

# Towards Computational Autobiographical Narratives through Human Digital Memories

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## ABSTRACT

Lifeloggging is an emergent technology which offers the ability to capture an individual's life experiences through digital means. While emphasis has been placed on taming such voluminous multimodal collections, it additionally opens new opportunities for retelling and sharing our personal life experiences. We explore these opportunities within the domain of lifeloggging and present the research questions, challenges and considerations to be addressed to achieve meaningful autobiographical digital narratives within such collections.

## Categories and Subject Descriptors

H.5.2 [User Interfaces]: Theory and methods, User-centered design

## General Terms

Design, Human Factors, Theory.

## Keywords

Narratives, digital storytelling, MEMEX, lifelog, life experiences.

## 1. INTRODUCTION

*"Telling stories is as basic to human beings as eating. More so, in fact, for while food makes us live, stories are what makes our lives worth living. They are what make our condition human."* [11]

From recounting an interesting weekend excursion or a recent holiday to our colleagues over lunch, to a lifetimes worth of memories from parent to child, our life stories are used to communicate our meaningful experiences to one another. We share our life memories readily in this form. So important are stories to our memories that Tulving [16] suggests our memories are stored as 'episodes', or in a manner which closely resembles story-form. Not only do our life stories allow us to share and communicate our experiences with those that matter to us, they also offer us the opportunity for reminiscence and reflection. The review of past experiences in the light of present circumstances often allows unseen solutions to present problems to be uncovered. The reflection on our personal stories, and perhaps on those of others, allows us to grow, develop and progress in our lives. Stories and storytelling are integral in our day-to-day lives.

While paintings, books and diaries are ubiquitous modes by which

memory and experience are preserved, within the last century we have seen incredible technological advances which have opened the door to new modes of capture and new possibilities for the expression of life experiences. For example, digital photography is now so ubiquitously available through digital cameras and mobile telephones that it is rare one is not available to us. As a result, we can, and do, snapshot any moment from our lives with ease. Similarly digital video enables us to preserve a visual recording of meaningful events, which can be later edited into personal stories through software. Blogging and social networks allow us to chronicle our lives using a range of rich, digital, multimedia artifacts and then share it with not only our family and friends, but potentially with millions of others. These technologies currently only offer explicit capture of personal memories. A user must intervene in the event and actively decide to preserve it through a photo or video. The stories we can tell digitally are therefore limited by the artifacts we have decided to capture. Imagine, however, if all of our life experiences were passively captured and stored without the need for intervention. Then the opportunities for telling and sharing life stories would be greatly increased. This is the promise of 'lifeloggging' technology, which is making the total capture of a life's experiences through digital means increasingly feasible.

As technology has advanced we have been continually offered new media through which we can both capture and express our meaningful life experiences in new and exciting ways. Lifeloggging is one such development that is sure to offer just that – a world of new possibilities for reminiscing, retelling and sharing our personal histories.

## 2. THE MEMEX VISION

The notion of 'lifeloggging' or digitally recording our life experiences may seem more at home in the realm of science fiction than reality, however, of late and owing to increasing interest from research, it has been gaining both popularity and prevalence. Despite its relative novelty, it is far from a new concept. In fact it was originally envisaged in the 1940's by Vannevar Bush who proposed the notion of a MEMEX or a life encyclopedia in "As We May Think" [5]. In his vision, the MEMEX was a large desktop "device in which an individual stores all his books, records, and communications, and which is mechanized so that it may be consulted with exceeding speed and flexibility." He saw this desktop as having cameras by which to capture documents, screens to display information and controls and levers by which to manipulate the information and follow associative trails. An individual would sit in front of the device and scan in their important documents, photographs or books, enter text via a typewriter or even enter information or communications by speaking to the device. Bush was even so bold as to propose the capture of biological recordings,

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suggesting, for example, that the electrical impulses of the eye might even be captured to preserve an image of what a person sees. Once entered into the MEMEX, a person should be able to call upon and review any item within it with ease and efficiency by manipulating the levers, entering a relevant reference or pushing a sequence of buttons. Once added, the information would give rise to "*wholly new forms of encyclopedias... with a mesh of associative trails running through them*" and he saw the collection of all sorts of information from a person's life in one central repository as the means by which to create "*an enlarged intimate supplement to [a person's] memory.*"

### 3. CURRENT STATE OF THE ART

While this vision must have appeared to many as if of a world born of H.G. Wells, it nevertheless inspired some to work towards such a memory surrogate and Vannevar's dream for the future [5]. However, today's realisation of the MEMEX is far from the unified solution originally proposed. Currently lifeloggers must capture their life using a slew of devices and applications. These include: desktop computer activity capture to log the duration of activities undertaken and the content of documents, such as emails, webpages or Word documents on a computer; mobile activity capture to record the applications used on a mobile device, the calls made and received and content from SMS text messages; biometric data which seeks to instrument a person with a series of sensors to monitor biological responses; and context logging software which through environment sensing seeks to determine the current (social) context of the lifelogger; and passive photo or video capture to preserve a visual recording of the activities of the wearer. The data captured by these tools and techniques can then be brought together to form an extremely rich multimodal collection of digital life experiences for an individual. Some of these tools are now explored in more detail.

To enable the capture of desktop activity there are a number of software suites available to lifeloggers, such as Microsoft Research's MyLifeBits [8] and SLife [14]. These applications continually monitor the operating system to determine what application is currently in use, retrieve details about that application and capture the content from the current window in focus. Not only does this provide the content the user is currently working with but it provides an indication as to their current mode of activity, i.e. am I writing a research paper or surfing the web during my lunch break? Similar to this, software like ContextPhone [6], developed by the University of Helsinki, allow the capture of mobile phone application use. Such tools also enable the logging of the activity and use of the phone including calls and SMS messages. Additionally mobile phone based logging tools offer the ability to capture an individual's context. By sensing the co-present Bluetooth devices around a mobile device a determination of 'who' is present can be made while sensing GPS and GSM location data and proximal wireless signals 'where' the individual is can similarly be uncovered.

Finally, and of much interest of late, is the research prototype developed by Microsoft Research Cambridge, UK to record a visual account of a person's experiences. The SenseCam is a small lightweight, wearable device that passively captures a person's day-to-day activities as a series of photos and sensor readings [7][8]. Photos are captured from the perspective of the owner as the device is worn around the neck and so is oriented towards the majority of activities which the user is engaged in. Owing to its fisheye lens, anything within the view of the wearer

can be captured by the SenseCam. At a minimum, the SenseCam will take a new image approximately every 30 seconds, but sudden changes in the environment of the wearer as detected by onboard sensors, can trigger more frequent photo capture. The device requires no manual intervention by the user as its sensors detect and record changes in light levels, motion and ambient temperature and then determine when is appropriate to take a photo. For example, when the wearer moves from indoors to outdoors a distinct change in light levels will be registered and photo capture will be triggered. The SenseCam takes images very frequently and collects an average of 3,000 images in a typical day. As a result, a wearer can very quickly build a rich and extensive visual diary of their day. The battery is sufficient to allow the camera to run all day, and can be fully recharged overnight, allowing uninterrupted recording during the day.

Previous research in this domain, such as that of Doherty and Smeaton [7] that segments the artifacts of a lifelog into higher-level discrete units or 'events', has focused on the management of such rich and voluminous collections. Increasingly, attention is turning to finding items within such enormous volumes of information. [12] proposes the use of context and content techniques to find these artifacts allowing retrieval scenarios such as 'find me the photo I looked at with my friend John when it was sunny'. However, we assert that this is only the tip of the iceberg in terms of the potential of such archives. For example, it may offer a digital surrogate to the functions of autobiographical memory and as such allow the: analysis of patterns or consequences across (a series of) life events to help in making life choice; to reflect on the connection between life events and the self; to relay our life to others in order to develop a bond, intimacy or empathy. Furthermore it would allow a digital record of our life history it to be preserved for future generations and already shows potential in medical applications, particularly for those with neurodegenerative diseases [10].

Lifelogs contain both content and context information about the day-to-day activities of a person's life and from this a wealth of semantic knowledge can be extracted. This adds even greater value to such collections and builds a far richer picture of our lives than could be achieved by examining the artifacts only in isolation. Bluetooth and GPS information not only offers the context of who and where, but also provides an understanding of the person's social dynamics and interactions. This knowledge allows lifelog data to be bound and connected by social networks. Rather than just mining the content of an email or text message to uncover key words for retrieval, the content of the digital artifacts can enrich our understanding of the digital recordings of our activities. From such content, themes, opinions, and descriptive text, can be obtained to enrich the representation of the events and relationships within a lifelog collection. Using the visual features of images within the collection, such as those captured by the SenseCam, the presence of semantic concepts can be reliably detected [15]. Using such concepts, a thematic network can be developed to complement the connections in a lifelog's social network and move towards the identification of causal relationships between events.

Kevin Brooks states that a "*metric of intelligence is the ability to understand enough about the world to recount it in a story*" [4]. In order to tell a coherent and meaningful life story, a lifelog must therefore have sufficient *understanding* of the story the user wants to tell and of the events and artifacts relevant to that story. We believe lifelogs possess both the volume and richness of context

and content to extract such understanding and enable intelligent semi-automatic narration of its biographical events.

## 4. STORY TELLING AND LIFELOGS

Storytelling has been explored previously in a number of small-scale studies. In [8] images from the SenseCam along with associated GPS location information is presented as a means to recount a ‘trip-based’ experience as a lightweight story in the form of an animated slideshow composed of SenseCam images. While relevant, this approach holds no understanding of the story other than the location at which activities occurred and does not take advantage of the full range of context that is potentially available within a future lifelog. Harper *et al.* [10] conducted a study with six participants into user-created digital narratives composed from SenseCam captured images. While the outcomes are very interesting, particularly highlighting the usefulness of such images in reflection and reminiscing over life experiences, it does not offer insight into the composition of such narratives, but rather the perception of them. Additionally, given the volume at which such a collection might grow, the applicability of manual composition of such narratives is questionable.

Of most relevance, but perhaps not within the domain of lifelogs, is the work of Appan *et al.* [1]. They explore the composition of digital narratives for everyday experiences using media such as photos, gathered during the user’s day-to-day activities. They highlight several noteworthy points. First they found that more traditional narrative models, such as those used in cinema or in the Agent Stories framework [3], appear unsuited to the communication of everyday experiences. Secondly, they assert that users do not want to spend time editing or authoring their stories. As a result in the case of ‘everyday narratives’, they favour the use of an emergent story framework in which the story evolves through feedback and interaction from the user. Interestingly they also advocate the use of low-sample capture of media within their narratives, citing the complexities of volume, data management and convenience. While in some ways we tend to agree, we feel that prior work in the domain of lifelogging, such as [7], overcomes many of the data management concerns. Additionally, low sample rates or low volume collections cannot offer the richness of content and context by which to understand the patterns and subtleties of a person’s life or to garner reliable semantic knowledge. We believe that this is highly important to ensuring the meaningfulness of autobiographical narratives.

## 5. TOWARDS COMPUTED AUTOBIOGRAPHICAL NARRATIVE

Brooks previously outlined the three components for computed narratives: namely the structural, representation and presentational [3]. In light of these components we outline some of the research questions, considerations and challenges to be addressed in order to achieve autobiographic digital narratives from lifelog content.

### 5.1 General Considerations

Given the volume of content contained within a lifelog collection, we cannot expect a user to manually locate and construct individual stories from its contents. As such we must make the process of constructing a narrative retelling as automatic as possible. The user should ideally simply overview the focus of their story and the system should allow either automatic or quick and easy selection of appropriate content. We anticipate this would be achieved by allowing the user to leverage the semantic, temporal and social networks that bind lifelog events, to rapidly

browse and identify causally related content for inclusion. Furthermore, we cannot expect a user to exhaustively annotate the content contained within that collection, so the knowledge and understanding required to represent and compose a narrative for a particular life experience should be gained by automatic means.

### 5.2 Structural Considerations

Structural considerations are concerned with describing the narrative in simple abstract terms. We envision that lifelog storytelling will be, as suggested in [1], event-based. As such we must seek to aggregate the artifacts of such a collection into these semantic units. This will require extension of the work of [7], which has solely focused on SenseCam images and not the full range of content within a lifelog.

It is often likely to be the case that these events will not be retold in isolation. With a series of related events contained within the one story, consequently the causality of these events becomes extremely important to the structure of that narrative. In fact, Onega and Landa [13] regard causality as essential, transforming a sequence of events into meaningful stories. As such we must seek to automatically identify causal chains of events in order to better sequence, structure and compose such life stories.

Further to this we must consider the types of stories that the users tell about their lives and how they share these stories. This will provide us with a better understanding of how to structure the stories from a lifelog. Narrative structures are used to ensure the story ‘flows’ from beginning to end. However, it is unlikely that the commonly used structures in computational narratives, such as those used by Brooks [3] will be directly applicable in this domain. For example, it is likely that personal stories will be shared with people you are acquainted with such as family or friends, and so an understanding of the characters involved may be implicit. As such, the resulting narratives are unlikely to need the introduction of settings and characters. While it is possible that there are general structures for lifelog-based autobiographical narratives, Appan *et al.* [1] suggest they should not be explicitly structured but rather be dynamic and exploratory. Consequently, are formal narrative structures required in this domain?

### 5.3 Representational Considerations

The representation of the story seeks to capture the relationships between the various story elements in order to facilitate the *reasoning* required to build the end narrative. Through the knowledge extracted from the content and context of each event (be it semantic, thematic, or social), understanding of the story elements can be achieved. This knowledge, and the networks it forms, can be represented as the potential *narrative paths* that the story may follow. While there is an obvious challenge to achieve this knowledge representation automatically within lifelogs, it is nonetheless vital to the success of the resulting narratives and so must be addressed.

Brooks explains that the better the representation, the more choices in the narrative paths for the story and this leads to a much better end narrative. An audience should actively desire to know the outcomes of a story, and with a better narrative, the experience becomes much more engaging achieving just that. This engagement is a vital component for lifelog stories. Currently lifelog retellings are achieved through rapid playback of SenseCam images or perhaps a more advanced summary slideshow as in [8]. From our experiences with these retellings, we have found that they are only inherently meaningful to the owner and find little resonance (other than as a result of the

relative novelty of the technology) with others. The retelling becoming a passive experience for them. Through this knowledge representation we can seek to include a better understanding of the events and consequently better communicate the meaning, significance and experience of the life story.

#### 5.4 Presentational Considerations

Within the presentation of a digital narrative, the system uses the structural and representational knowledge in order to choose and sequence story elements through reasoning and with a sense of aesthetic style. This is perhaps the most challenging component of a digital lifelog narrative: how should retellings from multimodal human digital memory archives be best presented, composed and communicated?

With a lifelog containing a wealth of content and context from a range of modalities, we must carefully consider how to: 1) select the most appropriate content to the story from each event; and 2) how to integrate this multimodal content into a coherent and aesthetic presentation. Additionally, the range of multimedia content requires us to contemplate the *fluency* of each of the media modalities and how this may impact on the end retelling.

There are many other factors that should be considered for these lifelogs. For example, our conversational stories about our life experiences tend to be dynamic in nature. Our stories evolve, often subtly, with each retelling based on the feedback we receive from our audience. Consequently, no two stories are ever the same. Should these components of conversational life stories also be included in our lifelog-based retelling? If so, how can feedback from the audience best be injected into the computational autobiographic story? Should narrative paths and/or the artifacts which compose a story slowly erode in favour of fresher content to ensure the dynamism of the story? Or should, as Appan *et al.* [1] suggest, the narrative presentation be interactive to allow such dynamism while preserving the possibility of the same story, however unlikely?

#### 6. CURRENT AND PLANNED WORK

We are in the process of gathering large-scale realistic lifelog collections from four participants. The lifelog recording will be conducted for a one-year period in which we aim to collect as rich a collection as possible. To this end each participant will capture: all desktop activity and content; all mobile activity and content; personal context using Bluetooth, GPS, Wireless network presence and GSM ‘sniffing’; SenseCam images; and biometric readings. This collection will be used to explore many of the research questions outlined above and be used to create autobiographical computational digital narratives.

We are preparing a number of user studies to investigate the practices of life stories. We are aware that current retelling techniques are ineffective to communicate life stories to others. These studies will help uncover the gap between current retelling techniques for lifelogs and real-world life stories, so that we might address their shortcomings and provide insights into how a user will want to communicate their experiences and what elements from a lifelog might be used to achieve this. The outputs of these studies will have direct implications for both the knowledge and understanding extracted from the collection and how it is applied.

Following this we will implement a semi-automatic narrative system which will allow a user to construct life stories from a series of causally related events. This system will be fully informed by the findings of our user studies and reflect how we

expect a user will want to retell their life experiences. With this implemented we can then probe and evaluate how the outputs of such a system can aid reflection and sharing of life experiences.

#### 7. CONCLUSIONS

Storytelling is a fundamental part of day-to-day life, allowing us to communicate our meaningful experiences with one another and offering a means to reflect on past experiences. Given that lifelogs are composed of life experiences captured through digital means, we believe that storytelling is no less important for human digital memory collections. The wealth of content and context information contained within lifelogs offers the potential to digitally interpret and facilitate reasoning of these experiences. However, the major challenge for storytelling is to achieve such understanding. We must also explore how best to present and construct the content from a lifelog into a coherent comprehensive retelling of one or more events, in such a way that it is meaningful, enjoyable and engaging.

#### 8. ACKNOWLEDGMENTS

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