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Scenarios for CAIM (Context-Aware Image Management)

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Abstract

This report describes a set of scenarios onto which image context sources are utilized to improve image retrieval and to enrich presentation of images. The scenarios are produced to enlighten the many facets of context-aware image management and to ensure a user centred focus in the process of developing tools within this scope.

Keywords

Information retrieval, images, context, metadata, scenario

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Preface

This report was written as a part of the CAIM (Context Aware Image Management) project[1]. CAIM is a research project funded by the Research Council of Norway (over the VERDIKT programme, project number 176858/S10). The project builds on previous research at University of Tromsø, University of Bergen, Norwegian University of Science and Technology, Munich University of Technology, University of Hawaii at Manoa and Telenor R&I in the areas of data management, image processing, information retrieval, multimedia, and mobile systems.

The goal of the CAIM project is to develop methods and tools for context aware image management, where image description, query formulation, retrieval from heterogeneous distributed environments and ranking are designed for using context information. The management of images involves different situations in which context information could be of relevance, including image capture, image organisation, image retrieval, and image presentation.

This report describes a set of scenarios in which image context variables are utilized to improve image retrieval and to enrich presentation of images. The scenarios are produced to illustrate the many facets of context-aware image management and to ensure a user centred focus in the process of developing tools within this scope.

Harstad/Tromsø, October 15th, 2007.

Sigmund Akselsen, Bente Evjemo and Anders Schürmann (editors)

[1] *http://caim.uib.no*

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1 Introduction

An image retrieval system is a computer system for browsing, searching and retrieving images from one or several image sources. Most image retrieval systems utilize the image's metadata in the search and retrieval process. The metadata is often manually annotated, which is both time consuming and laborious. Recently large efforts have been invested to provide automatic annotation tools, inspired by for instance work done on semantic web field and social web applications.

Simultaneously content-based image retrieval (CBIR) systems are emerging. These systems utilise structural image content (see next section) in a search-by-example approach, typically between a visual query and the images stored in an image collection. Within CAIM we define a visual query as

> *a visual expression of a human information need, sent as a request (query) to an image (or information) retrieval system. A visual query will include a picture possibly supplemented with keyword characteristics.*

One of the main objectives of CAIM is to develop algorithms for image retrieval based on visual queries given in the form of pictures. What is central to CAIM is the focus on context as both a complement to CBIR and a surrogate for semantic retrieval.

1.1 Metadata and context

Context information is certainly part of the metadata – data about data (Sundgren 1973), that should be compiled for images. Dublin Core (1995) adopted the term metadata for the descriptive characteristics needed for the documentation of objects: books, images, video, etc. held in collections. The function of metadata is to provide descriptions of the primary object that can be used for data storage and retrieval. In the context of CAIM, metadata descriptors can be:

- Collected automatically, such as time, position, and camera type.
- Derived, such as image size; structural profiles such as color distribution, texture and/or shape(s) contained; the distance between camera and object.
- Copied from other objects within a collection to member images.
- Manually added, such as the type and names of objects within the image, the photographer, title, and/or the activity illustrated.

The three main categories of metadata, suggested by Dublin Core, seem appropriate to describe the current challenges related to image retrieval (Hillmann 2005; Nordbotten 2006):

- *Structural metadata*, describing implementation/representation aspects, such as: color, texture, size, materials.
- *Context metadata*, defining the relationships between an object/ picture and its surroundings: e.g. author/photographer, publisher/owner, time/date, GPS and storage location, as well as relationships between objects within an image.

- *Semantic metadata*, describing the semantic content in the object/ picture, f.ex. for pictures: types and/or name(s) of objects/person(s) within the picture, the event depicted (17th of May), general location (country, land, sea), emotion.

Semantic metadata is the usual basis of user requests whereas todays CBIR techniques are mainly based on structural metadata. This situation is referred to as the *semantic gap* (Zhao and Grosky 2002). By combining structural metadata and context metadata we believe that some semantic metadata can be identified and thus possibly contribute to reduction of the semantic gap between user information requests and the shortcomings of current content-based image retrieval techniques.

There are other terms used to specify and categorize metadata. Sarvas (2006) for instance, distinguishes between two main categories, context and content metadata. By this distinction he wants to emphasize that information associated with an image can be independent of the situation (the context) or even change over time (e.g. a girlfriend becomes a wife; a tourist location becomes home town). Another example shows that the depicted activity might be classified as context (Dey and Abowd 1999) instead of semantic metadata. It is also claimed that *purpose* information might be included as context metadata (Sarvas 2006). In general, when acquiring images, there is a (main) purpose for doing so, though there might be different purposes for using the acquired image at a later point in time.

In the following, we will use the term *metadata* as derived from the definition given by Dublin core. Figure 1.1 exemplifies the three categories. Appendix 1 gives an extended list of structural metadata captured by the camera in the moment of exposure.

Structural metadata
Photo: digital
Colour: Blue, gray, beige

Camera and accessories
Altitude: 1 m.s.l.
Direction: 97 °
Incline: 5 °
Depth of Field: 50m – Infinite
Resolution: 1024x768
Camera: Nikon D200

Semantic metadata
Identity of objects: Coastal steamer named Nordstjernen, Wagonway glacier in the background.

Event or activity: Cruise, summer holidays

General location: Mountains, glacier, sandy beach, Spitsbergen

Context metadata
Time
Origin: 20.07.05 13:34:14

Location
Place/region:Magdalenafjord
Coordinates:
79.5626 N, 11.0618 E

Identity of image
File name: IMG_001.jpg
Photographer: Anders Schürmann

Weather information
Temperature: 5 °C Wind: 1.5 m/s - Breeze
Press/Hum:989hPa /79%

Use information
Sharing: Kari Normann
Part of collections: Svalbard holiday 2005
Commercial use: Spitsbergen Travel 2007

Figure 1.1 A photo with a wide range of associated metadata.

1.2 Image management

There are basically four main situations in which context metadata is relevant to image management (see figure 1.2): image & context capture, image & context organisation, image & context retrieval and, image & context presentation.

The amount of context information associated with an image could increase over time. At the time of image capture the time stamp itself is one typical piece of information associated with the image. At image organising time the image typically becomes part of an image collection. When images are organized into image collections the annotation efforts can be reduced. Whenever an image is used – when a query is executed and an image is retrieved - new context information is produced (who used the image and in which situations). In summary there are various challenges related to capturing and managing context information within the scope of image retrieval, and there are also challenges related to efficiently include context information in the processes of formulating queries and presenting search results.

In the CAIM project we will address context metadata related to several of these stages, included context metadata capture and context metadata utilised in mobile settings (see for instance (Akselsen et al. 2002)). The scenarios presented in this report shows basically how context is utilised in an Image & Context Retrieval situation.

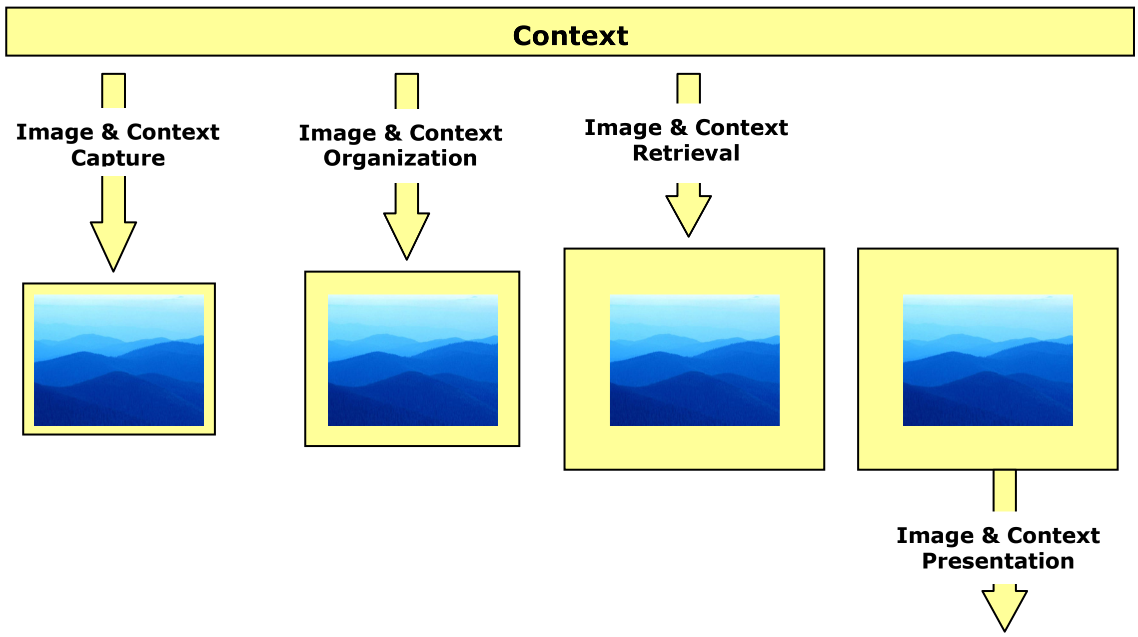


Figure 1.2 Context information associated with image increases over time

1.3 About the report

This report describes a set of scenarios (chapter 2) in which image context variables are utilized to improve image retrieval and to enrich presentation of images. The scenarios are produced to illustrate the many facets of context-aware image management and to ensure a user centred focus in the process of developing tools within this scope. A set of relevant data sources is described to support the realism of the scenarios (chapter 3). A brief summary is done in chapter 4, together with directions for further work.

2 Scenarios

A set of scenarios and information sources are described to illustrate the relevance of context-aware image management, to improve the realism of tools developed within the project, and finally to emphasize the user's position and ensure that essential user requirements are accentuated. The scenarios vary according to their relevance to professional and non-professional settings, and also according to the mobility aspects (see table 1).

Table 2.1 Scenarios illustrating how context might be utilised to improve image and information retrieval.

	Scenario title	*Category of setting*
1	City navigation	Non-professional, mobile
2	The most curious visitor	Non-professional, mobile
3	Inside but still outside	Non-professional, mobile
4	The tourist seeking activities	Non-professional, mobile
5	Exploring season variations and weather conditions	Non-professional, mobile and stationary
6	Archaeological sites	Professional and non-professional, mobile
7	Natural phenomena	Professional and non-professional, mobile and stationary
8	Enrich the lecture on sea animals	Professional, stationary
9	Snake bite and medical emergency	Professional and non-professional, mobile and stationary
10	Medical settings	Professional and non-professional, mobile and stationary
11	Police investigation	Professional, mobile and stationary
12	Journalist helper	Professional, mobile and stationary

2.1 City navigation

This scenario describes how mobile phones and instant image and context retrieval can help city visitors to find their destinations.

User experience

Anders is planning on attending a concert at Grieghallen. He was told by his aunt to walk along the small houses and then turn left. Now he feels a bit uncomfortable. There are small houses to the right but they are not where he expected them to be. And no street signs! Perhaps he should have turned left earlier? It is raining and hard to figure out in this misty weather. Being fifteen he is old enough to handle this situation. His mobile phone might help. He does not hesitate. It is like an elongation of his hand. He takes a photo of the building near by and gets the name of the street he is on. A 2nd query, for

Grieghallen, returns a map that eliminates further questioning. He will be there within a 500 meters' walk.

Query and context information
If Anders' mobile phone does not have GPS positioning, his position and the motive in the photo can be estimated by the position of the GSM cell in reach at the moment of image capture. The photo is included in order to identify the most likely building near Anders and thus his most likely position. This approach presupposes that the image collection searched is geo-positioned and thus narrows the search to a limited set of images; buildings within the reach of a GSM cell or within a given radius of a specific geographical position.

Table 2.2 Scenario elements

Task (intent)	*Info added by user*	*Info added automatically*
Where am I? Where was I?	Image	Position (GPS or GSM cell)
What is nearby?	Radius /distance	Position (GPS or GSM cell)
Where do I find?	Text, keyword	Position (GPS or GSM cell)
How do I get there?	Object selection on map	Present position

Data sources visited
The data sources visited and the result presentations can vary according to the specific task/scenario. For example, concert schedules for the different concert halls within the city could be helpful to "Anders" in the above scenario. Other text (or audio) documents could provide the history and/or use of the different buildings, or the sculptor and occasion/story for the city statues. It is reasonable to anticipate that the image collection contains multiple images of individual buildings both exterior and interior views.

Table 2.3 Data sources

Task (intent)	*Data sources visited*
Where am I? Where was I?	City images, city maps
What is nearby?	City images, geo-positioned databases holding point of interests, city maps
Where do I find?	City maps, geo-positioned databases holding point of interests
How do I get there?	City maps

User device and result presentation
In the above scenario, the user is assumed to be equipped with a camera phone which may have GPS positioning. However this latter cannot be assumed for all users.

Result presentation depends on phone unit characteristics, as well as an understanding of the query intent. For example, as indicated in table 2.3, the query (1) submits a source location and image, and receives a short list of images with the building names and addresses that match the input image (text information could be presented as an audio giving information about the building(s) in the list, and (2) submits the user's current location and desired destination, and retrieves a map over the shortest and/or most scenic route, including the distance to the destination.

Table 2.4 Result presentation

Task (intent)	*Result presentation*
Where am I? Where was I?	Object image with name, user position is shown in a map
What is nearby?	Images of object(s) with description and direction, map
Where do I find?	Images of object(s) with description and direction, map
How do I get there?	Object images, distance, map directions

2.2 The most curious visitor

In the moment of image capture the photographer is offered an opportunity to download information from sources related to the different motives identified within the image. A probable main motive is suggested by the system.

User experience I
Gerhard, this is exciting! The runners pass very fast and they look great! I want to immortalize this moment! The charming little church in the background, isn't it nice? The placement of the church seems rather strange - perhaps this was the old centre of the city. I am sure my camera phone will inform me.

The lady takes a series of photos and selects one of them to be the basis of a "capture information" process. It is initiated by some few key strokes on her mobile phone and she receives immediately short descriptions of the nearby buildings. She recognizes the church as the northernmost catholic church worldwide, and finds this piece of information very interesting. She easily selects the church information to follow this particular photo, and knows that information like time and positioning are added as a default choice. Meanwhile *the runners have disappeared, the street is passable and the middle aged couple can take a closer look at the yellow wooden church.*

User experience II
Another tourist uses a quite different strategy to inform herself. She takes photos of particular buildings or cultural monuments, and enjoys seeking information about the building or monument in the digital world.

Query and context information
In the first setting the initial photo serves as a key source for the production of the query, and it might not be part of the query. Based on GPS positioning and compass values (facilities added to the camera phone) and camera settings (e.g. focal length and blender) in the moment of capturing, a geographical area of interest is calculated (see also the *Inside but still outside* scenario) and added to he query. In the other setting the photo for sure is the basis of the searching process while the accurate position narrows the search and makes it more efficient.

Table 2.5 Query elements

Task (intent)	*Info added by user*	*Info added automatically*
Give me information about buildings and attractions captured within this image	Image	Time (hour, date) Position Camera direction Camera lens settings
What is this? Which cultural monument is this?	Image	Position

Data sources visited
Many geo-positioned points of interest (POI) data bases exist already. They are normally established and maintained by tourist offices and public authorities that for some reason or other benefit from structured geo-positioned information sources.

Table 2.6 Data sources

Task (intent)	*Data sources visited*
Give me information about buildings and attractions captured within this image	Geo-positioned points of interest databases in actual city
What is this? Which cultural monument is this?	Local and regional databases holding information about cultural monuments, e.g. BergenBy image database, point of interest databases related to National Scenic Route, Artscape Nordland (Skulpturlandskap Nordland). Also blogs produced by other people that have visited the site could be crawled (dependent on digital rights management).

User device and result presentation
As the mobile phone is used to initiate the search the result should preferably be shown on a mobile phone. It is challenging to present text beyond some few lines on small displays. Thus the information should be presented in key words and the text should be placed upon a simplified (e.g. a stylized) version of the image according to location relevance. For instance key words describing the catholic church should be placed in the upper-left part of the display. Link to Additional information can be given as WAP links.

Table 2.7 Result presentation

Task (intent)	*Result presentation*
Give me information about buildings and attractions captured within this photo	Names and key words related to identified objects are shown upon the image.
What is this? Which cultural monument is this?	Informative text about the building or monument is given on the mobile phone display.

2.3 Inside but still outside

To be outside and still have some glimpses of what is behind the walls. This might be beneficial in many situations. Here is one of them:

User experience
She is impressed as she enters the campus and experiences the size of the university buildings and their fitting into some superior architectural plan. The different styles and building materials inform the viewer of an institution that has grown over a long period of time. Today every door is closed, but she knows how to enter without entering. She takes a photo of the main building and initiates a search for further information. She recognizes this building as the one housing the welcome ceremony to morrow, and the response MMS confirms this assumption. The MMS holds some images depicting the main auditorium annotated with the architect's visions. Further there are pictures of the building's pieces of art. She fancies this piece of information, as her main passion in life, besides her profession and her family, is visual art and architecture. Doubtlessly she has to enter this building the next day.

Query and context information
The query contains an image followed by four coordinates describing the area of the photographer's main motive. These coordinates are calculated on basis of the cameras technical outfit and relevant image capture settings (see also *The most curious visitor* scenario). A user profile informs the information retrieval system about the user's particular interests. This user loves art, and thus the search addresses art sources and artistic information in particular.

Table 2.8 Query elements

Task (intent)	*Info added by user*	*Info added automatically*
Which building is this?	Image	Position (area) Interest preferences according to user profile

Data sources visited
The image as a basis for a CBIR search is here strongly supported by a primary positioning process. The CBIR search is used to justify the position base search or to select the right item among a limited number of alternatives. This approach presupposes that the accessed information sources on buildings are geo-positioned.

Table 2.9 Data sources

Task (intent)	*Data sources visited*
Which building is this?	Geo-positioned information on buildings etc

User device and result presentation
The user device at hand is a camera phone. The reply can take different formats. It could be an MMS presentation that consists of images and text. It could also include music or a narrator voice. Inside the MMS one could include links to WAP sites with additional information. Further, it could be a video that gives a more vivid impression of the attraction. However, this puts higher demands on the phone and the network.

Table 2.10 Result presentation

Task (intent)	*Result presentation*
Which building is this?	Informative text about the building (when raised, purpose, etc), pictures from inside the building. Links to video streaming site.

2.4 The tourist seeking activities

In contrast to the German couple in *The most curious visitor* scenario the Italian Anna is a more goal-directed tourist.

User experience
Anna loves museums. This is her first visit to Trondheim – her first night - and she is in the old part of the city. She can't miss the great cathedral. It's not open at the time, but she enjoys planning the adventures of tomorrow. The cathedral and the long stone buildings near by seem to be a natural starting point. She takes a photo and initiates a search for information. She specifies the question by selecting items from a short menu. She wants a guided tour and is soon given both time and price. It fit her time schedule and within a few strokes on her mobile she has booked a reservation for the morning tour within the cathedral. She then turns to the river banks and the bridge to explore the other side of the river.

Query and context information
The image together with the position is the primary query items. The position is needed to narrow the similarity search. When the object of interest is identified, the time stamp is used to select information related to the specific question.

Table 2.11 Query elements

Task (intent)	*Info added by user*	*Info added automatically*
What is going on here?	Image	Position Time (date, hour)
What are the opening hours and the prices?	Image	Position Time (date, hour)
Are there guided tours available?	Image	Position Time (date, hour)

Data sources visited
The scenario presupposes that geo-positioned image databases exist. Here sources held by tourist information bureaus, tourist destination companies, or municipal information sources, etc are visited.

Table 2.12 Data sources

Task (intent)	*Data sources visited*
What is going on here?	Geo-positioned database holding information about points-of-interest
What are the opening hours and the prices?	Same as above
Are there guided tours available?	Same as above

User device and result presentation
The device involved in this scenario is a mobile phone, and the searching result is shown as text on the mobile phone display.

Table 2.13 Result presentation

Task (intent)	*Result presentation*
What is going on here?	Informative text is given on the mobile display and WAP links to meet the most interested tourist.
What are the opening hours and the prices?	Opening hours is given on the mobile display together with prices and contact information. Immediate purchase of tickets is supported.
Are there guided tours available?	Information on time tables, costs, language etc. Immediate purchase of tickets is supported.

2.5 Exploring season variations and weather conditions

In situ travellers might seek images that show the visited place during other seasoning conditions. Back home they might want to add actual weather reports to their pictures.

User experience I
Curious about seasonal variations:
The water is cold, but refreshing. They have their lunch on the beach and happen to study the houses in sight. The painting has flaked off and they seem exposed to heavy storms. What would this place look like during winter time? They don't know exactly their geographical position and could not remember the name of the area. They take some photos with the mobile phone. They choose to enclose a picture of the small village church to ease the searching process. The photos are automatically tagged with date and geographical coordinates. Finally they add a quest for "winter scenes" to the query. The response includes remarkable pictures of frozen vegetation and rough weather, the little village covered by snow, and the landscape enlightened by the northern lights above. What a difference! It is fascinating. We should return in January!

User experience II
Enriching travel diary back home with weather reports:
Peter still hasn't organized the summer holiday photos even though it's easy and quite amusing. Luckily he had named the image folders properly. Yes – here they are – the nice summer memories from Northern Norway. There are several photos depicting his wife swimming. She seems to amuse herself – but wasn't it rather cold these days? He will check on that. He selects the images by some few clicks and sends them for weather annotations. He smiles when he receives the accurate temperatures midday and midnight in the time period of interest. It was never more than 17 degrees! "My wife is a tough woman!". He goes on annotating the images and the exact weather reports direct the process.

Query and context information
In both cases the images are expected to be tagged in the moment of photographing with both time and position (based on GPS). If seasoning difference related to a specific motive is addressed the image should be part of the query. If the user is interested in seasoning differences in the area in general, the position or the name - in case of a given localisation name - is the primary query element. The image is enclosed to select the most similar motive among a set of outdoor images from the specified location. The actual date determines whether the query is oriented toward summer or winter time (based on simple calculations).

In the case of annotating weather conditions the images are included to automate the extraction of position and time information. CBIR is not performed.

Table 2.14 Query elements

Task (intent)	*Info added by user*	*Info added automatically*
What does It look like here during winter time?	Name of place, if known, and images.	time (day, hour), position
What was the weather like when the picture was taken?	Images	time (day, hour), position

Data sources visited
The seasoning query directs search towards image collections identified by the location name or exact position. It is primarily outdoor pictures that are regarded interesting. It might be challenging to differentiate between indoor and outdoor pictures, and eventually select the most relevant images. Here similarity search is used. Back home and in case of bad memories the weather report databases are visited.

Table 2.15 Data sources

Task (intent)	*Data sources visited*
What does it look like here during wintertime?	Geopositioned image collections. In times to come public image collections like Flickr or web sites focusing on tourist attractions etc. might be geo-positioned.
What was the weather like at the moment of photographing?	Weather databases holding reports from the past (temperature, wind speed, humidity and sun radiation)

User device and result presentation
In the scenario the user is equipped with a mobile phone camera. The result should be shown immediately on the mobile phone display, but also sent to the user's electronic mailbox for later investigations. These presentations might be designed differently: a small set of images could be sent to the mobile, while a larger set of images together with text and videos could be sent to the mailbox.

In the weather report scenario the user sits by his computer organising his image collections. He receives detailed information about the weather and selects the most interesting parameters before the annotations fields are updated. In certain cases he may choose to keep the detailed parameters (e.g. air humidity, wind direction, and solar radiation, and in other cases he may choose to transmit these values into daily used phrases about weather condition (e.g. nice weather, sunny, windy etc).

Table 2.16 Result presentation

Task (intent)	*Result presentation*
What does I t look like here during winter time?	A small set of images is returned to the mobile as an MMS. Simultaneously another set of images (if many hits) is enclosed in an email with links to web pages giving further information of the place.
What was the weather like at the moment of photographing?	The weather report is presented in a table showing the different sensor values. The user selects the sensors of interest before any information is moved to the annotation field of the image

2.6 Archaeological sites

A picture of some landscape or object of interest (e.g. rock-shelter, cave, items or tools from ancient cultures) is used to get information about this topic, including guided tours and audio companions.

User experience

A tourist is visiting an archaeological site in Herand, Hardanger in western Norway. "– You can easily understand (and almost see) why people decided to settle here. They could fish in the fjord, work on the shore and find shelter in the rock formations that provided an almost ready made home. And it is actually dry in there (in a rainy area)".

What made the caves and rock-shelters good places to settle also made them suitable to preserve bones and other interesting items. More than 9000 year old tools and bone jewellery have been found (see example to the left). Herand is well-known among archaeologists. A rock carving area some hundred meters away from the cave is one of several visible signs of the site's history.

The archaeological findings in the area span from a 9000 year old hunter and fishermen culture, via a peasant culture that made a fire hollow some 5000 years later, and to the traditional farming society present today.

A visit to the area is interesting as the different landscapes and objects in the area have a history tied to them. Availability of human guides in the area is limited and the development of mobile electronic guides is therefore much appreciated by visitors to the area. A query image of the rock carving to the left could produce a translation of the text and links to more detailed information on the runic writing and the objects depicted.

Query and context information

A query in this scenario could consist of an image of an object/scene of interest taken with a mobile phone camera, supplemented with context information such as user preferences, time and location.

Table 2.17 Query elements

Task (intent)	*Info added by user*	*Info added automatically*
What kind of archaeological site is this?	Image	Position
What is this object?	Image	Position
Are there guided tours available for this site?	Image	Time (day, hour) Position

Data sources visited
Requests for information about archaeological sites could be routed to image collections maintained by the local university's archaeology department. High precision is demanded to identify and provide information on the right objects. High recall could be valued by those with special interests. This assumes an alternative receipt area, for example to the users e-mail address. Blogs maintained by archaeological interested persons might be visited, as well as data bases like Flickr.

Requests for guided tours presuppose identification of the place or item of interest. Time information like date, hour, week day, etc should ensure that a appropriate suggestion is made.

Table 2.18 Data sources

Task (intent)	*Data sources visited*
What kind of archaeological site/item is this?	Image collections and data bases maintained by local universities. Relevant blogs produced by other people that have visited the site.
Are there guided tours available for this site?	Local tourist information sources.

User device and result presentation
The user is typically travelling and uses his mobile phone camera. A short version of the result should preferably be presented on the small mobile phone display, while longer texts or multiple items could be sent to the users e-mail. It could be an MMS presentation with images and text. The result might include music or a narrator voice or links to WAP sites with additional information or videos that gives a more vivid presentation of the archaeological or cultural attraction. This puts a high demand on the phone and the network capacity.

Table 2.19 Result presentation

Task (intent)	*Result presentation*
What kind of archaeological site or object is this?	MMS presentation with images and text, and links to WAP sites with additional information
Are there guided tours available on this topic?	Short information about relevant guided tours are given (hours, durability, price , etc) and access to ticket systems

2.7 Natural phenomena

Retrieve additional information about a specific animal or other natural phenomena with its environment, habits, etc.

User experience
14 year old Jonas and his family are on vacation to the Cuyo Islands in the Sulu Sea. Deeply fascinated by maritime life and natural phenomena, Jonas has

spent the weeks prior to the trip studying the marine life in the Sulu sea and planning which animals and phenomena he should be looking for.

During the stay, Jonas spends most of the time exploring the seaside, using his camera phone to take photos of the animals and vegetation in the area. He is particularly thrilled about the skeletal remains his sister finds on the beach, but is unable to identify. Jonas presumes that it is a kind of dolphin. He is very interested in identifying the particular kind of dolphin, and gaining more information about it (such as an image or a movie of a living specimen). However, with no computer available and without his books he uses his camera phone to search for more information about the skeleton. He submits the image to a search engine using MMS, and soon receives a list of candidate dolphins.

Back home, Jonas browses through the images he took, and suddenly discovers a type of tree he has photographed before, on a trip to Canada. Puzzled by the fact that the tree could be growing in two very different habitats, he wants to identify the tree, and learn more about its habitat. He submits the images to a search engine, posts the images on various web forums, and e-mails them to his teacher, hoping that he might learn more about the skeletal remains.

Query and context information

Here three distinct query tasks are defined. First, Jonas attempts to find images and information about objects based on location. In the second task, Jonas attempts to obtain the identity of a particular animal based on a photo, as well as photos or a movie of the specimen. In this (hypothetical) example, an image is submitted to a CBIR based search engine using MMS, along with the position (GPS) where the image was captured. A CBIR search is performed by the system, and narrowed down by the GPS location, removing the most unlikely candidates, and returning a set of possible candidates to Jonas.

In the final tasks, Jonas again attempts to identify a particular object, but this time his is also interested in obtaining additional information concerning the tree's natural habitat. In addition to the image representing the tree, the context (place, time of year, etc) of both locations are part of the query which states two different questions: *Are the trees depicted in the images the same type*, and *should these trees grow in two very different habitats*?

Table 2.20 Query elements

Task (intent)	*Info added by user*	*Info added automatically*
Find pictures of animals and vegetation that exist in a particular (geographical) area	Keywords Position	None
Identify and find more information (Pictures, text, video) of a particular object	Image	GPS
Identify and compare two depicted trees, and obtain more information about the depicted trees	2 images	GPS Time

Data sources visited
The first task might require several different data sources, for instance text books, educational material, expert uses, and online resources. The second task requires access to database with marine animals which allows a MMS based CBIR search. The final task might require several different data sources, a biological database with CBIR search capabilities, domain experts, text books, and online communities.

Table 2.21 Data sources

Task (intent)	*Data sources visited*
Find pictures of animals and vegetation that exist in a particular (geographical) area	Text books, educational material, (online) databases
Identify and find more information (Pictures, text, video) of a particular object	Specialized image collections with (MMS based) CBIR capabilities
Identify and compare two depicted trees, and obtain more information about the depicted trees	Text books, educational material, online communities, CBIR enabled databases

User device and result presentation
The first task is likely performed from home or in a classroom setting, where the enquirer has access to several different information sources. Presentation of results from a search could be given as a list of candidate objects (with thumbnails and a textual description), allowing the user to select interesting objects and receive a list of images of the particular object.

Results from the second task should primarily be delivered to the camera phone. It is assumed that the enquirer is interested in getting results in real time, possibly at the expense of reliability. Only the most likely candidates should be presented directly to the phone, but it should be possible to store the results for later evaluation on a different platform – for example as an email with link to a web page giving further details, available for a certain amount of time.

In the final scenario, the user should be told if the two images depict the same tree, the identity of the trees as well as information about the trees and their habitats. It is assumed that, in opposition to the second task, the reliability of the results is more important than having the results presented in real time. Accordingly, the results might not be presented at the time of inquiry.

Table 2.22 Result presentation

Task (intent)	*Result presentation*
Find pictures of animals and vegetation that exist in a particular (geographical) area	A set of relevant images are returned to the computer, grouped by object depicted and illustrated by an example image.
Identify and find more information (Pictures, text, video) of a particular object	The most likely candidate (or a small set of candidates) should be returned to the phone, with a more detailed result set presented as a link or enclosed in an email.
Identify and compare two depicted trees, and obtain more information about the depicted trees	The results are processed and returned to the user, emphasizing reliability over speed of delivery.

2.8 Enrich the lecture on sea animals

A teacher is preparing a lecture on marine animals in general and dolphins in particular, and approaches an image collection with a marine theme in order to find illustrative pictures.

User experience
The weekend before the "Ceteacean week", high-school teacher Henning still needs to find images illustrating different aspects of dolphin life, life cycles, activities and habitat. While Google Images has been very useful in finding generic images of dolphins, he is getting frustrated when trying to find images for some of the more particular scenarios. He has spent the entire morning browsing through the two million images result set trying to find images of Beluga dolphins hunting in the arctic, an illustration of the food chain of the Indo-Pacific Bottlenose Dolphin or images of the precursors of modern dolphins. Henning has already given up on finding more information about the dolphin skull found by Jonas (see previous scenario). Henning would very much like to include the story in his Monday morning introductory class, but without any other information than an image (reproduced below) of the skull, he feels that his lecture will be dull.

Query and context information
In this setting, the teacher has different kinds of information needs. Finding general images of dolphins is a relatively easy task, solved using keywords. However, some of the others tasks require various degrees of contextual information, such as: *where* the images were taken*, the activities* occurring in the image*, when* the object depicted existed, or *what* the depicted object is. CBIR might be used on the image example, but should be combined with contextual data, such as the geographical position captured near the Sulu sea, or text describing that it is an image of a *skull*. Henning requires photos or information about the *type of* dolphin depicted, not necessarily information about the actual skull, or that it is a skull.

Table 2.23 Query elements

Task (intent)	*Info added by user*	*Info added automatically*
Give me pictures of dolphins	Keyword (e.g. Dolphin)	None
Give me pictures of Beluga Dolphins hunting in the Arctic	Image of a Beluga Dolphin. Geographical position (Keywords, GPS)	Position (If it exists in the image)
Give me an illustration of the food chain of the Indo-Pacific Bottlenose Dolphin	Image of the Dolphin. Keywords. Type of results required (Illustration).	None
Give me a picture of the (unknown) precursor of the Bottlenose Dolphin	Image of Bottlenose Dolphin Temporal data (?)	None
Identify the dolphin skull	Image of the skull Location of the skull	Position

Data sources visited
The most likely data sources visited are publicly available image collections, dedicated online image collections (museums, private collections) or search engines (Google Images) that might be accessed in real-time. Some queries might be posed to offline resources, either sent as email or posted to discussion groups / web communities.

Table 2.24 Data sources

Task (intent)	*Data sources visited*
Give me pictures of dolphins	Public image collections like Flickr or web sites focusing on animals, Google Images
Give me pictures of Beluga Dolphins hunting in the Arctic	(Public) maritime image databases, curriculum text books,
Give me an illustration of the food chain of the Indo-Pacific Bottlenose Dolphin	Curriculum text books, online maritime resources, museum of natural history, (e-mail), discussion groups (usenet, webforums), web communities.
Give me a picture of the (unknown) precursor of the Bottlenose Dolphin	Curriculum text books, online maritime resources, museum of natural history, (e-mail), discussion groups (usenet, webforums), web communities.
Identify the dolphin skull	Curriculum text books, online maritime resources, museum of natural history, experts on dolphin biology (e-mail), discussion groups (usenet, webforums), web communities.

User device and result presentation
The user is typically working from home, using a computer connected to the internet, using publicly available web resources, maybe using e-mail to contact possible experts. The results should be presented directly on screen, both as images and linguistic descriptions of the image contents. The open nature of some of the questions requires that the user is presented with information-rich answers, both visual and linguistic in nature, or with references to where such information might be found. The user should be able to refine the results, either through interaction (Relevance Feedback) or performing a new search.

Table 2.25 Result presentation

Task (intent)	*Result presentation*
Give me pictures of dolphins	A set of relevant images is returned to the search interface. The user is allowed to navigate interactively through the result set
Give me pictures of Beluga Dolphins hunting in the Arctic	A set of relevant images is returned to the search interface. The user is allowed to navigate interactively through the result set
Give me an illustration of the food chain of the Indo-Pacific Bottlenose Dolphin	A set of relevant images is returned to the search interface. The user is allowed to navigate interactively through the result set
Give me a picture of the (unknown) precursor of the Bottlenose Dolphin	A set of relevant illustrations is returned to the search interface, preferably either with more information about the object of interest, or references to where such information might be found
Identify the dolphin skull	The information is returned to the user as text.

2.9 Snake bite and medical emergency

A person bitten by a snake communicates directly with a medical emergency office. Fast identification of a poisonous snake might save lives.

User experience
A tourist in an isolated area gets bitten by a snake. He manages to kill the snake, but doesn't know what type of snake it is. He calls the emergency centre and explains the situation. It could be a very poisonous snake, and in order to make a better identification of the snake the emergency personnel instructs him to use his camera phone and send images of the dead snake, the immediate surroundings and the bite wound on his leg. When the emergency call centre receives the images as an MMS, they are entered into a snake recognition system which produces a reliable identification of the snake. Once they know the species of the snake they can instruct the helicopter to fly to the closest antidote depot before flying out to fetch the patient. The image of the wound indicates that the bite is quite severe and the emergency personnel instruct the patient in first aid measures while he is waiting for the helicopter.

Query and context information
Images of the snake and the snake's habitat, images of snake bite wound with estimate of time elapsed after bite incident, location of incident.

Table 2.26 Query elements

Task (intent)	*Info added by user*	*Info added automatically*
What kind of snake is this?	Image of dead snake Image of the wound	Position
Is the snake poisonous, and if so, what is to do?	Image of dead snake Image of the wound Description (at phone) of the symptoms	None
In case, where can a rescue helicopter fetch antidote?		Time (hour, date) Position

Data sources
Toxicological database of snakes / poisonous animals including medical data. Database with images of bite wounds with timestamp from bite incident. Very high demand for precision.

Table 2.27 Data sources

Task (intent)	*Data sources visited*
What kind of snake is this?	Animal databases such as *www.toxinfo.org* of the *Klinikum rechts der Isar* in Munich, Germany.
Is the snake poisonous, and if so, what is to do?	Antidote databases as maintained e.g. by national or regional poison centres.
In case, where can a rescue helicopter fetch antidote?	Databases holding antidote storage locations (if available)

User device and result presentation
PC with source for digital images, a camera phone or another handheld device. Datasheet on the identified snake including images, location of nearest antidote depot and first aid instructions.

Table 2.28 Result presentation

Task (intent)	*Result presentation*
What kind of snake is this?	Electronic display to the emergency call centre or the consulted poison centre for further decision making
Is the snake poisonous, and if so, what is to do?	Electronic display of datasheet and recommendation for action; display on handheld of the bitten person giving further instructions and, in case, information on the rescue
In case of poisonous snake, where can a rescue helicopter fetch antidote?	Datasheet for the rescue team

2.10 Medical settings

The use case below describes different professional medical settings of different types (service provision, education, research and development) and how image retrieval supports the medical personnel in diagnosing, training their skills, and testing new drugs and CAD[2] systems before launching.

User experience I
Diagnosis support tool (health service delivery scenario):
A dermatologist is seeing a patient in his office. Now and then he comes across rare cases where he needs to seek further information and this is such a case. The patient has a rare rash for which a correct diagnosis is very difficult, and depending on the diagnosis, very different treatments are recommended. To cope with this problem, the dermatologist takes some images of the rash, includes information about the patient's health condition and his health record, and sends this information as a query to a diagnosis support tool. From the

[2] *Computer Aided Diagnosis*

specific context of the current health problem, and the broader context of the patient's (distributed) electronic health record, the system runs a search for similar cases with documented outcome on a large reference database of anonymous cases, and returns the most likely cases. The dermatologist can then review these cases and finally become confident with his diagnostic decision. Since the case is difficult, the physician benefits from seeing similar cases prior to decision in order to improve accuracy. The diagnosis might also be reached faster than if the physician were to consult with his peers.

User experience II
Case-based training in a medial e-Learning setting:
A medical student is preparing for a test in mammography. There are quite a few images in the textbook depicting mammography scans, but they are not sufficient to give her satisfactory confidence. In order to further evolve her skills she starts an e-Learning application, selects the wanted subject: mammography, and level of difficulty: beginner. The application then presents her with a case that includes several mammography images. This case is easy and she solves it quickly. The system adapts to her swift response and the next presented case is more difficult. As she continues with several cases, the system continuously adapts the cases to her skill level and gives her feedback on her progress. Some of the cases are rather tricky and she decides to retrieve a larger set of medical records including images available on the Internet. She uses the present image as a query and receives a dozen images similar to the tricky ones. These images helps her to identify the small deviations that make big impact in the diagnose process. The transformation from a beginner student to skilled practitioner has started.

User experience III
Drug testing in pharmaceutical research and development:
A researcher, working on a new drug, wants to test the drug against the current gold standard. He uses images, taken through a microscope, of tumour-tissue samples to see how the drug is performing. The images are compared to other images of tumours treated by other drugs. By using metadata such as tumour size, demographic patient data, or risk factors, associated to the image the person performing the study can evaluate the system based on how long the tumour was treated.

User experience IV
CAD system testing in decision support research and development:
A software company, specializing in computer aided diagnosis (CAD) systems, wants to benchmark their latest lung tumour. The system is tested against the current gold standard. For this purpose they use a reference database offering a large set of annotated lung CT-images together with metadata about the patient and his health conditions, as well as the image acquisition.

Query and context information
These settings involve a wide range of information sources: images of rash, information about patient's health condition, and the patient's health record, and further; medical topic, level of difficulty, performance history on earlier cases, type of drug, name of disease, pathology, and type of problem supported by the CAD system.

Table 2.29 Query elements

Task (intent)	*Info added by user*	*Info added automatically*
Find similar cases to support diagnostic decision making	Images of the case under investigation Clinical patient data	Context data from the electronic patient record
Find training cases of relevance to selected topic and my skills	Medical topic Skill level	Present case comprising one or more images Current skill level
Find reference images for drug response to compare with images showing response on a new drug	Type of drug Disease/pathology	Image acquisition parameters
Find, in a large reference database, an appropriate subset for testing of a new CAD system	Type of problem supported by the system	

Data sources visited

For decision support in the framework of health service delivery, large central or distributed databases of anonymous cases with documented outcome. In order for such a solution to be adopted the results have to have high precision and confidence. The access must be secured and it can be difficult to get this access due to the level of sensitivity of the information. For eLearning settings in healthcare, access to a large database of medical cases for training purposes rated to different levels of difficulty is required. For research and development, sufficiently comprehensive reference databases for validation of e.g. drug response or novel computer aided diagnosis systems are mandatory.

Table 2.30 Data sources

Task (intent)	*Data sources visited*
Find similar cases to support diagnostic decision making	Comprehensive medical case repositories, capable of supporting case-based reasoning for a specific medical domain (e.g. oncology, or, more specific: lung cancer).
Find training cases of relevance to selected topic and my skills	Large databases of medical training cases, specifically elaborated with an emphasis on education, i.e. spanning the complexity of e.g. diagnostic tasks, and also presenting appropriate information and image annotations from expert authors to gain didactical success.
Find reference images for drug response to compare with images showing response on a new drug	Large (multi-centric) reference case databases, usually disease-specific, including images and metadata on the effect over time of different drugs on e.g. a specific type of tumours
Find, in a large reference database, an appropriate subset for testing of a new CAD system	High-volume reference databases with best available diagnostic evidence (gold standard) included for each case, e.g. the pathological finding after surgery for tumours

User device and result presentation
For the healthcare delivery setting: PC with connection to digital camera. Ranked list of the most likely diagnosis' including thumbnail images and vital information like diagnosis and outcome is presented.

For the e-Learning setting: PC or mobile device. The result is presented as one training case at a time. For the research and development settings: PC. The result is presented as a list of cases meeting the query criteria. After appropriate check and negotiation with the provider, the dataset is downloaded for the agreed validation purpose.

Table 2.31 Result presentation

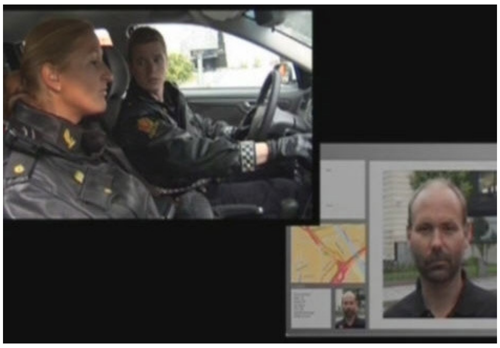
Task (intent)	*Result presentation*
Find similar cases to support diagnostic decision making	Galery of similar cases, e.g. with thumbnails of a representative image, complemented with key textual information
Find training cases of relevance to selected topic and my skills	One teaching case at a time, to be solved by the student or healthcare professional in a dialogue with the eLearning system
Find reference images for drug response to compare with images showing response on a new drug	List of cases meeting the search criteria; possibly illustrated by (selected) thumbnails; accompanied by a summary description to characterize the query result
Find, in a large reference database, an appropriate subset for testing of a new CAD system	List of cases meeting the search criteria; possibly illustrated by (selected) thumbnails; accompanied by a summary description to characterize the query result

2.11 Police investigation

Efficient image retrieval is used to: 1) Identify fingerprints found at a crime scene; 2) Identify persons involved in suspicious activities being monitored, and 3) Search for criminals or victims on confiscated image and video sources.

User experience I
Fingerprint identification:
A police investigator discovers some goods that he suspects are stolen. He seeks for fingerprints and finds some. He scans the fingerprints and submits them as a query for identity. A response is received showing the criminal record and home addresses of the persons involved. This helps the officer decide on action for putting suspects under arrest.

User experience II
Suspect identification based on images:
A police patrol car visits an area of high crimes. The officers spot a situation involving two persons that seem to fight each other. A photo of the persons involved is taken and submitted as a query for identity. A response is received at the display in the patrol car showing the criminal record of the persons involved. One of them has a clean record, the other not – but he has no heavy violence history. This helps the officers decide on the intervention action for solving the conflict.



User experience III
Interpol investigates sexual abuse of children:
Another set of videos of children being sexually abused is received by Interpol in London. It's Monday morning - where to start? The fact that this child might have appeared on other images brings, paradoxically, some hope. The officer pulls himself together. The pictures are disgusting as thousands of other pictures in this section. Still - to save one child from further harassments motivates him to start. As the total amount of videos and images available to Interpol throughout the world is enormous, it is important to filter out non-relevant sources or non-relevant image categories. Are there close up images of the face of the victim involved? The officer captures a sample of images from the video to build profiles for the victim, the criminal as well as any recognizable artefacts or landscapes in the scene. It is a girl being abused, five – six years old, Asian looks. The man involved is talking. What language? The officer records the voice and adds it to the criminal's profile. The profiles are completed as far as possible and the tough identifications process can start.

The officer is pleased not to be the one facing it all. Fortunately, the retrieval systems have sharp eyes and sound nerves. The next day there are two result lists on his desk. They both match the images in the victim query. The first one consists of a set of twenty identified profiles, the other one consists of fifty images with non-identified persons. Now the actual identification job is initiated.

Query and context information

Photos of fingerprints should be matched to existing collections of fingerprints. Time and position might help to narrow the search or make search more efficient (skip fingerprints of persons in prison or abroad on actual time slot). High precision is demanded to identify the right persons. In the Interpol case the query is formed as a particular *profile* of interest: *A profile* is a set of attributes that makes it possible to identify a person or an artefact. Examples:
Profile 1 - *The victim*: captured screen shots of face, gender, estimated age, race, nationality, captured voice samples, identification characteristics.
Profile 2 - *The criminal*: captured screen shots of face, gender, estimated age, race, nationality, captured voice samples, identification characteristics.
Profile 3 - *Particular artefact or landscape*: captured screen shots, characteristics.

Table 2.32 Query elements

Task (intent)	*Info added by user*	*Info added automatically*
Who owns these fingerprints? Return eventual criminal record	Image of fingerprints	Time (day, hour) Position
Identify the persons on the photo? Return eventual criminal record	Images	Time (day, hour) Position
Identify victim or criminal on photos/videos	Framed part of image and voice sample. Additional information like estimated age of persons involved and their language.	Time (day, hour) of capture and time of search Position
Identify item on photo, e.g. furniture, interior, building.	Image	None
Identify place or landscape on photos	Image	Position

Data sources visited

When fingerprints and photos of crimes are investigated, the information requests are directed to the police's internal data bases (fingerprint data bases and image collections of criminals). In case of face recognition the videos produced by surveillance cameras are investigated as well.

The Interpol case presupposes that world wide Interpol data bases are visited. There are portraits of identified victims and criminals, and additional data bases of unidentified participants. High precision is demanded to identify the right persons. High recall is valuable, but not necessarily demanded. When the individual is identified, additional information is gained from related data bases.

Table 2.33 Data sources

Task (intent)	*Data sources visited*
Who owns these fingerprints? Return eventual criminal record	Available finger print collections. When match is found, the respective criminal record is visited.
Identify the persons on the photo? Return eventual criminal record	Internal police data bases containing portraits of criminals.
Identify victim or criminal on photos/videos	World wide Interpol data bases
Identify item on photo, e.g. furniture, interior, building.	General image collections available on Internet, manufacturing image collections etc.
Identify place or landscape on photos	Image or video sources of any kind, also sources like Google and Flickr

User device and result presentation
To identify fingerprints a camera phone is used. Time from image capture to presentation of search results is crucial, and thus a device at hand should be used. Face recognition as it is described in the second setting might be initiated either by a camera phone (if captured by a camera phone) or a PC (if image source is a surveillance camera). When immediate response is expected the result will be presented as a ranked list of the 5 highest ranked results. The results could include profiles of persons, images, voice samples etc.

The Interpol case is a typical PC based procedure. The result might be presented as a ranked list of the fifty highest ranked results. The results could include profiles of persons, images and voice samples.

Table 2.34 Result presentation

Task (intent)	*Result presentation*
Who owns these fingerprints? Return eventual criminal record	Name person and information about the person’s present status
Identify the persons on the photo? Return eventual criminal record	Name person and information about the person’s present status
Identify victim or criminal on photos/videos	Name person and information about the person’s present status
Identify item on photo, e.g. furniture, interior, building.	Identity (brand, place of origin, etc) of item, or any information related to the item
Identify place or landscape on photos	Name of place and geographical position

2.12 Journalist helper

This scenario shows how journalists could search ordinary persons' local image storages (blogs) for the "right" photo and thus utilize other person's closeness to particular events both in time and localization. This approach might increase the number of accessible information sources dramatically. At the same time ordinary people are given possibilities to offer their photos for sale within a minimum of time consumption, costs and effort. The scenario is based upon an idea previously published in (SAPIR, 2007). A suggested user interface (Egeland 2007) is presented in appendix 2.

User experience

The head of the foreign news section, Pierre, looks carefully through the photos he got from the journalist covering the former president Bill Clinton's lecturing tour in Europe. Last evening 3000 people listened to him in a small city in northern Norway called Tromsø. Why do they do speeches in such odd places? Well – the speech addressed the environmental situation in the Barents region, and this city is located up there – being a small city in a huge rural area at the border between east and west. Do these photos provide a link to the evening's topic or at least to the location? Pierre is not convinced.

Clinton has a remarkable attractive force on the audience, and there are many journalists touring with him. Now the loyal readers of Pierre's newspaper are waiting for a pinpointing review followed by pictures taken in situ. The photos at hand show Clinton as he leaves the plane and is welcomed by the mayor of the city, but most of them depict the great statesman on stage. None of them are outstanding. Pierre searches for a photo that might explain why this particular city was chosen. He initiates a search and waits eagerly for the response.

Pierre is an experienced journalist, and he has an indefinable understanding of what he is searching for. Sometimes he knows he is pretty close to target and chooses to search for similar photos taken at the same spot and at the same time. However, Pierre has learned that open ended queries, being localization and time parameters from actual images, might produce rather unexpected and interesting results. Next these images might be added to second query based on similarity search. Another approach is to frame particular details in the photo to specify the subject of the wanted photos. The subject might be a person that represents an interesting group of people related to the event. Then Pierre frames a characteristic piece of the person's clothing. If the subject of interest is the environment in which the event is taken place – it could for instance be the boat visited by Clinton or the building housing the lecture - Pierre frames the nameplate of the boat or the speech platform (they are often named) respectively. When he works with in-depth articles where the time to publish is longer and the chance of hitting annotated images is bigger, he often adds textual specifications for the search.

Receiving the results he immediately recognizes one of the images as a first page item. The photo shows the well known profile of Clinton in the background, but the front and centre of the photo is dominated by a fisherman chatting with this prominent guest. It is obviously taken from the fisherman's boat and this particular approach accentuates the vulnerability of the small parties in the worldwide combat for environmental stability. The quality of the image is not very good, but the scene is extraordinary. Luckily it is licensed for public and commercial use.

When he is travelling Pierre uses the camera of the handy mobile phone. It does not provide high quality images, but they are still good enough. Dependent on time pressure and other conditions Pierre sometimes redirects the search results to his colleagues or to his own computer located elsewhere to better review the received images and start an iterative selection procedure. To keep the net based version of the newspaper vital and updated the top items are enriched by video clips. Amateur videos are most welcome as the quality of videos is regarded subordinate to the news' relevance aspect. Thus the journalists' helpers might launch videos as well as images.

Query and context information

The images already at hand for the journalist are used in the query, but also additional information could be used. One might consider different strategies:

1. *The query includes the following parameters: location, date, time, text, keywords/tags.*

   Location and time are automatically extracted from the images at hand and might form the query without any extra information given by the user. Here the image itself is not included in the query. This strategy presumes of course that the images are automatically tagged with geographical coordinates and a time stamp. Additionally the journalist is given a chance to adjust the time and date of interest and also the location. The date and time could be a specific point in time or a period, or even specific time slots at certain dates. The location could be a specific coordinate or an area to search within. In this particular case (see scenario) the journalist is familiar with the special light conditions at this latitude (midnight sun in summer time and darkness in wintertime) and searches for images that emphasizes these aspects. He then overrides the automatic selection of the image's time stamp and chooses night hours to ensure the retrieval of images taken at that time. In additional to location and time the query could also include text to narrow the search. This could be text that is found in the title, description or comments to the image. Or it could be keywords that the image has been tagged with.

2. *The query includes the following parameter: an image or a collection of images.*

   Here the image itself – or particular parts of the image – is used to direct the search. If the user finds the existing images relevant the query is build on the bases of one of these images, and a similarity search is initiated. If the user wants to specify the subject of the wanted image he frame particular details of the images and thus uses only parts of the image for the similarity search. Returning to the scenario the following example can be used to illustrate this strategy: There are indigenous Sami people living in Tromsø and they often wear their national costumes characterized by blue, red and yellow ribbons. A detail from their costume – that appears on one of the images at hand – might be used to find other images where these features are recognized. One might also fancy that this colour combination feature can be a leading thread to blogs or databases owned by Sami people or Sami organizations where images of special interest might be stored.

3. Combinations of 1 and 2.

Some queries initiate extensive searches including many nodes and voluminous image collections, while other queries initiate a limited search. The added context information – time and location and topic – direct the search to the most relevant nodes and thus make the search both more effective and efficient. Thus the aspect of serendipity and the chance of getting unintended hits are reduced.

Table 2.35 Query elements

Task (intent)	*Info added by user*	*Info added automatically*
Find images based on this event	Image	Position Time (hour, date)

Data sources visited
The project might access professional image bureaus and open image data-bases like Flickr. The latter one is relevant to the scenario and might also be a substitute to private blogs and image databases for demonstration purpose. Every Flickr image is tagged with an image title, a narrative description, location, time, IPR and licenses. Price information is not explicit given, and some kind of dialog between the journalist and the search service is necessary.

Table 2.36 Data sources

Task (intent)	*Data sources visited*
Find images based on this event	Private person's blogs or data bases like Flickr

User device and result presentation
The result presentation varies according to the device used to form the query. When a computer is used the result is shown as a matrix of images. To further inform the journalist the images could be plotted on a detailed map to show the position where the images were taken. The journalist could also choose to view the images as a timeline.

When an image is clicked upon additional information about the image will be presented. Every image is annotated with contact information, usually a phone number or an email address. If additional information as text, videos, or audio clips is available, the respective links to these information sources are added. The user might then select the most interesting image and complete the quest for his coverage image.

When a mobile phone or other handheld device is used, the result is presented as a list of images. There might be more than one image, but the number of images is restricted to avoid overload situations. The images might be plotted on a map, but only on explicit request from the user.

Table 2.37 Result presentation

Task (intent)	*Result presentation*
Find images based on this event	A set of images with contact information and price

3 Information sources

Some of the scenarios are inspired by the existence of specific data sources managed by the CAIM project partners. Other scenarios have caused certain data sources to be established or at least specified. Finally, some scenarios and data sources are described without a prior idea of how (or if) the suggested data sources could be accessed. In this chapter the data sources owned and managed by the partners are given particular attention (see table 3.1).

Table 3.1 The information sources on which the scenarios are based. Owner of information source (if any) is shown in brackets.

Ref	Scenario	Information sources
1	City navigation	Bergen city images (created by CAIM/UiB) Detailed digital map of Bergen
2 3 4	The most curious visitor	Lofoten archipelago images (Telenor) MOVE POI database (Telenor) Tromsø images (Telenor) Flickr.com and Panoramio.com might be used.
5	Exploring season variations and weather conditions	Weather reports covering the city of Tromsø (UiT) Weatherunderground.com might be used.
6	Inside but still outside	Campus images (UiT) Geo-coding of campus buildings (UiT)
7	Snake bite and medical emergency	Database of poisonous animals: the university hospital Klinikum rechts der Isar of the Technical University of Munich.
8	Medical settings	Medical reference image databases Digital medical records

3.1 Bergen city images

The Bergen City image database is under construction as part of the UiB/CAIM activities. It currently contains about 60 images of 8(10) objects, buildings and statues, captured using a digital camera. Geo positions have been added manually. Future image capture will use a mobile phone (N95) with appended GPS positions. The goal is to have 200+ images, in groups of 8-10 images/topic. These images will be complemented with 100+ images from a collection of scanned images from Bergen in the 1950s, owned by UiB's University Library. The intention is to be able to provide current and historical images to queries of the type "*what is this?*".

Geo positioning data for manual image annotation has been collected from the national geographic database (Norges kartverk).

Text and audio documents giving current use (e.g. concert schedules) and describing points of interest will be linked to the image set. The latter will be provided by the Bergen City Museum,

3.2 Lofoten archipelago images

Throughout the MOVE-project[3] several sources of information for the Lofoten archipelago were created, among them a collection of 106 images of the Lofoten region along the scenic route[4] (E10) from Fiskebøl to Å. The image collection was later manually positioned by means of satellite images, aerial photography and maps. The location is not coded in the images themselves, but is held in a separate database which has a reference to the actual image. By including the position in the database it is possible to make swift spatial queries by utilizing a spatial index. The format of the database is showed in the table below.

Table 3.2 Format of the move_image-table in the movegallery database.

id	filename	collection	path	date	time	utm_pos	ll_pos

The image collection has seen several uses and is currently available as a Network Link[5] for Google Earth. The image collection will hereafter be referred to as the *MOVE-gallery*.

3.3 MOVE point of interest database

In addition to the MOVE-gallery a collection of points of interest (POIs) were created to test a mobile guide service developed within the project (Evjemo et al 2005; Akselsen et al, 2006). The mobile service (see figure 3.1) facilitates map-based navigation POIs, runs on Java ME, and communicates with a central POI database over the mobile network.

Figure 3.1 The initial map is shown with POIs positioned on the map (left). Short description of attraction excerpted from POI data base (mid) and a WAP-site, also part of POI data base, with additional information (right).

[3] *http://www.moveweb.no*
[4] *http://www.turistveg.no/modules/module_123/templates/fp.asp?iCategoryId=138&vt=fp&iTVID=44&iInfoId=163&lang=eng*
[5] *http://move.tele.no/dist/ge/movegallery.kml*

The POIs are stored in a MySQL 4.1 database and organized into six categories: accommodation, dining, attraction, activity, events, and tourist information. The data base consists of three tables (see table 3.3 through 3.5. A total of 217 POIs were created. In addition to the Lofoten-POIs the database also holds 68 entries for POIs in the Tromsø region.

Table 3.3 Format of the Object table holding primary information about the POIs

Unique object ID	Owner's object ID	POI Title	Description (max. 255 characters)	Link to a WAP page	Category of POI	Type of POI	Owner ID	Timestamp

Table 3.4 Format of the Contact table holding contact information about POIs

Contact ID	Unique object ID	Surname	First name	Address	Postal code	Location	E-mail address	Phone number	Mobile phone number	Link to a reference page with additional information

Table 3.5 Format of the Positioning table which holds the POIs location

Positioning ID	Unique object ID	Coordinates of the POIs location (held as geometry objects)

3.4 Tromsø Event images

A collection of images from Tromsø was created during the summer of 2007. The collection contains 173 images which all were taken during the Midnight Sun Marathon event on the 18th of June 2007. However, some of the images are of a more general nature and are not directly linked to the event. In stead of storing the images in a dedicated local database, all images have been uploaded to Flickr[6] - a popular online photo management and sharing service. Here 28 images are publicly available from the *tele photo* user[7], while the rest have restrictive access. The images have been collected by different cameras including a digital SLR, compact cameras and a Nokia N95 mobile phone. Mobile phone images were automatically geo-positioned by a bluetooth GPS, and automatically uploaded to Flickr using the Shuzo[8] upload service. Images taken by SLR and compact cameras were geo-coded before upload from a PC, by pairing them with positions from a GPS-log which had been time synchronised with the cameras prior to the photo session. Common to both positioning methods are that the position is coded in EXIF metadata, in addition to being added as a Flickr type geo-tag.

3.5 Weather reports covering the city of Tromsø

The Department of computer science at University of Tromsø has since 1993 collected weather data. The information is gathered from a weather station including sensors for wind speed, wind direction, air temperature, relative humidity, air pressure, solar radiation, and gamma ray measuring. We have over 5000 days with weather data, and over 6.6 million measurements.

[6] *http://www.flickr.com*
[7] *http://www.flickr.com/photos/8940605@N02/map*
[8] *http://www.shozu.com*

From 1994 we have also, in connection with the gathering of weather data, taken pictures from the Science building at the University Campus. The pictures are used together with the weather data to show current and previous weather conditions in Tromsø[9].

An image is stored every 30/15th minute, depending on which year the image was taken. We have a total of 460000 images and 69 GB data. All this information is available to the CAIM project.

3.6 Campus images from UiT

We have currently access to a number of image collections, all containing images captured at the university campus in Tromsø. These collections have not been created within the CAIM project, but will be available for use in the project. We are also allowed to include most of these images in a CAIM specific collection, where the images can be enriched by context information.

The currently available images include both indoor and outdoor images, summer and winter images, image series from construction activities at campus, images from specific occasions, and images of student life at the University of Tromsø.

The images are at the moment not geo-coded. We expect to select a subset of images that will be manually geo-coded.

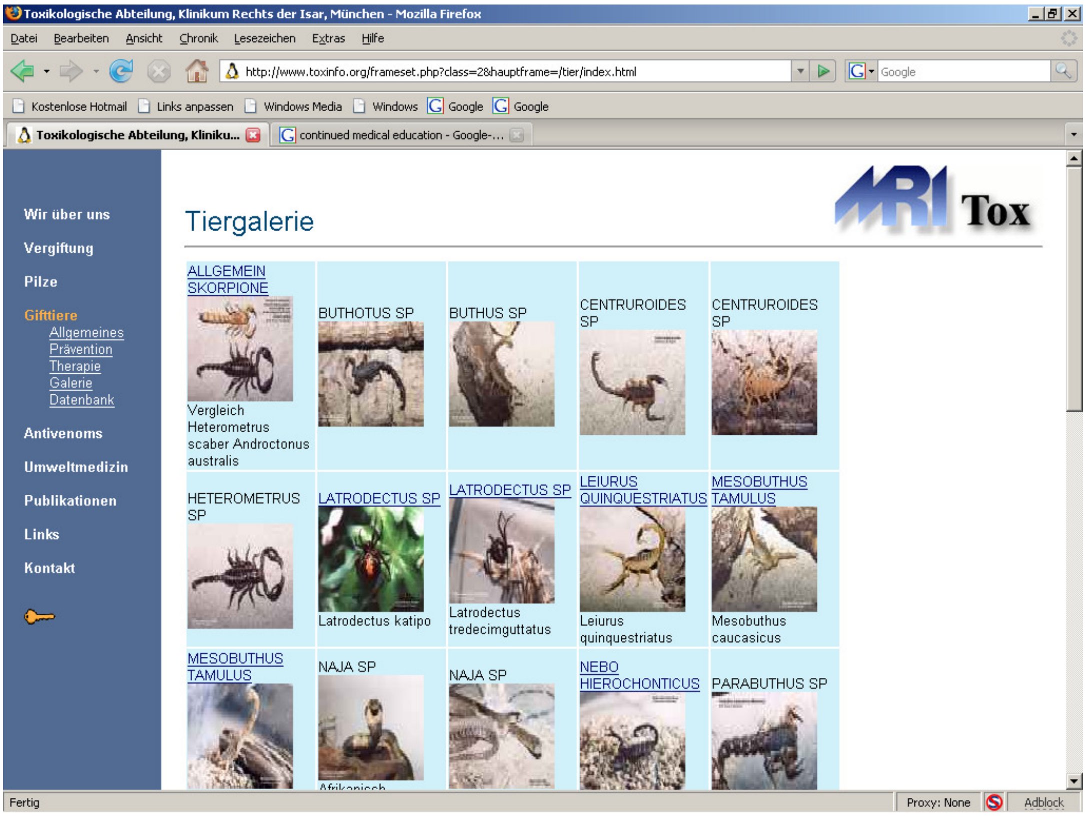
The "Maritime DB" consists of a collection of 196 images related to a maritime scenario. The collection is primarily based on a collection images, drawings and sketches of whales from Bergen Museum, expanded with images of dolphins, seagulls, sharks and other maritime wildlife, as well as images of related objects and activities, such as fishing vessels, maritime landscapes and humans interacting with maritime animals.

The images are stored in a database built using Oracle 10 with the *InterMedia* expansion, allowing for basic image processing and analysis, such as CBIR search. The collection was originally created for the *Virtual Exhibits on Demand*[10] project, and a description of the database structure is available online[11] (In Norwegian).

3.7 Snake identification images

An example of a suitable database of poisonous animals is the database of the poison centre at the university hospital Klinikum rechts der Isar of the Technical University of Munich[12]. The database currently contains pictures and information for almost all types of snakes, for all scorpions and spiders where medical information was available, and for relevant poisonous sea animals.

[9] *http://weather.cs.uit.no/.*
[10] *http://nordbotten.ifi.uib.no/VirtualMuseum/VMwebSite/VEDweb-site.htm*
[11] *http://nordbotten.ifi.uib.no/VirtualMuseum/Publications/VED-Report-lars.pdf*
[12] *http://www.toxinfo.org*



Figur 3.2 Animal gallery of the poisonous animals' database at the Klinikum rechts der Isar of the Technical University of Munich (TUM)

The challenge, however, will be to achieve an identification of the snake by matching the information delivered from the emergency site and the information contained in the database. At the time being, the problem seems worth being explored. A fast and robust solution with the required precision, however, might be difficult to achieve, if possible at all.

3.8 Medical images

There is a large variety of data sources that could be subject to the medical scenarios described in the previous chapter [Horsch/Blank/Eigenmann 2005].

An example from gastrointestinal endoscopy Continuing Medical Education (CME) is the Endoscopy Information System (EIS) developed by Technical University of Munich (TUM) in the ENDOTEL project (see Figure). The database contains more than 800 images, 21 videos, and expert texts for the different anatomic locations. It is also suitable for on-line decision support. The resource is publicly available on http://www.eis.telemedizin.org.

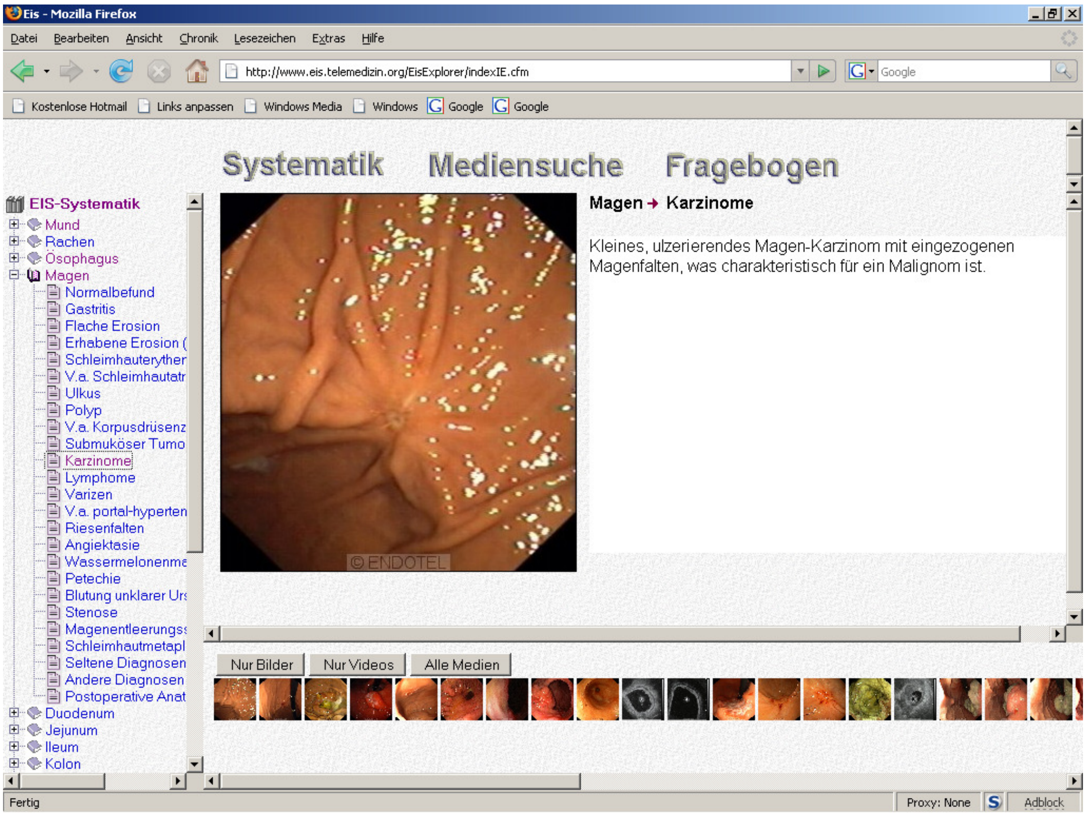


Figure 3.3 EIS search result for carcinoma of the stomach.

The EIS database is so far not providing the means for a case-based learning dialogue, i.e. it does not adapt to the skill level of a learner. The main reason for this is its focus on health professionals and its major purpose as tool for CME and clinical decision support.

4 Summary and ongoing work

The scenarios describe a wide range of user situations where context information improves image management and in parallel constitutes an information basis fundamental for new services to appear. The scenarios refer to different stages within image management (c.f. figure 1.2), even though the retrieval aspects are most frequently addressed. Some scenarios initiate and direct image retrieval based on similarity search (e.g. *Snake bite and medical emergency* and *Police investigation*), while others capture context information for the user's personal archives (e.g. *The most curious visitor*). There are also scenarios describing how context information captured in the moment of photographing assists in identifying the photographer's position and narrowing the needed similarity search to gain additional information on a topic of interest (e.g. *City navigation*, *Inside but still outside*, *Archaeological sites*). Further, there are scenarios where context information as timestamps narrows the needed similarity search for images (e.g. *Exploring season variations and weather conditions*). In other scenarios the user adds information that contributes to a more efficient similarity search. In the *Medical settings* scenario the user or, in a case of system learning capabilities, the system provides information about user skills and thereby narrows the similarity search.

The scenarios illustrate the different partners' application areas as well as applications of special interest to the partners. The scenarios will be revisited and used as references in the coming prototyping of context-aware image management tools. In the process of developing and evaluating new tools the CAIM project will examine issues related to *dynamic context capture and management, multimodal information retrieval,* and *query result presentation.*

There are simultaneous ongoing efforts, amongst them a set of precisely defined tasks performed by students during the spring and the short summer months of 2007:

- A study of the applicability of a container-based middleware system[13] as a platform to build components that are able to collect context information. The demonstrator will show how weather reports are captured and tied to images, c.f. the scenario *Exploring season variations and weather conditions* (Aarflot 2007).
- An examination of how data obtained from camera might support context-aware image management (Egeland 2007a) c.f. the scenario *Inside but still outside*.
- A mobile service (prototype) that effectuates information retrieval based on queries including image and position (Bakken 2007a). The information presented to the user should be annotated to the image on the according to the user's preferences, c.f. the scenario *The most curious visitor*.
- A set of images uploaded to Flickr which might be utilized in eventual testing of prototypes built on the scenario *Journalist helper*.
- A web based search engine (VISI) is implemented to test image retrieval from a various set of image collections (Næss 2007). Special attention is given to unskilled (regarding ICT) users' requirements.

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[13] *Argos described at http://sourceforge.net/projects/jargos/*

- Advices are given on how to design a user interface for image retrieval systems (Egeland 2007). Three cases are examined: *Vortex Image Search Interface*, developed by the CAIM partner at UiB, *Photobook,* developed by the SAPIR project[14], and the Journalist helper scenario.
- An evaluation of the SIFT algorithm[15] (Bakken 2007) is made to possibly improve the CBIR module of a system prototype addressing tourist purposes (Schürmann et al, 2006).
- Design and implementation of the city image DB for use in testing image retrieval algorithms (CAIM-UiB).
- An image capture and image retrieval prototype is designed and implemented (Fyllingsnes and Hartvedt 2007). The prototype appends GPS data to N95 mobile phone images and communicates with an Oracle interMedia database.

An important goal of the CAIM project is to design tools for context aware image management that supports a wide variety of applications. To do so a component-based architecture approach, using components and component frameworks, will be used. In parallel, efforts will be directed towards prototyping and small-scale field studies to address challenges related to dynamic image context capture. The scenarios described here will be used to illustrate the strength of the CAIM component-based architecture.

[14] *http://www.sapir.eu/*
[15] *http://en.wikipedia.org/wiki/Scale-invariant_feature_transform*

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Appendix 1 EXIF metadata

An example of EXIF (Exchangeable Image File Format) metadata stored by a Nikon D-200 kamera.

ExifTool Version Number	: 6.87
File Name	: dsd_0168.jpg
Directory	: .
File Size	: 4 MB
File Modification Date/Time	: 2007:06:14 08:56:46
File Type	: JPEG
MIME Type	: image/jpeg
Make	: NIKON CORPORATION
Camera Model Name	: NIKON D200
Orientation	: Horizontal (normal)
X Resolution	: 300
Y Resolution	: 300
Resolution Unit	: inches
Software	: Ver.1.00
Modify Date	: 2006:02:08 10:06:32
Y Cb Cr Positioning	: Co-sited
Exposure Time	: 1/180
F Number	: 7.1
Exposure Program	: Program AE
ISO	: 100
Exif Version	: 0221
Date/Time Original	: 2006:02:08 10:06:32
Create Date	: 2006:02:08 10:06:32
Components Configuration	: YCbCr
Compressed Bits Per Pixel	: 4
Exposure Compensation	: 0
Max Aperture Value	: 5.7
Metering Mode	: Multi-segment
Flash	: No Flash

Focal Length : 150.0mm
Firmware Version : 2.10
Color Mode : Color
Quality : Fine
White Balance : Auto
Focus Mode : AF-S
Flash Setting : Normal
Flash Type :
White Balance Fine Tune : 0
Color Balance 1 : 1.847656 1.339844 1 1
Program Shift : 0
Exposure Difference : 0
Compression : JPEG (old-style)
Preview Image Start : 3267
Preview Image Length : 23736
Flash Exposure Compensation : 0
ISO Setting : 100
Image Boundary : 0 0 3872 2592
Flash Exposure Bracket Value : 0.0
Exposure Bracket Value : 0
Crop Hi Speed : Off (3904x2616 cropped to 3904x2616 at pixel 0,0)
Serial Number :
Tone Comp : Auto
Lens Type : G VR
Lens : 18-200mm f/3.5-5.6
Flash Mode : Did Not Fire
AF Area Mode : Single Area
AF Point : Center
AF Points Used : Center
Shooting Mode : Single-Frame
Auto Bracket Release : Manual Release
Color Hue : Mode3
Light Source : Natural
Hue Adjustment : 0
Noise Reduction : Off
Sensor Pixel Size : 6.05 x 6.05 um
Image Data Size : 3921697
Image Count : 1307
Deleted Image Count : 0
Shutter Count : 1307
Image Optimization : Custom
Multi Exposure Version : 0100
Multi Exposure Mode : Off
Multi Exposure Shots : 0
Multi Exposure Auto Gain : Off
High ISO Noise Reduction : Off
Shot Info Version : 0207
WB RGGB Levels : 473 256 256 343
Lens Data Version : 0201
Exit Pupil Position : 107.8mm
AF Aperture : 5.7
Focus Position : 0x00
Focus Distance : 14.96 m
Lens ID Number : 139
Lens F Stops : 5.33
Min Focal Length : 18.3mm
Max Focal Length : 201.6mm
Max Aperture At Min Focal : 3.6
Max Aperture At Max Focal : 5.7
MCU Version : 141
Effective Max Aperture : 5.7

User Comment : dpreview.com 2006
Sub Sec Time : 65
Sub Sec Time Original : 65
Sub Sec Time Digitized : 65
Flashpix Version : 0100
Color Space : sRGB
Exif Image Width : 3872
Exif Image Length : 2592
Sensing Method : One-chip color area
File Source : Digital Camera
Scene Type : Directly photographed
CFA Pattern : [Green,Red][Blue,Green]
Custom Rendered : Normal
Exposure Mode : Auto
Digital Zoom Ratio : 1
Focal Length In 35mm Format : 225mm
Scene Capture Type : Standard
Gain Control : None
Contrast : Normal
Saturation : Normal
Sharpness : Hard
Subject Distance Range : Unknown (0)
GPS Version ID : 2.2.0.0
Thumbnail Offset : 27123
Thumbnail Length : 4860
Image Width : 2592
Image Height : 3872
Aperture : 7.1
Blue Balance : 1.339844
Image Size : 2592x3872
Lens ID : AF-S DX VR Zoom-Nikkor 18-200mm f/3.5-5.6G IF-ED
Lens : 18-200mm f/3.5-5.6 G VR
Preview Image : (Binary data 23736 bytes, use -b option to extract)
Red Balance : 1.847656
Scale Factor To 35mm Equivalent : 1.5
Shutter Speed : 1/180
Thumbnail Image : (Binary data 4860 bytes, use -b option to extract)
Circle Of Confusion : 0.020 mm
Depth of Field : 2.83 m (13.68 - 16.51)
Focal Length : 150.0mm (35mm equivalent: 225.0mm)
Hyperfocal Distance : 158.21 m
Light Value : 13.1
Date/Time Original : 2006:02:08 10:06:32.65

Appendix 2 User interface for mobile search

Mobile phone based user interface for the Journalist helper application (Egeland 2007). The example event used here is the car bomb attack at Glasgow airport in June 2007.