Context-aware Photography

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Abstract:
Modern cameras are equipped with several sensors that check, e.g., whether the picture was taken in landscape or portrait mode. This project describes ways to additionally augment a standard camera with a well chosen set of sensors that sample data while a photographer looks for motives and takes photos. The data collected during such a session can then be combined with the EXIF information and interesting patterns extracted. Sensors and their communication have been implemented using the Smart-Its platform.

Keywords:
Sensor Augmented Photography
Accelerometer, Compass, Light, Pressure, Temperature Sensors

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Theme: Adding Context Information to Digital Photos

Goal:
In this project it should be investigated how digital photos can be enhanced using context information. In a user centred design process the creation and use of additional meta-information – captured while taking the photos – should be examined.

Background:
In a photo a specific view at a particular moment in time is captured. Current digital photos contain an extensive set of meta-information by default. Most camera offer ways of storing meta-information about photos taken; a widespread way is to encode information within image files. Typical tags that are stored are date and time, camera model, images pixel size and resolution, focal length, exposure time, aperture, and ISO-speed. The meta-information attached to digital images is a rich source for retrieving a specific image from an archive.

Tasks:
In this project the concept of adding meta-information to photos should be taken further. In particular this includes the following tasks:

- surveying literature and commercial products with respect to additional meta information for digital photos
- surveying available sensors and their applicability for creating meta information
- creating and distributing questionnaire to potential users, analysis of the results
- implementing (hardware and software) of a wireless microcontroller based system to capture additional parameters using sensors while taking photos
- user tests with the developed technology with professional photographers and hobbyists
- analysis and presentation of the findings
Selbstständigkeitserklärung:

“Ich erkläre hiermit, dass ich die vorliegende Arbeit selbstständig angefertigt, alle Zitate als solche kenntlich gemacht, sowie alle benutzten Quellen und Hilfsmittel angegeben habe.“

München, 1. April 2005  Marion Gall
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1. Introduction

Since the launch of the first digital camera in 1990, the development of digital cameras has tremendously increased its popularity in people’s everyday life.

In a photo, a specific view at a particular moment in time is captured. Even with advances in video capturing, a moment captured in an image has not lost its appeal. In many cases new digital photography leads to an increased number of photos taken by individuals.

Current digital photos contain an extensive set of meta-information by default. Most cameras offer a way of storing meta-information about photos taken; a widespread way is to encode information in the image files. One example is the EXIF format, see [8]. Typical tags that are stored are date and time, camera model, image pixel size and resolution, focal length, exposure time, aperture, and ISO-speed. Some cameras also record information that is directly related to the content. One example is the distance to the captured motive as measured by the camera’s auto focus.

Including information about where a photo is taken has been proposed in various projects and several implementations are available. The general approach is to connect a location sensor to a camera. This includes cameras using a GPS receiver [1]. Furthermore, with mobile phones including a digital camera, the position information available in the phone (cell information or a more fine grained estimation) can be used as metadata, too.

Meta-information attached to digital images is a rich source for selecting a specific image from a larger archive. Our initial observations showed that many people use meta-data, in particular date and if available location, as an important filter when searching for a particular image. Furthermore we could observe that people who told us that they are not adding metadata to their photo collection still add some metadata by naming the folders. Typically, meta-information can be divided in three categories:

- Events (e.g. graduation),
- Locations (e.g. London), or
- Activities (diving holiday).

Combinations of these categories commonly appear, too. Often, ‘activity’ or ‘event’ is combined with ‘location’ and supplemented with an approximate date (e.g. Skiing St. Moriz 02). This minimal additional amount of information helps people to access their images. So far, meta-information has to be manually added.

Based on these observations and our experiences with sensors we investigated how additional meta-information can be automatically acquired. In our research we particularly investigate the following two questions:

- What types of meta-information may be useful for people when using digital images?
- What sensors can be used to acquire additional meta-information?

Based on a user centered design process we explore what information appears to be interesting to people and how it can be acquired in different contexts of use.

Our approach has been to explore a range of available sensing technologies that can be of use to produce meaningful meta-information. We focused on sensors that are available and can easily be attached to a camera. In our research we first
conducted initial interviews and an online-survey over the WWW (Section 2). Based on these findings we constructed a working prototype for meta-data acquisition that can be used together with an ordinary digital camera (Section 3). Using this prototype we performed a study with three professional photographers and two amateurs acquiring over 350 photos in regular shootings with meta-information (Section 4). In Section 5 we compare our work to related work in the area of context-aware photography.

2. What Users Want

In the early phase of the projects we conducted a small number of interviews with people on the topic of context-aware photography. In particular we were interested what additional information people would like to save with their photos. In these interviews we did not constrain our questions or the answers by technical feasibility. The initial results showed that there is an actual interest in supplementing photos with additional data, including location, activity, environmental information, physiological parameters and information about the current social situation.

These interviews lead to a more systematic survey on the topic.

2.1. Online Survey

With the survey we wanted to target a wide range of people, from individuals who rarely take photos or only take photos at special events, hobbyists who take photos in very special contexts (e.g. sportive activities), to professional photographers. To achieve this variety, we decided to design an online form [appendix] and recruit participants via email. The email distribution was started with students that took part in a one-day introduction to digital photography at our department and with the social network of the authors. In the email people where encouraged to forward the mail within their social network.

One goal was to find out what meta-information is already in use by people. We were interested in data that is recorded automatically (e.g. the time when a digital photo is taken and the shutter time) as well as additional information that is added manually when the photos are taken or shortly afterwards (e.g. naming photos or clustering photos into groups and folders).

We were interested how people use this information to organize their collections and how meta-data adds a substantial value to the pictures themselves.

Based on currently used meta-data, we extended this concept in the survey and asked for further information that people considered of interest for them.

In particular, we are interested what data could be acquired with sensors that could be included in the camera. Furthermore we questioned people what they would like to use the additional information for and in which situations.

The survey was fully completed by more than 100 participants. The reminder of this section describes the main findings.
2.2. Contexts of Interest

From the interviews and the survey we conclude that there are at least four main areas of interest in which users could see additional value.

- Handling of the camera
  One important example in this class is basic information about orientation, angles, and position of the camera with respect to the motive.

- Environmental conditions
  Light conditions, in which a shot was taken is one example in this class. In certain usage contexts information about temperature and further environmental conditions is valuable.

- Physiological information
  Physiological information, such as change in galvanic skin response and heartbeat, appear to be of interest in contexts where the person taking the pictures is closely involved in the action captured (e.g. sports, mountain tour).

- Social context
  This is mainly information about other people that are around when a photo is taken or in our study, by observing the test persons.

There were also some further interesting suggestions of the asked people for metainformation to be mentioned:

- Difference of the motive to the previous picture (e.g. more brightly, more darkly).
- A low dissolved 360° panorama, i.e. a rough overview, which was otherwise in the environment and the actual picture shows which detail.
- The names of the photographed persons.
- Concrete data to the motive, e.g. sights

How one can see, there are still many interesting enhancements that encounter interest with the end-users.

It also appears that the value of meta-data is closely dependent on the context in which the photos are taken. Considering hobbyists who take photos of specific activities and of professionals working in specific areas it is difficult to generalize. In the following section we present certain areas where additional meta-information is of use.

2.3. Application Domains

Generally it is often assumed that having more metainformation is better. But looking at the variety of EXIF information recorded with current cameras we found that most of the information is hardly ever used.

In our enquiries we were interested in concrete application domains where people can see the value of additional meta-data. The following areas appear to be important:

- Archive, search, and retrieval
  The obvious domain for using metainformation is in the area of archiving, searching, and retrieving specific pictures. Additional information on the context in which a photo was taken can help to search archives for specific
photos. This seems to be especially interesting for people with large archives and meaningful contexts.

- Reproducibility of images
  In professional domains, such as photography of machinery, the reproducibility of photos is of interest. With recorded context data, especially on camera handling and environmental conditions, it is easier to reproduce images.

- Automated presentation
  With a given range of context information, presentations such as slide shows or albums can be automatically created. Context information can be used to select visualization schemes, suggest background audio, and to group images.

- Fun and augmented presentation
  Photos of activities, where the person taking the photos was involved, can be enhanced with additional information. This seems especially interesting with regard to sports.

We intentionally did not look at automating the process of initiating capture, as investigated in [3]. In none of our interviews or questionnaires people raised interest in automating the actual process of taking the picture. Helping to make better pictures (e.g., automatically setting the camera right) is a central concern to people, but one of the important points in photography is that the user is in charge of the decision when to take the photo.

The feedback, we got, showed a potential for several interesting domains even with simple sensing technologies. However, our overall impression was that it is necessary to design a prototype that allows collecting real context information to judge its value.

### 2.4 Specific Sensors of Interest

We asked people to rate their interest in different sensor information. At this point people had answered questions about meta-information and usage of metainformation and they were aware of the concept of context-aware photography. We presented the participants with a list of parameters that can be sensed and asked them to rate the importance of this parameter. The importance could be assigned on a scale from 1 (useless) to 6 (very important). The following parameters were rated by at least 50% of the participants as useful or above (4, 5, or 6) [appendix].

- Light conditions (74%)
- Acceleration (52%)
- Weather (51%)
- Orientation (50%)

It was surprising to us that location in general was rated less important than the above. In the following list the percentage of participants that rate the information as 4, 5, or 6 is given.

- Precise location: 42%
- Street level location: 32%
- Town level location: 45%
It is interesting to see that people would be as happy with town level location information as with precise location information for the purpose of meta-data to digital photos.

Bio sensors, physiological sensors, temperature, and the detection of noise and smells where only considered useful by a minority of people.

Based on these findings we constructed a prototype that is described in the next section. We deliberately did not look into location information as this is available with cameras that include GPS (e.g. [1]) for precise location and with mobile phones that are using location based services on a coarse scale.

3. Prototype to Explore User Experience

To get more and in-depth feedback from users we built a prototypical system to record sensor data from various sources.

In the following technical structure and implementation are described.

3.1. Design and Concept

The overall system is designed as a tool to investigate the potential of using sensors of different types. First we considered using a PDA with a camera and a sensor board attached as a device to explore the user experience, similar as suggested in [6]. However, we realized that for ambitious hobbyists and professional photographers, using their own camera (or a model similar to their camera) is very important. Therefore the overall design consists of a sensor box that can be connected to the camera instead of a tripod or a flash.

A notebook computer has been chosen as receiver for the sensor box data connected to the camera. All sensor data is continuously streamed, time stamped and stored on the hard drive of the notebook computer. By synchronizing the clocks of the camera and on the notebook computer the sensor data can be matched to the photos.

3.2. Implementation of the Sensor Box

Reviewing the meta-information of interest and having the wide range of possible contexts of interest in mind, we built a sensor box equipped with various sensors.
Chapter 3.2 figure 1: The hardware architecture of the sensor box to be attached to the camera.

The main sensor box is based on a Smart-Its module with a basic sensor board attached [2]. The basic Smart-It includes a PIC18F452 microcontroller and a wireless transceiver (Radiometric SPM2-433-28). It sends up to a range of 200m outdoor. It ensures, that the data, which the microcontroller receives, will be transferred via radio to the receiver.

For our initial user trial it is equipped with the following sensors:

- Two 2-axis accelerometers, ADXL 220 give information on the orientation of the camera.
- A magnetic compass module that is connected via I2C to the processor (CMPS03). The accuracy is with 3-4°. Importantly for the accuracy is here the accurate horizontal adjustment of the compass module. The output of the compass value takes place as 0...255 (8 bits).
- Two light sensors, A 904014, provide information on the ambient light from different directions. With the help of the photoelectric cells it measures the lighting conditions of the environment.
- A touch sensor, QT 110, is placed on the camera. It collects information when a specific part of the camera is touched. Amongst others, this can indicate how quick a shot was taken. It creates sense fields through dielectric surfaces such as plastic or glass up to 100mm.
- A temperature sensor, DS 1621, that measures the temperature of the environment. The sensor can measure a range from -55°C to 125°C in an interval of 0.5°C. It reads and writes over a serial interface.
Chapter 3.2 figure 2 There is to see Mainboard, Mini Sensor Board and Compass

The software on the sensor box is written in C and continuously reads the sensors and transmits them wirelessly. The prototype fits into a small box, similar in size as an extra battery pack, and can be attached to the tripod mount at the bottom of the camera. This enabled the users to attach the prototype to a camera and work as they did before.

The basic hardware architecture of the sensor box is presented in Figure 1. The prototype of the sensor box is depicted in Figure 3.

Chapter 3.2 figure 3: The hardware of the sensor box (left) and attached to a camera (right).

3.3. Receiver and Storage

To keep the sensor box small we decided to have the storage in a separate unit that is wirelessly connected. As receiver we used a notebook computer that was equipped with a receiver for the wireless signal using a Radiometrix SPM2 module connected to a serial line using a serial to USB adapter. The computer with the receiver was placed in a backpack that was carried by the observer in the study. In Figure 3 the observer with the receiver and the photographer is shown.

On the computer runs a program that continuously reads from serial line and stores all incoming data in a file.

After the data were taken up by the sensors, they are transferred via radio to the laptop, carried by the Observer. For the transmission and filtering of the taken up data into a text file 2 Pearl programs were used, which was written by Paul Holleis, a member of the heilab-team. The first program takes all characters by serial line (here com1 is used) with appropriate speed (with only 384000), to be taken up and writes it into a file. The program reads the characters, here 10, goes through these by means of a for-loop, character of character and writes it in, if a file name was indicated.

To each line of sensor readings a time stamp and the actual date is added.

The problem of time synchronization between the clock of the camera and the one of the laptop could be solved as follows: Incoming sensor data is displayed on the laptop display. The current time of the laptop clock is shown next to it. Using the
sensor enhanced camera, a photo is taken of this display. After the photo session, we can calculate the difference between the two clocks.

Furthermore another Pearl file filters blank lines, lines that contained dollar characters and other "data garbage" arising due to bad transmission.

The resulting data records are then written into a text file.

The matching between sensor data and images is done separately when the pictures are downloaded from the camera. The second Pearl script is used to correctly adjust the sensor time stamps. In this step, we also connect the EXIF data of the photo with our sensor data. We used this setup throughout the study described in the next section.

4. Users Explore the Prototype – A Study

The user study was designed to evaluate the prototype in a realistic setting. In addition to collecting sensor information we observed the photographers when taking pictures.

4.1. Participants and Setup

For our study we recruited five individuals that expressed an interest in digital photography. All participants had been using a digital camera before.

Three of them are photographers running their own studios and have at least ten years of professional experience in different areas of photography. Two participants are hobbyists and know only the basic concepts of digital photography.

The basic approach in the study was to have participants taking photos as they normally would do and continuously record sensor data at the same time.

We gave participants a very brief introduction (about three minutes) to what the sensor box attached to the camera is recording. Then we asked them to take photos in whatever way they wanted. There were no guidelines predefined, the participants chose individually when to go for a photo session, how long they used it, how many pictures they took, and where they used it. The observer shadowed the participants during the whole time they were using the enhanced camera, see Figures 3 and 4.

Table 1 shows the summary of the individual sessions. A total of 354 photos were taken and the participants used the prototype approximately 353 minutes in different settings, mainly outdoors. Time stamped sensor data was recorded for all participants over the entire time of the study. Participants did not report that the attached prototype was limiting the way they could use the camera.

<table>
<thead>
<tr>
<th>Participant</th>
<th>No of pictures</th>
<th>Time (min)</th>
<th>Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Professional 1</td>
<td>69</td>
<td>114</td>
<td>Buildings; Indoors</td>
</tr>
<tr>
<td>Professional 2</td>
<td>10</td>
<td>5</td>
<td>Landscape</td>
</tr>
<tr>
<td>Professional 3</td>
<td>56</td>
<td>54</td>
<td>Night; Portrait, Outdoors</td>
</tr>
<tr>
<td>Amateur 1</td>
<td>51</td>
<td>82</td>
<td>Nature; Outdoors</td>
</tr>
<tr>
<td>Amateur 2</td>
<td>168</td>
<td>98</td>
<td>Landscape; Nature</td>
</tr>
</tbody>
</table>

Chapter 4.1 table 1: Participants spend different time exploring the prototype resulting in a diverse set of photos with metainformation attached.
4.2. Initial Results of the Study

Given the varying conditions and the individuals using the prototype we acquired a rich set of metainformation.

Chapter 4.1 figure 1: Sketch of setup. Metainformation is sent from the camera to a close-by observer equipped with a laptop for later processing.

Chapter 4.1 figure 2: Observer with receiver and tablet pc in a backpack (left); photographer with our digital camera, including our prototype (right)

From our first analysis of the sensor data, we can see that the handling of the camera before, during and after taking a picture can be isolated and shows interesting patterns. It can be found when the camera is held steady in a certain posture by the photographer (and it can also be seen how steady the camera is hold).

The Appendix [appendix picture 1] shows a photo taken by a professional photographer and the related sensor data. The black triangle marks the moment when the shot is taken.

The data plot shows that the photographer has reacted very quickly and has not pointed to the motive by steadily holding the camera, to configure it. When analyzing the data further it can be observed that he moved the camera along with the motive, took the picture and put the camera down afterwards.

Our initial analysis of the collected meta-data shows that there are potential improvements in several areas:

- Improving camera controls based on sensed actions and gesture, e.g. switching the display on when looking at the photo after a shot was taken.
- Determine the type of user and the environment in which the camera is used. This could be the basis for adjusting parameters and settings.
- Providing tips and hints to photographers by comparing the handling of the camera between amateurs and professionals.
5. Related Work

The idea to take up more information when photographing, was already pursued in other projects. In the following 3 are presented, as well as their differences to our system.

Using contextual information to trigger capture is an approach that has been explored in Startle Cam [3].

The hardware of this system consists of a wearable computer, wearable video camera, and sensors attached to the user. The camera can be implicitly controlled by physiological parameters of the user. E.g. it can be set to take pictures when the user is excited. To afford this, the camera supervises the reactions of the carrier of the camera via skin contact. The camera receives a signal and takes up several photos. These are then transferred to the Web server.

In the Sense Cam Project [4], a camera that automatically takes pictures is suggested as well. The hardware is a camera with sensors that is worn like a badge. Based on stimuli of sensors, still images are automatically taken. Typical triggers are changes in movement and changes in the ambient light level. The idea in this project is that by taking many pictures over the day (up to 2000 a day), those pictures may be helpful as a memory aid (e.g. “Where did I leave my phone?” or “Did I lock the front door?”).

In contrast to those we leave the control of when to take a photo completely to the user. Our initial study showed that the appeal of digital photography is to capture a certain motive at a certain time – and much of the creativity in people’s photos lies in those parameters. We aim at enhancing digital photography whereas SenseCam aims at creating a memory aid.

Integrating context information to digital photos for artistic purposes has been explored in a project at the Victoria Institute [5], [6]. Their prototype consists of a webcam and a set of sensors connected to a tablet pc (which functions as display). The user can take still images by pressing the shutter button. The actual image is displayed and 4 different effects related to sensor readings can be applied.

Compared to our device they went for a PC approach, giving users a different feel than when using a digital camera. From our initial interviews we concluded that the camera itself has an important impact on how people take photos.

Furthermore they only use the sensor information as additional parameters for changing images and the effects with data can be added only, after the picture was taken.

Our observation of the professional photographers showed that after evaluation of the data of the sensors, there are many possibilities for the development of automatisms as support for an amateur.

6. Conclusion and Further Work

Our initial findings suggest that additional information acquired by sensors enhances digital photography.

Various contexts, such as the handling of the camera, environmental conditions, and social situation are of interest to the user. Additional meta-information enables new application domains. With our prototype and study we showed that collecting meta-information is feasible and can provide interesting data for further analysis.

Currently we are analyzing the data collected in more detail. Ours aims are to get ideas for new technical developments, understand what it takes a person to make good photos, and how to use meta-data for augmented presentations.
7. Discussion

The inquiry shows that a potential and the desire for innovations of additional information exist and that they are also convertible. The evaluation of the numerous data will bring much explanation to e.g. further automatisms to the integration with a digital camera.

Problems during the research work were to achieve an accurate measurement of the sensors as well as a time alignment between the sensor data and the announcement on the laptop (time).

A statistic evaluation of the survey data, as well as the sensor data would be surely from large interest, both naturally the industry, but rather for the final user.

Both new technical ideas for conversion, as well as, as previously mentioned, algorithms for a more extensive mechanism function are quite conceivable.

With a further project of this kind, it would be to be added better additional sensors to the already existing. This would be biosensors, a second compass, as well as several touch sensors, in order to be able to reconstruct better, how the camera was held.

8. Acknowledgement

I would like to thank the whole hcilab-team at the Institute for Media Informatics at the University of Munich, my supervisor Dr. Albrecht Schmidt, as well as Matthias Kranz and Paul Holleis that they always took themselves, time for my questions and problems.

Special thanks to the professional photographers and the amateurs for the time, they invested into testing the sensors.
Bibliography

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LFE Medieninformatik an der Universität München
Fragebogen im Rahmen einer Projektarbeit von Marion Gall

Umfrage zum Thema: Context - Aware Photography

1. Wie viele Bilder fotografieren Sie ungefähr pro Monat?

☐ keine
☐ 10-25
☐ 25-50
☐ mehr als 50

2. Wie stufen Sie sich fotografisch ein?

☐ ich bin professioneller Fotograf
☐ ich fotografiere gerne & viel und suche mir eigenständig Motive
☐ ich fotografiere ab und zu (zumeist Schnappschüsse)
☐ ich fotografiere nicht und interessiere mich auch nicht für diesen Bereich

Wenn sie zur letzten Gruppe gehören: wetter mit Frage 22

3. In welchen Situationen fotografieren Sie?

Auf einer Skala von 1 bis 6.
Erläuterung: 1 = sehr oft, ... bis ..., 6 = nie
4. Ich fotografiere gerne, weil:

5. Gehen Sie gezielt im Alltag/ ihrer Freizeit los um zu fotografieren, bzw. ein tolles Motiv zu finden?

ja
nein

*Wenn nein: weiter mit Frage 7*

6. Wie häufig kommt dies im Alltag/ ihrer Freizeit vor?

*Erläuterung: 1 = sehr oft, ... bis ..., 6 = nie*
7. Informieren Sie sich regelmäßig über Themen der Fotografie?

- ja
- nein

Wenn nein: *weiter mit Frage 9*

8. Wo informieren Sie sich?

- Internet
- Fachbücher
- Fachzeitschriften
- Fotofachgeschäft

9. Wie hoch sind etwa ihre jährlichen Ausgaben für Fotoausstattung?

- 0 - 50 €
- 50 - 100 €
- 100 - 500 €
- 500 - 1000 €
- mehr als 1000 €

10. Besitzen Sie eine Digikamera?

- ja
- nein

Wenn ja: *weiter mit Frage 12*

11. Spielen Sie mit dem Gedanken, sich eine Digikamera anzuschaffen?

- Ja, ich plane einen Kauf noch in diesem Jahr
- Ja, ich plane einen Kauf im nächsten Jahr
- Nein, ich plane derzeit keine Neuanschaffung

Wenn nein: *weiter mit Frage 13*
12. Welches Modell besitzen Sie, bzw. möchten Sie sich gerne zulegen?

13. Wie wichtig sind Ihnen Automatikfunktionen (Belichtung, Autofokus, Blitz, etc.)?

   \( I = \text{sehr wichtig, ... bis ...}, \ 6 = \text{unwichtig} \)

   \[
   \begin{array}{cccccc}
   1 & 2 & 3 & 4 & 5 & 6 \\
   \end{array}
   \]

14. Wie wichtig sind Ihnen möglichst viele manuelle Einstellmöglichkeiten?

   \( I = \text{sehr wichtig, ... bis ...}, \ 6 = \text{unwichtig} \)

   \[
   \begin{array}{cccccc}
   1 & 2 & 3 & 4 & 5 & 6 \\
   \end{array}
   \]

15. Welche Funktionen vermissen Sie bei den Digitalkameras?

16. Würden sie auch mehr Geld für eine Digitalkamera ausgeben, die über die von ihnen angegebenen technischen Mittel verfügt?

   \[ ja \]
   \[ nein \]

   \textit{Wenn nein: weiter mit Frage 18} \\

17. Wie viel mehr würden Sie investieren?

   \[ \text{bis zu } 25 \text{ €} \]
   \[ 25 - 50 \text{ €} \]
   \[ 50 - 100 \text{ €} \]
   \[ mehr als 100 \text{ €} \]
18. Wenn es neben Daten zu Auflösung, Format des Bildes, Aufnahmedatum und -
zeit, 
die Möglichkeit der Integrierung, bzw. Aufnahme zusätzlicher Daten zu 
Metadata (z.B.: Ort der Aufnahme) gäbe: 
Würde Sie dies zum Kauf einer Digitalkamera bewegen, 
bzw. würden Sie sich zusätzlich eine neue Kamera mit diesen Funktionen 
kaufen?

☐ Ja, dann kaufe ich mir eine solche Digitalkamera.
☐ Ich habe bereits eine Digitalkamera. Die neuen zusätzlichen Funktionen reizen 
ich nicht zum Kauf einer neuen Kamera.
☐ Finde ich interessant - weiß aber nicht, ob es die Kaufentscheidung beeinflusst.
☐ Finde ich überflüssig.
☐ Nein, das ändert nichts. Ich kaufe mir keine Digitalkamera.

D.h. inwiefern ist oder könnte die Angabe der folgenden Zusatzdaten durch Ihre 
Kamera für Sie in der Anwendung relevant sein?

   Erläuterung: 1 = sehr wichtig, ... bis ..., 6 = unwichtig

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
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<td>Orientierung im Raum in Bezug auf das Motiv</td>
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<td>Ziemlich genau (GPS) (~10m)</td>
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20. Welche Metadaten, die hier nicht aufgeführt wurden, wären noch interessant? Denken Sie dabei an konkrete Situationen, in denen Sie fotografieren (z.B.: Sport, Urlaub, Verein, Ausflug, etc...)

21. Können Sie sich vorstellen, dass die verwendeten Metainformationen für folgende Anwendungsbereiche sinnvoll sind?

_Erläuterung_ : 1 = sehr wichtig, ... bis ..., 6 = unwichtig

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22. Geschlecht:

- weiblich
- männlich

23. Zu welcher Altersgruppe gehören Sie?

- bis 19
- 20 - 29
- 30 - 39
- 40 - 49
- 50 - 59
- über 59

24. Welchen Schulabschluss besitzen Sie?

- Keinen
- Hauptschulabschluss
Mittlere Reife
Abitur

25. Was ist ihre berufliche Tätigkeit?

Student(in)
Angestellte(r) / Arbeiter(in)
Selbstständige(r)
Schüler(in)/ Auszubildende(r)/ Lehrling
Doktorand
Sonstiges
Appendix II – Partial Results of the survey:
Appendix III – Core Board
Appendix IV – Pictures of the study and their analysis

Picture 1:

Picture taken with a digital camera including the sensor box. The chart below shows the metainformation of our sensors, before, during and after the picture was taken.

Chart with sensor data, before, during and after the picture above was taken. The figure shows the values of four accelerometers and the compass.
Picture 2:

Picture taken with a digital camera including the sensor box. The chart below shows the metainformation of our sensors, before, during and after the picture was taken.

Chart with sensor data, before, during and after the picture above was taken. The figure shows the values of four accelerometers, the compass and the 2 light sensors.