

PhotoFOAF: A Community Building Service driven by Socially-Aware Mobile Imaging

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Abstract

Mobile digital photography has become a ubiquitous service: nowadays, nearly every mobile phone is equipped with a camera. This results in huge collections of pictures that are hard to structure and has led to problems in saving, managing and exchanging digital pictures. PhotoFOAF presents a new approach to mobile imaging, exploiting the social context of a picture as an important part of the metadata. We present an approach that allows users to insert social metadata in pictures while capturing them. The resulting collections of captured pictures can be managed, searched and exchanged more easily by taking benefit of the personal social relevance of a picture. PhotoFOAF implements an end-to-end process to accomplish this and it exploits, enhances and stimulates social relationships between users during all the different steps.

1 Introduction

Mobile digital photography is available to the majority of people nowadays. In combination with popular online photo management and sharing websites, this results in a huge and growing archive of photographs available on the Internet. Metadata that helps to structure this collection in a reasonable way is still lacking. People tend to take lots of photographs, but problems arise when saving, managing and exchanging their digital collection. Most photographs contain no, limited or barely usable metadata, which often results in an unstructured collection of photographs and this makes finding that one particular image very difficult. Sharing pictures with friends usually takes a lot of time, and can be quite tedious. Furthermore, searching the collection of available photos of one person is hard but still feasible, but searching aggregated collections of different persons is practically impossible with current solutions. On top of this,

linking photos to other data sources, such as including photos in a blog entry, could also benefit from a more powerful approach.

In contrast with other current approaches that focus on the inclusion of geospatial metadata to photos, PhotoFOAF supports *social context metadata*. PhotoFOAF offers a convenient way of capturing metadata, but it differs from other approaches because it allows to link users that are part of a social network to photos. To accomplish this we use the Friend-Of-A-Friend (FOAF) profiles [2], a semantic web profile that describes individual users and their relationships with other users. The FOAF profile which describes the connections with other users positions the photos in the social network and indicates the *social relevance* of photos with respect to other users (in the social network). People appearing on photographs have a depicting relationship with the image. We use these depicting relationships to explore new human relationships between the depicted persons, often referred to as co-depiction (<http://rdfweb.org/2002/01/photo/>). This allows advanced possibilities in querying photographs and their inner relationships.

The remainder of this paper is structured as follows: We start in the next section with the description of related work where we differentiate our approach. Next we describe the system in a use case using a concrete example. Section 4 explains the different processes in the PhotoFOAF system, where sections 5, 6 and 7 reveal specific aspects of the system. Finally, section 8 discusses the future work and gives the conclusions.

2 Related work

Online photo sharing services like Flickr and Zoomr, use a folksonomy [6] to annotate photographs. In most cases adding the metadata is done while uploading the pictures or afterwards. This can result in general and imprecise

metadata [9].

Mobshare [10], a mobile phone picture sharing system, tries to simplify the exchange of pictures between mobile users. Blogging and visual representations of your photoalbum are simplified but metadata is neglected: time of capturing and a label that describes the picture are considered to be sufficient.

MMM2 [4, 5] tries to address the metadata capturing problem by using a complex algorithm. The algorithm uses the spatial, temporal and social context of the user and uses semi-automatic techniques. A list of possible subjects that can be used as metadata for the picture is generated. It is stated that mobile camera phones enable a new approach to annotating media by facilitating metadata capture at the time of image capture, facilitated by an automatized and collaborative metadata capturing technique [11]. However, there is less support for searching photographs, blogging and building community. Social relationships that result from photographs are not exploited.

PhotoStuff presents a toolkit to allow users to markup multimedia using concepts from ontologies that are associated with regions of an image. As an example on their website (<http://www.mindswap.org/2003/PhotoStuff/>), they use FOAF as an ontology.

Flipper is an experimental system, built around design themes for such systems with regard to their enhancement of social presence [3]. Field studies show that people share twice as many photos and have an increased sense of social presence when using the experimental system.

The previously described approaches use semi-automatic metadata capture or allow to add metadata afterwards using folksonomies. Our approach allows to add social metadata at the time of image capture based on the users' FOAF-profile and its location in the social network. Afterwards the social relationships resulting from the pictures and the relationships in the users' profile are combined to create a personalized adapted experience on the PhotoFOAF website.

3 Case Study

In this section we describe how the system works by first presenting a traditional scenario of taking pictures followed by the optimizations PhotoFOAF offers. Figure 1 shows the steps necessary to take and share pictures without using a system like PhotoFOAF. In step 1, Steven decides to take a picture of Sarah and Kris in the park. At home (step 2), he uses specialized software to upload his pictures from his camera to his personal computer. He only finds time to add the name of the picture (`Sarah_and_Kris_Park.jpg`) as metadata. Afterwards he uploads his pictures to his personal webspace, again using a different application taking a few minutes (step 3). In step 4 Steven posts a blog on his own

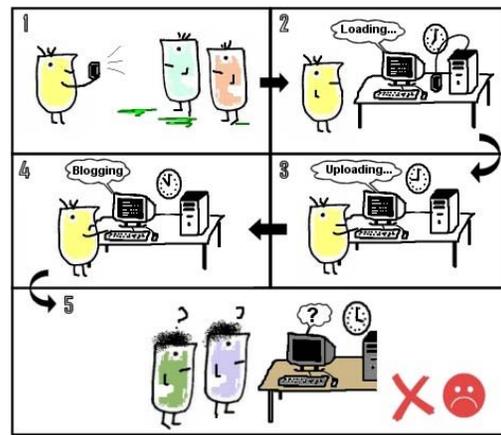


Figure 1. The traditional way to capture and publish pictures.

blogspace, and links to the pictures, using the URL from his own webspace. Monica and Emily, two friends of Sarah that are unacquainted with Steven, try to find the pictures of Sarah and Kris. However search terms “Sarah” or “Kris” do not return the required results. In this situation, Steven has to take the initiative to share the pictures with Monica and Emily, two people he might not even know. The described situation requires a push-scenario to share pictures with other people.

In figure 2, Steven takes pictures of Sarah and Kris in the park using his smartphone. Using the PhotoFOAF application, he can add “Sarah”, “Kris” and “Going out with friends” as metadata to each picture easily right after making the photograph. The pictures together with their metadata are uploaded immediately when network connection is available. After the upload, the photographs are available according to the privacy rights on the PhotoFOAF website. In step 2 (some minutes later) Monica and Emily can find the pictures they want to see on the PhotoFOAF website, using the search term “Sarah Abrahams”. All of the people using the system save a lot of time using PhotoFOAF. Pictures are obtained using a pull scenario and Steven or even Sarah can blog easily, even on pictures they did not take themselves.

4 The PhotoFOAF process

PhotoFOAF implements an end-to-end process to capture, annotate, upload, manage and query pictures. The first stage is always the image capturing activity, for which PhotoFOAF provides client side software that manages capturing, annotating and uploading pictures. The remainder of this section gives an overview of the different steps that are

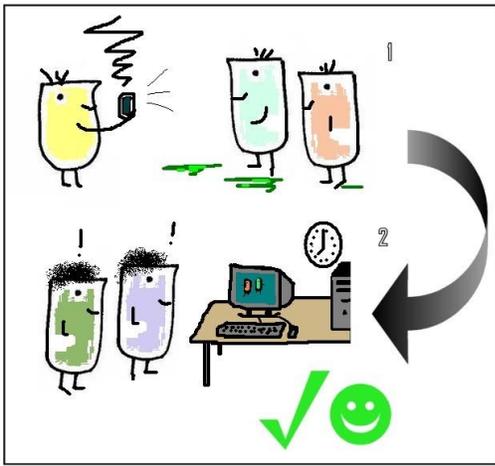


Figure 2. New approach of taking and sharing pictures using PhotoFOAF.

supported by PhotoFOAF.

1. On creating pictures users get the opportunity to add metadata in a convenient and fast way to their photographs. Using the users' profile, the system suggests people and/or interests that can be added as metadata. It is also possible to add the metadata afterwards, but we provide an intuitive and easy to use selection mechanism that lowers the threshold of doing this instantaneously. We benefit from more accurate and complete metadata.
2. The suggested metadata gets updated automatically as people take more pictures and the folksonomy supported by the website is used by other people.
3. The social relationships that can be derived from pictures e.g. persons A and B4 appear on the same photograph (figure 3) can be added to the FOAF-profile of A and B4, often referred to as co-depiction.
4. Users can set privacy rights on all of their pictures using the social network available. E.g. in figure 3, user A can easily allow access to all B-users and disallow access to all C-users. Furthermore, people can give access to pictures based on the level of social relevance, e.g. the social relevance between A and B2 is larger than the relevance between A and B1 (because of the relation between B2 and B3, where B3 is also related to A). Calculation of social relevance is described into detail in section 5.
5. Pictures are uploaded to the central server and relationships are stored in the database and in the picture itself.

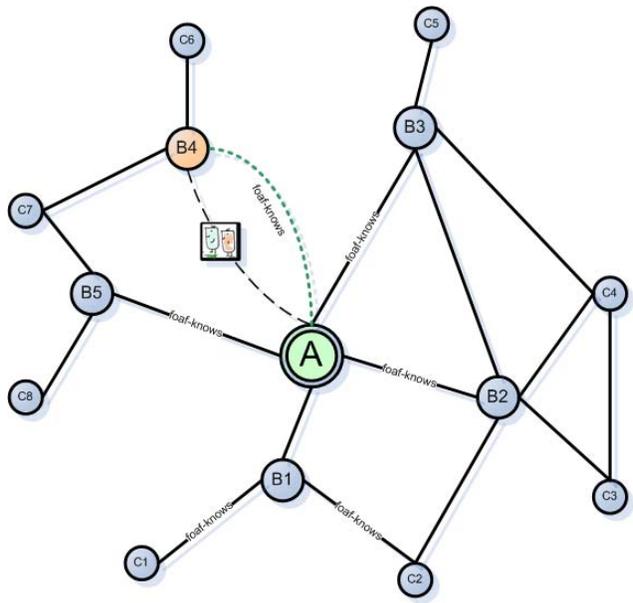


Figure 3. Social network created by FOAF-knows relationships and expanded by taking pictures.

6. Users visiting the website get a personalized interface thanks to the relations in the FOAF-profile and the social relationships deduced from the pictures. E.g. in figure 3 user B2 will also be presented with pictures of B4, a relationship derived from a combination of foaf-knows and co-depiction.
7. Searching becomes a lot more convenient thanks to the directly added metadata combined with the afterwards added folksonomy metadata. Complex searches of pictures, that contain people with certain characteristics or even with certain social connections (“who she/he knows”), become easy from a user’s perspective.
8. Blogging becomes easier thanks to the centralized storage of pictures, blogging on your own pictures, or pictures that depict you or your friends becomes straightforward.

5 Determining Social Relevance

We use Friend-Of-A-Friend (FOAF, [2]) profiles to identify people. This type of profile contains information about the social relations of the user next to traditional information that identifies the user (such as name, address, hobbies, hair color...). Most people tend to take pictures of their interests or friends, both described in detail in

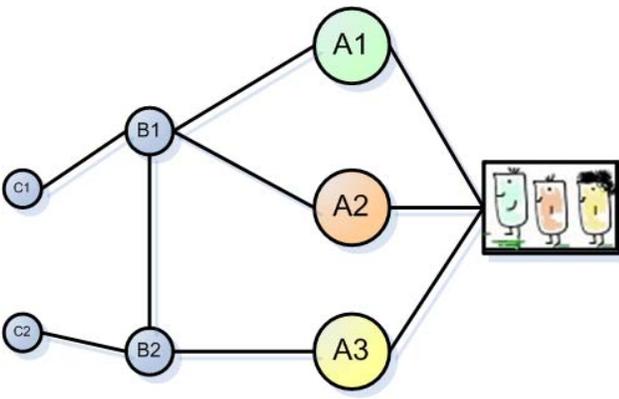


Figure 4. Social relevance network

the FOAF-profile. This way the FOAF-profile gives a nice suggestion of metadata to add to the picture. Figure 5 gives an example of a FOAF profile that is used by the PhotoFOAF system. This example shows that FOAF is a Resource Description Framework vocabulary (RDF, <http://www.w3.org/RDF/>) for describing people and social networks. Its RDF syntax allows us to easily query relations between different FOAF files and build a graph of related FOAF profiles. In this example we use the del.icio.us social bookmarking tags to specify the interests of a person: because of the fussiness of what human interests exactly are we use this folksonomy since it is a list of terms created by the end-users themselves. Even if the tags do not exactly match (a problem stated in [9]), an algorithm can be used to calculate how closely two tags are related (e.g. in the case of del.icio.us how many URLs the tags have in common) and use a threshold to determine whether or not the two tags indicate the same interest. Of course, other categorizations could also be used for this purpose. Using FOAF a social network of related FOAF-profiles is built and this network is used as input for calculating social relevance, a measure to detect how interesting a photograph is to a PhotoFOAF user.

Formula (1) is an heuristic used to calculate the social relevance (SR) of an image, where $|p_i|$ is the length of unique path i , and n is the number of unique paths between the node and the picture. Table 1 shows the results of social relevance calculation for the graph shown in figure 4 (the smaller the result, the larger the social relevance). To persons A1, A2 and A3 the created image is highly socially relevant, since these are the persons that appear on the image. The image is more socially relevant to B1 in comparison to B2, since B1 knows two persons on the picture in

A1,A2,A3 → 0	B1 → $\frac{7}{9}$	C1 → $\frac{10}{9}$
	B2 → $\frac{8}{9}$	C2 → $\frac{11}{9}$

Table 1. Social relevance of an image according to figure 4: each person in the graph is mapped onto a social relevance value by formula 1.

first degree, and B2 only knows one.

$$SR = \begin{cases} 0 & \text{if number of edges} = 1; \\ \frac{\sum_{i=0}^n |p_i|}{n^2} & \text{if number of edges} > 1. \end{cases} \quad (1)$$

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<rdf:RDF xmlns:foaf="http://xmlns.com/foaf/0.1/" ... >
...
<foaf:Person rdf:nodeID="me">
  <foaf:name>Ruben Thys</foaf:name>
  ...
  <foaf:interest>
    <rdf:Description rdfs:label="track and field"
      rdf:about="http://del.icio.us/unzip/trackandfield/" />
    <rdf:Description rdfs:label="books"
      rdf:about="http://del.icio.us/tag/books" />
    ...
  </foaf:interest>
  <foaf:knows>
    <foaf:Person>
      <foaf:name>Carine Franssens</foaf:name>
      <foaf:mbox_shalsum>...</foaf:mbox_shalsum>
    </foaf:Person>
    ...
  </foaf:knows>
  ...
</foaf:Person>
</rdf:RDF>
```

Figure 5. A FOAF-profile

PhotoFOAF exploits social awareness by using FOAF as the core of the system. FOAF profiles can be created from scratch, or existing FOAF-profiles can be imported and used as user profile in PhotoFOAF. Furthermore, the created FOAF profile can be reused in other FOAF-compliant websites or applications. This way, we create a centralized user profile, that is kept up to date automatically. After registering (by creating or importing a FOAF profile) users can log in and make use of all PhotoFOAF features. Afterwards, FOAF-profiles can be updated (semi-)automatically when new interests are discovered while taking pictures and new social relationships can be detected through co-depiction.

As more people adopt FOAF by creating and publishing their own FOAF profile, a social network of related people is created, making it more interesting to use applications like PhotoFOAF. Unlike other approaches [9] the persons that are co-depicted on a picture and the creator of

the picture are identified unambiguously. Each FOAF profile is uniquely identified by a URI, but for performance reasons we parse the FOAF file, integrate it in the picture and add the information in a custom database to allow easy server-side querying. We are still evaluating the use of an RDF-based triple store to hold the information for querying, such as Jena [7], Redland (<http://librdf.org/>) or Semweb (<http://razor.occams.info/code/semweb/>).

6 Embedded Metadata

All pictures produced by PhotoFOAF contain social metadata described in RDF format. As discussed in section 5 a collection of photographs result in a metadata graph that is obtained by aggregating all RDF structures that are related with the pictures. RDF Query languages, like SparQL (<http://www.w3.org/TR/rdf-sparql-query/>) and RDQL (<http://www.w3.org/Submission/RDQL/>), can be used to query these graphs. Furthermore, RDF makes it possible to manually add and query new metadata types. Adobe’s Extensible Metadata Platform (XMP) shows it is feasible to add extensible metadata to media objects [1]. This data would be much more difficult to use if it was stored separately in a relational database.

Because pictures contain metadata that refers to metadata contained in other pictures (e.g. one FOAF profile “knows” another FOAF profile), very complex queries are possible over a collection. Finding a picture through characteristics of the owner, people standing on the picture and their relations in the social network, shows the power of using semantic web techniques.

7 System architecture

As shown in figure 6, the top-level of the PhotoFOAF system consists of two important parts: a smartphone application and a client web-based application. The smartphone application allows users to take pictures with the PDA, annotate it with metadata (figure 7) based on the user’s FOAF-profile (shown in figure 5) and upload the pictures including metadata to the PhotoFOAF server. Metadata is stored in the database as well as in the picture itself using the Exchangeable Image File Format (EXIF). PhotoFOAF stores *interests* and *people* metadata in the EXIF ‘subject’-field, in order to make pictures with their metadata also usable in other applications. After uploading new pictures, the PhotoFOAF system detects new *foaf:knows* relationships based on co-depiction and adds these to the database and FOAF-profile.

The client web-based application allows users to view photographs immediately after they have been uploaded, furthermore people can blog easily using their own or oth-

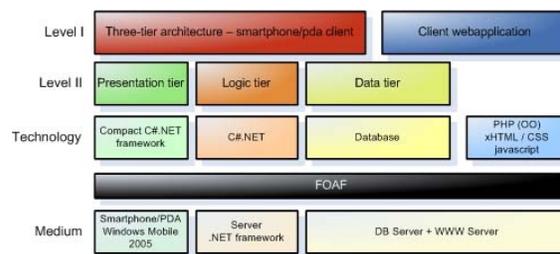


Figure 6. System architecture PhotoFOAF

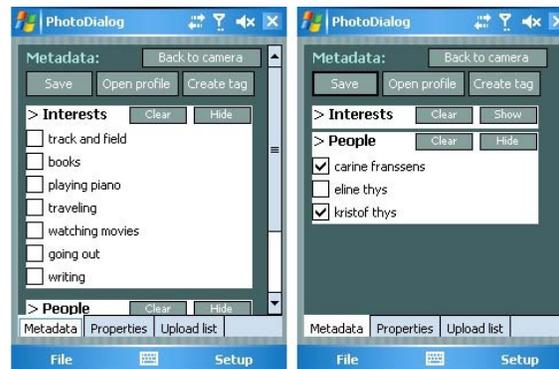


Figure 7. Adding metadata to pictures with the mobile client.

ers photographs. Thanks to the power of FOAF and the social relevance calculations (section 5) in combination with co-depiction, searching pictures with related people on it becomes straightforward. The client web-based application also uses the social relevance calculation to adapt the interface according to the users’ profile. E.g. socially relevant images and blogs are shown on the first page as shown in figure 8 (indicated with red rectangles).

8 Conclusions and Future Work

In this paper, we presented PhotoFOAF, a system to easily capture, upload, manage, browse and share photographs. PhotoFOAF takes into account the social relationships of the users during all stages of usage. PhotoFOAF builds on FOAF-technology and uses this to provide a social context of a picture and to create a community for managing digital images. Instead of just linking pictures with FOAF profiles, we embed parts of the social metadata inside the picture so metadata and data can be transported as one whole. Semantic web techniques make collections of pictures with social metadata easy to structure, query and manage the picture collection.

Adding metadata to pictures is always an extra burden however. A useful extension would be the automatic dis-

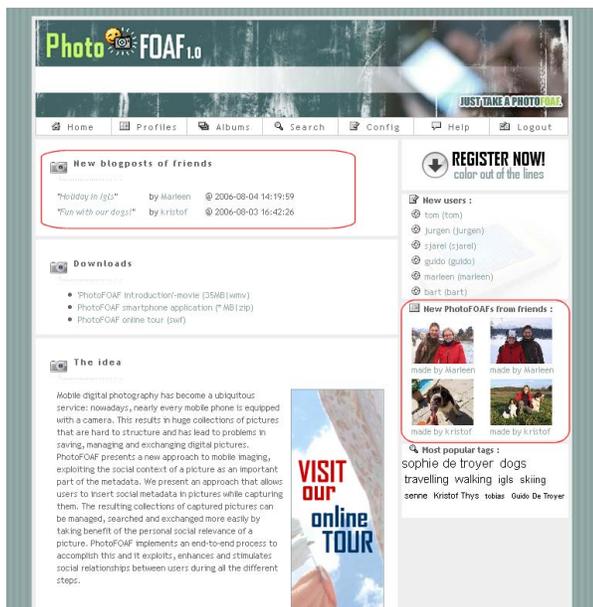


Figure 8. A screenshot of the web-based interface.

covery of FOAF profiles that need to be linked to a picture while capturing it. With Bluetooth and related protocols becoming available on most mobile devices, we might be able to use this to gather all FOAF profiles of people that are in the vicinity. Unfortunately, there is still no sufficient standardized means to accomplish this. We also plan to investigate more appropriate visualization techniques on the PhotoFOAF mobile clients and the community website. The former needs an optimal interface to support on-the-spot tagging and FOAF selection, while the latter could benefit from techniques that present the different facets of picture collections (e.g. picture-persons relationships) in a smart way so these collections can be browsed according to one of these facets.

The fully operational prototype website is available at <http://photofoaf.edm.uhasselt.be> and is currently available for public usage and testing. We believe our approach can tackle problems that often occur with picture management [8]. While users currently prefer to have a large overview of pictures and prefer to order pictures by timestamp, PhotoFOAF leverages part of these problems by providing a social context to each picture in a collection. This context allows for a personal view on the collection, and view the collection from different angles. Complex queries based on the metadata can be composed with relative ease. For example; one could look for a new tennis partner and ask photoFOAF to show all pictures that contain 2 males and 2 females that play tennis together and from which you know at least one person. The rdfweb co-

depiction example used in the introduction is a good example of using depicted people as a basis for browsing through a set of pictures; PhotoFOAF could even be used to present a photo collection ordered by co-depiction.

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