Pervasive Social Network

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Abstract—**Social Networking sites like Facebook and Twitter have become extremely important and are used by millions of people worldwide. In addition, the advent of mobile technology coupled with advances on the communications front, means that technology has started to move away from the traditional desktop setting and is becoming more pervasive. This research aims to show how a big screen setup in a public space, displaying a stream of comments from an online social network, can be utilised by the general public. The goal is to find whether such a system is able to instigate discussions between people - both physically and virtually, on the social network. The evaluation of privacy concerns, related to such a system in comparison with traditional social networks, will also be an important focus of this research. Similar work has already been done in particular contexts such as a classroom or a conference, however we aim in finding specific uses for such a system where the context is not as clearly defined. In order to achieve this, we created a social network called Occupy. The study described in this paper took place at the University of Malta, where a big screen projecting the stream of comments from our online social network was setup for discussion among those people on campus and those from outside. 66% of the users of our system believe that a pervasive social network adds value to traditional social networks, mainly by merging virtual discussions happening on the social network with physical discussions between groups of people. Through the use of a survey, analysis of the collected data and a focus group, benefits regarding the use of a pervasive social network can be presented.**

Keywords–Pervasive Technology; Social Network; Comments Stream; Big Screen; Privacy

I. INTRODUCTION

In the last few years, technology has started to shift from the traditional desktop setting and is becoming more pervasive. The rapid development of mobile technology combined with advancements in communication capabilities meant that people can have access to technology wherever they may be, at all times. This new kind of technology is referred to as Pervasive Technology and examples of this can be clearly seen in modern devices such as smart phones and tablets. These devices have excellent computational capabilities and are network-enabled. This means that their users are constantly connected to the internet and to each other. Social Networking Websites like Facebook, Twitter and Google+, have become extremely important over the years and are used by millions of people worldwide. In addition, Social Networking Websites are now starting to exploit the pervasiveness aspect of technology by developing mobile applications [1]. These applications allow users to be constantly connected with the social network through their pervasive devices.

A pervasive social network is an extension of the traditional social network. The most important aspect borrowed from the traditional social network is the recent intrusion in the field of mobile technology - mobile social networks. In addition, the basic structure of posting, retrieving and rating of comments is also common to both types of social networks. A pervasive social network also provides a mechanism for the creation of connections with other users as well as the browsing of these connections.

On the other hand, there are a variety of differences between the two types of social networks. The first of these differences is the fact that comments are displayed on a physical big screen placed in a specific location. This means that the discussions are not restricted to those users who are participating online. Instead, anyone who happens to be near the big screen may follow the discussions and participate.

In addition, the fact that the screen is tied to a particular location, means that the topics of the discussions might be "*hijacked*" by the context of the screen. Furthermore, the pervasive social network will post specific comments itself to try and instigate discussions between its users. In addition, the pervasive social network will try to suggest users in the vicinity who may be interested in starting a particular discussion by providing the location of the particular users.

The research that will be presented in this paper aims at finding new ways of extending social networks, so that they exploit the functionality offered by pervasive technology. We aim at identifying ways in which a big screen set up in a public space, displaying a stream of comments, can be used by the general public. Moreover, we aim to describe the reaction of the general public to such a system, in comparison to the way they normally use traditional social networks. The evaluation of the issues related to privacy as mentioned in [2] and [3] is also one of the main focuses of this research.

The reminder of the paper is structured as follows. Section II presents the Aims and Objectives, followed by the Literature Review in section III. In section IV we explain the Methodology with the Evaluation in Section V. Finally we present the conclusion and future work.

II. AIMS AND OBJECTIVES

The research question for this project is the following: "How can a big screen set up in a public place, displaying a stream of comments, be utilised by the general public?". The following is a list of goals that must be achieved in order for this project to be successful.

1) **Identify Uses:** The main aim of our research is to identify ways in which such a pervasive social network can be utilised by the general public. Moreover, we aim to describe the reaction of the general public to such a system, in comparison to the way they normally use traditional social networks.

2) **Merging Virtual and Physical Interactions:** Another important goal is to assess whether a pervasive social network can be successfully used to merge virtual interactions happening on the social network, with physical interactions between groups of people. Furthermore, the social network we add further information to the social graph such as location, thus allowing nearby users to find each other.

3) **An Active Social Network:** To further enhance the quality of the discussions, the proposed social network must be able to play an active role in the users' discussions, and so we will assess the users' reaction to such interactions.

4) **Privacy Concerns:** The evaluation of the issues related to privacy is also one of the main focuses of this research. We will compare the users' perception of our social network in comparison to other social networks.

III. LITERATURE REVIEW

A. Social Networking

A social network is a web-based service that enables a user to hold a public (with optional limitations) or semi-public profile. It also allows the user to maintain a set of connections with other users with the added possibility of viewing and managing his/her list of connections and connections made by others [4]. The way this web service is handled varies from one social network to another [5] [6] [7]. The main goal behind social networks, apart from allowing individuals to meet other people, is to provide the users a way to create and make public their own social networks.

There are many different types of social networks available on the internet, some of which are built for a specific purpose, while others are built for general connections. The most popular general purpose social networks are Facebook[1], Twitter[2] and Google+[3].

The normal procedure of interacting with a social networking website, is to first create an account. This can be done in a number of ways, but the most popular format is to provide answers to specific questions posed by the website. This helps in creating a web-based profile of the individual for other users to see and react to. Some social networks even allow the user to upload a profile picture or an avatar of themselves [8]. The users can then create links with other users which can be bi-directional on some websites or unidirectional on others. Moreover, users are also able to post content on the website which may be viewed by other users on the social network. Additional features such as the posting of photos and tagging of users may be present in certain types of social networks.

For social networks to be useful to our purpose, we must find ways of interacting with them and gaining access to as much information as possible from these valuable sources. The reason why we need to interact with these social networks, is that the users provide information about themselves and the connections that they have with others. More importantly, we can make use of existing, tried-and-tested technologies for developing a social network, without having to reinvent the wheel [9]. Several of the most popular social networking web sites are now launching what are called social network connect services [9]. Some examples of these connect services are Facebook Platform[4], Google+ API[5] as well as Twitter's API[6].

B. Pervasive Technology

The main idea behind the pervasiveness of technology is that as the years go by, technology and communication capabilities would be found in every environment imaginable, while at the same time, they are able to integrate seamlessly into the human users' everyday life [10]. It is now extremely common to integrate computing devices into anything electronically-based: we have programmable fridges and washing machines, smart phones and even smart TVs. Furthermore, social networks are also becoming pervasive through the development of mobile applications.

In Pervasive Computing, we can outline the accomplishments and the remaining challenges in these main areas: Context-Awareness, Automated Capture and Access to Live Experiences, Privacy, Time and Natural Interfaces [11].

A phenomenon that has happened in most of the major cities in the world and is now also spreading to Malta is what is known as *Digital Signage*. This is a fast growing market which aims at replacing the traditional poster billboards with electronic public displays [12]. This can already be seen in urban areas such as Shibuya Crossing, Tokyo and Times Square, New York, where the landscape is filled with large displays showing adverts from major companies [13]. Until now, these screens have been used for marketing purposes; however in this project we will propose a social network that can make use of such public displays.

C. Related Work

The literature we have found is mainly related to education, more specifically, the context of a conference [14]. Our system will not be tied to a particular context and as such, it will be designed differently and we expect that it will also behave differently.

The first interesting aspect that we noted out of the various research papers that we studied [15] [16] was the fact that most of them used a microblogging type of social network such as Twitter. However, we believe that by developing a custom social network, we will have more control over the discussions. Moreover, we will also be able to include more features that may be of interest to our research, but are not present in existing tools.

The first of these experiments was conducted at the ED MEDIA 2008 Conference in Vienna [17]. The focus of this study was to establish whether a microblogging website can be used to enhance a live event. To address this issue, a Twitter stream was set up during the ED MEDIA 2008 conference,

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[1]https://www.facebook.com
[2]https://twitter.com
[3]https://plus.google.com

[4]https://developers.facebook.com
[5]https://developers.google.com/+/
[6]https://dev.twitter.com

and all the conference participants were invited to follow this channel and participate. In addition, this Twitter stream was projected during the conference's keynote session and breaks, using an application called TwitterCamp [18], so that the online conversation among members of the audience using Twitter, could be displayed to the rest of the audience that were not using Twitter. The participants of this experiment, were asked to append the #edmedia08 hashtag in order to group the comments related to the conference together.

This experiment was redone a year later at the ED MEDIA 2009 Conference with a similar setting to the one done in 2008. However, an attempt to engage the audience more by keeping the Twitter Feed on for the entire duration of the conference was done [19]. In addition, the system was given more publicity than the year before in order to attract a larger audience. Another change from the previous year was the use of the #edmedia tag instead of the #edmedia08.

The following is a list of categories of comments identified by various studies [17] [20] [19] conducted on such experiments:

1) **Concerning the presentation**: Comments directly related to the presentation or any of the presenters.
2) **Discussion**: Interaction between two or more users.
3) **Links**: These comments contain links to online content that may or may not be relevant to the presentation.
4) **Comments**: This category encompasses feelings, thoughts and opinions of the members of the audience that are not necessarily related to the presentation.
5) **Establish Online Presence**: This is a very interesting point which can be defined as posting for the sake of posting.
6) **Pose Organisational Questions**: These are questions related to the logistics of the conference and its proceedings but not directly linked to the conference's topic as such.
7) **Exchange of Social Activities**: This category entails the setting up of social activities outside of the conference with other members of the audience. An example given by Ebner and Reinhardt [19] is that of inviting another person to go sightseeing.
8) **Arrange Short Meetings**: This means that users used Twitter to arrange meetings amongst themselves to perhaps continue their discussion about the conference privately.
9) **Documentation of Conference Activities**: Linked to the sharing of resources highlighted by [17] [20] but is related to the actual resources used for the conference.

All of these experiments tested the activity on the Twitter channel, before, during and after the conference. It is interesting to note that all experiments show an increase in participation when the conference starts in comparison to the activity before, and a decline in participation after it ends. This greatly suggests that such a system is indeed effective in creating discussion during conferences and live events.

IV. METHODOLOGY

For the purpose of this research, we created a pervasive social network called Occupy which is made up of two main parts. The first part is a traditional online social network that enables users to communicate through the use of comments. Furthermore, this social network enables users to create connections with other individuals, most importantly, those users that are within their vicinity. The second part of this social network is another website, which we refer to as the *Interactive Wall*. This website is responsible for extracting a stream of comments posted by the users of our system. This stream of comments is then displayed onto a big screen which is placed in a public space. Apart from displaying the stream of comments, the *Interactive Wall* will also try to play an active role in the discussions by displaying articles relevant to the current discussion on the wall (which are selected from news sources using artificial intelligence techniques).
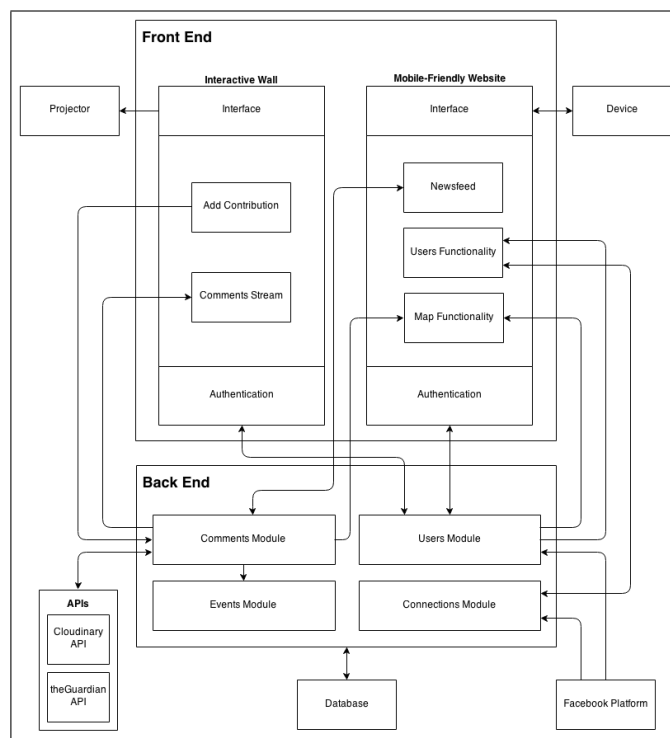

Figure 1. High-Level Block Diagram of the system

This system's design is split into two main partitions - a back end and a front end - as shown in Figure 1. These two partitions, which are further subdivided into modules, communicate with each other using the REST architecture[7]. This type of architecture enables the separation of specific roles between the server and the clients, by restricting the communication to standard methods.

The back end of the system - also referred to as the server - is responsible for handling all the functionality related to data. This is done in order to encapsulate the inner complexities of the system from the front end applications, so that they can then focus entirely on the graphical user interface and general client-side functionality. In addition, it also allows cross-platform compatibility since the client-side applications do not have to use a particular programming language to access and

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[7]Representational State Transfer (REST) is a programming architectural ideology that works on the principle of sharing references to the data rather than a copy of the data itself

manipulate data. The front end of the system - also referred to as the client - is responsible for exposing the system's feature in a user-readable format, namely the two websites mentioned. The front end does not perform any complex functions and more importantly it does not communicate directly with the database. It communicates with the back end in order to delegate the necessary functions requested by the users. Web sockets were also used to facilitate the exchange of certain types of real-time messages between the two parts.

The social network website includes three main features. The first feature is that of a *Newsfeed* where all the comments posted by the users of this system are displayed, sorted by a custom ranking algorithm that takes into consideration the number of *likes*, *dislikes* and comments as well as the time elapsed since its creation. This was done in order to keep the discussions flowing. The *Newsfeed* allows the users to contribute to the discussions by posting either a completely new comment or a reply to a previous comment. These contributions can also include an image. To give the users some measure of control over their content, the possibility of deleting comments was also included. Similar to the way other social networks operate, the comments are saved with the Global Positioning System (GPS) coordinates of the location from where the comment was created. However, to protect the privacy of the users, this feature can be switched off.

The second feature is that of a *Users* page. This allows users to see a list of people that have joined this social network, highlighting those that are currently *online*. To further protect the privacy of the users, only basic public information, such as the name, gender and locality, are displayed. Apart from giving the ability to see *Users* and *Friends* (and also creating new friendships), this system includes a feature that shows an individual what users are currently in his/her physical vicinity (*Nearby Users*).

The third feature is a map that is able to show the locations of some of the latest comments posted. Of course, since the users can opt not to share their location, only those comments originating from users giving the system their consent to track them are shown. Apart from the comments, the map also displays the location of the users that have agreed to share their location. This feature, together with the *Nearby Users* feature, were created in an attempt to investigate whether such a system is able to merge virtual discussions on the social network with physical discussions. The hypothesis is that by utilising this feature, people may confront a person (whom they may not know) posting on the social network, to continue the discussion privately.

The next part of our pervasive social network is the *Interactive Wall*, which is a website containing a stream of comments from our social network, that is displayed on a big screen. This wall is the main focus of our research, as it is the enabler of discussions, both physically and virtually. To further enhance this social network, we decided to make the Wall active in the discussions. This is done by allowing the social network to scan the different keywords attached with the comments posted on the system and retrieve a related article from an online source. This article is then posted to the social network as a contribution to the discussions. We will study the effect of such a system over the general public and what, if any, their reactions will be to such contributions coming from the system itself.

V. RESULTS AND EVALUATION

A. Evaluation Methodology

An experiment was carried out on the University of Malta campus, where a big screen showing our social network's interface was set up in a prominent place on campus. This experiment was held during the second week of January over a stretch of five days. It is important to note that this was during an exam period and so it might have introduced some bias to our study. Data obtained from this experiment was used as a valuable source of information for the purpose of this research, however we believe that this data alone is not enough to be able to draw conclusions. Similar to the previous work done in this area of research [19] [17] [16], we decided to conduct an online survey with the users of our system. Questions relating to the usage of this system as well as any concerns for privacy were put forward so that we would gather a general understanding of the public's view of our system and be able to draw conclusions based on this information. In total, the survey consisted of 21 questions that were split into three main sections – questions relating to demographics, to the usage of our system, and to privacy concerns. Apart from the survey, we also conducted a number of interviews during the experiment, so as to gather a better understanding of the users' first impressions in relation to our system. The same questions used for the online survey were asked during these interviews.

The last part of our research consists of a focus group, where a number of questions related to our system and how it compares to other similar systems were posed. The discussion generated in this focus group is also a major part of the evaluation of our research. The participants of this focus group were chosen based on their activity during the experiment and a total of six individuals took part.

B. Results

The response to our university experiment was highly satisfactory. A total of 425 unique users registered to our social network, 34% of which were females. Interestingly, only 35% of these users were active participants in this experiment and provided a total of 422 comments. In comparison to Facebook, our social network was outperformed in the percentage of users that are active in the discussions. In fact, 60% of all the users registered with Facebook are active participants in discussions [21]. We believe that the reason for this, is that people might feel apprehended when trying to post a comment to this social network. Other social networks may give a false sense of security and so people express their opinions freely without thinking that other users will see their comment. On the other hand, our system makes it explicit that whatever you will post, will inevitably be seen by a large number of people. Another point raised during the focus group is the fact that our social network is public. In other words, whatever a user posts will be seen by all the other users indiscriminately, while also including those individuals that are not part of our system, but can simply view the comment on the Interactive Wall. This further adds to the apprehension that users may feel, since they are sharing their information not only with their circle of friends but with virtually anyone who is either using the social network or is standing near the screen.

276 of the comments posted, introduced a unique topic to the social network, while the rest were a continuation

of previous discussions. The vast majority of the comments posted (94%) were text-only comments, while the remaining 6% included images. Figure 2 shows the usage of our system over a period of time. This includes a day before the actual start of the experiment, and a period of three days after it had ended.
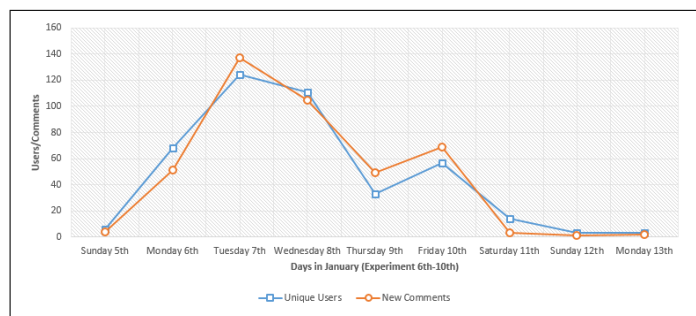

Figure 2. Usage of the system over time

From this graph, it can be clearly seen that the users of the system were most active during the experiment, at which time the screen with the comment stream was on. There was an immediate decline in usage after the screen was removed from campus, suggesting that this social network really does engage more with its users in its pervasive form rather than in its traditional form.

The topics discussed by the users varied, ranging from events related to the university, news from around the world, sports and other more general topics. Figure 3 shows the categories of comments that we identified during the experiment. Due to the fact that this was a new concept, a large portion of the comments posted were related to the system itself. When compared to the content uploaded to other social networks, the comments posted to our system seem to be heavily influenced by events taking place near the *Interactive Wall*. In fact, 68% of the comments posted are directly related to events that happened near the wall. Furthermore, despite the fact that the majority of the comments were posted by people who were near the wall (72 %), there was a small number of comments that were posted from other locations, including three comments from foreign countries. While the comments generated near the wall mostly had to do with events that happened near the wall, the other comments were largely personal advertisements. However, it is interesting to note that some of these comments were indeed linked to events happening near the wall, but in a different way. Instead of describing the events, these comments asked questions about them, and thus they created a real-time connection between people near the wall, and those at other locations.

As was expected, most of the participants of this experiment (48%) got to know of our system through word of mouth as well as through online media (31%), mainly Facebook. The poster set up to attract the users' attention and instruct them on how to interact with the system was not as effective as we had hoped, since only 12% of the users got to know of the system through it. It is interesting to note that 66% of the people who used our system believe that a pervasive social network adds value to traditional social networks. The most popular reason given for why it adds value, is the fact that it
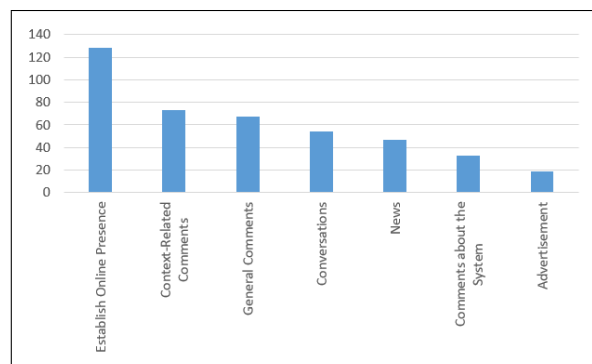

Figure 3. Purposes of using Occupy

enhances communication between those users who are online on the social network, to those users who are physically near the *Interactive Wall*. In fact, 73% of these users, believe that this social network is effective in merging virtual interactions with physical interactions.

A number of particular uses for such a system were identified during the focus group. The first of these uses is that it might be a tool for uniting people about a specific topic E.g. discussing the forthcoming exams (since the system was installed in a University during the exam period). Other social networks display content and comments that are relevant to you or your circle of friends, however, our system displays the same content to each one of its users. This may lead to a system that is able to reach a very wide audience with a single comment and so it can then be used to organise protests or similar gatherings. Another purpose identified during the focus group, is that you can immediately gather feedback about a particular topic, from a targeted sector of the population (within the context of the screen), simply by posting a comment. In addition, some users noted the fact that this system would be an ideal tool during academic conferences or cultural debates. In fact, the literature presented in this research shows evidence of the effectiveness of such a system in these contexts. This idea was developed even further and some people suggested that it might be a useful tool during concerts or political rallies.

Moreover, contrary to our hypothesis, the contributions made by the system (32 in total), went largely unnoticed. In fact, only one reply was made to a comment posted by the system, meaning that this feature was largely ineffective. In addition, 65% of the respondents answered that the discussions initiated by the pervasive social network were not effective in creating discussions. The reason we identified for this, is the fact that the source chosen for the harvesting of online information is not a local website, meaning that some of the articles extracted from this source were not relevant to the University of Malta's context.

Another question that we asked our respondents was whether our system's Nearby Users feature and the Map functionality were effective in creating physical discussions with people in the vicinity. 66% of the users of our system believe that they were indeed very useful features in that they allow you to continue discussions privately with people that are commenting on the social network. These users argued that these features extend traditional social networks in the sense that they make the communication on them more natural.

79% of the users of our system were concerned about their privacy when using any of the social networks. Furthermore, 74% of these users were aware that they have some measure of control over their own privacy. Interestingly, 52% of our users believed that our pervasive social network further invades their privacy, mainly because it constantly tracks their location and that they have no control over who sees their comments. This is a very interesting point, because although a large percentage of our users claimed that they were aware that they have control over their own privacy (switching off location-tracking and deleting comments), they still believed that our pervasive social network poses a greater risk to their privacy than other social networks. On the other hand, some users identified the fact that traditional social networks offer a false sense of security to their users. They claimed, that through the use of a pervasive social network, this false sense of security is not present, and so people are more careful of what they post.

VI. Conclusions and Future Work

A. Future Work

Despite the fact that the evaluation carried out proved that this system has met most of the goals set at the beginning of this final year project, some improvements can always be made. In this section we will be describing some of the improvements that were identified by ourselves or else suggested by the respondents of the survey or from the discussion generated during the focus group. The following is a list of future improvements that can be applied to this project:

1) **Automated Moderation:** Since this system is setup in a public place, there is no way of controlling who is actually viewing the content on the Interactive Wall. Some of this content may not be appropriate for minors within the audience and so some sort of moderation is required. Despite the fact that we employed manual moderation over the content being posted we believe that automated moderation would be far more effective.

2) **More Interactive Walls:** Another interesting suggestion that emerged during the focus group, was to include more than one Interactive Wall. Each wall would have its own URL and the comments are grouped together based on the URL they are originating from. This would be very interesting because we can then compare the different discussions originating in different contexts.

3) **More Informative Posters:** Based on the low percentage of users who got to know of our system through the informative poster, we think that more of these posters would help to attract the people's attention even more and as a consequence the activity rate increases.

4) **Hash-tag Functionality:** The users of our system are able to reply to existing comments and the topic of the original comment is assigned to the replying comment. However, this functionality was not clearly understood by the users. Instead of replying to comments through our reply functionality, the users created new comments and attached the original comment's topic manually. By removing this functionality, and employing a system of Hash-tags similar to that employed by Twitter, these comments

can then be grouped together based on the topic given, and the discussions could then flow much better. In other words, the users would then be able to view comments that are related based on the topic chosen.

B. Conclusion

The purpose of this research was to analyse the ways in which a big screen, set up in a public place, displaying a stream of comments can be utilised by the general public. For this purpose, we created a pervasive social network that is embedded in the environment and which is also context-aware and active in the discussions being held on the social network. We have thus attempted to find ways in which such a system could be used and assess its value in comparison to other social networks. Although not all of the goals set at the beginning of this paper were met, a number of positive points emerged, mainly the fact that it successfully merges virtual discussions happening on the social network to those happening physically between groups of people. In addition, this social network helped in raising awareness on privacy concerns related to social networks. Through the use of our system, the users paid more attention to the content that they post as they were constantly aware that whatever they will post will inevitably be seen by a large number of people. The main result obtained from this research is that this system can be a very useful extension to traditional social networks, given that the content being uploaded is moderated in some way. Furthermore, the research question proposed for this project was answered successfully as we identified a number of uses for such a social network.

References

[1] W. Dong, V. Dave, L. Qiu, and Y. Zhang, "Secure Friend Discovery in Mobile Social Networks," in INFOCOM, 2011 Proceedings IEEE. IEEE, 2011, pp. 1647–1655.

[2] O. Mabrouki, A. Chibani, and Y. Amirat, "Privacy in pervasive social networks," in Constructing Ambient Intelligence. Springer, 2012, pp. 296–301.

[3] M. Jadliwala, J. Freudiger, I. Aad, J.-P. Hubaux, and V. Niemi, "Privacy-triggered communications in pervasive social networks," in World of Wireless, Mobile and Multimedia Networks (WoWMoM), 2011 IEEE International Symposium on a. IEEE, 2011, pp. 1–6.

[4] D. M. Boyd and N. B. Ellison, "Social Network Sites: Definition, History, and Scholarship," Journal of Computer-Mediated Communication, vol. 13, no. 1, 2007, pp. 210–230. [Online]. Available: http://dx.doi.org/10.1111/j.1083-6101.2007.00393.x

[5] F. Schneider, A. Feldmann, B. Krishnamurthy, and W. Willinger, "Understanding Online Social Network Usage from a Network Perspective," in Proceedings of the 9th ACM SIGCOMM Conference on Internet Measurement Conference, ser. IMC '09. New York, NY, USA: ACM, 2009, pp. 35–48. [Online]. Available: http://doi.acm.org/10.1145/1644893.1644899

[6] A. Yamada, T. H.-J. Kim, and A. Perrig, "Exploiting Privacy Policy Conflicts in Online Social Networks," Technical Report, Carnegie Mellon University, Tech. Rep., 2012.

[7] S. B. Mokhtar, L. McNamara, and L. Capra, "A middleware service for pervasive social networking," in Proceedings of the International Workshop on Middleware for Pervasive Mobile and Embedded Computing. ACM, 2009, p. 2.

[8] J. Sunden, "Material Virtualities : Approaching Online Textual Embodiment," Ph.D. dissertation, Linköping University, Department of Communications Studies, Faculty of Arts and Sciences, 2002.

[9] M. N. Ko, G. P. Cheek, M. Shehab, and R. Sandhu, "Social-Networks Connect Services," Computer, vol. 43, no. 8, 2010, pp. 37–43.

[10] F. Michahelles, S. Karpischek, and A. Schmidt, "What can the internet of things do for the citizen? workshop at pervasive 2010," Pervasive Computing, IEEE, vol. 9, no. 4, 2010, pp. 102–104.

[11] G. D. Abowd and E. D. Mynatt, "Charting Past, Present, and Future Research in Ubiquitous Computing," ACM Transactions on Computer-Human Interaction (TOCHI), vol. 7, no. 1, 2000, pp. 29–58.

[12] M. Strohbach, E. Kovacs, and M. Martin, "Pervasive display newtorks–real-world internet service for public displays," in Proc. of 4th European Conference on Smart Sensing and Context, 2009, pp. 35–38.

[13] J. Müller, J. Exeler, M. Buzeck, and A. Krüger, "Reflectivesigns: Digital signs that adapt to audience attention," in Pervasive computing. Springer, 2009, pp. 17–24.

[14] S. Johnson, "How twitter will change the way we live," Time Magazine, vol. 173, 2009, pp. 23–32.

[15] J. Letierce, A. Passant, J. Breslin, and S. Decker, "Understanding how twitter is used to spread scientific messages," 2010.

[16] J. Letierce, A. Passant, J. G. Breslin, and S. Decker, "Using twitter during an academic conference: The# iswc2009 use-case." in ICWSM, 2010.

[17] M. Ebner, "Introducing Live Microblogging: How Single Presentations Can be Enhanced by the Mass." Journal of Research in Innovative Teaching, vol. 2, no. 1, 2009.

[18] D. Dura, "TwitterCamp at Daniel Dura," Nov. 2008. [Online]. Available: http://www.danieldura.com/code/twittercamp

[19] M. Ebner and W. Reinhardt, "Social Networking in Scientific Conferences–Twitter as Tool for Strengthen a Scientific Community," in Proceedings of the 1st International Workshop on Science, vol. 2, 2009, pp. 1–8.

[20] M. Ebner, G. Beham, C. Costa, and W. Reinhardt, "How People are Using Twitter during Conferences," Creativity and Innovation Competencies on the Web, 2009, p. 145.

[21] C. Smith, "By the Numbers: 89 Amazing Facebook User Statistics (updated march 2014)," Mar. 2014, retrieved from: http://expandedramblings.com/index.php/by-the-numbers-17-amazing-facebook-stats/.