On a Mobile Phone Contact List Based on Social Relations

Pasteur Poda[1,*], Rashid Ben Amed Charles Zongo[1], Ibraïma Dagnogo[1], Théodore Tapsoba[1]

[1]Ecole supérieure d'Informatique, Université Nazi BONI, 01 BP 1091 Bobo-Dioulasso 01, Burkina Faso

Abstract

Social relations are unquestionably the major provider of contacts in the mobile devices contact lists. However, they remain marginal in the literature of social software related to the contact list and are not at all integrated in its design. Inspired by African social and cultural practices, this paper is about a design of the contact list that integrates the social relationships existing between people in the real life. A desktop prototype of the proposed contact list designing allows to validate it. Illustrations of the developed application demonstrate the assets of the proposed contact list regarding issues such as contacts reminding/retrieval and homonymy resolving with respect to the real life. Additional capabilities of the proposed contact list reside in the creation of groups of contacts for group communications needs.

1. Introduction

One of the basic features available on mobile stations and user equipments is the contact list. The contact list is a database of contacts; a contact being most often a natural person and sometimes a legal entity. Basically, the contact list is used to save the contact information (phone numbers, names and surnames, addresses, …) of the mobile subscriber's contacts. Primarily, it is for allowing the users (i.e. the subscribers) to call their contacts without having to remember and dial the contacts phone numbers. Nowadays, user equipments comprised of smartphones offer contact lists with advanced features including a diversity of input fields that serve to identify and remember a contact entry.

Some of the common input fields are for providing detailed information such as multiple phone numbers, names and surnames, electronic and physical addresses, organization membership, notes for inserting discreet and discretionary data about the contact, etc. However, none of these input fields is intended for clearly describe the relationship that could exist between a given contact and another one of the same contact list. Simultaneously, it seems evident that relationships existing between people in the social life explain well how the contact lists are populated.

Social relations are defined in social sciences as any relationship between two or more individuals. A social relation is therefore a universal concept that depicts the social life from all over the world but it may be assumed that it is not experienced in the same way with Africans

*Corresponding author. Email: pasteur.poda@univ-bobo.bf

as with Western people. Indeed, in his investigations to formally explain how people construct social relations, Fiske established [1, 2] that people in all cultures use the same relational models to generate most kinds of social interactions but he also noted that the Moose[1] implement the models differently, in different domains, and in different relative degrees, than Americans. In the particular case of African societies, some social practices and behaviors make people contact lists to be rapidly and significantly populated. For example, a usually observed practice in African societies is that when a problem has to be solved, people use to resort to an acquaintance who, will in turn resort to his own acquaintance and so on until the right one who can actually help solving the problem. In that endeavor to solve the problem, several kinds of social relations (mainly family and friendly) are activated and can spontaneously give rise to the creation of new entries in the contact lists. Consequently, a contact list can be easily "crowded" with hundreds [3] even thousands [4] of contacts entries causing the user not to be always able to efficiently match a contact entry to the individual of the real life that it represents. This is further true insofar the "crowding" of contact lists increases the number of the rarely contacted contacts and gives rise to more homonyms occurrences. In such a situation of the contact list "crowding", the currently implemented contact information cannot be efficiently helpful whenever contact entries need to be matched to the individuals of the real life that they represent. It is also important to note that another habit in African social life is that the way people do to recognize someone is mostly based on social relations. An individual is sometimes identified by referencing one of his social affiliation. For instance, adults use to identify teenagers of their social environment by referencing the family affiliation (e.g.: a father, a mother, …) of those latters rather than using their names or surnames. In the same vein, it is common for African people to identify married women by referencing their husbands or their father/mother in a certain way.

Throughout these few examples illustrating some facets of African social life, it is clear that social relations play a major role in the process consisting of matching contacts entries to individuals of the real life, recognizing, remembering or identifying contacts of the contact list. This leads us to proposing a redesigning of the contact list by taking into account social relations. The proposed new vision of the contact list was introduced in [5]. It particularly aims at targeting African mobile users as it is inspired by their social and cultural practices. Beyong the fact that it could help facing the problems (contact matching, recognizing/identifying, remembering) mentioned above, the proposed new vision of the contact list could also stand for facilitating communications within groups of communities. Indeed, there are some events such as funerals, marriages, large family meetings which require a member of a group to share an information of social interest. In this case, if a group can be easily constituted based on the social relations, this could avoid a member of a group to, e.g., send as many short messages services as required to share an information. By this paper, the purpose is to provide a detailed description of the proposed redesigning of the contact list up to validate it with results of a desktop implementation.

In the remainder, we deal in Section 2 with a state of the art of works and inventions addressing the contact list. We present in Section 3 the new approach of the contact list designing. In Section 4, we deal with the technologies to be used for the proposed contact list implementation. In Section 5, we show results of the developed contact list software. We conclude the paper with Section 6.

2. Related Works

The proposed new vision of the contact list design is strongly inspired by social relations as they are experienced in African social life and more specifically in the sub-Saharan part of Africa. Ouoba et al. [6] proposed an approach that they called the *Toolé* approach, an approach based on the cultural values of the peasants of sub-Saharan Africa, to design an opportunistic networking strategy that facilitates and automates agricultural information broadcasting.

---

[1]The Moose (or Mossis) are the ethnic majority of Burkina Faso in West Africa

During the decade of the 2000s, the design of social software involving the mobile phone contact list has been an active field of research and innovation. Several related research works and inventions covered systems built based on the concept of awareness and besides many other issues. Lot of those systems are met under the vocabulary of recommendation systems and consist of making the mobile phone able to provide intelligent interactions with the users. Various kinds of awareness cues such as the mobile location and status have been used to prescribe recommendations to the users. In [7], a phonebook that contains in addition to phone numbers the context information about the user was implemented. The context information consists of awareness cues such as details on the user's connection status, his availability preferences or his location (e.g., at work, at home). The context information allows the potential caller to take the situation on the other end into account before setting up a call. These awareness cues about the user situation and environment were found to be very important when using a mobile phone. The smartphone contact list was extended [8, 9] to provide additional contextual information cues such as the time spent in the current location, the phone alarm settings and other cues that are useful to give information about the availability of the user. The design of the awareness cues of [8] was based on social psychological findings whereas that of [9] was inspired by eight hypotheses among which are *efficiency of accessing contacts*, *differentiation of important contacts* and *contacts as social piggy bank*. On the latter hypothesis, the authors were pointing out the need to take into account information that is related to the social relationships between contacts who are natural persons in the design of awareness cues. Is also observed [10] the trend for active mobile phone users to add further information that can help reinforcing the context of the relationship between the user and one of his contact. In a study extending awareness to mobile users [11], a desktop prototype called ConNexus allowed to evaluate the role of awareness in a collaborative environment. A system named iSocialize [12] was developed to implement and evaluate several kinds of awareness cues including activity, status, relation and vicinity. Unlike, most of

the systems based on awareness, Fiendlee [13] merged most of the useful awareness indicators and was oriented toward a mobile social networking application. The cues under consideration with Friendlee include current location and time spent there, local time and weather, status messages and status indicators (e.g.: available, busy, phone on hold, engaged, . . .). In [14], a social and personal context modeling method was proposed to support social networking applications of mobile devices. Using Bayesian networks, the user's contexts are infered from uncertain logs stored in the mobile device. Some of the user logs collected from the mobile device are geographical coordinates, day of the week, anniversary and type of scheduling such as friendship or business. A contact list recommendation system that recommends phone numbers according to the user's current situation was implemented. With regards to social networking application, we can also mention that solution [15] which was proposed to take advantage of social relationships and context information to provide recommendations to users of social networks. In the proposed new vision of the contact list, social relations are intended to be useful as potential awareness cues for mobile recommendations. For instance, social relations can be combined with location for providing recommendation services to the users. They stand for being well adapted for systems that suggest friends (contacts) in social networking software.

As about the context information sharing that the mobile awareness applications enable, a serious concern is that of privacy. Authors of [16] found that people decisions of sharing their context information are based mainly on the identity of the recipient of the information. The study reported in [17] also concluded that people decide whom to share context information with based on their relationship (e.g.: spouse, friend, peer, . . .) to the person. Therefore, it comes that casual contacts are assumed receiving less context information than contacts with other kinds of relationships [17, 18]. We therefore expect people to be more confident while sharing their context information with the proposed social relations based contact list. Indeed, the proposed contact list stands for being an efficient tool for contacts

identifying with respect to whom they are in the real life.

Associating mobile awareness to initiation of group communications, a community-aware mechanism [19] was proposed for efficient creation of groups of contacts. Mobile phones are thereby provided with a recommendation engine that helps an initiator of a group efficiently create a group from his contact list. Hendrey et al. [20] invented a system for location-aware connections of telecommunication units involving group communications. They offer a way for automatically and/or selectively initiating communications among mobile users whenever the mobile users can be geographically located. In the proposed redesigning of the contact list, we deal with group communications to address some needs in African social practices and social relations are hereby used as criteria for groups creation.

Several other works, involving the contact list but with minor correlation to our proposal, addressed contact information update and exchange. Methods for updating automatically mobile phone contact list entries [21] and improved systems for providing phonebook and bookmarked links to web sites for mobile users [22] were developed. A system [23] that proceeds with synchronization and updates enables the mobile phone to initiate, according to the circumstances, the appropriate form of communication with one of the contacts. Examples of methods for exchanging contact information include a method [24] of sending contact list data from one mobile phone to another mobile phone within a group and a system that is able to locate the mobile device and gathers contact information for an information server [25].

More recent related works were oriented toward the issue of efficiently retrieve a contact from a "crowded" (hundreds or thousands of entries) contact list. For that, adaptive interfaces exploiting the mobile context led to context-aware algorithms that predict at any time the next callee. In [26, 27], were proposed context-aware algorithms that used frequency and recency of communication as context cues. In [28], physical location was examined as a context cue for predicting the next callee. In the same momentum, several other researches are found, e.g. in [29–31]. Although our

social relations based design of the contact list is not oriented toward prediction of the next callee, it can help retrieving efficiently a contact in a "crowded" contact list provided a social relation of his is known.

3. New Approach of the Contact List Designing

The contact list, also called phonebook, is a database of the mobile phone user's contacts. It is generally stored in the Subscriber Identity Module (SIM) card and/or in an extended memory of the mobile equipment. Each entry of the contacts database can be viewed as an object subjected to diverse transactions such as the classical CRUD (Create Read Update Delete) functionalities and the emerging mobile awareness-based applications which are presented above in Section 2. As an object, each contact entry of the contact list can be described by a set of attributes generally called the contact information. These attributes serve to identify the contact and include the contact identity information (names, surnames), his phone number(s), his physical and electronic addresses, etc.

The new approach hereby proposed consists of modeling the contact list as a graph $G = (\mathcal{C}, \mathcal{E})$ of the contacts. Each node $C_j \in \mathcal{C}$ of the graph represents a contact and contains the currently observed contact information. Each edge $(C_i, C_j) \in \mathcal{E} \subset \mathcal{C} \times \mathcal{C}$ of the graph is for registering the social relationship that exists between two contacts. As shown in the graph representation of Figure 1, a contact list is therefore defined as a set of linked entities C_j, $1 \leq j \leq n$, each with its specific instance of the contact information and all sharing common treatments.

The social relations, represented by the edges of the graph representation of the contact list, can be any type of social relation. However, can be considered more meaningful, when considering the African social context, the family category of social relations. In Table 1, we provide a non-exhaustive list of social relations that can be considered.

With this redesigning approach, the current treatments to which the contact lists are subjected will continue working. Thus, the traditional CRUD treatments are preserved together with the emerging treatments regarding mobile awarness-based applications. Beyong
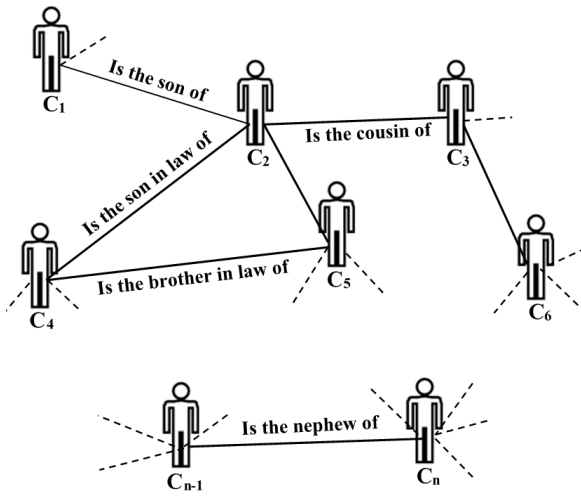
Figure 1. Graph representation of the contact list

Table 1. Examples of social relations

Category	Social relation name
Family	Is_the_father_of, Is_the_mother_of, Is_the_son_of, Is_the_sister-in-law_of, Is_the_daughter_of, Is_the_brother_of, Is_the_sister_of, Is_the_cousin_of, Is_the_uncle_of, Is_the_wife_of, Is_the_husband_of, Is_the_brother-in-law_of, …
Friendly	Is_the_classmate_of, Is_the_comrade_of, Is_the_buddy_of, Is_the_friend_of, …
Professional	Is_the_colleague_of, Is_the_collaborator_of, Is_the_chauffeur_of, …

these existing treatments, the proposed approach adds novel smart functionalities. Indeed, the new approach of the contact list makes it an interesting instrument of reminder. Let us consider a contact list with a rarely contacted contact C_{j0} and let us assume that the visualization of the classical contact information of C_{j0} fails to help remember who C_{j0} is in the real life. In these conditions, the proposed social relations based contact list can help remember C_{j0}. *Algorithm* 1 in Table 2 formally describes this novel functionality of contacts reminder. A second novel functionality, given by *Algorithm* 2 in Table 3, is for homonymy resolving. Let us assume that we are in presence of L homonyms C_j, $1 \leq j \leq L$, among which we need to select the right contact C_{j0} with whom we desire to communicate. So, for each homonym, his social relations with other

Table 2. Algorithm for forgotten contacts reminding

Algorithm 1: Given a contact list $(\mathcal{C}, \mathcal{E})$, find a social relation (C_{j0}, C_{j1}) that helps remember C_{j0}

```
Input: (C, E)
read C_{j0}
display D = {C_i | ∃(C_{j0}, C_i) ∈ E}
for C_i ∈ D
        if (C_{j0}, C_i) = (C_{j0}, C_{j1})
                break
        endif
endfor
```

Table 3. Algorithm for homonymy resolving

Algorithm 2: Given a contact list $(\mathcal{C}, \mathcal{E})$, select the right C_{j0} among L homonyms

---

```
Input: (C, E)
display D = {C_i, i = 1 . . . L | C_i like C_{j0}}
for i = 1 : L
    display D_i = {C_k, k = 1 . . . l, | ∃(C_i, C_k) ∈ E}
    for k = 1 : l
        if (C_i, C_k) = (C_{j0}, C_k)
                select C_i as C_{j0}
                i ← L + 1, break
        endif
    endfor
endfor
```

contacts are displayed and analyzed. Based on the social relations, we are able to select the right homonym C_{j0}. A third novel functionality is given by *Algorithm* 3 in Table 4. It consists of making a search for a contact C_{j0} for whom we assume not remembering the contact information (including names and surnames) and fortunately we remember one of his social relation (e.g.: C_{j0} is the cousin of C_{j1}). A search operation on C_{j1} has to be executed first, then after filtering out display only the contacts who are linked to C_{j1} by the right social relation. The contact C_{j0} who is searched for is probabily among these latter contacts.

In addition to the three novel functionalities that we have just presented, the proposed contact list offers perspectives to use social relations as potential cues to be integrated in the design of mobile awareness-based applications. For instance, social relations may be combined with some contextual cues such as the geographical location in order to recommend services

Table 4. Vague search for a forgotten contact

Algorithm 3: Given a contact list $(\mathcal{C}, \mathcal{E})$, retrieve an unremembered contact C_{j0} knowing C_{j1} such that $(C_{j0}, C_{j1}) \in \mathcal{E}$

> **Input**: $(\mathcal{C}, \mathcal{E})$
> read C_{j1}, (C_{j0}, C_{j1})
> display $D = \{C_i \,|\, (C_i, C_{j1}) \, like \, (C_{j0}, C_{j1})\}$
> for $C_i \in D$
>   if $C_i = C_{j0}$
>   select C_i, break
>   endif
> endfor

(e.g.: visiting a relative) that can contribute to the users' social relationships strengthening. In the context of African social life, it is current to see social events that involve systematically, by the fact of social relations, tens even hundreds of people. Examples of such events are funerals (for which any acquaintance of the deceased or of his family should be informed), customary marriages (for which is invited any person linked by a family social relation with the fiancé), civil marriages (involving people with as well family, professional as friendly relations with the two persons getting ready for the marriage), social visits in case of happy events (e.g.: baptism celebration, congratulation of a newborn parents) or in other cases like visiting a sick person or presenting condolences to a person. In the case of social visits, the groups to be created can be guided by professional relations, friendly relations or any other kind of social relations. To address such events management, the proposed approach of the contact list can facilitate groups creation for the purpose of sharing information using for example short messaging services. In addition to groups creation based on social relations, the proposed approach also offer the possibility to develop recommendation systems that can work based on the social relations to suggest to the mobile user the contacts with whom the information about a given social event must be shared.

4. Approach of Implementation of the Proposed Contact List

The scope of this study suits well with intelligent systems ingineering. To model social relations, a specialized language of Artificial Intelligence such as PROLOG can be used. As a language based on first order predicates logic for expressing knowledges, PROLOG formalism for writing facts and rules is well adapted to express the social relationship that exists between two contacts and for infering new knowledge. More precisely, PROLOG can be used to implement the proposed contact list in the form of a knowledge base comprising facts (social relationships between contacts) and rules (general laws applying to the social life domain). The PROLOG interpreter would play the role of an inference engine for the knowledge base management and exploitation. The user interface would be graphical and developed using Java programming language. JPL (Java interface to PROLOG), a Java application programming interface would stand for interfacing Java and PROLOG. However, this PROLOG-based approach to implement the proposed contact list could be considered as out of date. Indeed, emerging technologies namely those of the World Wide Web Consortium (W3C) standards package for linked data are also suitable.

With regards to the use of the linked data technologies to implement the proposed contact list, the approach consists of the system architecture of Figure 2. The knowledge base is built upon an ontology populated by individuals. The ontology implements the graph representation of the contact list by defining the graph of the concepts related to social relations. A social relationship existing between two contacts is, in this approach, well mapped onto the model of triplets. The model of triplets represents a knowledge in the form of a triplet as (*subject*, *predicate*, *object*). Using this model, a social relation can be represented by a predicate and the two contacts that it ties corresponding one to the subject and the other to the object. This model of triplets is used in the Resource Description Framework (RDF) [32]. To efficiently represent the concepts intervening in the proposed contact list and enable reasoning on the knowledge base to build, Web Ontology Language (OWL) [33] or Resource Description Framework Schema (RDFS) [32] are part of the W3C standards stack of linked data that can be used.
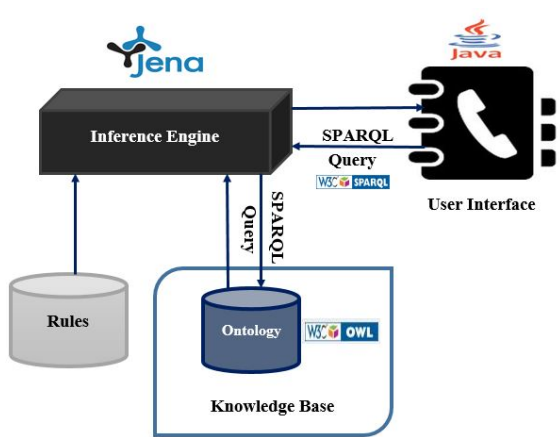
Figure 2. Technical architecture of the contact list software

Figure 3. Demo Sample of the contact list

To validate the proposed contact list software, we propose to implement it using the desktop oriented architecture depicted in Figure 2. In this architecture, three different features have to be distinguished. The presentation feature given by the graphical user interface and for the development of which Java programming language is selected. The second feature is the knowlege base implementing the proposed contact list. It consists of an ontology describing the contacts and the social relations that connect them each other. The rules are part of the knowledge base. They are used by the inference engine, the third feature of the architecture, to deduce new knowledge (e.g.: linking automatically contacts on the basis of logical consequence). For the implementation of this part of the arhitecture, Protégé, an open-source ontology editor [34] is selected together with the OWL syntax. The inference engine is in charge of the reasoning. To implement the inference engine and make it possible to interface both the graphical user interface and the knowledge base, Apache Jena is selected. Apache Jena is an open-source Java framework for linked data applications building [35]. For the queries management between the knowledge base and the user interface, the SPARQL protocol and query language [36] is selected. SPARQL is one of the W3C standards of linked data.

5. Results of the Developed Contact List Software

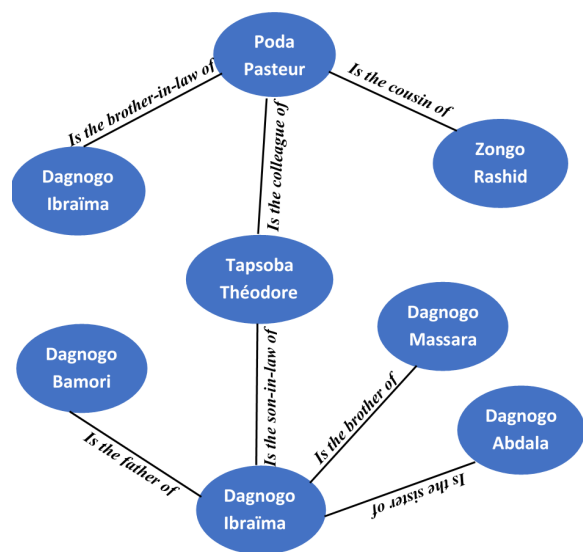We developed the proposed contact list application basing on the technical architecture of Figure 2 and using the selected technologies previously presented. The developed application is provided with both the classical CRUD functionalities and the three novel functionalities regarding homonymy resolving, contacts reminding and identifying. It also offers possibilities for groups creation using criteria that are the social relations. For the purpose of the demonstration, we created a contact list in which eight contacts have been registered, hence the instance of the contact list graph depicted in Figure 3.

To add a new contact in the proposed contact list, the developed application allows the user to fulfill the input fields presented in the screen shot of Figure 4. Some mandatory contact information that are the user's name, his surname and his phone number has to be provided. The social relation (i.e. the tie) that ties the new contact being created (i.e. "Poda Pasteur") to an already existing contact (i.e. "Zongo Rashid") is materialized with the selection of the appropriate social tie (i.e. "cousin of"). The button labeled "OK" allows the new contact information and social tie to be saved in the contact list. Upon completing the new contact insertion, the inference engine automatically updates the contact list graph by running the inference rules. This updating can lead to the creation of one or several other social relations with existing contacts.

Figure 4. Creation of a new entry in the proposed contact list

Figure 5. Exhaustive listing of contacts of any social tie with a given contact

One of the inherent novel functionalities of the proposed contact list makes it an effective reminder as explained through Algorithm 1 (see Table 2). To illustre this, Figure 5 is given. We assume not remembering the contact "Poda Pasteur" (a rarely contacted contact for example) with respect to the real life. The proposed contact list application allows all the contacts of the unremembered contact to be displayed. In the example of Figure 5, among the three contacts of the contact "Poda Pasteur" who are listed, the selection of the contact "Zongo Rashid" reveals that he is a cousin of the contact "Poda Pasteur". Knowing this social relation that ties the two contacts, the user is able to remember the contact "Poda Pasteur".

Another inherent novel functionality of the proposed contact list is that described in Algorithm 3 (see Table 4). Figure 6 shows a screen shot of how to vaguely

search for a contact (e.g.: "Dagnogo Ibraïma") whose contact information including his name and surname are forgotten. We assume that fortunately one of his contact (e.g.: "Poda Pasteur") is known. Knowing that latter contact and his social tie with the unknown contact, we can try by selecting both the type of social tie (e.g.: "is the brother-in-law of") and the known contact ("Poda Pasteur"). Then, vaguely searching in the list (in the example of Figure 6 there is only one element in the list) of the contacts who have "Poda Pasteur" as their "brother-in-law", there exist chances that the contact "Dagnogo Ibraïma" is retrieved.

The third inherent novel functionality of the proposed contact list is homonymy resolving. We have introduced it through Algorithm 2 (see Table 3). We assume having a certain number of homonyms in the contact list and we need to select the right one for initiating a communication with him. Homonyms possess identical contact information regarding their names and surnames but some other contact information (such as email address, phone number) can allow to distinguish them by the simple visualization. However, they
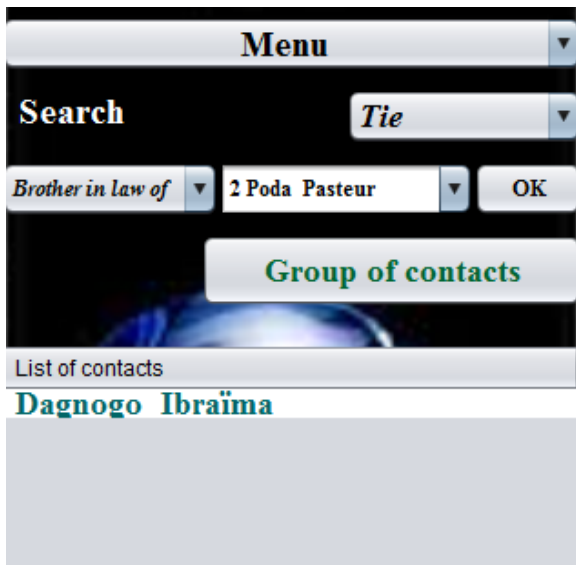
Figure 6. Vague search of a contact

Figure 7. A first homonym occurrence

cannot allow to recognize the right contact with respect to the real life. This is the case with the two homonyms occurrences of Figure 7 and Figure 8 regarding the contacts with name "Dagnogo" and surname "Ibraïma". In fact, the email addresses can help distinguish them but remain unpowerful in helping recognize the contact "Dagnogo Ibraïma" that we desire communicate with. Thanks to the proposed contact list, the social relationships between each homonym occurrence and other contacts can help recognize the one with whom we want to communicate. In Figure 7, we are about the contact "Dagnogo Ibraïma" who has "Poda Pasteur" as brother-in-law whereas in Figure 8 the second homonym occurrence is about a different "Dagnogo Ibraïma" who has "Dagnogo Bamori" as father. The homonymy is thus resolved.

To finish, let us now deal with group communications facilities that the proposed contact list enables. In Section 3, we exhibited the motivations for using the social relations as criteria to constitute groups for group communications. In the developed contact list application, we are able to select one or more criteria that are social relations in order to create a group. Figure 9 shows several possible choices of social relations as criteria for groups creation. It also let us imagine that the contact "Dagnogo Ibraïma" would like to create a group comprising of his sisters
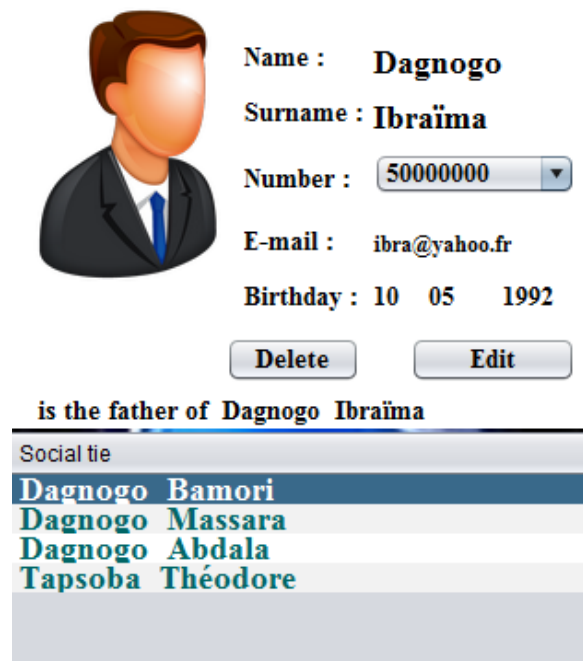

Figure 8. A second homonym occurrence

and brothers. After clicking on the button labeled "Validate", it results the creation of the group which members are displayed as shown in Figure 10. Once a group is created, a group communication channel can be identified. It can consist of, e.g., sending

9

Figure 9. Social relations as criteria for groups creation

Figure 10. Group communication: created group members

a short message service to all the members of the group or establishing an interactive messaging service conference or a conference call within the created group.

6. Conclusions

Strongly inspired by African social life, we proposed a redesigning of the mobile devices contact list based on social relations. We modeled the contact list as a graph of the mobile device user's contacts where social relations are the edges. We built the proposed contact list application architecture on a system comprising a knowledge base, an inference engine and a graphical user interface. We implemented this system using technologies of the World Wide Web Consortium standards of linked data and Java application programming interfaces. Results of the developed system allowed us to

evaluate the proposed contact list as an effective instrument that brought to the user additional novel functionalities of social interest. Beyond the classical CRUD (Create Read Update Delete) functionalities which are preserved, the proposed contact list furthermore allows contacts reminding, homonymy resolving, social relations based contact retrieval and group communications facilitating.

The achieved redesigning of the contact list and its validation giving the results of the implementation open promising perspectives for the integration of social relations in the design of mobile social software including mobile awareness-based applications. This is further important as social relations can play a crucial role in the human well-being. Indeed, the proposed approach can contribute much in relationships strengthening in the social life and bring happiness to people. In [37], the author noted that the evidence is substantial in psychology and sociology literature that social relations promote happiness for the individual and investigated in putting a financial value upon social relations and other life events. Holder *et al.* also discussed whether aspects of social relations and children's happiness are related [38].

References

[1] FISKE A.P. (1991) *Structures of Social Life: The Four Elementary Forms of Human Relations* (Free Press), New York.

[2] FISKE A.P. (1992) *The Four Elementary Forms of Sociality: Framework for a Unified Theory of Social Relations*, Psychological Review, 99 (4), pp. 689-723.

[3] KOMNINOS A. and LIAROKAPIS D. (2009) *The use of mobile contact list applications and a context-oriented framework to support their design* (ACM), In Proceedings of the 11th International Conference on Human-Computer Interaction with Mobile Devices and Services, p. 79.

[4] BENTLEY F.R. and CHEN Y.Y. (2015) *The composition and use of modern mobile phonebooks* (ACM), In Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems, pp. 2749-2758.

[5] PODA P., COMPAORÉ A.J. and SOMÉ B.M.J. (2016) *Redesigning Mobile Phone Contact List to Integrate African Social Practices* (Springer, Cham), In Proceedings of International Conference on e-Infrastructure and e-Services for Developing Countries, pp. 26-32.

[6] OUOBA J. and BISSYANDÉ T.F. (2012) *Leveraging the Cultural Model for Opportunistic Networking in Sub-Saharan Africa* (Springer, Berlin, Heidelberg), In International Conference on e-Infrastructure and e-Services for Developing Countries, pp. 163-173.

[7] SCHMIDT A., GELLERSEN H. and STUHR T. (2001) *Context-phonebook extending mobile phone applications with context*, In Proceedings of Third Mobile HCI Workshop.

[8] OULASVIRTA A., RAENTO M. and TIITTA S. (2005) *ContextContacts: re-designing SmartPhone's contact book to support mobile awareness and collaboration* (ACM), In Proceedings of the 7th international conference on Human computer interaction with mobile devices & services, pp. 167-174.

[9] JUNG Y., ANTTILA A. and BLOM J. (2008) *Designing for the evolution of mobile contacts application* (ACM), In Proceedings of the 10th international conference on Human computer interaction with mobile devices and services, pp. 449-452.

[10] BOYD D. (2004) *Revenge of the User: Lessons from Creator/User Battles*, Talk at Emerging Tech.

[11] TANG J.C., YANKELOVICH N., BEGOLE J., VAN KLEEK M., LI F. and BHALODIA J. (2001) *ConNexus to awarenex: extending awareness to mobile users* (ACM), In Proceedings of the SIGCHI conference on Human factors in computing systems, pp. 221-228.

[12] ANDERSEN B.L., JORGENSEN M.L., KOLD U. and SKOV M.B. (2006) *iSocialize: investigating awareness cues for a mobile social awareness application* (ACM), In Proceedings of the 18th Australia conference on Computer-Human Interaction: Design: Activities, Artefacts and Environments, pp. 7-14.

[13] ANKOLEKAR A., SZABO G., LUON Y., HUBERMAN B.A., WILKINSON D. and WU F. (2009) *Friendlee: a mobile application for your social life* (ACM), In Proceedings of the 11th international conference on Human-Computer interaction with Mobile Devices and Services, p. 27.

[14] MIN J.K., KIM H.T. and CHO S.B (2008) *Social and personal context modeling for contact list recommendation on mobile device* (IEEE Computer Society), In Proceedings of the 2008 IEEE/WIC/ACM International Conference on Web Intelligence and Intelligent Agent Technology, volume 3, pp. 381-384.

[15] GAO Y., ZHANG C., WANG Y. and SUN L. (2011) *A directed recommendation algorithm for user requests based on social networks* (IEEE), In 2011 IFIP 9th International Conference on Embedded and Ubiquitous Computing (EUC), pp. 457-462.

[16] LEDERER S., MANKOFF J. and DEY A.K. (2003) *Who wants to know what when? privacy preference determinants in ubiquitous computing* (ACM), In CHI'03 extended abstracts on Human factors in computing systems, pp. 724-725.

[17] DAVIS S. and GUTWIN C. (2005) *Using relationship to control disclosure in Awareness servers* (Canadian Human-Computer Communications Society), In Proceedings of Graphics Interface 2005, In Proceedings of Graphics Interface 2005, pp. 145-152.

[18] LUGANO G. (2008) *Mobile social networking in theory and practice*, First Monday, 13(11).

[19] GROB R., KUHN M., WATTENHOFER R. and WIRZ M. (2009) *Cluestr: mobile social networking for enhanced group communication* (ACM), In Proceedings of the ACM 2009 international conference on Supporting group work, pp. 81-90.

[20] HENDREY G.R., TANAKA H.A. and KOOPMAN JR P.J. (2003) *Method and system for selectively connecting mobile users based on physical proximity*, U.S. Patent No. 6,542,750. Washington, DC: U.S. Patent and Trademark Office.

[21] HENRI F.M., STEPHANIE L.W., TONG Y. and YINGXIN X. (2009) *Method of and System for Updating Mobile Telephone Contact Lists entries*, U.S. Patent Application No 11/867,287.

[22] GUEDALIA I. and GUEDALIA J. (2006) *System and method for dynamic phone book and network content links in a mobile*

device, U.S. Patent Application No. 11/638,272.

[23] Apfel D.A. (2006) *Unified Contact List*,ÂăU.S. Patent No. 7,139,555. Washington, DC: U.S. Patent and Trademark Office.

[24] Northcutt J.W. (2009) *System and Method of Sharing a Contact List among Mobile Phones*, U.S. Patent No. 7,613,472. Washington, DC: U.S. Patent and Trademark Office.

[25] Chesnais P., Wheeler S. and Pomeroy S. (2009) *Methods and apparatus for organizing and presenting contact information in a mobile communication system*, U.S. Patent No. 7,620,404. Washington, DC: U.S. Patent and Trademark Office.

[26] Plessas A., Stefanis V., Komninos A. and Garofalakis J. (2013) *Using communication frequency and recency context to facilitate mobile contact list retrieval*, International Journal of Handheld Computing Research (IJHCR), 4(4), pp. 52-71.

[27] Stefanis V., Plessas A., Komninos A. and Garofalakis J. (2014) *Frequency and recency context for the management and retrieval of personal information on mobile devices*, Pervasive and Mobile Computing, 15, pp. 100-112.

[28] Plessas A., Georgiadou O., Stefanis V., Komninos A. and Garofalakis J. (2015) *Assessing Physical Location as a Potential Contextual Cue For Adaptive Mobile Contact Lists* (IEEE), In 2015 IEEE International Conference on Computer and Information Technology; Ubiquitous Computing and Communications; Dependable, Autonomic and Secure Computing; Pervasive Intelligence and Computing (CIT/IUCC/DASC/PICOM), pp. 1316-1324.

[29] Barzaiq O.O. and Loke S.W. (2011) *Adapting the mobile phone for task efficiency: the case of predicting outgoing calls using frequency and regularity of historical calls*, Personal and Ubiquitous Computing, 15(8), pp. 857-870.

[30] Phithakkitnukoon S., Dantu R., Claxton R. and Eagle N (2011) *Behavior-based adaptive call predictor*, ACM Transactions on Autonomous and Adaptive Systems (TAAS), 6(3), p. 21.

[31] Sun C., Wang Y., Zheng J. and Hsu D.F. (2013) *Feature fusion for mobile usage prediction using rank-score characteristics* (IEEE), In 2013 12th IEEE International Conference on Cognitive Informatics & Cognitive Computing (ICCI* CC), pp. 212-217.

[32] McBride B. (2004) *The resource description framework (RDF) and its vocabulary description language RDFS* (Springer Berlin Heidelberg), In Handbook on ontologies, pp. 51-65.

[33] McGuinness D.L. and Van Harmelen F. (2004) *OWL web ontology language overview*, W3C recommendation.

[34] Protégé official web site, http://protege.standford.edu.

[35] Jena official web site, https://jena.apache.org

[36] Prud E. and Seaborne A. (2008) *SPARQL query language for RDF*, W3C recommendation.

[37] Powdthavee N. (2008) *Putting a price tag on friends, relatives, and neighbours: using surveys of life satisfaction to value social relationships*, The journal of Socio-Economics, 37(4), pp. 1459-1480.

[38] Holder M.D. and Coleman B. (2009) *The contribution of social relationships to children's happiness*, Journal of Happiness Studies, 10(3), pp. 329-349.