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AR Based Memory Triggering Lifelogging System

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Declaration of Authorship

This is to certify that the work presented in this thesis is the outcome of the analysis and experiments carried out by MD. Nazmus Sakib and Mehrab Mustafy Rahman under the supervision of Professor Dr. Md. Kamrul Hasan, Department of Computer Science and Engineering (CSE), Islamic University of Technology (IUT), Dhaka, Bangladesh. It is also declared that neither of this thesis nor any part of this thesis has been submitted anywhere else for any degree or diploma. Information derived from the published and unpublished work of others has been acknowledged in the text and a list of references is given.

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Abstract

In recent times, HCI-related research has shown an increasing interest in systems designed for supporting human memory. As regards, the extent to which Augmented Reality (AR) being used to experience the reality is blooming and being applied to each and every sector of HCI thoroughly. In this paper, we are presenting a system and its design, build-out and procedure to reminisce past memories using life-logging system where users will store images with related details in cloud storage based on location. When the user will come back to the location, using the concept of Geo-location-based AR, the stored image will be augmented onto the pre-existing reality. As a result of tapping onto the objects, the pre-stored images with provided details will be overlaid on the view screen. We propose that such approaches can encourage more mindful engagement with life-logging system and AR promoting positive effects linked to reminiscing.

Keywords: Augmented Reality, Life-logging, Reminiscence, Crowdsourcing, Memory Retrieval

Contents

1 Introduction

1.1 Overview

Developments in technology have meant that people can record and store vast quantities of personal information which is very much a necessity because in our ageing population the number of persons suffering from chronic diseases is increasing.[1] Persons suffering from dementia may lose the ability to recall names, past activities, and objects. Not only for the aged population, if we think about the younger generation, there are many of the minute details of past events that are not being fetched properly, sometimes the important information are being overlooked, other times it is taking a long while to get the facts necessary at the moment. For this reason, Life-logging has become a necessity and with the increase in mobile devices available to the population it now has an easy outlet or practise.

Lifelogging is a very powerful tool for Reminiscence which is the core focus of this paper.[3] A lifelog is the phenomenon whereby people record their own daily life in varying amount of detail, for a variety of purposes. The record contains a more or less comprehensive dataset of a human's life and activities. The data could be mined to increase knowledge about how people live their lives. Any system that can achieve this lifelog capability is called a life-logger.[2][4] Reminiscence is the act of recollecting past experiences or events. An example of the typical use of the reminiscence is when a person shares his personal stories with others or allows other people to live vicariously through stories of family, friends, and acquaintances while gaining an authentic meaningful relationship with a person. For example, a person may have visited a place of interest today; maybe after 2-3 years he returns to the same spot again, his brain goes 2-3 years back and tries to recollect memories related to this location. This whole act of memory recollection and recognition falls under reminiscence.

Augmented reality (AR) is an interactive experience of a real-world environment where the objects that reside in the real-world are enhanced by computer-generated perceptual information, sometimes across multiple sensory modalities, including visual, auditory, haptic, somatosensory and olfactory. Different types of AR methods include: Projection based, Recognition based, Location based AR.

1.2 Thesis Outline

This paper aims to show the viability of augmented reality display as method of reminiscence along with the traditional life-logging systems. It presents and discusses a reminiscence process which aim to build and maintain episodic memories of life. The reminiscence process utilizes life-logging entities, namely time, place, persons, and automatically recorded media, all aggregated into activities.Following relevant studies, the present study examined the applicability of reminiscence therapy for improving cognition and social emotions in people using nostalgic physical items, images as assistive device.Based on the above, this study enacts augmented reality (AR)[6]techniques to present nostalgic story modes including family or friends-related nostalgic images, nostalgic implements, nostalgic moments etc for people to enjoy immersive memories of old days. The rest of the paper starts with an overview of our motivation, related work and our proposed solution to the existing system.

2 Problem Description

2.1 Problem Identification

The existing methodologies are not enough to enhance reality and build real-time experiences in terms of visualization while retrieving memories. Even if some of them are helpful to reminisce but there is always trade offs which is problematic.

2.2 Motivation & Scopes

Augmented Reality (AR) makes the real-life environment around us into a digital interface by putting virtual objects in real-time. Augmented Reality uses the existing environment and overlays new information on the top of it unlike virtual reality, which creates a totally artificial environment.[9] Augmented Reality can be seen through a variety of experiences. Recent developments have made this technology accessible using a smartphone which led to development of wide varity of augmented reality apps.

Augmented Reality Apps are software applications which merge the digital visual (audio and other types also) content into the user's real-world environment. There are various uses of AR software like training, work and consumer applications in various industries. Humans have always used visual-based methods to help them remember information, whether it's cave drawings, clay tablets, printed text and images, or video.

Lifelogging and other personal informatics systems help users collect data for self-monitoring and reflection. Human memory is unquestionably a vital cognitive ability but one that can often be unreliable. External memory aids such as diaries, photos, alarms and calendars are often employed to assist in remembering important events in our past and future.[5] The recent trend for lifelogging, continuously documenting ones life through wearable sensors and cameras, presents a clear opportunity to augment human memory beyond simple reminders and actually improve its capacity to remember. Here, we have tried to integrate AR and lifelogging system to get better output in case of momeory recall.

To simply put the motivation of our work, we can say-

- Firstly, No Geo-location based AR for reminiscence
- Secondly, Memory triggering event is not properly utilized.
- Thirdly, Make the human brain echo its perception of the original event as precisely as possible.

2.3 Research Challenges

Currently, every available AR headset is a bulky piece of hardware that may be too expensive for the masses. Also, a majority of AR headsets need to be tethered to a computer, making the entire experience limited and inconvenient. Alternatively, consumers can use their smartphones or tablets for AR applications. However, mobile AR faces major issues in displaying visuals accurately. For instance, mobile sensors such as accelerometer can be disturbed by electric interference, which is commonly witnessed in urban areas. Additionally, smartphone cameras are built for 2D image capture and are incapable of rendering 3D images. Hence, the hardware required for AR technology needs to be enhanced before mass adoption.

Many different approaches have been made to recall memories in cases of memory impairment patients. In those methods, some built in devices such as smart phone, sensecam, GPS sticks etc have been used. These approaches requires human dependency. We are trying to go for an approach where we will reduce human dependency along with less effort to activate reminiscing when the participants want. There lie several technical challenges.[8] Also to trigger memory by viewing the augmented object it demands to be as real as possible. 3D image could be an option. But to convert every general 2D image to 3D will be huge task supporting which is not feasible for a smartphone. So, other parameters needs to be considered to compensate this issue so that the proposed method can withstand. Lifelogging is also another challenge where users need to insert relevant data along with each pictures which can be repetitious. So, there should be an option to skip information which is not very important for any particular pictures.

There are several parameters to trigger memories. To structure any lifelogging system we need to consider different types of reminiscence approaches.[9] Memory recalling, recognition, recollection, reflection are different types of reminiscing techniques and we need to choose one from these. Now, we need to be confirmed that any particular approach that we take will be best suited for our proposal.

2.4 Existing Methodologies

[1]Lifelogging system for reminiscence is not new procedure in terms of memory triggering. In every lifelogging based reminiscence process, an assistive device; as in: Sensecam, a device which is wearable and takes pictures based on motion, GPS location and other factors. There are also some individual devices as in camera, voice recorder, GPS tracker for collecting the information for lifelogging system. But these individual devices are not feasible enough for collecting information as the user may find it unfavorable.[2] There is also another device called Memorylane which is wearable and takes pictures daylong as the user moves everywhere. Then another caregiver helps to find the memory cues for further memory triggering.

3 Background Study

In terms of the intended key terms of our proposal, we have gathered necessary background knowledge which will be applied in implementation of the proposed system.

3.1 Lifelogging system for memory bump

[7] The idea of a Life-log or a personal digital archive is a notion that can be traced back at least 60 years. The vision is that technology will allow us to capture everything that ever happened to us, to record every event we ever experienced and to save every bit of information we have ever touched. Indeed, in recent years, this vision has been given a new lease of life, recent impetus and enthusiasm coming mainly from a number of technological advancements. These include the development of smaller, lighter-weight capture devices and sensors (capturing everything from image, location and ambient sound to heart rate), advances in wireless networking, and massive increases in digital storage capacity making the archiving of huge amounts of personal data possible. Now, as never before, technology offers the possibility of capturing data from everyday life both continuously and unobtrusively.

As a result, a number of new efforts to build systems and devices to support life-logging have emerged in recent years, as in: SenseCam, a device containing a camera and embedded sensors worn around a user's neck which automatically takes a series of still images over time as well as capturing other aspects of life events such as ambient light levels, temperature and movement. In addition to SenseCam, there are many other life-logging systems being developed both in research laboratories and as commercial products.

Many potential benefits have been put forward for such systems, but by far the most common proposition is that, by capturing data about our daily activities, life-logging systems will offer effective support for memory of our own personal past. These arguments range from supporting the reliving of or reminiscing about personal events, to more specific functional support for memory including finding lost objects or documents, remembering names, remembering whom you met, details of conversations, and remembering past actions or events. In other words, life-logging applications claim to support a whole range of ways in which we can look back, re-live, re-examine, and search through our past experiences.

Such systems generally make some (usually implicit) assumptions by their very design. One is that the more data captured the better in helping us to look back. So, these devices aim to capture and store as much data as possible in the course of daily life. Naturally, one result of such undertakings is a huge amount of data that must be structured, organized and searched through. However, there is little systematic evidence that the data offered up by life-logging systems do in fact support human memory, and little research to help us understand how they might do so.

3.2 Reminiscence

Reminiscence is the act of recollecting past experiences or events. An example of the typical use of the reminiscence is when a person shares his personal stories with others or allows other people to live vicariously through stories of family, friends, and acquaintances while gaining an authentic meaningful relationship with a person.

In normal scenario, reminiscence can be a memory bump to retrieve past memories, but for the older adults the reminiscence is more of a necessary assistance.[11] Also, for those people who suffer from memory impairment. As a solution of this cases, [5] a smart conversational agent is used as an assistant to help the elderly people to reminisce. A chatbot which is designed to talk with the older adults through which different memory triggering events or scenarios are intentionally arisen. This chatbot is somewhat more sustainable in terms of a human assistant as any person would not have that steadiness as a bot.

This chatbot would have the background information of that particular older person and would try to draw the conversation towards at a point where the memory triggering factors may lie.[5] The follow up conversation will not only be based on text, also pictures which were taken several years ago at a different place with some familiar people and music, as we know reminiscence profoundly depends on background music or some old songs, which may trigger some events related to them. Also, each reply will be based on the immediate earlier text from the older adult, which will be analyzed to check the reaction of that person and the next reply will be based on that. The information collected from the conversation are stored to use for future purpose. This procedure mainly works on episodic memories which is similar to our proposed topic.

3.3 Cloud technology

Augmented Reality is a combination of real-world data and computer data to create a unified user environment. For the real-world data, lifelogging technique is rigorously used where the user information is stored. This information is retrieved later for creating the latter part to create a real-time experience.[8] As, the user information can be huge, the convenient way is using cloud technology. Virtual memory is comparatively safe and efficient in terms of physical memory. [6] Cloud technology can be used for several purpose and as it is accessible from anywhere, it is preferably used.

Cloud system or cloud computing technology refers to the computing components (hardware, software and infrastructure) that enable the delivery of cloud computing services such as: SaaS (software as a service), PaaS (platform as a service) and IaaS (infrastructure as service) via a network (i.e. the Internet). Cloud system users access computing services using web browsers, which represents a computing model that shifts the computing workload to a remote location. Internet based email applications are a prime example of a cloud system that provides a platform for the delivery electronic messaging services. Cloud computing is also sometimes referred to as utility computing, since consumer usage of cloud systems is metered and billed in a manner similar to a commodity like water or electric services.

3.4 Augmented Reality

Augmented reality (AR) is an interactive experience of a real-world environment where the objects that reside in the real world are enhanced by computer-generated perceptual information, sometimes across multiple sensory modalities, including visual, auditory, haptic, somatosensory and olfactory.[12] AR can be defined as a system that fulfills three basic features: a combination of real and virtual worlds, real-time interaction, and accurate 3D registration of virtual and real objects. The overlaid sensory information can be constructive (i.e. additive to the natural environment), or destructive (i.e. masking of the natural environment). This experience is seamlessly interwoven with the physical world such that it is perceived as an immersive aspect of the real environment. In this way, augmented reality alters one's ongoing perception of a real-world environment, whereas virtual reality completely replaces the user's real-world environment with a simulated one.[15] Augmented reality is related to two largely synonymous terms: mixed reality and computer-mediated reality.

3.5 Crowdsourcing

[10]Crowdsourcing touches across all social and business interactions.Crowdsourcing is the practice of engaging a 'crowd' or group for a common goal — often collaboration, innovation, problem solving, or efficiency. It is powered by new technologies, social media and web. Crowdsourcing can take place on many different levels and across various areas. Assembling people based on their common interest which will be basically seeking for a particular purpose, crowdsourcing plays a significant role.

4 Literature Review

4.1 Lifelogging system using Sensecam to reminiscence

[1]All of the lifelogging systems are directly linked with the advancement in the capturing, storing, processing and display / visualization tools. One of the earliest advancements in this field came through the use of a capturing and storing device named as SenseCam[2]. What SenseCam does is pretty simple yet very effective. The user wears the device around his neck and goes about his daily life. Sensing the change in location or after a specified period of time the camera takes pictures and stores them. This method is strong because it takes in all of the images that a person in general would not have bothered to take in to account; later that day whenever the person tries to go through those images or store them to some device to watch them later on, it creates a good overview of the episodic memory which definitely helps the user to reminisce the moments, actions and individuals related to this specific event.Another feature of the SenseCam is the web browser, where the users can connect the images from the camera to the web browser. Since most users related to reminiscence therapy is elderly persons with little to no experience in using computers, steps had been taken to minimize the efforts required to go through the browser and upload the pictures into the SenseCam web browser.

Figure 1: The SenseCam lifelogging device

[13]With advancement in technology and science, different lifelogging tools can be seen now a days which keeping the ideas of SenseCam in mind, brought out changes and efficiency in how they take in inputs, how they store and what they output and how they do it. One of those system was named Review Client which uses the principle of Reminiscence Therapy and makes it possible to visualize the life log as sets of Activities[4]. Reminiscence Therapy (RT) involves the discussion of past activities and events with other persons, usually with the aid of tangible prompts such as photographs, daily life items, music and archived sound recordings. RT is one of the most popular psychosocial interventions in dementia care, and is highly rated by staff and participants. This has mainly 2 parts: 1) the memorylane and 2) the reminiscence interface.

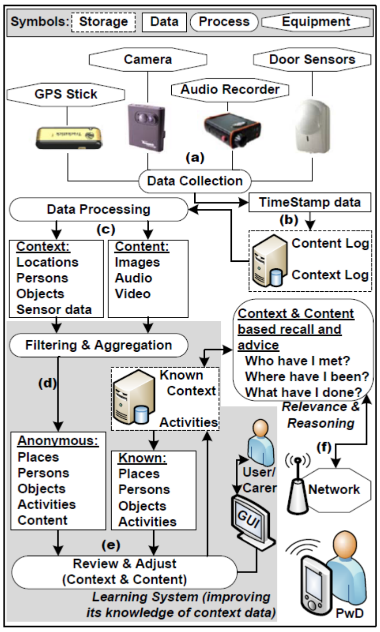

Figure 2: The MemoryLane Architecture

In the memorylane architecture, the steps included data collection, data processing, aggregation, review-adjust. Finally, in the reminiscence interface chronologically the events and the related images and the peoples associated pops up in the home screen and the patient or user maybe able to view and recall the past experiences related to the incident or event.

4.2 Lifelogging system using cue to reminiscence

[2]Time to time the patients or users are unable to recall all of the memories, for example,EMI- Episodic Memory Impairment patients have a caregiver with them to talk and remember the different past events[3]. Different life loggers are again necessary in these cases and a strong and emergent lifelogger system will be described here. In this new type of lifelogger, there are 3 phases of operation 1)Input phase 2)Cue Chooser 3)Review with Memexerciser.

In the input phase, there are again 3 input methods: Image input, audio input and location input. In the Cue chooser phase, the caregivers of the patients are able to access the system where they select one or multiple cues related to the incident which will be a minimalistic input in nature providing a maximum output, i.e. some incidents may not require audio , some may require geolocation coordinates, some may require both etc. These will be selected by the caregivers according to necessity and use cases.

Finally in the review with Memexerciser phase the users are able to view the stored images with the digital audio or location values along with the caregivers which supplies as a strong fighting option against victims with EMI.

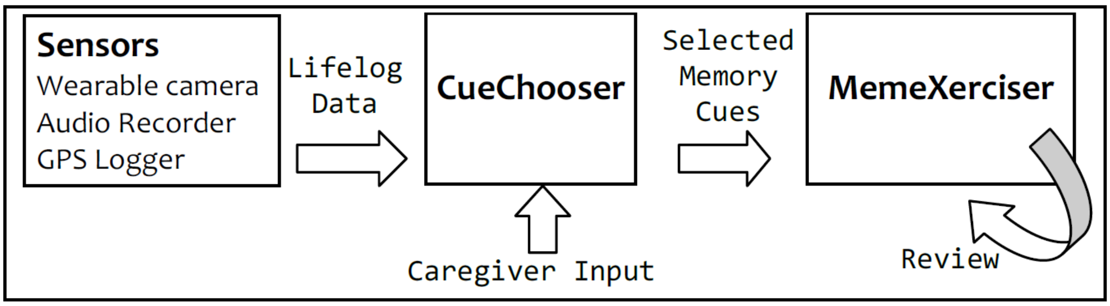

Figure 3: System Design: Capture, Selection, and Review

4.3 Smartphone based lifelogging system

This article has some significant work that was related to life-logging and reminiscence by the use of a newly developed system, Smartphone based Lifelogger[1] . This system brings out a new approach to memory recall and recognition because the input system in this case is somewhat different from the rest of the existing systems.

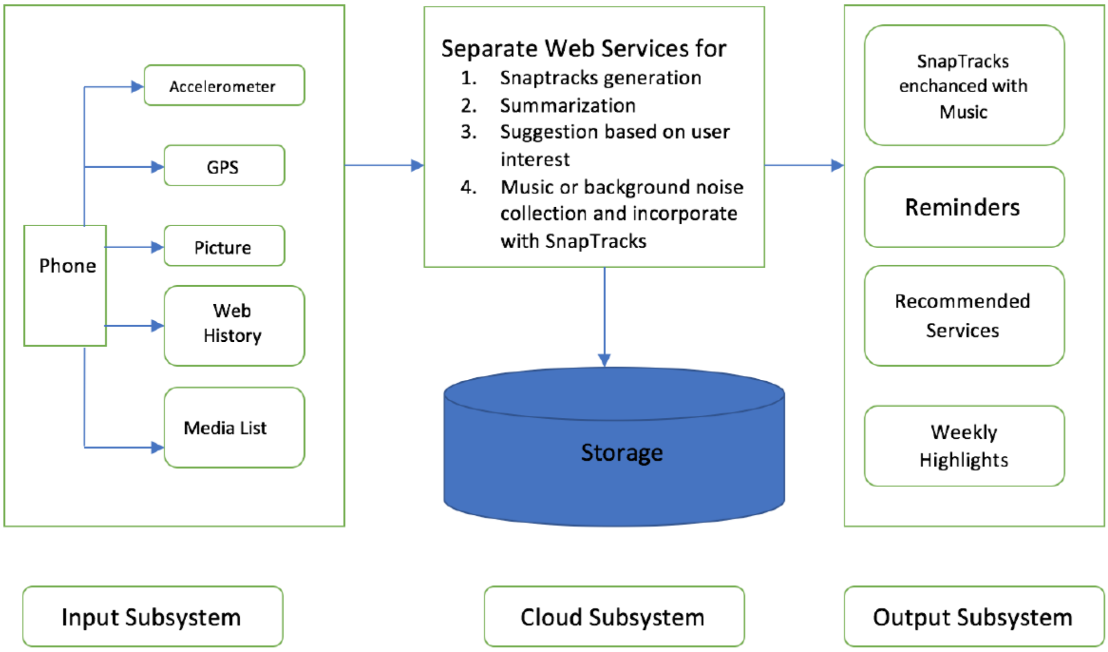

Figure 4: Proposed System

Along with the visual cues of memory trigger the audio cues are also considered here. For example, some songs maybe associated with the certain image and if the song and the image are retrieved together and played simultaneously, it can definitely have a far reaching impact and can bring out the desired goals of reminiscence easily. Even if some music or songs are not associated with the image, definitely some background noise is associated over there which has the same effect as the case with the song attached to the image is. Thus along with the regular details of the image like location, date, name, temperature, now some background noise also comes into play which is no doubt more efficient than the existing methodologies

4.4 Images as triggering parameter for recalling past memories

[3]SenseCam images do facilitate people's ability to connect to their past, but that images do this in different ways. So they made a distinction between "remembering" the past, and "knowing" about it, and provide evidence that SenseCam images work differently over time in these capacities. They also compare the efficacy of user-captured images with automatically captured images and discuss the implications of these findings and others for how we conceive of and make claims about life-logging technologies. They tried to figure out 3 things :

- Whether or not subjects wore SenseCam
- Whether images taken with SenseCam were automatically taken or user initiated
- Whether memory was tested at a short or a long interval (3 versus 10 days)

Based on the procedures, subjects were asked to wear a camera for eight hours (10am-6pm) each day collecting the cameras from and returning them to the same location in the mornings and evenings.On arrival on the first day, subjects were instructed how to use the camera and were told that from time to time it would automatically take pictures. In addition, they were asked to take at least 40 pictures a day (at least 20 before 2 pm, and 20 after 2 pm) by manually pressing a button on the camera They were instructed to take these photos "as if you are creating a visual journal of your day". Subjects were subsequently asked to return on days 6 and 12 (Group A) or 5 and 13 (Group B) to complete the study. Recall. These tests were designed to discover which events that occurred on the day in question subjects could recall before and after viewing a given set of images. Each session tested one of the Control days and one of the Sensecam days,dividing up each day into morning or afternoon. Half of the subjects were tested for a Control day first, and half for a SenseCam day first.

Initial free recall: Subjects were first asked to recall as much as they could about the first half of the day in question.They were given two minutes in which to write a description onto a paper worksheet providing detail about "what","where", "when" and "who" for each remembered event.

Viewing and ordering of images: Subjects were then presented with a randomly-ordered series of ten images (see Figure 1). If tested about a SenseCam day, these were their Active or Passive images from one half of that day. Alternatively, if tested about a Control day, they were shown Active or Passive images taken by another person they were experimentally "yoked" to. In this case, this meant another subject also participating in the study who wore another SenseCam device on the same day. Whatever the case,subjects were asked to arrange the pictures in the order in which they thought they had been taken.

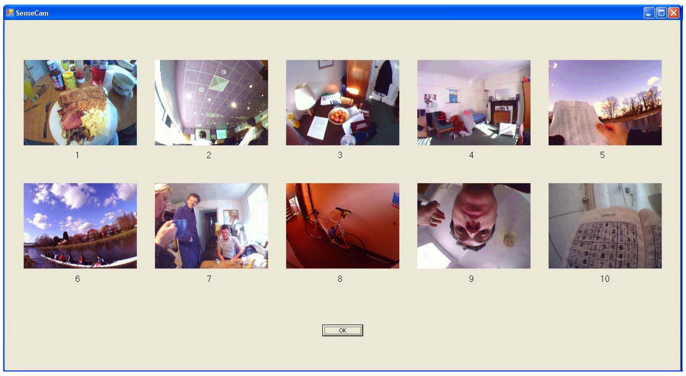

Figure 5: An example of SenseCam images as presented in the temporal "ordering" task

Final free recall: Once this had been completed, subjects were given another two minutes in which they could add to or amend their account of the first half of that day using a different colored pen. Again, they were asked to tick "Remember", "Know" or "Guess" for these amendments. It was suggested subjects ticked "Know" if something in the 5 images suggested that an event must have occurred, even if it was not truly remembered.

Recognition: After the recall test, subjects were tested to see if they could distinguish their own images from those taken by another person (in this case the same subject they had been yoked to in the recall test). None of the images in thisphase had been previously presented.Subjects were presented with an image and asked to respond“Yes” or “No” on the keyboard as to whether the image was one of their own (irrespective of whether it was taken actively or passively) or not. Subjects were given a maximum of 10 seconds in which to identify the image,making this judgment for 40 randomized images in which half of the images were taken by the participant being tested(ten Active and ten Passive) and half taken by a different participant (ten Active and ten Passive). Then through some result evaluation we can see that whether SenseCam images significantly improve people's memory for past personal events. The simple answer is “yes” but the data from this study paint a richer picture about how such images make connections to one's personal past.

So, it can be said that, This study provides evidence that at least some kinds of cues captured by life-logging technologies, in this case SenseCam images, can be shown to provide effective links to events in people's personal past. Further, it suggests that the automatic way in which SenseCam captures these images results incues which are as effective in triggering memory as images which people capture on their own initiative. In fact, with regard to the recollection of past events, these passively captured images may even cause people to remember more events than they would with their own actively-captured images.

4.5 Reminiscence Therapy Using the Integration of Virtual Reality and Augmented Reality

[8]Integrated system of virtual reality (VR) and augmented reality (AR) to construct a visualized reminiscence therapy system, which provides not only reminiscence entertainment but may also aid in dementia prevention for healthy and sub-healthy (a therapeutic working concept which defines an intermediate stage between health and disease) elderly people. Through nostalgic elements triggered by the AR/VR three-dimensional model and video/audio interaction, the feasibility of our integrated system for reminiscence therapy is thus verified. Through

reminiscence therapy, memories and thoughts can fully be activated as a therapy for elderly people. The visualized reality system developed in this study can further promote the social interactional satisfaction of elderly people.

VR:VR is constructed through any of the following three approaches:

- Geometry-based VR: Also known as graphic-based VR, this involves the creation of objects. required for a three-dimensional (3D) simulated scenario using 3D model-building software,
- Image-based VR: This was introduced to solve problems related to the frame rate in graphic-based VR, which can be exacerbated by bandwidth insufficiency in networks
- Hybrid VR: This combines the advantages of graphic- and image-based VR, both of which exhibit shortcomings in practical applications, to store images and data for video playback.

AR:[8]The main point of AR is to integrate 3D virtual objects into real-world environments to strengthen perceived interactions with these environments and to enable users to rapidly acquire useful and relevant information. Virtual objects can reveal information that users cannot perceive with their physical senses, enabling them to smoothly complete tasks in the real world. Unlike VR, which is designed as a substitute for the real world, AR integrates virtual information with the real world.

AR is a variation on VR. VR places users in computer-simulated realities, whereas AR overlaps reality with virtual images presented to users. Therefore, rather than replacing reality, AR merely augments it. In addition, Azuma (1997) stated that there are three necessary characteristics for establishing AR: (1) a combination of virtual and real spaces; (2) instant interaction modes; and (3) 3D spaces involving X, Y, and Z axes.

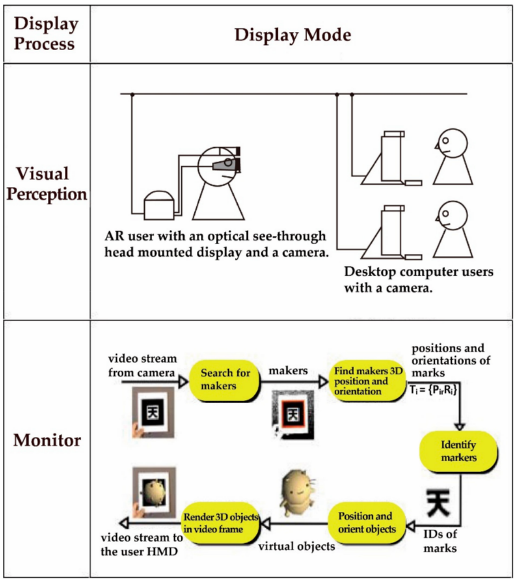

Figure 6: Augmented Reality (AR) display modes

[8]Finally, A historic house scene was imported into the Fader VR system using the above mentioned 360 degree video. This video was edited using Power Director, and visual effects were implemented using Adobe After Effects. Subsequently, the AR image cognition systems on Vuforia and MAKAR were incorporated with the Unity engine to develop the reminiscence therapy system. Text, music, and images of scenery from the 1950s and 1960s were uploaded to the Fader cloud as VR trigger points for scene switching on the VR headset (Figure 5). The completed Fader VR files were transferred to the Samsung Note 5 Android phone, which was then placed in the VR CASE headset, allowing testers to explore the nostalgic virtual space.

Finally, Reminiscence therapy can be applied to alleviate weariness and meaninglessness related to aging in elderly people. This type of therapy stimulates elderly people to remember pleasant events. Through reviewing past events, they can reconstruct their overall awareness of their life value, philosophy, and stories, thereby developing self-care, cognition, and social interaction abilities and adopting strategies to solve current problems. Gradually, these elderly people can develop their self-identity, improve their psychological health, and enhance their life satisfaction.

4.6 Methodological Framework for Crowdsourcing

Case studies cover the different phases of the research lifecycle, beginning in the research design phase by examining open innovation challenges, moving to the implementation phase of crowdsourced cognitive interview data collection, and concluding with supplemental data collection. [10]Successful implementations of crowdsourcing require that researchers consider a number of dimensions, including clearly articulated research goals, determination of the type of crowdsourcing to use (e.g. open innovation challenge or micro-task labor), identification of the target audience, an assessment of the factors that motivate an individual within a crowd, and the determination of where to apply crowdsourcing results in the overall research lifecycle. Without a guiding framework and process, investigators risk unsuccessful implementation of crowdsourced research activities. The purpose of this paper is to provide recommendations toward a more standardized use of crowdsourcing methods to support conducting research.

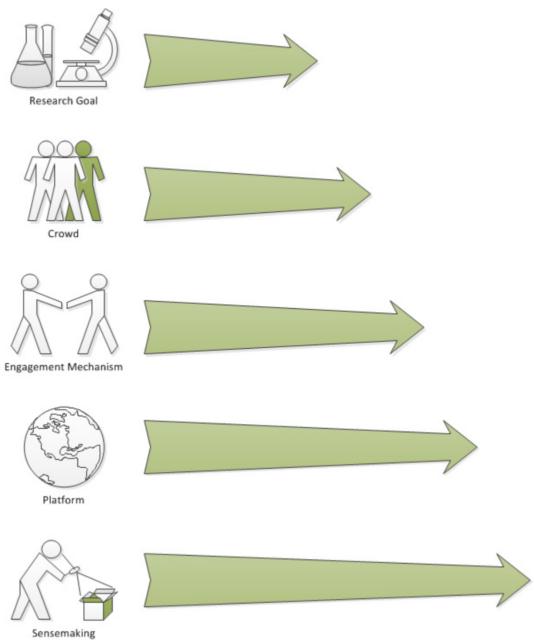

Figure 7: Components of Crowdsourcing in Research

There is a flow to developing these components that begins with the research goal.

Establish the Goal of the Research: The research goal is the first component that should be established by an investigator as they consider crowdsourcing. Clearly articulating the aim of the crowdsourcing initiative before beginning should be considered best practice.

Define the Target Audience: Once the research goal is established, the audience required to achieve this goal can be defined. Researchers must know their crowd. Depending upon the research goal, specific audience segments may need to be targeted. For example, if the goal is to determine the mail return rates from the United States Census, then researchers will need to target individuals capable of contributing data required to conduct this sort of analysis (e.g., data scientists).

Identify Suitable Engagement Mechanisms: Knowing the audience will help the research team target recruiting and participation in the crowdsourcing event and inform the crafting of an effective engagement mechanism. This mechanism should be designed to appeal to the likely motivations of individuals within the crowd, encouraging them to take part in the crowdsourcing activities. This is one of the most important steps in the planning process.

Determine a Technical Platform to Support Activities: A suitable platform to support the crowdsourcing activities is identified after the researcher has defined the target audience and designed an engagement mechanism. This platform provides a forum for communicating and exchanging value with participants. Selection criteria for a crowdsourcing platform should include the availability of the resource to members of the target audience, the ability to integrate relevant engagement mechanisms to drive ongoing participation, and the means to distribute incentives after completion of the activities.

Inventory Data Quality Standards: Finally, investigators should define standards to characterize usable data, or other crowdsourced returns, that can be applied toward satisfying the research goal. Ensuring that there is alignment between the incoming data from a target audience and the research goals will increase the likelihood that these goals will be achieved.

So finally, Crowdsourcing holds promise as a means for researchers to achieve new and ambitious research goals; however, without a guiding methodological framework, researchers run the risk of being unsuccessful in their crowdsourcing endeavors. Incentives should appeal to the motives of the crowd. Only when motives and incentives are aligned will activation occur. Once activation occurs, researchers should consider activation supporting mechanisms. Monitoring the behavior of participants is also encouraged. As our case studies showed, sometimes tweaks will need to be made to ensure the researcher gets the proper data back to achieve their goals.

5 Proposed Methodologies

The device we used for our experiment was a smartphone having the simple properties like GPS locators, networking facility, camera, accelerometer and internet connection. The smartphone that we or the users intend to use must have a smartphone with some minimum processing capability. This is necessary because the functionalities and codes to run require some additional processing powers that are there in the mid to upper range smartphones available in the market now a days. We have allowed only manual uploading of data into the system because in our proposed system the user himself will be responsible for creation of points of interests that will allow them to trigger previous memories when they have visited the place later on.

As for input, the user will have to select some images that he would like to select for reminiscence and some additional information associated to it. The additional input parameters will be described later on into the system.

Then comes the information storage into the cloud subsystem, the cloud will not only be responsible for storing the data sequentially and systematically rather it will also have to do some processing on the cloud. The system will incorporate some crowdsourcing features into the system. The crowdsourcing features will be incorporated in the cloud.

Our output subsystem will have the following feature, it will output the interest points known as POINTS OF INTEREST or POI in short, whenever the user reaches to that location where that poi was previously stored. An interesting feature of the output subsystem is that because of the crowdsourcing feature (described later on) the user might not have himself clicked but someone else might have clicked and tagged him into that poi. So although the user can view that poi he is not the owner of that particular POI ,but it will not affect the user experience that he may get while browsing the poi and checking the information associated with it.

5.1 Subsystem

As shown in the Figure[8], our proposed system has 3 subsystems. The Input Subsystem takes input using the Smartphone and sends it to the Cloud Subsystem which handles storage and processing capabilities. Finally, the output subsystem, provides output that is meaningful for the user.

5.1.1 Input Subsystem

The Input subsystem consists of the following components:

- Accelerometer: The accelerometer is used for taking movement input for the system. Users' movements and their positional information is logged into the system

- GPS: GPS data is needed for Snaptracks positioning. Source is a smart phone. GPS with a timestamp is used for mapping an event to a time and a place. In a nutshell,it will give track record of users day to day activities as a feedback; a key functionality of lifelogging systems. The acquired track record is displayed to the user. This data can be used to figure out the users regular routine and help the user to maintain it

- Camera: Taking pictures for logging automatically has become the norm with lifelogging systems . Photos will be taken when the user wants to take a picture of something memorable or once the user moves to a different location, photos would be taken at regular intervals.

- Date : the system will take the inputs of date while associating the images and categorizing them. This will be an automated input, i.e. the user will not be bothered by it.
- Time : the system will take the inputs of time while associating the images and categorizing them. This will be an automated input, i.e. the user will not be bothered by it.
- Weather : the system will take the inputs of weather information like temperature and humidity, while associating the images and categorizing them. This will be an automated input, i.e. the user will not be bothered by it.
- Event Name Description : This will be a manual input, where the user has to do it by himself. He will need to input the name and description of the event for which he has clicked that picture and decided to store it for reminiscence. It can be from a simple walk in the park to some bigger occasions like weddings.
- Location Name : Along with the coordinates from the GPS, a user can also input some local or known names of the places where has taken the pictures of. This is also a manual input
- Photo Credit : User can also set the name of the person who has taken the picture, i.e. if my friend has clicked a picture of me, I can add him as the collaborator or provide him the credit of taking the picture. This field is manual.
- People Associated :The picture clicked can also contain many people in it. The system will allow tagging them individually and this will create the opportunity of crowdsourcing. This has to be a manual input from the users end.

- Other tags : Memory triggers work best when associated with objects .For this reason we have allowed a field for it also. This also has to be manual.

5.1.2 Cloud Subsystem

The cloud subsystem will have 2 parts:

- Storage: the cloud subsystem will incorporate data and store them according to the POI.The information the user has stored will be saved accordingly there.

- Crowdsourcing: The tagged people will be crowdsourced and connected via this feature. The user will get tagged if someone decides to tag him and he can do so as well to others. He will be able to view poi of other peoples as well. This processing of crowdsourced data will be done on the cloud

5.1.3 Output Subsystem

The output subsystem will be responsible to give the users the necessary feedback that they desired. For this reason the user has to turn on the app and use the view image module. The user whenever he reaches to a poi whether it be created by himself or got tagged will be notified through some android notification where he can access to and turn on the camera through the app and view the area around him. He will be able to see some poi around him since the poi data will be stored and retrieved when he comes to that place. The poi data will show the image associated along with some of the information that he had previously saved while providing input and that is how he will be able to view the system and recall memories of that event whenever he is at that location.

5.2 System Flow

The system flow diagram here will show how the data flow is occurring here:

From the input subsystem after getting the required inputs the data will flow into the cloud storage and be saved there. During this phase, the processing part

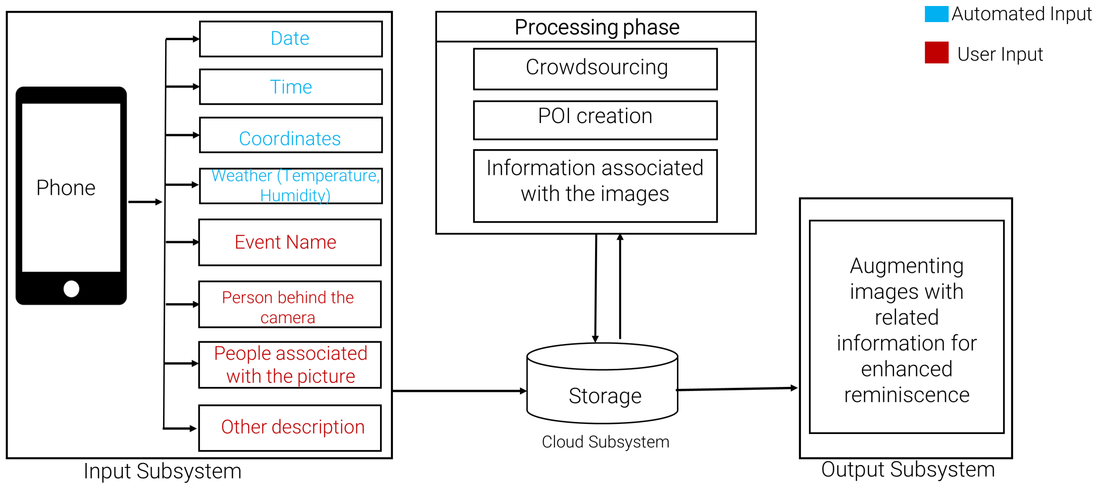

Figure 8: System Flow from the system perspective

of the crowdsourcing and poi creation will occur virtually on that location. After that when the user will come to that location, and view through the application using his camera, he will be able to view those poi and while clicking the poi he is able to view the data stored there,e.g. the images and the associated data.

5.3 System Implementation

For our system to be implemented we had picked the most available form of smartphone which is android and thus we had worked on android studio for building our application. Because of the complicacies of working with augmented reality applications we decided on using the WIKITUDE SDK, because it contains some built-in function and API calls that ensures easy build up of geo-location-based AR implementations. We were also lucky enough to use the sample codes provided along with the SDK ,working on which we were able to build the system. Some snaps of the implementation are given below on the next page, the image will show some poi that were created and some dummy values associated with the POI while tapping on them:

We had created 2 poi, one with poi 1 and another with poi15, if we tap POI-15 we can see the following data.

We had also created a prototype and what output we intend to show in the pro-

Figure 9: Points of Interest built using Wikitude SDK

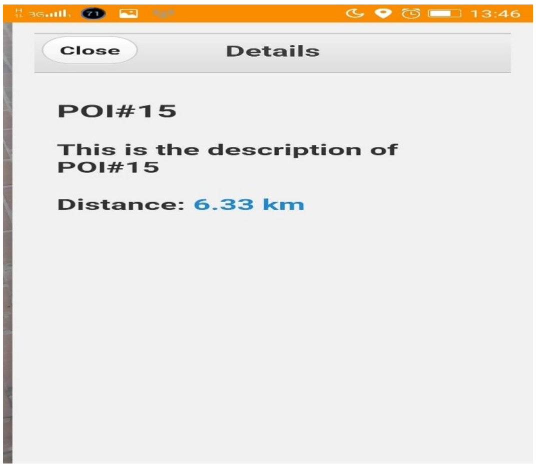

Figure 10: Details of POI

totype,is given below on the next page. The prototype shows some of the basic functionalities and characteristics of the desired output. We had used the AXURE RP9 for prototyping the project and it was outputted in html format.

Figure 11: A snap from the prototype

6 Result Evaluation

6.1 Analysis

To see whether our system really boosts reminiscence as it is supposed to, we developed our own experiment. We recruited 12 participant.The participants are all university 4th year students without any prior history of memory impairment issues. We considered a recent event happened at IUT, Farewell 2019 and based on that event we set 6 questions which were answered before and after using the system. This questionnaire session took place after 15 days prior to the event.

6.1.1 Questionnaires

What is questionnaire: A questionnaire is a set of questions typically used for research purposes which can be both qualitative as well as quantitative in nature. A questionnaire may or may not be delivered in the form of a survey, but a survey always consists of questionnaire. A questionnaire is a set of questions typically used for research purposes which can be both qualitative as well as quantitative in nature. A questionnaire may or may not be delivered in the form of a survey, but a survey always consists of questionnaire.

Set of questionnaires used : For recalling memories for any particular event we need to consider several properties while setting up questionnaires. According to that, we have considered visual, coherence, time, visul perspective, own's action and sensory details for six questions respectively.

1. During the farewell 2019 event for Batch'15, can you name 10 people who got onto the stage from batch 15 ?
2. Name the bands that had performed that day.(hint: there were 4 bands in total)
3. What are the sequences and timings of the performances of the bands ?
4. Can you describe one significant moment with details?
5. Can you name 5 juniors you have taken photos with?
6. How was the environment and weather?

The questions had been carefully set up in light of some sample images shown to them related to them and the event that set up a good criteria to understand whether successful recall of memory was achieved or not. Following the standards of a standard questionnaire, the whole setup was carefully taken into consideration.

Scoring: Each of the questions were marked evaluating the scores of the individuals. The questions did not carry the same values as each question had varying level of effort associated to answering them through memory recall.

- Question 1: 10
- Question 2: 4
- Question 3: 5
- Question 4: 5
- Question 5: 5
- Question 6: 1

6.1.2 Result analysis

After getting the answers from all 12 participants, we calculated the average of their scores and used ANOVA(Analysis of Variance) test to evaluate the result.

Questions	Using the system	Without using the system
Q1	4.9	3.5
Q2	4	3.9
Q3	4.3	2.2
Q4	4.9	4.2
Q5	4.7	4.3
Q6	3	2.8
	$X_1 = 4.3$	$X_2 = 3.5$

Figure 12: Table of average score of 12 participants

After that we plotted them to a bar chart which shows the dissimilartites between two samples.

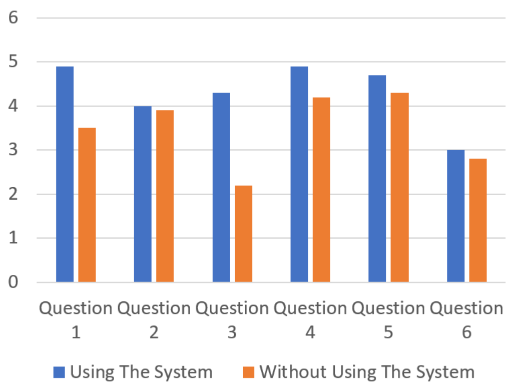

Figure 13: Bar diagram of the average values

From this table we denoted Degree of freedom for sum of squares within (SSW), sum of squares between (SSB) and degree of freedom for both SSW and SSB. From, this data value we got to evaluate F-statistics value.

As we have used null hypothesis testing, so we have to determine the F-value to compare whether our system withstands.

Null Hypothesis: There is no changes in term of reminiscence after using the system.
Alternate Hypothesis: There is changes in term of reminiscence after using the system.

Now, we have got SSW = 5.03, DOF of SSW = 10, SSB = 2.03 and DOF of SSB = 1.
If we consider F(1,10) value from F-statistics table for level of significance = 0.1, then our evaluated value has to be greater than the F(1,10) value so that we can reject our null hypothesis.

\	df_1=1	2	3	4
df_2=1	39.86346	49.50000	53.59324	55.83296
2	8.52632	9.00000	9.16179	9.24342
3	5.53832	5.46238	5.39077	5.34264
4	4.54477	4.32456	4.19086	4.10725
5	4.06042	3.77972	3.61948	3.52020
6	3.77595	3.46330	3.28876	3.18076
7	3.58943	3.25744	3.07407	2.96053
8	3.45792	3.11312	2.92380	2.80643
9	3.36030	3.00645	2.81286	2.69268
10	3.28502	2.92447	2.72767	2.60534

Figure 14: F-statistics table for alpha = 0.1

After the calculation, we get the value = 4.04 and from the f-statistics table for alpha = 0.1 gives us 3.28 which is smaller than our evaluated value. So, we can reject the null hypothesis. This essentially means our system works better than the usual system.

7 Future Work

In out proposed paper, we have used only images with some related information as lifelog data. But for reminiscence, other data types are also important because images are not solely responsible to recall memories. So, in future, we desire to work with audio clips which can be a music clip or a small voice clip. We also, wish to have a feature for automatic tag where people associated with the picture will get tagged without any human effort. Also, we wish to add a feature which will notify the user periodically by sending image of past memories. These images will be blurred and the blurriness will be reduced as the time passes. So the image will be less blurry with time.

8 Conclusion

We have tried to utilize human memory as much as possible. We have tried to implement a system where the pre-stored images will be used to recall past memories using AR. To get the fullest experience of AR, the image should be in 3D. This is basically a smart phone based system where rendering a 2D image will not be feasible. Also our sample space were only based on 12 participants.

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