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Master Thesis

in Telemedicine and e-health

ActiveTeen- A Mobile Social Networking Mapping and Gaming application

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by

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Dedication

To my beloved family in Palestine

&

To my friends In Norway and Spain

Acknowledgment

I would like to show my gratitude to both supervisors Vicente Traver- Spain and Randi Karlsen- Norway for their continuous support, guidance and constructive thoughts regarding this work. Not to forget my teachers represented by Gustav Bellika and Gunnar Hartvigsen who supported me all the way.

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Abstract

This research presents theoretical and technical aspects behind ActiveTeen application. Being new to mobile development, a thorough analysis for selecting one mobile platform for the development were established is seen as a crucial point to the key success of the application. Two competitive platforms including the iphone and Google Nexus1 were nominated and the iphone was selected.

Software engineering methodologies were employed in the application, beginning from collecting the requirements, UML design presented by use cases, initial user interface and architecture of the system. Such methodologies helped in clarifying and maintaining pieces together for the implementation phase. ActiveTeen is seen as a contribution to the telemedicine research in the promotion and the prevention of Obesity and overweight among adolescents, and to the open source community to expand it and add more features to it.

Executive Summary

Using mobiles for health related purposes have been studied for a while and new concepts such as mhealth have been introduced. The latter is believed to have a great potential in taking health related applications to a higher level especially with the introduction of a high-tech mobile phones called “smartphones”. This research presents different aspects of mobile’s potentials that have been employed in ActiveTeen which is a Mobile Social Networking Mapping and Gaming Application that intends to help adolescents in doing at least 1 hour of physical activity.

To approach the problem, several methodologies have been employed. Thorough analysis of two competitive mobile platforms has been performed as part of a selection process in ActiveTeen development. Another Analysis were performed represented by Related Work and State of Art which discusses different applications that have been implemented on the selected platform and is considered to be relevant to ActiveTeen application and share some functionalities with it.

Software Engineering (SE) methodologies is seen to play an important aspect in any project life cycle beginning from software requirements; the functional and non- functional requirements (FR, FNR) which describe what kind of functionalities the system is trying to achieve, protocols and guidelines to comply with and ending by a fully running application.

The structure of this thesis is as the following:

Chapter 2 presents the theoretical part which gives an overview of co-related concepts that is directly related to ActiveTeen application. It is very essential to be familiar with such concepts and it can be considered as an added value to the research.

Chapter 3 presents a partial software engineering methodology summarized by the software requirements (FR and NFR), Unified modeling Language (UML) design summarized by use cases, initial user interface and system architecture.

Such methodologies are considered to be the starting point for tackling the problem in a broader vision.

Chapter 4 presents the implementation part starting by choosing a platform, discussing the components of the application and how things are programmatically done.

Chapter 5 presents the overall results and the evaluation process.

Chapter 6 presents a discussion about this work, its limitation and the lessons learned.

Chapter 7 presents a conclusion of the thesis and discusses the problems encountered during the project life cycle. Future work presents and discusses what couldn't have been achieved in this thesis and why and present other solutions to be integrated with the application in the future.

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Abbreviations

UML: Unified Modeling Language

mHealth: Mobile Health

SE: Software engineering

FR: Functional Requirement

NFR: Non Functional Requirement

PA: Physical Activity

WHO: World Health Organization

CHF: Congestive Heart Failure

ICT: Information and Communication Technologies

PDA: Personal Digital Assistant

UX: User Experience

EU: European Union

FTO: Fat mass-and-obesity-associated gene

GPS: Global Positioning System

SNs: Social Networks

3G: Third Generation

iOS: iphone Operating System

API: Application Programming Interface

XIB: X- icon Interface Builder

BMI: Body Mass Index

CHF: Congestive Heart Failure

COPD: Chronic Obstructive Pulmonary Disease

SMS: Short Message Service

UC: Use Case

GMaps: Google Maps

GHz: Giga Hertz

CPU: Central Processing Unit

JVM: Java Virtual Machine

SDK: System Development Kit

DRAM: Dynamic Random Access Memory

eDRAM: Enhanced Dynamic Random Access Memory

URL: Uniform Resource Locator

HTML: HyperText Markup Language

HTTP: HyperText Tranfer Protocol

Chapter 1- Introduction

1 Introduction:

1.1 Motivation

The lack of regular physical Activity (PA) among adolescents is increasing day after day, and that increases the prevalence of obesity and overweight worldwide. It had been identified by World Health Organization(WHO) as a global epidemiology [1] because of its huge numbers, its relation to several diseases and the fact that it also increases significantly with age, and consequently developing what is called “diseases of old age”. Such diseases may include: diabetes type 2 , some types of cancer, high Blood pressure, hypertension, high blood cholesterol, Congestive Heart Failure (CHF), Heart disease, Stroke, and some others that include Gallstones and gallbladder disorders, gout, Osteoarthritis, complications of pregnancy, Poor female reproductive health, Bladder control problems and Psychological disorders [2-4].

Health policy makers worldwide are pushing towards a precious goal which is “health for all” that had been recommended by the WHO and yet far from being achieved. However, some still believe that the rising notion of ubiquitous computing also called nowadays “pervasive computing” with context awareness as one of its basic components, may have a significant impact on achieving such goal. It had been introduced by Mark Weiser in 1991 and it is based on environments that are saturated with computing and communication capabilities to be integrated with human users [5]. Technology at that time wasn’t ready to achieve such vision, yet after almost 20 years, much has been done especially with the advancement in Information and Communication Technologies (ICT), ubiquitous wireless and mobile technologies.

Using mobiles in health applications have been visible in the market and has many opportunities in improving the quality of life, care, health education and reduce costs for patients with chronic diseases such as diabetes. It is commonly used to collect community and health data, exchanging the collected health data with the practitioners, researchers and patients, real-time monitoring of patient vital signs, and direct provision of care [6, 7]. Mobile market is growing rapidly where it is estimated that there are more than 3.5 billion mobile phones over the globe and the number is expected to double in the next decade [8, 9]. In Norway, more than 85 % of adolescents owns a mobile phone [10] and another study in the US shows that 75 % of adolescents (ages 12-17) own a mobile phone where 46 % of its usage goes for games [11].

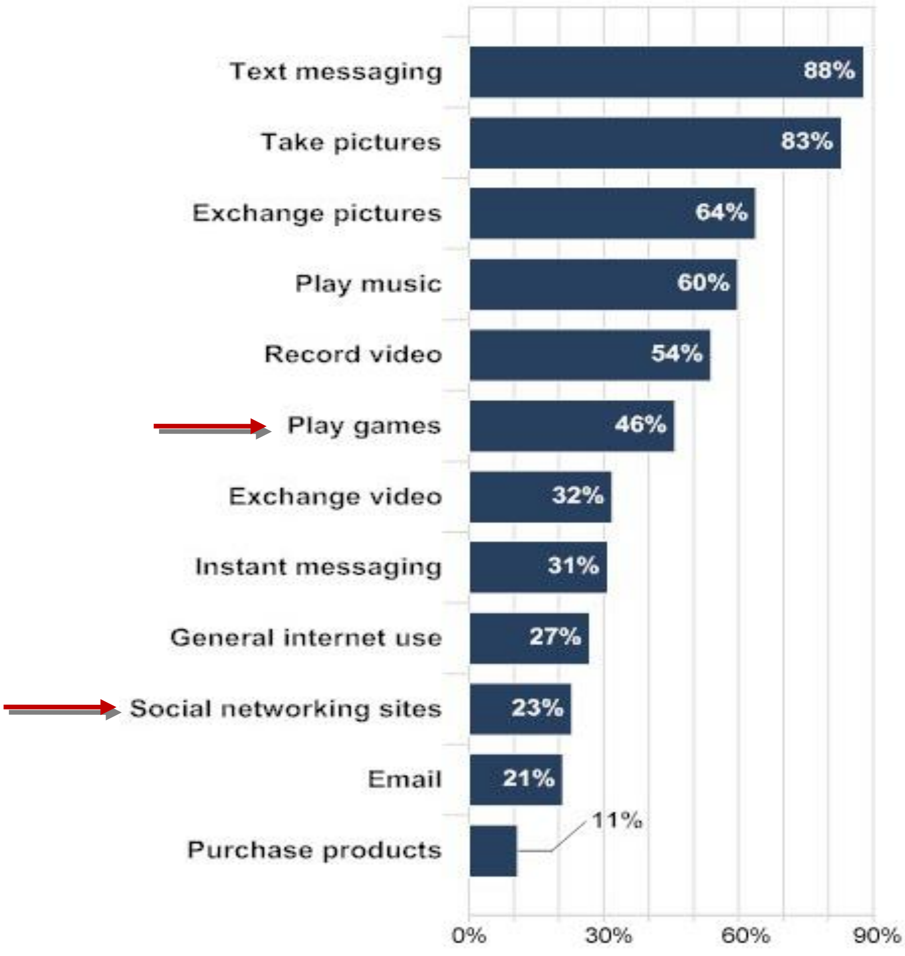


Figure 1- Games and Social Network usage among adolescents [11]

Adolescents tend to have the latest high- tech mobile phones called Smartphones. There seems not to be a standard definition for smartphones and several definitions can be found in the literature whom which a relevant one had been obtained

“A smart phone is a handheld device that combines the functionality of a cellphone, a Personal Digital Assistant (PDA) and other information appliances such as a music player [12]”.

ActiveTeen intends to help adolescents to do physical activities in a regular manner. Such application may have a significant impact in reducing overweight, obesity and achieving good health outcomes. According to one large survey that had been conducted on 2000 adolescents, 1 out of 5 uses Smartphones for gaming and in Social Networks (SNs). Mobile gaming is increasing rapidly and reached 5.6 billion USD in 2010 and it is expected to be doubled in 2014 [13]. Statistics show that there are more than 42.7 million Smartphones in the US alone and by 2012, it is predicted to have 70 % of Europe’s mobile market [14, 15].

As for the SNs, it is estimated that more than 500 million Facebook users >=13 years old- over the globe where nearly 73 % of SNs users are adolescents and almost the same number for adults [15, 16]. Facebook and Twitter are the most leading in mobile web usage. It is estimated that more than 35 % of Facebook users and 37% of Twitter users, employ mobiles in accessing or connecting to those Websites [17, 18].

The mobile social networking mapping and gaming application interactively gives rewards to adolescents, depending on their physical activities and maybe integrated with one of the SNs like Facebook or Twitter. The results (e.g. user’s physical activities, given rewards, location), can be shared with other users as a mean of motivation and excitement.

Smartphones (e.g. Iphone and Nexus 1) have Powerful internet and multimedia capabilities, a satisfactory User Experience (UX) in addition to its mobility nature and its availability worldwide [19-21]. Such features and capabilities, makes them more than just a normal mobile phone. A thorough analysis for two Smartphones (iphone 3GS and Nexus 1) discussing its upsides and downsides and selection criteria will be discussed in more details in chapter 4- Implementation. Such analysis took a great deal of attention as; it will help in choosing a most suitable platform in developing a mobile social networking mapping and gaming application. On the other side, it is very important to check different type of similar applications that had been deployed on the selected platform as it will help in identifying some features and functionalities of the device and this will be presented under the Related Work and State of Art section in chapter 2.

Context awareness and some other co-related concepts, visions and tools including mhealth, serious games, location- based service and social networking technologies will form the core of the mobile social networking mapping and gaming application and thus used in the promotion and the prevention of obesity and overweight. Obesity categorized diseases and the latter concepts, visions and tools will be discussed in more details in chapter 2 as well.

1.2 Scope and Research Problems

WHO considers obesity as a global epidemiology and emphasizes the need of fighting obesity by any means necessary. This research comes as an initiative to achieve such goal by addressing the problem of obesity among adolescents and by creating an application that combines different types of technologies and services to help them achieving at least 1 hour of physical activity.

1.3 Target Group

There are more than 1 billion overweight adults; among them more than 300 millions suffers from obesity over the globe, where 26 million overweight and obese children in Europe alone [22]. A European Union (EU) report indicates that obesity and overweight for adolescents (13-17 years old) in 7 European countries are exceeding more than 20 % with Crete peaking to 35% and 32.3 in Spain [23, 24] . The American heart association report indicates that, 31.9 % of children (2-19 years old) in the United States (US) are overweight and obese [25].

Obesity is a major cause for chronic diseases and disability. It weakens body's immune system, causes cardiovascular disease, hypertension and stroke and certain forms of cancer [26, 27]. There is a relation between genes mutations in what is so called Fat mass-and-obesity-associated gene (FTO) and obesity [28]. A recent study had been conducted in 10 European countries with more than 752 adolescents participated in a healthy lifestyle. Key finding is that, 1 hour of physical activities largely negated the gene's effect [29].

1.4 Scenario

John is a 15 years old child who lives with his 41 years old mother and a 13 years old sister in a small city called Tromsø which is located in Northern Norway. Although he is so young, he follows with the latest advancements in technologies and mobiles and he likes to play video and computer games and spends many hours watching TV. He rarely socializes with his friends after school neither does a PA like running. He wanted to go out from this boring routine, be active and also socialize with his friends but, he doesn't know how.

Before he turns into 16, his mother asked him to make a wish for a birthday present and John wished for a Smartphone. Later on, his mother bought him the device and he was so happy and excited to check it out. while exploring some of the applications available on the internet, he finds an application called ActiveTeen which is a mobile social networking mapping and gaming application that intends to help adolescents in doing PA. Then he decides to install it and explore its features.

ActiveTeen enables John to plan and register single and collective activities with other friends using social networking tools. He knows that his best friends Alice and Samantha own a Smartphone as well, and then he suggests

ActiveTeen to them so that later on, they will be able to suggest it to other friends and they all can try the application together.

Since the Smartphone has a Global Positioning System (GPS) enabled functionalities combined with Google maps app, connection to SNs application and in the sense that many young people now owns the application, a multiplayer game can be established between friends and the friends of friends .

ActiveTeen offers some kind of flexibility regarding timing, places and people. John can be as single player who decides when is the good timing for his PA, where the PA shall take place or in the same context but within a multiplayer game that include his friends. As a single player or in a multiplayer game, ActiveTeen will Enable John to insert his preferable routing tracks for his PA, suggestions regarding routing tracks of his current locations, whether he want to share such information with his nearby friends so that they can meet on the run and a notification should be triggered if he doesn’t do a PA at all.

John has to press the start button to start the PA, and during the PA, John will be able to have full control over his ipod and the music will be running on the background. He will be able to view maps which may show a list of preferred routing tracks, nearby friends and places. John has to press the finish button when he is done with the PA. In another View, he will be able to access his overall progress which may include Measured steps (Pedometer), time, distance and rating among his friends in the SN. Such information can be viewed privately or maybe shared with his friends or make it available for public.

ActiveTeen sends rewards which are some sort of virtual gifts to John if he has the highest rating among his friends to motivate him and his friends to do more PA.

1.5 The Goal

The main goal of this research is to investigate the rising notion of ubiquitous computing usage as part of health promotion and prevention through physical exercise. The research will try to present co- related concepts and technologies regarding ubiquitous computing and physical exercise which can in turn be used as a reference to ehealth researchers and developers working in the field of mhealth. To achieve a good outcome, such co-related concepts shouldn't be detached from each others. In other words, when talking about physical exercise, we cannot ignore obesity and maybe include weight loss and nutrition. When talking about motivational part we cannot ignore engagements of other users or maybe friends on the SNs. Therefore, it is necessary to present and discuss such concepts in a broader sense in order to expand the knowledge around it. None of the researches we know about have tackled or combined such concepts thoroughly or presented a multi- dimensional study such as in this proposed research.

Another goal is to create an application that employs such concepts and technologies and can be used as a prototype which may contribute to health promotion and prevention. It is a mobile social networking mapping and gaming application that intends to help adolescents in fighting obesity and overweight by motivating them doing PA in a more flexible and joyful way.
The recent advancement in ICT mobile technologies and pervasive computing has a good potential in achieving such goal.

1.6 Assumptions and Limitations

Physical inactivity among adolescents is increasing day after day which increases the prevalence of obesity on a global level. There are many successful stories when it comes to employing mobile phones as a mean to encourage users to do physical activities. This will be discussed in details in related work section. SNs, maps and the sense of gaming which is part of ActiveTeen functionalities may have a good potential in taking the physical activity application to a higher level.

The research assumes that the mobile platform is connected to internet either by a Wireless Fidelity (Wi-Fi) or Third Generation (3G) in order to access (e.g. SNs, map). To obtain user's location data and map, the GPS must be enabled.

Users must have a valid iTunes account to download and install the application and at least iOS 3.0 and above in order to use the application. Users must have a valid Facebook and Twitter account in order to use the application's social part.

Since the application is intended to be deployed on an iphone, several limitations will be discussed in details in later chapters and can be summarized as follows:

- The platform itself is a limitation (for example small screen size, visual keyboard, internet connectivity).

- Apple related procedures, frameworks and guidelines limitations.
- SNs Application Programming Interface (API) and that include limitations to both Facebook and Twitter API.

- The official iphone programming language is Objective- c which is seen as an un popular among developers community, Lack of garbage collection and there is a lack of support for other programming languages.

1.7 Methods

This section presents and discusses all the methods that were employed in this thesis.

1.7.1 System Requirement and Design

Software Engineering (SE) methodologies is seen to play an important aspect in any project life cycle beginning from software requirements; the functional and non- functional requirements (FR, NFR) which describe what kind of functionalities the system is trying to achieve. These functionalities were extracted from the project scenario presented in section 1.4.

Once the FR and NFR have been identified, it was the time to identify "who" does "what" and that was the responsibility of the use cases. In other words, the use cases are mainly used to capture the system behavior in the actor's point of view as scenario-driven threads through FR. Once the use cases have been identified, the application becomes clearer to draw and imagine. An initial user interface presents a clear image of how the system should look like before starting the implementation phase.

Critique

Perhaps the requirement section, gives an insight of what kind of functionalities need to be accomplished, however the design still lacks some flow diagrams such as Activity Diagram which is a graphical representation of activities and actions, Data Flow Diagram which is a graphical representation of the flow of the data with a system and Process Flow Diagram which is a graphical representation of the system processes. As an extension to the UML use cases, the system may include Class Diagrams which is used to describe the system structure. The design can be expanded to include such diagrams and maybe some others.

1.7.2 Related Work and State of Art

The Related Work and the State of Art present and discuss different applications which have been cited in the literature or been published already to the App Store. Such applications have been classified in a way that reflects their functionalities and considered to be relevant to ActiveTeen application.

Critique:

This section focused more on reviewing applications that were implemented on an iphone. Perhaps, the review should include more applications that were implemented on other platforms for a future deployment of ActiveTeen.

1.7.3 Implementation

Overview

Two main methodologies have been used in the implementation part and that includes the platform selection and the other is studying tools and the official programming language for the selected platform.

Platform Selection

There are quite many available smart phones in the market and to restrict the search; some criteria have been employed as part of Nomination process. The two nominated platforms are the iphone and the Nexus 1. The iphone is a proprietary, fast growing and powerful platform owned by apple while Nexus 1 is an open source, recent (released in 2010) and powerful platform owned by Google. There are a lot of available reviews for the latter platforms and there seems to be a lot of competition among them and that makes the research even harder. The main focus is to explore and present the mobile phone technology principles in depth as part of a learning and selection process.

Critique:

Perhaps the arguments regarding the platform selection process were not strong enough. However, the method succeeded in presenting enough knowledge about the up and down sides of the two platforms.

Learning by doing

Once the platform is been identified, a research has to be done on what kind of tools for that specific platform are available and how they can be used to achieve the project goals. During the development process, learning by doing methodology had been employed by examining and testing the available components and try to learn from it. However, using books, video tutorials had been also helpful for a new mobile developer like me.

Critique:

Being familiar with a programming language like objective- c could have saved time in the implementation process and that could be used to implement some of the remaining functionalities presented in chapter 5. Results and maybe some additional functionalities presented in chapter 7- Future work.

1.8 Results

This research presents and discusses concepts, tools and technologies employed in ActiveTeen iphone application. The application is part of an ongoing telemedicine research in the promotion and prevention of obesity and overweight among adolescents. It intends to help adolescents achieve at least 1 hour of PA like running or jogging. 15 out of 22 functionalities (68.2%) have been fully implemented in ActiveTeen application.

The lack of knowledge about iphone programming and API limitations made it hard to achieve the rest of the tasks. To substitute, several functionalities that was seen relevant to ActiveTeen application and wasn’t mentioned in the design were implemented. The additional functionalities are discussed in more details in 4.3 and chapter 5.

1.9 Significance and Contribution

The Main contribution is presenting a multidisciplinary study regarding (e.g. obesity, SNs, mhealth, serious games) just to mention some, and this by itself can be considered different pieces to a new concept called “Mobile Social Networking Mapping and Gaming Application” as none of the researches that we know about, have combined such disciplines under one umbrella such as in this research.

Another contribution is an iphone 3GS prototype that is built on the top of iOS 4.0 operating system and fully documented software engineering (SE) methodologies will be presented as an important aspect of the project life cycle. More than that, source code documentation will be discussed and annexed and this will include the objective-c code, the resources that are built on the xcode Integrated Development Environment (IDE) and the X- icon Interface Builder (XIB) user interface files that are implemented in the interface builder.

Chapter 2- Background

2 Background

2.1 Overview

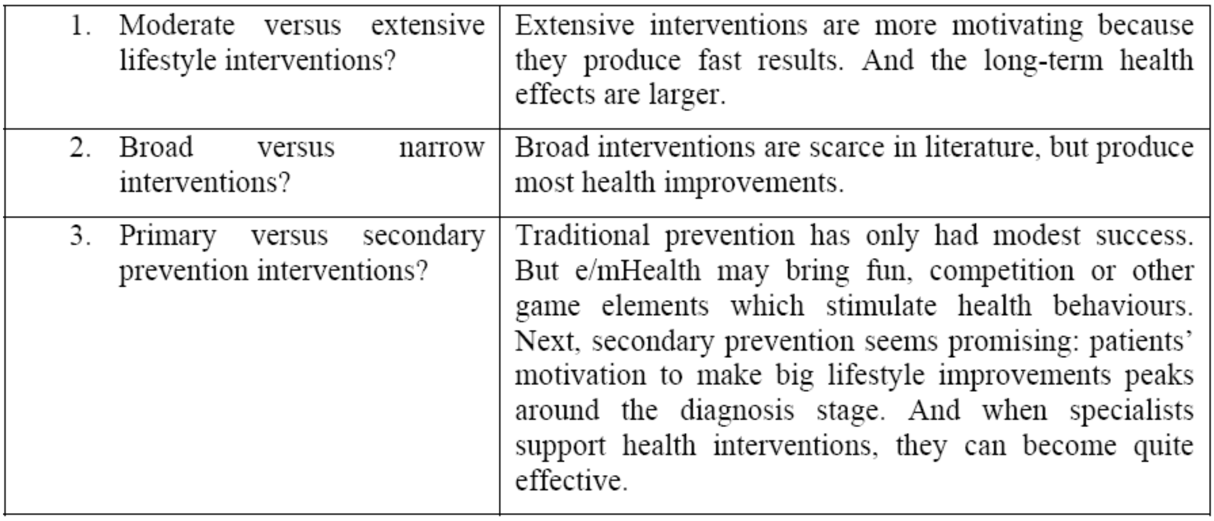
The proposed prototype is seen as an umbrella which combines different co-related concepts. Such concepts have been rarely discussed in a comprehensive way and the main Purpose of this research is to remove ambiguity around such concepts and to provide a running application as a proof of concept and that can be seen as an added value to the telemedicine research.

2.2 Obesity and overweight

2.2.1 Definition

Obesity and overweight is often considered to be a multifactorial and is based on both genetics and a sedentary lifestyle factors. It is a major cause of morbidity and mortality and its associated with Type 2 diabetes mellitus and some other diseases that will be classified and discussed later in the next section. BMI for age and sex is the most common international standard for measuring overweight and obese individuals [30].

WHO and many healthcare institutes are still using this formula when referring to Obesity and overweight. It is calculated as weight divided by height squared where Body Mass Index (**BMI)** ≥**25 kg/m^2** is considered to be as overweight and **BMI** ≥**30 kg/m^2** as obese**.** However, such measurement has a limitation as it doesn't take into account the body fat distribution [31].



1. Moderate versus extensive lifestyle interventions?	Extensive interventions are more motivating because they produce fast results. And the long-term health effects are larger.
2. Broad versus narrow interventions?	Broad interventions are scarce in literature, but produce most health improvements.
3. Primary versus secondary prevention interventions?	Traditional prevention has only had modest success. But e/mHealth may bring fun, competition or other game elements which stimulate health behaviours. Next, secondary prevention seems promising: patients' motivation to make big lifestyle improvements peaks around the diagnosis stage. And when specialists support health interventions, they can become quite effective.

Table 1 Which interventions best reduce age-related disease progress? [32]

Simons et al. addresses some interventions that best reduces age-related diseases summarized in the table above [32]. They argue that extensive lifestyle interventions are most attractive and effective as it brings fast results to all participants such as weight loss and increased energy and thus motivation is improved. And the other reason is that, it creates a fast learning curve among participants to continue adopting the new lifestyle with much less chances of falling back into old behavior.

As for the second question, authors argue that the aim decides which interventions to take. In most studies, the narrow interventions are more preferable and if it aims to improve the health outcomes, then broader interventions are probably more effective.

And finally the last question, authors argue that e/mhealth applications may bring fun, competition and motivation thus helping in changing behavior as primary interventions. For the secondary interventions, authors argue that it seems promising as patients who are diagnosed with a specific disease are likely to follow guidance from specialists and that's when it becomes quite effective.

2.2.2 Obesity and overweight associated diseases

Obesity is often linked directly or indirectly to several types of diseases. Here is a brief classification and clarification of the main diseases:

Diabetes Type 2 mellitus

It is a chronic disease that is characterized by a target- tissue resistance to insulin which leads to further complications such as heart diseases, stroke, kidney failure, blindness and nerve damage. Such resistance is justified by the molecular sensing of obesity- induced metabolic stress by the Endoplasmic Reticulum (ER) and the inhibition of the insulin action [33]. Such disease exists heavily in the industrialized societies and strongly related to obesity [34]. Several studies indicate that there is a strong association between FTO gene region on chromosome 16 and type 2 diabetes [28, 29].

Cardiovascular diseases

- **CHF**

  The disease is caused by a progressive systolic or diastolic dysfunction of the left ventricle [35, 36]. It is often higher in individuals suffering from type 2 diabetes and is considered to be lethal.

Figure 2 Congestive Heart Failure [37]

- **Enlarged Heart**

  It is a disease where the heart muscles are thickened causing the heart rhythm to be disturbed and would later on cause a heart attack.

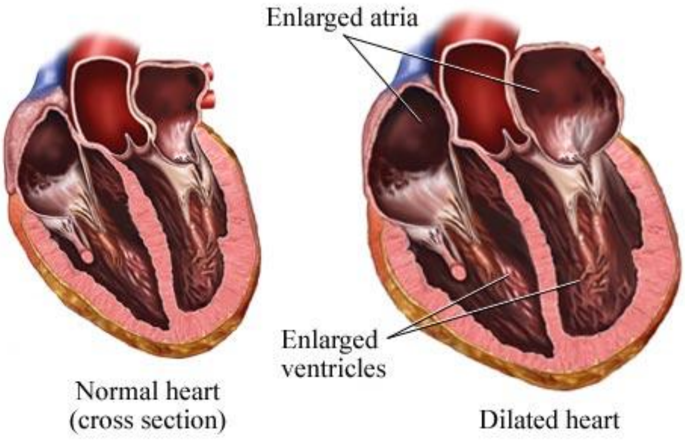


Figure 3 Enlarged Heart [38]

- **Cor Pulmonale**

  It is commonly known as a Right Heart Failure (RHF) because of a change in the structure and function of the right ventricle of the heart due to a respiratory disorder. It has been closely associated with Chronic Obstructive Pulmonary Disease (COPD) which is the leading cause for disability and death [39]

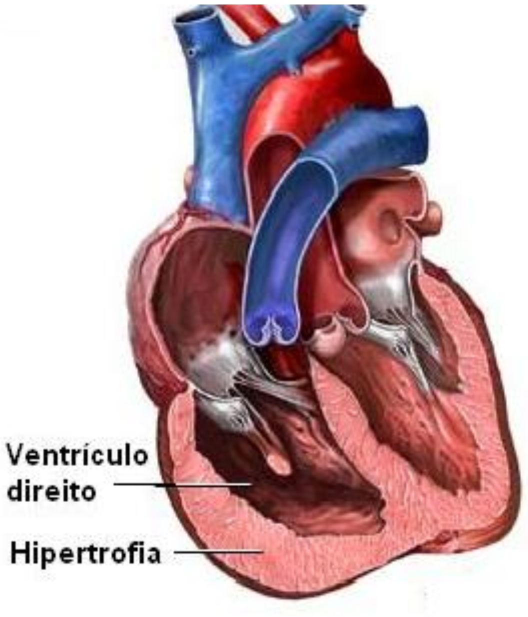


Figure 4 chronic Cor Pulmonale [40]

Additional cardiovascular diseases may include Vericose veins and Pulmonary Embolism as well [41].

Neurologic diseases

- Stroke
- Headache
- Dementia

Certain types of cancer

- Colon Cancer
- Breast cancer
- Uterine Cancer

2.3 Mhealth

The term Mobile Health (mhealth) lacks a clear definition [32] but is known to be an evolving area of ehealth and basically tries to employ mobile communication technologies in delivering healthcare services efficiently. ehealth was defined as follows:

“e-health is an emerging field in the intersection of medical informatics, public health and business, referring to health services and information delivered or enhanced through the Internet and related technologies. In a broader sense, the term characterizes not only a technical development, but also a state-of-mind, a way of thinking, an attitude, and a commitment for networked, global thinking, to improve health care locally, regionally, and worldwide by using information and communication technology” [42].

The motivation behind it is that there is a shortage of healthcare workers and that is challenging for healthcare providers and governments. On the bright side, half of the world population which is now around 7 billion own a mobile phone where it is predicted that half a billion smartphone users will use the mhealth applications [43]. Such growing figures gave motivation to several Non Governmental Organizations (NGOs) like WHO to target the developing countries using mhealth by supporting the development of an open source EpiSurveyor software for mobile devices which is used to train more than 1,000 health workers in 20 countries in sub- Saharan Africa [44]. Growing evidence of using mobiles in delivering healthcare services is believed to have a significant impact on taking the healthcare system to a higher level and some believes that it could fill the gap of healthcare workers shortage specially in developing countries which is limited in financial and technical resources [45].

Part of a large research in the US, a grant with 1.2 million USD has been approved in 2007 to develop an application for patients with chronic diseases (Diabetes) using wireless technology. The Main idea is to transfer data from glucometer to a mobile phone and then transferred to the patient’s Electronic Health record (EHR) [46].

Future enhancement will be seen in mhealth applications with the introduction of Fourth Generation (4G) networks and Body Area Network (BAN) This will include personalized predictive healthcare (Patients profiles, history) and mobile on demand health care service [47].

ActiveTeen can be considered as a mhealth application since it is mobile-based application that has a pedometer and a social context. Such application can be extended to have more health-related services such as (e.g. calorimeter, nutritional programs, a heart rate monitor) and this can push it to a stage where it can be widely adopted. The extended features and services of the application will be discussed in more details in chapter 7- Future Work.

2.4 Context awareness

Everything in this world happens in a certain context and people used it to get things done. Context-awareness had been investigated in computer science for more than 40 years especially in natural language processing and Human Computer Interaction (HCI) [48]. However, context and context-awareness have been seen to have a significant impact on mobile-centered applications and been investigated since the beginning of the 1990's with the rise of different mobile computing components. The idea is to create context-aware applications that are adaptable to the location of use, nearby people, hosts, devices, search behavior of the user, as well as the changes that may occur to such objects over time [49-51]. Mobile phones are both pervasive and personal and they happen to be correlated and therefore targeted to context-aware computing.

Defining context is considered by many as a dilemma. Some definitions of context mainly give some synonyms by referring to it as the environment or situation which makes it hard to adopt. Definitions of context provided by Schilit et al. and Pascoe [49, 52] are more accepted in this field but still they are more specific. Pascoe defines context as

"the subset of physical and conceptual states of interest to a particular entity".

The following definition seems to be more realistic and it gives a clear meaning to Context- aware computing which is defined as:

"Any information that can be used to characterize the situation of an entity. An entity is a person, place, or object that is considered relevant to the interaction between a user and an application, including the user and applications themselves" [53].

Some examples of context-aware systems include Context-Aware Electronic Patient Record (EPR), hospital bed, Pill container, air conditioners, security systems with sound and motion detectors, assembly plants with safety sensors, adjust the light of a mobile phone…etc [54, 55].

Schilit divided context into 4 categories. The 4th category which is "time" is seen to be an important and natural context for many applications but hard to make it fit into the 1st three categories and this include:

- Computing Context (e.g. Network connectivity, communication bandwidth and costs, nearby resources)
- User context (e.g. User's profile, location, nearby people)
- Physical context (e.g. lighting, noise levels, temperature)
- Time Context (e.g. Day time, week, month)

Some people's actions can often be predicted by their situation. Context comprises of Contextual Information which may be retrieved from heterogeneous systems (e.g. queries) and Commands (e.g. command print-To a nearby printer) which can be helpful in representing that. Contextual information has many different types and properties which makes it hard to express and model them [49]. Obtaining and representing high level contextual information such as "a person current activity" is a big challenge because it's hard to sense and model such complex social context.

Current context-aware systems succeeded to a good extent to represent the contextual information in real applications such as for the "location" using GPS, it is still unclear that some other applications are still difficult to sense or they are not useful.

The general impression about context- aware computing is that representing and dealing with people as contextual entities is so difficult, and that's because we are not like systems and devices and we tend to improvise. Context modeling is considered to be a key feature in the context-aware systems. Context is represented in rule-based systems and such systems still suffer from some difficulties summarized by ambiguity, boundary conditions and undefined models. For these reasons and some others such as (e.g. privacy, security), obtaining a complete context- awareness system is hard to achieve [50].

Context-awareness has been used in personal identification, personalized health monitoring systems. Depending on patients measured vital signs, disease patterns, some functions have been added to such systems to send reminders and medication support. Such sensitive data should travel reliably, securely to the remote source (e.g. physician, nurse) [56].

Using wireless and mobile technologies in context-aware computing and healthcare applications has been criticized because of its pitfalls. Patient-operated terminals, in most of the cases has to be wearable so as vital signs and diseases patterns can be transferred to a remote location, and this can be in adequate to some patients who suffers trauma. Multiple wireless network types (e.g. 3G, Wi-Fi, 4G, Bluetooth) with inconsistent quality of service leads to a sensitive data loss in addition to the leakage of data as a result of weak security in such types of communication. Using sensor communication is not adequate, as its battery life is short and some interference with other sensors may happen. But let’s not forget the fact that, Technology by itself has good and bad features and, can be to some extent misused by others and, therefore legislation plays an important role.

The main issue regarding context information is that “who” may gain access to such information and “when” taking into consideration that most of the patients are bothered by the idea of being located at anytime and by anyone, and some are worried that such information can be logged and misused by others.

Achieving privacy, security and efficiency in such systems is very important and this can be accomplished by ensuring the accuracy of information regarding location and identities in addition to secure communication channels, and authenticated users may gain access to such systems. This concludes that the system architecture should provide the user with access control and should have guarantees regarding privacy, functionality and efficiency [57, 58].

2.5 Social Networks

2.5.1 Overview

SNs play an important aspect of millions of user’s daily practices worldwide. It is based on web 2.0 technologies where users are not considered to be as viewers any longer but as interactive publishers. In fact, such technologies have been used in many telemedicine and e-health applications and seen to play an important aspect and a key success by bringing the social context to such applications. SNs is defined as

“Web- based services that allow individuals to (1) construct a public or semi-public profile within a bounded system, (2) articulate a list of other users with whom they share a connection, and (3) view and traverse their list of connections and those made by others within the system [59] “.

The next section presents shortly two of the SNs that have been employed in the ActiveTeen application.

2.5.2 Facebook

It is a fast growing SN founded by Mark Zuckerberg in 2004 and considered to be the most favorable among users with its wide range of services that include (e.g. creating a profile, add other users as friends, sharing photos, locations, and news). It is estimated that 78% of Facebook usage goes for the latter [60]. In Norway, Facebook is the third largest media and it is estimated that Half of the Norwegian society which is more than 4.8 millions are registered on that site [61] .

2.5.3 Twitter

It is an online SN site founded by Jack Dorsey, Biz Stone and Evan Williams in 2006. It enables users to stay connected with other users. The type of communication is directed, meaning that users can post short messages (Tweets) and other users can read it if they decide to follow while those users who posted those messages don’t necessarily needs to do that [62]. Twitter has more than 190 million monthly visitors with more than 65 million Tweets every day [63].

2.6 Serious Games and games for health

The serious games initiative has been first introduced by Ben Sawyer and others in 2002. Here is a comprehensive definition that includes both games and serious games

“Entries will be considered a game if they involve an assigned challenge and employ a compelling form of positive and/or negative reward system. Entries will be considered a serious game if they use the gaming attributes described above to overcome a designated problem or deficiency, and provide appropriate feedback to the user about their efforts” [64].

This definition fits with the purpose of the ActiveTeen application as it tries to include the motivational and fun attributes in creating a multiplayer physical activity game where the users can be rewarded by some kind of virtual gifts for their efforts.

2.7 Related Work and State of Art

There are several factors to be met in order for mobile services to be widely adopted as kleijnen et al. argues. The key factors are ease of use and usefulness, accessibility (anytime, anywhere), communicability (Social influence), payment (pay per minute usage, downloads) and finally the critical mass which is the minimal number of adopters that makes the service sustainable [65]. This seems to be true to a good extent in the very first releases of mobile phones. Nowadays, other key factors such as UX, usability, extensibility and security play an important aspect for a wider adoption. Chapter 4- Implementation presents these aspects in more details.

Since the iphone had been selected as a platform for development, this section is of a great importance as it is meant to present different types of applications that is related to ActiveTeen focusing mainly on functionalities and capabilities of such device and thus learning from it and maybe add new features that doesn’t exist in other available applications.

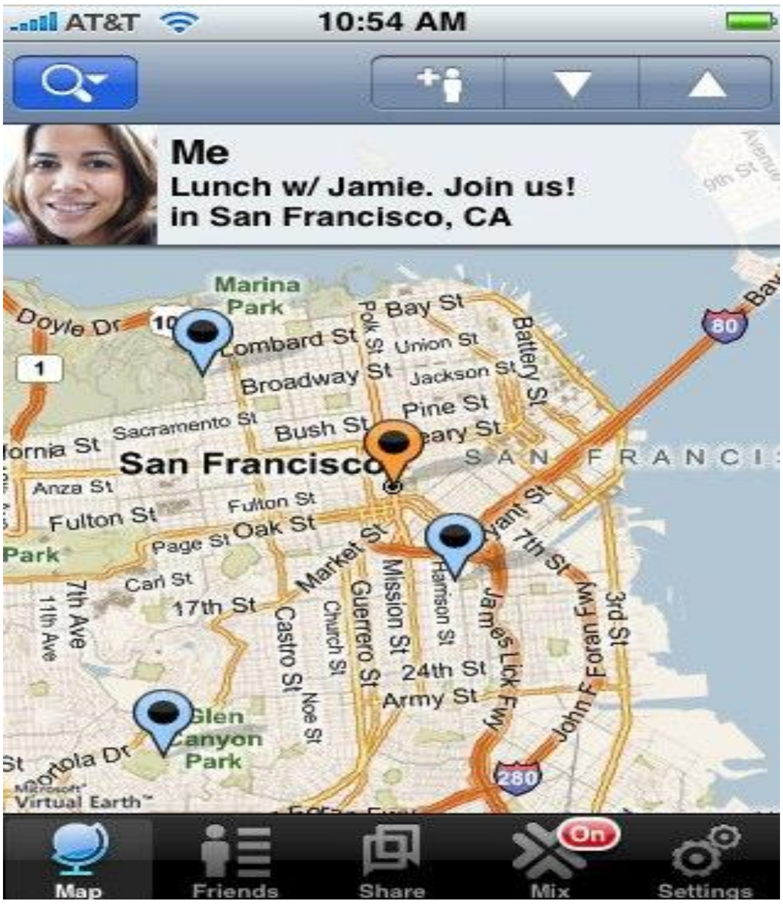
Suh et al. presents an iphone training guidance system for cancer rehabilitation based on Bayesian networks [66]. It presents and discusses different aspects of user’s motives and its rating among males and females, social context and different algorithms to customize physical exercise plans. The system seems to have ignored the UX and added a lot of overwhelming data entry to be part of user’s interaction with the system. ActiveTeen shares similarities with this application in the motivational and social context and put UX and less data entry as one of its top priorities.

Neat-o-games are mobile- based social game that aims to encourage physical activity through competition. The research is based on two games; NEAT-o-Race which uses the data emitted from the accelerometer based on user’s moves to animate an avatar. User can compete with other users and the winner is rewarded with activity points that can be used as hints to solve mental games in NEAT-o-Sudoku [67]. Stanley et al. presents a GPS- based exercise mobile game targeting children between 4- 12. The game is intended to be used in outdoor activities and uses walking in real world to follow a treasure map- like representation and a puzzle- fighting mini game to find the creatures and fight with them. The game also has a map editor that enables parents, educators and recreation specialists to customize it for the children in order to use it [68].

There are currently more than 200, 000 applications and more than 30, 000 games available for downloading from the App Store and the number is growing rapidly [69, 70]. A classification methodology is needed as different tools will be used in ActiveTeen development and this may include SNs, location- based service, sensors, games and avatars features. The core logic in the Classifications of such applications will be basically based on the latter. And to restrict the search even more, such applications examples will be mainly categorized based on good rating scores, features uniqueness and easiness of implementation and this will lead to a simplified task with more or less the same results.

2.7.1 Location- based applications

Loopt is a location sharing application essentially for the mobile set which enables users to connect with friends nearby, what they are up to and delivers notifications about places nearby and events [71, 72]. It uses the GPS chip that is already integrated with the iphone to place the user on a map. Loopt is not fully integrated in one application on the iphone since it doesn’t support multitasking and its services are splitted into 3 main application; LooptStar, LooptPulse and LooptMix. Loopt is dependent on friends and that they install the application else it would be useless. It scans the address book to look for existing users and sends invitations via Short Message Service (SMS) not email, in order to build a network. SMS is charged individually and the person who receives the SMS is charged. On the bright side, Loopt has reached more than 4 million users especially after introducing Apple iOS 4 which supports multitasking and it has a well defined and intuitive privacy controls [71].

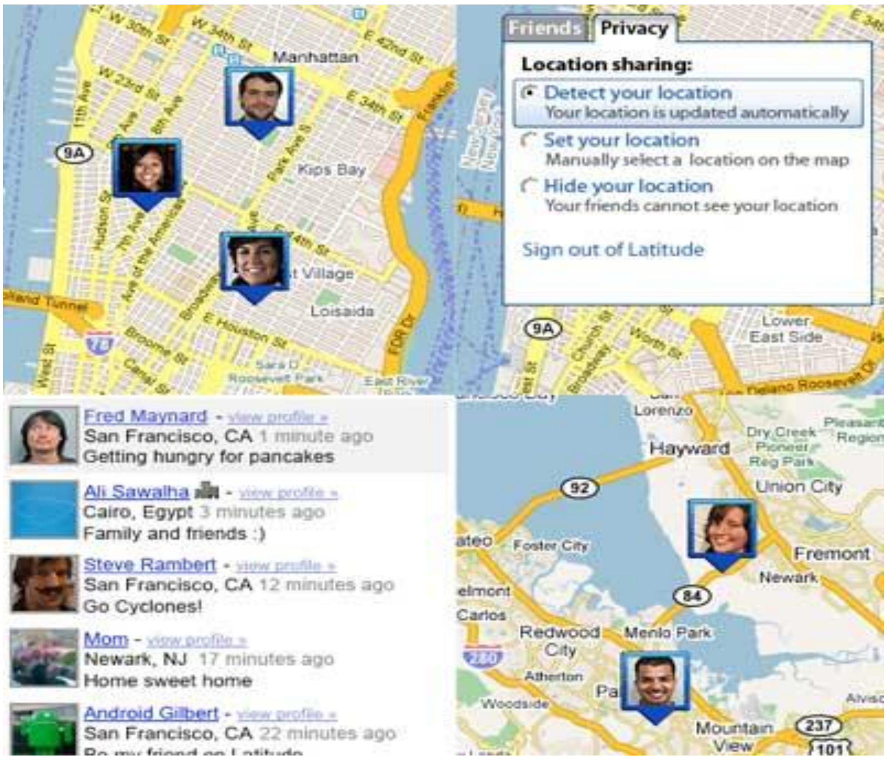


Me
Lunch w/ Jamie. Join us!
in San Francisco, CA

Figure 5 Loopt [73]

The application shares similar functionalities with other applications in the market including “where” which delivers notifications about places near you and “Whrrl” which helps users to locate their friends, share experiences regarding nearby restaurants and events [74, 75].

Google Latitude is a location- based application that had been developed by Google and uses Latitude feature that is already integrated in Google Maps that is available on iphone. It enables you to control your location, see where your friends are on a map, contact them using SMS, instant message or by a phone call.



Friends | Privacy

Location sharing:

● Detect your location
Your location is updated automatically

○ Set your location
Manually select a location on the map

○ Hide your location
Your friends cannot see your location

Sign out of Latitude

Fred Maynard - view profile »
San Francisco, CA 1 minute ago
Getting hungry for pancakes

Ali Sawalha - view profile »
Cairo, Egypt 3 minutes ago
Family and friends :)

Steve Rambert - view profile »
San Francisco, CA 12 minutes ago
Go Cyclones!

Mom - view profile »
Newark, NJ 17 minutes ago
Home sweet home

Android Gilbert - view profile »
San Francisco, CA 22 minutes ago
Be my friend on Latitude

Figure 6 Google Latitude [76]

It offers different levels of privacy controls by allowing users to share, set, and hide their location [77, 78].

Glympse is an iphone application that allows users to share their location at Facebook friends newsfeed by granting them a temporarily access time to their current location. The application is very useful in a situation where you are stuck in traffic and you wanted to update the co-workers about your situation by giving them a Glympse- limited amount of time to your current location.

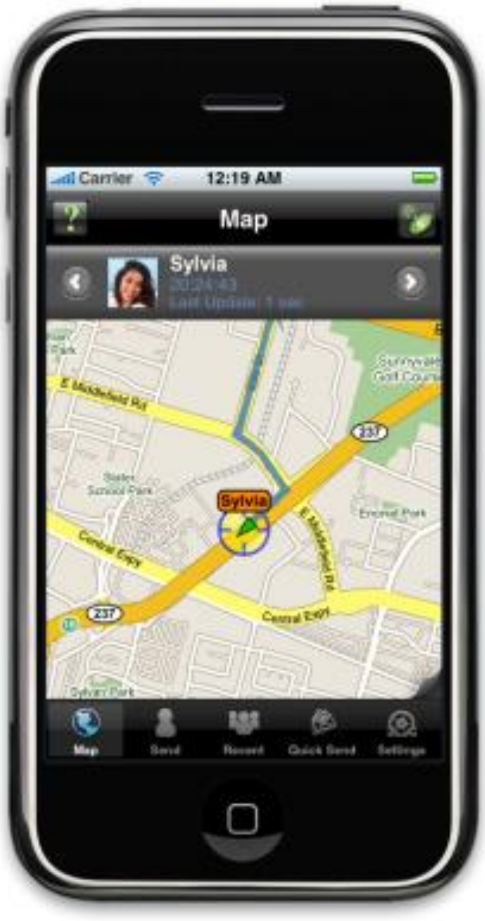


Figure 7 Glympse [79]

Introducing Apple iOS4 which supports multitasking is very helpful in the survival of such application and many other location based service applications as it can be still updated with the user's current location even if the application is not running.

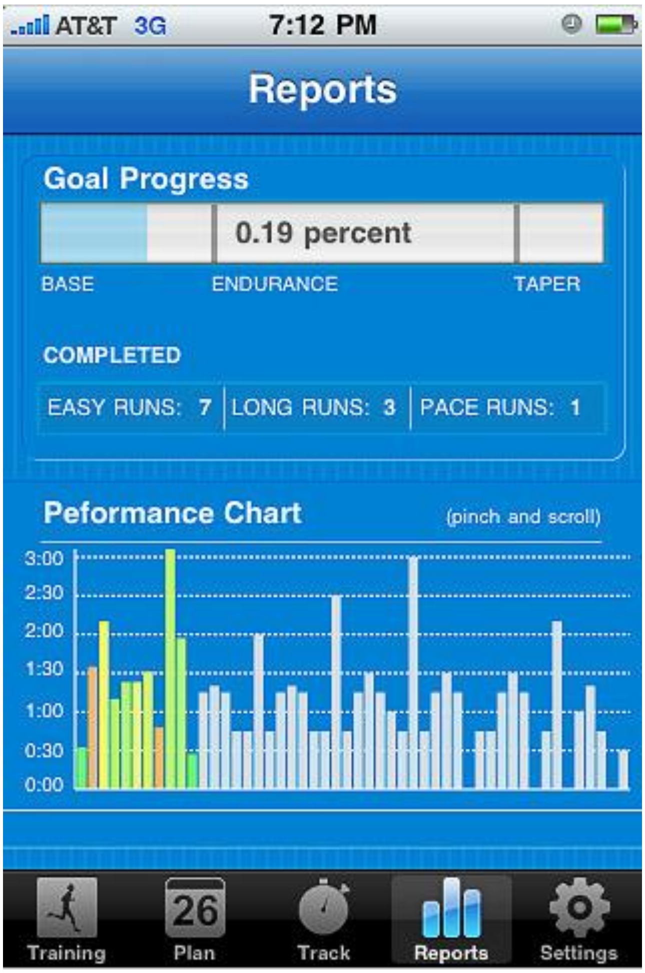
2.7.2 Physical Activity Applications

Nike + ipod is a pedometer originally was designed for the ipod and then integrated with the iphone. The data is transmitted from a waterproof and unbreakable sensor planted in a sport shoe to be received by another sensor attached to ipod or the accelerometer on the iphone.

Figure 8 Nike + ipod [80]

The data storage is transient as the shoe sensor establishes a wireless connection to the wireless receiver each time it detects a step movement and the data is stored or displayed on the ipod [81, 82].

Run Coach is an iphone application which targets seasoned and novice runners by giving them an opportunity to select from a variety of training plans (e.g. 5k, 10k, half marathon and marathon).



Reports

Goal Progress

0.19 percent

BASE ENDURANCE TAPER

COMPLETED

EASY RUNS: 7 | LONG RUNS: 3 | PACE RUNS: 1

Peformance Chart (pinch and scroll)

Figure 9: Run Coach [83]

It offers runners personalized plans, tips about running and nutritional values of food and enable them to track their progress while running**.**

RunKeeper is an iphone application that tracks user’s fitness activity via GPS. It has an intuitive interface that tracks distance, pace/speed, burned calories and shows the path traveled on the map.

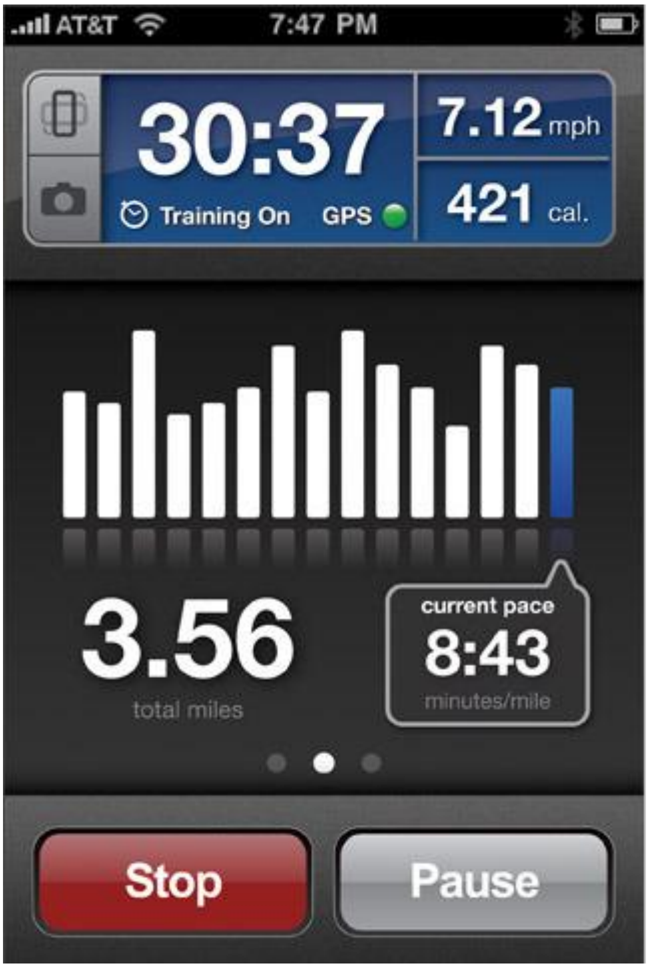


Figure 10: Run Keeper [83]

It allows users to synchronize their activities to runkeeper’s website [84] and share their progress with friends on SNs [85].

Chapter 3- Requirements, Design and Architecture

3 System Requirements, Design and Architecture

3.1 Methodologies overview

Maintaining a platform selection gave knowledge about its capabilities (e.g. user experience, security). Such knowledge helped identifying the scenario key points and problems to solve. The Scenario is basically a natural language that explicitly identifies the interaction between the user and the system. From the scenario, we were able to identify the FR and NFR of the system. Use cases in accordance were created based on the FRs using a tool called “Enterprise Architect”. Based on these methods, we were able to imagine how the application would look like. Adope Photoshop were used to draw the initial user interface of the application.

3.2 Functional Requirement

FR1- The application shall provide user to be connected to Facebook either by an existing account or by enabling the user to create a new account.

FR2- The application shall provide the user to view customized news feed regarding current and planned running or jogging activity.

FR3- The application shall provide information for the user regarding nearby friends where user can view their profile information including name or nickname, photo, location and how far they are.

FR4- The application shall provide information for the user regarding nearby places which includes for now parks and general information about them, photos and link to a map showing where it is located.

FR5- The application shall provide integration with Google maps and GPS to provide the user with his/ her current location with zoom functionality.

FR6- The application shall enable the user to add, edit and update a PA which is for now running or jogging as a single player activity and have the choice to share it with his friends on the SN for a multiplayer activity.

FR7- The application shall enable the user to view the available routing tracks for his/her current location and have the choice to share it with friends on the SN.

FR8- The application shall provide the user with the ability to play their local music while running or jogging.

FR9- The application shall provide the user with the ability to view the overall running or jogging progress in tabular bases showing distance, time, steps and have the choice to share those results with his friends on the SN.

FR10- The application shall provide user with a rating among his friends.

FR11- The application shall provide users with virtual gifts to keep the motivation up.

FR11- The application shall provide notifications for the user in case of being not active enough on weekly bases.

3.3 Non- Functional Requirement

NFR1- The application shall respect connection to Facebook guidelines.

NFR2- The application shall respect user's privacy by providing security to the data, not publishing any related- user's information or user's current location without a permission to do so.

NFR3- The user interface shall be clean and intuitive and comply with Apple development guidelines.

NFR4- The application shall be compatible with iOS 3.0 and with later versions.

3.4 Use Cases

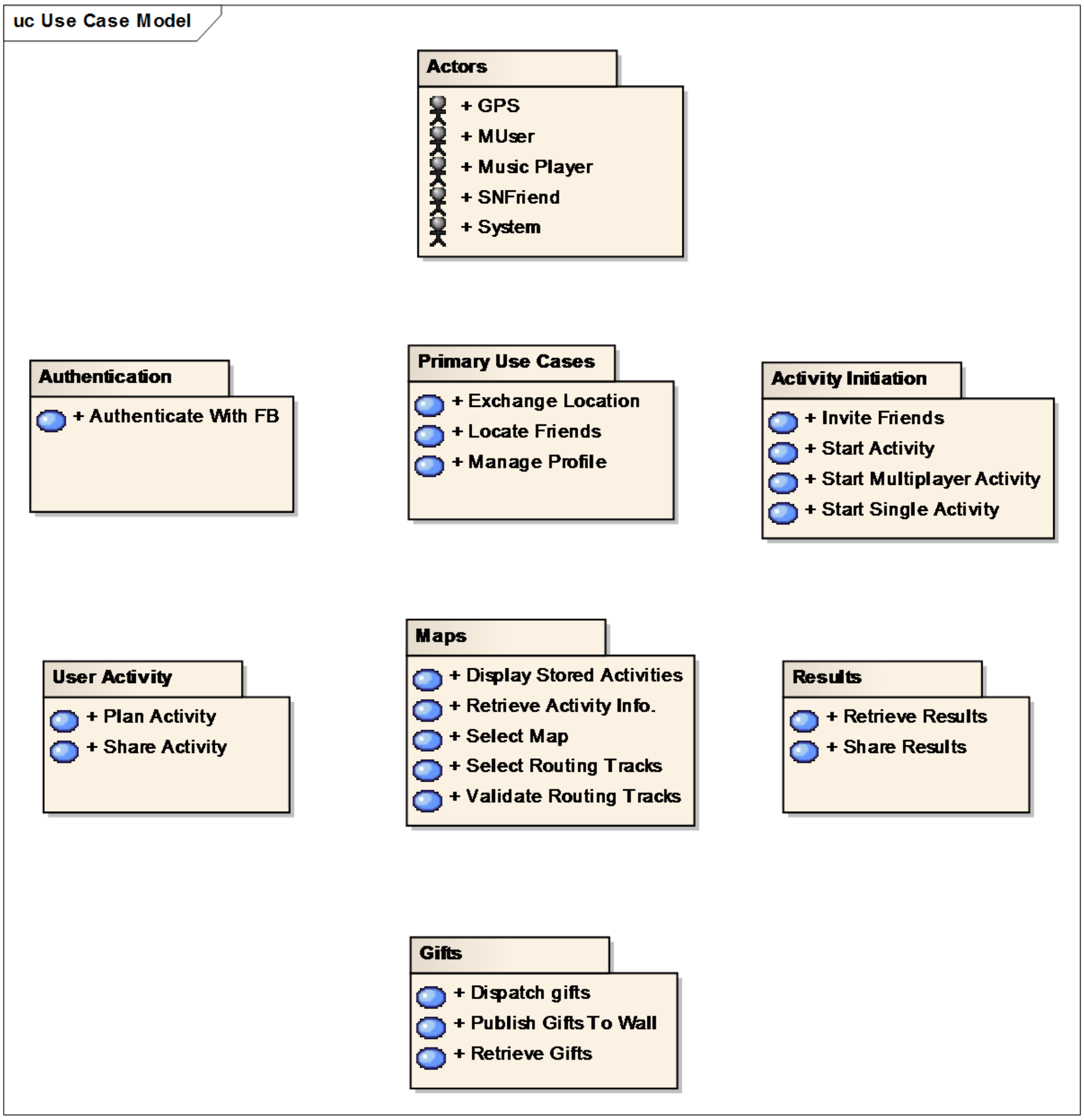


Figure 11: Use Case Model

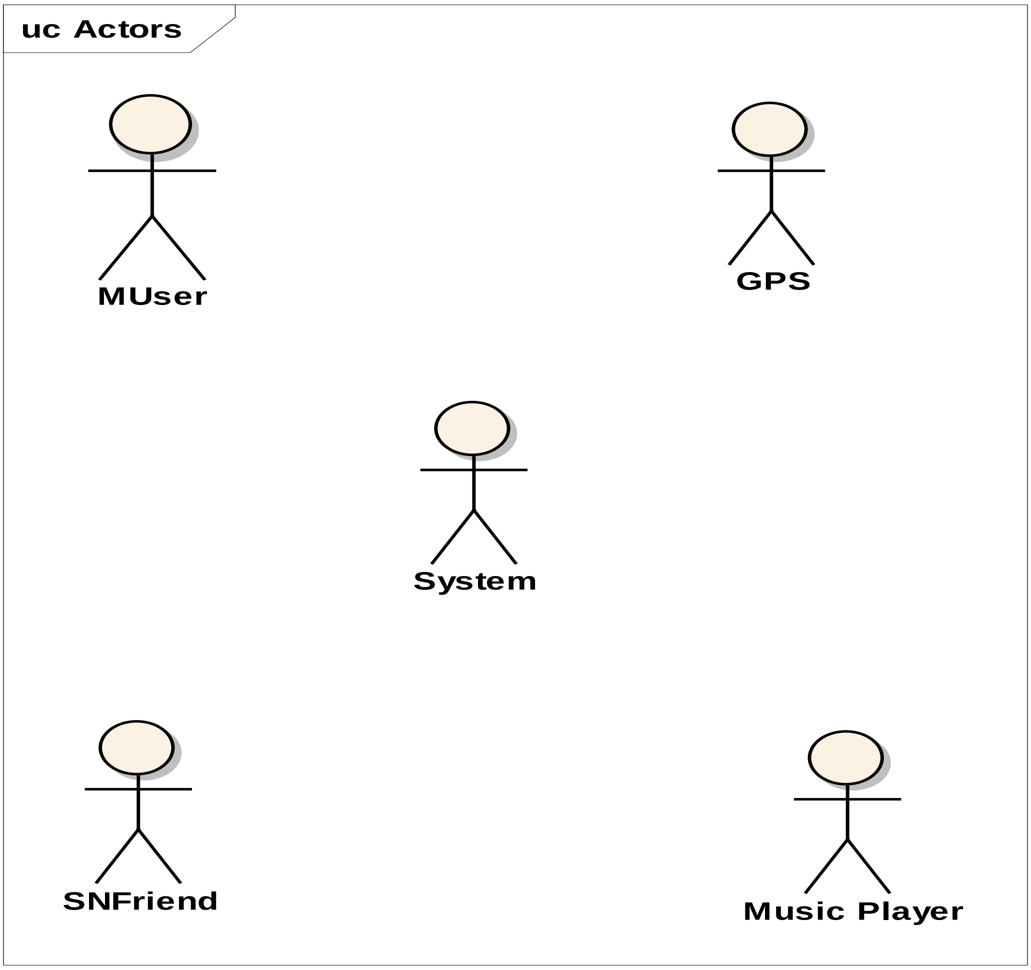


Figure 12: Actors

GPS

This is the Global Positioning System. It manages any related Location based Service and Mapping

MUser

This is the Primary Actor of the system. It is the mobile user

Music Player

While doing a PA, User have access to their local music library.

SNFriend

This is a Facebook friend that the mobile user had on his/her friends list.

System

This actor will be managing the arithmetic and control part.

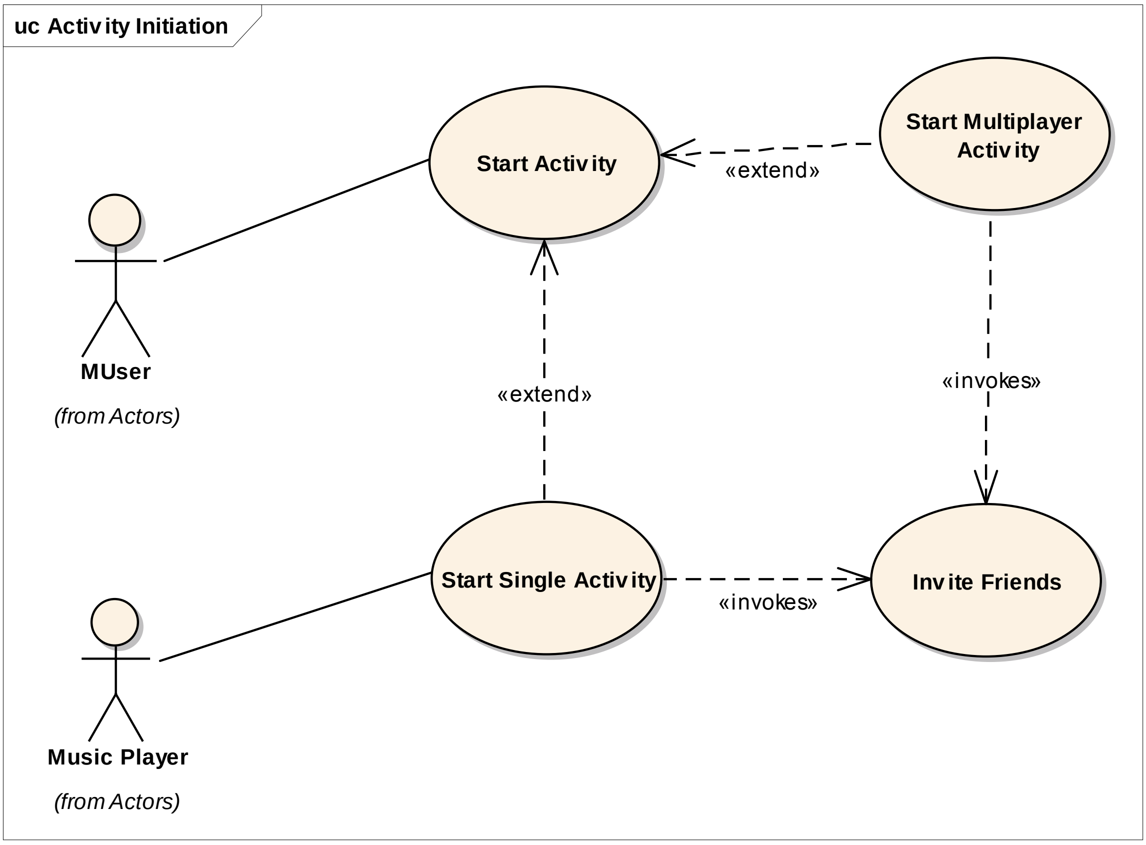


Figure 13: Activity Initiation

Invite Friends

The user invites other friends who are registered on Facebook to join his/her activity.

Start Activity

The user decides to initiate an activity.

Start Multiplayer Activity

Once the user invites other friends to join an activity, a multiplayer game is initiated.

Start Single Activity

The user chooses to have an activity for him/ herself (Single Player).

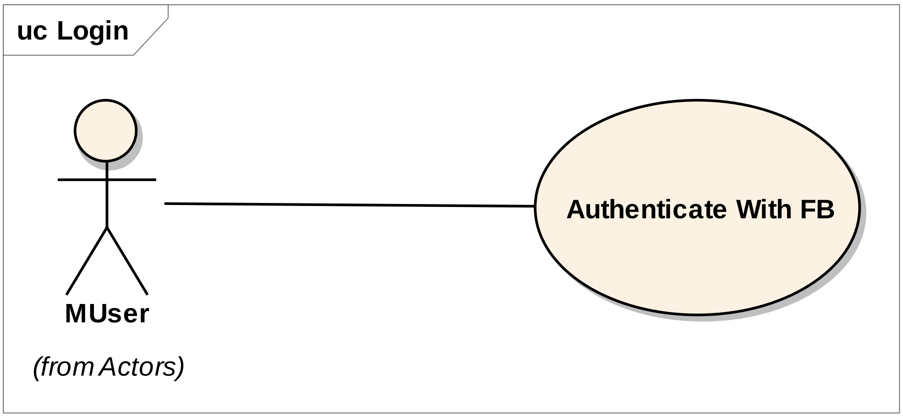


Figure 14: Login

Authenticate With FB

Users install the application and see the Connect with Facebook button. The user clicks the button to log in to the site.

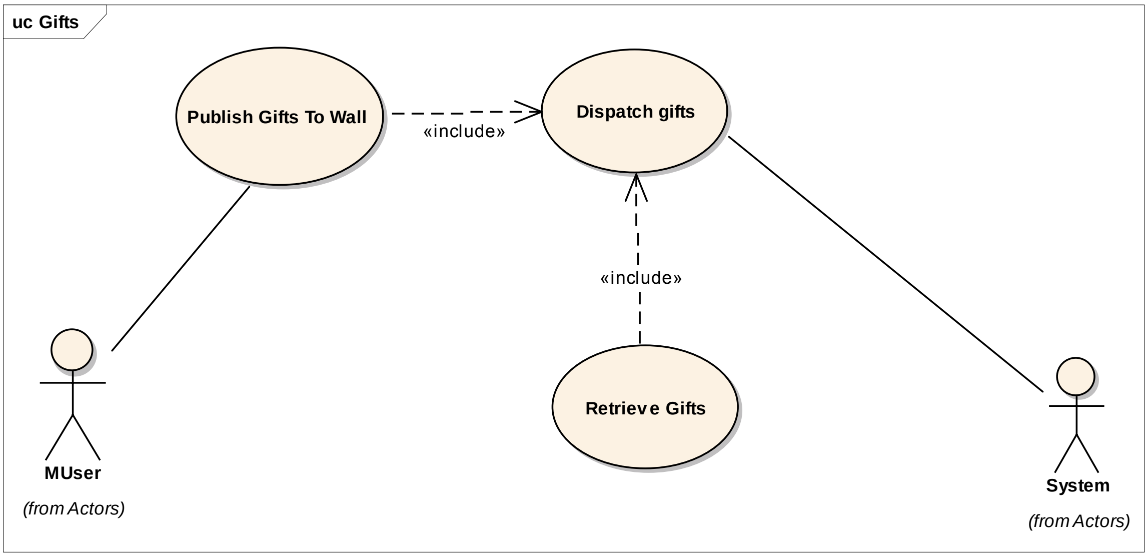


Figure 15: Gifts

Dispatch gifts

The system has a list of stored gifts. Once the user reaches or achieves a specific task, the system triggers one of the gifts so as to be sent to that specific user.

Publish Gifts To Wall

User can see the published gifts on his/her Facebook Wall. The gifts will be published once the user reaches his/her goal.

Retrieve Gifts

System retrieves the gifts from a stored list.

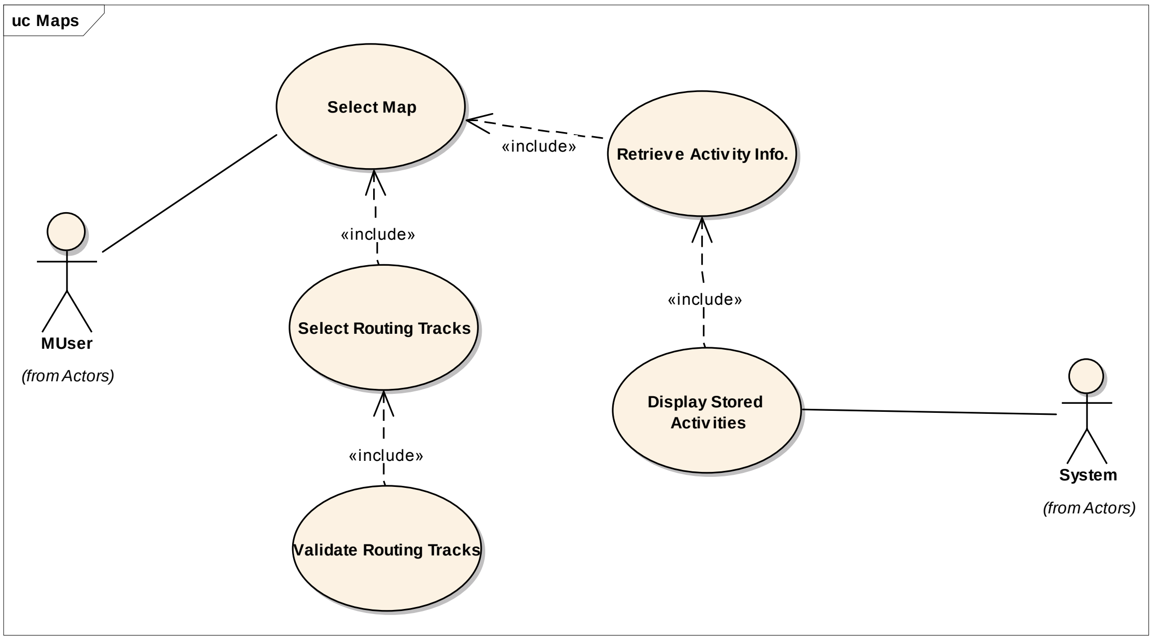


Figure 16: Maps

Display Stored Activities

Display a list of stored activities.

Retrieve Activity Info.

Retrieve information about activities.

Select Map

User can select a map from a list.

Select Routing Tracks

Mobile user can select routing Tracks in his/her local area to perform running or jogging.

Validate Routing Tracks

Check if the routing Tracks are Valid.

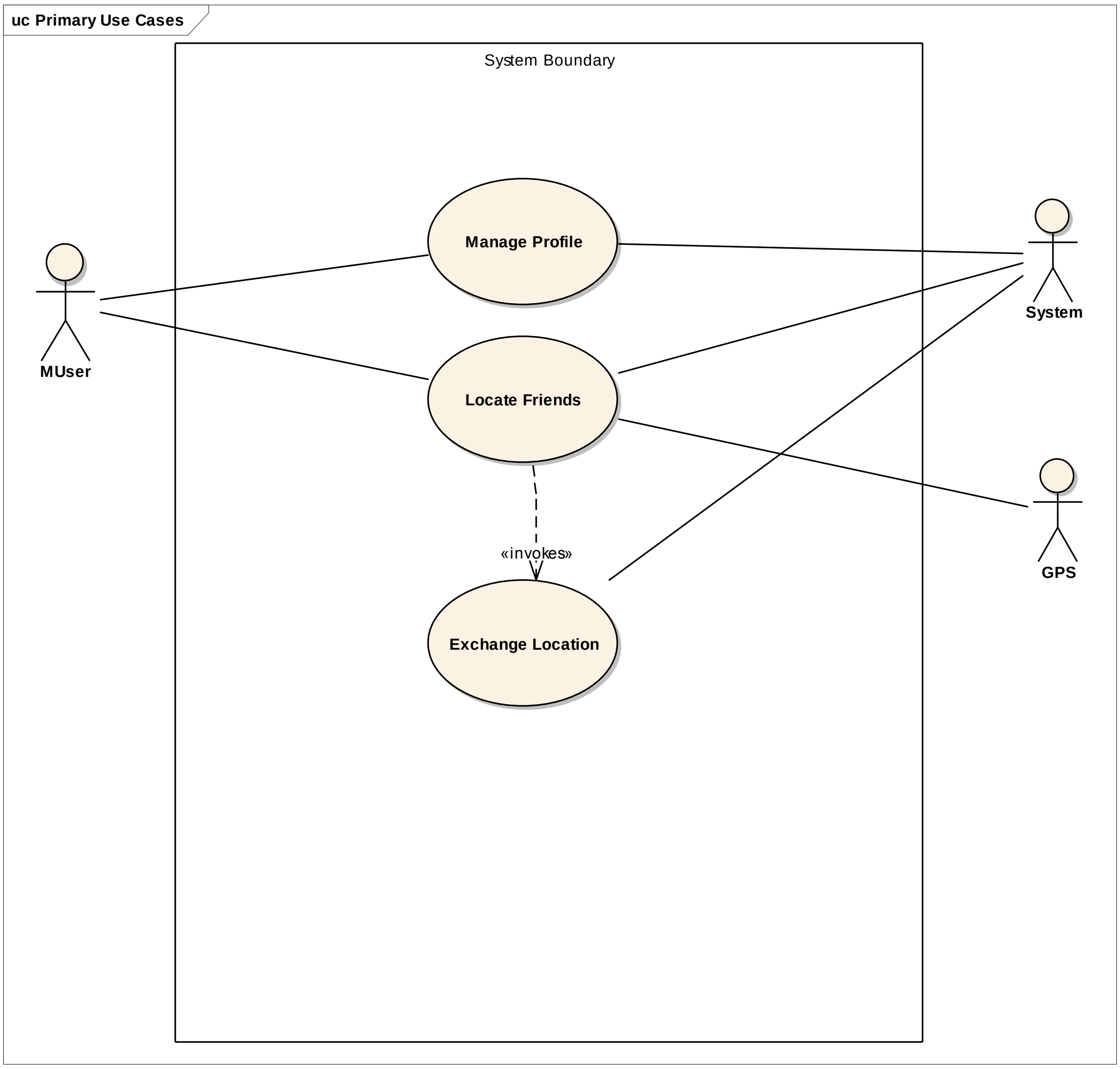


Figure 17: Primary Use Cases

Exchange Location

The Location based service (LBS) must be enabled in order to perform any location based operation.

Locate Friends

User can locate his Friends on the SN where he/she can see a profile picture, where they are and what do they do and how far are they.

Manage Profile

User has control over what to show in his/her profiles.

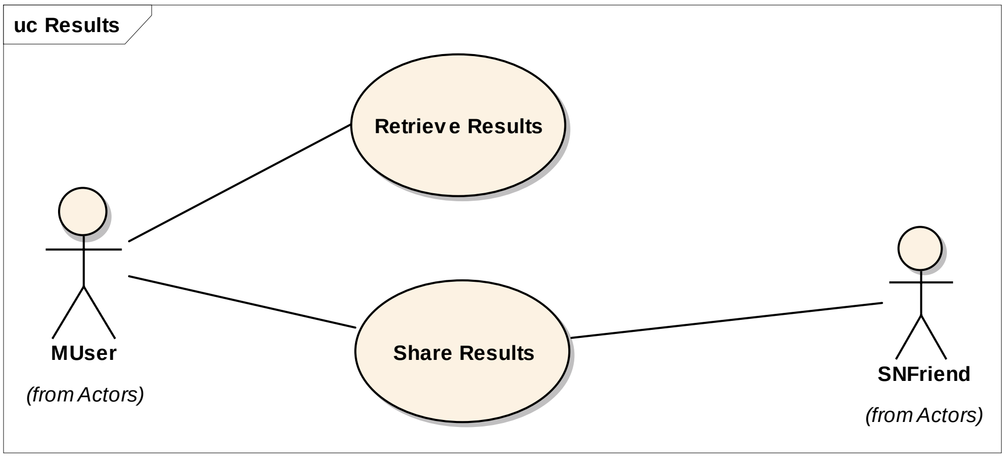


Figure 18: Results

Retrieve Results

User can retrieve results regarding Steps, time, distance and rating among his friends

Share Results

User can share Results with his friends on the SN. he/ she can chose which data to share at any time.

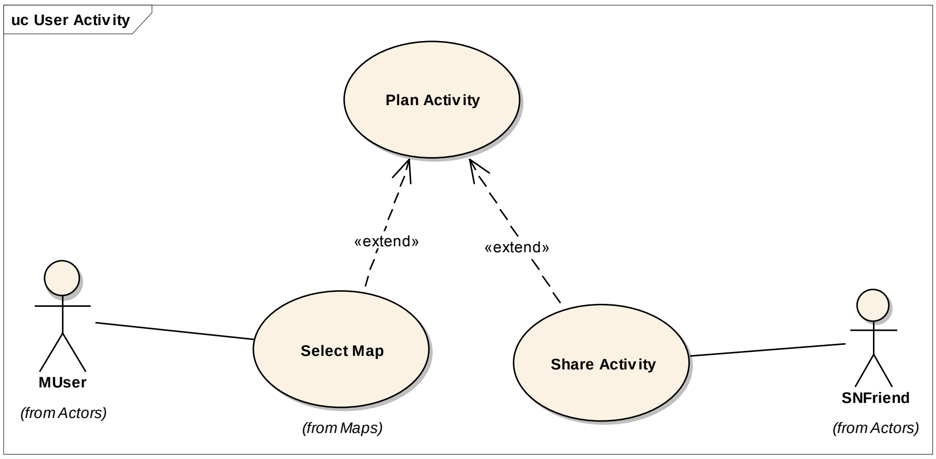


Figure 19: User Activity

Plan Activity

User will be able to plan a physical activity.

Share Activity

User will be able to share the activity with friends on the SN

3.5 Initial User Interface

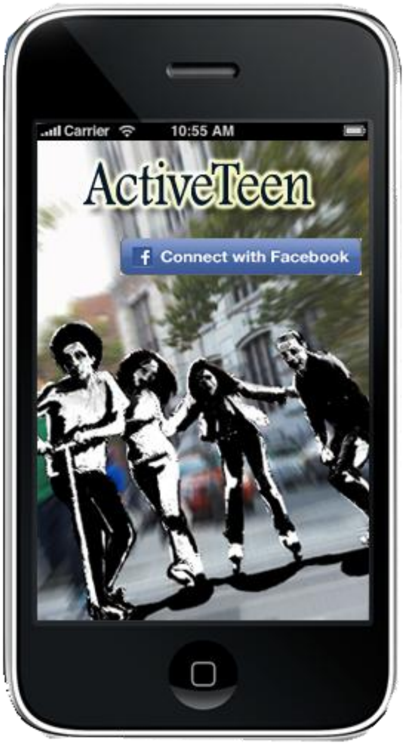
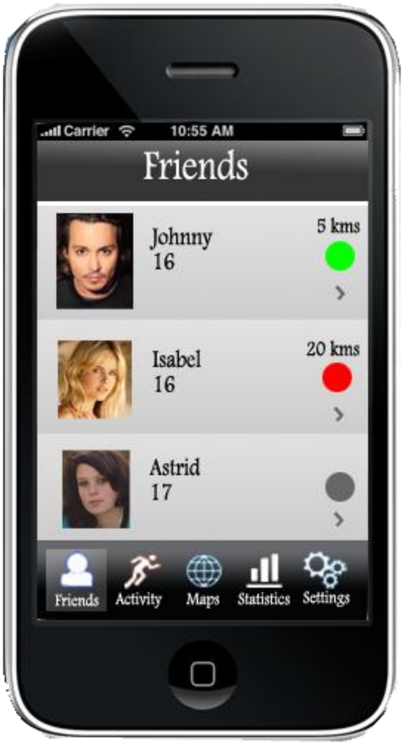


Figure 20: Facebook Connect



Friends

Johnny 16 — 5 kms

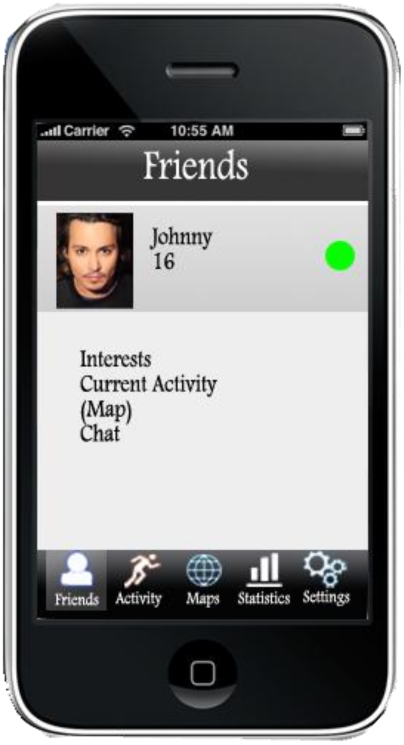
Isabel 16 — 20 kms

Astrid 17

Figure 21: User’s Facebook Friends

After launching the application, User will be able to connect to Facebook after providing the necessary credentials as depicted in Figure 20 and this will make a cross- communication with ActiveTeen Application on Facebook. If user is successfully logged in, a list of Facebook friends as depicted in Figure 21 with their profile picture, name and age will be displayed on the left side of the screen.

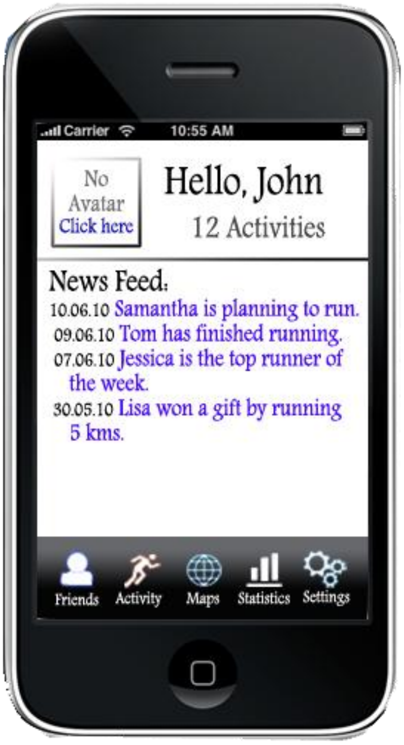
On the right side of the screen, a detailed view (the arrow) about friend’s location distance, the green circle signifies that the user is online and is willing to participate with other friends in doing a PA, the red circle signifies that the user is busy doing PA with others and the grey circle signifies that the user is offline and physically inactive.



Friends

Johnny
16

Interests
Current Activity
(Map)
Chat



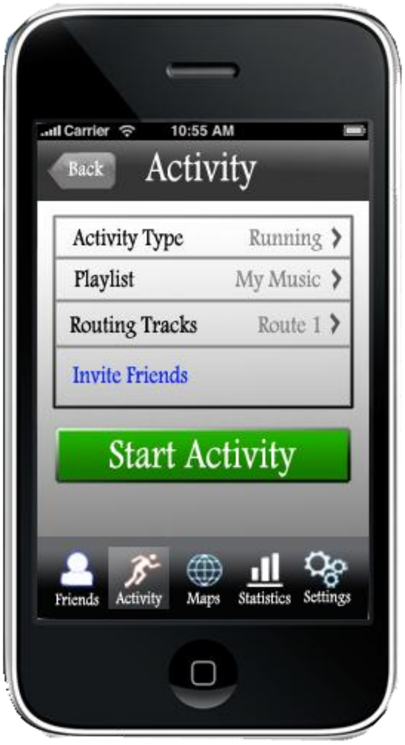
Hello, John
12 Activities

News Feed:
10.06.10 Samantha is planning to run.
09.06.10 Tom has finished running.
07.06.10 Jessica is the top runner of the week.
30.05.10 Lisa won a gift by running 5 kms.

Figure 22: Facebook friend's Details **Figure 23: Customized News Feed**

Figure 22 depicts a detailed view about user's information. User can see what other friends like, their current activity, where are they on the map and they can even chat with them either to socialize or either to start a PA together.

User can be updated about other friends PA using a customized new Feed and a date stamp as depicted in Figure 23. Such functionality can help in motivating and engaging the user with other friends. List of achievements about user's PA and an avatar is displayed on the top of the screen.



Activity Type Running
Playlist My Music
Routing Tracks Route 1

Figure 24: Physical Activity

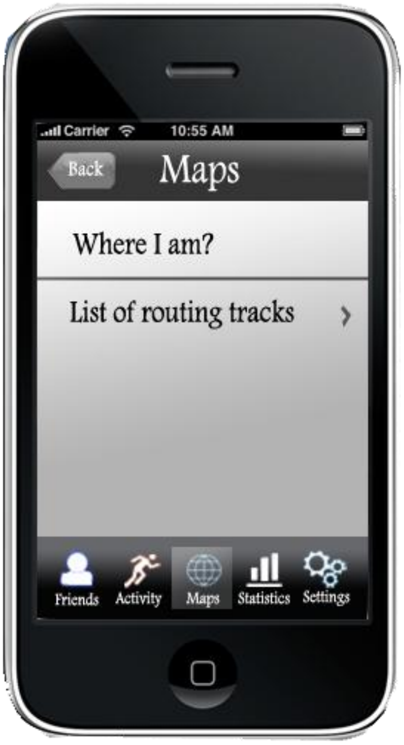
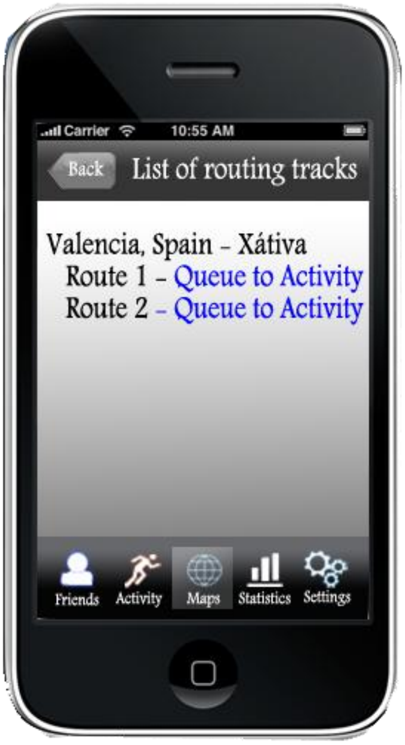


Figure 25: Maps

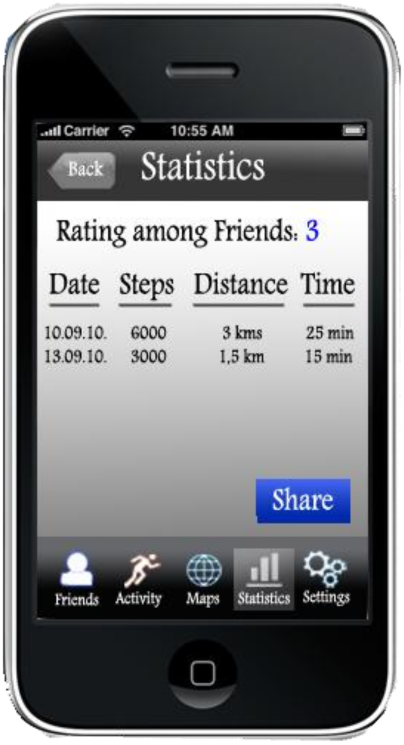
Figure 24 depicts switching between Friends Screen to Activity Screen tab bars. PA screen shows the activity type which is for now running but can be improved to have other PAs like (e.g. biking, hiking). User can create their own music playlist and add their favorite songs from the internal music library. If the user changed his address, the application should be able to display a list of available routing tracks for the user's current location and the user can invite other friends to join the PA. When the user clicks the Start Activity button, other friends should be updated about the routing tracks and the type of Activity. In Figure 25, user switches between Activity to Maps where user can see where they are on the map and they can see the available routing tracks.



List of routing tracks

Valencia, Spain - Xátiva
Route 1 - Queue to Activity
Route 2 - Queue to Activity

Figure 26: List of Routing Tracks



Statistics

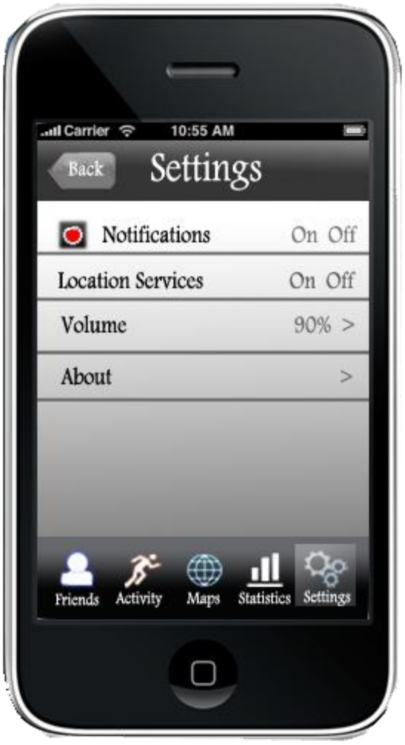
Rating among Friends: 3

Date	Steps	Distance	Time
10.09.10.	6000	3 kms	25 min
13.09.10.	3000	1,5 km	15 min

Figure 27: Application Statistics

Figure 26 depicts a highlighted maps tab bar with a list of available routing tracks in the current region. User can then decide where the PA should take place depending (e.g. current location, interests) and he/ she can queue that routing track to Activity tab bar.

Figure 27 shows a highlighted Statistics tab bar where information regarding user's rating among friends, date stamp, steps, distance and time taken. User can share such results with other friends on the SN as part of engagement and motivation.



Notifications On Off

Location Services On Off

Volume 90% >

About >

Figure 28: Application Settings

Figure 28 depicts the application's settings where user will be able to control the basic functionalities. User can switch on/off notifications and the current location. Such functionalities may help in achieving less disruption and also preserves user's privacy. User can also adjust the music volume up and down using a slider.

3.6 ActiveTeen Architecture

ActiveTeen is a client- server architecture where the iphone is the main client and multi-servers which include Facebook, Twitter and YouTube Servers. The iphone uses SQLite 3.0 to store data locally in a folder called Document directory. The other databases are located on each of the servers to retrieve user's credentials and data. Each component of the architecture is explained in details in section 4.4.

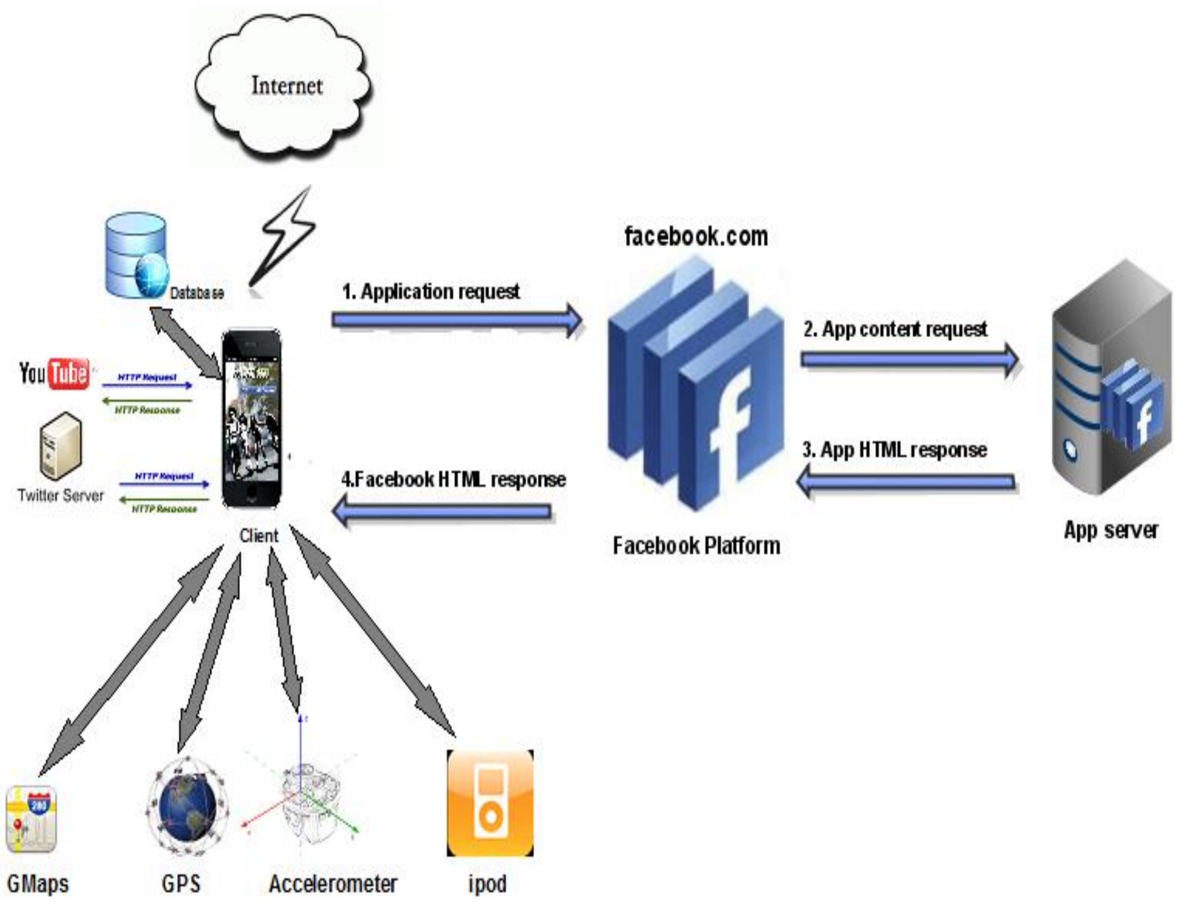


Figure 29: ActiveTeen Architecture

Figure 29 depicts the basic ActiveTeen architecture on the iphone. Here we summarize shortly the basic components of ActiveTeen:

Facebook Component: Once the user tries to login using iphone facebook connect and the login credentials have been verified, a request is sent to facebook servers where ActiveTeen application resides. The content of application can be (e.g. friends, pages, news feed) and the response is returned as HTML. The type of communication is based on client (iphone) - server (Facebook) architecture.

Twitter Component: The twitter architecture is evolving day after day since the old architecture doesn't scale. It was based on a cached pages stored in a database and accessed using its API. However, the new architecture is based on different types of caching and database indexing where it is still basically client- server architecture which uses HTTP requests and Responses. User is prompted to provide valid credentials to login to twitter and if he/she is successfully logged in, then they can write short messages (tweets) and post it to their wall where followers of that user can see it.

Youtube Component: Apple provides YouTube access using an integrated YouTube player that enables users to search and play videos directly from within the iphone. Using the open Uniform Resource Locator (URL) framework, some educational videos and tutorials can be launched within ActiveTeen application. Such videos are made by experts in physical exercises and nutrition and can be helpful for the application's users.

GMaps component: This component provided by Google is integrated into iphone application. It can access all the basic features of Google Maps by loading the HTML/Javascript and controlled by a set of objective- c methods that mimic the subset of the Javascript methods.

GPS Component- The iphone has a built- in GPS and apple provides a component called the "Core Location" which enables users to access GPS information such as (e.g. Latitude, longitude, distance, speed).

Accelerometer Component: The accelerometer is basically a device that measures both the acceleration and gravity by sensing the inertial force called g- force (gravity). It had been integrated on the iphone and Apple provides a component that can access the accelerometer data from within the application. The component was employed to measure steps (pedometer).

ipod component: The ipod is a portable media player that is integrated on every iphone.Using iTunes, users are able to download and synchronize the music to the iphone devices where they have full control over their own music.

Chapter 4- Implementation

4 Implementation

4.1 Platform Selection

4.1.1 Overview

The selection methodology for a Smartphone will be based on reviewing the literature around some of the famous Smart phones in the market. As the application intends to motivate users to do physical activities therefore; a good choice of a mobile platform may have significant impact on a successful implementation and might lead to a wider adoption. In this sense, from the user perspective, common principles regarding user experience and usability, security, interoperability, reliability, openness and other technical issues will be discussed.

4.1.2 Nexus 1 Technical Specifications

Nexus 1 is the 1st smartphone delivered by Google and its sold unlocked (Not offered through carriers). The software and the user experience is pure Google and the hardware, is delivered by HTC. It uses Android 2.1(Other android phones uses earlier versions) which is an open source phone operating system that runs on linux 2.6 kernel with java applications on the top of it. Android 2.1 is known to be lightweight and faster than windows mobile [21].

Nexus 1 weighs 130 grams with a 1GHz Snapdragon CPU - the fastest on the market, a 3.7" capacitive AMOLED touch screen and a display running at (480 x 800 pixels) which is a standardized high end Smartphone resolution. It also has 512 MB of RAM which is enough to run concurrent applications (4GB Micro SD Card which can be expanded to 32 GB). A 5 megapixel autofocus camera (2x digital zoom) with a flash led, GPS, WiFi (802.11b/g) and Bluetooth 2.1 + EDR (supports A2DP Bluetooth stereo). The talk time is up to 420 min, while the internet usage lasts up to 5 hours on 3G and up to 6.5 hours on Wi-Fi and the good part is that the battery can be replaced easily. Contacts for example can be synchronized automatically through gmail account, Facebook and MS exchange. However, there are some problems in adding yahoo e-mail accounts in addition to the outlook calendar and notes synchronizing and that’s not the case of gmail calendar which can be synchronized automatically [86].

4.1.3 iphone 3Gs Technical Specifications

The iphone is a smartphone that has internet and multimedia capabilities. It is purely designed and marketed by Apple and it was first released in 2007. Iphone succeeded to create hype and an acceptable prolonged UX [19]. Current analysis that had been published by Reuters news agency shows that iphone sales had climbed from 6.7 % in 2008 to 17.3% in 2009 [87] with more than 33.75 million iPhones sold in the Fourth Quarter (Q4)- 2009) [88].

The iPhone 3GS weighs 136 grams and almost identical to iPhone 3G. It features a 3.5 inch display with 480 x 320 pixels with an oleophobic surface which means that the surface is less prone to fingerprints and easier to clean. It contains a 600 MHz Samsung ARM processor and 32KB of Level 1 cache (3g model – 418 MHz ARM processor and 16KB cache). Third-party App Store application Memory Info also reports the 3GS has more memory available than previous models to run applications. It comes with two storage capacities; 16GB and 32GB.

4.1.4 iphone 3Gs User Experience and Usability

The iphone 3G and 3Gs are quite the same with slightly little improvements such as in performance, higher camera resolution with video capability, voice control, doubled the downloading speed to 7.2 mbps. The iphone focuses on user experience more than features, and that helped in changing the way different mobile manufacturers used to think [20]. Times magazine called it “the best invention of 2007” as Many great ideas and processes had been assembled in one device and made accessible to normal users [89]. The device power comes from a physical button called home screen which is the opening gate to its interface that displays a list of horizontally installed applications; 9 home screens with up to 16 installed application’s icons in addition to 4 icons on the dock.

The main way of retrieving, synchronizing data between iphone and a pc is through iTunes using a Universal Serial Bus (USB) cable. The same mechanism is used in the case of music and video files. The interface is somehow flexible and it is meant to serve the user’s needs; when you want to make a call or watch a video, the keypad appears if you need it and disappears if you don’t. In the case of typing, the letters is shown in a large size to avoid typing mistakes (hovering), automatic spell checking and correction, predictive word capabilities, dynamic dictionary, magnifying glass and most importantly the cut, copy and paste capabilities. With all such features regarding typing, the speed is somehow limited because it lacks a physical keyboard.

The iphone has 3 sensors; light sensor (dimming the back light), proximity sensor (deactivates display and touch screen when initiating or receiving a call and that’s to save battery and to avoid pressing a key) and an orientation (accelerometer) sensor which switches from portrait to landscape (180 degrees) and that is necessary, mainly for gaming and typing. However, the iphone lacks multi-tasking although it has this functionality when playing music and you want to make or receive a call, the music fades away. In addition, the iphone cannot be customized else its jailbroken [90, 91].

4.1.5 Nexus 1-User experience and Usability

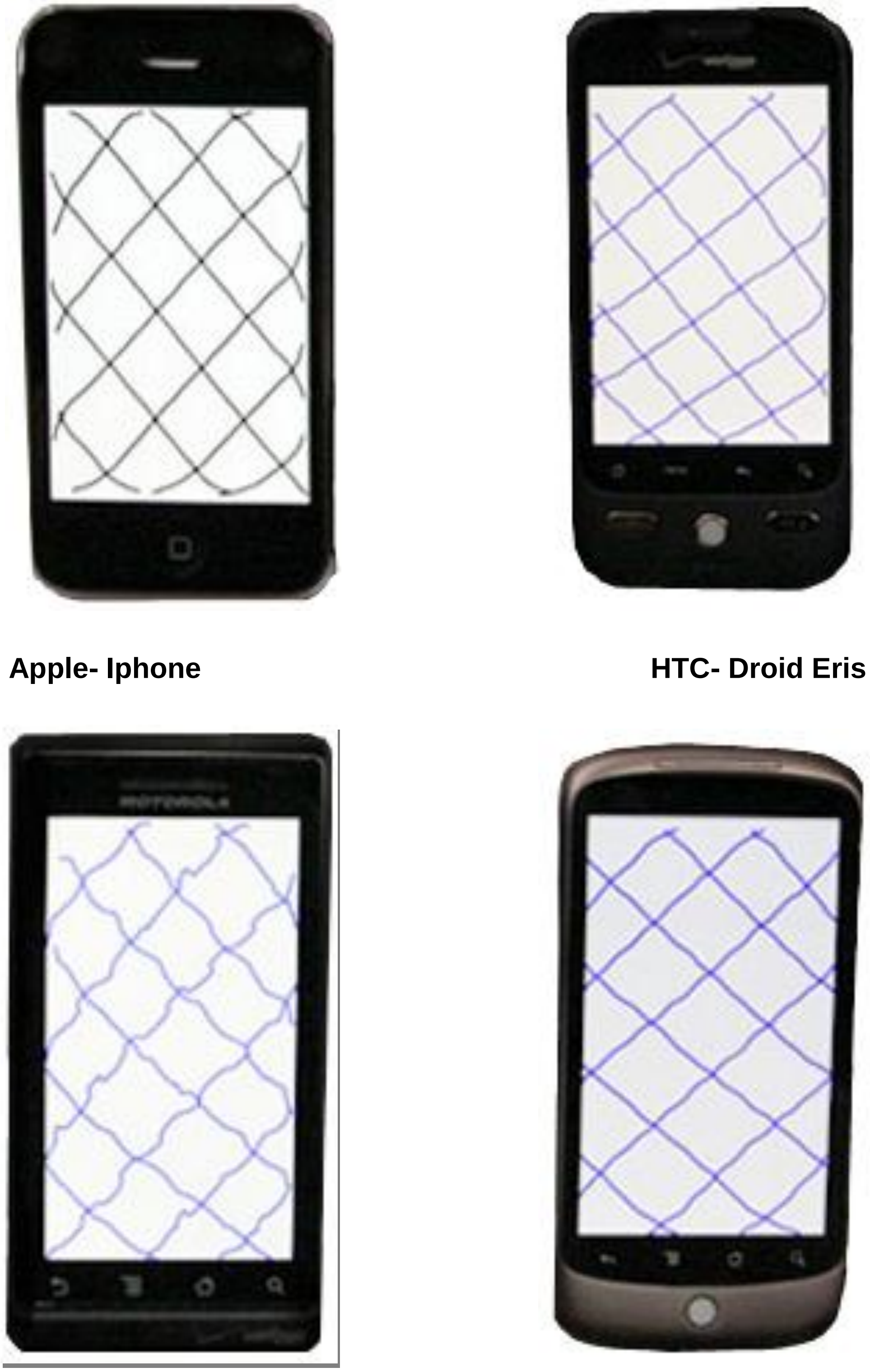
Nexus 1 uses stock android interface which is slightly simple to be used by most of users. It offers an easy way to be customized to fit with the needs and the desires of its users specifically the developers. It provides “live wallpapers” that is animated and can react to different user inputs, “Application drawer” that let you access the installed applications with a single button and display them in a 3D cube to be scrolled down and up instead of closing an application to access another (multi- tasking).

The nexus 1 adds also multi-touch or what is called pinch-to-zoom functionalities to the web browser, gallery, and maps applications and it has also the ability to transcribe voice to text (Virtual keyboard can be annoying to some users), noise cancelling dual microphones, GPS guided turn-by-turn voice directions to drivers. Its good to mention that the nexus 1 has the ability to display different widgets on home screen, combined email inbox and play flash contents [92, 93].

Google received thousands of complains at the 1st month it released the nexus 1 but Google made an update (on the air) and fixed most of the serious problems. There are still some issues including 3g connectivity problems, touch screen sensitivity and image resolution is low on the web browser (16 bit instead of 24 bit) [94].

4.1.6 Touch Screen Sensitivity Test

Touch screen have been well seen in the market such as in mobile phones, kiosks and Automated Teller Machine (ATM). However, such technology faces severe limitations when it comes to mobile phones as it has small icons and the precision can be of a big issue [95]. Significant improvement had been made in that field with the introduction of the smartphones such as the iphone and Nexus 1. The user interface for both smartphones is built around a highly sensitive multi- touch screen which is considered to be one of the best compared to other smartphones. MOTO Development Group which is a leading enterprise in consumer experience, innovation and technology conducted a sensitivity test between four smartphones using a robotic and human finger [96]. The test results bellow shows that the iphone has the highest lines precision where the Nexus 1 and Droid Eris has a fairly well precised lines and Motorola Droid has the worst [94].



Apple- Iphone

HTC- Droid Eris

Motorola Droid

Google Nexus 1

Figure 30: Touch screen sensitivity Test

4.1.7 Iphone and nexus 1 Security

Apple introduced security architecture for the iphone summarized by limiting the number of application installed and gave them a limited functionality. Mobile Safari for example refuses to support flash display or the ability to download archives such as dmg or zip. The iphone doesn't listen to any Transmission Control Protocol (TCP) or User Datagram Protocol (UDP) ports for incoming data. More than that, the iphone doesn't allow third party applications to be installed else it's downloaded using AppStore or using iTunes with a small set of the filesystem to be visible over this connection; Apple has restricted any kind of access to the filesystem.

Such limitations may help strengthening security by reducing the exposure to potential vulnerabilities. If an attack occurs to that specific application over that connection, the attacker may gain the highest privilege level that may allow him/her to run the code in the context of that application. Since there is no address randomization supported by the iOSX, that application remains at the same address in memory which makes it easier for attackers to write a reliable exploit code and causes the application to be vulnerable [97].

The Nexus 1 OS is called Android 2.1 which is built on a linux kernel where it inherits most of its powerful security mechanisms That is based on *Isolation*- Every application runs in its own linux process and each process run on its own Java Virtual Machine (JVM) with each application has a unique linux- UID so That its own files are not exposed to the other applications.

When an application is trying to access other application's components, it has to have a *permission* to do that. Permissions are assigned to applications by the package installer which initializes a dialogue with the user.

The third security mechanism for android is using *signatures* which allow any android application to be signed with a certificate and the private key is held with its developer. Such applications may share the same UID and the same permissions. However, existing security models can be exposed to a critical vulnerability [98-100].

Security is a critical issue in developing health- related applications and in that sense, iphone security seems to be a better choice as Apple's Personnel reviews the source code for malicious code before publishing it on the AppStore. That is not much of a case in the android market since it was built on an open source.

4.1.8 Iphone 3Gs and nexus 1 Easiness of programming & Openness

Apple Had been criticized for having a "closed" strategy regarding its products and it didn't change much with the release of its first mobile handset "iphone" in 2007. Locking the iphone to a specific operator, high prices and restrictions regarding developing third party applications were the major criticism. Later on, Apple warmed up towards–interoperability [101] by allowing the development of third party applications for the iphone using objective-c as a programming language. Objective- c is the native language for Mac OS X and it is considered to be unpopular among developers [102]. It gave the developers an opportunity to sign up and download the SDK for free [103, 104]. Later on, developers can send the finished product to Apple to be checked and then published to AppStore where Apple Takes 30% of the profit. The positive side is that, some applications can be extended and integrated with SNs technologies (e.g. Facebook and Twitter).

As mentioned earlier that, the nexus 1 is built on the top of an open source OS called android 2.1 in addition to a middleware and key applications. It is developed by Google and it uses a modified version of linux kernel. its popularity is increasing from 6% in 2008 to 21% in 2009 [105]. The main strategy of Google is pushing towards openness which can be seen clearly in Android 2.1 that offers an easy way to be customized to fit with the user's needs specially the developers [106].

However, android 2.1 is a promising OS and yet had been criticized for having so many bugs. Java is a popular programming language and it is commonly used in developing applications for the Android. Yet, Android 2.1 doesn’t comply with some of the java standards like Java SE and ME and this may cause compatibility and garbage collection issues which may slow down applications and may affect responsiveness [107]. (Table 2 presents a summary of hardware and software specifications for both Smartphones).

4.1.9 Comparison between Nexus 1 and iphone 3Gs

Figure 31: Iphone vs. Nexus 1 [108]

	Iphone 3Gs	Nexus 1
CPU	600 MHz	1 GHz
Memory	256 MB (eDRAM)	512 MB DRAM
Weight	135 grams	130 grams
Battery Life	Up to 5 hrs talk time and 300 hrs of standby on 3G	Up to 7 hrs talk time and 250 hrs standby on 3G
WiFi	802.11b/g	802.11b/g

GPS	Turn by turn and digital compass	Turn by turn and digital compass
Sensors	Accelerometer, Proximity sensor and Ambient light sensor	Accelerometer, Proximity sensor and Ambient light sensor
Camera	3 megapixels, No Digital zoom Neither LED Flash	5 megapixels (2x Digital zoom) with LED Flash
Storage Capacity	16, 32 GB	4- 32 GB
Operating System	iOS 4.2	Android 2.1
Application Store	iTunes + AppStore	Android market
Multitasking?!	YES (iOS4.0 and above)	Yes
Security	No access to filesystem, no TCP or UDP ports are opened for incoming data, limited installed applications with a limited functionality	Built on linux kernel security mechanisms (isolation, permission and signatures)
Resolution	480*320 pixel	800 x 480 pixel (PenTile RGBG)
Supported Video Formats	H.264, MPEG-4, MOV, M4V and MP4	H.264, H.263 and MPEG-4,
Supported Audio Formats	AIFF, AAC Protected, MP3, MP3 VBR, Audible (formats 2-4), Apple Lossless WAV	MP3, AAC+, Ogg Vorbis, WAV, and MIDI
Supported Image Formats	PNG (Highly Recommended), TIFF, JPEG, GIF, BMP, CUR, XBM	JPEG, GIF, PNG, and BMP

Table 2: iPhone vs. Nexus 1 Software and Hardware Specifications

4.1.10 Selected Platform

There seems to be a lot of competition when it comes to Smartphone's market. The iphone market is growing rapidly and has the most sales worldwide while on the other hand, the android market is facing difficulties as discussed above with much less sales than the iphone. This study presents and discusses some of the important features for two of the most competitive smartphones devices; the iphone 3Gs and Nexus 1. Apple's iphone 3Gs is a robust internet and multimedia device with a smooth user experience and has a great potential in developing health-related applications. On the other hand, learning an unpopular programming language like objective- C can be interesting and challenging at the same time.

The mobile social networking mapping and gaming application can be deployed in other Smartphones, meanwhile, the iphone is selected as a platform for developing ActiveTeen Appliclation based on the performed analysis and hopefully it will use most of its powerful capabilities such as UX, security, GPS and the accelerometer.

4.2 iOS SDK

4.2.1 Introduction

Apple announced the iphone in 2007 where no third party applications could be developed. One year later after so much of critics, apple releases the iphone SDK which is now called iOS SDK. Much of the critics remain such as the development is a Mac OS X- based and many of the developed applications couldn't make it through to the AppStore because of apple's imposed restrictions as iphone developers may not have conformed with Apple's Guidelines, frameworks or supported API's.

When the iphone was selected for development in ActiveTeen application, the current iOS SDK version was 3.1.3 at that time. Even with the fixes that had been made to that version, Multitasking was not supported and that was challenging due to expectations that some of the services might need that. Multitasking is the ability for third party applications to run in the background. As the thesis was evolving, and almost the time was right for the implementation phase, Apple announced the iOS SDK 4 which supports multitasking and this could be considered as an added value to this research.

The next sections examine how ActiveTeen application had been developed on an iphone 3Gs and what kind of tools were needed to achieve that.

4.2.2 Iphone Architecture

Understanding the iphone architecture gives an insight on how the application at the top level interacts with the iOS and how cocoa touch mediates between them.

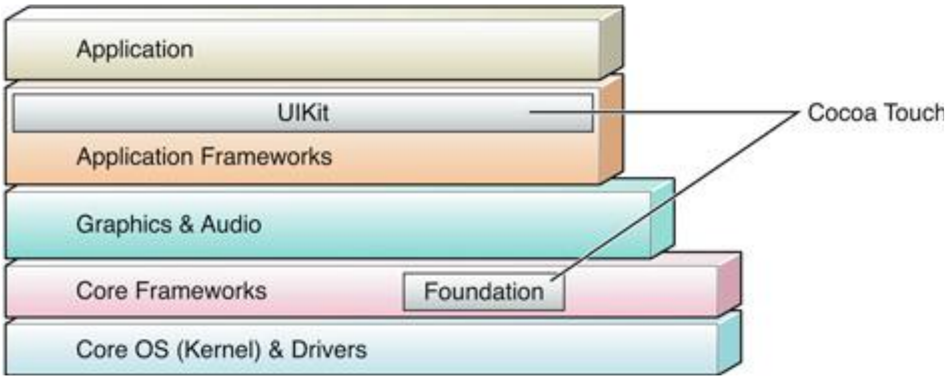


Figure 32: The iphone software Architecture [109]

The figure above describes the iphone software architecture. The **Core OS** which consists of the kernel, drivers and services such as networking, security and power management and sits between the end user and the hardware.

Cocoa touch is an API that provides an abstraction layer for iOS and is largely represented by UIKit framework in its “Touch” part which defines the application behavior and that includes event handling and drawing. it is the most common API among iphone developers and the UIKit is imported in every iphone project. Another complementary part of cocoa touch is the Foundation framework which defines the behavior of objects and its data types, collections and OS services.

Cocoa Touch uses the classical Model-View- Controller architectural pattern in the application's development. The model is basically the classes that contains the application's data (domain objects), the views are the user interface (Screen) and controllers which are mostly instances of a view controller represented by a code operating on the domain objects. Each view controller is responsible for one single view and without the controllers, no communication is possible between the views and the models.

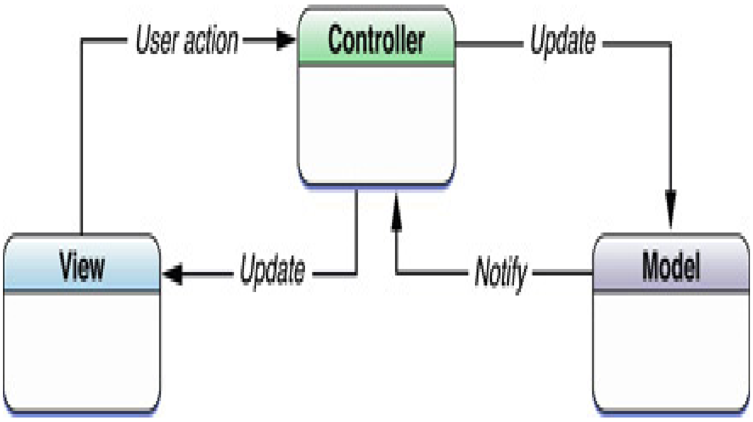


Figure 33: The MVC Architecture [110]

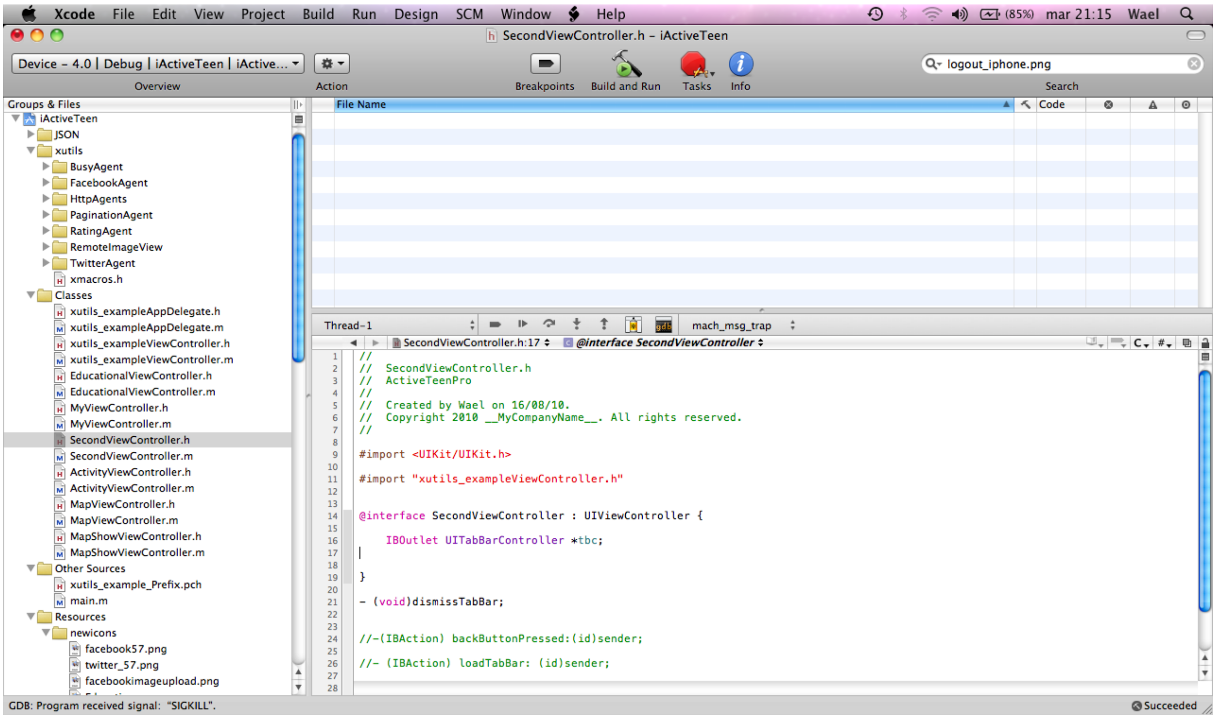
The Model View Controller (MVC) architecture is easily extensible and ensures a maximum reusability since you can write a class to do a generic tasks and this class can be used in any application [110].

The **graphics and audio** layer consists of Graphics, animation, sound, and video. At the top level resides the application which must be downloaded from the AppStore after being approved by Apple [111].

Objective- c is a language commonly used in cocoa touch development and had been introduced in 1980. It is a combination of a procedural programming language called C and an object oriented language called Smalltalk and it had been used to create an operating system called NextStep by a company called Next. Apple bought the company in 1996 in order to replace its Macintosh OS and introduced what is called now “Mac OS” in 2000 [112].

4.2.3 Xcode

Xcode is the official Apple’s IDE that is used in the development of MAC OS X and iphone native applications.



```
//
//  SecondViewController.h
//  ActiveTeenPro
//
//  Created by Wael on 16/08/10.
//  Copyright 2010 __MyCompanyName__. All rights reserved.
//

#import <UIKit/UIKit.h>

#import "xutils_exampleViewController.h"


@interface SecondViewController : UIViewController {

    IBOutlet UITabBarController *tbc;


}

- (void)dismissTabBar;


//-(IBAction) backButtonPressed:(id)sender;

//- (IBAction) loadTabBar: (id)sender;
```

GDB: Program received signal: "SIGKILL".

Figure 34: The Xcode IDE

It is an integration of several tools as depicted in figure 34 and here, we will mention the most important tools that contributed to ActiveTeen application which includes:

Xcode workbench:

Briefly talking, this tool is used to manage the project and to write, run, find errors, debug and compile the code. It consists of four main areas:

1. Toolbar : it mainly specifies the target device whether it is iphone, ipad, Mac OSx or a simulator, build and run, perform tasks…etc.

2. Text editor: this is where the code is written and it has a code sense and breakpoints features just to mention some.
3. Organizational groups: this is where the hierarchical representation of source files, folders (groups), interface builder files, frameworks, targets and a tool called SCM to connect and synchronize to external repositories.
4. A simple representation of source files, Graphical User Interface (GUI) files and frameworks.

The figure above shows also the Classes group (folder). Notice that both classes of the same view controllers are differentiated by its ending .h and .m classes. The ViewControllers.h is a header file that defines the instance variable (Outlets) and actions (Methods) in a generic way. The ViewControllers.m is the implementation of the actions. Cocoa touch uses delegates extensively and represented by a keyword (_AppDelegate.h and .m) and they are classes that does certain things on objects at a certain time and its acting on behalf of the UIApplication class.

The UIApplication class is a standard part of UIKit and it calls application delegate if it exists to launch common application wide behavior and developers don't need to be worried on how things are done internally. The other sources group contains the main() method and a precompiled header (.pch) which is a list of header files from other external frameworks used in the project.

Interface Builder:

This tool is used to create a user interface. It is represented by the ViewControllers.xib class which defines all the connections between the corresponding outlets and actions. Some developers may find it hard to deal with specially in the beginning but later on, things turn to be a straightforward process.

Instruments: it is basically used to identify memory leaks or a code that affects performance.

4.3 ActiveTeen Components

4.3.1 Overview

This section discusses the main components of ActiveTeen project. Each component will be discussed separately and an objective- c code regarding each of the components will be shortly presented. This will guarantee more understanding about the features of the application.

4.3.2 Facebook and Twitter Agents for iphone

Social Networking applications such as Facebook and Twitter play an important aspect in many current applications. In fact, it is considered to be a key success if such applications could be integrated with such technologies to reach large numbers of users that may adopt it.

Both Facebook and Twitter APIs have been integrated in ActiveTeen application running as a client on iphone 3Gs. Integrating Facebook and Twitter into ActiveTeen, needs a member account in order to create a Facebook and Twitter application that resides on their servers. Once the application is created, developers can obtain an application key and a secret. These two parameters are passed as an argument to initiate the session.

The Facebook architecture is basically a client- server communication where an http request is sent from the mobile client to the Facebook server which is later on forwarded to the web application server that has access to the Facebook databases. An HTTP response is returned carrying data and displays it as HTML. The Facebook data may include (e.g. friends, feeds, wall) which won’t be displayed else the user enables that specific application to access such data with permission after pressing the Facebook login button. Once credentials have been verified, users can update their status about their physical activity plans, take and upload photos, access Facebook places, friends and news notifications.

Twitter uses a simpler architecture than Facebook where developers are obligated to get an API key and a secret to authenticate the application. The authentication process been used for both Facebook and twitter's users is called "login authorization and session cookie management" which means that the user's login credentials are cashed on the mobile client for a fast access. Using Both APIs will ensure that many of the user's friends may see the updated status and can be engaged in that physical activity.

Parts of Facebook and Twitter components have been posted as a tutorial and used in ActiveTeen project [113]. The components were updated to fit with project goals and additional features have been added as well. The application API key and secret are defined in the application delegate and that's where the application is being initialized using `applicationDidFinishLaunching method`. The FacebookAgent class calls the method sharedAgent to retrieve the references (Code Snippet 1).

```
- (void)applicationDidFinishLaunching:(UIApplication
*)application {

[[FacebookAgent sharedAgent]//

initializeWithApiKey:@"7ac82286316026f8a74beb55d3ec18bf"

ApiSecret:@"07d8a4dda03a41d8247e26737766ff00"

ApiProxy:nil];

[window addSubview:viewController.view];
```

Code snippet 1: Facebook and Twitter Integration

In iphone application the window which is basically a view is not commonly used in iphone applications. It existed as part of Mac Osx architecture and it remained used in iphone applications but rarely used. However, in here we are adding a subview to the window view.

After the application finishes launching and after verifying the API key and secret, an alert with a welcome message is displayed (Code snippet 2).

The alert is basically a view that may have a title and a message of type strings. We allocate a portion of memory for an object called “alert” using UIAlertView alloc and we initialize it using the title and the message. The delegate:self means that the object is sending messages to itself. Since Objective- c deoesn’t have a garbage collections, we release the alert object using [alert release].

```
NSString*    title = @"Welcome Back ActiveTeen!! ";

NSString*    msg   = [NSString stringWithFormat:@"Check Out the
INFO Button on how to proceed"];

UIAlertView* alert = [[UIAlertView alloc] initWithTitle:title
message:msg


delegate:self cancelButtonTitle:nil otherButtonTitles:@"OK",
nil];

     [alert show];

     [alert release];

}
```

Code snippet 2: Display an Alert

Here is the method to to post text to Facebook user’s wall. Notice the application id in the linkurl, this is the ActiveTeen unique id which was given once registered on facebook (Code Snippet 3) .

```
-(IBAction) OnFacebook:(id)sender{

    [[FacebookAgent sharedAgent] publishFeedWithName:@"ActiveTeen 
Post Section"

                      captionText:@"Share your Physical activity 
experience with Friends"

                          imageurl:@"friends_but.png"


linkurl:@"http://www.facebook.com/apps/application.php?id=1324284334
66127"

                userMessagePrompt:@"Share Your physical activity plans 
With Friends"];
```

Code snippet 3: A method to post messages to friends wall

Additional features had been added to the component using the open URL schema. Users can now see their friends, read news feeds, get user’s places and take a picture directly from the iphone camera and upload it to Facebook (Code Snippet 4).

```
-(IBAction)getFriends {

    NSURL *fbFriends = [NSURL URLWithString:@"fb://friends"];


    if (![[UIApplication sharedApplication] openURL: fbFriends]) 
{

     //if this failed to open, the website will be opened in 
Safari

     NSURL *webURL = [NSURL 
URLWithString:@"http://www.facebook.com/?sk=ru&ap=1"];
```

```
    [[UIApplication sharedApplication] openURL:webURL]; }}


-(IBAction)getStatus {
    NSURL *fbStatus = [NSURL URLWithString:@"fb://feed"];
    if (![[UIApplication sharedApplication] openURL: fbStatus]) {
     NSURL *webURL = [NSURL
URLWithString:@"http://www.facebook.com/?sk=nf"];
     [[UIApplication sharedApplication] openURL:webURL];   }
}
-(IBAction)getPlaces
{
    NSURL *fbPlaces = [NSURL URLWithString:@"fb://places"];
    if (![[UIApplication sharedApplication] openURL: fbPlaces]) {
     NSURL *webURL = [NSURL URLWithString:@"GET
https://graph.facebook.com/me/checkins"];
     [[UIApplication sharedApplication] openURL:webURL];}}
```

Code snippet 4: Using the Open URL Scheme

Now that the first view that holds all the social context is been implemented, additional features are needed and wont be suitable to have all of the features in one view since the iphone screen size is comparasingly small and besides, it is important to stick to the initial design presented in section 3.5. Switching between different views is quite challenging and took a great deal of time understanding how things work.

The challenge arises when trying to mix two templates that has different features; a UiviewController which represents the social networking view and the TabBarController with each TabBarItem representing different functionalities. To solve this obstacle, A button had been added to switch between both of the views and to present the second view with TabBar Items in it. The views are shown animated (UIModalTransitionStyleFlipHorizontal) and it gives a nice user experience (Code snippet 5) .

```
-(IBAction) OnButtonClicked:(id)sender;{

SecondViewController *second =[[SecondViewController alloc]
initWithNibName:nil bundle:nil];

second.modalTransitionStyle =
UIModalTransitionStyleFlipHorizontal;

[self presentModalViewController:second animated:YES];
```

Code snippet 5: Switching between main screen and the Tab Bar screen

After the view is displayed successfully with the tabbar items in it, how do we come back to the initial view. To solve this obstacle, a back button had been created and added as a subview inside each of the tab bar items inside the viewDidLoad method. This will enable user to switch back and forth between views. (Code snippet 6).

```
- (void)viewDidLoad {

    self.view = tbc.view;

    UIButton *button = [UIButton
buttonWithType:UIButtonTypeCustom];

    [button setFrame:CGRectMake(0.0f, 4.0f, 70.0f, 30.0f)];

    [button setImage:[UIImage imageNamed:@"arrow_left.png"]
forState:UIControlStateNormal];

    [button addTarget:self action:@selector(dismissTabBar)
forControlEvents:UIControlEventTouchUpInside];

    [tbc.view addSubview:button];

    [super viewDidLoad];


- (void)dealloc { // used to release objects from memory

    [tbc release];

    [super dealloc];}

}
```

Code snippet 6: Back button to return to Main screen

Now that the button is presented, how to dismiss the view and come back to the main view. Here comes action:@selector(dismissTabBar). The selector is a unique identifier that is used to select which method (dismissTabBar) to execute on a specific object (Back button) (Code Snippet 7).

```
- (void)dismissTabBar {

    [self dismissModalViewControllerAnimated:YES];

}
```

Code snippet 7: The Selector Method

The next section identifies the other application components that exists in each of the tab bar items.

4.3.3 Pedometer

A pedometer has been implemented in ActiveTeen using an integrated three – axis accelerometer. The latter is basically a device that measures both the acceleration and gravity by sensing the amount of inertial force in a given direction. Measurements are given by g- force (g= gravity) and that value when returned by accelerometer, it means which direction been sensed. If the iphone is held upright (Portrait orientation) that means, its approximately 1g of force on its y-axis has been detected and reported by the accelerometer. And if it's held in an angle of 45-degree that means that the value is distributed roughly equally between the two axes.

The iphone register a larger value than 1g if it was shaken, dropped or thrown. That indeed is considered to be a limitation to the implemented pedometer since users can shake the iphone and obtain considerably a false measured steps [114]. Measured steps are displayed on the iphone screen and can be shared with the user's friends on Facebook. In that screen, users has a direct access to Google maps where they can see (e.g. where they are, search for places, directions).

The component for measuring steps were posted here [115]. This component lacks a saving and loading functionality. Meaning that, the measured steps are starting from zero after closing the application. An enhancement had been added to save and load the measured steps using a cocoa foundation class called “NSUserDefaults” which is basically a small database for the iphone applications.

In order to access the accelerometer, we must create a class that conforms to the UIAccelerometerDelegate protocol, implement a method that accesses the accelerometer information and let the instance of that class be the accelerometer delegate (Code snippet 8).

```
UIAccelerometer *accel = [UIAccelerometer sharedAccelerometer];

accel.delegate = self;

accel.updateInterval = kUpdateInterval;

#define kAccelerationThreshold       1.4

#define kUpdateInterval              (1.0f/10.0f)

if ( fabsf(acceleration.y) > kAccelerationThreshold) {

steps++;
```

Code snippet 8: Pedometer

```
UIAccelerometer *accel = [UIAccelerometer
sharedAccelerometer];

accel.delegate = self;

accel.updateInterval = kUpdateInterval;
```

If the iphone is in normal usage, the (kAccelerationThreshold) default value is 1.3 g- force and if we want to detect the shake on one of the axes, this value has to be >1.3 which is called “intentional force”.

```
#define kAccelerationThreshold        1.4
#define kUpdateInterval               (1.0f/10.0f)
```

In a pedometer, the most common used acceleration threshold is 1.4. since we assigned a delegate, we need to specify an update interval (kUpdateInterval) in seconds and in here the update occurs every 10 seconds.

The method would detect a movement on the y- axis above the kAccelerationThreshold which is assigned to 1.4. and once the shake is detected, it increments the steps variable by 1.

```
if ( fabsf(acceleration.y) > kAccelerationThreshold) {
          steps++;
```

This method is used to save the measuredSteps which is basically a label (UILabel) of type String (NSString) in the NSUserDefaults database (Code snippet 9).

```
NSUserDefaults *prefs = [NSUserDefaults standardUserDefaults];
[prefs setObject:measuredSteps.text forKey:@"Steps" ];
[prefs synchronize];//Save
```

Code snippet 9: Saving the Pedometer data

To load the data, you would basically do something like that (Code snippet 10)

```
[measuredSteps   setText:[[NSUserDefaults   standardUserDefaults]
objectForKey:@"Steps"]];//Load
```

Code snippet 10: Loading the Pedometer data

4.3.4 Location Awareness

Location based services were introduced in 1996 but it was not known until the introduction of Radio Frequency Identification Device (RFID) technologies in 2004. It all started when some mobile operators started a location based service in fleet management and for users who wanted to track their children and pets. Nowdays, such services are commonly used in mobile gaming, marketing and health [116] and can be summarized in to two basic categories:

- Reactive: invoked by the users (e.g. nearby places).
- Proactive: automatically initiated based on events- user movement.

Such services are co-related to pervasive computing- context awareness discussed in section 2.4.

Core location framework is part of LBSs and had been integrated in ActiveTeen Application. It comes as part of the iOS SDK and it uses the iphone built- in GPS (Most accurate), cell tower triangulation (Less accurate) and Wi-Fi Protected Setup Internet Protocol (WPS-IP) address (the least accuracy) to display information about a location. Services are detected automatically and hidden from the application's users. Using the latter framework enables users to obtain location's information such as Latitude, Longitude, Altitude, Distance and Speed. Such information can be helpful for users who change their address or may want to change the pace and keep up with the measured distance.

A considerable amount of attention is needed when using such services in mobile applications since it drains the battery quickly [114].

The components used to provide user's location posted in Apple website and some other books [114, 117]. I added methods to obtain distance, speed and time Stamp to it.

The distance is determined by creating an object distance from the CLLocationDistance and we determine the distance between the newLocation and the startingPoint. The distance will be displayed in KMs (distance/1000) as a float value in a UILable (distanceTraveledLabel) (Code snippet 11).

```
CLLocationDistance distance = [newLocation
distanceFromLocation:startingPoint];

NSString *distanceString = [[NSString alloc]
initWithFormat:@"%.2f KMs", distance/1000];
distanceTraveledLabel.text = distanceString;
[distanceString release];
```

The speed is calculated based on the newLocation object as a float value and displayed in a UILabel (speedLabel).

```
speedLabel.text = [NSString stringWithFormat:@"%.2f m/s",
[newLocation speed]];
```

The time stamp is given for the current location of the user.

```
timeStampLabel.text = [newLocation.timestamp description];
```

Code snippet 11: Displaying speed, distance and time stamp from GPS

4.3.5 Maps

ActiveTeen uses the MapKit framework in order to place the user on Google maps. Since the application is used for running, a routing track is displayed on the iphone screen using google maps. This routing track is basically a KML file which consists of latitude and longitude points and can be created easily. This can be helpful in cases where users would like to use the same path again and again. However, ActiveTeen lacks a methodology to import and display such files and that can be considered as a limitation.

The open URL scheme were used to access Google maps from within the iphone and to display the routing track, I used the KML viewer sample code provided by Apple [118].

4.3.6 Educational Materials

This is basically educational videos about nutrition and physical activity that is obtained from YouTube. Such videos are for some experts in nutrition and physical activity and could be helpful for the users who wanted to learn. I used the open URL scheme to access those videos which used the YouTube player installed on the iphone.

We define a button called (`openVideoPhysical1`) in an action method and we include the link to the video on YouTube. Obviously, the name of the method, button and the links varies from one to another (Code snippet 12).

```
-(IBAction) openVideoPhysical1
{
[[UIApplication sharedApplication] openURL:[NSURL
URLWithString:@"http://www.youtube.com/watch?v=90cHm9UO9bs"
]];
}
```

Code snippet 12: Access videos from YouTube

4.3.7 Music

The ipod music library on the iphone had been integrated in ActiveTeen application to bring more joy to the user when running or jogging. Users can create a play list, select and add their favorite songs from the iphone music library where the album cover photo, song title, artist and albums are displayed in the screen. Meanwhile, users can pause, skip forward and backward between songs.

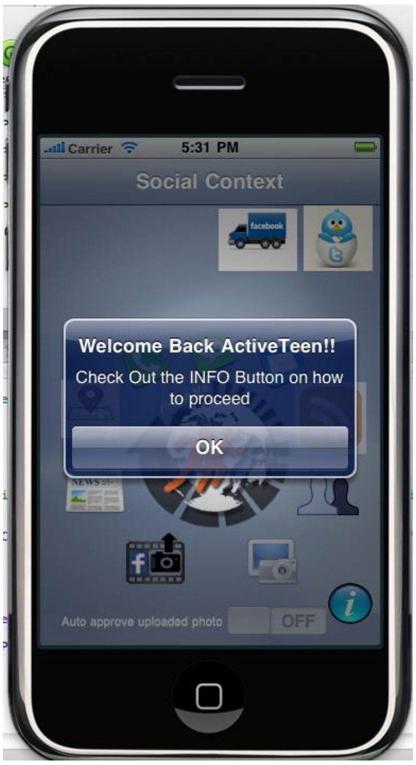
To access the ipod music library, I used the music player framework posted in this tutorial [119]. Additional changes have been added especially for the look and feel and switching between screens.

Chapter 5- Results and Evaluation

5 Results and Evaluation

5.1 Results

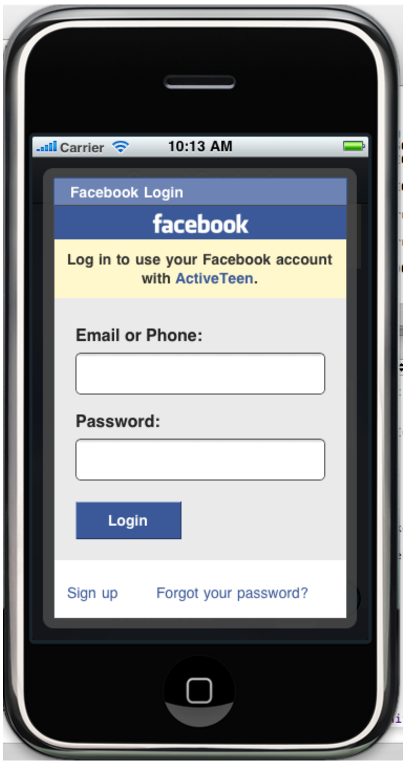
ActiveTeen has been successfully integrated on an iphone 3Gs. This section presents what had been achieved depending mostly on the functional requirements and the initial user interface made by photoshop. ActiveTeen represents an integration of several tools and technologies in one running application that tries to help adolescents achieve at least 1 hour of physical activity which is for now running or jogging. I followed different design patterns and tried to follow most of Apple design guidelines [120] to give a more user experience and a smooth interaction with the application. The figures bellow describes the application in more details.



Welcome Back ActiveTeen!!

Check Out the INFO Button on how to proceed

Figure 35: Social Context Main Screen



Log in to use your Facebook account with ActiveTeen.

Figure 36: Facebook Login

Figure 35 shows ActiveTeen initial screen which handles different social context features. An alert is displayed to get user attention on how to use the application which can be accessed using the info icon at the down right corner of the screen. The light in the background is demped to focus on the alert and to provide a more user experience. User has to press on the alert to make it disappear else none of the features can be accessed.

Figure 36 shows that the user touched the login Facebook icon. The user is able to login with an existing account and password or create a new account. The user is kept logged in as long as the application is installed on the device.

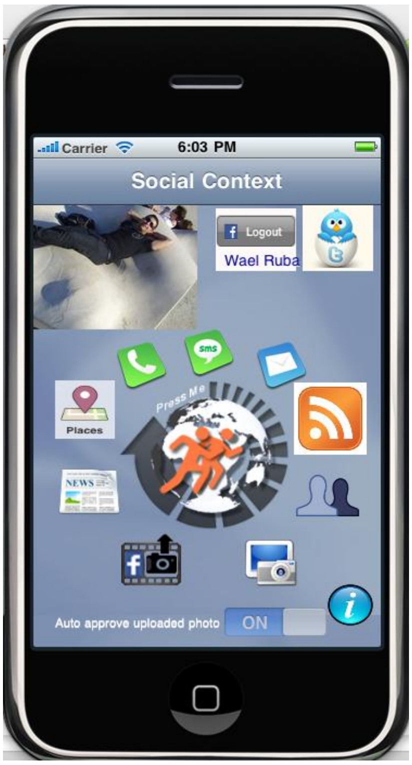
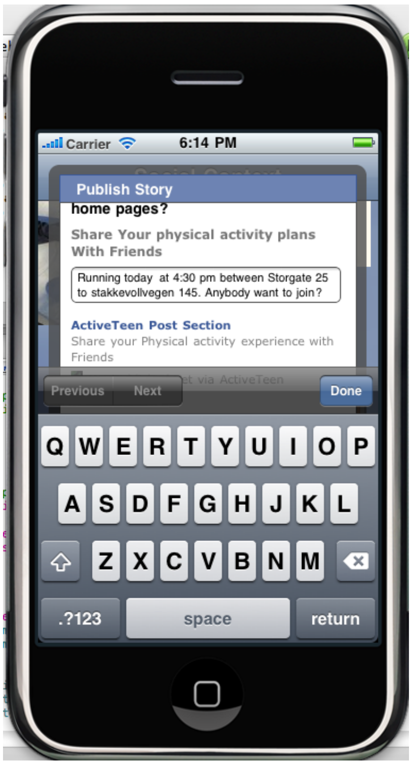


Figure 37: Logged in to Facebook



home pages?

Share Your physical activity plans With Friends

Running today at 4:30 pm between Storgate 25 to stakkevollvegen 145. Anybody want to join?

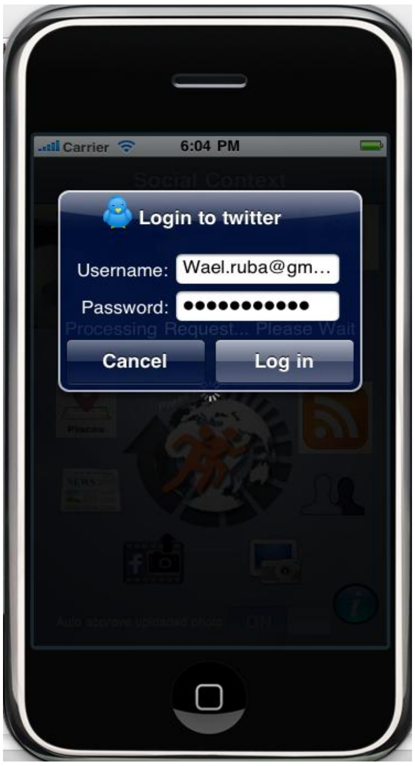
ActiveTeen Post Section

Share your Physical activity experience with Friends

Figure 38: Publish feed to User's wall

Figure 37 shows that the user is logged in to Facebook. The user's name and profile picture is displayed on the screen with the ability to log out. If the user decides to log out, then he/ she will be asked to provide credentials again.

Figure 38 shows that the user touched the RSS feed icon (Orange). The user can share what goes in his/ her mind and post it to Facebook wall either by telling other users about PA plans, or that he/ she finished doing the PA. This may guarantee that other users may participate with that user or maybe give them the motivation to do it.

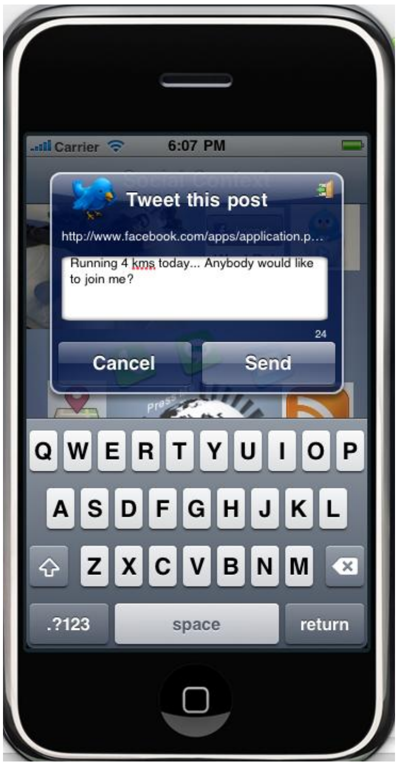


Username: Wael.ruba@gm…

Password: ●●●●●●●●●●●●

Processing Request... Please Wait

Figure 39: Login to Twitter



http://www.facebook.com/apps/application.p…

Running 4 kms today... Anybody would like to join me?

Figure 40: Publish feed to Twitter

Figure 39 shows that the user touched the Twitter icon on the right upper corner of the screen. The user will be asked to provide credentials in order to get access. We assume that the user has an existing account else the user need to go to go twitter website and sign up. If the user is successfully logged in then he / she will be able to post short messages (tweets) as depicted in figure 40 and other followers of that specific user can see it and make a reply.

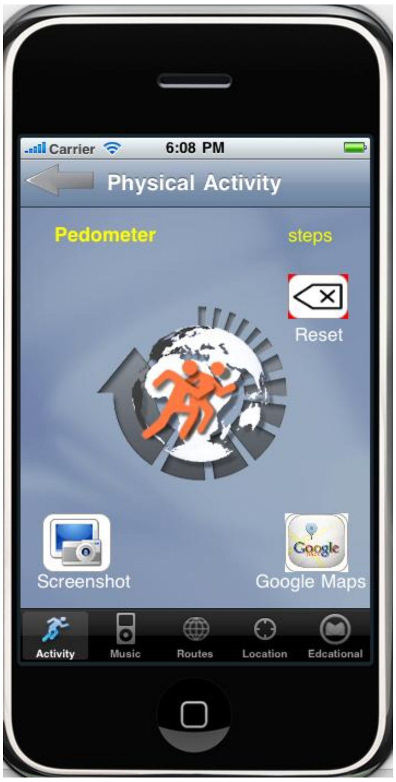


Figure 41: Pedometer

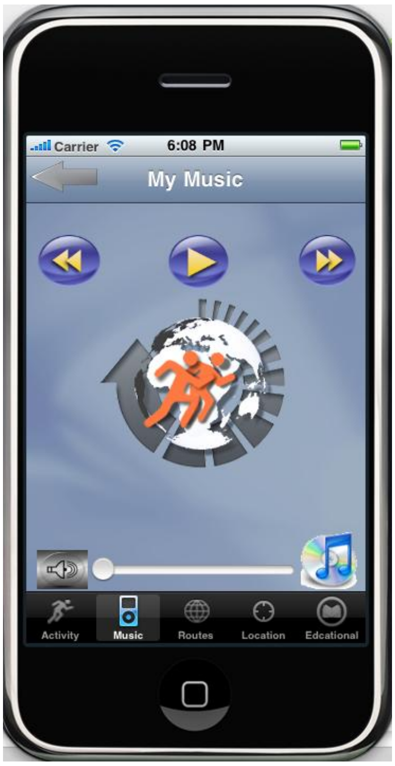


Figure 42: Play music

Figure 41 shows that the user touched the Activity icon located on the tab bar. Notice the alpha channel added to the icon to provide a more UX. The pedometer measures how many steps the user achieved using the built- in accelerometer device. The accelerometer data is incremented automatically and saved in the case that the application might crash. User can touch the reset icon which makes steps count to 0. User also has direct access to Google maps installed on the device and can take a screenshot of the screen which is saved automatically to the camera roll photo albums. Once the photo is saved, then the user has the ability to post it to ActiveTeen photo album section so that other users can see it.

Figure 42 shows that the user touched the Music icon located on the tab bar. User has to press the iTunes icon to access the music library. We assume that the user has some music saved on the iphone. Once this is done, then the user can select which songs to queue or select from the play lists already saved on the device. User can skip forward and backward between tracks, pause and control the music volume. The song and album title, singer and an image of the album is displayed on the screen.

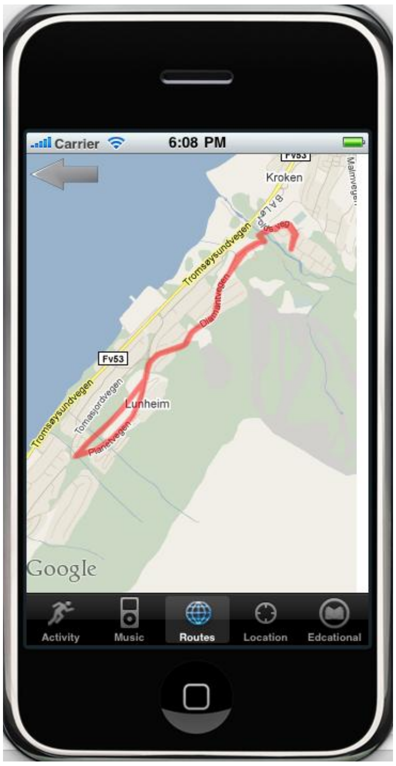
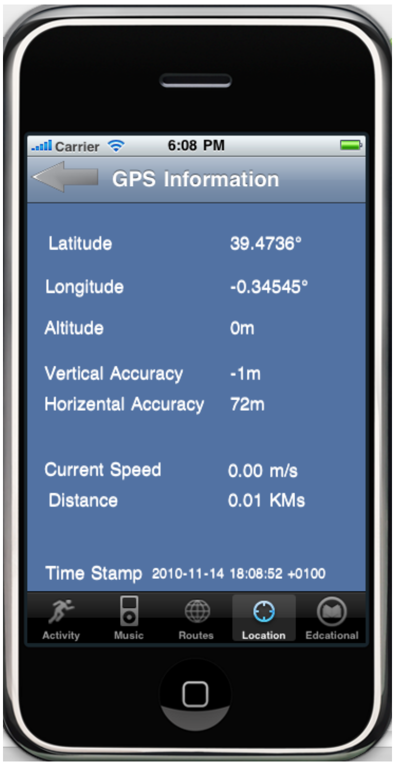


Figure 43: Available Routing Tracks



GPS Information

Latitude 39.4736°

Longitude -0.34545°

Altitude 0m

Vertical Accuracy -1m

Horizental Accuracy 72m

Current Speed 0.00 m/s

Distance 0.01 KMs

Time Stamp 2010-11-14 18:08:52 +0100

Figure 44: GPS information

Figure 43 shows the available routing tracks. A routing track can be used in physical activity to keep up with the pace and for users who might change their address. It is basically a KML file that consists of coordinates and other features drawn on a map and can be created using Google earth or other tools.

Figure 44 shows the GPS information. It consists of User's coordinates (degrees), GPS precision (m), speed (m/s), distance (km) and a time stamp showing date and time.

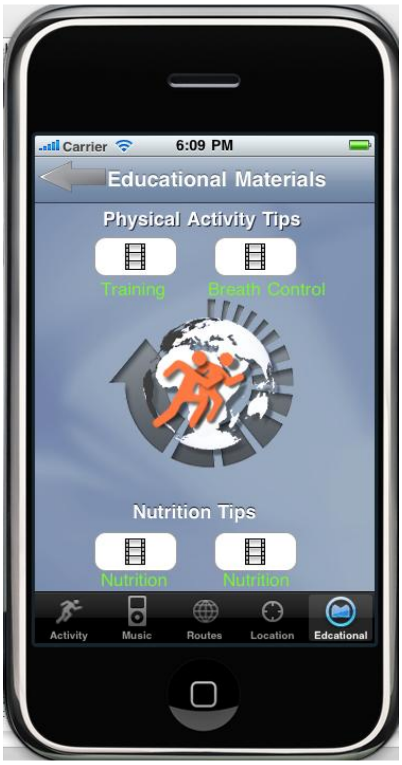
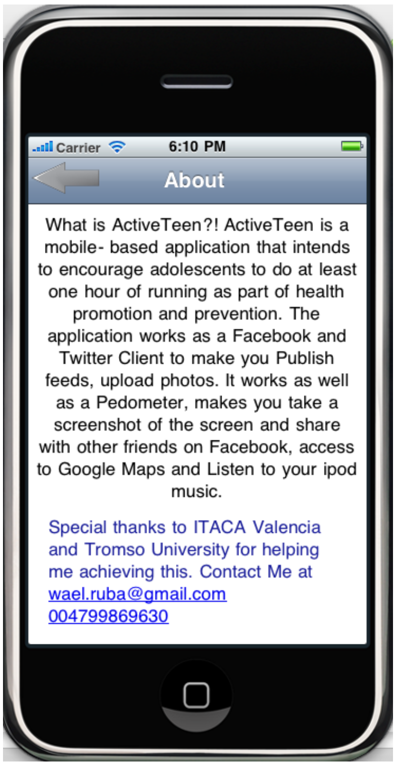


Figure 45: Video Tutorials



What is ActiveTeen?! ActiveTeen is a mobile- based application that intends to encourage adolescents to do at least one hour of running as part of health promotion and prevention. The application works as a Facebook and Twitter Client to make you Publish feeds, upload photos. It works as well as a Pedometer, makes you take a screenshot of the screen and share with other friends on Facebook, access to Google Maps and Listen to your ipod music.

Special thanks to ITACA Valencia and Tromso University for helping me achieving this. Contact Me at wael.ruba@gmail.com 004799869630

Figure 46: About Application

Figure 45 shows YouTube video tutorials. The video are displayed using the YouTube media player installed on the iphone. It shows different kind of training techniques, stretching, breathe control and nutrition.

Figure 46 shows the about the application screen. It includes information about the application and it can be extended to have a text and video tutorials to guide the user further.

5.2 Evaluation

Testing and evaluating the application on real user is beyond the scope of this research. However, a testing and evaluation method is presented in chapter 7- Future Work. To evaluate the application, a cross-sectional methodology has been employed where we compare what had been proposed in the functional requirements and what had been achieved in the result section.

FR#	Short Description	Implemented	Comments
FR1	Connect to Facebook	1/1	User can connect to Facebook either by an existing account or by creating a new account.
FR2	Facebook News feed	1/1	User can post and read news feeds.
FR3	View nearby friends, profile, photo and location.	¾	Not fully customized. User can access friends, photos and locations using Facebook places.
FR4	Nearby places	0/1	Not implemented
FR5	Google maps and GPS	2/2	User has access to Google maps and the GPS information
FR6	Add, edit ,update and share a physical activity.	2/4	The application is limited only for running or jogging. The news feed is used for sharing.
FR7	View the routing tracks of user’s location and share it on the SN.	1/2	User can view the routing track and cannot share it.

FR8	Listen to music while running or jogging.	1/1	The ipod music library has been fully integrated.
FR9	Information about Running or jogging distance, time, steps and ability to share on SNs.	4/4	User can obtain information about time, distance, measures steps and can share on SNs.
FR10	Rating among friends	0/1	The application is unable to provide user's rating
FR11	Award user with virtual gifts depends on user's rating posted to wall on the SNs.	0/0	Facebook closed the virtual gifts shop in the beginning of august 2010 [121]. The feature is being excluded from the evaluation process.
FR12	Physical Inactivity Notifications	0/1	The application is not able to send notifications to the user on a timely manner in case of physical inactiveness.
Total		15/22	

Table 3: ActiveTeen Evaluation Process

The table above shows the overall functionalities that had been proposed in the functional requirements. 22 functionalities had been identified in ActiveTeen project where 15 of them have been fully implemented. This is equivalent to approximately 68.2%. The table below presents the additional functionalities that were employed and seen to be relevant to ActiveTeen application and were not introduced in the functional requirements.

Additional functionalities	Comments
Twitter login and post a feed	User is able to login to Twitter and post a feed
Send SMS, Email and call	User is able to send SMS, compose an email and make a call.
Take a picture and post it to Facebook	User is able to access the camera from within the application and post it directly to Facebook.
Educational materials	User is able to access some of YouTube videos regarding physical activity and Nutrition.
Speed and distance	User is able to see on which speed he/she is running or jogging and a total distance from the starting location to the end location.

Table 4: ActiveTeen Additional Functionalities

Chapter 6- Discussion and Lessons Learned

6 Discussion and Lessons Learned

6.1 Overview

Iphone was selected as a platform for developing an application that helps adolescents in doing a PA. The application tries to combine different tools and technologies to bring the motivational aspect to the latter. Users are now able to do a PA, listen to music, and interact with friends on Facebook and followers on Twitter. Context information regarding location, distance, speed and time can be obtained using a built- in GPS.

6.2 ActiveTeen Limitations:

6.2.1 Internet connectivity

ActiveTeen is unable to decide whether the mobile device is connected to internet or not. Apple provides some classes called “Reachability” which must be implemented in any iphone application in order to be published to App Store. ActiveTeen currently assumes that the device is connected to the internet and it doesn’t alert the user about disconnections when the latter tries to access SNs or maps.

6.2.2 Twitter News Feed

Users are able to post tweets to their followers but they are unable to view what other followers post.

6.2.3 GPS information

The application takes between 2-3 seconds before it updates the location information, speed and distance. But this may differ from one region to another based on coverage.

6.3 Lessons Learned

This work gave me a good opportunity to understand obesity, its implications and to be part of many initiatives to fight it. Get to know in depth the rising notion of ubiquitous computing and its importance in persuasive or pervasive computing. Be more familiar with the project planning, design tools, architecture and iphone programming. The latter gave me a good opportunity to understand and tackle the challenges that may rise when integrating several technologies in one application.

As for being abroad in Valencia- Spain, this was of a great experience. I get to work in a team with ITACA employees, live culture, socialize and learn some Spanish. I was also selected to present part of my master thesis in a conference about nutrition which was held in September, 2010 in Porto-Portugal [122]. The conference gave me an opportunity to present my work, get feedback and knowledge from developers and nutritionists and employ it in ActiveTeen Application.

Chapter 7- Conclusion and Future Work

7 Conclusion and Future Work

7.1 Conclusion

This thesis presents and discusses different tools and technologies around ubiquitous computing which gains focus day after day. Such attention is gained by the rising notions of mobile applications which can be seen to play an important role in health promotion and prevention specifically in fighting obesity which is considered to be a global epidemiology.

The Thesis also presents a complete process of developing an iphone application called ActiveTeen which tackles the problem of integration among different tools and technologies. The latter tries to bring the motivational aspects in doing PAs mixed with fun. Different methodologies have been employed beginning from the software requirements gathering, system design and a proposed architecture ending by a fully running application. Additional functionalities which were discussed in the previous section should be added to the application in order to be widely accepted.

7.2 Future Work

7.2.1 Overview

There are several services that couldn’t be implemented on ActiveTeen due to its complexity in comparison with the time period of the thesis. The next section presents those services shortly.

7.2.2 Open Feint

This tool consists of web services that provide social gaming features such as leaderboards, achievements and challenges. It supports only iOS and Android smartphones games and applications [123]. As a matter of competition, an OpenFeint button could be added to ActiveTeen application to add deeper motivational aspects and users can have a choice to send the data to OpenFeint servers to compare it. Such data may include, measured steps, distances and maybe calories which can be turned to a user rating among friends on SNs.

7.2.3 Nutrition

Fighting obesity cannot be achieved without tailored nutrition guidance. In order to take ActiveTeen to a higher level, an integration of dedicated databases for nutrition must be employed. This may include (e.g. Recipes, information about calories, food suggestions).

There are some formulas to measure energy expenditures (calories) using the measured steps obtained from the accelerometer [124, 125]. The calorimeter can be optimized to work with the nutrition database to present notifications and suggestions in accordance.

7.2.4 Heart Rate Monitor

The iphone has a built- in microphone that can be used to monitor the heart rate. Some studies have been focusing on determining the type of physical activities (e.g. running, walking) based on the data from the accelerometer augmented with the heart rate data [126]. Another iphone application called WANDA B which enables caregivers to monitor patient’s weight, heart rate, blood pressure and other vital signs. The application is already in use in clinical trial.

7.2.5 Set a goal

As a matter of enhancement to ActiveTeen application, user can set a goal regarding measured steps and a track of their weight shown as a percentage indicator.

7.2.6 A testing and Evaluation Method

Testing

A special certificate is needed in order to test and evaluate ActiveTeen on real users. It is called “Distribution certificate” or “Ad Hoc” distribution and its included in the 99 $ developer fee. Apple provides a step by step installation of the certificate and once its properly installed, then the application can be sent by email to up to 100 users for beta testing [127]. The iphone has a Unique Device Identifier (UDID) which must be registered by the application developer in the distribution certificate for each beta tester. Beta testing can be very helpful in finding and fixing bugs, and in getting a feedback from users about the application’s features prior to submission to App Store.

Evaluation

Noticing that each iphone has a UDID, the developer can perform an overall evaluation on real users by sending them the application by email. Users then can download, drag and drop the application to iTunes and then synchronize it with the iphone. An ActiveTeen evaluation survey can be created and sent to users. The survey may include e.g. features feedback, UX, security and most importantly its impact on the users over a period time. Focusing on physical exercise, the evaluation survey should include questions regarding nutrition, weight loss, changing of behavior and life style.

Emphasizing that the number of users participating in beta testing can be sufficient, however, to obtain more accurate results in evaluating the application, this can be considered as a limitation.

References

1. Caballero, B., *The Global Epidemic of Obesity: An Overview.* Epidemiol Rev, 2007. **29**(1): p. 1-5.
2. Chow, W.H., et al., *Obesity, hypertension, and the risk of kidney cancer in men.* N Engl J Med, 2000. **343**(18): p. 1305-11.
3. Lowrance, W.T., et al., *Obesity is associated with a higher risk of clear-cell renal cell carcinoma than with other histologies.* BJU Int. **105**(1): p. 16-20.
4. Fowler, M.J., *Diagnosis, Classification, and Lifestyle Treatment of Diabetes.* Clinical Diabetes. **28**(2): p. 79-86.
5. Weiser, M., *Some computer science issues in ubiquitous computing.* Communications of the ACM, 1993. **36**(7): p. 75-84.
6. Tachakra, S., et al., *Mobile e-Health: The Unwired Evolution of Telemedicine.* Telemedicine Journal and e-Health, 2003. **9**(3): p. 247-257.
7. Mirza, F. and T. Norris, *Opportunities and barriers for mobile health in New Zealand.* Stud Health Technol Inform, 2007. **129**(Pt 1): p. 102-6.
8. Wheeler, T. *3.5 Billion Phones - 5000 Days*. 2008 [cited 2009 11.10]; Available from: http://www.rcrwireless.com/article/20080909/WIRELESS/809089995/35-billion-phones-5000-days.
9. *mHealth and Mobile Telemedicine - an Overview*. 2007 [cited 2010 20.April]; Available from: http://www.ehealth-connection.org/content/mhealth-and-mobile-telemedicine-overview.
10. Bjergli, J. *8 av 10 tiåringer har mobiltelefon* 2007 [cited 2010 18.may]; Available from: http://www.nettavisen.no/it/article963732.ece.
11. Pew Research. *Chapter Two: How phones are used with friends - What they can do and how teens use them* 2009 [cited 2010 25.May]; Available from: http://pewinternet.org/Reports/2010/Teens-and-Mobile-Phones/Chapter-2/Specific-activities-via-cell.aspx?r=1.
12. Mokhonoana, P. and M. Olivier, *Acquisition of a Symbian smart phone's content with an on-phone forensic tool.* Department of Computer Science–University of Pretoria, 2007.
13. Rosenberg, D. *Mobile-gaming revenue to hit $11.4 billion in 2014*. 2010 [cited 2010 22.may]; Available from: http://news.cnet.com/8301-13846_3-20006056-62.html?part=rss&subj=news&tag=2547-1_3-0-20.
14. Neate, R. *Smartphones to take '70pc of Europe's mobile market' by 2012* 2009; Available from: http://www.telegraph.co.uk/finance/newsbysector/mediatechnologyandtelecoms/6041063/Smartphones-to-take-70pc-of-Europes-mobile-market-by-2012.html.
15. Lenhart, A. *Social Media and Young Adults* 2010 [cited 2010 23.april]; Available from: http://www.pewinternet.org/Reports/2010/Social-Media-and-Young-Adults.aspx.
16. Facebook. *Facebook's Privacy Policy*. 2010 [cited 2010 07.05]; Available from: http://www.facebook.com/policy.php.
17. Parfeni, L. *Twitter Chirp: Twitter Has 106 Million Users* 2010 [cited 2010 15.april]; Available from: http://news.softpedia.com/news/Twitter-Chirp-Twitter-Has-106-Million-Users-139872.shtml.
18. Palihapitiya, C. *Facebook Mobile: 100 Million and Growing*. 2010 [cited 2010 20.may]; Available from: http://blog.facebook.com/blog.php?post=297879717130.
19. Karapanos, E., et al., *User experience over time: an initial framework*, in *Proceedings of the 27th international conference on Human factors in computing systems*. 2009, ACM: Boston, MA, USA.

20. Anderson, S. *7 User Experience Lessons from the iPhone (Introducing UX)*. 2010; Available from: http://www.slideshare.net/stephenpa/7-user-experience-lessons-from-the-iphone-introducing-ux.
21. Gade, L. *nexus one*. 2010; Available from: http://www.mobiletechreview.com/phones/Google-Nexus-One.htm.
22. Jackson-Leach, R. and T. Lobstein, *Estimated burden of paediatric obesity and co-morbidities in Europe. Part 1. The increase in the prevalence of child obesity in Europe is itself increasing.* International Journal of Pediatric Obesity, 2006. **1**(1): p. 26-32.
23. LOBSTEIN, T., N. Rigby, and R. Leach, *EU Platform on Diet, Physical Activity and Health: The International Obesity Task Force EU Platform Briefing Paper.* Brussels: IOTF in conjunction with EASO, 2005: p. 2006-05.
24. Cattaneo, A., et al., *Overweight and obesity in infants and pre-school children in the European Union: a review of existing data.* Obesity Reviews. **11**(5): p. 389-398.
25. WRITING GROUP MEMBERS, et al., *Heart Disease and Stroke Statistics--2010 Update: A Report From the American Heart Association.* Circulation. **121**(7): p. e46-215.
26. Mokdad, A., et al., *Prevalence of obesity, diabetes, and obesity-related health risk factors, 2001.* JAMA, 2003. **289**(1): p. 76.
27. Mathers, C., et al., *The burden of disease and injury in Australia.* Bulletin of the World Health Organization, 2001. **79**: p. 1076-1084.
28. Frayling, T.M., et al., *A Common Variant in the FTO Gene Is Associated with Body Mass Index and Predisposes to Childhood and Adult Obesity.* Science, 2007. **316**(5826): p. 889-894.
29. Ruiz, J.R., et al., *Attenuation of the Effect of the FTO rs9939609 Polymorphism on Total and Central Body Fat by Physical Activity in Adolescents: The HELENA Study.* Arch Pediatr Adolesc Med. **164**(4): p. 328-333.
30. Flynn, M.A.T., et al., *Reducing obesity and related chronic disease risk in children and youth: a synthesis of evidence with 'best practice' recommendations.* Obesity Reviews, 2006. **7**: p. 7-66.
31. Jódar, L., F.J. Santonja, and G. González-Parra, *Modeling dynamics of infant obesity in the region of Valencia, Spain.* Comput. Math. Appl., 2008. **56**(3): p. 679-689.
32. Simons, L. and J. Hampe, *Exploring e/mHealth Potential for Health Improvement: A Design Analysis for Future e/mHealth Impact.* 23rd Bled eConference. from www. bledconference. org.
33. Ozcan, U., et al., *Endoplasmic Reticulum Stress Links Obesity, Insulin Action, and Type 2 Diabetes.* Science, 2004. **306**(5695): p. 457-461.
34. Steppan, C.M., et al., *The hormone resistin links obesity to diabetes.* Nature, 2001. **409**(6818): p. 307-312.
35. Lago, R., P. Singh, and R. Nesto, *Congestive heart failure and cardiovascular death in patients with prediabetes and type 2 diabetes given thiazolidinediones: a meta-analysis of randomised clinical trials.* The Lancet, 2007. **370**(9593): p. 1129-1136.
36. Kenchaiah, S., et al., *Obesity and the Risk of Heart Failure.* New England Journal of Medicine, 2002. **347**(5): p. 305-313.
37. Jewett, S. *CAN YOU RECOGNIZE THE 8 COMMON SIGNS OF CHF?* 2010 [cited 2010 august 15]; Available from: http://www.wellsphere.com/nursing-article/can-you-recognize-the-8-common-signs-of-chf/1120721.
38. Barb. *Cardiomegaly The Enlarged Heart*. 2009 [cited 2010 19.Nov.]; Available from: http://www.clivir.com/lessons/show/cardiomegaly-the-enlarged-heart.html.
39. Weitzenblum, E., *CHRONIC COR PULMONALE.* Heart, 2003. **89**(2): p. 225-230.
40. Miguel, A. *Cor Pulmonale*. 2009 [cited 2010 17 august]; Available from: http://www.medicinageriatrica.com.br/2009/01/17/cor-pulmonale/.
41. Beebe-Dimmer, J.L., et al., *The Epidemiology of Chronic Venous Insufficiency and Varicose Veins.* Annals of Epidemiology, 2005. **15**(3): p. 175-184.
42. Eysenbach, G., *What is e-health?* Journal of medical Internet research, 2001. **3**(2).

43. Researc2Guidance. *500m people will be using healthcare mobile applications in 2015*. 2010 [cited 2010 13.dec.]; Available from: http://www.research2guidance.com/500m-people-will-be-using-healthcare-mobile-applications-in-2015/.

44. A. Waugaman and D. Aylward. *MHEALTH FOR DEVELOPMENT: THE OPPORTUNITY OF MOBILE TECHNOLOGY FOR HEALTHCARE IN THE DEVELOPING WORLD*. 2010 [cited 2010 25.oct]; Available from: http://www.unfoundation.org/global-issues/technology/mobile-health-for-development.html.

45. Zuehlke, P., et al. *A functional specification for mobile eHealth (mHealth) Systems*. in *e-Health Networking, Applications and Services, 2009. Healthcom 2009. 11th International Conference on*. 2009.

46. Pattichis, C.S., et al., *Wireless telemedicine systems: an overview.* Antennas and Propagation Magazine, IEEE, 2002. **44**(2): p. 143-153.

47. Siegemund, F. and C. Florkemeier, *Interaction in pervasive computing settings using Bluetooth-enabled active tags and passive RFID technology together with mobile phones.* Proceedings of the First Ieee International Conference on Pervasive Computing and Communications (Percom 2003), 2003: p. 378-387

558.

48. Schmidt, A., M. Beigl, and H.W. Gellersen, *There is more to context than location.* Computers and Graphics, 1999. **23**: p. 893-901.

49. Schilit, B. *Context-Aware Computing Applications*. 1994.

50. Chen, G. and D. Kotz, *A Survey of Context-Aware Mobile Computing Research*. 2000, Dartmouth College.

51. Iguchi, M. and S. Goto, *Anonymous P2P Web Browse History Sharing for Web Page Recommendation.* IEICE - Trans. Inf. Syst., 2007. **E90-D**(9): p. 1343-1353.

52. Pascoe, M.J., *Adding Generic Contextual Capabilities to Wearable Computers*, in *Proceedings of the 2nd IEEE International Symposium on Wearable Computers*. 1998, IEEE Computer Society.

53. Dey, A.K., *Understanding and Using Context.* Personal Ubiquitous Comput., 2001. **5**(1): p. 4-7.

54. Bardram, J.E., *Applications of context-aware computing in hospital work: examples and design principles*, in *Proceedings of the 2004 ACM symposium on Applied computing*. 2004, ACM: Nicosia, Cyprus.

55. Bellotti, V. and K. Edwards, *Intelligibility and accountability: human considerations in context-aware systems.* Hum.-Comput. Interact., 2001. **16**(2): p. 193-212.

56. Kumar, S., et al., *Ubiquitous computing for remote cardiac patient monitoring: a survey.* Int J Telemed Appl, 2008: p. 459185.

57. Zhang, D., Z. Yu, and C.Y. Chin, *Context-aware infrastructure for personalized healthcare.* Stud Health Technol Inform, 2005. **117**: p. 154-63.

58. Jang, W.-S., W.M. Healy, and M.J. Skibniewski, *Wireless sensor networks as part of a web-based building environmental monitoring system.* Automation in Construction, 2008. **17**(6): p. 729-736.

59. Boyd, D.M. and N.B. Ellison, *Social Network Sites: Definition, History, and Scholarship.* Journal of Computer-Mediated Communication, 2008. **13**(1): p. 210-230.

60. Carr, A. *Twitter Crushing Facebook's Click-Through Rate: Report*. 2010 [cited 2010 19.Nov]; Available from: http://www.fastcompany.com/1694174/twitter-crushing-facebooks-click-through-rate-report.

61. *Facebook forbi VG*. 2010 [cited 2010 19.Nov.]; Available from: http://avis.dn.no/artikler/avis/article398249.ece.

62. Huberman, B., D. Romero, and F. Wu, *Social networks that matter: Twitter under the microscope.* ArXiv e-prints, 2008.

63. Kincaid, J. *Latest comScore Stats Show Twitter Growth Is Still Strong*. 2010 [cited 2010 19.Nov.]; Available from: http://techcrunch.com/2010/06/18/latest-comscore-stats-show-twitter-growth-is-still-strong/.

64. Susi, T., M. Johannesson, and P. Backlund, *Serious games–An overview.* Skövde: University of Skövde (Technical Report HS-IKI-TR-07-001), 2007.
65. Kleijnen, M., K.d. Ruyter, and M.G.M. Wetzels, *Factors influencing the adoption of mobile gaming services*, in *Mobile commerce*. 2003, IGI Publishing. p. 202-217.
66. Suh, M., et al. *Bayesian Networks-Based Interval Training Guidance System for Cancer Rehabilitation*.
67. Fujiki, Y., et al., *NEAT-o-games: ubiquitous activity-based gaming*, in *CHI '07 extended abstracts on Human factors in computing systems*. 2007, ACM: San Jose, CA, USA.
68. Stanley, K., et al., *PiNiZoRo: A GPS-based Exercise Game for Families.*
69. West, J. and M. Mace, *Browsing as the killer app: Explaining the rapid success of Apple's iPhone.* Telecommunications Policy. **In Press, Corrected Proof**.
70. Scott, J. *App Store Metrics*. 2010 [cited 2010 13.june]; Available from: http://148apps.biz/app-store-metrics/?mpage=appcount.
71. Siegler, M. *Loopt Hits 4 Million Users, Propelled By iOS 4 And Android*. 2010 [cited 2010 19.july]; Available from: http://techcrunch.com/2010/07/09/loopt-4-million/.
72. Loopt. 2010; Available from: http://www.loopt.com/.
73. Ferdz. *Loopt: Friend Finder or Friend Stalker?* 2010 [cited 2010 19.Nov.]; Available from: http://ramenberry.com/2010/01/08/friend-finder-or-friend-stalker/.
74. July, I., *The Wide, Wide World of iPhone App Development.*
75. Chakravorti, B., *Stakeholder Marketing 2.0.* Journal of Public Policy & Marketing. **29**(1): p. 97-102.
76. Knight, T. *Google Latitude raises privacy concerns* 2009 [cited 2010 19.Nov.]; Available from: http://www.electricpig.co.uk/2009/02/06/google-latitude-raises-privacy-concerns/.
77. Nack, F., *The world of mobile AR.* IEEE MultiMedia. **17**(01).
78. Scipioni, M. and M. Langheinrich, *I'm Here! Privacy Challenges in Mobile Location Sharing.*
79. Justin. *Glympse location app launches for the iPhone*. 2009 [cited 2010 19.Nov.]; Available from: http://gpsobsessed.com/glympse-location-app-launches-iphone/.
80. Vaa, A. *Nike og Apple utfordrer*. 2009 [cited 2010 19.Nov.]; Available from: http://www.idg.no/macworld/nyheter/article127679.ece.
81. Chen, C., S. Anton, and A. Helal, *A brief survey of physical activity monitoring devices.* University of Florida Tech Report MPCL-08-09, 2008.
82. Campbell, A., et al., *The rise of people-centric sensing.* IEEE Internet Computing, 2008: p. 12-21.
83. Tahnk, J. *10 Essential iPhone Apps for Runners*. 2010 [cited 2010 19.Nov.]; Available from: http://mashable.com/2010/02/23/iphone-apps-runners/.
84. Runkeepr. 2010 [cited 2010 15.may]; Available from: http://runkeeper.com/.
85. Kanstrup, A., K. Bjerge, and J. Kristensen, *A Living Laboratory Exploring Mobile Support for Everyday Life with Diabetes.* Wireless Personal Communications. **53**(3): p. 395-408.
86. Nguyen, H. *Nexus One Review*. 2010; Available from: http://www.ubergizmo.com/15/archives/2010/01/nexus-one-review.html.
87. Thorman, C. *Survey Results: Which Smartphone Will Own the Healthcare Market?* 2009; Available from: http://www.softwareadvice.com/articles/medical/smartphone-survey-results-1073009/.
88. Dowling, S. *Apple Reports Second Quarter Results*. 2009; Available from: http://www.apple.com/pr/library/2009/04/22results.html.
89. Grossman, L. *The best invention of 2007*. 2007; Available from: http://www.time.com/time/specials/2007/article/0,28804,1677329_1678542,00.html.
90. Win, B., et al., *Security Middleware for Mobile Applications.* Middleware for Network Eccentric and Mobile Applications, 2009: p. 265-284.
91. Block, R. *iPhone review, part 1: Hardware, interface, keyboard*. 2007; Available from: http://www.engadget.com/2007/07/03/iphone-review-part-1-hardware-interface-keyboard/.

92. O'Grady, J.D. *10 ways the Nexus One slays the iPhone (updated)*. 2010; Available from: http://blogs.zdnet.com/Apple/?p=6328&tag=col1;post-6359.

93. wikipedia. *Nexus One*. 2010; Available from: http://en.wikipedia.org/wiki/Nexus_One.

94. Wauters, R. *iPhone Beats Droid, Nexus One And Droid Eris In Touchscreen Performance*. 2010; Available from: http://techcrunch.com/2010/01/09/iphone-droid-nexus-one-touchscreen-performance/.

95. Olwal, A., S. Feiner, and S. Heyman. *Rubbing and tapping for precise and rapid selection on touch-screen displays*. 2008: ACM.

96. Moto Labs. *Touchscreen Analysis*. 2010 [cited 2010 20.April]; Available from: http://labs.moto.com/wp-content/uploads/2010/03/DIYTouchscreenAnalysisII.normal15.jpg.

97. Miller, C. *Security Evaluation of Apple's iPhone*. 2007; Available from: http://securityevaluators.com/files/papers/exploitingiphone.pdf.

98. Chaudhuri, A., *Language-based security on Android*, in *Proceedings of the ACM SIGPLAN Fourth Workshop on Programming Languages and Analysis for Security*. 2009, ACM: Dublin, Ireland.

99. Enck, W., M. Ongtang, and P. McDaniel, *Understanding Android Security.* IEEE Security and Privacy, 2009. **7**(1): p. 50-57.

100. Goode, A., *Managing mobile security: How are we doing?* Network Security, 2010. **2010**(2): p. 12-15.

101. Walker, G.H., et al., *From telephones to iPhones: Applying systems thinking to networked, interoperable products.* Applied Ergonomics, 2009. **40**(2): p. 206-215.

102. TIOBE. *Programming languages popularity index*. 2010; Available from: http://www.tiobe.com/index.php/content/paperinfo/tpci/index.html.

103. Allen, C. and S. Appelcline, *iPhone in Action: Introduction to Web and SDK Development*. 2008: Manning Publications Co. 472.

104. Zdziarski, J.A., *Iphone open application development*. 2008: O'Reilly. 280.

105. Carton, P. *New Survey Shows Android OS Roiling the Smart Phone Market*. 2010; Available from: http://www.changewaveresearch.com/articles/2010/01/smart_phone_20100104.html.

106. Merholz, P., *Google's Nexus One: Can Openness Win?* 2010.

107. Wikipedia. *Android*. Available from: http://en.wikipedia.org/wiki/Android_%28operating_system%29.

108. Cox, J. *Google Nexus One vs Apple iPhone 3GS* 2010 [cited 2010 20.Nov.]; Available from: http://www.cio.com/article/513989/Google_Nexus_One_vs_Apple_iPhone_3GS_.

109. Apple. *What Is Cocoa?* 2010 [cited 2010 20.Nov]; Available from: http://developer.apple.com/library/mac/#documentation/Cocoa/Conceptual/CocoaFundamentals/WhatIsCocoa/WhatIsCocoa.html.

110. Apple. 2010; Available from: http://developer.apple.com/library/ios/#documentation/general/conceptual/DevPedia-CocoaCore/MVC.html#//apple_ref/doc/uid/TP40008195-CH32-SW1.

111. Dudney, B. and C. Adamson, *iPhone SDK development.* Pragmatic Bookshelf, 2009: p. 576.

112. Bennett, G., M. Fisher, and B. Lees, *Introducing Objective-C and Xcode*, in *Objective-C for Absolute Beginners*, Apress. p. 97-116.

113. Sonny, S. *FacebookAgent Update: Easily Run FQL, get User info, get/set permission and friend list!* 2010 [cited 2010 25.aug]; Available from: http://amanpages.com/iphone-app-development-core-sdk-cocoa/facebookagent-update-easily-run-fql-get-user-info-getset-permission-and-friend-list/.

114. Mark, D. and J. LaMarche, *Beginning iPhone development: exploring the iPhone SDK*. 2008: Springer.

115. Matt. 2010; Available from: https://github.com/computermatt/25-Apps-in-Aug/tree/master/step%20counter/.

116. Bellavista, P., A. Kupper, and S. Helal, *Location-Based Services: Back to the Future.* Pervasive Computing, IEEE, 2008. **7**(2): p. 85-89.

117. Apple. *Location Awareness Programming Guide*. 2010 [cited 2010 19.sept.]; Available from: Location Awareness Programming Guide.

118. Apple. *KMLViewer*. 2010 [cited 2010 25. Sept.]; Available from: http://developer.apple.com/library/ios/#samplecode/KMLViewer/Introduction/Intro.html.

119. Begemann, O. *The Music Player Framework in iPhone SDK 3.0*. 2009 [cited 2010 25.Aug.]; Available from: http://oleb.net/blog/2009/07/the-music-player-framework-in-the-iphone-sdk/.

120. Boudreaux, T., *Programming the Iphone User Experience: Developing and Designing Cocoa Touch Applications.* 2009.

121. Morgenstern, J. 2010 [cited 2010 20.sept]; Available from: http://blog.facebook.com/blog.php?post=405727117130.

122. *World Nutrition Congress 2*. 2010 [cited 2010 10. Dec.]; Available from: http://nutrition2010.com.pt/docs/scientific/workshops.pdf.

123. OpenFeint. *The best social gaming network for both Android and iOS devices*. 2010 [cited 2010 13.dec.]; Available from: http://openfeint.com/about.

124. Foster, R.C., et al., *Precision and accuracy of an ankle-worn accelerometer-based pedometer in step counting and energy expenditure.* Preventive Medicine. **41**(3-4): p. 778-783.

125. Suh, M.-k., et al. *WANDA B.: Weight and activity with blood pressure monitoring system for heart failure patients*. in *World of Wireless Mobile and Multimedia Networks (WoWMoM), 2010 IEEE International Symposium on a*.

126. Curone, D., et al., *Heart rate and accelerometer data fusion for activity assessment of rescuers during emergency interventions.* Trans. Info. Tech. Biomed. **14**(3): p. 702-710.

127. Apple. *Distributing Applications*. 2010 [cited 2010 09.Dec.]; Available from: http://developer.apple.com/library/ios/#documentation/Xcode/Conceptual/iphone_development/145-Distributing_Applications/distributing_applications.html.

Appendix 1:

ActiveTeen Source Code

See the attached file

Appendix 2:

Enterprise Architect and UML Design

See the attached file