Through two different Lenses: a Tool for new Perspectives into Context

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ABSTRACT
With the advent of ubicomp, designers of interactive systems face a growing need for research methods that enable them to understand aspects of context. Existing methods have already employed visual media as a means to analyse context. Utilizing the capabilities of modern smartphones, we present 'BehindTheCamera' (BTC) that goes beyond traditional photography by adding another perspective through the simultaneous use of front and back cameras. A thematic analysis of the results of a field study involving 30 people working in pairs revealed six categories of BTC use: Conventional Use, Sense of Location, Facial Tagging, Social Interaction, User Perspective, Technical Perspective. We argue these contribute understandings of context in three ways: *humoticons* showing the emotional valence of situations; *perspective axes* through the two cameras connecting distinct aspects of the context; and *narrative arcs* about potential interactions.

Author Keywords
Context analysis; design method; photography; research method; ubiquitous computing; user experience;

ACM Classification Keywords
H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION
With the advent of ubiquitous computing (ubicomp), designers face extended challenges that are typical for systems that take interaction beyond the realm of classic desktop machines. One key challenge is the interpretation and exploitation of user context, now that we are no longer bound to the desk and screen. According to Suchman (1987), the user's situation influences his or her actions and behaviours. Subsequently, researchers and practitioners have invested much effort into the development of design methods for capturing, analysing and utilizing the user context. Many of these methods have been inspired by traditional techniques from the social sciences, e.g. by ethnography or visual anthropology (Collier & Collier, 1986). The vast variety of methods with their different backgrounds makes it clear that the understanding of user context is not a trivial task. Context is not a one-dimensional construct but harbours many facets (Schmidt, 1999). Accordingly, there are many attempts to find an operational definition of context in ubicomp. One of the most cited definitions is by Dey (2001, p. 5):

Context is any information that can be used to characterize the situation of an entity. An entity is a person, place, or object that is considered relevant to the interaction between a user and an application, including the user and applications themselves.

Dourish summarizes that context is used in two different fashions in ubicomp. First, it is seen as additional information that can be employed as retrieval cues. Second, interactive systems make use of context by giving tailored responses to the user (Dourish, 2004). He acknowledges that researchers also consider social aspects of user context going beyond more technical approaches towards context that merely focus on capturing environmental data (e.g. location and temperature) by sensors. However, Dourish (2004) points out that this task has rarely been accomplished (p. 20):

[… The] social and technical ideas often sit uneasily together. Ubiquitous computing systems may be more responsive, and yet they seem to fail to address the sociological critique. Turning social observation into technical design seems to be problematic.

Dourish (2004) goes on in his article to suggest an alternative view of context, moving away from a computationally, stable and predictable approach that attempts to capture and remodel context. Instead, he proposes context as being dynamic and unstable, arising from the users' activities. Zimmermann et al. (2007, p.560) also put emphasis on the dynamic nature of context-aware systems and define five basic categories for context information that describe an entity or user: *individuality* (i.e., information about the user himself or herself), *activity*, *location*, *time* and *relations*.

As ubicomp and interactive systems evolve, researchers are now considering the experience of a technology at its full bandwidth. This means, designers are well aware that they build systems that are experienced sensually, emotionally as well as intellectually. As a consequence, researchers from the user experience (UX) strand call for better tools for understanding users' felt experience when engaging with a system (McCarthy & Wright, 2004).

We assume that the user's experience is closely interlinked with the context in which the user is living. Not surprisingly, methods for understanding the user experience intersect with those for analysing user context in ubicomp, e.g. cultural probes are employed to learn

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about other peoples' feelings in specific situations (Wright & McCarthy, 2008; Abowd et al., 2002).

In this paper we introduce our own tool at the intersection between UX and context research – a smartphone application named *BehindTheCamera* (BTC) – that we have designed for capturing visual user context information. We see this tool as an additional method for targeting the challenge of context analysis in a provocative and rich fashion.

Today, high quality smartphones are shipped with two cameras: one camera built into the front (primarily for video phone calls) and one in the back of the phone (for traditional photos). Taking advantage of both front and rear camera, we have developed an application for smartphones (BTC) where front and back camera are triggered almost simultaneously and hence enable the photographer to capture two opposite perspectives at a time. It is our hope and intention to provide designers or researchers with a useful and at times provocative or inspiring tool for looking into the many facets of user context through two different lenses.

In a field study featuring 15 groups with two participants each, we find that BTC is not only capable of capturing plain photographic information, but also can reflect complex aspects of the users' situation that are contained within Dourish's extended notion of context. Even though BTC is a lightweight technology, it adds an additional perspective for researchers to look at, capture and reflect on context. This could be used to complement the existing toolkit of methods like video analysis, cultural probes (Gaver et al., 1999) and experience sampling (ESM) (Larson & Csikszentmihalyi, 1983).

The contribution of this paper is three-fold. First, we propose our new tool (BehindTheCamera) for studying the use context of interactive systems. Second, we identify six salient categories of BTC use among the images that were produced by the participants in a field study. Besides the categories' theoretical value for understanding how the participants engaged with BTC, they can practically be employed to guide future BTC users in their context analysis. Third, on a more abstract level we find two phenomena across all categories: on the one hand so-called *humoticons* that can convey the emotional valence of a particular situation and on the other hand the appearance of *perspective axes* and *narrative arcs.* We employ these phenomena in order to theorize on possible working principles of BTC, which might account for the rich impression of context that eventually unfolds in BTC images.

We go on in the next section to review research methods for studying user context. After the literature review, we introduce our prototype (BTC) and describe the field study that we have conducted in order to explore its potential as a research method. We conclude with the presentation and discussion of the study results.

RELATED WORK

As mentioned in the introduction, ubicomp has a strong interest in capturing and employing user context in interactive system design. Several authors (e.g. Abowd et al., 2002; Dourish, 2004) have stressed the importance of gaining a broad understanding of the settings in ubicomp. They seek to gain holistic insights and put emphasis on the users' practice when engaging with technology:

The challenge for ubicomp designers is to uncover the very practices through which people live and make these invisible practices visible and available to the developers of ubicomp environments. (Abowd et al., 2002, p. 54)

In other words, contextual information becomes relevant, if it is reflected in people's practices (Dourish, 2004).

This accentuating of user practice in the course of ubicomp system design also plays an important role in UX design. Wright & McCarthy (2008) point out that "knowing the user" (p. 637) is a crucial challenge in experience-centred design and provide an extensive review of methods that allow the designer to better comprehend their users. Not surprisingly, a number of methods of UX to understand the user intersects with those methods that are used in ubicomp to learn about practices around pervasive systems and thus to learn about context.

Both ubicomp and UX employ ethnography or variations of ethnography. This constitutes a time consuming process and requires the researcher to expose him- or herself to the field in order to observe the subject of study. This is particularly challenging with interactions taking place in multiple locations and across extended time-spans. Observations are transcribed into field notes for later evaluation. Besides field notes, the camera lens is a common tool for data collection in ethnography. Both photography and the social sciences share a common desire in studying social phenomena (Becker, 1974). At a first glance, photography appears to be not only accurate but also very objective compared to e.g. note taking. However, it is important to keep in mind, that the production and interpretation of pictures is just as much affected by social conventions (Sontag, 1977; Chalfen 1987). In their classic text Collier and Collier (1986) emphasize that the *"[...] camera, however automatic, is a tool that is highly sensitive to the attitudes of its operator; it is a tool of both extreme selectivity and no selectivity at all."* (ibid. p.9). The same authors also clarify the difference between photography and video as research methods: *"The special value of film and video lies in their ability to record nuances of process, emotion, and other subtleties of behaviour and communication that still images can only suggest. With the still photograph one can quantify human content, describe in detail, measure distances, define relationships."* (ibid. p.144) Collier and Collier (1986) further suggest to hand the camera over to the subjects of study in order to receive authentic pictures out of the peoples' life and to let the subjects decide what is worth to be framed into a picture.

This aforementioned technique is certainly related to the so-called cultural probes (Gaver et al., 1999) that are used both in ubicomp and in UX to inspire new designs and for *"provoking new perspectives on everyday life"* (1999, p. 26). Besides a (disposable) camera, cultural

Figure 1. Context researcher using the BTC app to investigate a public transport system. Ticket validation machine (A) and ticket machine (B) are of primarily interest in this illustration. As indicated by arrow C, A and B are arranged contrarily along an axis.

probes contain a number of provocative requests (e.g. "make a list of your favourite food") that are not intended to capture an accurate picture of the participants, but to let them express themselves in a creative fashion. Without relying on explicit user interaction, Harper et al. (2008) employed automatically taken passive photography by the *SenseCam* (Hodges, 2006) to get insights into participants' lives enabling them to get an alternative view on everyday activities.

Other methods from ubicomp comprise the logging of user interaction data, surveys, ESM (Larson & Csikszentmihalyi, 1983), diaries and interviews (Brush, 2010). Whereas logging is primarily intended for the evaluation of existing technology, the other methods can also be more exploratory and used to understand people and their contexts of everyday practice. What these tools have in common is their capability to capture and allow for the inference of contextual information.

UX design employs a number of additional methods in order to get to know the users and their practices or even to put the designer into the users' situation (Wright & McCarthy, 2008), e.g. participatory design workshops (Kensing & Blomberg, 1998), experience prototypes (Buchenau & Fulton, 2000), technology probes (Hutchinson et al., 2003) and contextual inquiry (Beyer & Holtzblatt, 1998).

Beyer and Holtzblatt (1998) point out, that user observation can lead to an overwhelming amount of data due to the complexity of life and call for tools that allow the designers to capture context information without drowning in data.

We add to the list of context research methods by suggesting a lightweight tool (BTC) based on mobile phone cameras. We propose a novel kind of photography and provide researchers with two fresh lenses for studying context from different perspectives. The methodological niche BTC fills is enabling capture of aspects of context that can be represented visually i.e., aspects that are visible in the moment and/or located in space. BTC's primary strength is the two simultaneously taken images that relate to each other and can potentially reveal new insights into constellations of design spaces for potential interactive systems.

The BTC application (also referred to as "app" in this paper) operates as explained in the next section. The question this paper explores is what do context researchers do with BTC if they have such capability and how can we interpret this with respect to understanding context.

BEHIND THE CAMERA APPLICATION

As also described in Güldenpfennig et al. (2012), BehindTheCamera (BTC) is a picture taking application for mobile phones with two cameras: one camera facing

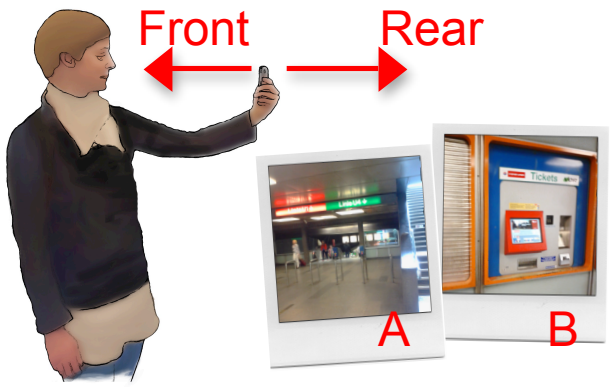

Figure 2. Context researcher taking a BTC image. We denote pictures taken with the front facing camera (Front) as back side images (A) and pictures taken with the rear camera (Rear) as front side images (B). The red arrows indicate the directions in which the cameras are facing. Please note, that in this illustration the photographer holds the camera away from the body to take a picture of the ticket machine as well as the ticket validation machine (and not a picture of the own body).

the front and another one the back. It is implemented for the Android system and we ran it on Samsung's Nexus S. The special feature of BTC is that it can trigger both cameras almost simultaneously and hence has the capability to capture two perspectives at a time. Similar to the standard camera functionality of a smartphone, the user presses a soft button after framing his/her picture. The app then takes a picture of the front motif, and with a slight latency of approximately 1 second, a second picture with the back camera. This latency time was set as a default to deal with the front facing camera needing time

to adjust to the ambient light, not just in bright daylight, when the latency can be close to 0 seconds, but also in suboptimal light conditions, such as indoor pictures in dim rooms. The user gets feedback (a short vibration of the phone and display of BTC image) as soon as both front and back image have been captured. Waiting for the back image to be completed before giving feedback prevents situations where the user will remove the camera from his/her target too early (during the latency time).

Figure 1 and Figure 2 illustrate the usage of the BTC app. Figure 1 shows the whole scene, and Figure 2 exemplifies which sides of the phone or camera will be referred to as front and back throughout this article. The pair of front and back images will be denoted as a BTC image. A BTC image is a photo that can metaphorically be turned around to reveal the back image.

As an exploratory prototype, BTC features a minimalistic user interface and employs simple interactions, because we wanted to keep the focus on the concept of 'two-sided' photography. Güldenpfennig et al. (2012) describes an exploratory study of everyday use of BTC. In the paper on hand we focus on its specific use as a research tool to study context.

STUDY

To explore the novel ways our tool could be used to capture context, we ran an explorative field study with the BTC prototype featuring 15 groups of Masters-level students. Each group was comprised of two persons. The participants were asked to employ BTC to document either an existing ubicomp system or to explore a possible design context for a new ubicomp technology. This was part of a user centred design process, beyond the scope of this paper to fully discuss, eventually resulting in fully implemented ubicomp systems, that were informed by the results of this context analysis. In the remainder of the paper we will denote the study participants as (context) researchers, because they are employing BTC to analyse context for informing and inspiring their ubicomp designs.

They were given the written instruction (excerpt):

Context Analysis: Pick a specific context (for a future) "beyond the desktop" application. Describe the context, including users, relevant context factors and how they might influence the users and the interaction with potential "beyond the desktop" applications. Understanding context can include an analysis of people, their behaviours, their situations and environments, their perceptual, cognitive, and behavioural capabilities, and/or their interaction with their artefacts. Such an understanding should serve to inspire and ground new design directions and/or form the core of a requirements analysis. […] Photos are an important form of documentation for context research, thus the documentation should involve a textual description of the context as well as at least four photos taken in the context including their description. […] Students […] will receive a Nexus S phone with a preinstalled photo app (BTC) […].

Each group had two weeks to fulfil the exercise after they received the Nexus S Android smartphones. It is important to note that the participants were only provided with a technical briefing for BTC and did not get any further explanation of the app's purpose or usage suggestion, since we were interested in unbiased observations of BTC use cases. In other words, we were interested in what our participants would make out of this new kind of 'two-sided' photography without being pushed into a specific direction.

After two weeks, the participants came back and gave a 20 minutes presentation of their images. They submitted their images and a written discussion of the investigated context. This resulted in pool of 193 images (image pairs) as noted in Table 1 with accompanying text descriptions that were the focus of the analysis. Subsequently, we collated and analysed the data pool of all BTC images for recurrent patterns or themes. Two of the paper's authors together identified salient usage patterns by iteratively coding the images following a thematic analysis procedure (Braun & Clarke, 2006). The outcome is a set of six categories that were reviewed by the third author and reflect the way the participants employed BTC. Furthermore, we identified a phenomenon that we have labelled *humoticon*, .i.e., the charging of some instances of BTC images with emotional information. In addition, we elaborated two themes of use (*perspective axes* and *narrative arcs*). We propose that those two themes capture the underlying mechanisms of BTC images that convey the app's value for the designer of ubicomp systems, i.e., what the designer can learn from BTC images to inform the understanding of context.

Group	Number of BTC images	Group	Number of BTC images
1	9	**9**	24
2	12	**10**	19
3	11	**11**	7
4	10	**12**	28
5	10	**13**	5
6	11	**14**	11
7	7	**15**	19
8	10	**Σ**	193

Table 1. Number of BTC images taken by each group.

We go on in the following two sections to describe the six categories of use and then the themes, namely *humoticons*, *perspective axes* and *narrative arcs*.

FINDINGS

The participants chose to investigate the following settings or contexts by means of the BTC app: smart home environments, restaurants, pubs, internet cafes, intercom systems, hiking tracks, shopping streets, public transportation systems, supermarkets and social games events. In analysing the resulting 193 pairs of BTC images, we identified the following six categories:

Conventional Use, Sense of Location, Facial Tagging, Social Interaction, User Perspective, Technical Perspective. The distribution of these images across the categories is depicted in Table 2. Each BTC image was assigned exclusively to one category (the one closest related), although many instances fit into more than just one category. Hence, it is important to note, that we consider our categories to be quite fluid and without strict boundaries. They serve as an analytical instrument for illustrating the ways in which BTC was employed by the participants. In the end, it is up to the designer to interpret and utilize the images. However, we propose that this openness to interpretation is a benefit when thinking of and designing for novel products.

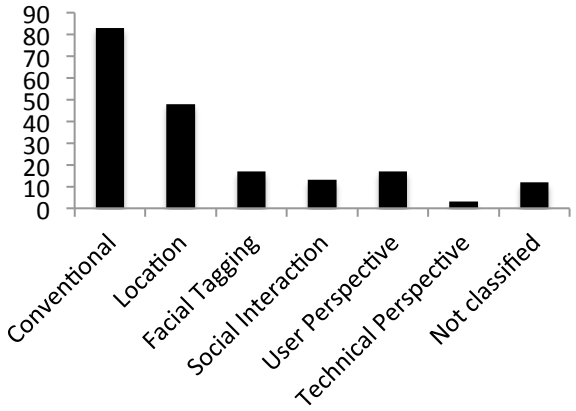

Table 2. Distribution of BTC images across the categories.

Each of the following subsections is dedicated to one category featuring anchor examples. We do not explicitly explain the *Not Classified* category (n=12), which was used for images that we could not fit in any of the fundamental categories and did not contain relevant information in terms of our analysis.

Conventional Use

Many BTC images (n=83) have been assigned to the conventional category, i.e. the photographer used the app as if it was just a regular camera. The high number of such photos is not a surprise, since we did not explicitly encourage the participants to make creative or

Figure 3. A participant of group 9 (right side) documented a tripping hazard inside a bathroom (left side).

unconventional use of BTC (e.g. utilize both simultaneously captured images to show interesting perspectives). Figure 3 depicts such an image and illustrates a tripping hazard in a bathroom. According to the participant from group 9, he was documenting the obstacle as if he had a regular photo camera, ignoring the back camera of his phone. The images of the *conventional use* category lack the rich additional value afforded by the BTC instances laid out in the following sections.

Sense of Location.

The participants employed BTC to capture a broader picture of the scene or the feel of a location in a number of instances (n=48). In order to accomplish this the photographers held the camera away from their bodies as illustrated in Figure 1 and 2. Hence, we assigned BTC

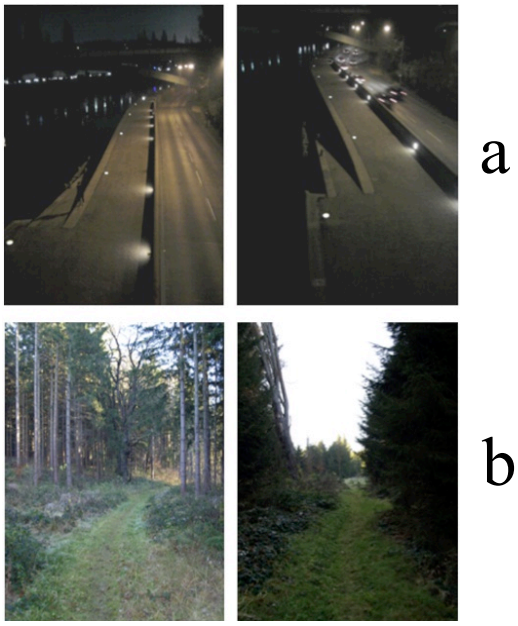

Figure 4. Potential urban (a) and rural (b) jogging paths captured by group 8.

pictures to the category *Sense of Location* whenever the app was used to take two opposed images that are able to convey a rich feeling of the surroundings of a location. Figure 4 illustrates such an instance. Here, the participants captured jogging paths, because they planned designing for ubicomp sports applications.

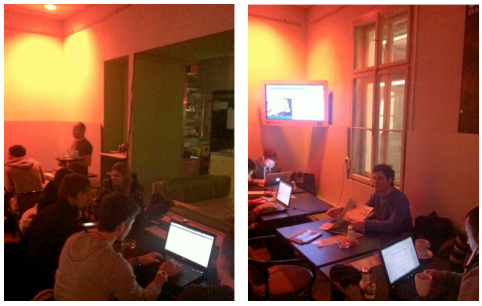

Figure 5. Group 14 captured the spatial relationships of people and furniture within an (internet) cafe.

The majority of the groups (n=8) used BTC to capture a broad image of the scene at least in one instance. For example, participant group 14 analysed a coffee shop by employing BTC images as depicted in Figure 5. Here, we

can see the interior of a crowed bar. In the words of the participants, this image was taken to establish the "physical setting" and to emphasize "[… that] common devices would be large LCD screens, hi-fi equipment, power plugs and computers." (group 14) It makes the ambiance of the space more tangible, including elements such as lights and video, which according to group 14 are currently still controlled by the staff of the café. The photographer must have been situated in the middle of the scene, because we as observers of BTC images can always rely on the geometric or perspective arrangements between the images, as depicted in Figure 2.

Facial Tagging

We assigned images (n=17) to the category *Facial Tagging* whenever the backside conveys an affective commentary regarding the motif on the front side. In other words, the facial expression of the photographer reveals his or her emotional reaction towards the captured situation. This kind of facial tagging was used as an easy way to add an additional layer of information. Hence, the user employs the back camera to direct a message to a future observer of the picture, i.e., "look, this is funny" (Fig. 6) or "I don't like that" (Fig. 7).

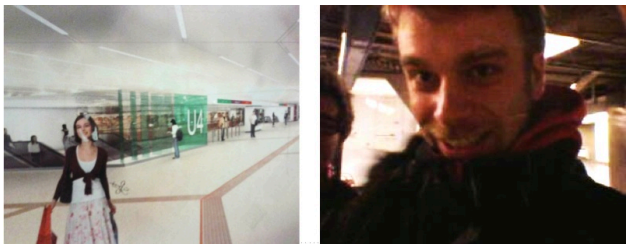

Figure 6. Participant (right) smiling at advertising billboard (left; detail).

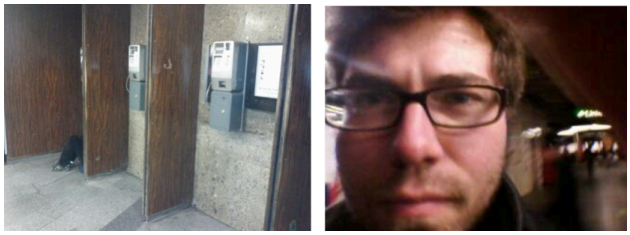

Figure 7. Participant looking sceptically at the decrepit state of the public phones in a metro station.

Group 1 chose public transport as their design space and aimed to understand the motivation for why people decide to use the public subway system and which context factors influence this behaviour. Among other things, this group captured Figure 6 that displays an architectural model of the planned rearrangement of a metro station in order to make it more attractive to the passengers. Figure 7 shows public phones in a metro station. On the back side of the BTC images they show their approval and dislike, respectively.

Social Interaction

In common with the proceeding category in many instances of *Social Interaction* (n=13) the back sides depict the face of the photographer. However, in this category, front side images also contain one or multiple persons. Moreover, the images reveal the interplay or relationship between the involved subjects in this particular moment. In contrast to facial tagging, the affective response of the photographer is not primarily addressed at a future audience as a comment but rather to demonstrate social interaction aspects as part of a particular context.

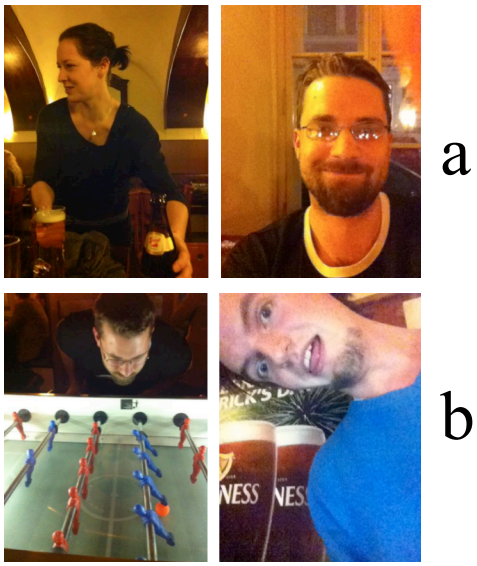

Figure 8. Documenting social interaction in a bar (a) at a soccer table (b).

Group 7 aimed to design novel technology augmented services for bars and restaurants (e.g., ordering, entertainment etc.) and used BTC to understand social interaction in this context (see Fig. 8). The images show different types of social interaction, amongst peers, with the wait staff (Fig. 8a) and situated around games (Fig. 8b) provided by the restaurant or bar. In their description of the images, group 7 stated that in the context of a bar the main aims of the guests are "fun, relaxing and social interaction" (see Fig. 8), that "nobody wants to be bothered by complicated systems" and that the systems have to be robust regarding dirt and heavy (physical) use (see Figure 12).

Figure 9. Passengers keeping social distance in the subway station.

BTC was also used in a different way to capture social interaction without depicting the face of the photographer. An example is from group 2 who captured social interaction, or rather its absence, in a subway station (see Fig. 9), stating that: "[T]he passengers keep a certain distance at most times. The fewer people are in a station, the bigger the personal distance". Figure 9 captures also the sense of the location, however even more so it describes the social interaction of the passengers as emphasised by group 2.

Figure 10. Passenger buying ticket (left); ticket validation machine (right).

User Perspective

In the category *User Perspective* (n=17) the context can be seen through the eyes of a potential user. The user is connected to the interactive system, which potentially includes the effect of specific context factors on the interaction.

For instance, in Figure 10 the observer can see how a subway ticket is bought as well as the machine where the ticket had to be then validated. Hence, this is showing a potential progression of the user interaction.

Figure 11. Interaction with the intercom at day and night.

Figure 12. Capturing the essence of the interaction with a dart machine.

Figure 11 shows the influence of the time of day on the visibility of the intercom interface to a building. Combining both front and back side, the experience of the user being blinded by the reflections of the sun during the day becomes rather vivid and thus comprehensible for the observer (see Fig. 11a). On the other hand Figure 11b depicts the same device under different lighting conditions at night.

Group 7 positions the context researcher right into the middle of a crucial moment of the interaction with a dart machine. Not only does the observer see the interface from the user's perspective but also the position and gesture taken by the dart player in this interaction (see Fig. 12).

Technical Perspective

In contrast to the aforementioned user perspective, the category *Technical Perspective* (n=3) is about the relationship of a specific technology with its surrounding context. On the one hand, BTC shows how a technology impacts its surroundings and on the other hand the context can be seen through the lens of a certain technology located within it. Thus, on one side of the BTC image one can see a section of the environment and on the other side a technology intertwined with this environment by design.

Figure 13. Fruit on display in a supermarket lit favourably.

Figure 14. Stairway (right) seen through the security camera (left).

Figure 13 illustrates such a relationship between technology and context, namely lights with the purpose to illuminate the fruit on display below.

Literally through the lens of a technology, in this case a security camera, Figure 14 shows the stairway in a subway station as if it were taken by the security camera. As group 1 puts it: "There are cameras at every stairway for the surveillance of the passengers. [BTC shows] the scene from the perspective of the surveillance camera".

DISCUSSION

Having designed the BTC app to allow the (almost) simultaneous capture of front and back images, we wanted to understand if and how this might be useful for understanding aspects of context for the purpose of design. In the study just presented, we have seen many examples of BTC images that we argue can be valuable to designers and researchers alike. We present the proposed six categories of images as a preliminary repertoire for the use of BehindTheCamera as a design or research tool.

The category with highest image count is *Conventional Use*, since we did not provide any instructions for BTC. Consequently, often times the app was used like a regular camera according to established photo practices, and as in conventional use of cameras as part of data capture, e.g., in ethnography or as part of a cultural probe pack. Nevertheless, novel or unconventional BTC images clearly outnumbered instances of conventional usage. Within those categories *Sense of Location* was most prevalent. It conveys the feeling of being in a specific situation to the observer and thus has the potential to foster a better understanding of this location. However, we argue that less common categories, e.g., *Technical Perspective*, are equally valuable since they contribute new ways in capturing context.

As mentioned by Collier and Collier (1986), Chalfen (1987) and Sontag (1977) observing, taking as well as interpreting images is not a trivial task, but is influenced by subjective and social practices. These additional categories constitute the foundation of a repertoire for BTC that supports researchers in documenting and understanding the different facets of context through their subjective use of the app. We therefore provide for future BTC researchers the six categories as a guideline for how this app could be utilized to get good results for capturing context.

Underlying BTC mechanisms

From a broader perspective, taking the analysis beyond the borders of the set of categories, we have identified two common phenomena within the picture set that we will discuss in the following section: first, we will describe an observation that we have labelled as *humoticon,* i.e., the human face as an emotional cue. Second, we will further elaborate the themes of *perspective axes* and *narrative arcs*, which might offer an explanation for the working principles of BTC and why BTC might be useful for the viewer. We discuss each in turn, drawing attention to how they can contribute to a relational understanding of context, where the connections between the images convey additional information beyond the individual constitutive images.

Humoticon

Many BTC instances reveal a human face in the back side image and often this face hints at the emotional valence of the displayed person. In most cases that person is the photographer of the BTC picture. We term this effect *humoticons*, as a form of emoticons enacted in-situ. Hence, this does not apply for images from the categories *Sense of Location* and *Technical Perspective*, because here one key attribute is that the backside does not display the creator of the picture. However, for BTC instances containing a human face in the back image, these so-called *humoticons* can potentially allow for the inference of the emotional response of the photographer or user to the situation at hand. This is most prevalent in images of the *Facial Tagging* category, where the participants appear to deliberately send an emotional signal (see e.g., Figure 6). More examples of this phenomenon can be found in images from *Social Interaction*. Here, we see participants deliberately staging social interaction. As part of this, we learn about their social as well as emotional involvement in a situation. Moreover, images from this category can also contain a spontaneous response to an actual social situation.

In contrast to traditional photos, e.g., as they might have been captured as part of a cultural probe, the designer's or researcher's understanding of the context can be extended by images that are not only focused unidirectional on an external object, but also explicitly relate the user's engagement with the scene. Hence, the object of study is directly related to its users. Another possibility is the portrayal of persons who can be (emotionally) connected by a BTC image pair. We propose that being able to see the user's face can be of special value for the designer because of the potential evocativeness and cues for richer understanding added by the human attributes and their visible emotional engagement. Furthermore, in the course of a design process, this could be used to assess the user experience during the interaction with a prototypical system.

Since the *humoticon* within a BTC image can serve as an indicator for the user's experience in this particular moment, the BTC application combines aspects of cultural probes and ESM, i.e., the BTC features a picture of the object of interest, as with a cultural probe, and at the same time conveys the user's (emotional) reaction to this object, as ESM triggers often try to capture. Complementary to experience sampling BTC could be employed to capture human experience in different situations and over time. This could be seen as an event contingent ESM where the event is defined by the user who is triggering the camera.

Perspective Axes and Narrative Arcs

BTC images allow us to explore relationships, not just between the photographer and target image, but also temporal, spatial and narrative relationships. This is because the technical implementation of BTC, enabling us to trigger both cameras at a time, results in two images that are by definition temporally and spatially intertwined, and by creative construction possibly also narratively intertwined, i.e.: from a more geometric viewpoint, the spatial configuration of front and back image is arranged by a *perspective axis* (see Figure 1 green arrow C); and BTC images can also feature sequential attributes by building a *narrative arc* between front and back image to convey an elementary story. We suggest that such spatial, temporal and narrative intertwining of BTC images can contribute richer understandings of context than any single image or at times even whole series of single images.

Figure 1 illustrates the perspective axis of both front and back image (indicated by the green arrow C). Front (A) and back image (B) are arranged along a perspective axis, so to speak. This may seem trivial, however this observation is worth elaborating further, because it can imply certain advantages for the observer as well as for the photographer of a BTC image for understanding context.

On the one side, the observer can always rely on the "fidelity" of the spatial relationship captured in the BTC image, i.e., front and back images are in line and not twisted. This is essential for the viewer to make sense of the images, putting front and back together to reconstruct the space in which the BTC instance is situated. This reconstruction of the scene can be more elaborate when the observer has a BTC image with its two sides rather than a traditional photograph as we have seen from the instances of *Sense of Location*. In these instances, the surroundings are captured particularly well, because the photographer intentionally points the camera away from his/her body to draw an axis between opposing points of interest (see Figure 4 and 5). This kind of geometric relationship is also quite prevalent in BTC images from the category of *Technical Perspective* (see Figure 13 and 14).

On the side of the photographer, BTC can eventually open new perspectives on a certain context, because as seen with the images of our participants, the app encouraged them to explore uncommon positions to capture a good BTC image. This became evident when we tried to reconstruct certain BTC images by the participants. Figure 10, for instance, positions the camera in such a way that the subway ticket validation machine is captured simultaneously with a passenger buying a ticket at the ticket counter opposite it. For further illustration, see Figure 1, which was re-enacted by the authors in order to explain the app.

We further suggest that possibilities for creating visual connections promote occasions for researchers to more deeply engage in, and analytically reflect on, the situation they are observing in order to identify aspects that both cameras could capture. As such it can encourage a conceptual shift of focus from an object as a potential target (as in conventional photography) to exploring relationships in the scene. Figures 13 and 14 are cases in point. We therefore envision that BTC can lead to similar provocative new insights or provide new lenses on everyday life as Gaver et al. (1999) intended with their cultural probes.

While Figure 10 can be employed to understand what we mean by *perspective axes,* what is even more prevalent in this instance is a sort of sequential and/or temporal relationship between the two images that constitutes a *narrative arc*. The observer learns not only that the validation machine and the ticket counter are connected spatially, but can also infer that there is a sequential relationship in the story of this use context, namely that the passenger is likely to walk from the counter to the machine to validate their ticket. Technology, its users and the potential interactions as part of a task flow are connected together in front and back image.

In a similar fashion, Figure 11 contains the story about the user pressing a button of an intercom and captures interactional aspects within the images, as well as temporal aspects between the sets of images conveying the differences between day and night. A different sequential-temporal narrative is told in Figure 12, which tells us about a person who will be throwing a dart at a board. As observers of both figures, we are put in a moment of suspense before an interaction that is about to happen. The user is just about to press a button (Figure 11) or to start a game (Figure 12). By engaging in the action as photographer the user lifts the suspense and creates the *narrative arc* between front and back image.

In summary, BTC is a novel photographic tool that offers new relational perspectives for understanding context, both in terms of perspective axes and narrative arcs. The two different lenses provided by BTC and the evocative way in which it encourages researchers to expose themselves to the field, make the app also a suitable complementary tool for supporting established user research methods like contextual inquiry (Beyer & Holtzblatt, 1998) or classical visual anthropology (Collier & Collier, 1986) and direct observation/ethnographic enquiry. Given that it runs on ‘everyday’ smart phones, it is also highly amenable to being given to participants themselves, e.g., as part of an enhanced probe pack, to capture their own subjective and creative engagements with their own contexts.

Given that the paper on hand describes an exploratory study, we didn’t give participants any instructions about specific settings to investigate with BTC. As such we are unable to make strong conclusions about the applicability of BTC in different contexts. However, it seems to be already clear that the BTC app demands open-mindedness and creative users. It appears to be able to inspire new perspectives on familiar settings or novel ways of exploring new settings. However, to find these new perspectives, it requires the users to be alert and imaginative to the possibilities of BTC beyond the use of traditional photography.

The rich manner of representing contextual information, which is afforded by the app’s properties, makes BTC a lightweight but still creative tool for capturing and understanding context. Further, we suggest that the very simplicity of the tool opens up even more possibilities for exploration beyond those which our participants explored here.

CONCLUSION AND FUTURE WORK

In this paper we presented our smartphone app BehindTheCamera as a novel tool for capturing and understanding context. In an exploratory user study with 30 participants we identified six salient categories of BTC usage. Our participants found unconventional and creative ways of employing BTC that opened up new perspectives on context and laid a foundation of a repertoire for the use of BTC as a context research tool. As such, the categories have both theoretical value for

understanding how participants can engage with BTC, and they can also practically be employed to guide future use of BTC for context analysis.

On a more abstract level we identified two phenomena across all categories and employed these phenomena to theorize on possible working principles of BTC, which might account for the rich impression of context that unfolded in BTC images.

The first was to do with capturing emotional valence, where faces could be used as a cue to the emotional assessment of a situation captured by BTC. We labelled this phenomenon *humoticon*. The second phenomena across categories was to do with capturing a different form of relationship as *perspectives axes* and *narrative arcs*, emerging from the spatial, temporal and/or interactional relationships between front and back image. These constitute the underlying mechanisms of how observers reconstruct and make sense of BTC images.

For future work we plan to study the BTC app with a given set of categories of use taken from the BTC repertoire elaborated in the findings section instead of the exploratory approach taken in this paper. This will possibly lead to less conventional images, but to a broader set of examples for the *unconventional* categories giving further insights how BTC can offer new perspectives on context. In addition, we seek to investigate in more detail what use scenarios or what aspects of these scenarios are especially suitable to be studied with BTC application in terms of gaining knowledge about contextual information.

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