www.ietdl.org

Published in IET Networks
Received on 26th January 2013
Revised on 4th May 2013
Accepted on 30th June 2013
doi: 10.1049/iet-net.2013.0009

ISSN 2047-4954

Survey on social networking services

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Abstract: The social computing, such as social networking services (SNSs) and social Networking Platforms (SNPs) provide a coherent medium through which people can be interactive and socialize. The SNP is a Web-based social space, specifically designed for end user-driven applications that facilitate communication, collaboration and sharing of the knowledge through a variety of SNSs, such as text, video and audio streams. In the conventional SNPs, such as Facebook, LinkedIn and MySpace, computers are not capable of acquiring the information based on the common intelligence and human behaviour. This survey provides a comprehensive overview of the current SNSs and discusses different possibilities of incorporating the existing SNSs into the context-aware techniques that include semantic Web, social search and social recommendations. The context-aware computing provides services customisation based on the individual human characteristics, such as human preferences, mood, behaviours, and emotions. The Integration of contextual information with SNSs can be more useful and productive for the development of the intelligent social communicational services. This survey provides several possible future research directions especially in the field of social search and recommendation that can provide better social communication capabilities. Moreover, this study will provide new directions to the future researcher for designing future generation context-based SNSs that provide services based on the on-demand collaboration.

1 Introduction

The substantial growth of social computing in recent years has created the need for a development of novel theories and methodologies to address the human behaviour and social relations [1]. The social computing enables online communication through user content contribution and provides the new data patterns based on the human behaviours and characteristics, such as age, race, relationship and language [2]. Moreover, social computing-based applications provide a coherent medium through which people can be interactive and socialise by developing a Web-based communication channel that integrates different social networking services (SNSs) in the social networking platforms (SNPs).

A Web-based social space termed as SNS is specifically designed for the end user-driven applications that enable communication, collaboration and sharing of the knowledge though an assortment of a media [3]. Different SNSs, such as photo, audio and video sharing, have emerged as an essential resource for the dissemination of information about the human interaction patterns. Roblyer's analysis about the current SNSs shows that the SNSs have supplanted TV as a popular medium for acquiring the information. According to Roblyer, 55% of Americans spend more time using SNSs than watching TV [2].

Most of the SNSs are integrated into a comprehensive and coherent paradigm called the SNP. The SNPs provide a framework for different SNSs to integrate and propagate. Moreover, SNPs allow users to establish social communications based on the mutual interests and cultural backgrounds [1]. The most popular SNPs are Facebook, LinkedIn, MySpace, Tumblr, Instagram, Google+ and Friendster. According to a recent statistical analysis, Facebook has more than 1 billion active subscribers worldwide and Google+ has more than 250 million active users [2, 4]. This survey will present a comprehensive overview of popular SNSs and provide a coherent framework of different SNSs and their extension to the context-aware SNSs.

In social computing, interactivity patterns of the human behaviours are based on the contents. Most of the work presented in the past focused on: (a) content-based, (b) media-based and (c) geo-location-based SNSs [1, 5–8]. The content-based SNSs allow the text-based interactions among individuals, such as communities, blogs and social news.

The media-based SNSs provide the social interaction through various multimedia formats, such as video and audio. Geo-location-based SNSs provide location-based social communication. However, all of the aforementioned techniques lack the semantic analysis, which is the most integral and crucial part of the true understanding. In [1, 2, 4, 9, 10], the authors defined and compared different SNSs. The authors [4, 9, 11] presented different statistical analyses of the popular SNSs, and in [2], the author discussed different types of the content-based SNSs. However, all of the abovementioned studies overlooked the importance of context-aware computing in the SNSs. Gartner, the most prestigious information technology and advisory company of the USA, predicted that the next generation of computers will be the context-aware computers [12]. Mark Weiser, chief scientist at Xerox PARC, emphasised the integration of context-enriched services, such as location and social attributes to anticipate the end users' requirements. The context-aware computing provides the services customisation based on the individual human characteristics, such as human preferences, mood, behaviours and emotions [12]. Moreover, the context-aware computing improves the quality of interaction by providing service-oriented architecture for the social computing [13].

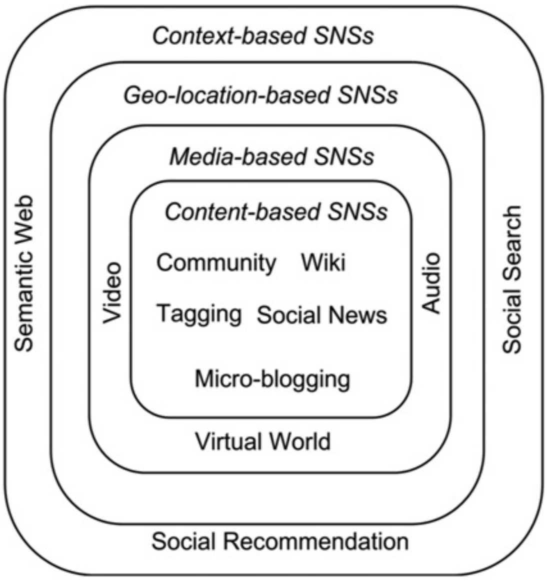

Fig. 1 *SNSs framework*

We believe that the media, geo-location and context based SNSs can improve the traditional text-based interaction of the content-based SNSs as presented in Fig. 1.

The importance of context-based SNSs has increased in the past few decades, yet no substantial amount of research has been performed in this burgeoning area of the social computing [13–15]. The computer interactive infrastructure can be enriched by leveraging information about the users' personal context (profile, preferences, attitude and habits) that provides sophisticated context-aware services, such as semantic-based search and recommendations. We believe that our work is the first to provide analysis of the existing content, media, and geo-location-based SNSs and their extension for adopting the context-awareness techniques for better social communication based on the evaluation of human behaviour. Moreover, this study will provide new directions to the future researcher for designing context-based SNSs based on past experiences, intelligent connectivity patterns and on-demand collaborations.

Most of the content-based SNSs, such as short messaging services (SMS), chatting, blogs and Wikipedia were introduced in the 1980s and 1990s. The media-based SNSs, such as virtual world and video sharing were launched in 2002 and 2005, respectively. Moreover, the most promising geo-location-based SNSs were introduced in 2008 [16]. Furthermore, context-aware SNSs, such as social search and recommendations, have been attracting users' attention since 2009 through providing on-demand services to the users. A temporal timeline of the evolution of all the aforementioned SNSs are presented in Fig. 2.

The remainder of this survey is organised as follows. An overview of different context-based SNSs is presented in Section 2. Section 3 discusses various content-based SNSs, and Section 4 provides a comprehensive study on different media-based SNSs. Section 5 presents geo-location-based SNSs. The survey is concluded with a discussion on the importance of privacy in Section 6 and a description of future work in Section 7

2 Context-based SNSs

In conventional social interactive environments, such as Facebook, LinkedIn and MySpace, computers are not capable of acquiring the information based on common intelligence [17]. An integration of the contextual information with interactive computing can be a promising solution for the development of effective intelligent social communicational services [18, 19]. Following the formal

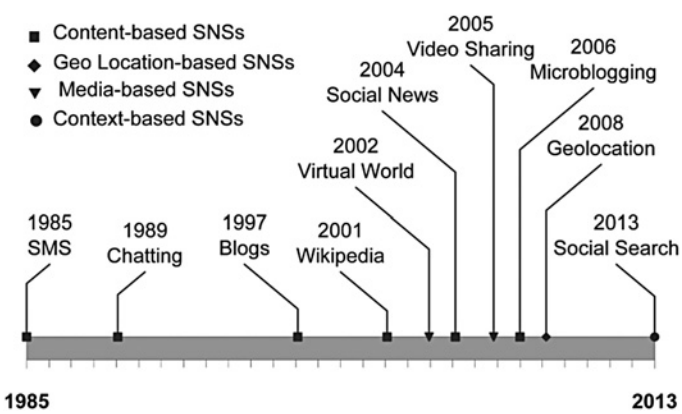

Fig. 2 *SNSs evolution*

definition of contextual information formulated by Anind *et al.* [18], the term 'context' refers to the relevant information that can be used for the categorisation of various attributes and situations of entities, where the entities can be a place, person or object.

There are two main categories of contextual information, namely: (a) physical contextual information and (b) logical contextual information, as presented in Fig. 3. Physical contextual information can be acquired by using hardware sensors, whereas the logical contextual information can be obtained by analysing the human habits, attitudes and preferences [20].

As a result of the ease of application and large availability of hardware sensors, the most of the context-aware systems use physical contextual information. However, the successful implementation of logical contextual information in social computing is still a challenging task for researchers because of the high complexity of human behaviours [18, 19]. Different types of context-based SNSs are briefly characterised in the remainder of this section.

2.1 Social semantics as SNSs for knowledge management

The context-aware SNSs provide an appropriate platform for the integration of physical and logical contextual information that can be gleaned from tagging a picture or joining different communities. Such data can also be acquired by referring to user profiles that provide static information about the users' behaviour, such as interests and hobbies. The social semantic Web implements ontologies for context-based knowledge management [21]. Detailed descriptions of the aforementioned techniques are provided in the subsequent text.

2.1.1 Ontologies and semantic Web: An ontology can be defined as a formal representation of knowledge as a set of objects, concepts and conceptual relationships between the objects and concepts in a specific domain [18]. Moreover, ontologies establish a common understanding between humans and machines of a situation, event or object. Valls *et al.* defined ontologies as meta-information that provides information about the inter-document relations in a machine executable format [18, 22].

The syntax and semantic based interpretation of a textual document in the Web-based systems is crucial for the

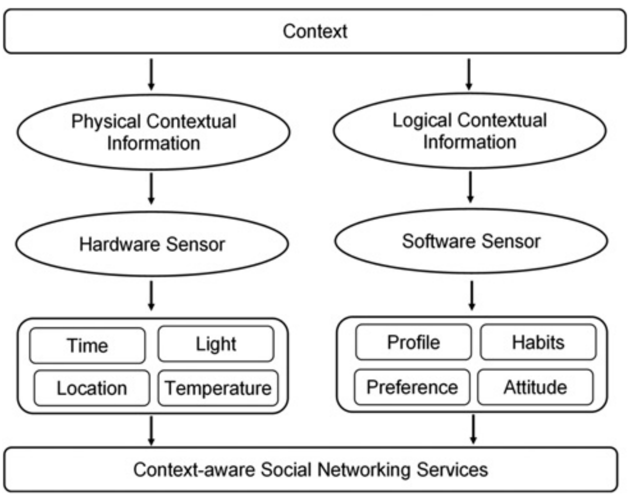

Fig. 3 *Context-aware SNSs*

retrieval of up-to-date, consistent and accurate information. Web-based systems, such as Webmail, e-commerce and wikis require different ontologies for the correct interpretation of logical relationships between semi-structured texts [20]. However, building a universal ontology is still difficult, especially with a large number of users exhibiting diverse backgrounds [18].

The semantic Web or 'Web of data' is an extension of the current Web that complements human-readable documents on the World Wide Web (WWW) with the machine executable meta-information (ontologies) and encodes the Web-based information into a computer understandable format [22]. Moreover, the semantic Web allows machines to present logical connections among the information using different ontologies [23].

The most popular computer understandable format, Extensible Markup Language (XML) is widely used to represent the syntax-based content structure of documents in the Web-based applications. The heterogeneous format of XML provides ease of execution both for human and machine. In XML, semantic annotation of a document is provided in the form of metadata. The Resource Description Framework (RDF) and Web ontology languages (OWL) are the popular XML derivatives designed for the metadata definition that present the computer understandable vocabularies. Recently, Facebook announced a new platform called 'Open Graph' that includes RDF-based markup to incorporate metadata by adding contextual information [15].

2.1.2 Social semantic Web: The social semantic Web is the implementation of semantic Web technologies in a social networking knowledge base [22]. Friend-Of-A-Friend (FOAF) is an example of a popular social semantic Web-based ontology that provides logical and machine-understandable information about the social relations and friends using RDF and XML structures. The main feature of FOAF ontology is the high data interoperability that refers to the extendable and flexible integration with other systems [22]. In scientific literature, FOAF ontology has been extensively used for establishing logical connections among the users based on their habits and profiles. In [23], the authors apply FOAF ontology to extract user profiles and to find experts for sharing knowledge about a specific domain area. Finin *et al.* [23] presented an ontology-based semantic Web that provides a machine-readable human description (FOAF) and proposed a heuristic approach to discover and extract the information about the users from FOAF documents. Another well-known example of social semantic-based applications is a Semantically Interlinked Online Community (SIOC) [23]. The SIOC ontology is used to interconnect online community information, such as blogs, mailing lists and Wikipedia and is usually combined with the FOAF methodology [24].

The concept of the social semantic Web has also been presented in [24]. The author proposed a general categorisation schema as an initial knowledge base for the construction of ontology using tags. Tagging is a popular method of organising various types of social Web data, such as photos, Web pages and videos. Users can store the tagged data in backlog files to share the contents with a person possessing similar preferences and interests. The authors in [24] have introduced a concept of 'folksonomy', which can be defined as a set of categorised information derived from the tagged data. The ontologies derived from

doi: 10.1049/iet-net.2013.0009

the folksonomy represent collective and dynamic trends of community interests from a diverse user population. The main weaknesses of using the folksonomy concept are the lack of precision, conceptual relationships and synonym misinterpretation in the tagged data [25, 26]. However, to overcome the aforementioned limitations of folksonomy, there should be consistent and pre-defined rules or techniques to tag photos, Web pages and videos.

Recently, a Web-based prototype has been developed that allows the ontology-based tagging of individual terms for the extraction of relevant material from scientific research papers in the area of life science [15, 22]. Castro *et al.* [15] introduced the Living Document (LD) concept that combines semantic Web (ontologies) and social Web (tagging) for additional filtering of the search results from scientific research papers. The LD allows the selection of related material from the available research papers, online databases and online resources based on the case-specific ontologies that can be further extended by the user-generated tags.

The proposed approaches can be widely used in the existing content, media and geo-location-based SNSs (Sections 3–5) for incorporating the context-based concepts to provide more accurate and predictive results.

2.2 Social search as SNSs for knowledge searching

The information retrieval and knowledge discovery is the main purpose of the Web search. As a result of the fast and updated information available on the Web, users usually rely on Web search engines to obtain the information. The Web search methods can be classified into two main categories [27], namely: (a) navigational search and (b) informational search. The navigational search refers to a search for a particular website, whereas, the informational search focuses on clustering the information on a specific topic [27]. Moreover, a keyword-based browsing and navigation of the Web is considered a solitary activity. However, traditional search methods on the Web are specifically designed for the individual purposes of the Web users and do not adequately support the social search concept.

2.2.1 Role of collaboration in social search: The effectiveness of a search process on the Web-based search engines can be improved by the suggestions and assistance of a user's friends and contacts in the social network [27, 28]. Evans and Chi [29] defined social search as the shared efforts of a group of users to obtain the relevant information.

Collaboration is an important aspect of an online interactive society. The search engines must support collaborative interactions among users for searching the online information [30]. In such interactive environments, the searcher can obtain assistance from friends or colleagues to acquire the information [30]. In the searching process, users can collaborate by suggesting different keywords, query syntax and query reformation. Moreover, the social search can improve the search results by making the user aware of proper syntax and vocabulary. Furthermore, as the users have more information about the query or keyword that has already been applied, social search can avoid duplication of the searching efforts and can provide a visualised social search interface to all the users [29].

2.2.2 Social search model: In scientific literature, various social search models have been proposed [14, 27, 28]. Chi *et al.* [14] introduced two basic social search models: (a) social answering model and (b) social feedback model. In the social answering model, the user can visit SNPs (Facebook, MySpace), discussion forums and blogs to ask for the answers that are difficult to find through the traditional keyword-based systems. Social answering systems depend on efficient recommendation algorithms for the retrieval of relevant answers [14]. A social feedback system acquires feedback from the user to rank the search result by asking for the votes, tags and bookmarks via different algorithms, such as PageRank [31]. Moreover, various data-mining algorithms can also be used to construct ontologies for efficient browsing using tags and bookmarked documents [14]. A social feedback system has been implemented as a support mechanism for the users in 'Mr. Taggy', a social search system proposed by Chi [14].

The analysis of social interactions among the system users can improve the social searching process [14, 27, 28]. One of the current research topics in this domain is the development of the automated search tools which enables an efficient management of all the internal communication protocols. The social search can synchronise all the collective search activities of the users. For instance, 'SearchTogether' is a social search tool developed by Morris, which enables the synchronous or asynchronous communication while searching the Web [32]. Similarly, 'CoSense' is developed by Sharoda and Meredith that allows a group to contribute in the process of sense-making and information-seeking during social searches. Additionally, 'TeamSearch' developed by Morris *et al.* enables a small group of users to search for the digital photos from a digital media repository [10].

The effectiveness of the social search process can be improved by the suggestions and assistance of the user's friends. Therefore based on the stated assumption, future Web search engines will comprise not only the information about the contents, but also will contain the knowledge about the users' information seeking behaviour, such as what, why, where and when people search. The provided information may motivate upcoming researchers to design new SNSs that will complement interactive techniques and user-friendly interfaces to support social searches. Semantic-based search engines, such as Bing (2009), Google (Knowledge Graph) (2012), Lexxe (2005), Swoogle (2007), Yummly (2009) and Rendipity (2012) have been gaining popularity for the past few decades [10]. Recently, Facebook partnered with Bing and introduced a social search engine called 'Graph Search' that implements the search 'with friends and for friends' and associates the results with friend's suggestions [33]. Moreover, the Microsoft's search services, such as Live Search, have already been replaced with the Bing search engine. Furthermore, Yahoo search is also powered by Bing [10]. However, social search is not without limitations. For instance, difficulties may involve conflicts pertaining to the selection of searching approaches, such as bottom-up, top-down and hybrid approaches [10]. Moreover, the lack of standard collaborative models for the information seeking behaviour of the users makes the social search process more challenging for researchers.

2.3 Context-aware recommendation systems as SNSs

The Web-based recommendation systems have evolved at a prodigious rate over the past few decades. A recommendation algorithm garners user interests as an input and creates a list of recommendations. Moreover, the recommendation algorithms help online users to avoid information overload by filtering the information [34, 35]. For instance, Amazon.com can be considered a good example of such systems, where recommendations of the products are based on a customer's interests. Similarly, Flixster.com is a popular recommendation system that refers to movie files [34]. The basic recommendation systems are classified into two main categories, namely: (a) content-driven recommendation systems and (b) collaborative-filtering-based recommendation systems [36]. The abovementioned recommendation systems can be combined into hybrid multi-level structures for the better performance.

2.3.1 Content-driven recommendation systems: The content-driven recommendation systems recommend products based on the product description and customer's interests. Several text-based applications also use a content-based information filtering approach for the recommendation of text-based items on Web, such as online articles and books [37]. The implementation of content-based recommendation systems is based on a keyword approach. In the keyword approach, the importance of any word in the document can be evaluated by using different weighted measure techniques, such as: (a) Term Frequency/Inverse Document Frequency (TF-IDF), (b) Bayesian classifiers, (c) clustering and (d) Decision Trees (DT) [37–39]. However, new users with very few preferences may not be able to obtain the accurate recommendations. The content-based recommendation algorithm relies on a sufficient number of items preferred or rated previously by the users for prediction. In such a case, two different items with similar features may remain indistinguishable when sufficient information is not available to discriminate the items [38].

2.3.2 Collaborative filtering (CF)-based recommendation systems: A CF approach predicts recommendations by evaluating an item's purchase history and an item's grading criteria through similar users [40]. The CF structure presents the problem as a two-dimensional (2D) matrix comprised pairwise values of the users and items [41]. Moreover, the CF-based recommendation system recommends items by evaluating similarities between different users who have rated the item. First, the nearest neighbours of the selected item are identified based on the high similarity patterns. Second, the selected item will be further evaluated based on the neighbours' opinions.

The CF approach has attracted much interest because of the ability of exploring the complex data patterns without extensive data collection [41]. Several successful commercial systems, such as Amazon, Netflix and LastFM [42] use CF-based recommendation systems to generate the recommendations about items, such as news, books and movies. However, according to Fengkun in [40], CF is unable to identify the neighbours as friends or strangers. While making decision, people usually rely on recommendations from a friend rather than a stranger [40]. Moreover, Sinha and Swearingen [41] compared the recommendation systems and concluded that users preferred recommendations from the friends over the recommendations made by commercial recommendation systems, such as Netflix and Amazon.

The substantial amount of work has been done in the field of recommendation systems. However, most of the existing approaches focus on recommending items to users and users to items and do not consider contextual information, such as place and time. Moreover, most of the abovementioned approaches deal with relevant items without incorporating any contextual information. Therefore Context-Aware Recommendation Systems (CARSs) have been developed for the integration of the contextual information into the recommendation systems as explained in the subsequent text.

2.3.3 CARSs: Various SNPs, such as MySpace, Facebook and LinkedIn pioneered the combination of the social relationship information of users with the CF to generate advanced CF-based recommendation systems [43]. Similarly, Liu and Lee [40] proposed a 'CF with friends' approach that selects nearest neighbours based on the social network information of the user for the product recommendations. Moreover, Liu and Lee [40] used the social network data for the recommendations using a 3-fold process: (1) collect data about the preferences and social relationships of the users, (2) develop strategies to select the nearest neighbour based on the social relationships and (3) generate recommendations. Liu and Lee presented an innovative concept to enhance the recommender system. However, the analysis presented in their paper is limited to a single Cyworld Website in South Korea and most of the experiments were conducted on the social Web service simulator, which may not reflects the realistic social Web-based scenario for the users located in diverse regions [44]. Another successful application of combining CF with social network information has been observed in [43, 45].

Recently, CARSs have been discussed extensively in scientific research literature, particularly the location recommendation services for various mobile devices [46], shopping assistants [47] and conference assistants [48, 49]. Adomavicius and Tuzhilin [46] presented a thorough review of contextual information in various stages of the recommendation process by introducing three algorithm paradigms: (a) contextual pre-filtering, (b) contextual post-filtering and (c) contextual modelling. In contextual pre-filtering, the contextual information is used to select a relevant set of records in the form of ratings. The rating can be predicted further based on any traditional recommendation algorithm. In the contextual post-filtering, the ratings are predicted using any traditional recommendation system and the result is contextualised based on each individual. In contextual modelling, context is integrated into a recommendation model [46]. Panniello *et al.* provided a comprehensive comparative study on the abovementioned algorithms to find out which algorithm performs better than the other [45]. The authors observed that selecting pre-filtering or post-filtering depends on a specific application. However, the post-filtering approach often performs better than the pre-filtering approach in the recommendation process [45].

Another CARS-based approach has been suggested by Sieg *et al.*, which presents a hybrid semantic Web system that integrates the CF with ontologies [36, 50]. The authors introduced an ontological-profile of users based on their behaviours. The user profiles are updated based on the interactions and relationships among the users, defined by the ontologies. In the recommendation process, the ontology-based user profiles are compared to generate the semantic neighbourhoods. However, extraction of the contextual information using ontologies is a complex

doi: 10.1049/iet-net.2013.0009

process in the real life scenarios because of the multifaceted nature of human behaviour.

The concept of CARS seems to be a promising solution for future generations of social semantic networking services (SSNSs) and can be easily extended by developing new modules and tools [51, 52]. Moreover, the CARS may introduce a 'Trust Calculator' in future that estimates trust degree parameters of the users based on their social relationships. For instance, the users that are placed into the trusted categories would have high priority to recommend and the users not in the trusted categories would be assigned a low priority. The trust calculator can improve the performance of the recommendation systems by reducing the number of users to be evaluated by selecting best neighbours. However, CARSs can be sensitive to popularity bias, prefix bias, perceived reliability and noise [10].

3 Content-based SNSs

Content-based SNSs are primarily textual and provide basic computer-mediated communication that promotes the text-based interaction among individuals. However, the functionality of the content-based SNSs can be further extended by incorporating media, geo-location and context-based SNSs. The contents of content-based SNSs are generated by the users. Therefore, the successful implementation of content-based SNSs depends on the willingness of the contributors to share information [53]. Using the context-based SNSs as described in the Section 2, existing content, media and geo-location-based SNSs can be improved through the integration of the contextual information, such as contents, audio/video streaming and location. Basic content-based services are surveyed in the rest of this section.

3.1 Community-based SNSs

The computers can provide an interactive environment for the social collaborations. The development of the social interactivity can be accomplished through a concept of virtual communities. A virtual community is an online community that allows the text based interactions [11, 54, 55]. Moreover, the interactions in virtual communities are either based on the common objectives or common interests. Furthermore, online communities are useful in various application areas, such as: (a) business, to solve the problems in workplace, (b) education, to disseminate the knowledge and (c) health, to discuss the treatment-related issues and to deliver the healthcare services [11, 56, 57]. A radical expansion of community-based SNSs has been observed over the past few years [11, 54, 56]. However, verification and authenticity of the information delivered through such platforms are still challenging components in the community-based SNSs [11].

3.2 Blogs

A Web blog is another popular content-based SNS that provide a chronological order of the Web links that can be archived, updated and searched [58]. The blogs provide services that are comprised of: (a) archiving of the past contents and (b) updating the records of previously visited blogs [58]. Moreover, blog provides updated information about particular topics and allows readers to post the comments in response to certain subjects. Readers prefer to visit blogs frequently rather than static Websites because the contents of the blogs are continuously updating [58]. Moreover, blogs leave the old contents to be used as a future reference in the form of archives [59].

In scientific literature [58, 59], blogs have been used as: (a) pedagogy management tools, (b) assessment tools and (c) e-learning tools. The authors [59, 60] described the role of blogs in the field of academia. The blogs can be used for building a knowledge-base in the formal instructional setting and address wider audiences than the conventional teaching methodologies [59]. For instance, in [60], Martindale and Wiley incorporated blogs into a graduate course where students used the blogs to post their ideas along with the relevant Web resources and created a distributed knowledge-base of the research literature. Similarly, Daniel [59] demonstrated the use of aggregators in the research, so that the students could obtain updated information about the newly published research. Moreover, blogs have been used successfully as an e-learning tool to support mutual, collaborative, and social learning in distance learning courses [61]. Furthermore, blogs offer a clear advantage over online communities, because blogs archive the previous collection of resources with the new one for current and future use [60]. The scientific literature also witnessed the wide applicability of blogs in various areas, such as in politics and business [61].

3.3 Wikipedia

A Wikipedia is the most famous free online encyclopaedia service that allows users to participate in the process of creating, deleting, and editing the contents of the Web pages. Currently, the Wikipedia is comprised of more than 3 million articles in more than 300 languages [62]. The Wikipedia is based on a software called 'Media Wiki' that allows the content management by easily creating and editing the Web pages using a text-editor. Moreover, the Wikipedia provides learning collaboration and knowledge sharing facilities in a very flexible manner. The Web users do not need to have prior technical knowledge for editing or adding the contents in the Web pages. However, the contents of Wikipedia are not machine-interpretable and are always presented in plain text [63]. Moreover, summarising similar contents and gathering the scattered information about a specific topic presented in the different articles are still issues that need to be addressed [62]. Furthermore, the credibility of Wikipedia is doubtful because of the malicious and unproductive edits that disseminate inaccurate information [63]. Finding accurate strategies to overcome the abovementioned limitations are the current challenges for future researchers.

3.4 Micro-blogging

A micro-blogging service is a content-based SNS that is gaining popularity because of the rapid communication and cross-platform accessibility [64, 65]. Different services have been designed based on the micro-blogging, such as Twitter that share up-to-date information in a rapid manner [66]. Recent studies show that Twitter is becoming more popular and specifically recommended in disaster management [67, 68]. One popular use of Twitter is the rapid and real-time communication of situational awareness for disaster management [64, 66]. Moreover, many political campaigns in the USA used Twitter as a communication forum [66].

3.5 Social news

The concept of social news shares a collective vision of the individuals' opinions and perspectives about particular news. In contrast to formal news publishing, where the information is only broadcast, social news is a promising Web 2.0 application where the news and stories are ranked based on the popularity [69]. For instance, Slashdot allows users to post comments on the latest news related to science and technologies. Reddit introduced a concept of voting on the articles and offers the communities for specific types of news where users can post their comments related to any published article. These communities can also form a group in favour of or against the addressed issue. Moreover, Newsvine and Digg are popular social news services [70]. Newsvine mostly focused on customising the latest news based on the users' preferences and Digg allows users to submit relevant links and reports different news stories [70].

3.6 Tagging

A tagging is the way of semantically describing an entity that can be used for the future references through browsing and searching [67]. Currently, tagging is used to annotate various functionalities. For instance, Guan *et al.* [71] presented a state-of-the-art graph-based learning algorithm for the document recommendation in social tagging services. In the aforementioned approach, the closest documents that have not been tagged previously will be recommended for the future tagging. The algorithm shows promising results when compared with the existing conventional recommendation algorithms. However, the author only focuses on the text documents recommendation. Moreover, the algorithm needs to be more scalable, so that the approach can be implementable to the large datasets.

3.7 Chatting

A chatting service refers to the online direct communication and transmission of the text-based messages. The concept has extended further as multicast and voice/video on-line communication. The chatting service is one of the most popular content-based SNS, where users can communicate online with the friends and strengthen their social ties. For instance, MSN Messenger, Skype and Google chat are popular examples of the online communication platforms.

4 Media-based SNSs

A media-based SNS establish a social connection among users through the various multimedia formats, such as video and audio. Unlike content-based SNSs, media-based SNSs have a high level of interactivity [72]. Different types of media-based-SNSs are characterised in the following subsections.

4.1 Photo and video sharing

In recent years, we have witnessed a rapid growth of media-based SNSs, designed for providing interactions between the users within communities by sharing multimedia streams, such as photos and videos [72, 73]. The most popular SNPs that use photo/video sharing SNSs are Flicker, Instagram and YouTube [72, 74]. The photo/video sharing SNSs are popular because of their vast array of functions, such as: (a) real-time photo exchange (b) tagging, to describe the contents of an image (c) frame, that allows users to interpret a portion of an image (d) favourites, that allow users to select the most memorable collection from the group of images and (e) comments, that allow annotation of the image in an appropriate manner [3, 72].

The photo/video sharing SNSs have been used extensively in business. Nov *et al.* [72] incorporated photo/video sharing SNSs in the Integrated Marketing Communications (IMC) model to promote online communication between various companies and the customers. The use of photo/video sharing SNSs has dramatically improved the way consumers receive and react to the market information [72].

4.2 Social virtual world

A concept of virtual world has emerged from adopting the characteristic of interactivity from the social networking and three-dimensional (3D) space from the online gaming. The virtual world can be defined as an online community based on the simulated 3D digital space [75]. The Web users participate in the virtual world through artificial agents or avatars that are graphical representations of the participants. The avatars can interact with the dynamic and rich environment by communicating through the voice and can perform different actions, such as walking, driving and dancing. Moreover, the virtual world provides a sophisticated mean for stepping into a simulated social interactive environment that reflects the realistic communication scenarios and human cognitive behaviours [76].

The basic motivation behind the use of virtual world is the cybernetic articulation of users' social, personal and business activities. Using simulations, users can participate in any domain including, office work, social interaction and business. For instance, the Keneva is a 3D virtual world that extends the social computing from the 2D to 3D interactive environment [77, 78]. Moreover, Keneva allows users to: (a) create a personalised profile, (b) join different groups, (c) interact through the messaging, blogging 3D avatars, and (d) invite the friends from a contact list on different events that are virtually organised by the registered users. Furthermore, Moove, There.com and Active worlds are popular examples of similar social virtual world [75]. According to a Report, currently, 27 million active users of Facebook are associated with virtual world [79].

5 Geo-location-based social networking

The location-based SNSs are gaining popularity because of the advanced location-oriented hardware and software technologies, such as GPS-enabled devices, wireless communication technologies and Internet connectivity through WiFi [6].

A holistic location-based social networking system termed as 'GeoSocialDB' is introduced by Counts and Marc that provides the following location-based social services: (a) location-based news feeds (b) location-based news ranking and (c) location-based recommendation [80]. Moreover, Zheng and Xie [6] specify three major research issues that need to be addressed in the scalable implementation of location-based SNSs, namely: (a) designing a location-based query operation for the optimised query performance, (b) designing privacy-aware queries to protect the user location privacy and (c) utilising materialisation techniques to

IET Netw., 2013, Vol. 2, Iss. 4, pp. 224–234
doi: 10.1049/iet-net.2013.0009

accelerate the performance in terms of computation overhead and query response time [6, 80]

In real-life scenario, people usually plan to visit places of interest while travelling to an unfamiliar location. However, proper travelling plans are not known in advance. To solve the aforementioned problem, GPS-trajectory-sharing presents an interactive approach to represent user's travel experiences and can provide reference for other users during the travel planning process to the unknown places [5, 6]. One's visited location histories can be tracked with a sequence of time-stamped locations, called trajectories [7]. The trajectories physically connect the visited locations in the world and provide information that can be further used for the experience sharing and geo-tagging multimedia content [6–8]. In the scientific literature [5, 80], various location-based SNSs have been discussed, such as GeoLife [7]. The GeoLife service performs three basic operations: (a) shares the life experiences, (b) provides the travel recommendations, such as top interesting locations, and (c) provides the friend recommendations based on the similarities among the location histories. However, an efficient approach is required to retrieve the user's desired GPS trajectory from a large-scale accumulated GPS dataset.

The most popular mobile devices, such as smart phones and location-based mobile social networks, such as FourSquare [81], Social Local Mobile (SoLoMo) [82] and BrightKite [83] are gaining interest of the researchers, where the users can share the location with friends using the friendship networks. Based on the scientific literature reviewed, we observed that for the accurate implementation of location-based SNSs, there are two key challenges: (a) up-to-date information about the venues, such as nearby restaurant management, menu, food prices and quality of food and (b) popularity ranking of the venue [69]. We believe that the abovementioned challenges can be address by introducing physical and logical contextual information in the current Geo-location-based SNSs.

6 Privacy in SNSs

All of the aforementioned SNSs strengthened the social connections by allowing users to create the profiles, join various social groups and find friends with the similar interests and hobbies. However, the users of SNSs reveal significant amount of personal information, such as contact information, photos, profile and interaction patterns. Proliferation of the personal information may present a variety of risks for individuals, such as identity theft, cyber stalking and unintentional fame [84]. Recently, many incidents of privacy breaching have been reported on the various SNSs. For instance, the beacon application [85] of Facebook gathers all of the information about users' online activities without users' permission and Quechup [86] has been reported to illegitimately access users' contact list for viral marketing. Therefore privacy concerns in the SNSs have been extensively addressed in the research community. The personal information of users' needs to be protected from: (a) other unauthorised users in the social network and (b) social network services providers [84].

An architecture termed as 'FaceCloak' has been presented by Luo *et al.* that enforces the users' privacy on social networking websites and allows the users to shield personal information from other anonymous users [84]. Moreover, Anderson *et al.* [18] proposed another privacy-enabling client-server social networking architecture in which the server is untrusted and acts as an interface to a content delivery network, whereas clients are responsible for data confidentiality and composed of many software layers, such as application layer, data structure layer, cryptographic layer and network layer. The proposed architecture protects the users' social information, such as profile information, messages, comments and friendship links from the unauthorised access.

The issues of privacy in centralised SNSs arise mainly due to the fact that in the centralised social networks, all of the users' data resides at the central server owned and controlled by the service provider [87, 88]. The SNSs providers deploy expensive hardware and software platforms and provide the SNSs to the users without any cost. In return to these free of cost services, users provide their private information to the SNSs provider, which can be easily exploited by the SNSs providers [88]. The scientific literature provides the solution of the aforementioned problem in the form of distributed social networks. The foremost advantage of distributed social network is that there is no central entity controlling the users' personal data because all of the data is stored locally on the user devices. The users have complete authority over their personal data. Moreover, users' personal data, such as the contextual information, can be stored in the encrypted form to make the data more secure against unsolicited access by the malicious users or any third party service provider. In scientific literature, there are numerous attempts [89–91], based on the distributed mechanism to address the privacy issues of SNSs. The common aspect of most of the proposed techniques is their emphasis over the exploitation of distributed systems to protect users' personal data from the malicious attacks.

7 Future work

There have been a number of research initiatives in the field of SNSs. However, the area is still in the evolutionary stage and needs significant research specifically in the field of social search, social recommendations, interoperability, scalability and privacy. Moreover, the analysis of available contextual information and providing the personalized assistance to the users based on various machine learning and text mining techniques is still a promising research area to be addressed extensively.

Currently, SNSs lack interoperability and do not allow users to share the contents and context across different SNSs. Moreover, because of the enormous and rapid growth of SNSs, scalability in large scale SNSs is a major issue that needs to be addressed in the future. The Scalability is an important parameter to determine the long term efficiency and effectiveness of the large-scale SNSs. The SNSs should be scalable enough to handle the increased number of users efficiently. However, the task of designing and developing robust and scalable SNSs becomes more challenging because of the increasing number of users.

The privacy and security issues of various SNSs are still an important field of study for upcoming researchers. Although, in scientific literature, there have been numerous attempts to address the issues related to users' privacy, much efforts need to be made to develop different technologies that can circumvent the threats raised by the unauthorised users and SNSs providers.

Table 1 Social networking services in different social networking platforms

SNPs	Content-based SNSs				Media-based SNSs		Geo-location-based SNSs	Context-based SNSs		
	Community blogs	Social news	Tagging	Chat	Audio/ video	Virtual world		Semantic web	Social search	Social recommendation
Facebook	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Flicker	yes	no	yes	no	yes	yes	yes	yes	yes	yes
LinkedIn	yes	yes	yes	yes	yes	no	no	no	no	no
MySpace	yes	no	yes	yes	yes	yes	no	yes	yes	yes
Google +	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Ipernity	yes	no	yes	yes	yes	no	yes	no	no	no
YouTube	no	no	yes	no	yes	no	yes	no	no	no
Orkut	yes	no	yes	yes	yes	no	no	no	no	no
GetGlue	yes	yes	yes	yes	yes	no	yes	yes	no	yes
Live Journal	yes	no	yes	no	yes	yes	no	yes	no	yes
film trust	no	no	yes	no	no	no	no	yes	no	yes
Foursquare	yes	yes	yes	no	yes	yes	yes	no	yes	yes

8 Conclusions

Existing social computing systems have emerged through a series of evolutionary steps from single systems to network systems and from network systems to social network systems. The SNSs are attracting researchers' attention because of the significant increase of virtual social interaction. Despite all of the advancements in the content-based, media-based and geo-location-based SNSs surveyed in this study, SNSs still require further improvements. Context-aware technologies and the increasing diffusion of semantic-based applications offer a new direction to improve present SNSs.

Table 1 provides an exclusive overview of the main features and implication of different content-based, media-based, geo-location-based and context-based SNSs in the various popular SNPs, such as Facebook, Flicker and LinkedIn. It can be observed that the latest trend is to include the context-based technique into existing SNSs for better, real-time and on-demand communication. We hope that the presented issues will lead the researcher to explore the important research areas, such as on-demand collaboration, on-demand communication, social search and CARSs.

9 Acknowledgments

We are grateful to Juan Li, Matthew Warner and Daniel Grages for their feedback on draft of this survey report. Samee U. Khan's work was partly supported by the Young International Scientist Fellowship of the Chinese Academy of Sciences (grant no. 2011Y2GA01).

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