ABSTRACT
Nowadays, the use of mobile devices is no longer only for accessing information but also become useful for supporting heathy lifestyle management. More and more different kinds of mobile applications are developed for helping people to facilitating the progress of fitness-training. This article is a literature review that aim to discover the current visualization and usability issues involved in developing fitness-training application on mobile devices. By researching on related work, it is proved that visualization of mobile software application can make it productive and accessible. It is important to find out how to make visualization of mobile software application interactive and usable for users. This literature review identified the problems of usability and visualization when developing mobile software applications for fitness-training and examined some appropriate solution approaches for those problems. In addition, this literature review identifies several usability criteria and models to evaluate the effect of the design approaches.

Author Keywords
Usability, Visualization, Mobile device, Fitness-training, Human Computer Interaction

2. DEFINITION AND SCOPE
In this literature, only the software applications related to fitness-training are included. The mobile devices cover the following: laptops, smartphone, tablet, smart watch and wearable electronic devices.

3. BACKGROUND AND MOTIVATION
In the modern society, ones’ heath status has become a measurement of quality of life. As mobile devices are widely used, different kinds of fitness-training apps are developed to encourage people to participant in physical activities. However, if users do not know how to use the apps, the functionality of the apps will be useless. The consequence will be people give up using those apps as they are inconvenient and inefficient. The visualization and usability of a software application in mobile devices has become important aspects.

4. LIMITATIONS OF MOBILE DEVICES
Actually, unlike developing software applications in desktop computers, mobile devices have more software and hardware constraints need to be considered. It is necessary to research on the usability of fitness-training applications suitable for portable electrical devices.

In the article Visualizing Information on Mobile Device [1], the author has summarized some major limitations of mobile device that developers should concern about as following:

- Limited display because of screen size, resolution
- Less powerful hardware of mobile device comparing to desktop computers
• Different input technique as mobile devices are commonly touch based while desktop computers using keyboard and mouse.

• The available tools for mobile devices are still lower level than desktop devices.

• Impact from the variations of physical environment will affect the interaction between user and application.

• Large amount of data stored on remote database will affect the interactivity on mobile devices since the connectivity is slower and unstable comparing to desktop computers.

• The performance and operating system vary greatly among different models of mobile devices.

From the above summary, it is obvious that software application developed for desktop computers are not suitable well for mobile devices without extensive modification. In another published paper entitled Usability of mobile applications: literature review and rationale for a new usability model [6], the above points of view are supported. In the near future, some of these restrictions introduced as above are not possible to disappear because of portable devices need to remain compact in size.

5. USABILITY CHALLENGES

Since there are many limitations of mobile devices, the developers will encounter a lot of challenges while developing fitness-training applications for mobile devices. The way to visualize five types of data which are text, pictures, maps and physical objects for mobile applications have become issues for usability. Each of those data types has unique challenges [1].

Text

Presenting text is different from presenting it in desktop computers due to mobile devices’ limited screen size. To solve this problem, researchers have proposed many presentation techniques. One approach technique is Overview+Detail.

Picture

In desktop computers, it is easy to browse any size of photos, charts, diagrams. However, for mobile devices, browsing large size of any picture will be an issue due to limited screen resolution on mobile devices. Users usually have to take actions of scrolling and zooming. To reduce the number of those actions, it is proposed to adapt text visualization techniques such as RSVP. This technique can enable users to cycle through different chosen portions of a photo.

Map

Unlike desktop computers have to be stable, mobile devices can be used while users are moving. Therefore, many map-based applications can be added to mobile devices such as navigation. However, due to the large amount of data of maps, what contents should be displayed and how they are presented becomes a challenge of usability.

Physical objects

Currently, it is possible to visualize computer-aided design models in mobile devices. But due to different power of hardware between mobile devices and desktop computers, the efficiency of visualization of design models in mobile devices is affected. However, users performing tasks on mobile devices usually do not expect it can have the same level of detail and performance as desktop computers. The challenge is that how to make it simplified and manageable for users.

Abstract data

Abstract data such as calendar-based applications can be easily displayed in desktop computer. But visualizing it on small phone is difficult. Tradition way of displaying a one-month calendar seems to be impossible.

In the following literature review, some solution approaches of some of the above usability challenges will be introduced.

6. DESIGN APPROACHES

6.1. Design process

The author of the paper of Visualizing Information on Mobile Device [1] proposes six major checklist processes for developers to build mobile application visualization, which improves the design efficiency and usability of the application. The following concepts are addressed as the six major checklist processes:

• The mapping of information:

  How the information should be encoded and display for users is a question needed to be thinking about when developing user interface of an application. It includes different types of data such as numbers, lines, string and so on. Precise mapping of those data types can improve the visualization of the application. A constant mapping of information throughout the application is an important aspect.

• Selection of data

  Which data type should be chosen for visualization is also an issue. Displaying unrelated data for some tasks may lead users to make wrong decision and misunderstand the original goal. This issue becomes more critical in mobile device because of the limited screen space for visualization.
• **Presentation**
  The layout of the user interface on available screen space is important. A suitable design of layout can be more effective for user.

• **Interactivity**
  It means how users are engaged with the application. Users will have better user experience and exploration abilities with an application of good interactivity.

• **Human factors**
  This refers to whether the visualization is easy for people to recognize and understand. The application interface has to take into account human physical and cognitive capabilities.

• **Evaluation**
  It is necessary to validate the effectiveness of visualization with proper usability evaluation method and technique.

A sample application is demonstrated in the article [1] for explaining the different design solutions for mobile devices and desktop computers. This gives a good approach to improve the visualization design working on mobile devices.

### 6.2. User interface design technique

For designing user interface of mobile device, the traditional techniques for designing desktop computer software will not be very useful. Exploring for new techniques for designing user interface of mobile devices is necessary.

In the article of *Designing Visual User Interfaces for Mobile Applications* [2], the peculiarities of human interaction with mobile device are illustrated. It shows evidence of how more difficult to build a usable and efficient mobile user interface of applications for users by traditional UI knowledge. The author provides a tutorial for designing mobile GUIs and visualizations of applications. It also shows how to face the design limitation of mobile device by examining the different types of design techniques and tools.

Currently, with the increasing advanced graphical hardware capabilities, it is possible to develop new type of interface such as 2D and 3D interactive graphics to enhance the usability of mobile application. This helps users can deal with more complicated tasks and larger amount of information easily. In addition, mobile devices have the advantage of providing functionalities that are not available on desktop system such as GPS, NFC physiological sensors and so on. There are some issues of how to visualize those functionalities especially from mobile devices in the user interface.

Several advanced techniques are introduced in the article as solutions of above issues. For example, visual dynamic queries, new navigation widgets, 3D visual instruction, zoomable user interfaces. Those techniques also improve the influence of mobile GUIs for users.

#### 6.2.1. O+D visualization approach

For building a fitness-tracking application, the information needed to be displayed would be a large amount. The Overview+Detail visualization technique provides a potential solution for designers to design the user interface of mobile application.

In the article of *on the effectiveness of Overview+ Detail visualization on mobile devices* [5], it researches on how Overview+Detail technique has influence on displaying large amount of information in both desktop device and mobile device. Overview+Detail technique is the approach of providing both overview and detail information in visualization of applications by displaying two separate area of views. One area is for the context information and the other is for detail information. This technique is widely being used in desktop applications (such as Google Map desktop version). Whether using this technique in mobile application has become an issue. In this paper, researches of Overview+Detail technique in both desktop and mobile context are conducted. It includes researching on the design space for Overview+Detail visualization, Overview+Detail presentation, Overview+Detail usage, empirical evaluations of Overview+Detail visualization. The researches provide a detail analysis of the advantages and the disadvantages of Overview+Detail visualization technique on mobile devices by comparing the research outcome of both desktop and mobile studies. In the second part of this paper, two features of Overview+Detail interface, adding interactive capabilities to the overview and highlighting possible objects of interest in the overview, are analyzed by conducting user study.

The result shows that both features have benefit for users and improve the users’ performance. However, since the knowledge of advantages and disadvantage of mobile devices is still limited, it is needed to carry out further analysis.

#### 6.3. Gamifying design approach

Although everyone knows the importance and advantages of working out, many people are not determined enough to work out for long term. How to encourage people and improve their way of thinking and behaviors becomes an important issue while developing mobile fitness-tracking software.

- 6.2.1. O+D visualization approach
- 6.3. Gamifying design approach
In the article of User Requirements for Gamifying Sport Software [4], it researches on whether sport tracking software system can be designed to affect human’s behavior actions with persuasive technologies. To find out what is the user requirement for sport tracking software application to make it appealing to users, a four-week long experiment with five participants were conducted. These five participants were required to perform several workout tasks with sport tracking devices included GPS sensor. There were two different levels of gamification. One level is no gamification and the other is providing gamification by transforming the exercising activities into game-like activities with a lot of visual feedback, such as average speed, distance, map, time. After the experiment, the participants were required to provide the feedback of the devices.

The result of the experiment shows that it is important for the sport tracking software to provide feedback for users. The feedback provided is truly affecting and improving the users’ physical performance. It is necessary for designers to consider the types and amount of feedback while developing a fitness-tracking system. In addition, the result of experiment also shows that users are encouraged to overcome themselves in exercising performance after they receive the feedback of average speed, which is represented as “score” in a game.

However, the feedback of participants also shows that the interaction between fitness-tracking software and users has to be simple and easy to use. This is because too complicated user interface of fitness-tracking software may cause disorientation and anxiety of users.

This paper provides evidence for designing fitness-tracking system that gamification is an important factor for improving users’ exercising performance. It reminds designers to consider more about the interaction styles and human factors when designing a fitness-tracking application. Also, it brings out the issue of what level of complexity of visualization is suitable for human users in fitness-tracking system. The usability feedback obtained from the participants in the experiment provides a potential solution of the issue.

7. USABILITY EVALUATION
Usability evaluation for software application is an important process on measuring the application capacity to meet its goal. In this section, usability requirement and usability model of mobile software application is discussed.

7.1. ERGONOMIC CRITERIA OF FITNESS APPS
In term of fitness-training application, the usability requirement of users is different from other applications. In the article entitled A Usability Evaluation of Fitness-Tracking Apps for Initial Users, [3] it is analyzed for the usability of the most popular fitness-tracking apps by walking through the major task focused of those apps. In this paper, the author first presents the usability concept of fitness-tracking apps and the inspection method of usability. Then introduce the ergonomic criteria evaluation technique of fitness-tracking apps as following:

- **Guidance**
  The system should guide users to achieve their purpose. The quality of guidance is affected by visual organization, instant feedback, instruction of a system.

- **Workload**
  Workload is the measurement of how the system reduces the cognitive load. It means the system should only show what is necessary to be shown and users can choose what they want to do.

- **Explicit control**
  It means a user request is processed precisely by the system and provides appropriate action control for users.

- **Adaptability**
  It measures the quality of flexibility and user experience of the system. Flexibility means users can customize the system to their preference. Users experience means users can reach their purpose in many ways the system provided. This includes step-by-step instruction and shortcuts to lead users.

- **Error management**
  It measures how the system avoids errors and help users to recover from errors.

- **Consistency**
  It measures how consistent of user interface for similar context.

- **Significance of codes**
  It means how easy to understand the code of the system with the provided reference.

- **Compatibility**
  It measures the performance of the system running in different environment.

The author demonstrates the evaluation technique by evaluating five popular fitness-tracking apps in Play Store which are RunKeeper, Nike+Running, Runtastic, Runtastic Pedometer, Endomondo Sports Tracker. Those apps have different design basics and functionalities.

In the inspection evaluation process, those apps are firstly installed in the same mobile phone in Android operating system then conduct an exploratory research in each app to
examine the coverage of their task. According to the research result, a list of main tasks was defined to be evaluated by the ergonomic criteria.

**Figure 1: Results of inspection evaluation by ergonomic criteria of the five apps**

By comparing the five analyzed apps, the results show that it is important to carry out a usability evaluation and each application inspected is identified to have some usability problems that users may encounter while using the application. It is helpful for evaluating fitness-training application by applying these ergonomic criteria.

### 7.2. USABILITY MODEL FOR MOBILE DEVICES

A mostly being used usability model created by Nielsen identifies the following attributes of usability:

- **Efficiency**: How effective and accuracy users can achieve their intention.
- **Satisfaction**: How users feel comfortable with the product.
- **Learnability**: How easy users can understand and learn to use the system.
- **Memorability**: How easy the system can be reused by users without learning again.
- **Errors**: the error tolerance of the system

However, the above usability model is derived from traditional desktop application. It does not consider the usability challenges of mobile devices. A more suitable model for mobile device is needed.

#### 7.2.1. PACMAD: usability model of mobile device

Mobile application designers sometimes ignore the fact that users always intend to interact with mobile devices when they are on the move. In the article entitled *Usability of mobile applications: literature review and rationale for a new usability model* [6], it introduces a new usability model which is called PACMAD. This model incorporates cognitive load since this aspect has directly influence to the usability of an application. To validate this model, a literature review on the existing models of usability is conducted in this paper. The attributes of usability and the limitations for mobile applications are introduced from the literature review.

The review conclusion shows that a lot of existing models do not consider mobility and its consequences. The PACMAD usability model for mobile application is developed based on the existing usability models with attributes of *Efficiency, Satisfaction, Learnability, Memorability* and *errors*. However, it also identifies three more factors which are *User, Task and Context of use*. Those factors will affect the final interface design of mobile applications. The following figure compares PACMAD with other two existing usability model.

**Figure 2: Comparison of PACMAD model and other two existing models** [6].

For developing a fitness-tracking application, it is important to validate the usability of the application. It is useful for developers to validate the usability of mobile applications by using the PACMAD model.

### CONCLUSION

In this literature review we have examined the usability of fitness-training applications for mobile devices and identified the usability challenges and visualization issues concerned. Also, we discover some user requirements for fitness-training applications that developers should not ignore. Some potential solution approaches are inspected and they provide suggestions for us when we are developing fitness-training applications for mobile devices. Finally, this literature has studied serval usability criteria and models. It is concluded that by considering the normal usability criteria on top of PACMAD model, the
effectiveness of the design approach for mobile fitness apps can be fairly effectively evaluated.

FUTURE WORK
More research particularly in the area of fitness-training applications and user interface design would be valuable. The Overview+Detail design approaches introduced by Burigat had provided positive results for usability of mobile applications. But further more research is required while developing more complicated user interface. Also, in this literature review, there is only few design techniques are introduced and analyzed. Furthermore research on detailed design approaches would be necessary. More research on more existing fitness-training applications would be helpful to realize the effect of different design techniques.

REFERENCES


