Food Fight: A Social Diet Network Mobile Application

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Master of Engineering Capstone Project Report

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Abstract

The growth of smartphone technology in today's society has paved way for a myriad of consumer applications that target various aspects of our lives. One such area lies within the health and wellness category and relates to our dietary and eating habits. However, the percentage of downloaded applications in the health category is dominated by those in the gaming category on both markets from Android and Apple. Thus, in conjunction with the health start-up Blue Goji as an industry partner, this project proposes a solution through the introduction of crowdsourcing and social elements into the meal journal process in order to increase user retention. Existing smartphone applications targeting this sector are investigated and their benefits and shortcomings are analyzed in order to in to aid in developing a new application that will engage more users in tracking their eating habits for the purposes of improving their health. Through feedback from user study groups, changes to the application are made to align it with the customer's true needs and the application concept is evolved through multiple iterations. Finally, future improvements and suggestions for alternative ideas are proposed with regards to the final prototype produced for the project.

Introduction

The growing popularity of mobile smartphones has given rise to new methods of interaction between consumers, businesses and in general the world around us. For the end user, the smartphone provides the benefit of having a wealth of knowledge, information and services, literally at your fingertips. Conversely, as a platform for mobile applications of all kinds, it is now possible for a single application to connect, communicate and deliver content to millions of users as they go about their daily lives. For most companies and organizations that currently have mobile application offerings, the potential to reach a large market represents an opportunity for profit and smartphone users are viewed as their customers. However, in this project, we view the users as members of a community and rather than view them as customers, we attempt to leverage our users as a resource that can provide data and information that without the mobility and access of smartphones would otherwise be unavailable.

Specifically, this project focuses on the area of health and wellbeing and the potential data that can be acquired regarding the lifestyle and dietary habits of the user. In the past, information such as the types of food we eat, the amount of exercise we perform and the number of hours we sleep could only be recorded manually and analysis of this information would only occur if it is presented to a health professional or if a research group was conducted. Using a mobile application, information can be collected for a large number of users and analysis can be performed on a large data set very quickly and easily.

Based on the above observations, we have developed a mobile application, Food Fight, which collects dietary and lifestyle data from the user. Through the data we collect, we

attempt to introduce value to the user by building a community where healthy lifestyle choices in terms of diet are examined and rewarded based on actual results. Traditional health programs have predefined 'healthy' behavior and although we consider the input given by nutrition and fitness experts in our project, we also propose a system where we record the effects of certain diets on a large number of users and through these results, we evaluate the effectiveness of a particular diet.

Thus in this project report, we present the following:

a) The process of customer development by which the idea for Food Fight evolved and the feedback provided during trials and tests.

b) The final Food Fight prototype application, which encourages users to follow specific dietary and lifestyle guidelines and through their input, provide feedback on possible improvements.

First we review relevant work in similar applications and related fields. We then describe approach we took in order to design and develop an application that would meet the needs of our industry partner Blue Goji as well as meet the wants and needs of the customer segment we are targeting. This is followed by a discussion of the feedback received through various iterations of the application and finally we make proposals for improvements and possible future work.

Literature Review

Though there exists numerous commercial offerings of applications targeting dietary improvement and personal health tracking, data regarding the effectiveness of certain approaches are better documented in academic studies, which will therefore form a foundation upon which our product ideas are developed.

Academic research in this area is very broad and often spans multiple disciplines with research being published in the fields of pervasive and ubiquitous computing, human computer interaction, nutrition and dietetics. The literature reviewed for this project can be divided into 3 groups: the use of gaming to promote healthy eating, dietary assessment using mobile aids and journaling methods incorporating phone cameras.

Gaming and Health

Research relating gaming to health has involved using various gaming mechanics to improve user interaction and engagement in monitoring and improving their health. One method found to educate people on nutrition is to allow them to challenge each other based on nutrition facts in a casual social game setting [1]. The advantage of casual social games is the ability to spur on critical thinking outside of gameplay and although the game simplistic in nature, it shows the notion of competition is a key driver that can be utilized to encourage continuous usage.

Building on the notion of casual social gaming, daily healthy water intake is shown to increase by using a visual representation of the need to drink water in the form of a withering tree [2]. How healthy your tree is dependent on the amount of water consumed and results show improvement with the visual aid both with and without other players.

This suggests the power of a visual representation to something normally that cannot be seen such as the need for water. Although we may know we need to drink water and we may feel thirsty, a visual cue and an external need (to save the tree from withering) is a stronger motivational tool that can push us to perform actions.

This concept is fully developed and tested through a virtual-pet based game targeted at a younger audience [3]. In this application, data entry is performed through images and users will receive feedback on a -2 to 2 point scale with comments narrated by the pet. It was found that during the trial, "children playing the game ate a healthy breakfast 52 percent of the time; kids who didn't play it ate a healthy breakfast approximately only 20 percent of the time". Furthermore, both positive and negative feedback from the pet invokes a responsive action suggesting that the motivational ability of the game comes from the emotional connection with the pet and the ability to see the effects of their actions on the pet. The gaming mechanic from this study was similar to the initial proposal for Food Fight which also revolves around the concepts of virtual pets. However, the applications created for academic studies were not designed for prolonged use and thus did not consider user retention. For Food Fight, we proposed to incorporate further gaming elements such as competition in the form of challenges for the virtual pet to complete against friends.

Mobile Health Tools

Aside from research merging games and health, there are also a large number of studies on using mobile devices for various uses in health and fitness. The growth of mobile phones in recent years has allowed new methods for health related applications to reach out to and assist users [4].

SapoFitness [5]and Hyperfit [6] are both studies involving a mobile application application serving as a reminder tool, meal planner and calorie tracker. Both of these applications contain a large number of tools useful to the user and provide a portable and relatively easy method to enable users to perform personal health tracking and diet management. Although user feedback is positive, these types of applications are geared towards health conscientious users, as a significant amount of effort is required for input with no reward other than potential health gains. In particular, the need to calculate portion sizes to enable calorie counting is a potential source of high error to the resulting statistics shown by the application and studies have shown that calorie counting/portion estimation improves if users are trained and use developed techniques [7]. The average user who does not have the initial motivation would unlikely to be willing to perform these tasks and thus an application like Food Fight which is intended for all audiences must be easy to use and require minimal effort form the user.

Camera based journal systems

One way to minimize user effort is to use the availability of camera in modern smartphones to enable visual recording through food photography. However, the problem of food recognition and portion estimation remains and attempts have been made to solve this via different methods. Using computer vision, researchers have shown that it is possible to segment and classify foods with high accuracy under certain conditions [8], [9]. Furthermore, it is also possible to perform volume estimation enabling the calculation of portion sizes and thus an estimation of calories consumed. Although the research in this area is promising, and accuracy rates are shown to be high, it is important to note that most experiments are performed under controlled environments with a limited number of test data. In the real world, a mobile application using these algorithms could be faced with an

extremely wide variety of food in different combinations. A key issue is the ability to segment or separate the image into different parts containing different foods and this is clearly not possible with some meals such as seafood pasta. For these algorithms to be used in publically distributed application, there must be contingencies in place when the computer vision algorithms fail.

An alternative to computer vision is using crowdsourcing to perform the nutritional analysis on the food images [10]. In this study, a method of dividing the crowdsourcing tasks on Amazon Mechanical Turk is outlined which improves the accuracy of the analysis performed by the crowd-sourced workers. Thus, given an average user, the crowd-sourced solution would provide a greater accuracy than if the user were to perform the portion estimation themselves. However, a major drawback to this method is the inherent time delay between the user taking the photo and the completion of the crowd-sourced tasks. Again, for users that are already motivated to achieve their health goals, this would not be a major problem but for an average user without a strong motivation, this delay would detract from their experience of the application and would outweigh any efforts to inject interest or create engagement through game mechanics.

For Food Fight, we choose an approach that finds a middle ground between the methods described above that aims to avoid technical issues while maintaining user engagement.

Methodology

The planning and development of Food Fight consisted of finding a balance between multiple requirements, limitations and goals set by the various stakeholders of the resulting application.

The first of the stakeholders addressed were the industry sponsors Blue Goji and the development of Food Fight would ultimately be for the purposes meeting their goals and objectives. However, since Blue Goji itself is a start up and our application would not have foundations in any existing product line, we were essentially developing around an untested and unproven idea concept. As a result, we placed an emphasis on market research and customer development to discover exactly what kind of product we should develop. Based on the guidelines given by the company, we developed a set of value propositions that would attract users whilst fulfilling the functional requirements of the application. The method of providing these value propositions and meeting these functional requirements are manifest through specific features implemented in the application.

To test whether our value proposition does indeed match users' expectations and desires, we conducted trials and interviews with potential users. Lastly, desired features in the application were further influenced by the technical capabilities of our team members as well as the robustness and practicality of the state of the art.

Functional Requirements

Functional requirements for the application were determined through discussions with the industry partner Blue Goji. The underlying motivation for the application was the ability to gather diet related data through a mobile application that was interesting and accessible to

users. The key feature of the application was to be the recording of data through taking photos with the desired information consisting of what types of food was being captured. In line with the company's other proposed products, the application would need to present the topic of health in a fun, interesting and engaging way that is different to what is already available on the market.

Value Proposition

The value proposition for the user was determined through analyzing existing products, reviewing user feedback and consulting with nutritional experts. The main goal for the product was to provide a positive impact on the user's health but as evident through the literature analysis, there are many ways to achieve this. Existing approaches include applications such as calorie counting applications, games and nutritional databases. The method chosen for this project was influenced by our industry partner and their desire for an application incorporating computer vision, machine learning and or crowd-sourcing. In addition, through analyzing existing offerings available in the market, we searched for a potential white space that would allow our application to stand uniquely amongst others.

Customer Development

In order to ensure that our proposal was marketable and addressed the needs and wants of the customer base, we tested our idea through trials and interviews with potential users/customers as well as experts. To do this, we created simple mockups that would enable us to explain the function, flow and features of Food Fight to the user and we obtained feedback regarding the idea concept, the usability of the design and quality of engagement. Interviews were conducted with people within our personal network who would fall into the customer segment were targeting. Based on the feedback supplied, we

adapted and evolved our app concept until a we found solution that both satisfied our industry partners and gained positive feedback from users.

Product Development

Once we had settled on an idea and direction, we began evaluating the technologies and platforms suitable for implementation. In selecting a suitable platform, we evaluated the mobile market and determined which mobile platforms we would target and whether we would deliver the application as a native mobile application or a web application. We also evaluated the various frameworks and technologies available for building mobile applications with regard to our application goals and our expertise as a team.

Development of the Food Fight mobile application was split into front-end, back-end and algorithm design tasks. By separating the development into independent tasks, our team members were able to make progress on parts of the application without reliance on the completion of unrelated components. This method of development suited the time resource availability of the team as all team members had varying timetables and workloads. A drawback to this method is that extra time was required to integrate the parts of the application to ensure consistency in terms of code structure and functionality as well as the user interface design.

After developing a prototype application, testing was performed on a similar audience as the initial customer development trials. The users were asked to evaluate the transition from the trial concept to the actual application and feedback was received regarding the final quality and usefulness of the resulting application.

Results and Discussion

The product design and development of Food Fight went through significant changes in both process and results before arriving at the final product. From the methodology followed in the previous section, the learning and results from each stage of the project contributed to each version of the product proposal and are discussed here.

Initial Concept

The initial concept for Food Fight as prescribed by Blue Goji was an HTML5 based mobile phone application that would utilize computer vision in order to automatically tag foods. Gaming elements were to be injected into the application to engage the user such that they would continue their usage over a long period of time. The goal of the application would be the ability to collect a large amount of information regarding the dietary habits of the users. This information could then be used in other Blue Goji products or offerings targeting the health and wellness theme,

With this basic outline, we evaluated the current market in terms of similar applications in order to discover whether there were any potential white spaces for our application to exploit. From our investigation, we found that the current offerings of health applications could be divided into two categories: health tools such as calorie counting applications and games which used food/health for context. Though both categories were well represented in terms of applications, the top apps in the health and fitness categories were tools such as fitness trackers or calorie counters.

The user feedback provided within the iOS and Android application markets showed that health tools were not able to engage users unless the user had a predisposition towards

health and were already in the market to look for apps that would assist them in tasks such as weight loss or calorie counting. Users who did not have a strong interest or motivation for weight loss and exercise found the application cumbersome and tedious to use. These applications required the user to perform tasks such as searching for the exact foods eaten as well as estimating the serving sizes which required effort on the part of the user.

On the other hand, food/health related games received negative feedback in terms of the fact that they provided no educational value and did not aid the user in improving their diet or health. These games did not fair as well in terms of popularity compared to the above mentioned health tools.

From our research, our first proposal for Food Fight was a game focused around a virtual pet that the user would be responsible for. As users recorded their meals, the virtual pet will grow and evolve based on how well the user was eating, If the user was eating a healthy diet, the virtual pet would grow strong whilst if the user binged on unhealthy junk food, the pet would grow fat and unhealthy. This concept both engages the user by giving the user responsibility and a reason to continue their food recording whilst also providing feedback on their diet.

In order to reach the most customers, it was decided that we would target the application on both the iOS and Android platforms. We also decided to develop Food Fight as a native application as the gaming elements and experience would suffer if we used an HTML5 based framework. However, due to the limited experience on our team and the project timeline constraints, learning both Objective-C and Java to code the applications natively would not be feasible. Therefore, we searched for an alternative solution and found one through the

Corona app development tool. Using Corona, our application could be developed using the Lua language and ported to both iOS and Android systems. Furthermore, the Corona framework incorporated various features that are useful for designing game elements.

User Feedback

Using Balsamiq as a mockup tool, we presented our first concept to potential users and the response was mixed. People were intrigued by the idea and felt that it offered a different way of food journaling. Some users felt that this would be particularly suitable for children and believed it would be a great application for them to give to their kids to play with. Users were also found the food recognition feature intriguing, as it was something they had not heard of before. Though this feedback was not directly negative, meeting with Blue Goji raised some major issues that prevented us from proceeding with this proposal.

Figure 1 Mockup of virtual pet concept

One major issue was that although the gaming elements injected into the application were attractive for the user, it was only targeting a younger audience as older users who were not into mobile gaming had no interest in the gaming elements of the application. In order to fulfill the goals and product direction given by Blue Goji, our application would need to target a wider audience and provide health value to adults. The second issue with this proposal was the dependency on an automatic food recognition algorithm as the central function of the application. Although our research showed that food recognition is possible through computer vision, it has not yet been proven in any products outside of research and

we did not have the expertise to build this system while ensuring it would have the robustness and accuracy to fulfill the user's expectations.

Revised Prototype

Given the learning from our initial proposal, two key aspects of our core idea would change and evolve into a more suitable offering. The first change was regarding the injection of gaming elements. Though an interactive game would be able to engage users through visuals and user experience, this form of interaction would only suit audiences of a particular nature. Therefore, instead of incorporating traditional gaming elements into Food Fight, our second proposal would facilitate engagement by introducing competition between users through comparisons of their diets and the rating of their diet.

By bringing the focus back onto the users' health without the distraction or guise of a recreational game, Food Fight would try to provide useful feedback to the user. In order to differentiate Food Fight from other offerings, one important goal was to stay away from calorie counting which requires the user to document their diet in detail. Although this was the established norm for various other applications, the feedback given by expert nutritionists and dietitians did not emphasize calorie counting as the most important tool for diet improvement. In fact, their opinion was that the most important objective would be to try and slowly influence a behavioral change that would persuade people to gradually improve their diets on their own. Suggested methods include peer support, positive feedback and frequent reinforcement of the idea that dietary changes are required for health improvement.

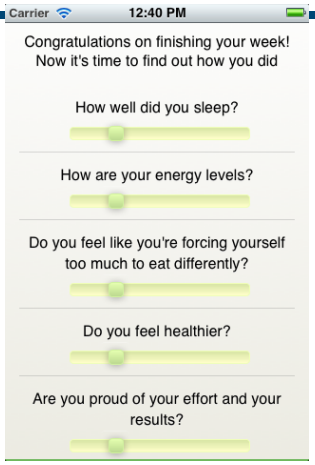

Figure 2 Weekly User Questionnaire

Following the advice of nutritional experts whilst avoiding traditional calorie counting methods, we decided to leverage social elements to create a sense of a group environment for the app user and facilitate interactions between them and other users who had similar health goals. The application would provide weekly feedback regarding the user's diet while also asking for input from the user regarding their perceptions of their diet and their general wellbeing throughout the week. This provides the data input that would be useful to Blue Goji as well as for internal algorithms to evaluate user diets. At the same time, users would be able to the diets of people with similar goals and also provide suggestions and recommendations.

Technology Considerations

From a technology perspective, automatic food recognition through computer vision was deemed unfeasible and unnecessary in terms of the marketed position of Food Fight which was more firmly rooted in social health feedback and behavior change. Also, moving away from traditional gaming elements meant that the Corona development platform would not be required and the application would no longer need to be native without the performance requirements demanded by games. This allowed us to revert to an HTML5 based application deliverable to both iOS and Android. In addition to HTML5, we utilize Phonegap, allowing us to package the HTML5 application in the form of a native application and grants access to functionality such as the phone's camera and GPS.

Figure 3 Architecture of Food Fight system

For the front-end of the application, we chose to use Jquery Mobile to create the user interface negating the need for a custom CSS layout while providing consistency through different phone platforms. For the back-end, we chose to use PHP and SQL due to the availability of sample code and documentation. The resulting application was successfully delivered onto iPad, iPhone and Android phone for user testing.

System Overview

The final Food Fight prototype is essentially a social food journaling application with health feedback provided to the user. A user account is created when the user first signs up and information such as their height and weight are recorded and used to calculate their progress. Each user has a specific measurable goal they wish to attain and the app helps to track their weekly changes. The functionality of the application can be divided into four sections: profile, journal, advice and network.

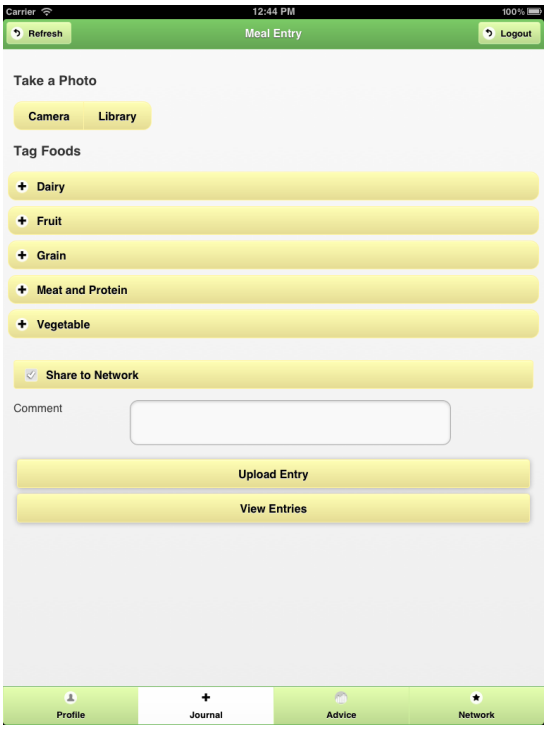

Figure 4 Journal Entry Page

In the profile section, the user is able to view their own profile and make changes to what can be publicly seen by other users of Food Fight. In addition, they are able to see their goal, the type of plan they are on and their most commonly entered foods. The journal section enables users to take photos and tag foods. These become meal entries which are stored on the Food Fight server. Each meal entry can consist of a photo and several tagged foods chosen from the food database we have created. Also recorded is the time of the entry and the user is thus able to view their previous entries in a chronological order, which provides a visual way of seeing exactly what they ate in the past week.

The user also has the option of sharing their entry to the network feed. The network feed consists of comments and entries made by other users of Food Fight. As each entry and comment is attributed to a user, we are able to selectively show foods and comments from users with similar goals or physical attributes. Finally, the advice page is intended to provide health feedback to the user based on their progress, the food they have been eating and how they feel.

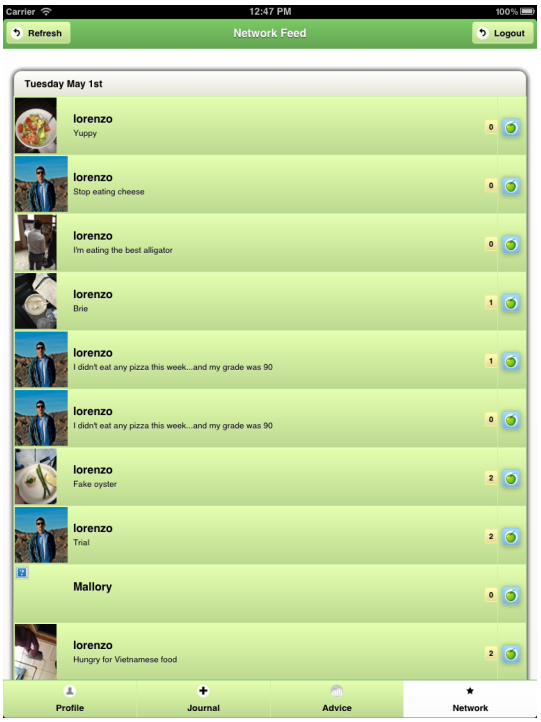

Figure 5 Network Feed Page

Conclusion

In this capstone project, a clearly growing awareness has been identified in society regarding the everyday health and wellness of the general population. Furthermore, as the purveyance of mobile technologies such as smartphones continues to increase, mobile applications will have unique opportunity to target personal health and wellness in a new way.

The design, development and feedback for Food Fight as part of the project shows the various difficulties faced when trying to find a subtle balance between functionality for the user and user engagement for a mobile application. In order to obtain useful data from the user, the user must be engaged by the application to ensure prolonged usage. At the same time, a mobile application in the health space is expected to and therefore must provide perceived value to the user's health and wellness.

In addition to the design issues, the dynamic nature of the mobile application market results in new applications constantly being released. Throughout the development of Food Fight, competitors with similar products in the space had appeared and highlight the necessity of product differentiation if it is not possible to be the first to market. Even in a relatively peripheral category such as health applications, there are already dozens of applications attempting to address the issue of improving users' diets.

The final prototype for Food Fight was developed and shown with positive feedback but a longer trial would be required to truly determine whether the features incorporated into the product are sufficient to engage and retain the user over a period of time. To make the

transition from a prototype to a release candidate, the application back end would need to be more robust and capable of handling higher amounts of traffic. In addition, there would need to be some moderation of shared images and comments in order to filter out inappropriate content.

For future work, depending on the success of user trials over a longer period, the concept developed for Food Fight could be taken and improved beyond what was developed for the prototype. Features that could further capitalize on the social elements could be introduced to the application and the algorithms for calculating weekly grades for the user could be improved or replaced with a machine learning algorithm. Using machine learning, we could simply use the weekly user input to determine any correlation between positive/negative feedback and certain diets. Given sufficient data, it may be possible to infer what types of diets would lead to positive input feedback, which would allow the application to give recommendations to the user.

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