Gamification of Citizen Sensing through Mobile Social Reporting

David N. Crowley*†
*Digital Enterprise Research Institute
School of Engineering and Informatics
NUI Galway, Ireland
Email: *firstname.lastname@deri.org

John G. Breslin*†
and Peter Corcoran†
†Electrical and Electronic Engineering
School of Engineering and Informatics
NUI Galway, Ireland

Karen Young‡
‡Information Technology
School of Engineering and Informatics
NUI Galway, Ireland
Email: *†‡firstname.lastname@nuigalway.ie

Abstract—The explosion of user-generated content on the Social Web published from mobile devices has seen reporting applications grow in popularity from self-reporting style workout tracking applications like Fitocracy[1] to community reporting applications like FixMyStreet[2]. In this paper, we introduce the concept of social mobile reporting where a community of people report on issues within their environment. We discuss annotating contextual metadata to reports, and the use of gamification to create an engaging user experience. We propose a design of the architecture of a social reporting framework including a description of the reports server that incorporates semantic data harvesting and provision. We outline a mobile application including game design elements of the mobile user experience, and a discussion of imaging technology to aid in processing of citizen reports and we provide some ideas for future work along with our conclusions.

Index Terms—Gamification, mobile social reporting, citizen sensing.

I. INTRODUCTION

Recently, developments in methods for microblogging and photo sharing through mobile platforms have led to the notion of mobile social reporting (i.e. a distributed group of people reporting information back to the Web and their networks about a particular event of interest). This in turn has made possible the concept of citizen sensing, whereby a mass of these citizen reports can be gathered, analysed and mined for meaningful information about the event being observed [1]. In citizen sensing, the people themselves are acting in a similar manner to physical sensors, but what is being sensed must typically be derived from the texts of their status updates, photo captions or microblog posts. Also emerging is the combination of citizen sensors using mobile and pervasive computing environments with other non-mobile sensors, enabling research areas and novel business opportunities (e.g. combining data from fixed webcams with cameras on mobile phones) [2].

In the area of mobile social reporting, gamification is becoming a popular means to encourage people to share information about where they are and what they are doing, usually through a points and trophies system whereby awards are made based on activity levels and context. The gamification of everyday aspects of life can be seen in apps and websites through services like Fitocracy, Foursquare[3] and Nike+[4]. Citizen reports can be made through the various large social platforms like Twitter and Facebook, but there are also a number of dedicated services for reporting urban issues by users, for example FixMyStreet in the UK, SeeClickFix[5] in the USA, and FixMyArea[6] in Ireland. However, predominantly these reports are sent to local government agencies to deal with.

We are developing a framework to report social, physical, and amenity issues that affect quality of life factors for users. These problems can be access related (traffic, footpaths, or lifts), graffiti, or other anti-social behaviour, but by reporting these users could gain points and even "level up" as with other gamification apps. By adding game elements into a social reporting application, we aim to engage users and hope to create a sticky, viral, and engaging experience for the user. We also propose that the framework would allow users to apply fixes in certain situations, for example, allowing users to take before and after pictures of a litter clean-up operation, for which they could receive extra points. This could be useful when applied to areas for which local government agencies are not open or for which they have no jurisdiction (sportsgrounds, private colleges, etc.) For public spaces, there could be an incentive for doing so (e.g. reduced home refuse collection charges).

In this paper, we will describe related work in citizen sensing, adding metadata to microblog updates, and the gamification of citizen reports. After describing the overall architecture including a description of the reports server that incorporates semantic data harvesting and provision, we will describe the mobile application, including our thoughts on the mobile user experience and image processing from citizen reports and we will give some ideas for future work along with our conclusions.

II. CITIZEN SENSING ON THE SOCIAL WEB

The Social Web has enabled people to connect to others through shared objects of interest (for hobbies, work top-

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[1] http://www.fitocracy.com/
[2] http://www.fixmystreet.com/

[3] https://foursquare.com/
[4] http://nikeplus.nike.com/plus/
[5] http://seeclickfix.com/
[6] http://fixmyarea.com/

ics, socialising, etc.) or for shared motivations (for political campaigns, volunteerism, community activism, etc.), through applications such as blogs, wikis and "life streaming" or microblogging [3]. Aid and humanitarian efforts are being facilitated through mobile applications [4] and microblogging services, where citizen-led efforts often outstrip the mainstream media in terms of conveying information about what is going on in a geographical area or for sourcing information regarding a time-sensitive event. For instance, Sheth [1] has presented on the emerging topic of citizen sensing, with an example using an aggregation of information on the Mumbai attacks in 2008 as provided by locals and visitors through the Twitter service and using tag identifiers such as *#mumbaiattacks*. Goodchild [5] also discusses citizen sensing but in the field of Volunteered Geographic Information (VGI) envisaging citizens as a network of human sensors with over 6 billion components, each an intelligent synthesiser and interpreter of local information.

These citizen sensors can complement other sources of sensor data through emerging integrations of sensor networks and social networks, virtual sensors and feeds from online weather services, and geotemporal services. Parafiynyk et al. [6] have described how rapidly changing data streams and unstructured data from amateur observers can be augmented using semantic technologies for the purposes of citizen science. Peer-to-peer traffic analysis has been proposed by Dornbush et al. [7], and this could be augmented with data from microblog posts regarding traffic status. While the texts of citizen reports can be mined for useful information, there is a lack of structured metadata being attached to these reports apart from date and place (through timestamps and geolocation information), which would facilitate improved processing of the context for a report. In fact, most mobile devices have a host of contextual sensor information that could be used to augment a citizen report. For example, the compass direction of a mobile phone when a report is being made could be quite important for triangulating an issue (e.g. a tweet about noise pollution, or a photo on a littering issue).

III. CONTEXT IN MACHINE TAGS

Twitter Annotations is an initiative from Twitter that allows attaching additional structured metadata to posts, going beyond the geotemporal annotations normally found in social media content. Twitter's guidelines for the annotations state that the goal is to "bring more structured data to tweets to allow for better discovery of data and richer interactions."[7] One specific use case for annotating metadata to microblog posts is to allow attaching of sensor data from mobile devices or embedded sensor devices in the user's environment to provide contextual data. Sensors have a diverse range of functionality and implementation; this has led to standardisation efforts within many communities. The SSN (Semantic Sensor Network) ontology tries to build on these efforts by representing a sensor by what it measures (the domain), the physical

sensor (the grounding), and its functions and processing (the models). The SSN ontology creates a domain-independent and full model for sensing applications by merging sensor focused, observation focused, and system-focused models. The SSN ontology can describe sensors in terms of capabilities, measurement processes, observations, and deployments [8]. Research in the area of citizen sensing has tried to leverage the power of the SSN ontology aligned with the SIOC (Semantically Interlinked Online Communities) [9] ontology to describe sensors on mobile devices in emergency reporting applications on microblogging platforms [10].

IV. GAMIFICATION

Deterding et al. [11] define gamification as the use of game design elements in non-game contexts. This definition as the authors recognise is very broad to allow for the variety of gamification types but this definition creates a distinction between gamification and serious gaming. A common game design element introduced into gamification applications is the concept of rewards. Zichermann et al. [12] divide rewards into four distinct categories - status, access, power, and stuff (SAPS). Status is the relative position in relation to others using the application (a ranking system), can be implemented using leaderboards or badges/trophies. Access gives users early access to promotions/sales or new features, a classic example of this is frequent flyer rewards from airlines, which can allow upgrades or access to luxury lounges. Power can be given by promoting users to moderators on forums or allocating them a limited set of powers over other users, this can also be a useful way to get interested users to manage a forum. Stuff can be a reward or prize, a freebie for the user to reward them. Mobile applications that implement these techniques include Foursquare, Nike+, and Epic Win[8](a to-do list application that encourages users to complete their tasks). Foursquare as an example of a gamified mobile application uses status and stuff from the SAPS model to incorporate game elements into the application. Status for Foursquare users is being the Mayor of a location they check into regularly. Foursquare users can also collect badges by completing different check-ins, like the "JetSetter" badge for checking in at multiple airports. Leaderboards are also included in the application as each check-in accumulates points for the user. In addition, users can acquire free stuff or discounts through check-ins, often by repeated check-ins in the same business. These game elements are features that can be incorporated into a mobile social reporting application and use similar concepts to reward users.

V. REPORTS FORUM

The Reports Forum will produce data using Semantic Web technologies such as RDF (Resource Description Framework). The Drupal 7 platform already publishes its content using de-facto standards like FOAF and SIOC, but we plan to provide an aggregation of citizen reports represented in SIOC augmented

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[7]http://dev.twitter.com/pages/annotations_overview

[8]http://www.rexbox.co.uk/epicwin/

with sensed data using the SSN (Semantic Sensor Network) ontology. Publishing in RDF facilitates interoperability and the ability to publish to or to utilise any Linked Open Data initiatives run by local or national government agencies (e.g. many agencies in the US and in Europe are providing data on public places and resources in KML[9] and other formats[10], which can be mapped to RDF).

VI. ANDROID APPLICATION

To allow mobile users to report social problems within their environment a Google Android application will be developed. Android was chosen due to its relatively open nature and access to hardware sensor APIs. This application will allow users to post pictures and textual descriptions of the issues. These descriptions when posted from the mobile application can be short in nature and be in the form of tags for example litter, graffiti, or other short descriptive features of the problem. The location of the user when posting will be acquired using GPS or through mobile phone cell triangulation and Wi-Fi networks. The location information will aid in verification of duplicate issues reported and by attaching contextual metadata to the post such as the direction the reporter was facing when posting a photo, a more accurate description of the location of the report can be created for later verification and image recognition.

VII. GAMIFICATION & GAMEPLAY DESIGN

The game elements of the application need to be fun, engage users socially and encourage a cooperative as well as competitive playing style. Ideally users will be intrinsically motivated to "improve" an area via social reporting (e.g. on litter or graffiti), but will also benefit from cooperative social motivation. Users report an issue in their local environment using the mobile application or through the forum, by completing a report the user gains points in the social reporting system. Other users can then vote for or against the importance of this issue gaining the user points and generating more visibility for the issue in the application and on the forum. Any registered user will be able to vote for or against any report initially after an initial review period the introduction of a karma/reputation like system similar to Reddit[11] or Stack overflow[12] will be examined.

Fig. 1. Litter Collection/Clean-up Badge

Duplicate reports from users can also gain points but these duplicates will help to verify earlier reports in conjunction

[9]http://www.galway.ie/gis/
[10]https://explore.data.gov/catalog/raw/
[11]http://www.reddit.com/
[12]http://stackoverflow.com/

with image analysis and any points gained will be shared between all user reports. While users can report these social, physical, and amenity issues, they can also in some cases help fix these issues as an individual or as a team/group endeavour. Team members or individuals through these fixes can help the community they live in while also gaining points in the social reporting system. Users can also receive badges and trophies for completing certain tasks. Figure 1 is an example of a badge for a user or group of users completing a task, in this case cleaning up litter. Some badges will be easy to get but some will be more "Easter egg" like to encourage users that complete tasks that are harder or more difficult (or rarer), for example a badge for clearing up litter with a huge group or fixing the most voted for issue of a week or month.

Displaying player statistics via a leaderboard or assignment of user roles (e.g. Mayor in Foursquare) additionally adds the dynamics of competition among friends to the game. Other motivations for gameplay include the addition of extrinsic rewards (e.g. vouchers or coupons for reduced bin charges, parking coupons, reduced entrance fees to public amenities, etc.). Bjork [13] identifies the importance of the psychological principle of social proof in social games, exercised with the sending of invitations via the user's social network and the provision of continuous feedback that other friends are playing, and therefore approve of playing, the game. Research in social gaming has identified the role played by these social games in providing distraction or filling gaps in the workday [11] and identified the requirement for "easy success" both in terms of gameplay and user interaction. The user's interaction with the application, in contrast to their interaction pattern in playing video games or commercial off-the-shelf games, is one of low-intensity repetition with restorative relaxation appearing as a typical motivation for use [13]. The repetitive activity (e.g. checking in, uploading pictures) has low suspense, low cognitive load and low emotional intensity and has been compared by [11] to a quasi-meditative mindset. Each task the user performs in using the application should be fast, simple and require minimal user effort, both cognitively and in user button clicks.

VIII. MOBILE USER EXPERIENCE

The challenges involved in providing an engaging experience for the mobile user are well documented: the device constraints (small screen, finite power resources and wireless network capacity limitations), coupled with an unpredictable use environment (varying user commitment to task and distributed attention in diverse situations and contexts [14]), lowers the user's tolerance for difficult interfaces. In order to attract a significant user base in an increasingly populated application landscape, a mobile application has to do something other applications do not or do it better. To be successful, a mobile application must be centred on a core user story, a core goal which can be embedded in an enriching and engaging user experience, but must never be lost [15]. The core goal of this application has been clearly identified as mobile social reporting - allowing users to post reports with relevant ease

on issues within their environment. Having identified this core goal, the challenge, then, is to embed this goal in an engaging user experience.

When developing a mobile application, an exploratory "take it or leave it" approach to users predominates. This requires the provision of an engaging user experience for users to persist in "using" the application [16] after downloading it. Potential users will consist of all smartphone users who will begin to use and continue to "use" this application as a result of the engaging User Experience provided at both a device and social level. Social games have a strong appeal to those who are not the traditional audience for competitive and video games [11], including 33% of those surveyed were over 35 years old and 51% female. Users of mobile devices often need to focus on more than one task and when using a mobile application, may have their attention divided across several activities. The design of mobile experiences must, therefore, accommodate the user's varying commitment and distributed attention [14]. Mobile applications that demand too much attention may distract users from more important tasks or lead to users being disinclined to continue using the application. Often users are only using the application to achieve a goal [17]. Interfaces for mobile applications, therefore, need to be designed to require as little attention as possible and minimise the amount of user effort required to achieve their goal. This can be achieved in a number of ways. Ginsburg [18] lists such measures as smart defaults, predefined lists of values, suggested matches, storing recent activity and voice/image recognition. The design of a successful mobile experience then is not about providing feature richness, as would be provided in desktop applications, but rather about the provision of a fast, specific service that satisfies a clear user goal.

IX. INTEGRATION OF MOBILE & SMART IMAGING

Today's users of mobile devices also carry very sophisticated imaging technology in these devices. Face detection is commoditised in the latest generation of technology and emerging technologies will allow more sophisticated detection, tracking and recognition both of people and objects within image and video sequences. Add to this the geolocation capabilities which confirm where an image was captured and we have a very sophisticated tool to add to the "social reporting" and "social gaming" experience. In this section we consider some of the potential for the integration of such imaging technology into the social networking infrastructures outlined above.

A. Imaging to Establish a Game Scenario

The emerging capabilities of next-generation handheld devices [19] will extend some of the capabilities of today's face detection technologies to enable more generic recognition and identification of objects and, indeed, more complex image scenes. Thus we can envisage a situation where game players capture an image of a suitable gaming challenge (e.g. litter or graffiti) which can be initially verified on their mobile device. Such data can then be transmitted to a remote server together with location and time data where it can be further analyzed and collated with other images of the same game challenge. Once challenges are verified by a sufficient number of reporting events it is easy to determine the original finders and reward them according to the social importance of this game challenge. It would also be possible to gather image data to train an extensive set of image primitives which can be used for future recognition of significant game challenges from additional image and video sources. For example, networks of street surveillance cameras could be re-purposed to more socially positive activities by detecting new litter or graffiti and passing this data back to the social gaming network for correction.

B. Imaging to Monitor Game Contributions

A key element in any such gaming system has to be the monitoring and verification of contributions from game players. After all, without some peer recognition or similar reward there is little motivation to play such a game. Mobile imaging, combined with location and time data, provides an excellent tool to aid such verification activities. It was mentioned above that face detection is effectively commoditized in today's mobile devices. In addition some degree of facial recognition is also possible, although it tends to be unreliable and somewhat limited by the unconstrained nature of most consumer imaging. There are also some privacy and trust issues in allowing the recognition of people from images. Given, in the context of a gaming infrastructure that it is an opt-in social environment we could assume that users would register and they should be willing to allow some limited form of personal identification from images/video sequences, for example for verifying players that have completed game tasks.

On the assumption that game players are willing to register and allow authentication within the game context, then we remark that a combination of face data with surrounding image regions defining the hair and clothing of an individual has been shown to be extremely effective in identifying individuals, or groups of persons within large image datasets and for unconstrained images [20]. It has also been shown that training datasets can be recombined for recognition system based on PCA (Principal Component Analysis) without a need for explicit re-training from all original images [21]. This allows for a rolling database of volunteers, yet allows original training images to be discarded - thus the gaming system does not need to store images after the initial registration of a player. This last aspect should help deal with some privacy concerns. From the above discussion it can be seen that capturing a simple image of a completed gaming challenge, together with the person(s) involved can provide quite a robust, yet simple mechanism to verify and score the contribution of game participants.

X. USE CASE

We have outlined a general use case for this social reporting system of a community mobile reporting effort to help with issues in their local environment. As mentioned, there are other systems similar to the concept described here but it is hoped

with the addition of gamification to engage users and also with encouraging a feedback loop within the system that allows users to also fix reported problems. We also acknowledge that not all reports will be fixable (or legally should not be fixed by non-governmental agency employees) by users of the application. So while encouraging users to get involved in fixing a problem, the application and website will also encourage users to tag items with the relevant governmental agency with responsibility for the area/issue. Then by creating links with the local government agencies, the most voted for issues each week/month would be reported to the relevant bodies. This allows for the creation of two feedback loops encompassing the application, the users and the government agencies, one where the users are actively involved in both the reporting and in applying the fix, and another where the user would report the issue but then would hopefully see the relevant agency fix the issue.

XI. Future Work

The goal of this research is to create a mobile reporting platform that incorporates gamification elements. The core of this work is the mobile reporting application, forum, and, the use of open web standards to allow easy interoperability of data published on the platform. The gamification elements within the mobile application is an attempt to quantify in future research whether users are more engaged by introducing game elements within a mobile reporting application. With the development of ubiquitous computing devices like Google's Project Glass that uses augmented reality technology combined with Googles Android platform. Devices such as Project Glass will ease the posting of reports as described here, the user will be able to look at the issue, and then using voice commands take a picture and tag the report with relevant keywords.

XII. Conclusion

In this paper, we have outlined a mobile social reporting framework that utilises the social web and social gaming to create an enjoyable, sticky experience for the users. By embedding game elements within the framework, it allows the possible measurement of the gain in user engagement through this gamification. We have described how by designing with gameplay in mind we hope to create a fast, specific service that satisfies the users goals. By using web standards and semantic technologies to build the reports forums and in creating the annotations within the reports aligns this work with the open (government) data movement and can leverage and aid any local government initiatives. This work also contains a discussion on how imaging technology can be used to verify contributions of users through facial recognition technologies to determine user identity and to verify. These technologies in conjunction with geolocation data can verify that the person(s) have completed a gaming challenge (fixed a reported issue). By encouraging users to fix certain issues, the reporting platform aims to create a feedback loop to encourage users to report and to take part individually or as a group in fixing these problems.

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