Customization of Graphical Visualization for Health Parameters in Health Care Applications

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***Abstract*—In the 21st century, health care systems worldwide are facing many challenges as a result of the growing concern of diseases in humans, such as intestine, breathing, paralysis, nutritional value, and urogenital disorders. The use of the mobile technology in the field of healthcare system not only reduces the cost but also facilitates quality of the long-term health care, intelligent automation and rationalization of patient health monitoring wherever needed. While regular monitoring of the readings of the vital signs is critical, it is often overlooked because of the busy life schedule. There is a number of apps for health monitoring systems, but users are generally not satisfied with these applications because of the lack of custom graphical visualization of parameters representations like daily, weekly or yearly graphs, and the relationship between the vital signs. In this research study, we identify a principal issue in the health monitoring application, which is the custom graphical visualization of parameters representations of the health monitoring application. To solve the identified problems in this research study, we focus on the design and implementation of custom graphical visualization of parameters for health monitoring applications. The model emphasizes on the monitor, save and retrieve logs. System usability scale has been modified and evaluated for usability, learnability, and customization of the graph. In this research study, we took N=20 in observation for collecting the readings of Heart Rate, Skin Temperature, Respiration, and Glucose Rate. A total number of responses collected were R=60 from the age group of 24 to 40 years. Comparisons were made between three different Android based health monitoring applications, i.e., S-Health, Health Monitoring and the developed applications. The usability and learnability responses for the developed application as compared to other two applications are significantly high. The overall System Usability Score for the developed application was significantly high.**

***Keywords*—Custom graphical visualization; health monitoring application; learnability; usability**

I INTRODUCTION

In the past few years, significant research has been done in the field of Human Computer Interaction (HCI), such as improvement in the usability, efficiency, and learnability of the systems. Klasnja et al. [1] focus on how behaviors can be changed and monitored in human-computer interaction (HCI) technology. HCI intervention strategy focused on the effectiveness of the measuring (e.g., self-monitoring, conditioning) systems that help in studying the experiences of people with a better understanding of technology. In the last several years, HCI used to support health behavior change is an explosion of HCI research technology. HCI researchers are developing many applications to promote diabetes and emotional self-regulation physical activity, healthy diet, glycemic control, etc.

Fragopoulos et al. [2] researcher said that with growing ratio of the patients in these days, the cost of the health facilities is also massively increasing which causes the patient frustration and anxiety and their common issues become more chronic to deal with the disease. Therefore, quality facilities with smallest financial and medical assets are of great importance. Observing the health complaint of human being in the home and outside the home has been largely mentioned to hold this task.

A wide variety of styles and methods have been used for questionnaires and interviews with users from controlled clinical trials, health care information systems in the field of assessing the impact. WAN et al. [3] focus on the laboratory computer systems and the natural environment for the benefit of human interaction in the field of healthcare.

The concept of an effective visual presentation by a suitable choice of data sets is to facilitate understanding. Within the field of visualization, data can be applied to similar types, many of which are more strategic. These different techniques highlight certain features or data visualization purposes, and clear images. In most cases, the delivery method is appropriate; however, there is a number of ways to present important information quickly and accurately. For a specific data set it is difficult to choose the best visualization technology. This selection problem is compounded by the complete lack of concept evaluation of the effectiveness of methods for certain types of research.

The user, who understands the expert evaluation and user studies, often commonly performed using oral opinion and carried out through the evaluation of the technique. The utility and effectiveness of the measures, the speed of reactions of such customers or reduction in the error rate increases as, quantify to the relatively simple, while others are problematic. For example, the data are highly subjective, because it is difficult to evaluate a better understanding and insight. Oral evaluation approaches that rely on the opinions of the personal preferences, consumer expectations, cultural prejudices scientific fields, and resistance to change can be affected by. The work described in this paper to measure a user's cognitive processing load placed on non-active, non-intrusive monitoring

equipment using visualization techniques to assess plans objectively.

Rosse et al. [4] researchers said that health-related rules for applications or lack of guidance material are accurate and reliable. Apps education and management involves focusing on pain relief, and what healthcare professionals (HCPs) are aiming for. A total of 111 applications met the inclusion quality. Application and content development was the low level of participation in the HCP group.

Many papers recently developed mobile context aware of the plans to review the application. Smart space, healthcare, advertising, mobile directory, remember and disaster warning program reviewed papers covering the following six categories based on their application domains have been selected. These design techniques, simulations and discussion of areas selected on the basis of human interaction computer applications to show their impact on HCI research.

II Related Work

Much research work has been done on the point to analyze the necessity for Human health care and is to rise in developing countries like Pakistan as outcome of great population growth and the challenge for human living charms are enhancing day by day, in that condition it is tough to fulfill with future need of upcoming years. Still there is great need of such smartphone application for living good lives, and to facilitate and patient and their near ones in cost effective and user-friendly way. The existing related work in this regard described below.

U-Health Services based on wireless network that took health care of people anywhere and anytime is proposed by the [5]. They said that latest technology Progress in the field of remote sensing, networking, the development and processing is speed up. By using the wireless and mobile networks, patients can monitor and manage hospital investigation safely and effectively. Although there are a lot of services for your health, including business services, visualize and make uHealth more active in the future.

The survey on Body area wearable sensor based systems used for healthcare services have been conducted by [6] and it is observed that healthcare costs were rising and population of world going to aging phase. Hence, aging population need to monitor their vital signs for good health status without getting the regular appointment from the doctors and go through chaotic process.

Dürager et al. [7] proposed that structural health monitoring (SHM) is the lateral integration of a variety of different disciplines in engineering science. From an engineering structural design point of view, it includes loads and damage monitoring including the different disciplines related to this. Once SHM is defined as a system is realized, it is necessary to be in a structure is implemented that it generates the appropriate benefit in terms of life cycle costs. The study considered SHM in this regard and how the benefits can be determined using mostly examples from aviation.

Ko, JeongGil, et al. [8] described that in last couple of years, increase in development of wireless sensor network technologies that was showing of rising modern technology, development in wireless sensor network, lot of benefits for improving in health care service, farming systems, and automatic home appliances services were done. Yet, still there is great need of such applications in which the user can customize their views as per their need.

Medical surveillance for early growing array of wireless sensors to monitor patients in their daily environment have shown that there is a significant interest. The various wireless sensors and general building applications from scratch smell word information remains a challenge. Software offers, and that the resources and capacity of the battery produces only a low overhead introduced dying between devices. Such middleware is to represent the needs of the dying. SEEGER, C [9] focused on wireless sensor and shows the minimally affected resource-intensive applications sensing Martha phone with an excess of 3% CPU usage and memory usage under 7 MB that appears to meet. The number of applications using our middleware whether the 12 sensor readings per second at 99.9 percent, information delivery, for bonding, we are guaranteed to handle.

Waite et al. [10] described that the incidence of diabetes is on the rise on the back of general use exponential technology personal mobile phone. Progress with respect to data storage, wireless communication and mobile applications (“apps”) has great potential to support the self-management strategies for people who suffered from diabetes. While there was emerging sign base for the positive benefits of these technologies in the care of patients with diabetes, they used a small-scale mixed style approach to usability issues of proposed prototype to identify diabetes care. Their studies also made the individual experience of disturbing glucose diabetes disease application. Hence, it is concluded that the use of software is suitable for children and young people, and the ability to visualize the personal information through the application of glucose seen as an important function by users follow.

Wapata et al. [11] proposed experimental study of 22 evolution criteria have been done. They introduce of smartphones and tablets describe the stages of its service led market growth in the more advanced communication and computer skills presented. Stages of life of patients use this service system and improve their health, as well as the interaction between doctors and patients to facilitate. Researchers such as dementia and autism, accents, and Parkinson's disease, and as many health conditions suggested steps for service requests. Usability often use mobile devices and technology issues with limited experience are used by people who requests them, is an important factor in acceptance.

III Research Methodology

Increasing HCI research on mobile based technologies for supporting to human health and behaviors. There are many health application are developed by HCI research. Most of the applications provides only the readings of different vital signs. Only few applications provide the graphical visualization of different parameters of health. However, the evaluation for customized visualization of Health Monitoring Applications is still a key issue. A prototype has been designed and developed for custom graphical visualization of different health parameters. Attractive and simple GUI with professional touch

and user friendly facility provided to users for monitoring health vital signs. The main function of designed prototype is to monitor vital signs and store their reading and provide log and graphical representation of records on custom need of users.

The BioHarness 3.0 BAN Device connected using the Bluetooth is used to collect the readings of vital signs such as Skin temperature, Heart Rate and Respiration Rate. The reading about glucose is manually inserted by the user. An android based application have been developed to facilitate the customization of the graphical visualization of different parameters. The developed prototype provides the customization to show the reading for days, weeks and months as per need of the user. The system also provides the customization to show the readings at particular date and time. Furthermore, user can customize the graph representation for the combination of different parameters on same axis. The snapshots of the prototype are shown in Fig. 1 to 4.

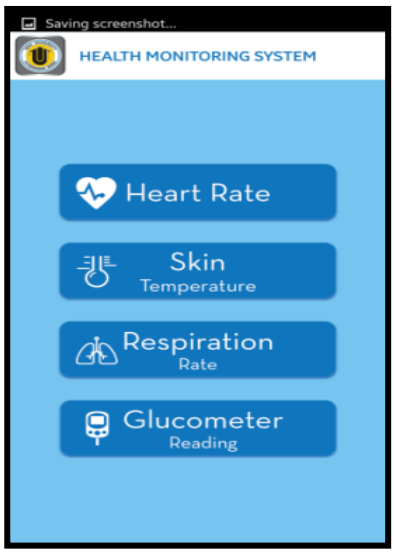

Fig. 1. Main screen of the designed prototype.

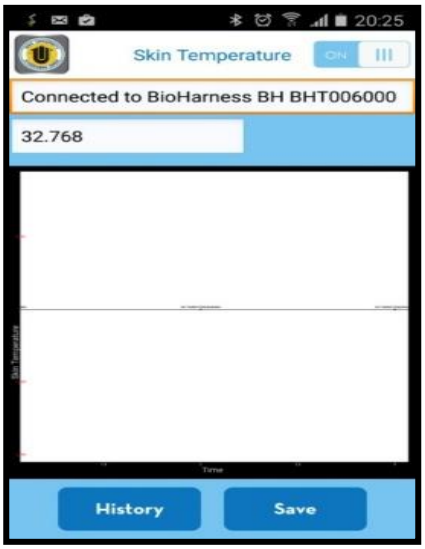

Fig. 2. Connecting with BioHarness sensor.

Fig. 3. Customization of the graphs for different parameter.

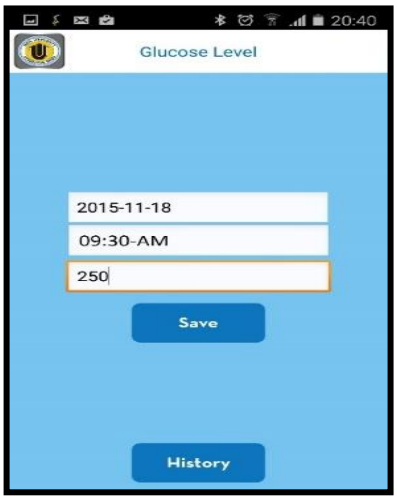

Fig. 4. Input reading of Glucose Level.

IV Usability Evaluation

The user survey (N=20) is conducted for evaluating the usability, learnability and custom visualization of the designed prototype. System Usability Scale (SUS) have been modified for covering all the usability attributes. Usability evaluation will be applied on proposed android prototype to compare the results with other two android prototypes i.e. S-Health app and Health Monitoring app.

V Evaluation Results

The data collected in data collection phase were evaluated. The three SUS Questionnaire Survey was given to 20 participants for data collection. Evaluation results for each section are discussed below:

Evaluation results for average comparison between three apps according to 12 Questions in Questionnaire survey:

For evaluating questions wise average comparison of three apps: 1) HM app; 2) S-Health app; and 3) Proposed app were done. The collected data was arranged in data set for further analysis presented in Table 1 and Fig. 5.

TABLE I. EVALUATION RESULTS OF QUESTION WISE COMPARISON BETWEEN THREE APPS

S.No	HM App	S-Health App	Proposed App
Q1	3.4	3.55	4.1
Q2	2.85	3.35	2.5
Q3	3.85	3.65	4.4
Q4	3.7	3.65	3.95
Q5	3.45	3.85	3.7
Q6	2.85	3.1	3.65
Q7	3.55	3.35	3.8
Q8	3.2	2.8	3.4
Q9	3.3	3.4	3.85
Q10	3.3	4.05	4.15
Q11	3.8	3.85	4.3
Q12	3.2	2.85	4.45

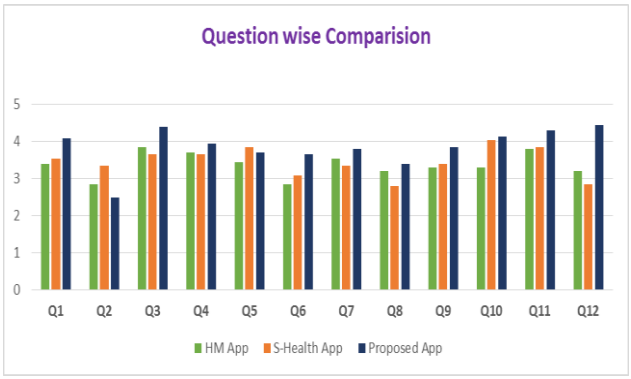

Fig. 5. Results of question wise comparison between three apps.

Evaluation results for learnability, usability and customizability measurement between three prototypes:

For evaluating the learnability of applications — 1) HM; 2) S-Health; and 3) Proposed — Item # 1 and Item # 4 were used from the SUS questionnaire data survey. Average responses from 20 participants for Item # 1 and Item # 4 are calculated in Table 2 and shown in Fig. 6.

Evaluation results for SUS Score of HM app, S-Health app and proposed app:

According to user survey for three prototypes (HM App, S-Health App and Proposed App) the SUS score for three prototypes. All three prototypes SUS score is above average it means according to usability they are above average and proposed app SUS score is higher than HM app and S-Health is given in Table 3 and Fig. 7.

TABLE II. EVALUATION RESULTS FOR LEARNABILITY, USABILITY AND CUSTOMIZABILITY BETWEEN THREE APPS

	Learnability	Usability	Customizability
HM App	3.55	3.294	3.5
S-Health App	3.6	3.444	3.35
Proposed App	4.025	3.681	4.375

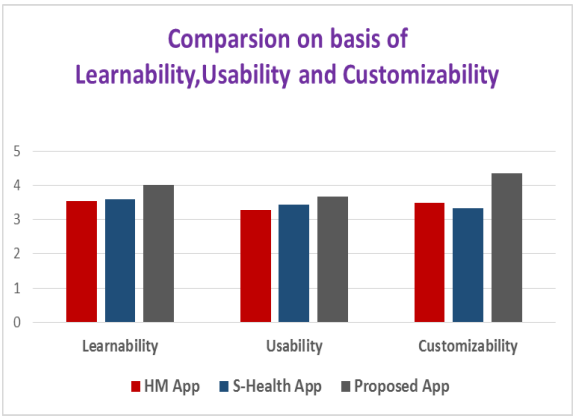

Fig. 6. Result for learnability, usability and customizability of three applications.

TABLE III. SUS SCORE OF THREE APPLICATIONS

	HM App	S-health App	Proposed App
SUS Score	101.125	103.625	115.625

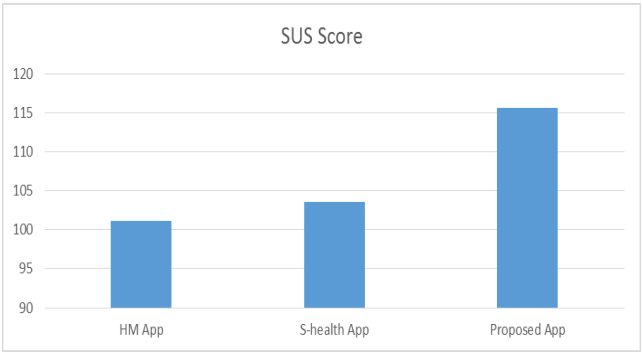

Fig. 7. SUS score for HM app. S-Health and Proposed prototype.

TABLE IV. AVERAGE SCORES OF USER RESPONSES FOR THREE PROTOTYPES (HM APP, S-HEALTH APP AND PROPOSED APP)

USER	HM App	S-health App	Proposed App
U1	4	3.667	3.667
U2	2.583	3	4
U3	3.917	3.167	3.583
U4	3.833	3.083	4
U5	3.667	3.75	3.75
U6	3.833	3.583	3.75
U7	2.25	3.75	4.167
U8	3.75	3.583	3.75
U9	4.083	3.583	4.417
U10	2.167	3.5	3.917
U11	3	4	3.667
U12	2.667	2.917	3.167
U13	3.333	3.25	4
U14	3.583	3.583	4
U15	3.5	3.5	4.583
U16	3.583	3.417	4.25
U17	3.583	3.667	3.833
U18	3.5	3.417	3.75
U19	3.417	3.417	3.333
U20	3.167	3.25	3.5

Evaluation result of three Apps according to Mann Whitney Test:

For evaluation result according the Mann Whitney Test, we took average of all 20 user responses for HM App, S-Health and Proposed App as shown in Table 4.

VI Conclusion

The motivation behind this study is to provide custom graphical representation of parameters of health monitoring application. For measuring the customizability and usability a prototype was designed and assessed by the (N=20) participants.

The application mainly focus on providing the user with the option of adding various variables and health parameters constraints (Heart Rate, Skin temperature, Glucose Meter readings and Respiration rate). Further the interface of the application is flexible for showing the graphs for combination of health parameters at different intervals. The participants including the patients, doctors and other users elucidated that the customized healthcare systems is potential tool to provide the information about one's health parameters at any time without any cost which was previously time consuming, inaccurate and costly task.

From the literature review it is found that health monitoring application is great tool to monitor vital signs not only measure usability but enhance the mobile based health monitoring application development. The overall System usability Score for the developed application is 115.65 that is significantly high as compared to HM and S-Health application.

Results indicates that average learnability scores for the HM application and S-Health application are same whereas it is significantly high for the Developed application. After Mann Whitney test shows that HM app is not significant with S-Health but HM app is significant with Proposed App and S-Health is significant with proposed app at significant level of 0.05. The Usability measurement for all three application were same in all evolution results where there is great impact have been observed in developed application for the responses related to the customization of visual graphs.

VII Future Work

The designed prototype was evaluated for usability, learnability and customizability using the System Usability Scale method. However. The customization of the other parameters like body posture, ECG, calories intake, blood pressure, etc. should also be incorporated that could possibly lead to improved results.

The actual adoption of such systems in current hospital systems could lead to better treatment decisions, better treatment outcomes and an improvement in the overall quality of patient care. In addition, healthier patients who have fewer complications related to chronic conditions spend less time at clinics, in the hospital, or in the emergency room, all factors that could lower healthcare costs.

The incorporation of intelligent agents to support the patient and medical staff in customized visual representation provides quality healthcare system.

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