate the severity of the patient health status based on the information received, and manage the tele-monitoring process between the patients and the health professionals, thus reducing some of the task overload of the latter. The second group involves the health professionals, who are enabled to view monitoring outcomes through their system referred as the Health Professional Platform (HPP), and in the next step define the patient monitoring plan, i.e., configure the pre-conditions under which the notifications can be triggered.

In this paper, a usability framework for mobile applications is proposed. Field studies were performed under which users were given our own build applications and they are analyzed while interacting with those applications. Section III defines the proposed methodology. Section IV discusses the evaluation of the data and Section V is the discussions and Conclusion.

3. Proposed Methodology

Our proposed methodology comprises of two parts. In the first part, we introduced a new feature which is “Waste-app” that automatically cleans up the cache in order to use memory more effectively. Second, we proposed a hybrid of multiple models to address many usability issues. Usability is about ease of use, understandability, learnability and operationability. We are building a model which consists of all essential usability attributes for mobile applications. Our proposed model is hybrid of ISO 9241-11, ISO 9126-1, Nielsen, Zhang, PACMAD, Moe and Voelle. In this model, we describe that mobile applications should be developed in order to fulfill usability aspects.

Waste-app is basically designed for using memory effectively. Technology is emerging day by day and with every passing day new mobile devices are being introduced. These mobile devices are affordable to every person, so their internal storage is not that remarkable. When the user installed only two to three apps, he faced low internal storage issues. Users find difficulty while using apps when pop up notifications alerting you about low memory. Applications are unable to update because of low space which results in poor performance of the app. Internal storage is filled with cached data and unnecessary updates. User must clean cache manually which is an overhead and layman has not enough knowledge about this. After studying user issues, it has been observed that there should be a way to automatically clean up cache. “Waste-app” has been introduced which automatically cleans up cache for better memory usage resulting in better performance. Waste-app cleans up cache as it gets filled which improves performance of user installed apps. It also notifies about the apps which are not in use for a long time.

Devices should be designed with enough disk space. Each device should be installed with a built-in “Waste-app” application that could be able to delete those applications which are not being used by the user for a specific long period of time and automatically cleans up cached data. The time should be 30 days. After that, if the application is not in use by the user should be removed. Memory could also be saved by restricting automatic updates to manual. Each device should be built in with Anti-Virus to avoid malicious attacks.

3.1. Effectiveness

Effectiveness is the foremost attribute for mobile applications. In usability aspects we always talk about interface, ease of use and its consistency. Interface should work speedily and provide desired output to users. Mobile applications are effective if they have the following characteristics. If the interface performs one task at a time without making it complicated for user. Interface should facilitate searching by reducing the amount of text we enter for search using some filtering techniques. Interface should be designed in a way so that user can easily replicate or repeat their actions. Application should not crash if there comes an error.

3.2. Efficiency

Efficiency is another important attribute for mobile application development. It refers to the amount of resources used in terms of time and space. The interface must be able to improve the speed and accuracy of data as the user intended. It also refers to the immediacy of response towards the actions performed by users. Mobile applications are effective if they have the following characteristics. Interface should provide some filtering functionality to reduce the amount of input text. Interface should also have auto-complete feature. Interface must be error free. Applications are designed in a way so that they notify the user about update of latest version.

3.3. User Satisfaction

Mobile applications should be designed for user satisfaction. The user must be provided with means for providing feedback on the use of the application. Satisfaction is defined as freedom from discomfort and a positive attitude towards the use of application. Satisfaction is achieved by fulfilling the following characteristics. Applications allow users to rate their experience on the use of application. Interface should be easy and comfortable for users. Interface should also be pleasing on eye. Cognitive load on user should be less.

3.4. Learnability

Learnability refers to the application learnability for all levels of users whether novel or expert. Learnability basically simplifies the use of application. Learnability is achieved by fulfilling the following characteristics. Application should provide easy help and guidelines for novel users. Applications should be quick and consistent on all screens so that the user does not find difficulty while switching to other screens. Interface is designed in a way so that it provides an easy and familiar method for taking input.

3.5. Demand of user attention

Demand of user attention refers to the minimum level attention given by the user to operate the application so that user may divert their attention to an important task while still operating the application. Demand of user can be achieved if the application adapts the following characteristics. If the user is busy and unable to pay attention to the application, then application must notify user by using warning messages. Application can also use visual and audio cues to not distract user from performing the main task.

3.6. Navigation

Navigation refers to a navigation plan in order to move between different activities (screens). Interface is designed to provide flexibility and freedom for moving between the screens. Navigation can be achieved if the application adapts the following characteristics. Application's interface should provide necessary shortcuts like "Home, Menu, Go to and Back". The application uses 'breadcrumbs' to enable consumers to know their exact position on the screen.

3.7. Installation

Installation is another important attribute for mobile application's usability. It refers to the ease of installation, configuration, and setup of the application on the mobile device or smart phone. Installation can be achieved when applications adopt the following characteristics. Application should be easily installable. Updates should be installed after successful installation of the application. QR code should be able to download applications from "Google Playstore".

3.8. Safety

Safety refers to the technical design of mobile applications considering the safety of consumers especially in case of emergency or accident. Safety can be achieved when the application adapts the following characteristics. The application should be able to generate warning messages or alerts about the space or memory consumption. If the application consumes too much space or there is not enough memory in the device, it should provide an alert. Moreover, it should also give suggestions from where to delete data to free disk space. It should also ask before accessing user's personal information. It should be able to tolerate user errors like syntax errors or wrong clicking of a button. It should always ask about the confirmation of deleting a data to avoid a situation when user accidentally deletes his data. This way loss of data can be procured. Moreover, the deleted data should reside in the memory for a little time for the case if user wants to recover his deleted data. The application should be able to support App-monetization should be limited i.e., a smaller number of ads should be allowed by the application to avoid interruption.

3.9. Mobile Context

Mobile Context refers to the aspect of taking into account environmental factors such as cold, sunlight and darkness that may inhibit the use of application. It refers to the exchange of data between different applications. Data sharing between different apps should not interfere with each other, it should only share its data without affecting the application or making it slow. Exchange of data should be provided with API integration support. For example, if we want to access maps in our applications, we add google APIs in them. Whenever that maps method is invoked, control will go to API server. It will fetch the data to the application. This is a sort of interfacing.

3.10. Support

Support refers to providing resources to help the user operate the application. It aims to provide convenient access to resources in the event of users having difficulty operating applications. The application should have the following features in terms of support. The application should support FAQs. It should be developed to prevent simple errors.

Figure. 1 Proposed Usability Framework

4. Discussions

In this phase, different mobile applications from both android Play Store and apple iTunes were selected for analyzing usability. We select top rated apps and perform usability analysis. We perform field studies where people from different genres are included as test subjects and their demographic information was also collected. Then we conduct video recorded interviews to find out the issues users face while using the apps. After this process it has been observed that the most annoying thing to users was low internal storage issue. For resolving this issue, we introduced a novel feature Waste-app which automatically cleans up cached data. We analyzed other usability aspects by giving small tasks to users. Then we categorize these tasks based on their level of completion and ease for measuring usability. We categorize tasks into five categories: completely successful, prolonged successful, partial, unsuccessful, gives up. In the completely successful category, users complete tasks accurately without the need of any external guide and also they recall it. In the prolonged successful category, users found confusion while completely their tasks and often unable to immediately recall afterwards. In the partial category, users require some guidance to accomplish their task. In unsuccessful, users are unable to complete their tasks even after proper supervision. And in the gives up category, users think that they are unable to use the app and leave. After analyzing them we propose a model which helps users in all scenarios and improve usability.

In context of evaluation of the model, “Waste-app” played phenomenal role in improving the usability. As memory plays an important role for improving performance which is improved by introducing this tremendous new feature. The data is collected from evaluation of field studies. Studies indicate that mere field study is not sufficient for usability guidelines of mobile applications. These guidelines are non-standardized and flexible documentation approach. We investigate different models like PACMAD, ISO-9126, Moe, Voelle, Nielsen and Shneiderman. These models were not appropriate for addressing all the usability problems. To address all of usability issues hybrid of these models is proposed with a novel feature i.e., built-in Waste-app, notification of the update and controlled app monetization. We have evaluated our model on different built-in android applications and following them increased efficiency is observed as compared to the existing system. The accuracy of the model is 93.5% based on subjective analysis.

5. Conclusion and Future Work

In this paper, a mobile usability model is proposed that helps in ease of use of mobile application. Guidelines for mobile usability are non-standardize format because the requirements of users keep on changing in the real world. We proposed a hybrid model for usability measurement. Also, we introduced a novel feature “Waste-app” which improves usage of memory by automatically cleaning up cache and making apps more robust. It also removes apps which have not been in use for long to free up the memory for more important tasks. The future approach will be evaluation of mobile applications in combination with field and laboratory studies.

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