1. Rationale of Research Project

My Honors Research aims to investigate the application of data recorded by various life-logging technologies for humans who have no memory impairments. SenseCam and ActivityTrails are two such life-logging technologies that will be used for this particular investigation. While life-logging technologies are very good at capturing activity data, minimal research has been done on characterizing the description of activities that life-logging technologies support. Thus, my research will examine the detailed description of recorded activities and identify the types of details both life-logging technologies help people remember.

2. Introduction

Life-logging is the act of recording different aspects of your daily life in digital form. Gordon Bell, author of “Total Recall,” refers to these digital records of our life activities as our “e-memory” [1]. Recordings of our personal activities through digital technology is a phenomenon we are increasingly becoming familiar with: recording of our web activity in our web browser’s history, archives of emails received and sent, videos and photos of important moments in our life, playlists of the music we listen to most frequently, etc. Increasingly, more and more of what we do are being represented in digital form, and thus leave “digital traces” of our activities. Because it is now common to have most aspects of our lives represented in digital form, reviewing our digital records may benefit us by providing us with the opportunity to have a richer recollection of our past life activities [2].

2.1 SenseCam

Microsoft Research’s SenseCam is a life-logging device that archives a wealth of information on personal life history (see Figure 1). SenseCam consists of a camera, data storage chip, and electronic sensors that can capture and store about 3,000 images. It is encased in a lightweight case about the size of a corporate ID badge. Photos are taken with a wide-angle “fish-eye” lens to capture an image likely to contain most of what the wearer can see (see Figure 2). It is typically worn around the neck, capturing traces of activities users are engaged in from a “first-person” point of view. The electronic sensors on the SenseCam detect changes in light levels, motion, and ambient temperature to determine when it is appropriate to take a photo. (ie. when the user moves from indoors to outdoors, the change in light levels will be detected, triggering the SenseCam to take a photo.) Thus, SenseCam is a wearable digital camera, which performs automatic capture that can serve as a pictorial diary from a user’s visual perspective.
Figure 2. SenseCam images taken at the Chicago SenseCam 2009 Conference (from left to right): 1. Train ride from Chicago Midway Airport to Hotel Allegro with Professor Hollan, Gaston Cangiano, and Adam Fouse. 2. A healthy breakfast of fruit and black tea on the first morning of the conference. 3. Emma Berry visits Professor Jim Hollan, Gaston Cangiano, Adam Fouse, and other Conference speakers at our table. 4. Walking to Maggiano’s Little Italy (with Professor Hollan and Adam in the lead) to dine with Conference attendants. It was cold!

Novel ubiquitous life-logging devices like SenseCam have been found to benefit those who have memory impairments by acting as a memory prosthesis [2]. SenseCam is a life-changing device for those who have memory impairments because the details captured in SenseCam images support episodic and autobiographical memory [3].

Different from those with memory impairments, reviewing one’s digital record will not only help with the recollection of past events for the sake of reinforcing feelings of continuity and supporting a sense of self [4]. Not only will individuals have a clearer memory of events, times, places, associated emotions, and other conception-based knowledge in relation to a past experience, but may also be able to reinstate the context of past experiences to remember something important that may have been forgotten. Empirical evidence shows that access to our memory is biased around landmarks—memory landmarks are the entry points to our mental representations of the past, and also increase the accuracy of our long-term and episodic memory [5][6]. Upon identifying what cues or landmarks are crucial in helping individuals “recollect” in SenseCam images and ActivityTrails recordings, how it supports their memory for past events can be identified. Individuals may gain utility from reviewing and reflecting on SenseCam images and ActivityTrails data because it may give them access to information from the past that they might need in the present. For example, individuals will be able to resume where they last left off on an robotics project, recall the name of the restaurant they dined at last Monday, or reexperience the emotional context of a conversation with an old friend at their high school reunion by virtue of potential cues that exist in SenseCam images and ActivityTrails recordings.

Even in healthy individuals, forgetting is not something unfamiliar. We experience forgetting because not everything in our working memory is encoded into long-term memory [7]—a lot of times, we don’t necessarily know what we need to remember in the future, and thus forget things we once had access to in our working memory [10]. Moreover, even when past events are encoded into long-term memory, we sometimes have trouble accessing this information without the aid of a visual reminder. Post-it notes and calendars are an example of visual reminders used to help us with “remembering.” A visual reminder is one technique that helps reinstate the context of our past activities, allowing us to get back to things we want to resume in the present. Reinstating the context of a past-encoded memory of a particular event through visual cues helps bring details of this memory to the surface because traces of these memories remain even when we forget [7]. This is strong evidence that validates that forgetting is not analogous to information falling out of our brains [7].

2.2 Episodic and Autobiographical Memory

Episodic memory and autobiographical memory is a type of long-term memory of temporally unique events. What makes these memories autobiographical is that they are a personal representation of our past events [8]. Specifically, the context surrounding events and spatial information encoded in our episodic memory [8] is different from other forms of memory in the sense that episodic and autobiographical memory is accompanied by the feeling of remembering in comparison to what we know as fact. Episodic and autobiographical memory access the context and personal participation in an event, such as the “who,” “what,” “where,” and “when” details of our past [8]. Thus, a lifelog containing a digital record of our e-memories may be able to provide a richer recollection of life by providing context and content to help support episodic memory of humans. Lifelogs will most likely provide the opportunity
of reviewing and reflecting on information about who we have encountered, when and where we were encountered, how long we were encountered for, what activity we were engaged in, etc. and aid in the recollection of our past activities.

2.3 ActivityTrails

In addition to SenseCam, ActivityTrails is another life-logging device, though it records onscreen user activity. ActivityTrails is a software prototype created by UCSD graduate student, Gaston Cangiano that captures desktop activity screenshots during instances that are “interesting.” Interesting activity is calculated using an algorithm that denotes changes in desktop activity, such as by the number of keystrokes made, number of applications open or closed, and the number of windows open or closed. ActivityTrails also prompts users to log events or activities in a dialogue box when users feel the information is worth noting for the future (see Figure 3). During instances where users do not want their desktop activity recorded, ActivityTrails can be temporarily disabled to suspend recording.

![ActivityTrails Event Log](image)

Figure 3. ActivityTrails Event Log: Automatic log prompts users to type a short description of their activity.

ActivityTrails runs on a desktop computer transparently — only a small icon is visible on the task bar to indicate that the software is running (see left image, Figure 4). Though ActivityTrails features are still in development, currently, users are able to search through their desktop activity recordings through keywords (see right image, Figure 4), viewing thumbnails of screenshots (Figure 5), and reviewing a video summary of selected segments of desktop activity. Thumbnails of desktop activity will include a wide range of information, such as, images of websites viewed, typed text on a Microsoft Word document, computer games played, and Facebook profiles visited. When users are viewing thumbnails of screenshots, ActivityTrails also provides a word cloud that displays key words to help describe what the thumbnail includes (see Figure 6).
Figure 4. ActivityTrails interface: (left) ActivityTrails icon on the task bar shows ActivityTrails is active. (right) Users can search for thumbnail recordings through keywords.

Figure 5. ActivityTrails interface: Preview of summary thumbnails expands to a viewable size with mouse rollover. Thumbnail expands to a full-screen video summary when clicked.
Cangiano developed ActivityTrails to allow users to navigate and search their past history on their computers through screenshots of desktop activity. Specifically, Cangiano conducted an ethnographic study on law office workers using the ActivityTrails software to help law office workers recall information such as the following: the exact name of their client, the details of an interaction they had with a particular client, and information on a past viewed document they need for a case they are working on [9]. In contrast to Cangiano’s use of ActivityTrails, I will be using ActivityTrails in combination with SenseCam to investigate how data from both life-logging devices can aid with memory recollection and context reinstatement.

3. Tracking Activities

Currently, there are related lifelogging ventures, like Trackulous and Slife that record user data like SenseCam and ActivityTrails. Trackulous is a website that allows users to track whatever they want to, such as Elaine’s waist circumference and the number of Glee episodes Lara has watched in the past month [10]. Though Trackulous does not automatically capture data, the website provides a way of visualizing data that has been inputted on the website in the form of a line graph. Benefits that users receive from visualizing their data range depend on the type of data they inputted on the website. In contrast, Slife is a downloadable application that keeps track of one’s activity on the computer by recording the amount of time that was spent on applications, a browser, and other desktop activities [11]. In addition, it also allows users to log notes for activities that took place off the screen, such as the duration and context of meetings and phone calls. It is useful for visualizing how time was spent on-screen to help improve productivity and help people “get things done.”

Similar to what SenseCam and ActivityTrails data may be useful for, Evernote is another technology that is more related to supporting memory and recollection of past activities [12]. Evernote is an application created for users to capture and store everything from business cards, recipes, web pages, and shopping lists, to provide users with quick access to this information through a powerful search function. Evernote is a tool for conveniently recalling information like, the website that was viewed last Wednesday, the name of the Realtor that was met at lunch, and the things that need to be bought at the grocery store because it supports information captured in the past and allows users to search through this information via keywords, titles, or tags. ActivityTrails provides similar search tools to Evernote for users who want to “get back to” certain information they may have forgotten. Though existing SenseCam browsers do not have similar tools, one of these browsers automatically identifies distinct images out of the large number of images captured [13].

Though visualizing various types of data as done by Trackulous, Slife, or Evernote may be useful, SenseCam and ActivityTrails data may be valuable for different reasons. Data recorded from SenseCam and ActivityTrails may give users an account of their past experience or past activity. This information may be useful for recalling details.
that users may need in the present, like a restaurant name, the recipe to Grandma’s pumpkin pie, where a project was last left off, etc.

What differentiates other tools from SenseCam and ActivityTrails is the way the data is captured. SenseCam and ActivityTrails capture information automatically, without requiring users to consciously capture information. This is an important distinction because as humans, we don’t necessarily know what we will need to remember. In addition, the act of explicitly tagging what we want to remember in Evernote does not coordinate with what we actually do in the physical world when we want to remember something—we don’t actually consciously “tag” things in the real world in order to remember it. This is why SenseCam and ActivityTrails data will most likely be more effective in supporting our episodic memory. Because SenseCam and ActivityTrails devices record automatically, it resembles more of how we do things in the physical world and most likely leverages our cognitive ability to recollect our past events. Conscious capture of information may be useful when we know what types of information we will need in the future. However, this is not the case. Therefore, automatic capturing may allow the acquisition of information that conscious capturing can miss. This allows SenseCam and ActivityTrails more potential to serve as meaningful digital representations of our past.

4. Project Plan

4.1 Research Question

SenseCam images and ActivityTrails recordings have a richness of context that aid in the recollection of one’s autobiographical events [2]. Therefore, this research aims to characterize the rich description of recalled events that SenseCam and ActivityTrails are helpful for. Specifically, this would involve noting how participants talk about their activities (i.e. what natural things do they do) and what types of details are described in their recollection (i.e. people, objects, places, actions, time). Furthermore, consistencies and significant differences in participants’ description of their activities will be compared for activities recorded with SenseCam in comparison to activities recorded with ActivityTrails.

4.2 Specific Aims

The goal of this research is to identify the different types of details recalled from reviewing SenseCam and ActivityTrails recordings, in addition to identifying activities that both devices are useful for. Understanding what types of details SenseCam and ActivityTrails recordings support may provide possible implications for the design of a SenseCam browser and ActivityTrails interface, in addition to a foundation for a further comprehensive research.

4.3 Participant Recruitment

Participants for this experiment will be recruited from individuals within the experimenter’s social network group. Participants will be recruited in this manner because reliable participants are vital to this study. Friends or colleagues that are asked to participate in the study are more likely to consider the safe handling of the SenseCam device and have more motivation for participating in a comprehensive study, in comparison to randomly selected individuals. To recruit participants of age, sex, and academic background (i.e. major) in equal percentages, the experimenter will ask the following questions to participants:

1. What is your age?
2. What is your sex?
3. What is your major?

Because this study is investigating how SenseCam and ActivityTrails data is helpful for memory recollection in
people with no memory impairments, participants selected will not have any history of, or current memory impairments. This will be ensured by asking participants directly if they have any memory impairments, as in the following question:

4. Do you have any brain disorders?

Because this study will rely on gathering data of a single activity for each participant, the following questions will be asked to participants to help the experimenter identify an activity that would be appropriate to record using SenseCam and/or ActivityTrails:

5. Describe your daily activities in a typical weekday.

6. Do you work? If so, where, what do you do, and for how many hours at one time?

7. Do you regularly engage in sports or other physical activities? If so, what type of sports or physical activities and for how many hours at one time do you engage in this activity?

8. Are you involved in any extracurricular activities? If so, what activities and how long does this activity typically last?

9. Do you have any hobbies? If so for how long do you do these activities?

10. Do you have a computer? If so, is it a PC or Mac?

11. How many hours a day do you use your computer for?

12. What kinds of activities do you use your computer for? How many hours do you spend doing these activities?

To ensure that the privacy of participants is not violated, the selected activity for each participant will be an activity that each participant is comfortable recording. Thus, the following question will be asked:

13. Would you feel uncomfortable recording any of these activities with a recording device?

For this experiment to be feasible, at least a minimum of 9 participants is needed—at least 3 participants for each testing group is desirable. The total number of participants gathered will be randomly assigned into the following 3 groups:

Group 1: Participants will only review SenseCam data
Group 2: Participants will only review ActivityTrails data
Group 3: Participants will review both SenseCam and ActivityTrails data

Though participants will be divided into 3 groups, all participants will record with SenseCam and ActivityTrails.

4.4 Data Collection by Participants

Participants will be asked to record with SenseCam and ActivityTrails for a span of less than one day. Participants will be instructed to only record when they are participating or engaging in the selected activity that was chosen with the experimenter from the initial questionnaire that was administered. Prior to having participants record their activity with SenseCam and ActivityTrails, participants will receive a brief training on SenseCam and ActivityTrails to become familiar with the functions of both devices. At this time, the experimenter will download ActivityTrails onto their laptop. If the participant will be recording on a desktop computer, participant will receive a copy of the ActivityTrails software to take home with them in order to download ActivityTrails onto their desktop. In addition, the participant will receive the SenseCam to bring home with them.
Data will be collected in the form of SenseCam and/or ActivityTrails images: Participants assigned to all groups will be instructed to turn on SenseCam and ActivityTrails when they are engaging or participating in their chosen activity. Participants will need to wear the SenseCam around their neck and activate the “on” switch to record during their activity. Participants will also need to turn on ActivityTrails when they are engaging in their chosen activity. Though participants will be instructed to record with both devices during their chosen activity, participants are still able to turn off the SenseCam device and ActivityTrails software temporarily during instances they do not want to have captured. (i.e. when entering the restroom, security checkpoints, writing a personal email, etc.). Should participants want any images or screenshots captured during a certain time period to be deleted without being seen by anyone (i.e. during a time when they would have preferred for the SenseCam and/or ActivityTrails to be deactivated but forgot to deactivate it), they can note the time period so the researcher can delete all images from that period.

After recording with the SenseCam and ActivityTrails for the selected day, the participant will return to the laboratory the next day with the SenseCam and/or their laptop so the experimenter can download the images from SenseCam and ActivityTrails onto a designated computer within the laboratory. If participants recorded on their desktop, they will be instructed on how to transfer their ActivityTrails data onto a portable device. At this time, experimenter will also delete, without seeing, any images falling in a time period that they have marked for deletion.

4.5 Browsers

Participant will be scheduled to return to the lab to review SenseCam and/or ActivityTrails images after a week from their recording day. The following three browsers will be used for reviewing SenseCam images and ActivityTrails data:

1. Dublin City University SenseCam Browser: a browser developed by researchers in the CLARITY centre based in Dublin City University that automatically segments images into distinct events (see Figure 7)

2. ActivityTrails: software developed by UCSD graduate student, Gaston Cangiano, which allows users to conveniently review their past computer history through thumbnails or video summaries (see Figure 4, 5, and 6)

3. Annotation: a browser developed by UCSD graduate student, Adam Fouse, which graphs sensor data and allows for viewing both SenseCam and ActivityTrails images together (see Figure 8)

![Figure 7. Dublin City University SenseCam browser: Thumbnails of distinct images appear in order of time.](image-url)
When participants are asked to review their recorded data, the Dublin browser will be used for reviewing SenseCam data for participants in Group 1 because this browser automatically segments a large number of images into distinct events, eliminating the need to manually discard repeated images and images that may not contain useful information (i.e. blurred or black images). ActivityTrails software will be used to review ActivityTrails recordings for participants in Group 2. Similar to the Dublin browser, ActivityTrails also segments a large number of desktop activity recordings into distinct events in the form of thumbnails or video summaries. To review both SenseCam and ActivityTrails data, Annotation will be used by participants in Group 3 to review the combination of both SenseCam and ActivityTrails recordings.

4.6 Data Collection by Experimenter

To control what types of details are remembered without the aid of SenseCam and/or ActivityTrails, prior to reviewing SenseCam and/or ActivityTrails data, participants will be asked to narrate the details they remember from the activity they recorded without the aid of SenseCam and/or ActivityTrails images. After, participants’ memory for the recorded activity will be tested with SenseCam and/or ActivityTrails data by asking participants to narrate the details they remember from the images through auto confrontation. At this time, participants will be video recorded.

Auto confrontation will be used as a method for reflection because it will allow participants to confront their own activity to reveal the cognitive processes that underlie their activities [15]. Recording participants’ responses in video form will allow the experimenter to note significant “recollection” moments through the indexing of audio and visual data the video can provide. Because it is not possible to understand all that happens when participants are narrating details they remember in real-time, reviewing video recordings of participants will allow the researcher to review word-for-word what was articulated by the participant that reveal subtle insights about how life-loggin technologies aid in the recollection of past events. Capturing and reviewing activity through video recordings is fundamental to the success of this project. At any point and for any reason, the subject may ask to have the video recording turned off and/or erased, and at which point, the researcher will cease video recording and take adequate steps to remove the participant’s data from the camera.
4.7 Measurements

“Recollection” will be measured by the types of details the participant remembers from reviewing SenseCam and ActivityTrails data. For the purposes of this study, the following five types of detail will be considered as a form of recollection. Four out of the five categories were selected because they were identified as good cues in SenseCam images for triggering memory recollection for those with memory impairments [3].

A. People (i.e. name of person, things associated with people, faces, etc.)
B. Object (i.e. material items)
C. Place (i.e. description of environment)
D. Action (i.e. activities)
E. Time (i.e. time of day)

The five details remembered (i.e. people, object, place, action, and time/date) will also be classified on a scale of 1 through 3; 1 denoting a low degree of recollection and 3, denoting a high degree of recollection. From the experience of analyzing video of several participants’ auto confrontion of their activity recordings for UCSD graduate student, Gaston Cangiano’s dissertation research, participants commonly recalled details that were in particular categories. These categories were used to classify the degree of recollection of the details that participants recollected. Category 1, 2, and 4 (below) were adapted from Cangiano’s measurement methods. However, for the categories to fit the possible degrees of recollection in this study, slight modification was made to the categories by adding category 3. The following are the proposed categories for degrees of recollection that were adapted for this study:

1. Nothing recalled (no detail is remembered from recordings)
2. Physical context (detail is noted from what is visible in the recordings)
3. Physical context (detail is noted from what is not visible in the recordings, i.e. sounds)
4. Emotional/mental context (detail outside of what is visible in the recordings is noted, i.e. phone conversation)

4.8 Expected Results

Results from this experiment are expected to inform the research in activity recording, context reinstatement, video analysis, event segmentation, and other related research of the Distributed Cognition and Human-Computer Interaction Lab at UCSD.

A comprehensive analysis on participants’ rich description of their recorded activity will be characterized by identifying the kinds of details, such as details about the people, objects, places, actions, and time they are able to recall when reviewing SenseCam and ActivityTrails images. In addition, these details will be categorized by a degree of recollection to identify if the details recalled are present or absent in the images.

I hypothesize, SenseCam and ActivityTrails will support memory for different details because both devices record different kinds of activities. Because the SenseCam device may be more appropriate for recording off-screen activities (i.e. playing soccer, meeting with a group of people, cooking etc.) memory for the interaction with people and what was going on in their environment may be high. In comparison, ActivityTrails may be better for remembering personal details (i.e. tasks that need to get done, email conversation with friend, what they were eating for lunch, etc.) because ActivityTrails records on-screen activity.

In terms of the categories for details, SenseCam will most likely be helpful for recalling details such as people, places, and actions because SenseCam images may contain these visual details and activities recorded with SenseCam will most likely involve interactions with people in specific environments. ActivityTrails will most likely be helpful in recalling actions and time/date because activities recorded on a computer may be limited to information such as what application or browser is being used. Because most of our activities on screen are influenced by the time of day, (i.e. class time, work time, leisure time, etc.) I expect temporal details to be recalled when reviewing ActivityTrails data.
In addition, there could be something special about what types of details can be recalled by participants in Group 3, who review images from both devices. Participants may have a more comprehensive recollection of details that are about people, their environment, and when certain events were going on.

Though participants may recall different details by reviewing one or both SenseCam and ActivityTrails recordings, I hypothesize that there could be more high-level recollections. This hypothesis is grounded by the research findings for those who have memory impairments [3] and also my experience in analyzing videos of participants’ recollection for Cangiano’s dissertation research. In addition, I acknowledge SenseCam images and ActivityTrails data to have details that are not recorded by traditional recording devices like a digital camera or video camera. This gives me reason to expect that because SenseCam and ActivityTrails recordings display different information, they could support recollection of details that are of higher level.

Should results differ from my expectations, results will still inform what types of details are remembered by reviewing SenseCam and ActivityTrails data. Since most of my predictions are based on implications of results from studies with humans with memory impairments [3], results that differ from my expectations will reveal that SenseCam and ActivityTrails support different kinds of detail that is recollected for humans with no memory impairments.

5. Projected Timeline

The following is a timeline of goals to accomplish that spans Winter Break through 10th week of Winter Quarter. All goals define the process of when data will be collected for the study. Goals also acknowledge that an IRB application for research involving human subjects must be completed before the study is conducted:

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