

Consumer Usage of a Digital Memory Device Prototype

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Abstract

We report qualitative consumer field trials of a prototype digital memory device known as SenseCam. We presented SenseCam to 25 consumers in the US (N=9), Japan (N=8), and South Korea (N=8) to determine initial interest and expected use cases. This was followed by respondents using an actual prototype camera for approximately one week and reporting on their experience. Actual use cases differed substantially from those initially expected by respondents. The results suggest that successful usage may emphasize stationary capture relatively more than moving scenes, and may emphasize recording of full scenes rather than recording outwardly from the body of what one has seen. We discuss implications for concepts of digital memory and suggest that general consumer interest in such a device may be related to construction of interesting narratives rather than the capture and review of factual data. We suggest future directions for device design and related interaction research.

1. Introduction

Digital technology is increasingly making it possible to capture our everyday experiences and to use the resulting data in various ways. One may retain email for later reference, capture written notes as digital text, save emotionally significant voice messages, track where one has traveled with global positioning systems, examine one's electronic calendar far back in the past, and assemble photographs and videos by date, location, and subject. There are new applications for mobile devices every day. The sum total of collected data that one may save and review has been described as "digital memory" [3,9]

In the human-computer interaction (HCI) literature, digital memory (DM) has been discussed largely in terms of the instruments, data sources, and algorithms that implement DM systems (e.g., [3,9,10,15]). There has been little consideration to date of users' experience of such systems and what they actually do with them. In this work, we present a prototype digital

memory device known as SenseCam [15,19] and describe a series of field studies where people used the device. We report the most common usage scenarios and factors that resulted in greater or lesser user satisfaction. We then reconsider the assumptions of DM and argue that the conception of DM as a data storage and retrieval analogue may not reflect actual user experience of such devices.

2. The SenseCam Device

SenseCam [15,19] is a Microsoft Research design of a wearable, automatic camera that is similar in size and weight to a deck of playing cards (Figure 1). It comprises a digital camera with memory for thousands of photographs and a sensor subsystem that triggers photographs to be taken according to various environment changes. Environmental triggers include change in motion (accelerometer), change in temperature, warm-body detection (infrared), change in ambient light, and passage of onboard clock time. The camera may be placed in a location or worn around one's neck with a simple strap. When a change in the environment is detected, the camera automatically takes a photograph and records the environmental conditions.

The general usage case for SenseCam is to wear the camera while going about a day's activities. At the end of the day, the user downloads the photographs and may review them with playback software that presents them like a video, such that a whole day's activities may be reviewed as a sequence in a few minutes. The user may also pause on any specific image and review, bookmark, or archive it.

Using simple video editing software, one may create a movie with music or narration from the images. Such a movie can present a video documentary of the user's recorded experience that collapses hours of experience into a video of a few minutes' duration. Such a compressed video with added music or narration may be more manageable and enjoyable for many purposes when compared to an hours-long recording from traditional video cameras.



Figure 1. SenseCam (64x71mm body)

Table 1 presents a general outline of a user's steps to capture a sequence of images with SenseCam, review the sequence, and optionally add music to it.

Table 1. SenseCam user experience sequence

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| <ol style="list-style-type: none"> 1. Place SenseCam around neck or on another surface. 2. Turn it on. SenseCam automatically takes photographs. 3. After using it up to 24 hours, download photographs to a personal computer. 4. Review images quickly with video viewer. 5. Delete any that are unwanted, and tag any as desired. 6. Optionally, use video editing software to compile the images into a short video, with each image shown briefly in sequence order. Add music or narration as desired. |
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Prior research with SenseCam has largely fallen into four domains: (a) investigation of algorithms to parse its data [e.g., 5,8]; (b) application of SenseCam in various monitoring environments such as research and education [e.g., 1,6]; (c) user interface issues [e.g., 12,13]; and (d) application to assist people with special needs, such as the blind and memory-impaired patients [e.g., 4,17]. SenseCam has shown especially strong promise as an intervention with memory-loss patients, where review of a day's activities may help with memory retention and consolidation [4,11]. To date there appears to be no research that examines how a general audience would wish to use such a device or which use cases are likely to be more or less successful and interesting for general consumers.

3. Research Questions

We investigated general consumer use of SenseCam with the ultimate aim to determine whether such a device appeared to be a viable consumer electronics product. To address such a question is a complex undertaking involving several kinds of research that include initial concept testing, field work on product usage, market sizing, and demand estimation. We do not report here on the ultimate outcome of the business question. Instead, we report a core part of the research that informed the outcome: the question of user need. What would people do with such a device and why?

We divided that high-level question of user need into several specific research questions. (1) What would general consumer users do with SenseCam? (2) How satisfactory are the outcomes of those uses, and what are the factors that lead to success? (3) What kinds of features are necessary for such a device to meet the use cases? (4) Are there general, higher-order concepts that may help designers to understand users' experience? The team used answers to those questions to inform strategy around such a device, to identify key engineering issues, and to identify areas for further technological and market research.

We report here on customer use case research, but it is significant to note one result from the parallel business research that informed the research here: for our strategic interest, the identified primary audience for such a device would be adult, young- to middle-aged enthusiasts of point and shoot digital cameras (hereafter "DSC" for "digital still camera", and where "enthusiast" denotes self-report that the person routinely takes more than 60 photographs per month with a digital camera). Such DSC "photo enthusiasts" were estimated to comprise 13% of digital camera users in the United States.

The team identified three market locations of particular interest. First was the United States (US), because the US is the largest single market for consumer electronic (CE) goods. Additionally, we wanted to investigate a non-US location that might confirm or refute US findings. We selected Japan because it is the second largest CE market, is culturally quite different from the US, and is home to many photo enthusiasts. Finally, we wished to assess a third market known for leading edge product adoption. We chose South Korea (hereafter "Korea") as the third location because its consumers are often early adopters of new technology products and it has a very high usage rate of mobile cameras (both DSC and mobile phone cameras).

As noted above, in addition to the research reported here, the team conducted parallel research on business and HCI issues. This included general concept

reviews of the SenseCam device in the US, Japan, and France; pricing research for such a device in the US, Japan, and France; and investigation of the optimal field of view and physical design for such a camera.

One conclusion from the latter work is significant to note here because it shows one way in which SenseCam is substantially different in design from common DSCs: the optimal field of view for such an automatic camera appears to require a very wide angle lens with an approximate diagonal field of view (DFOV) of 90-100 degrees (approximately 18-21mm focal length equivalent for traditional 35mm film cameras). Ordinary DSCs often have maximal DFOV around 63 degrees (35mm focal length equivalent). The wider angle is needed to capture a scene of interest when photography is unattended. This requirement leads to several physical design implications that might be difficult to incorporate into a standard DSC (such as designing a lens that could accommodate both this extreme wide angle and standard DSC close-up focus in a small and cost-effective system).

4. Method

In each location (US, Japan, Korea), our research consisted of three phases. First, we met with potential users from the target audience in a focus group setting to demonstrate and discuss the device concept. We showed and explained the SenseCam device to respondents along with a live demonstration (recording a portion of the group session) and sample videos created by the research team. Respondents discussed the concept, what they liked or disliked, and what they might do with it.

Second, we offered all respondents in each group the chance to participate in a field trial of an engineering prototype of the device. Each respondent who participated was given a prototype camera (one of 62 handmade units constructed by Microsoft Research) along with software to download and review the images. We demonstrated how to use the camera and the software and sent respondents away with a SenseCam prototype and software to use for one to two weeks.

Third, respondents who participated in the field trials were scheduled for a follow-up group session in which they would return the device, discuss their experience with it, and if they wished, demonstrate some of the video that they captured with it.

Our measures were primarily qualitative in nature and included (a) the list of use cases initially conceived by respondents; (b) initially reported interest in such a device; (c) actual use cases attempted with it in field trials; (d) comments and concerns after using it; and (e) reported interest in such a device after using the prototype. This research was primarily conducted in

October-December 2005 and has been embargoed for publication until now.

5. Study 1: US Field Trials

A third-party research facility recruited 9 adult photo enthusiasts (5 male, 4 female; ages 30-55) in Portland, Oregon, for the initial concept presentation session. The list of *anticipated use cases* was to take images from a special event such as a wedding; to capture images from extreme sports; and monitor employees in a workplace. Respondents' largest initial concern involved differentiation of SenseCam from other DSCs: they felt that the SenseCam capability could be easily integrated into other cameras and discounted the idea that SenseCam's design is substantially different from DSCs due to its being wearable. Respondents expressed moderate interest in such a device if priced similarly to other DSCs. All 9 respondents agreed to participate in field research with the prototype.

The *actual use cases* attempted by respondents are shown in Table 2. None of the anticipated use cases were actually attempted; instead, respondents found other things of interest that occurred to them after the initial session. In general, respondents noted that the more things they attempted with SenseCam, the more usage scenarios occurred to them and the more they wished to try.

Table 2: US Field Use Cases

Holiday gift exchange at work
Dining: record restaurant experience [N=3 users]
Shopping: images of what they saw [N=4]
Home renovation: time lapse video
Filming around the house: general experience [N=4]
Driving: attach to mirror and film from the car or motorcycle [N=3]
Cat monitor: get images of what cat is doing

Several respondents shared videos with the group. Of those, the most engaging to the group were videos that showed stationary scenes, such as the food going by at a conveyor belt sushi restaurant. Movies with movement of the camera (such as wearing it while shopping) were felt to be "jarring" and "disorienting". A few respondents produced videos that added music to their sequences; those were the most widely enjoyed by other respondents. No participant spent much time editing the final sequence; they did minimal editing to select starting and stopping points and perhaps to remove unwanted frames, but otherwise left the sequences as captured by SenseCam.

Respondents' primary concerns with the SenseCam prototypes fell into three areas (other than

engineering issues). First, wearing the camera on a lanyard around the neck was not practical for several female respondents, as the camera rested in a position where it pointed upwards at an angle, rather than straight ahead. Second, several respondents wished for additional features such as GPS tracking. Third, there was concern around privacy; respondents noted how easy it was to “forget about” the device and take photographs in places they did not intend.

After using the prototype models, 7 out of 9 respondents stated that they would be interested to purchase a device with SenseCam functionality at a price similar to other DSCs.

6. Study 2: Japan Field Trials

A third-party research facility in Tokyo, Japan, recruited 8 adult respondents, all DSC users (all male, ages 19-23 in one group of 4, and ages 30-53 in another group of 4). *Anticipated use cases* included to record events while traveling, to monitor suspicious people outside a home, to record daily life for one’s blog, to mount on an automobile to take photos in case of an accident, and to have children wear it for safety. However, 6/8 respondents denied that there was any significant use for such a device, because they believed photographs should be taken intentionally. All 8 respondents agreed to try the prototype device for a one-week field trial.

The *actual use cases* attempted in Japan are shown in Table 3. Most respondents tried 3-5 different usage scenarios. Compared to the US, respondents in Japan attempted more of the scenarios they had initially anticipated (e.g., home life and automobile), although most of the scenarios were still unanticipated.

Table 3: Japan Field Use Cases

Video walking around the neighborhood [N=5]
Wearing it to shops [N=3]
Walking the dog [N=2]
Taking nighttime pictures of city [N=2]
School festival [N=2]
Film while driving car or motorcycle [N=4]
Concert [N=2]
Photos of one’s golf swing
Images while dog wore it [N=2]
Cooking

Japanese respondents also attempted more scenarios and a wider diversity of scenarios than US respondents. The reason for this is unclear; possible explanations include random variance, higher interest in technology, or a culturally-influenced desire to be more thorough or helpful in evaluating a product and giving feedback on it.

There were two primary areas of concern with the SenseCam experience in Japan. There was much concern about taking inappropriate photographs, and especially of *appearing* to be interested to take inappropriate photographs (e.g., of women). For instance, one respondent said that his wife would not want him to use such a device because other people would think he was doing something inappropriate. There was also confusion about SenseCam as a camera, and how its operation differed from familiar cameras. In particular, respondents were puzzled by the concept of using sensors to take photographs and complained that it did not always take the photographs they wanted.

Respondents in Japan did not share their videos with the group. In review of sample videos from the research team, the young adult men complained that all of the samples were “boring.” For sequences taken while wearing SenseCam, there were complaints that the cameras filmed people’s backs (e.g., of people in front of oneself in tourist locales), rather than their faces, and that swinging motion of the camera diminished the quality of the videos. Although stationary camera sequences were not specifically described by these respondents as superior, they appeared to be so in relative comparison to respondents’ complaints about moving sequences.

After using the prototype models, 4 out of 8 respondents said they might be interested to purchase such a device. There were two primary areas of interest: (1) to add capabilities not readily available with current cameras, such as such as filming wildlife with time lapse photography; and (2) to wear the camera while touring in other countries, where there would be less social stigma from taking photographs in public.

7. Study 3: Korea Field Trials

In Seoul, 8 respondents were recruited by a third-party facility for research sessions in two groups (a group of 4, aged 21-24 with 1 male and 3 female respondents; and a group of 4, aged 30-40 with 2 male and 2 female respondents). In the initial concept review, respondents spent a great deal of time discussing the camera’s styling, repeatedly comparing the prototypes and concept images unfavorably against Korean mobile phones. They said that everyday photography was nearly synonymous with mobile phone camera usage, and did not see the need for another device to take ordinary photographs.

Their *anticipated use cases* for SenseCam were to make a photo diary of everyday life, to take photos at a party, to record sights when traveling, and to collect evidence in case of an assault. All 8 respondents agreed to the field trial of SenseCam, but 1 unit

malfunctioned, so only 7 respondents completed the field trials.

The Korean respondents' *actual use cases* are shown in Table 4. Each of the 7 respondents tried 1 or 2 use cases. This usage frequency was lower than that of US and Japanese respondents. Although absolute frequency was too low to determine a clear trend, there was some indication that Korean respondents used their cameras more frequently in social situations, such as recording parties or social outings with friends, than did US and Japanese respondents. This might simply reflect random factors or different composition of the groups in Korea (younger than in US, and more women than in Japan); or it might indicate a higher integration of cameras into social situations in Korea due to the prevalence of mobile phone cameras.

Korean respondents did not share personal videos taken with SenseCam with the group. The overall level of dissatisfaction and complaining about the camera functioning (see below) meant that it was difficult to assess whether there were some factors that led to more success with the camera. However, respondents did say that the photography should be "predictable" and denied the utility of a sensor-based or automatic camera because it does not take the photographs one wishes.

Table 4: Korea Field Use Cases

Photos of commuting on subway and trains [N=2]
Walking around the neighborhood
Meetings with friends [N=3]
Taking photos at parties [N=2]
Stationary position in the home [N=2]

After using the SenseCam prototypes, Korean respondents complained extensively about the perceived poor quality of the images from the prototype cameras. They also commented repeatedly on the fact that photography should be intentional (not automatic) and was most naturally paired with a mobile device used for other purposes (e.g., a mobile phone).

Even with field experience using the cameras, several respondents said they "*just don't get*" the need for such a device. There was extensive discussion again in the follow-up group sessions about the physical design of the product and how they were embarrassed to wear such an ugly device. This suggests that the Korea research results may have been skewed, if respondents were unwilling to use the device due to its appearance. Overall, 2 of the 7 prototype users in Korea said they would consider purchasing such a device because it added substantially new use cases for photography.

8. Discussion: Overall SenseCam Use Cases and Success Factors

Our findings are primarily qualitative in nature; we intended the current research to provide guidance about initial consumer impressions of the SenseCam device and insight into how they were likely to use it. Thus, our conclusions should be interpreted principally as hypotheses: they suggest likely patterns of consumer interest and factors affecting the user experience of such a device but do not represent critical tests or conclusive results for a population. In actual development of a product, the findings presented here could be used to inform initial design and research directions, which would then undergo additional, detailed investigation.

Overall, there were three key findings from the SenseCam field research. First, in each location, we observed substantial difference between respondents' anticipated and actual use cases for SenseCam. It was often difficult for respondents initially to think of use cases, and the uses they imagined were often either very narrow (e.g., security monitoring) or unlikely to yield good results (e.g., in extreme moving conditions). However, when given the prototypes, respondents attempted things they did not anticipate and, at least in the US and Japan, were eager to try multiple scenarios. This suggests that such a device has potential to be repeatedly used (because people think of new things to do with it) although communicating its "value proposition" may be difficult (because of the narrowly imagined anticipated uses). One possible avenue for consumer adoption of such a product might be through "viral" spreading, where successful uses of the camera, such as one person's interesting videos created with it, inspire others to adopt the product.

Second, users were concerned about the operation and public acceptance of an automatic camera. Respondents were often confused by the concept that SenseCam used sensors to take photographs and they often did not understand how its capabilities and requirements (e.g., wide angle lens, wearable design) differed from simply adding a timer into existing DSCs. As we noted above, there were a variety of concerns around privacy and the acceptability of using such a device in public. We noted a potential interaction between this privacy concern and the initial expectations of the camera: if one's expectation is that such a camera is to be worn and used in public, but public usage is undesirable, then the value of the device would necessarily be low. A possible avenue to combat this interaction would be to emphasize usage of the camera in settings where privacy is less of a concern. Such settings include family events, the home,

and locations where cameras are acceptable, such as tourist destinations and sporting events.

Third, users' productions from SenseCam, i.e., sequences and produced videos, were of mixed appeal. Many respondents attempted to take sequences that involved nighttime or low-light photography, a moving camera, or capture of fleeting events such as a golf swing; these routinely produced disappointing sequences. Enjoyable sequences were much more likely to include at least occasional stationary usage (e.g., set on a table watching a scene; or mounted in one location), were taken in moderate or outdoor lighting conditions, and recorded extended scenes (e.g., an event). As movie producers have long known, the addition of a music track also substantially increased the appeal of a produced video sequence.

We observed differences in user response that may be related to cultural factors. Compared to the US, these included heightened concern about privacy in Japan, more use cases attempted in Japan, less perceived value of the device in Korea, and more attention to the physical design in Korea. Because of our small samples in each location, we cannot conclude that specific cultural factors were responsible for these observations. However, observed consumer interest level and use cases appeared to be substantially among the US, Japan, and South Korea. This suggests that a product team would wish to devote further attention to international market or cultural differences before developing such a device for a worldwide market.

In short, the findings suggest that the appeal of a device such as SenseCam might be enhanced through attention to three factors: (a) design that leads users to emphasize relatively more stationary usage over usage that involves motion (e.g., de-emphasize wearing the camera around the neck); (b) examples and promotional information that display use cases more likely to lead to enjoyable sequences (events, stationary scenes, social scenes, and the like); and (c) the ability to select and add music to the final video product.

There were several limitations of the present work. First, it was primarily exploratory to identify use cases. Future work could rely upon such a list in order to standardize coverage of use cases. Also, the present work covered slightly different user audiences in different locations, varying by gender mix and age group. This reflects sample variation from location to location as well as other research questions not discussed in the present report. More exact equivalence of samples would be useful if one wished to draw more conclusive results comparing samples, rather than to form hypotheses as presented here. Finally, it is likely that the consumer view of such a product would have changed since this research was performed in late 2005, due to advances in digital camera technology, general

electronics miniaturization and product consolidation, and the increasing popularity of video sharing sites.

9. Reconsidering Digital Memory

A fundamental premise of a "strong" digital memory concept is that human memory is fallible but may be enhanced through technological additions that will assist people to recall events and information [3,9]. In such a model, memory is conceived as being an information store for factual data and the function of recall is to locate and review the stored data. A device like SenseCam is appealing because it can capture additional data and make it available as an adjunct to the information system [3].

While such systems are certainly possible and perhaps desirable, it is unclear whether this information-based model accounts well for likely consumer usage SenseCam. In our field research with SenseCam, we observed several behaviors that were potentially at odds with a strong DM interpretation. First, respondents only talked about SenseCam in terms related to factual recall of information *before* actually using it. In anticipated use cases, respondents often mentioned scenarios such as security monitoring which emphasize factual recall. However, *after* using SenseCam, users were more interested in whether the experience achieved what they intended and whether the resulting videos were enjoyable. This suggests that attention to factual recall was not the most salient measure of success for SenseCam.

Second, respondents often seemed to be more interested in using SenseCam to record what they could *not* see, rather than what they could see. SenseCam was frequently used to record individual or social events in which a respondent was participating; rather than recording the person's own point of view (e.g., by wearing it), it was used to record a third-party point of view. This would argue against a strict interpretation of the resulting information as being about *memory*; rather, it may be more about enhancing *perception* by using SenseCam to add a new point of view.

Under the DM model, a photograph may be regarded as capturing factual information. However, a photographic image only makes sense when put into a narrative context [2,16]. Because SenseCam captures a stream of images, it may assist in creating such a narrative – and it will affect the narrative through its choice of images and structuring of them (e.g., through point of view, sensor selection, and time compression of the sequences). This is consistent with the observation that the addition of music provides a more enjoyable experience of the video sequences; such music has no place as a memory but it adds an emotional and narrative component.

This means that SenseCam sequences may be of questionable utility as *memories* in a general consumer case, but are perhaps much more likely to be interesting *narratives*. Thus, it appears that one might expect SenseCam to be of more interest to consumers to construct and share stories about their lives, rather than to capture and replay observations as data [7,18].

10. Future Research Directions

For consumer usage of a device like SenseCam, future HCI research would need to examine two core aspects of interaction with the device: the physical design of the device in relation to usage scenarios that are valuable to users; and the software design that supports successful creation and replay of image sequences. The field research reported here suggests a clear direction for exploration of physical design: to enable the camera to be ported or worn on the body because respondents expect that, but relatively to *de-emphasize* such usage in favor of design that encourages more stationary usage that leads to more enjoyable sequences.

For software design, our field research provides relatively little guidance but our observations (as well as team experience using the device) are consistent with two suggestions: that many users are unlikely to engage in detailed video editing, so the software should support relatively easier and less complex management of sequences; and that adding music to the final sequence is an important part in the construction of a narrative.

From a market perspective, the largest issues appear to involve a disparity between anticipated and actual use cases, and consumer confusion about the value of an automatic camera and its differentiation from existing DSCs. Use case disparity might be addressed in part through physical design that promotes the intended use cases, as well as other materials such as packaging and promotions that emphasize those use cases.

Confusion with other cameras may be a more complex issue to address. However, our research demonstrated that people who used SenseCam (in the US and Japan) were able to distinguish it from other cameras with experience and to see differentiated value. This suggests that market adoption of such a device might occur gradually as people became more familiar with it and saw uses (e.g., from friends or promotions) that provide a mental model for understanding its value.

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