School of Computer Science, Engineering and Mathematics

Virtual Agents for Dementia: Personal Assistant, Trainer and Therapist

Master Thesis of Biomedical Engineering

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Declaration of Academic Integrity

'I certify that this thesis does not incorporate without acknowledgment any material previously submitted for a degree or diploma in any university; and that to the best of my knowledge and belief it does not contain any material previously published or written by another person except where due reference is made in the text.'

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Abstract

Memory life events and experiences are important information to recall personal details and achievement to document the traits and characteristic that makes someone unique and personal. Memories do decline across adult lifespan , which potentially leads to dementia and this distinctive chronic memory declination in aging group, not only leads a pessimistic view due to disappointment in regaining their memory but also disheartening for the family members as the patients often forgetting the critical moments that cherished and their identities that values. This thesis will focus on a method of significant life events storage by daily life video recording in order to manage their memories in replacement with digital memories of life, helping the memory recovery and data retrieval, and possibly brain training for the dementia for a chance to revive their cognitive function. Challenge in increasing amount of digital "memories" will soon meet the challenge of "information overload", which requires a better approach to manage and storing the events. Therefore, the research mainly involves studying concept behind reserving significant key frames extraction for digital memory hooks whilst disposing redundant video frames to reserve the digital memory. This thesis covers the literature review studies the human brain that affects the memory in conjunction with consultation from experienced caretakers and medical professionals, collecting data to identify key life events that is crucially important for digital memory hooks and identify technique to distinguish the feature from personal life memory to extract flawless video key frame.

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1 Background Information

Many existing devices allow people to record the habits pattern of daily lives easily that improve the self-awareness and a substitution of the limited human memory. Emerging technologies throughout these years have changed the way we communicate to our past and preserve the special moments. Cameras, mobile phones, computers have allowed capacitance in efficient data storage of a personal activity data. Personal life tracking can be very useful when you start to have memory deterioration across adult lifespan. When people start fighting with time of gradual declines in brain functions before progressing towards dementia, people will start to cherish every bits and pieces of daily activities without missing the important memories. Thus, digital memory will be most reliable personal properties to keep a person reminded of all past moments that is not going to happen again and keep track of daily activities that seem difficult to remember.

1.1 Aim and Goals

Previous Chapter shows brief background as part of the research directions. The study may then involve professionals and experienced caretakers with dementia in an institutional environment, but also possibly relatives/families and the home environment.

The goal of this project is to study and capturing the important daily events of the person with dementia. The focus will in particular be remembering and naming visitors. The proposal is to develop a system that will create multimodal semantic memory “hooks” that will facilitate remembering these people and events. Therefore, the research study will require process of continuous video recording and extract the key frames relevant to important personal information then reserved as the electronic personal information to subliminal recall the memory of subject.

The project aims to recognize a proper human-machine interaction input in order to develop a precise nature of the system with appropriate interventions. The successful intervention experience requires assistance and approval of dementia professionals without altering the uncontrollable behaviour at the same time to avoid unethical application.

The goal achievement is the development of user friendly personal memory recorder whilst extract the useful relevant memory that served the device as **TRAINER** to improve the performance and quality of life; **ASSISTANT** to guide the subjects through dynamic and vivacious daily activities; and **THERAPIST** to recover the dementia behaviour and be socially active again. More understanding the research purpose illustrated under research proposal in Appendix D.

1.2 Thesis Overview

This thesis covers mostly literature review from various backgrounds that is useful to precede this research study. Chapter 2 covers the background the brain functions that highly affect human memory and how the deterioration of human brain leads the cognitive issues that commonly observed from the aging group. Chapter 3 outlines the research focus group that will be the major subjects to assist the study and some review from related professionals and caregivers of the subject to share their experiences and problems to understand the unknown possibility before proceed the experiments in order to avoid any unethical issues. Chapter 4 premeditates the previous section and outlines nursing and clinical aspects for behavioural interventions. This chapter also study on conventional cognitive therapies that expected to slow down the progression of the disease. Chapter 5 studies existing flinders research and some existing life-logging technologies, which have potentiality to extent as part of the research work by collating the ideas to the development in the video recording and video key frame extraction.

In the next final chapters, elaboration of the research works state clearly a distinct view of the research challenges and range of research scope have extended. There are three major research works outlined to achieve the aim of the research. Chapter 7 summarize some reviews and opinions from the professionals to identify details to present the correct moments and their views in collaboration between human and machine. Chapter 8 inspects some existing technologies that support the video process and accessible to any individuals

to monitor and capture the life events. The following chapter integrates the view to structure a framework of proposed interventions. The final chapter remarks updated assessments and discussion of this research, and suggesting future works to complete research goal.

2 Cognitive Declination in Elder Adults

It is inevitable that cognitive declination increases from progression of aging especially in adult with dementia due to brain degeneration. Although dementia is not a part of aging process, the severity of cognitive progressive disorder leads to cognitive impairment whilst body parts immobility due to trailing brain-body coordination. The problems found altering the mental functions and daily performance. Many causes can lead to progressive cognitive declination, including family history of Alzhemier's dementia, depressions, medication side effects or metabolic/ endocrine derangements (National Institute on Aging, 2017). This chapter reviews anatomical study of brain that affects the cognitive functions and how it deteriorated throughout the human lifespan.

2.1 How Memory Works

Human memory indicates the person's uniqueness through performance of daily activities and accessing their personal identities. Researchers has discovered in years that human memories is not a standalone brain function but consists of many mode of operation incorporate with the stages of memorisation. One interesting experiment has carried in Mcgill University for a subject that have problem in memorising activities of his life (Brain Documentaries NOVA, 2016). The experiment requires the subject to trace the shape of a star using a mirror. The result is astounding that although the subject cannot remember the events he had taken every day, he unconsciously performs the motion skills flawlessly.

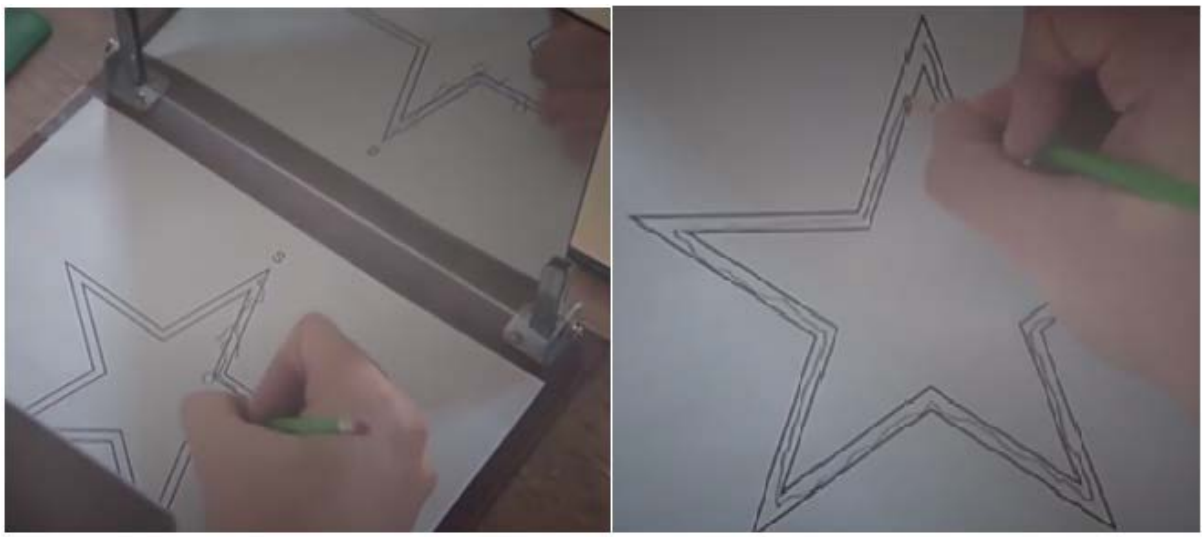

Figure 2-1(a) Experiment of tracing star through mirror (b) Result from training

From the experiment, the researchers able determine that human memories work in all modalities, relies on different notation of the brain, as the result human memories deteriorates in different stages, depends on the terms of memorialisation.

2.2 Brain and Cognitive Function

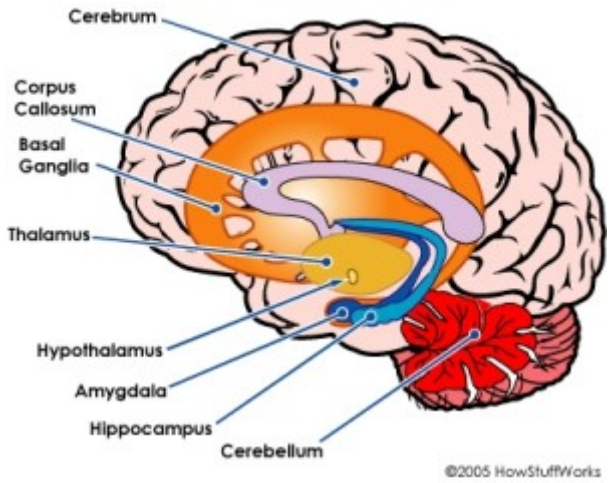

Figure 2-2 Limbic System and Basal Ganglia (Mastin, 2010)

A brain limbic system consists of a hippocampus, which locates in the medial temporal lobe beneath cerebral cortex (Mastin, 2010; Robertson, 2014), conduct a major coprocessor that control desires and emotions, consolidates information from short-term memory to long term memory so as utilities as core subject to cognitive learning and transferring information into memory.

Hippocampus plays important roles in the consolidation of information from short-term memory to long-term memory and spatial navigation. Hippocampus is capable of growing new neurons, which affects the behaviour the memory learning new things (Mastin, 2010).

The limitation of the growth of hippocampus is highly influenced by glucocorticoids. Glucocorticoids is a class of steroid hormones and can be easily impaired by stress related issues and brain degeneration (Fukumoto et al., 2009; Koenig, Kirkpatrick, and Lee, 2001; Mizoguchi et al., 2003). As people ages, their learning speed is deteriorating as the brain are not able to receive complex task at once, where the person has low efficacy in learning new things and keep forgetting things.

Complex tasks are mediated between synapses in brain cells to process the knowledge of activity performance. When a person is reading a book, the brain performs an interpretation. The activities include eye roll, interpretation of colours and characters, recognise the combinations of words and letters, interpretation of the meaning of words, collect data, interpret the storielines, illustrate the meaning and synopsis of the reading material subconsciously, and at the same time, controlling eye muscle to browse through reading material and judge the timing to flip the pages by signalling the finger's muscle when the reading reaches the end of page and so on. One simple and relax situation requires numerous neurons function to visualise the task although it seems to be one task.

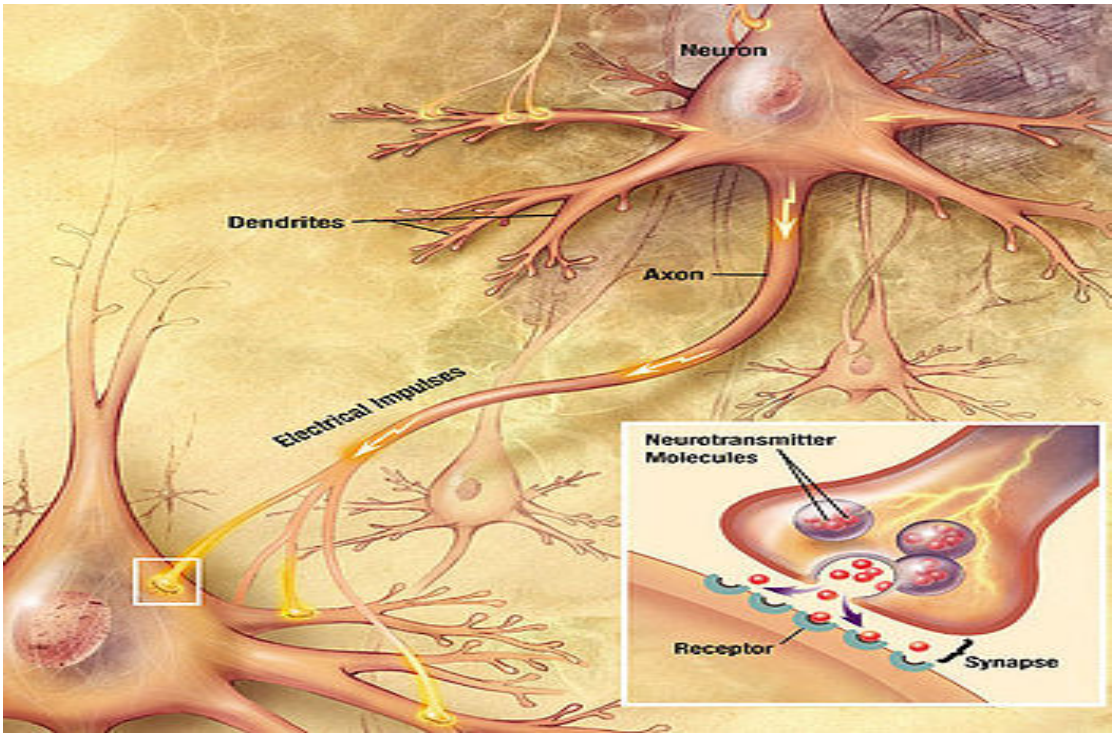

Figure 2-3 The Process of Synaptic Transmission in Neurons

Figure 2-4 shows the process of synapse transmission to form a memory. There are billions of neurons in the human brain. The process of transmitting incoming signals from human perception requires nerve impulses generated from neurons to neurons. Communication from neurons to neurons bridged through their axons and dendrites. Axon contains myelin to help speeding up the transmission to the brain. Once a transmitted signal reaching to the tip of axon, the electrical impulses released from neurotransmitters to synapse the end of dendrites by nearby neurons. The signals received from nearby neurons through dendrites. Dendrites also branch from the cell body to deliver messages from axons impulse signals to excite the neurons and neurons (Patlak et. al., 2000).

2.3 Memory Processes

Process of memory represented as complex computer storage, starting from perception, encode, storage and recall (Miller, 1956). Human memories illustrated as mode of cognitive recognition through multiple systems and the system can be categorised as three stages: from sensory memory to short-term memory to long-term memory.

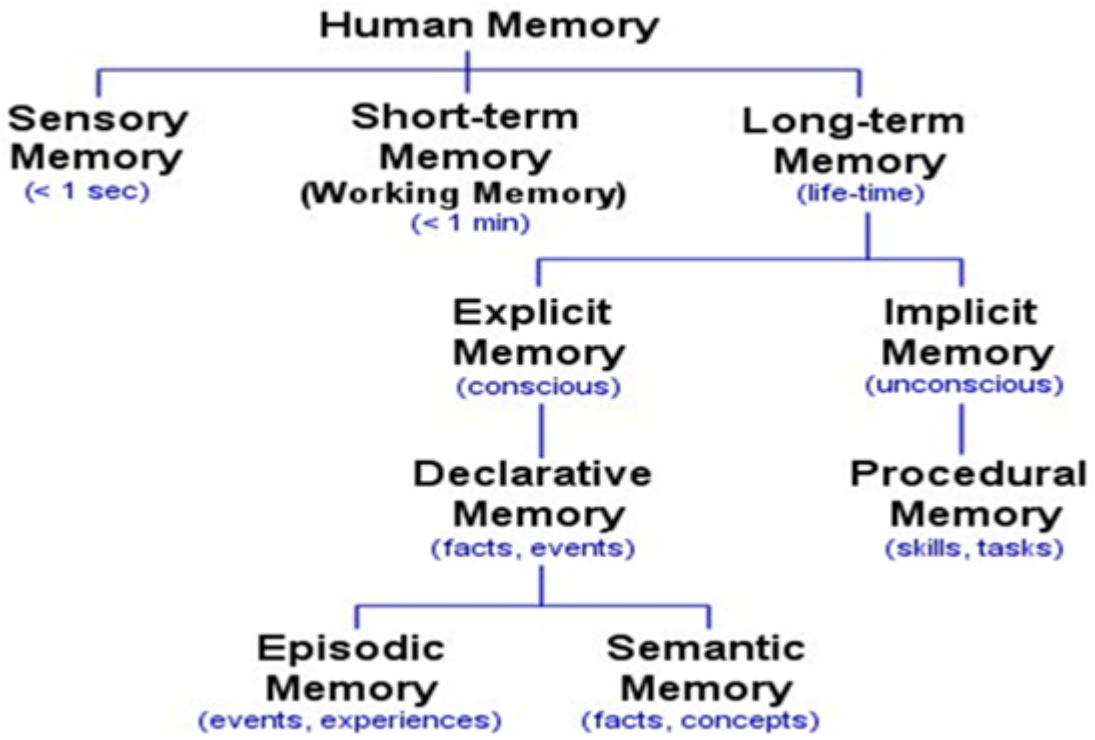

Figure 2-4 Type of Human Memory (Mastin, 2010)

Sensory memory is part of the memory that acts on response after received impressions through human perception. For example, recognise an object as bicycle and remember the look through observation. This part of memory is the shortest form of human memory that works as "buffer" for stimuli and the information is lost when the sense of stimuli is completed. Short-term memory is part of memory that holds the temporary sensory information and possesses the ability to remember and process information at the same time.

Short-term memory holds small amount of information and will disappear typically less than 1 minute (Mastin, 2010). The best description to this form of memory is assuming as a "post-it" note which the process of information is available in short period. Some researchers classify short-term memory and working memory as two distinct memories (Aben et.al, 2012; Diamond. A, 2013). Working memory is a form of memory that more related to theoretical framework of structures and manipulation of stored information

(Mastin, 2010). Short-term memory is the first forgotten information in early dementia followed by long-term memory.

Long-term memory stores information in very long period and this memory decays over time. Short-term memory can become long-term memory through cognitive trainings and practices. Figure 2-3 describes the different categories in long-term memories. Many findings showed that dementia person has early deterioration in episodic and semantic memory (Jelcic et. al.. 2012; Shadbolt et. al., 2008; MaDuffie et. al., 2012; Mastin, 2010). Episodic Memory is a form of long-term memory that remembered consciously with a context, i.e. Time and date of the activity. For example, a person may remember riding on a bicycle and whether the person remember the closest date of his last riding is related to this type of memory. This type of memory is susceptible to forgetting. Semantic Memory is a form of memory that remembered by reference to known knowledge and less contact with the context. For example, for a person to explain what is bicycle required the information retrieved from this form of memory. The memory can be relatively permanent but can decline years before the diagnosis of dementia. Procedural memory is the form of memory that performs unconscious imprinted reference of personal skills and how to perform the correct movements. This memory is an implicit memory that relies on repetitive practices to form the memory and also known as “experiences”. For example, to knowing how to ride a bicycle is a form of procedural memory. The declination progresses in the later stage of dementia. The person eventually forgets how to perform daily activities and require assistants from caretakers.

In this research, individuals with episodic and semantic memory deterioration are likely main subjects of the research to perform relevant data memory hook. The research focus is to preserve the problem where the patient is forgetful (shot-term memory) to improve the cognitive recall and recognition to introduce long-term memory. Studying in working memory is also recommended in this research, to recognise the features of dementia progression, as it is likely the key area in training in retaining memory in executive activity and attentive function. According to Baddeley and Hitch, working memory is a form of short-term memory which control and coordinates the operation of phonological loop, which deal with spoken or written information through human perception and visuo-spatial

sketch pad, which stores and process information in visual or spatial form. Central executive plays the main role in working memory that allocates data into subsystem and drives the information into memories. Working memory has the lowest storage capacity and it is also likely known as short-term memory (Baddeley and Hitch, 1974; Mcleod, 2008).

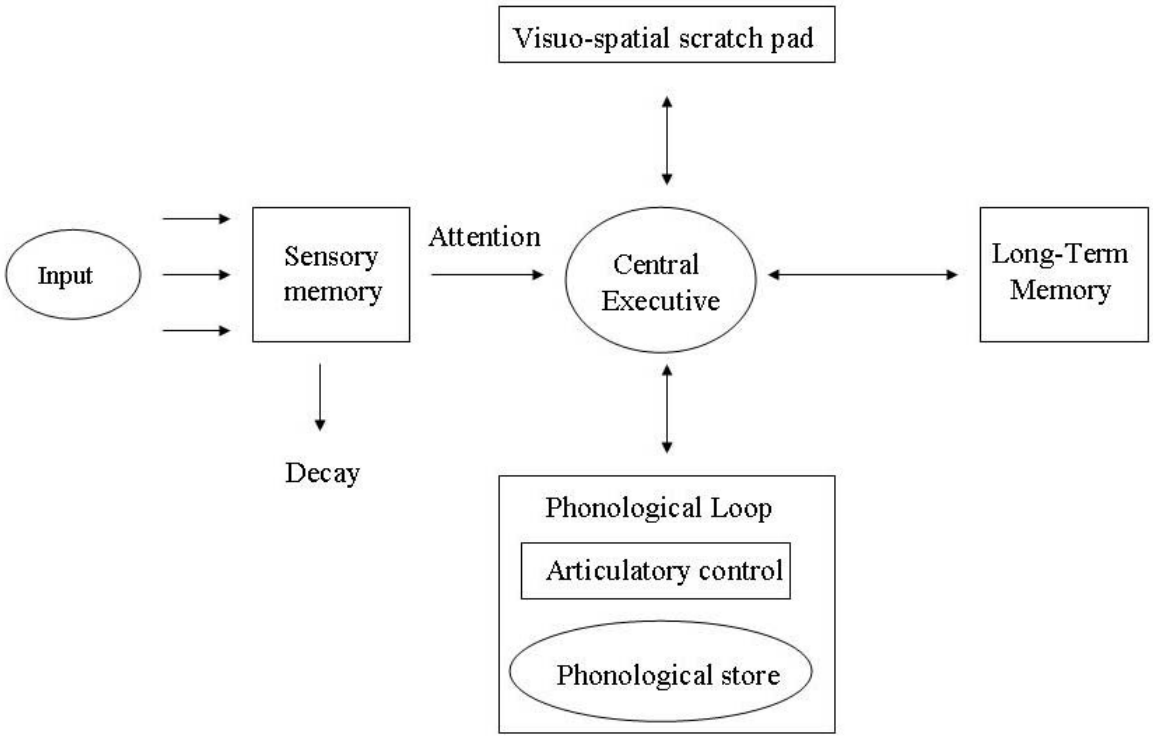

Figure 2-5 Workin Memory Baddeley and Hitch Model

Sensory memory is less focus in this research context as it is a non-related to cognitive issue but more to attentive performance. To identify the subjects that are accountable to assist this research, I will conduct some interview from dementia caretakers and seeking successful assistance/partnership for accessing studies on the subjects. The limitation to this research is considering the issue of involving the vulnerable dementia subjects and requires supervision and support from dementia's professional therapist to ensure the study is ethical.

2.4 Reason of Memory Deterioration

In every milliseconds, millions of synapse sends the massive signals to the brain at once through neurofibrillary (Buschman et. al., 2015) to supply neurotrophic factors, which can

be described as representation of electrical routing system. If neuron unable to receive neurotrophic factors, a neuron shrivel and die, which means the information from brain signals will not be stored as memory.

Few literatures supports that the early stages of dementia is diagnosed caused by cortical thinning of hippocampus (technically para-himppocampal subregions) which caused by shrinkage of the area due to the aged brain degeneration (Sabine et. al., 2016; Petersen et. al., 2015; Fabian and Neil, 2015). Neurofibrillary tangles also leads to cognitive impairment which resulted by the failure of the signal cannot pass through the synapses to the brain cells (Guillozet et. al. 2003; Petersen et.al, 2015, Costandi, 2012). Accumulation of the brain nerves, which also known as neurofibrillary tangles, is likely to cause the deprivation of cognitive function such as in sleep disorder, stress and aging stages (Costandi, 2012)

One weakness has been discovered from the reason of deterioration of the hippocampus is the exposure towards schizophrenia and depression. Therefore, in Alzheimer disease, hippocampus is the main region that leads to disorientation, memory loss and cognitive malfunction in the early symptoms. Stress levels for people with dementia are often inappropriate due to the signals of distress. One concern of the intervention is to reduce capacity to cope with stress. Person in stressful condition has high probability in the levels of cortisol in blood stream. When blood pressures rise, cortisol that enters the brain will kill the brain cells and degenerate the brain function. Research from the University of Kuopio in Finland also discovers that patients with high blood pressure or high cortisol levels have three times higher risk of having dementia (Ryan, 2016).

3 Subject group

3.1 Australia Background

Majority people suffered with memory loss with mild cognitive impairment and have higher chance progress to dementia. According to the Alzheimer's Australia, there are more than 1800 cases arise each week for people growing with dementia. The number keeps rising and expected to increase to 400,000 in less than five years without medical breakthrough (AIHW, 2016). Dementia is the main concern from the federal government as it is the greatest cause of disability in aged Australians, the second leading cause of death of age population group and third leading cause of disability burden to government funding and is epidemic.

The National Health and Medical Research Council (NHMRC)'s National Institute of Dementia Research was established with the support from Federal Government as part of the commitment to ensure priority research in dementia is coordinated, funded and communicated (Fight dementia, 2016). $200 million budget is announced in 2014 to support the research towards dementia (AIHW, 2016). As seen the dementia research is exceedingly support by the government, wide ranges of research has been carried on for years in terms of clinical, medical, rehabilitation and technological innovations to) using relevant NHMRC schemes to prioritise quality of life of the dementia group.

Dementia often found in older generation. There are 10% of Australians aged above 65 found to have the relevant disease and 31% for over Australians aged 85 and above (Fight Dementia, 2016). Stage of progression are summarised from Table 1.1.

Table 1 Progression stages in Dementia (AIHW, 2016; Fight dementia, 2016, Alzhemier's Australia, 2016)

Dementia Stages	Characteristic
Mild	• Experiencing memory lapses i.e.: forgetful on recent events, lost or misplacing objects, repeating things • personality changes, passive or withdrawn • finding difficulty in solving complex tasks

	• trouble organizing or expressing thoughts • May still perform their activities independently • Lack of enthusiasm to try new things
Moderate	• Forget recent events completely • progressing severe memory loss of distant past • Require assistance and reminder in their daily live to perform regular daily activities and self-care • increasing confusion with time and space or poor judgment • agitation and suspicion • changes in sleep patterns
Severe	• worsening physical capabilities which require full-time daily assistance • a loss of the ability to communicate • difficulty in eating and swallowing • restless • an increased susceptibility to infections, such as pneumonia

As a person aged, the quality of neural information through sensory to cognitive systems declines. This is due to their progressive cognitive deterioration which causing frequent memory loss and physical capability deteriorates as well as their cognitive capabilities. Elder generation finds difficulty to learn a new knowledge and even they have tried harder to memorize the brand new knowledge but that tend to be more successful if they keep practicing and reminded from time to time. However, it will start to get bored and lost passion for repetitive brain exercises. Personality change is more obvious when the sickness is more apparent. It is even more significant when the elders is diagnosed with Dementia, where they practically loss of enthusiasm for previously enjoyed activities, deterioration of social skills, emotions fluctuation, vagueness and forgetful to their closest people, places, recent events. They often find it difficulty in persistent and frequent memory (Healthdirect, 2015).

In fact, there has no proper cure for dementia, as early symptoms are subtle and vague. Only prevention and continuous rehabilitation provided by clinical field to assist the patients to prevent accelerated declination. The care plan is needed be performed long before dementia is diagnosed. Multiple researches has been suggested that dementia can be

prevented and delayed with intact cognitive memory function, from diet plan, amount of daily activity and sleep patterns (Elliott, 2016). For the person who has already diagnosed with cognitive declination become dependent against substitution of external caretaking and assistive technology. Significant symptoms includes short term or long term memory loss, confusion, personality changes, withdrawal from loved ones and lack of enthusiasm or ability to perform simple tasks will define a person is progressing to dementia. Diagnosis defines the assessment guidelines from clinical practitioners to identify the level of the patients and suitable care plan. Example of assessment tool can be seek online including "National Chronic Care Consortium Tools for Early Identification, Assessment, and Treatment for People with Alzheimer's Disease and Dementia" from Alzheimer's Association and "Screening & Diagnostic Assessment of Non-English Speaking People with Dementia" via Fighting Dementia of Alzheimer's Australia.

This research goal is to focus on daily video recording of the patients to understand the behaviour of the dementia patient and possibly replay to show some memory hook to improve the cognitive function or slow down the declination. The stages of the severity will be a part of the consideration to choosing the target users. The patients with mild cognitive decline are likely independent to operate the activity whilst moderate patients are likely require the assistance from caregivers to perform these cognition activities. The patient with severe dementia stage whose have worsened self-managing capabilities and unable to communicate will be unlikely to perform this activity but this research will replay some memory hook with interactive interface to sooth their emotions and hopefully will improve the cognitive function. The aim of the research is to focus on the dementia patients to record, replay the memory hook, which expect some result of improved memory or slowing down cognitive declination.

3.2 Caretakers Review

Dementia patients unable to take care of themselves independently as they suffer from cognitive deficiency hence, assistance from the third person will help the patients to stay connect to past and present. Even with human assistance, weakness to fatigue and stress is inevitable. More than 2 hours continuous work with dementia requires a huge commitment of patience, emotions, vitality for patients to work. According to the view of experienced dementia caretakers, majority early sign dementia group are taken care by the closed families with adequate trainings given by professional, while severe dementia will have problem in performing their daily routines, will require professional caretakers to look after their daily activities, the medical plan and contacting their relative.

Patients with problem in communication are the main concern by the caregivers. Many occasions reveal the patients who suffered from cognitive impairment loss the expression of words, which the caretakers require to indicate and understand the patient's request. Often if the caretakers give the wrong instructions or assistance, the result will agitate the patients and makes the situation uncontrollable. Worsen cognitive impairment requires more effort to take care of which burdens the caregivers.

Some are not acknowledge or accept diagnose of dementia and acting as they are always right due to the feeling of shame, embarrassment, resentment and frustration. Social Isolation as they only have the sense of self. The relationship with families and friends is always in suspicious and non-trustworthy (Golvers, Memory Rehabilitation in Early Dementia, Hunter New England Area Health Service)

Involving and contributing the strength and time requires complete effort which sometimes the caretakers will withdraw from their own daily activities and neglect their own health and emotions (WebMD, 2016). Care giving responsibilities often carried away which the caretakers are often burnout and loss their control, which there are many research that caretakers end up in psychological health issues, physical exhaustion and emotional crisis in their later stage, and often, developed new dementia diseases. Psychiatric research has pointed out that caretakers' burden is strongly associated with the duration of the care,

severity of the disease and the educational level of the patients. Informal caretakers and professional caregivers of dementia patients have higher chance of having physical and psychological burnout.

As part of the consideration, this research would like to follow the footstep not only manage the care plan of the patients and will hopefully serve a part of functionality to assist the caregivers from the exhausting situation while allow the patients' self-management capability. Some existing research in Flinders' University has promising outcomes (see Chapter 5.3). To extend the scope of the project, this research will focus on the video playback of the important moments of patients which the expected outcomes will not only serve as part of the cognitive training but also helps to control the emotions of the agitated patients. Clinical intervention will much needed in order to achieve the success but also preserve the ethic for examination before the activity is ready to goes on the test subjects.

4 Dementia Interventions

Intervening a daily activities of a dementia patient require massive assistance and consideration, which also require cooperation involvement from authorised caretakers. Conventional interventions of the caretaking is not organized and random, which therefore wear out have negative effect on the caregivers. Taking care of progressive and uncontrollable disease might leads to psychological and emotional health problems for the caretakers.

Dementia is often loss of judgement and finding reasons unless there is third person to provide guidance and words. The caretakers often react, engage their activities by hinting towards the choice, and give positive compliments to sooth their moods. One common exercise is companion walking with patient, as this is helpful to dementia to soothes their mood and ring back their memories. There are many occasion that the dementia subject will talk about their personal life out of the blue through “muscle memories”

Caring the patients requires healthy interventions to remove the burden for caretakers and effective for patients. It is advised to avoid complex tasks in order to avoid stressful situations, whilst keep environment and routine the same, to maintain consistency for active interventions.

Conventional interventions by caretakers are studied and can be categorised into three sections: Cognition-Oriented Interventions, Stimulation-Oriented Interventions and Emotion-Oriented Interventions.

4.1 Cognition-Oriented Interventions

Cognitive declination in dementia involves malfunction in memory, communication, orientation, decision-making and judgment. Cognitive declination is reversible or delay with early diagnosis and prevention. Cognitive training includes repeated practice and exercises help to boost the person’s memory, flexibility, problem solving and attentions. Procedure of computerised cognitive training includes individual programs, multi-modal, multi cognitive

domains, graded difficulty, feedback and accessible. Mnemonics and acronyms word play and rhymes to hint associate words through pictorial representation are proven effective in cognitive recovery (Adele, 2013). One example of the cognitive skill training is Lumosity game platform (www.lumosity.com). Scientists and game designer to improve the brain function from cognitive games invent this training program. Games include memory training, math operations, and attentive strategy in accordance with pictorial representation. The game strategy widens the mind searching and boosting the subconscious thinking. The outcomes of this therapy is still questionable as this can be targeted to any individual that are proficient with computers and internet and the result are evident with a long term data collection. Similarly, cognitive retention therapy is a definitive therapy comparing to Lumosity, which is one of the program to recover the brain cognition. The method is adapted from Dr. Mira Ashby in her brain injury rehabilitation program by combining with word exercises and visual stimulation to create interesting activities to stimulate participants' five senses and improve their thinking (Alzheimer's Innovation Institute Inc.) . This has been proven an innovative method in various research that the quality of life of dementia and improved and rebuild and established the old memories and new memories of the patients (Ashby, 2006; Blefsky; Alzheimer's Innovation Institute Inc.).

Research has supported that psycho-educational interventions are often effective in patient management (Arango-Lasprilla et. al., 2014; Beinart et. al, 2012; Lukens and Mcflarene, 2004). This method covers range of activities in conjunction with education to solve the related problems (which similar to engaging learning from early ages), by accessing the background knowledge and individual information of the patients, then put into strategies linking counselling and supportive interventions. The mode of interventions using materials such as booklets, video recorder, audiotapes, computers, and social media that allows the handiness in interaction between professional caretakers, patients and general practitioner through online delivery mode. The patients are encouraged and motivated through this method and less burden to the caretakers.

Besides, taking care of the patients also rely onto the cultural factors of the dementia. For example, in Latin America, the population are more uniquely religious, high regards on well-being and close to family (Lasprilla, 2014). Therefore, the caretakers will emphasize a

cognitive behavioural therapy, which promotes the psycho-educational interventions that modifying beliefs whilst developing new knowledge to control the behaviours and manage the problems of the patients that frustrate, angry and strange behaviours. This method only effective to the patients but also relieve the burden on care giving including the families to control the stressful situation.

4.2 Stimulation-Oriented Interventions

Art and music therapy is often used in care centre to sooth the emotions of the dementia person or wake the person up.

Apart from daily routines from eating to sleeping, art therapy improves a person's living perspective creatively. Research finds that creative art works may prove potential neurological improvement. Changes in colours of participants' choice in an art may assist diagnostic in brain and emotional change through realistic and abstract hatchings in the drawings (Fightdementia, 2016). This method not only be encouraged in dementia care institution but also in aged care centre to promote opportunity in understanding their living behaviour and cognitive activity stimulation.

Few research has been shows that music not only sooths the emotions but unlock the memories and promote trainings. Familiar songs and tunes that relevant to the personal life will soothe and stimulate the grey area of the brain to bring back the forgotten memories, which is why it is easier to recall song lyrics. Music like oldies and classical music is a sensory and intellectual simulation to boost the memory of the dementia patient (Schaeffer, 2016; Alzheimer's Association-Caregiver Tips and Tools, 2016)). When people listen to the music and remembering the tunes, the knowledge will be stored as procedural memory, which is different to the episodic memory that stores the special events of the personal life. Aged person is likely misplaced the episodic memory while the procedural memory will be left intacted (livescience, 2016). According to Professor Paul Robertson, the brain receptively sensitive to music where he use the description "it's a case of first in, last out" for the breakdown of the memory (Dementia and Music, 2016). The clinical research also decides to develop the music therapy to cognitive exercises by fitting the vital information into the

lyrics using a tune to improve the memory (Winckel et. al., 2012). Repetition of the lyrics and rhythm is crucial to inject the information explicable into the brain function. In 1993, Flinders University has run a research on the effect of musical and speech signal on conscious subjects to study the effect of the signals towards the brain function. The process of supraliminal speech has significant effect on right hemisphere, (handle the music process) and has least effect on left hemisphere (handle the speech process) (Powers et. al., 1993). The subjects who are sleep has not yet been considered in the research but hypothetically, there is possibility the music is effective on brain information process; it is surely effective to dementia subject.

Dementia subject is likely to have irregular and disturbed sleep cycle. More than half of severe patients is likely to suffer from sleep disorder breathing, which the patient temporary stop breathing during their regular sleep. The phenomenon is sleep apnea (sleepdex, 2016). The sleep disorder can be caused by the common snoring that leads to an obstruction of the oxygen level in the blood and to the brain, which elevates the level of dementia. Research also found out that disrupted sleep is one of the sign that cause the dementia in early stage (Costandi, 2012). Sleep-learning is always myth to transfer the information and new knowledge during sleep. Some people convinced that playing some music while in the process of get into sleep boost the alertness and learning speed of the person. The studies also found that playing the Mozart music while studying seems to boost the memory. The researchers from Sapienza University of Rome suggest that Mozart's music can activate neuronal cortical circuits, which relate to attentive and cognitive functions (Freeman, 2016). The effectiveness of sleep-learning is often disproved theory as one research proved that the process requires alpha wave brain activity to stimulate the brain learning function. Alpha brain wave only occurs right before sleep or upon awakening and it does not occur during REM (rapid eye movement) or non-REM sleep (Mastin, 2013).

Real-Oriented is a technique to help the dementia subject to reconnect with time, place and surrounding. This technique use daily cues routinely on daily basis to prompt in a conversation for the dementia to orientate the events for the person retrieving the forgotten memories. According to British Journal of Psychiatry, this technique has drastically improved the cognitive functioning by slowing down the cognitive decline, which delay

nursing home placement. This technique suitable for the person who confuse with time and dates but been declined for people who are fixed with their believing and forced to accept their belief. The limitation of reality oriented technique would respond the fact without acknowledge the person's feelings, which will cause distress to the subjects (Heerema. E., 2014). The cues such as large clocks with date and time can be useful to indicate the happening and reminder of the day (Memory Matters, 2016).

4.3 Emotion-Oriented Interventions

Recently, many practitioners perfected Real-oriented technique by inducing validation technique, which apply more sensitivity and wisdom to response against patient's emotional state and personality. Validation therapy guides the patients by validating their feelings and work through a solution by judging the proper situation, reminiscing by rephrasing a conversation, be sensitive to match and express the emotion. Combination of both therapy has proven to decrease in emotional distress while simplify the task of taking care the patients effectively (Heerema. E., 2014).

Reminiscence is useful when the dementia subject is unable to participate verbally. The way of reviewing the past will stir up their agitation and sadness to give them a sense of happiness. This will require a visual diary of the personal lifetime so it will be easier to interact with them. Photographs and messages of the loved ones, special events recall, anniversaries, favourite music will promotes the patients to ask more questions and engaging them to flashback to their memories (Fight dementia, 2016).

Likewise, stimulated presence therapy provides an emotion oriented intervention to reduce agitation and uncontrollable behaviours of the patients. This method uses videos or plays recording of the closest relatives of the patient. The method has improved the performance of taking cares the patients during the challenging behaviours. The research has proven significant improvement in behavioural disturbances and the effect is reversible if the intervention is withdrawn (Peak and Cheston, 2002). Most caretakers accept the method as a substitution to pharmacological intervention as it enhances the well-being and more

effective to improve the performance of usual care (Peak and Cheston, 2002; Camberg et al., 1999).

5 Assistive Technology in Dementia

5.1 Electronic Memory Aid for Dementia

As part of the research consideration, dementia's family always favours the technologic assisting device and caregivers as ease of convenience in communicating, perform a care plan and patient management. Assistive technology for dementia is important to promote dependence and manage safety risks for dementia and caregivers to establish routine and improve the quality of life for individuals independently. Few important consideration of technological innovation for those who live with dementia is that people who suffered with dementia is often confuse with timeframe and dates. Time is extremely important to keep the patients be reminded of all the care plan, medication management, scheduled events and important date of their love ones as confusion may leads to agitation and anxiety, which worsen the disease. There are many cases that the dementia patients are wandering blankly in street and lost their thinking and potentially end up in police station or lost or hit by a vehicle. Preserving the safety of the patient is crucial to protect their vulnerable instinct and unpleasant flexibility. When the situation is in haste, the caregivers or the dementia person themselves must know how to reach the help from their loved ones quickly. One favourite dementia's assistive technology is the ease of accessibility on the mobile phone or device interface with location tracking gadgets (Alzhemiers.net, 2014). The specifically designed of the technology must be user friendly to the patients by using a wide screen and big picture display and with a large push buttons. As they might have the problem in remembering a number, the phone also designated with storage of contact numbers associate with the photos of the patient's close relatives so the patients been able to access the person with pictorial recognition. The patients and caregivers are fond of reminder agent to establish the care routine, to keep the important events, and accessing important meetings. Inducing the human labour with intelligent machine is a considerable method, as the machine not only knows nothing about fatigue and mind exhausted work, but work in environment with active repetitive and responsive task.

5.2 Benefits of Human-Machine Interaction in Dementia World

Communication and information processing has become crucial in order to achieve a conscious interaction between human and computer. Successful intelligent machines interact to their surroundings and people through the replacement of the sensory perception with devices such as, replacement of eye vision with camera and video recorders; audio listening with microphone or speech recognition device; communication speech with computer generated waves or pre-recorded human voice; tactile sensory with sensors and motion detectors and so on.

The smart device must be user friendly and able self-diagnose and perform correct yet harmless action to human at the same time exhibiting confidentiality and protection towards the private records provided from the users. In order to work with intricate tasks, the challenges to write the conceptual software code is enormous and required lots of logics, mathematical, unique languages and protocols. The follows by continuation of theoretical analysis, verification and simulations as prototype before readily surfaced to users. Interaction between human and computer has become a possible solution despite of the complex computerized networks and system complexity. Their success to achieve a flexible framework in order to harness complexity has made the future research more evident and unceasing development.

The advantage of the global accessed is accessing to ubiquitous infrastructure simultaneously everywhere and not limited, i.e.: internet access, phone application and media. Vast development of computing allows people to connect globally, processing and gathering information, interaction with surrounding environment and exhibiting contemplative behaviour. One example is the medical professions input and retrieve the information of patients and keep track with their conditions.

5.3 Quantifying Oneself in digital Autobiography

The term "quantifying oneself" can be also described as "life-logging", "life-blogging" or "life-glogging". It is similar like writing a diary, but the induce with something more such as, pictures, videos, conversation history, activity tracking and anything that is related to personal and social identities. There is interesting video regarding "How Life logging is transforming the way we remember track our lives" - https://www.wired.com/insights/2013/06/how-lifelogging-is-transforming-the-way-we-remember-track-our-lives/. The video explains how accurate life logging can track personal activities, for example how long and you have watched the TV and how life logging record the time and date of your performed activity accurately. The usage is has pros and cons in terms of the life bits storage capacity, third person's consent against privacy violation, life status, health and wellness.

Microsoft-MyLifeBits is one of the challenge efforts to experiment in lifetime storage, which leverages SQL server to support: hyperlinks, annotations, reports, saved queries, pivoting, clustering, and fast search (Gordon and Jim, 2007). By storing all the personal information into the programming machine, a subliminal program is written to store the selective information in the subconscious to reinforcing the useful personal information such as the person the patients meet, special events and important messages. Microsoft researcher, Gordon Bell has been carried the experiment and his name has become synonymous with life logging. He worn the camera since 2000 to record, capture and store all data to quantify his personal data in order to process a machine enhanced photographic memory. Unfortunately, the research waived since his retirement (Elgan, 2016). Mobile phone has been a convenience to life logging device. Mobile users are able to interact with virtual agents like "Siri" and "Cortana" to search through the massive storage. Bell pointed out that it is still to extensive to process the life logging due to battery limitation, data storage overload for hardware. "…For now, it's not possible to automatically record everything using a mobile device. In the future, he said, we could see the price of memory come way down, as well as breakthroughs in battery technology and artificial intelligence (A.I.)" (Gordon Bell, 2007). Life logging research is not dead as revolution in future technological advancement will sure keep up with the possibility in photographic memory storage and data retrieve.

5.4 Existing Research

The key to dementia intelligent device is to be able to perform interpretation and reasoning to use the databases of a patient. Machine learning using successful applications and theoretical advances that has the solutions to the challenges is definitely a practice in this research to get the maximum benefit in order to assist the person with dementia successfully.

University of Bordeaux has research a detection of daily living with wearable videos to study the dementia (Karaman et. al., 2006). The camera attached to the patients all day to record their daily events, later viewed by caretakers and medical practitioners. The modal description is defined using motion, location, speech and noise detections. The patient has more freedom of movement and travelling route with the attachment onto the limb of the patient. However, the movement that shaken the recording device and change of environment regularly has caused many irregularity in motion and lighting sensitivity due to the device. The research has the solved the irregular motion and lighting changes using the camera "viewpoint" to used as a temporal segmentation using hierarchical hidden markov model. This research has not carried on for semantic features, which is an opportunity to discover the usage and reference to further study for designing a virtual agent for dementia.

Flinders University has continued works on Thinking Head project, which is an embodied conversational agent that assist people one-to –one in learning and teaching representation using intelligent computerized-tutoring systems. Currently, the main area lies in the creation of applications for second language learning. One successful development, Memory, Appointment and Navigation Agent (MANA) are a virtual reality tool with embodied conversational agents that engage in multimodal semantic purpose (Anderson et. al, 2012; Powers et. al, 2010). The benefit of this device is the system embodied with an A.I. and operated without mouse and keyboard. The research is developed in Flinders University that helps the people with early stage dementia in accordance with computer generated 'person' that allow a dementia carer to create a schedule of daily activities and appointments. This device serves as reminders for the dementia patients to work independently in their living without the carers. ***AnnaCares*** from Clevatar is also a

resourceful app that is accessed on www.annacares.com for hand devices that serves as a digital personal assistant to track and monitor their care plan. Both applications share mutual objectives to encourage interactive relation of the patient and the device that will improve the healthy living. My research will be extension to the existing application to motivate a healthy intervention by bringing more function towards brain training and interactive event recall in order to assist the dementia people and expect to improve their cognitive function.

Therefore, as an extension to the existing research from Flinders University and University of Bordeaux, the scope of the research can be narrowed down to focus on the existing technology evaluation for video recording and video data collection. The evaluation judged by efficiency to preserve the size of the media and data retrieval for relevant memory hook for the starter. The idea carrying a wearable camera experienced in this research to check the efficiency. This research will study a method to identify the key frames for memory hook and seeking the advice from the professionals with dementia and reviewing some existing research.

6 Research Works

6.1 Problems and Challenges

Consideration in video recording of a lifetime is the judgement in keeping all the relevant and irrelevant information accordingly as these will clog up the memory of the machine. In order to start record a person's daily events, assume a person have 70 years of life in average, which equivalent to $2.2x10^9$ secs for a lifetime. According to grand challenge of memories for life in 2008, the challenge in managing the information over a human lifetime is the problem in selectively searching, storing, securing and removing the digital memories.

With the massive storage of the data of a person lifetime, which is 34380gigabytes hard drive storage for 100kbits/ sec, the automated storage device must be able to "judge" the database that is preferable selection of "crucial memories" and least preferable "temporary memories". Clarification against privacy and trust of the personal identity is required to protect and security the confidential data and justify the selection of data that can be published to public (Shadbolt, 2008).

6.2 Scope of the Project

This research will have to divide into three specification(s):

- Seeking advice from the experienced caregivers to understand the situation of dementia and to ***identify the proper interventions***
- ***Technological Evaluation*** to see the suitability of the video recording
- Identify an appropriate ***method of key frame extraction*** to reserve electronic hardware storage

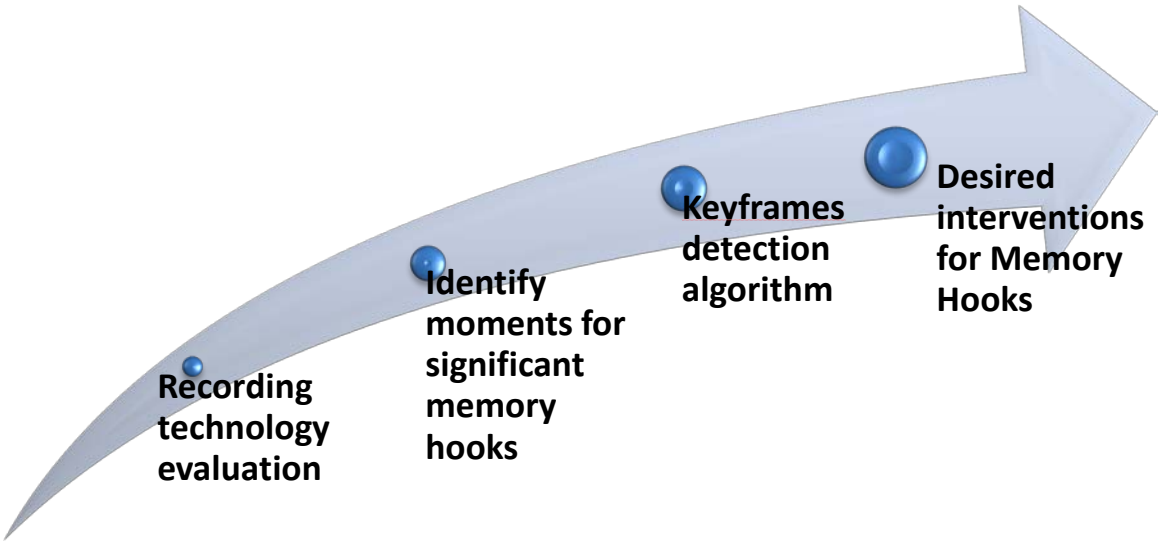

Figure 6-1 Structural Flow of Research Work

7 Data Collection from Related Professionals of Dementia's

Evaluating and gaining evidence support from individuals related to the framework my research project would establish clear view of the structure of the projects. There are seventeen interviews includes twelve nurses or carers, two speech pathologists and three medical staffs being conducted. First 4 interviewers are responds in written answers on questionnaire papers which found ineffective so the rest of the subjects are questioned literally. Interviews questions are prepared in advance to understand the current situation and limitation of caring dementia subjects, stress level and possibility of agreement if inducing with proposed technology assistance. Additional questions are proceeded freely or ignored by judging their professional background. The interviewed subjects answered the questions freely and skipped to answer some questions according to their will.

All the answer of each questions are collected in paperwork due to the limitations of accessing of high quality audio recording devices and distracted environment backgrounds. The rundown of the interviews are drafted in dotted points then revised in electronic documents (see Appendix A). Uncertain answers are reviewed by phone interviews.

Both outcomes are satisfying as this will structure the this research to have clear vision of some details of identifying the significant memories that is helpful in identifying video key frames and opinions to be considered in this chapter.

7.1 Understanding Care Giving Situation

Dementia patients are withdrawn from being socially active. Constraining themselves from comfort zone would allow the recording session to be under controlled supervision. Carers have sacrificed most of their works substituting their memories to remember the patients care plan. The tasks are truly exhausting, stressful with physical works and wasted. According to C3 subject, understanding their backgrounds and lifestyle will a better care plan. Guiding them back to reality requires patience, respect and understanding as mentioned by C5 and C6. Family members must possess strong determination and

perseverance to withstand the mood change of the patients like mentioned by C17, a daughter who needs to confront suspicious and misunderstandings for her sick mother.

Communication is crucial to keep patients socially active. The mode of interaction collected from this interviewed can be summarised as below:

- Keeping a carried plan routinely also saves time and work
- Compliments and positive reviews are to keep the patients engaged in activities
- Pictures, cue cards and verbal language are helpful when they are unable to participate verbally
- Eye contact and positive gesture i.e.: hand clap, big thumbs up, rewards to calm their mood
- Simple and repeated instructions, or hinting to help them to express their lost words

7.2 Identifying Significant Memories

Memories can be personal or social, shared or private. Certain events stored as memories evoke time and place with exquisite clarity and the memories are either national or personal. Pictures and video to present patient's flash bulb memories will calm the agitated situation and promote unconscious memory recall.

Most interviewed subjects agreed that dates and times are the major memories for the patients with disoriented reality that cause them confused with date and time. Helping to keep track with reality will assist them to recover in cognitive functions.

People and events are also significant memories related to personal activities. Person who presented such as visitors, carer of the day, person that encountered with in social occasion is good to recall. The events that affect their moods and special events such as anniversaries, family dinners, birthdays, organised events from facilities, daily activities from activity room will highlighted as significant memories. Locations of the events are important memory hooks to track their physical movement.

Another significant memory is mood change according to the activities they carried. According to C12, a good weather that makes a patient in good mood is worth to remember and that will evoke a positive response in emotions.

Other memory hooks like personal achievements, backgrounds, conversation history and emails worth considered as part of this research works in achieving significant memory hooks. Care plan has been progressed under AnnaCares from Clevertar, to induce as less consideration in this research.

7.3 How memory hooks be presented

Since date and times are important key frames that may assist cognitive learning, this information illustrates as in picture cues and enlarged words. Key videos and photos will need to be stored according to calendar and location thus it will present accurate memory hooks with correct information.

Routine explicit hook: projecting events to shows the highlighted memory during evening will promote the patient to engage in interactive session and prevent patients from time confusion.

Privacy and security access are the main ethical concerns of the memory hook. According to C3, giving them a video playback will assure with the reality but sometimes will also agitate them. Exposing the truth will leads to confusion and uneasiness. A positive judgement required to make decision that will assist a positive feedback. This leads to discussion in next section.

Aged patients with progressive cognitive decline are not technology-savvy and slow in learning to use a new interface. According to C12, less choice and touch screen is more user-friendly. Similar to MANA project, ideal presentation is by promoting intuitive teaching mode that has fewer functions operated by users. Voice recognition similar to Iphone SIRI agent will also be a good option to activate the working device. Cue cards and pictorial

representation also gives a teaching mode also inducing a human-machine interaction interface.

7.4 Proposed Interventions

Most interviewed subjects have similar consent in agreeing that music and reminiscence therapy has positive influence of recalling their memories. Same techniques have proven in the literature review that patients are more engaged and socially active with these therapies. Showing photos and video clips are efficient method to improve memory recovery unconsciously and continuously awake their episodic and semantic memories unconsciously.

According to memories of life in grand challenge 2008, privacy and security addressed as an issue to prevent it in public sharing (Shadbolt, 2008). Appointing a person to managing the care plan seems to be a solution but that will need agreement to gain the families or individual supports.

Reality orientation therapy is appropriate to present cues to reality and lead to less confusion of time and dates. However, there is concern about presenting facts without considering their moods will worsen the situation. For example, a video clip of the medication has been taken but the patient firmly denial that the pill is taken and would like to take a pill will agitate the emotions of the patient. Therefore, substitution of validation therapy will be appropriate by promoting positive judgement to the situation. The reasoning and conveying an aesthetic judgement into conversational expressions in the machine will be a challenge to study in future works.

8 Technology Evaluation

Leap progression in modern scientific and technological devices allow capability in many video recording gadgets and cameras to record the important life bits. The advancement also allowed by tracking the date and time of the moments i.e.: Facebook has introduced “on this day app” by pulling information off from previous posts, either relevant or irrelevant, and tracking the photos of the day for the users to decide posting in public or stay private. Some mobile life-logging apps Saga, Narrato and Optimize are free access application that create a “digital autobiography” to ensure the person have routine lifestyle, and managing the activity levels and stress. The technology market is wide and to decide which one is suitable to people with cognitive decline and user friendly, considering the person may not know how to operate the device, technological evaluation is required in this research.

Bear in mind also that the preferred computer operating systems (O.S.) will not exactly be the same for all users i.e.: Windows, Mac, Linux and so on. In this research, I assume to work on an operating system that is mutually compatible. According to StatsCounter from July 2016, OS statistics report shows that Windows 7 has highest usage trend, followed by Window 10 and so forth. This research will work on highest consumer-level operating system, which is Window 7 but will also ensure the compatibility towards higher O.S. Version to ensure flexibility for people who will upgrade the firmware in the future.

Table 2 Top Operating Systems for Dekstop from StatCounter

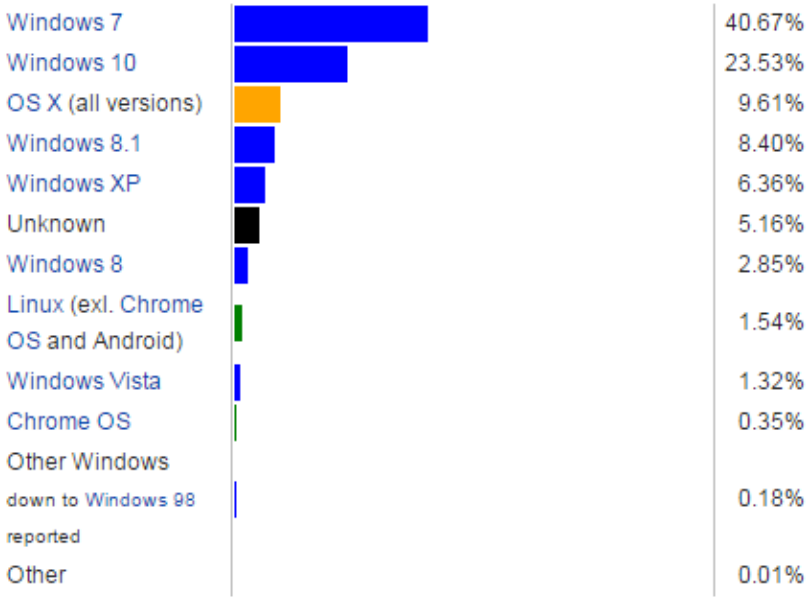

Table 3 OS Platform Statistics (http://www.w3schools.com/browsers/browsers_os.asp)

2016	Win10	Win8	Win7	Vista	NT*	WinXP	Linux	Mac	Chrome OS	Mobile
September	28.0%	11.4%	37.0%	0.2%	0.0%	1.3%	5.8%	10.2%	0.2%	5.7%
August	26.8%	12.0%	38.1%	0.2%	0.1%	1.5%	6.3%	9.8%	0.1%	5.5%
July	25.4%	12.4%	38.7%	0.3%	0.1%	1.6%	6.1%	9.7%	0.1%	5.6%
June	24.0%	13.0%	39.8%	0.3%	0.1%	1.5%	6.0%	10.0%	0.1%	5.3%
May	22.6%	13.6%	40.7%	0.3%	0.1%	1.6%	5.6%	10.2%	0.2%	5.2%
April	21.2%	14.1%	41.2%	0.4%	0.1%	1.7%	5.5%	10.6%	0.2%	5.1%
March	19.5%	14.7%	42.4%	0.4%	0.1%	1.9%	5.5%	10.3%	0.2%	5.1%
February	17.8%	15.2%	43.1%	0.4%	0.1%	2.1%	5.6%	10.4%	0.2%	5.2%
January	17.0%	15.8%	43.2%	0.4%	0.1%	2.2%	5.7%	10.2%	0.2%	5.4%

8.1 Recording Hardware(s)

Selection of recording device varies with the physical mobility of patients. In this research, the patients are active within the nursing house environment, personal living area, activity rooms, garden, rehabilitation centre, visiting hairdressers, family dinner venue. This research is comparing three mode of recording device: stationary, wearable and controllable. Webcam, surveillance cameras and wired cameras are stationary recording devices are fixed to a position. Non-movable devices require external linking to the storage hardware and can be replaced or managed. Wearable recording devices are a wireless camera that can be carried according to mobility. The photos and videos can be captured

effortlessly by simply mounted to the clothing of the users. Controllable devices such as DSLR cameras, mobile phones, and camcorders are mobile and user dependant but it allows the user to capture the exact moments instantaneously.

In this research, three modes of devices constantly used to capture the videos and photos in order to identify the process and understand the usage. Since the ethical application has not registered, the author is working as a research subject. A webcam is setup in a constraint environment as an ease to monitor the movement of people from passing by or visiting. Events from outside constraint area captured with wearable camera, together with DSLR camera and mobile phone as backup to capture the exact moments. Resolutions of each device are HD 1080p for video clips and more than 5megapixels. The length of studies, usability, and specifications are summaries as below:

Table 4 Specification summaries and Period of Study of Recording Devices

Mode	Static	Wearable	Controllable	Controllable
Type & Version	*HD PRO WEBCAM C920*	*Narrative Clip*	*Microsoft Lumia 640 XL*	*EOS 600D DSLR Canon*
Feature(s)	H.264 video compression; equipped with Video and photo capture, face tracking, motion detection; Skype video record	5MP; Output format jpeg; Automatic orientation of photos; wide angle lens;	13MP	18MP
GPS	Internet connection	✓	✓	✓
Wireless Connection	USB Connected	✓	✓	✓
Power supply	Cable	125 mAh battery	3000 mAh battery	1400 mAh battery
Area suitability	Indoor	Outdoor & Indoor	Outdoor & Indoor	Outdoor & Indoor
Memory	Unlimited (depends on external hardware storage)	8Gb	8Gb	8Gb and changeable
Capturing mode	Continuous	automatically capture photos every 30 seconds	Capture with own desire	Capture with own desire
Length of study	25 weeks	3 days (missing)	25+weeks	25+weeks (seldom)

Since the subject have expected minimum mobility, static recording device is ideal for scheduled and routine video recording due to the constant power supply. Considering that majority of aging group are less literate with the usage of technological advancement, less contact with device is more subtle and user friendly to the users. Wearable camera is practically useful when the subject's mobility is great or away from the usual comfort zone, to replace the visualisation in blind spot. Unfortunately, the length of study is short for this wearable camera in the research as the device has gone unaccounted in the crowd when studies the usage in the public area. As the result, the out-zone video capturing has been replaced with controllable recording devices but drawbacks of limited power capacity and small memory, the device is allowed to record mini video clip or photos with the full user control. Therefore, this research will spend most time on the static, wired webcam for starter.

8.2 Software Requirements

Recent market is now available with softwares that have highly improved application in vision management due to the high demand in surveillance system. Some video surveillance software i.e.: Ispy, Geovision and NCH video surveillance software has very powerful features despite capturing video in high resolution but also equipped with plugins for face detection, face recognition motion detection, time stamping for video recording.

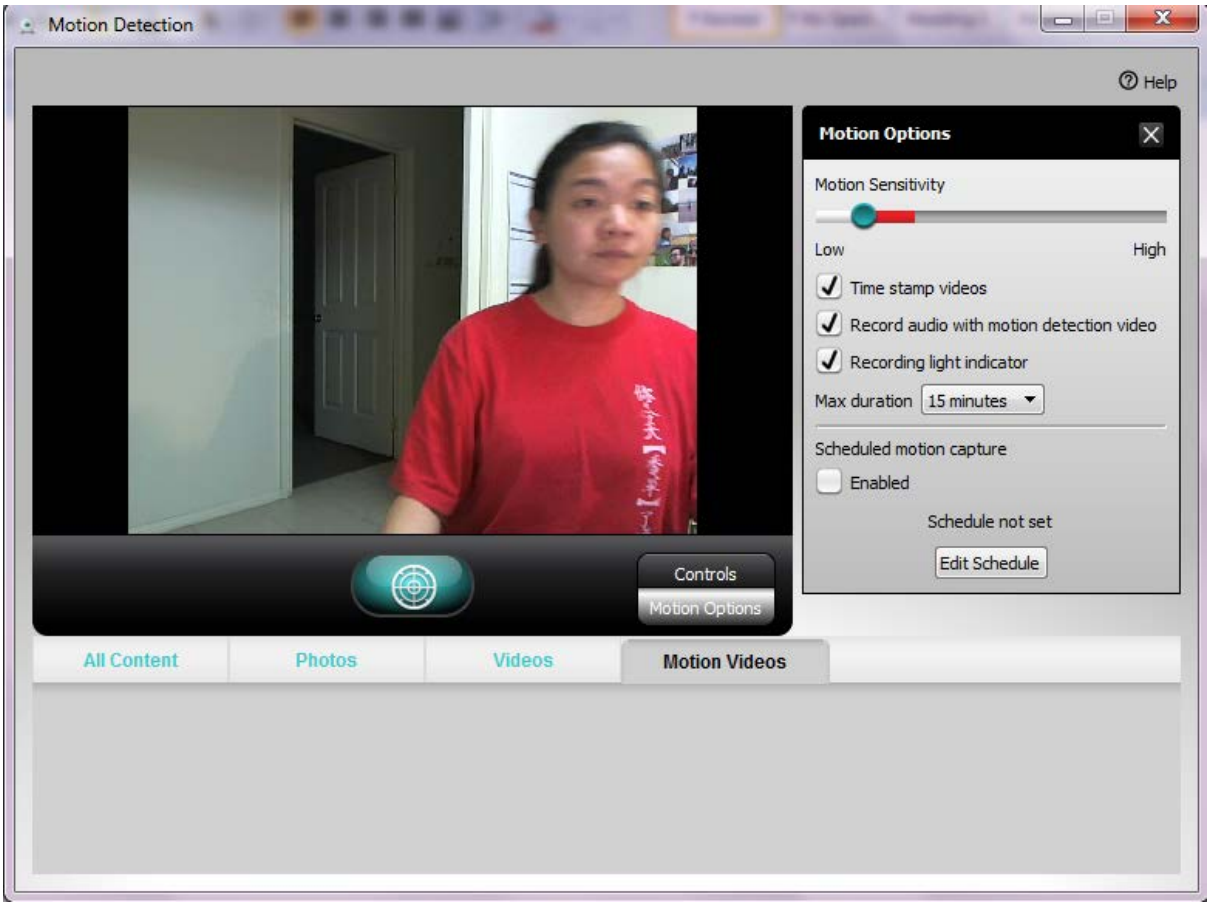

Figure 8-1 Logitech (R) Diagnostic Tool - Motion Detection Control Panel

Softwares listed above also allow monitoring remotely and accessing recorded frames through internet and works with USB cameras. The benefit of these softwares is they work direct live acquisition and processing with readily control panel i.e. adjusting the sensitivity, lighting and frame rates, which more or less remove the additional work on image/video processing. The collected data that captured from wearable camera and controllable camera exported as desired data or pre-processed data. Additional vision processing will be

required to improve the frames and photos to shorten or eliminate the redundant frame display to reserve the storage and direct to essential key frames. The aim achievement is to ***record video*** and ***extract relevant video/pictorial key frame*** to hook up the memories to retain the patients' memory trainings. To identify useful key frames of the recorded videos and clusters of photos, the significant memory hooks will be required and is discussed in next chapter.

The working procedures are divided into few approaches:

Approach 1:

Since USB webcam are able to run under surveillance software, the final video key frame and photos can be obtained directly.

Approach 2:

Data collected from wearable camera and controllable recording devices require filters to shorten while preserve key frames and images.

Approach 3:

Specific key frame extraction i.e.: smaller video clip, animated clip or photo representation

The summary of vision acquisition procedure is structured under the flow chart below:

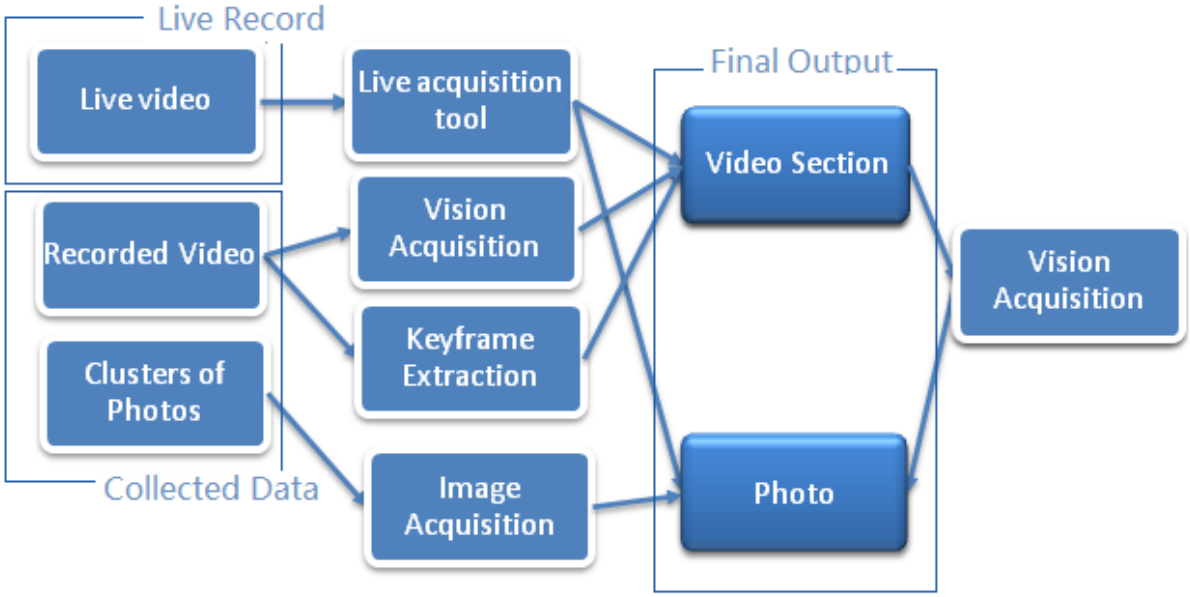

Figure 8-2 Video/Picture Processing Flowchart

8.3 Working Format

The formats are aimed reserve the storing capacity in certainty by working with smaller or compressed size data. Photo formats are normally less than 5MB and all formats i.e.: JPEG, TIF, png, GIF, rgb are allowed to work with. Most photo storage from phones and hardware are tend to store with JPEG format and this will be the most validate work format to study with. Picture formats can be compressed with the open source web link: https://tinyjpg.com/ or http://compressjpeg.com/. Qualities of the photos rely on the resolutions of the taken pictures.

There are various formats of videos, for example, .avi, .wmv, .flv, .mp4, .mpeg, .rmvb and so on. The working data will require compressed to the ease of processing. Considering video size, codec, image quality and compatibility to extract the key frames, I have found that the most common format to work with is .mp4.

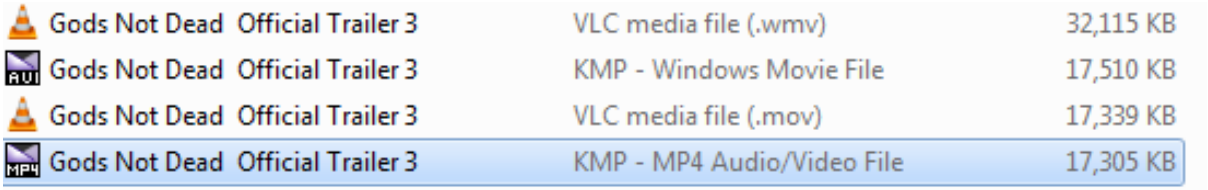

Figure 8-3 Video size in Various Format

Benefits to work in mp4:

- Compressed size video
- High compatibility with many softwares
- Easily extracted into frames
- High image quality

8.4 Others

There are also bundle of open source software that saves people from the burden of video recording and processing. Suggesting video recorder i.e.: VLC player, NCH debut capture and Movavi are trial in this research to check the ease of usability.

Good video recording tool becomes versatile if it supports external recording from mobile phones, webcams, wireless devices and other recording tool. Expected schedule recording is helpful to control the recording time such as sleep patterns, active period of dementia patients. Desired feature of video softwares contain support or converts into .mp4 format to compress the video size. This is useful later to extract video key frames.

Table below shows the checklist of the software that includes the desired features above:

Table 5 Comparison of External Video Recording Tools

Recording Software	VLC Media Player	NCH Debut	movavi
Freeware	✓	✓	✖
Operating System Compatibility	Windows, Linux, Mac, IOS, Android, Unix	Windows, Mac, IOS, Android	Windows, Mac
Supported formats	3GP, ASF, AVI, DVR-MS, FLV,	avi, wmv, flv, mpg, mp4, mov and more	MP4, AVI, MPG, VOB, MKV, FLV, SWF, MOV,

	MKV, MIDI, QuickTime, MP4, Ogg, OGM,WAV, MPEG-2 ,AIFF, Raw audio, mp3 Raw DV, MXF, VOB, RM, DVD-Video, VCD, SVCD, CD Audio, DVB.	video formats	M2TS, WMV, 3GP, 3G2, WebM, OGV MP3, WAV, FLAC, WMA, M4A, OGG, AAC JPEG, JPG, PNG, TIFF, GIF, BMP and more
Video Conversion to .mp4	✓	✓	✓
Record Dekstop Screen	✓	✓	✓
Record from webcam	✓	✓	✓
Record from external device	✓	✓	✓
Record streaming video	✓	✓	✓
Record from wireless/mobile device	×	✓	✓
Record time Lapse	×	✓	✓
Record Audio	✓	✓	✓
Schedule Recording	×	✓	✓
Create photo snapshots	✓	×	×

The study of the technological evaluation is a particular reference for this research purpose to structure a framework to study the key frames. The final working format of the media data are .mp4 for video and .jpeg for photos. Since video recording tools are readily available in software market, it grants more works on editing the videos and photos to setup the key frames. The approaches from Figure 7-3 rely on the type of videos and photos to be processed, whether it is relevant to memory hooks. For example: if the subject is inactive or sleeping and just sitting blank, the key frames can be eliminated; disruption within the sleep pattern, drawings, time of having pills, activities organized in nursing home, and more activities with more movements can be stored as memory hook references.

9 Key frame extraction

Concept behind this key frame extraction is related to a personal e-memory archive sorting. Part of the consideration is the concept of information control, which to be displayed, which to be archived and which to be disposed.

Key frame extraction is required to remove the stack overflow of the memory space of hardware whilst finding significant frames from video. Short-term memory declines much faster than Long-term memory. As mentioned from the previous chapters, short-term memories can be transferred into long-term memory with “consolidation” and constant reminder. The concept behind this key frame memory hook is to “wake-up” a short-term memory and “routinely recall” into long-term memory.

9.1 Key frame Detection Algorithm

There are four possible key frames to structure as main frameworks:

- Date and time of any events
- Recognise the subject with relevant identity and personal information and identify family members or support individuals for the subjects
- activities of the day, special events
- Monitor the react through recorded expressions such as smiling, crying, frowning, grimacing etc.

The structure above identified through the various modes of recognition techniques that have been readily existed in video softwares. Date and time commands can be achieved directly through stamped time videos. Performing physical activities require physical movements, which is represented by motion detection. Various person presented in a scene can be recognized through face detection and processed in face recognition. Mood change is detected by analysing face features by bordering and zooming the result from face recognitions.

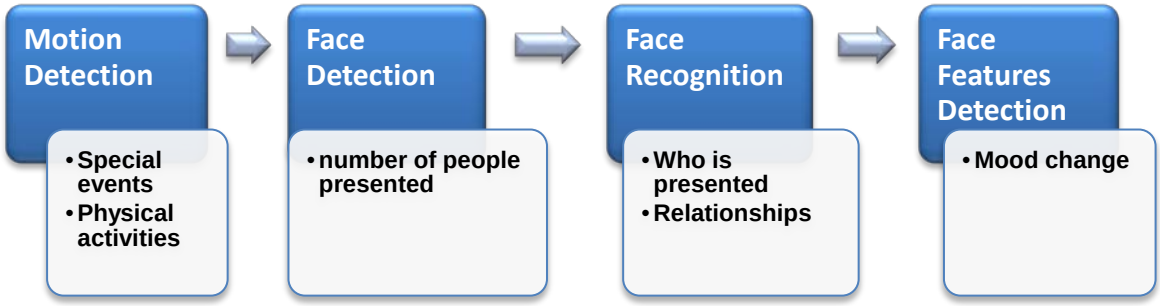

Figure 9-1 Key frame Extraction Guidelines

9.2 Key frame Extraction Practices

Ffmpeg:

It is not difficult to work out a key frame extraction using FFmpeg, which is an existing platform solution that converts and extracts videos fast and accurately. In this research, Ffmpeg is examined by converting mp4 format into thumbnails in jpg format.

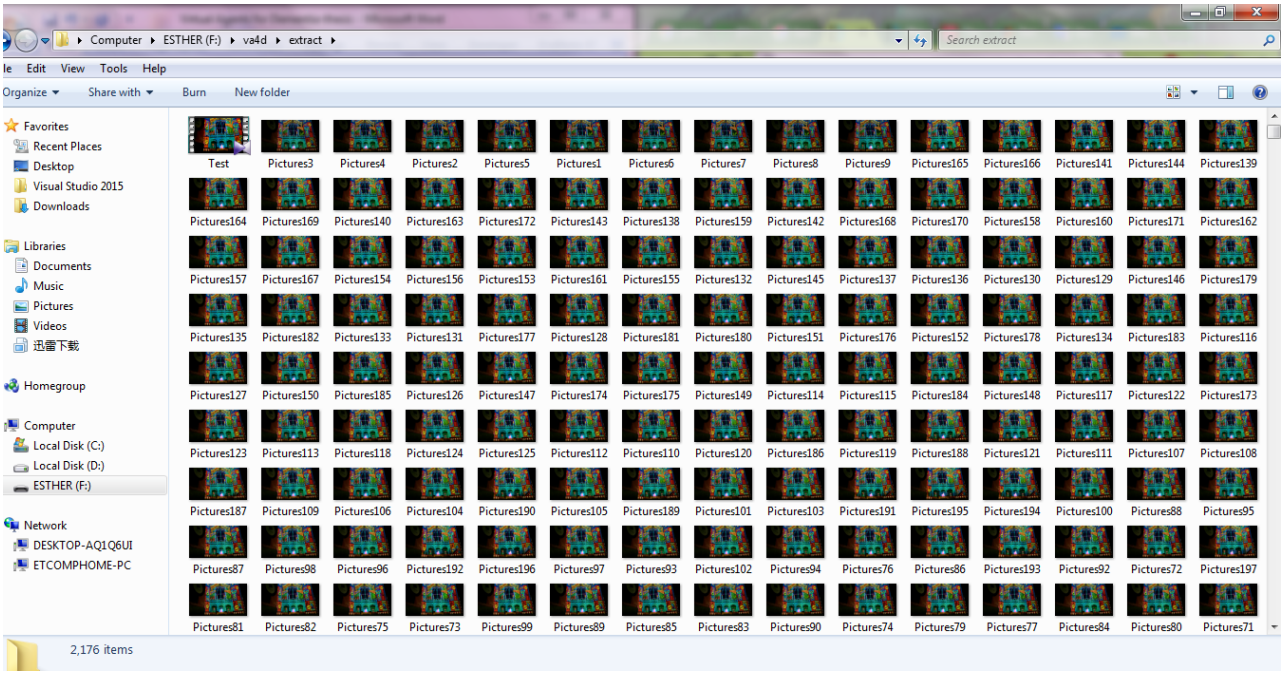

Figure 9-2 Extractions of picture thumbnails from FFmpeg

The thumbnails represented each framesets of the video and surprisingly the total thumbnails size is not far from original video size. The result can be seen in Figure 9-3 by comparing original video size on the left from total thumbnails size on the right.

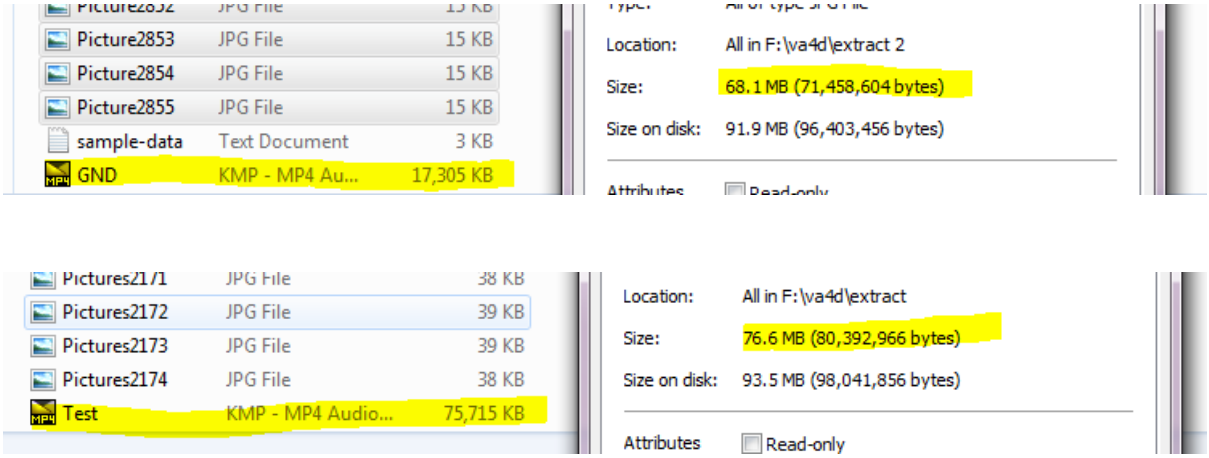

Figure 9-3 Comparison between original video size and extracted key frames

This outcome gives an assurance to preserve the digital storage when archiving key frames for memory hook.

Ffmpeg also allows selection of thumbnails according to scene change by filtering the percentage and number of scene changes of thumbnails required from a video. Smaller percentage of filtering results in more accurate for extracting continuous frame change from a given video example. Figures below target extraction of first 30 frames of scene change from different percentage of filtering. From the extraction results, 10% filtering allows significant frame extractions with clear viewing of different people and background. The video used here is “God is not dead trailer” which is referenced from YouTube video: https://www.youtube.com/watch?v=bMjo5f9eiX8.

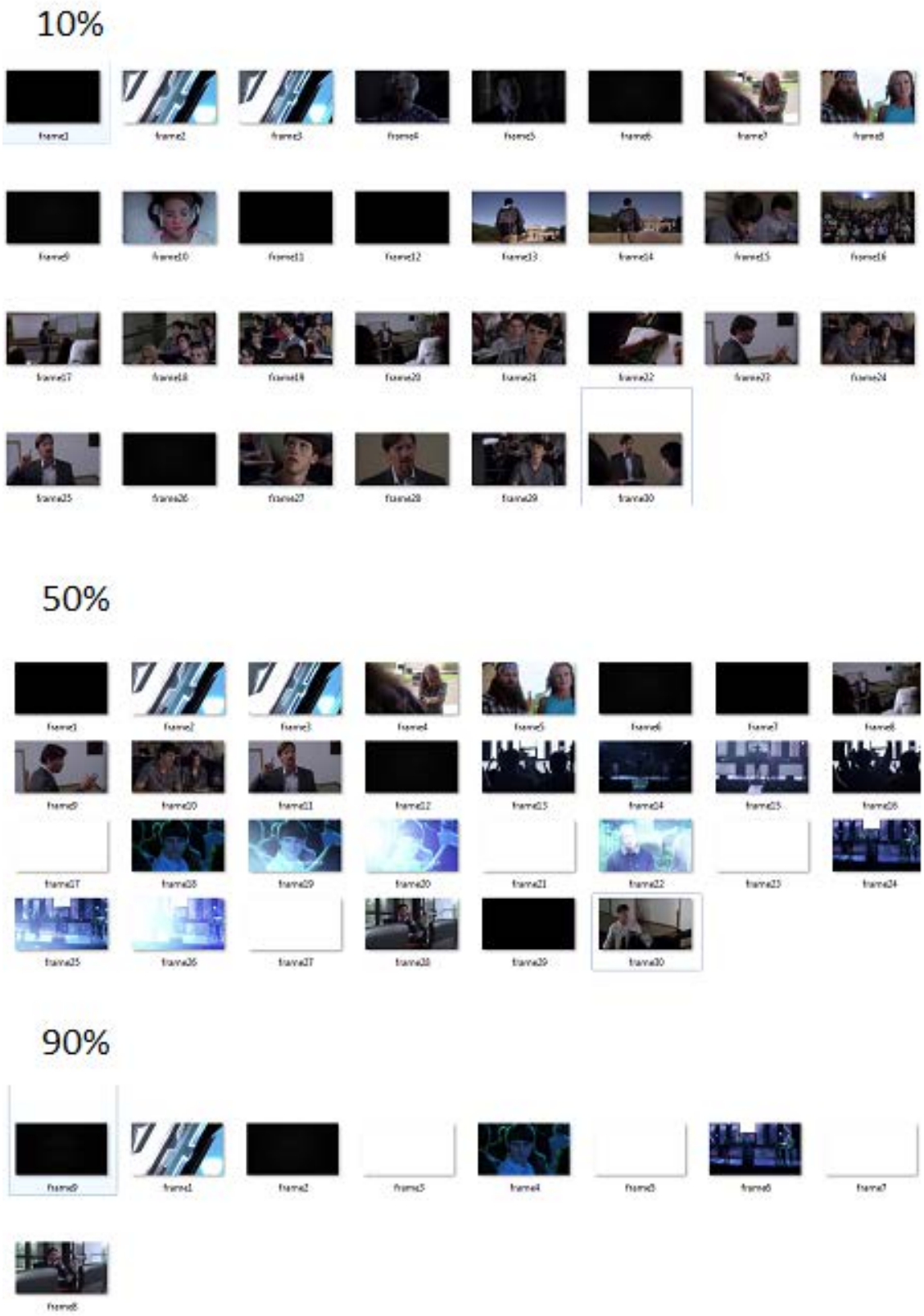

Figure 9-4 Comparison of percentage filtering of extracting first 30 framesets

Not only creating key photos, this platform also creates small video clips with selected thumbnails. This will be useful to create an animation of a key frame in archived in media storage to obtain a memory hook in the future. New output can be renamed according to the date and time of the framesets to keep track of a genuine record of the video taken.

In conclusion, ffmpeg is simple and user friendly and less likely to create errors. The accuracy of key frame extraction is reliable and the accuracy can be trial and error by adjusting the filtering percentage. The drawback of ffmpeg is it has less information in accessing the tutorial. Since it is a free cross-platform solution, it also has open support by other video softwares i.e. Ispy video surveillance camera software.

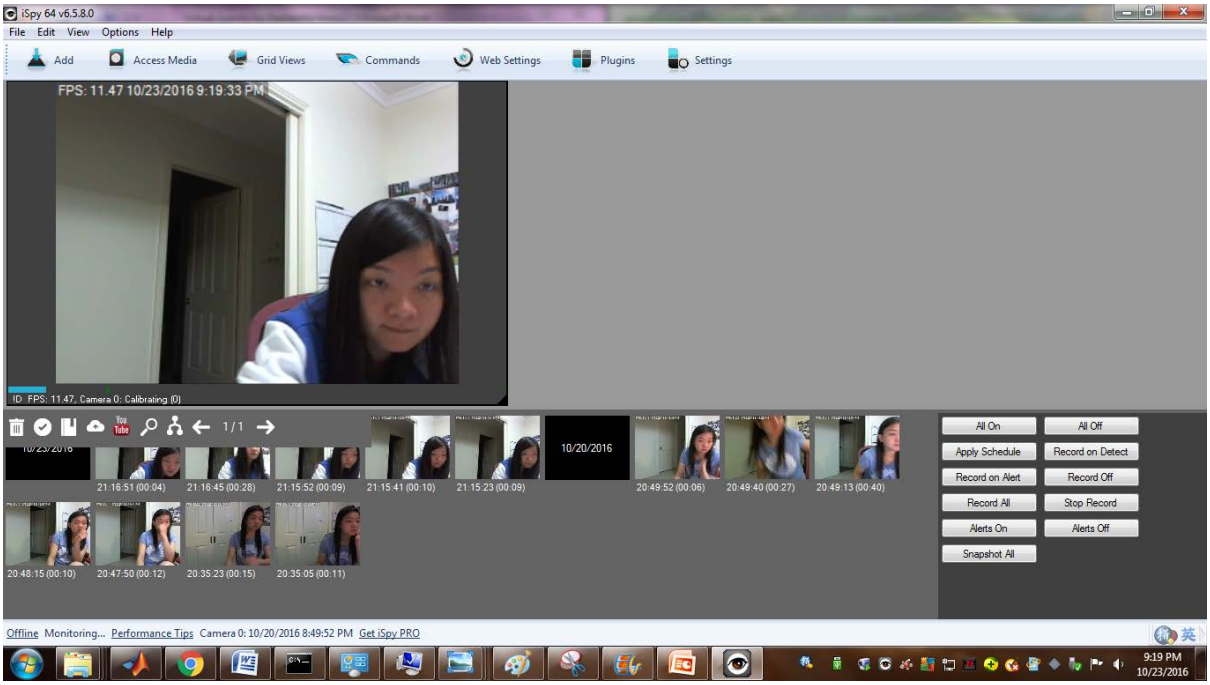

Figure 9-5 Ispy Video Surveillance Camera Software Interface

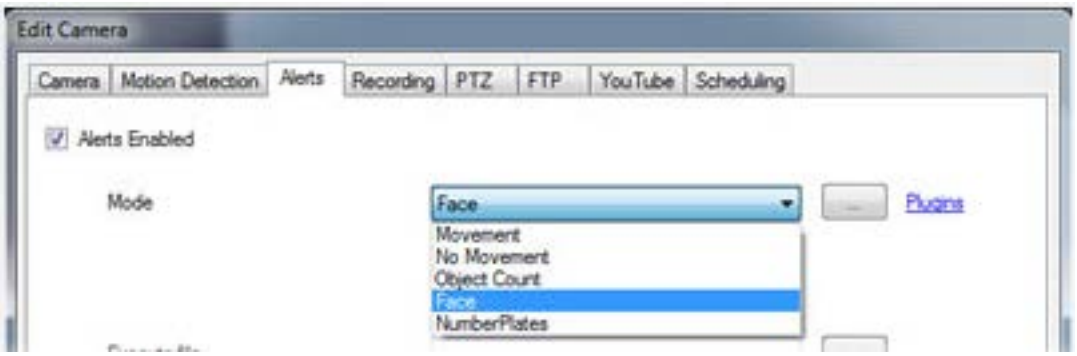

Figure 9-6 Additional Plugins for Ispy

Ispy also has additional functionality such as stamped time real-time record, face detection and motion detection. Together with Ispy, the task of extracting key frames and archiving the significant memories will be simplified.

Matlab

Simple matlab practices are taken on the face mapping for face recognition and detection and possibly emotion recognition. There are two references of face detection algorithm: Viola-Jones Algorithm and KLT algorithm. In this study, the system detects faces in live video acquisition using the Viola-Jones algorithm, identifying Eigen corners within face boundary, and tracks the corners of the boundaries using KLT algorithm. The face tracker box is replenished every 10 frames to detect positions of new faces. That means it will also works as slow motion detection. The name of the detected subjects can also be inserted into live acquisition video as seen in Figure 9-8.

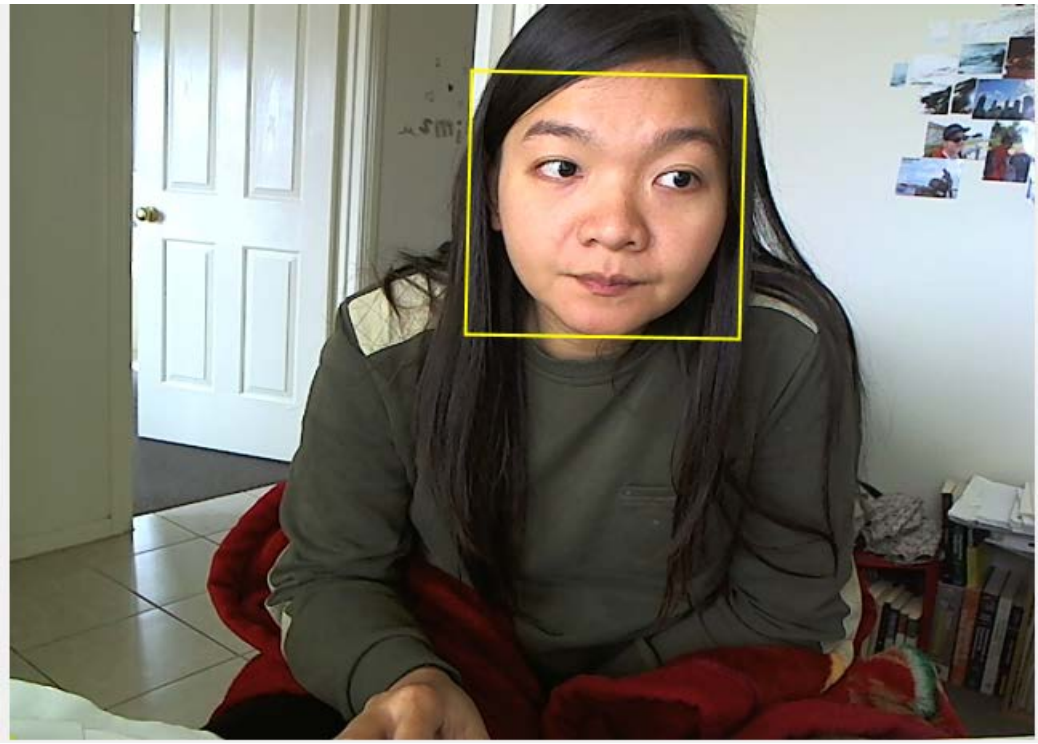

Figure 9-7 Face detection using live video acquisition

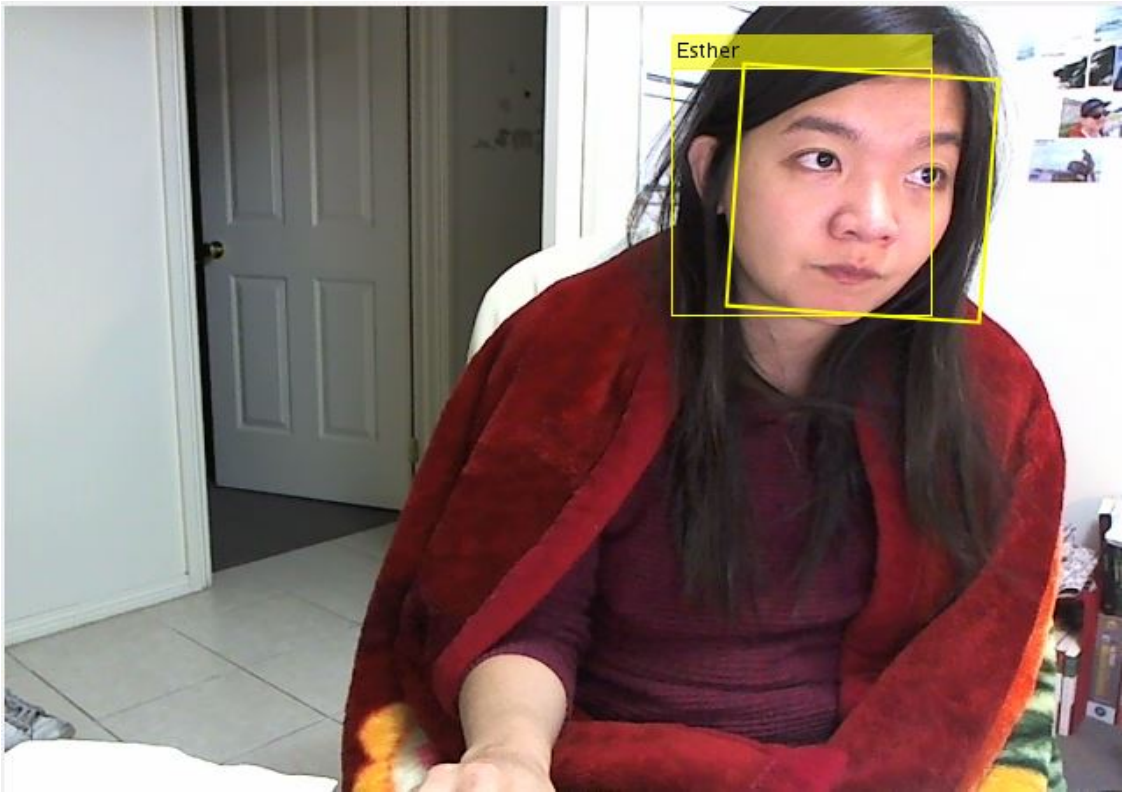

Figure 9-8 Face detected with names in Live acquisition

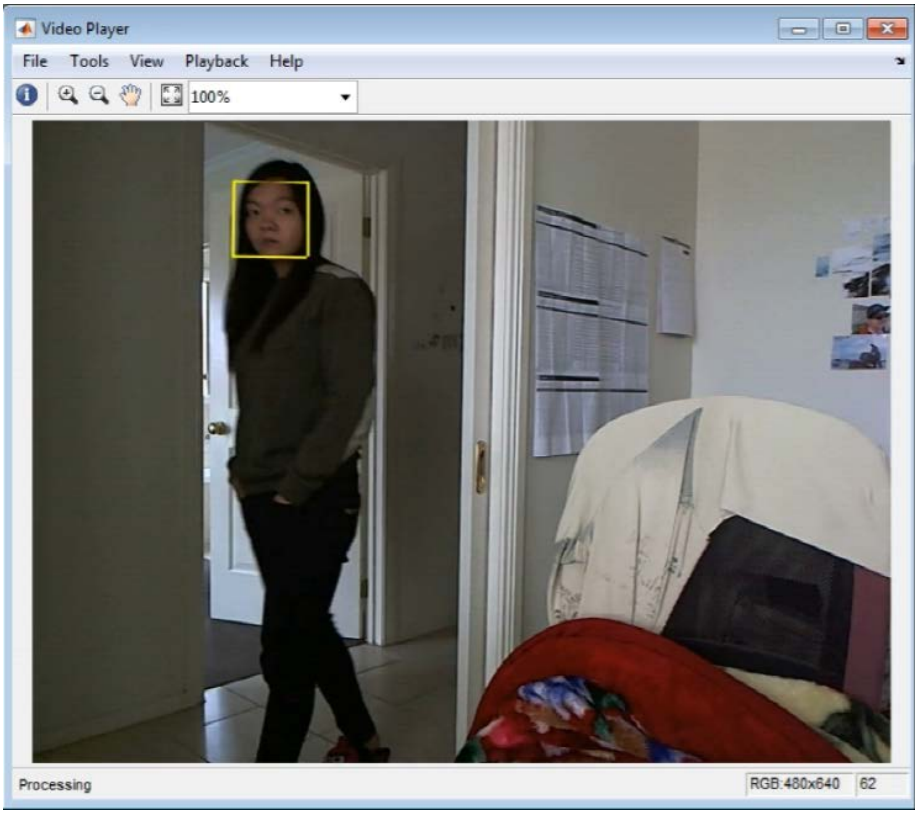

Figure 9-9 Motion detection using face detection algorithm

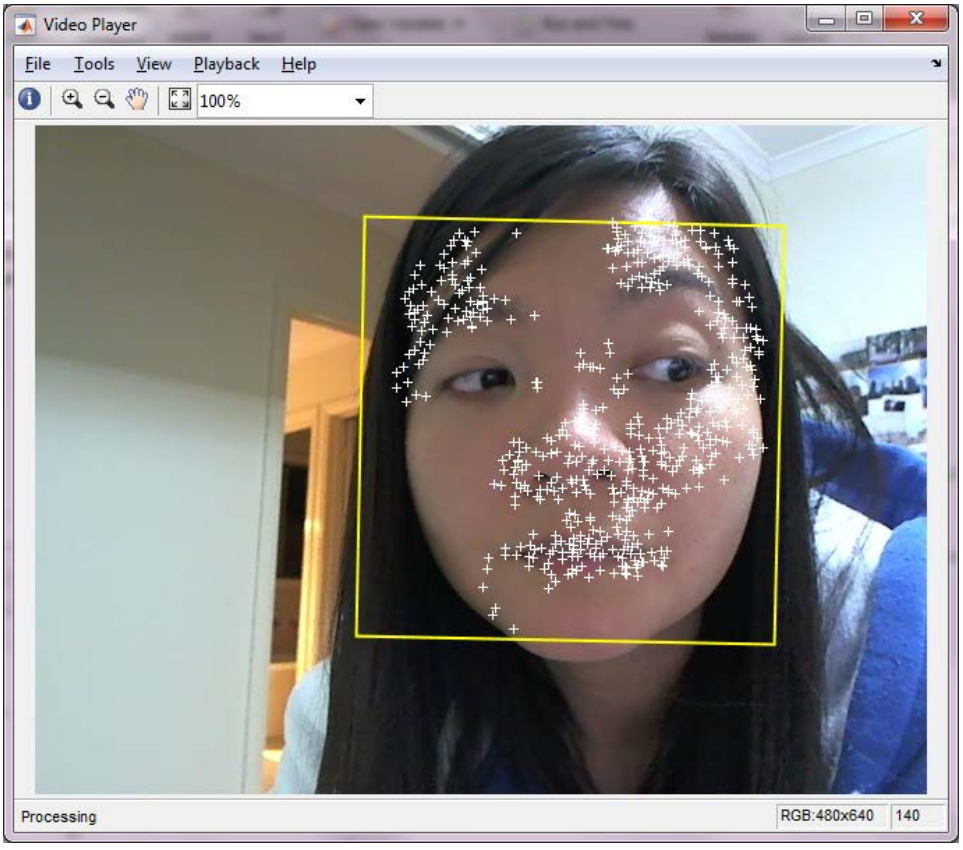

Figure 9-10 Tracking Face Features

Figure 9-11 Multiple Faces Tracking

The benefits of using Matlab to study the detection algorithm are it gives clear direction of applying face detection, face recognition and motion detection. Code can be altered to

allow multiple face tracking and extract the face to study the face features (see Appendix C for matlab code).

This research covers the study of functional features in coding to compare and judge the usability of both ffmpeg and matlab. The limitation from the matlab is the coding is more complex and more time consuming and the expected outcomes will be truly accurate and applicable to many situations such as adjusting lighting, resolutions, detection speed and so on. The other limitation is the framerate from Matlab video capture are slow and there is always delay in face and motion detection. Therefore, adjustment that is more detailed is required to improve the assignments. From observation, Matlab do have more flexibility in transferring the choice of extracting mode but will require more practical code works to obtain high accuracy of outcomes. All these assumptions are unable to validate until a proper examination is conducted to confirm the living style of the working subjects and identify the significant memory hooks. In this research study, no actual subjects are studied.

10 Summaries

10.1 Up-to-date assessment

Interview/Discussion with professionals

Discussion with the related individuals with dementia helps to clarify the challenges and some solutions to structure the proper interventions. Interviewed subjects from different backgrounds and different professions provide relevant information to understand the caretaking issues, cognitive declination issues and method to promote the ease usability onto every individual by neglecting the complex interface structure. Proposed interventions are expected to help this research accessing the key frame brilliantly and achieve significant results to improve patient's cognitive function by slowing down the declination and prevent the issues from early stages.

Technology evaluation

Considering that patients are likely to work in constrain environment, a wired webcam are employed in most of this research to study the method of video recording and extracting video key frames. From the study, many found softwares are readily in use for this research purpose. Preserving the working memory capacity of the machines can be achieved by storing all archive video memories in mp4 format while photo format will be less of the concern but the compression can be achieved if required. Various video recording tools are compared according to ease of use and available features. Since the pros and cons are varies in research views , selecting one of the most helpful resource i.e. Debut video recorder and Ispy will provide most access and to capture daily videos in compressed mode and with additional features that is useful in this research.

Key frame extraction

This research experimented various coding in matlab to understand the structuring concept in key frame extraction such as motion detection, face detection, face recognition and face feature detection to create key frames from live video acquisition. The application of the extraction mode is compared using ffmpeg and Matlab. From the study, Matlab has

flexibility and specific in direction to work on the logic of key frame extraction framework in the future. Ffmpeg is simple and promote fast learning in key frame extraction but the working mode relies more on guessing and viewing through the media manually to understand the input to extract the required key frames. Both methods require more works in terms of structuring the logic and this will be the future work.

Overall, this research has more focus study on evaluations by reviewing the works and receiving opinions from individuals that related to working subjects to analyse the view from different angles before the logic of frameworks are in place.

10.2 Future Works

Once the framework of the key frame extraction is ready, the logic of the framework is required and the proposed interventions induced to the framework to shaping the logic of the actual memory hook. Then the system will be ready to study on the actual subjects.

Since it will involve the vulnerable individual mostly, dementia patients, ethical application are in progress before the experiments are applied onto actual subjects. The proposed partners are nursing homes: Helping Hand, Alzheimer's SA, Centre of aging and uniting care centre. Seeking the partnership and ethical application will be part of the channel to access the experiments and retain feedback. The working proposal is shaped and can be visualised in Appendix D.

The teaching mode will need to be deliberately examined and improvised to promote the effective interaction between the patients and the contact person or device. The frameworks will be gradually integrated through data collections and feedbacks from the working subjects. The future works structure is listed below:

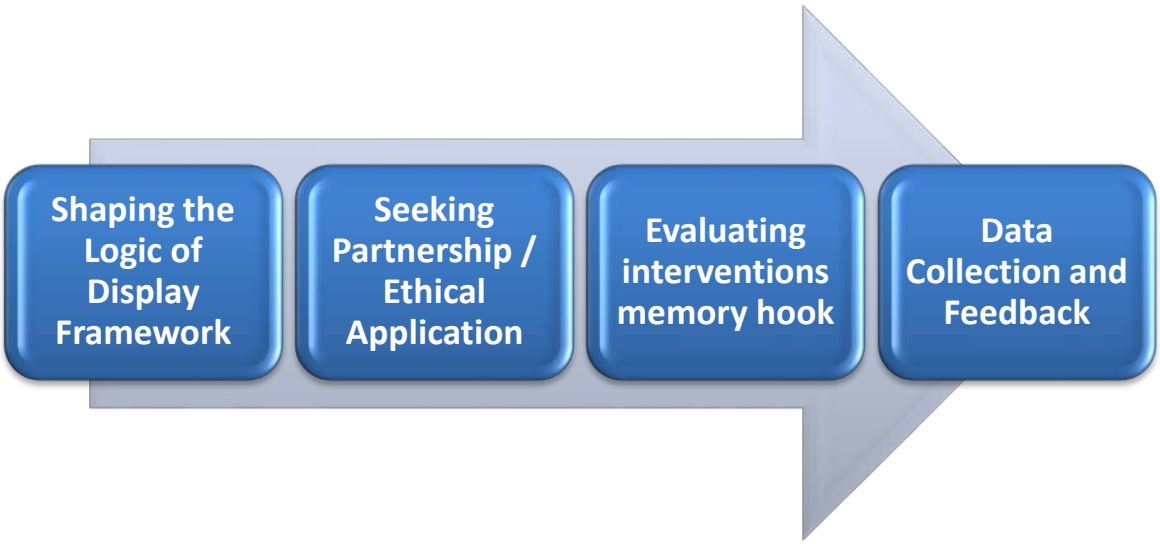

Figure 10-1 Frameworks of Future Works

In the future, the idea of learning when you sleep is an interesting subject and can be part of the study. To understand whether sleep teaching is helpful by hooking a memory recall

session or training session before sleep will allow a person to acquire the cognitive boost will be an open source to prove the concept behind unconscious cognitive learning for people is a myth or it is not.

This research only accesses few useful recording devices and softwares that are available on the research ground. More advancing hardwares and softwares have not been able to confer. Some advance vision devices i.e.: Microsoft Kinect and Intel® Realsense are based on webcam with add-on peripheral which enable users to work on a natural user interface using body gestures and voice activation commands. Their associated libraries allow compatibility to many other runtime and frameworks and is available in http://www.intel.com.au/content/www/au/en/architecture-and-technology/realsense-overview.html and https://msdn.microsoft.com/en-au/library/dn782033.aspx . In Kinect, the camera equipped with infrar red, which allows high accuracy in detecting skin tone, body index, movements regardless of surrounding brightness. The detection of captured keyframe relies on exposure length of infrared frame. This will be useful in face recognition and motion detection in high accuracy. Realsense SDK 2016 extends its features more mature with human and computer interaction and has algorithm availability in face tracking and recognition, which enhance the experience of capturing photography and videography related to this research.

As mentioned before, this research using the existing Matlab code and ffmpeg to simulated the algorithm for key frame extraction. There are limitations for both solutions and particularly in Matlab, the simulation of the motion detection has often delayed in response and not suitable for live video streaming. OpenCV has strong focus on real-time applications and is written in optimized C/C++, which is suitable for computer vision acquisition. The users required background knowledge in programming languages to operate the platforms. The coding is more advancing with flexible functionality and it is worth to be tested in the future. Overall, this research concludes with the study of the cheap hardware and software that are commonly available and user friendly and potentially accessible to every individual. Therefore, suggested further studies on hardwares and software required additional funding and access to understand wider prospect in key frame extraction for memory hook.

In conclusion, there is development of media capturing technology will keep up and automation in technology will soon become available to save the concept of life logging of memories for person's life.

10.3 Expected Outcomes

The project expects outcome of user-friendly device to assist dementia's family and caretakers by enhancing the machine and human interaction. It is believe the success use of the design promote usage durability in helping the subjects on track with their daily schedule and care plan and medication management whilst retaining their physical and emotional information promptly and flawlessly. The development also designed to engage interactive teaching mode to keep subjects active and vivacious and achieve significant cognitive improvement. The core of the development is to serves as an intelligent personal assistant, trainer and therapist to slow down progression the cognitive decline, promoting independent living, improve physical and psychological performance and enhancing quality of life and recover the social behaviour of dementias.

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12 Appendix

Appendix A

Interviews Q&A:

C1- General Nurse, Jamie. Y, aged 23

C2-RAH Nurse, Susie, aged 33

C3-aged centre carer, Ling, aged 42

C4-midnight nurse, Emilly. C, aged 28

C5-Nurse, Gordon Thia, aged 27

C6-intern nurse, Cynthia, aged 33

C7-medical intern RAH, Gabriel, aged 24

C8-speech pathologist, Elaine, aged 42

C9-retired nurse, Elaine, aged 78

C10-speech pathologist, Grace Koh

C11-senior nurse, Chen Need, aged 56

C12- ARC Dementia Research Fellow, Dr Kate Laver

C13-registered nurse, Penny, 27

C14-pharmacist, Elaine Bong, aged 28

C15-General nurse, Elizabeth, aged 30

C16-Home nurse, Abby, aged 29

C17-Dementia's family/caretaker, Kristine, aged 56

Q: What is your worse perspective of the dementia's situation?

C1: They are extremely diversed from people, sometimes ask people to back off and stay in their own comfort zone. Whenever you pass over his/her territories, they will shout at you and that takes time to comfort them. They are very random and forgetful. They get confuse with day and nights. Some patients can ask who you are everyday we meet. We as nurses try our best to accommodate.

C2: forgetful even when you repeat daily by introducing yourself; when they try to express something that is unexplainable, they become aggressive and violence

C3: One case is a patient claimed that she was going to give birth but when you understand her background, she never gave birth; They gets hallucination and very suspicious. Worse case is one patient realise he is not at home and he climb the fence to escape from the care centre and got himself injured.

C4: Sleepless patients. Some patients have sundown syndrome where they remain active although it pass midnight. Some patients get agitated when they are confused with time.

C5: stressful and require many physical works

C6: We sometime find it stressful to managing the different situations of the patient and as a nurse we learnt how to overcome the stresses. We do have mental stress as we can find ourselves restless even we found ourselves physically weary.

C14: I did not have experience with them but from my work experience but I have seeing the family members bring the patient to the pharmacy shop. From my observation, the family members are mentally stress and physically tired

C17: My mom's situation is very worrying. She has been psychotic and doubting. She chased me out from her house for sometimes because she thought I was going to take over her property.

Q: What are the significant behaviours you will find from the dementia patients?

C5: Some patients have depression and lost confidence. From understanding their life background, they may encounter some suffering and tribulation that leads to dementia. Stress leads to the sickness. They sometimes draws away from groups, they loss confidence, some patients have psychotic issues and require psychological helps. They find themselves disoriented with reality and confused with time and dates. Severe patients will find problems in limb coordination and require physical help.

C6: Different stages have different behaviours. Early cognitive decline tend to forgets things and don't remember certain events. The behaviours will progress and tends to forget more and more things, missing verbal like aphasia and also the long-term memories. At critical stage, the patient is losing the physical capabilities and requires full-time assistance which consequence in muscular dystrophy. At final stage, the patient will suffer from complication in brain atrophy that leads to fatality.

C14: **T**hey are very bossy and impatient. My customer bring his sick husband to our shop to prescript some medications, the husband keep urging her and shouted to leave the place and get home soon.

C16: They find themselves very lost and vulnerable and consequently loss confidence and anti-social. They are vey affectionate to things that is closely related to their background and they get used to. When we organise a group session, many patients are unwilling to shift to a different room and they get uneasy when they do so. This happens occasionally in my care centre.

C17: She relies on her sleeping pills to sleep well at night. Sometimes she overtook the pills because she forgot she had taken the pills and I decided to hide them away. She can't even remember I have came home everyday and she always ask why don't you visit me for so long.

Q: What is your most worried situation when taking care of the dementia patients?

C1: When they are out of sight especially when it is their routine to ask them to stay in activity room and get engaged. Unless there is special case where the person is unable to move which need assistance but that is only the case when they have late stage. We try our best to keep them in the sighted compound at the same time give them freedom, like if they need to go to washroom, we have to accompany them. Their safety is our priority.

C3: Swift change of mood and I have to act to response. Another is communication barrier. I found them are incoherent and to understand what they are saying is impossible

so I record their habits and preferences and give them cue card with pictures or letters in huge characters. Some patients are not difficult to catch up with and have common answers, either they request to go washrooms, want to drink coffee or having biscuits or asking to for a walk.

C4: Mental stress due to communication problems; worried about being beaten up by patience; loss patience with the patients. Some patients hold their resentment and gets very agitated.

C6: Miscommunication is the major problem. The patients know what they want to express and they do express as they have wanted and we have to guess what they want to explain.

C8: The patients will afraid of changes, try to avoid the change of scenes as much as possible. Routine seems to be the best option to manage the care plan, less confuse to patients and less confuse to carers

C9: For example, they want to express “cold” but they can’t remember the exact word and they repeat the word “snow” until we figure out they try to express they are cold. Guess we all doing our best job to guess the word.

C17: She is very suspicious and mild psychotic, she laughed and next minute she will cry for no reason. I remember I bring her to her booked clinical appointment, which she have requested, then next minutes, she said she did want to see the doctor and was angry why I lure her into medical centre.

Q: If there is the situation when the patient is agitated, how did you comfort them/ How would you intervene when you dealing with patients?

C1: Distraction. Sometimes we give them their photo albums to revert their concentration and calm them down. Otherwise, we just give space for them to yell and shout until they are exhausted and calmed.

C2: stay away is the better option, constrain the agitated patient in one zone while keeping other patients away from them. Only experienced or trained nurses are authorised to comfort them.

C3: It's like taking care of a child in daycare centre. Encourage them, give them positive review, give them their favourite things to distract them, remind them of their favourite moments and soon they will forget what happened just now since they have very short-term memory.

C4: Give them a gentle touch, rub their back , hold their hand to give them comfort. Ask them the reason, whether they want to have meal, physical pain, uncomfortable bedding, changing diapers. The last solution is give them medication i.e.: anti-anxiety, anti-psychotic pills.

C6: Ask them what is going on and try to make them listen to oldies as it seems bring back good memories. Give them massage and calm them down.

C14: Music therapy will leads them to good old times and thinks of their family.

C16: I try to make sure they welcomed me before I start intervene. I stay alert and extra cautious, as they are confused with unfamiliar people. Blend in I should say. As a carer, my responsibility is to ensure their care plan is fulfilled and intervention do need practice

Q: How would you communicate with the patients?

C1: We try to use simple and repeating the instructions. Lend a hand if they try to reach something that you don't understand from them by pointing to the objects from the direction of their sight. Body language may be helpful also. Hinting by giving them a range of words and letters or pictures.

C3: It's difficult, sometimes I will find them attentive deficient, so engaging them and drag them back to situation is my major task. Sometimes play along with their hallucinations

and brings them back to reality or try to revert the situation to gets them sleep and calm them down.

C4: I will show them pictures to hint them it's time to have their dinner or having their pills.

C5: Firstly, show them respect and try your best tolerate with them, meaning, you need to have proper eye contact to show you have pay attention to them. Give them a proper non verbal gesture, like nodding your head to show agreement, uses simple and non-lengthy conversation to interact with them.

C6: Greetings and show respect, try our best to make friends with them. They get agitated if we touch their personal belongings

Q: What common activities are given for them which will help them in cognitive training?

C1: There is no proper cognitive therapy in our nursing room. But our facility did provide them some activities like art and craft, listen to oldies songs and dancing, morning tea session and so on.

C2: We have organised many events like BINGO, outside musical performance, animal therapy, tea break session. Sometimes, we have authorities outside facilities to give some cognitive therapy session like art and craft, mnemonics and acronym brain trainings and so on. Art and crafts seems very positive with cognitive recovery because aged group uses imagination to work their minds.

C3: We try our best to simulate their rooms as same as their previous living areas by bringing back their old furnitures under family's consent and arrange their space like their old room. We also bring back their photos and their gadgets they collected during their active age. We try to reminiscence and try our best to make everything as similar as their usual life preference to prevent them from homesickness and uncomfortable. Photos will

give them chance to talk about their background stories. Understanding their habits and characteristics may solve many problems.

C4: There is no proper cognitive training but we prepare activities that gets them engage and keep them in positive manner. Activities like cooking class, bingo, viewing outdoor horse riding competition and other arranged programmes. Showing them their taken photos and surprisingly they tell us story behind the pictures as if they have recalled their memories. Music therapy that sooths their emotions and give them good rest. Mirror as a therapeutic tool for patients to ensure they recognize and remember their own looks. This therapy is quite common because the patient stuck in their young memories and this will help them to get back to reality.

C5: Quiz, spelling bee, guess the word games that runs in activity room and in a group.

C7: It will be difficult to train them if they reach their severe stage. But we can intervene years before the disease is diagnosed by slowing down the progress. Music therapies and physical management plan is practical to prevent cognitive declination. Sleep patterns are the major issues that affect the breakout of the disease as regular sleeps pattern promotes growth of neurons.

C12: Problem solving sessions to keep them alert and keep away from boredom. Reminiscence is also a good way to recall their memories.

Q: What do you think if there is a virtual agent that have the capability to interact with dementia patients whilst managing their care plan, medication plan, activities and diet plan, and also helping the carers. Do you think that will be helpful to you? (showing them annacares video)

C1: That can be really interesting, but my initial instinct is the virtual agent might confuse the patients. For carers, we try to encourage human to human interaction especially for severe dementia, virtual agents machine might not necessary be useful.

C3: That's definitely brilliant, to get them attentive and carry out care plan is my greatest challenge and very mind exhaust.

C4: Medication plan is truly useful. Patients are afraid to be overdose since they are forgetful. There body clock is all messed up, so it is better to have a device that manage the care plan and grades care givers hectic life.

C17: It surely will when the patient try to drawn away from people. This device will be a good companion while family members can access the device remotely to track her movements.

Q: We will considering the concern of yours and try our best to induce in this research. So I hope to ask you some questions that might be helpful to my research. My research is to capture daily videos of patients, reviewing the video and extract significant videos of the day to create a reminder of the day. What do you hope to achieve from that and any pros and cons you would think of?

C2: It worths trying as I hope to have something that works multi tasks in one device as sometimes, I have to run and understand patients log all the time and I myself will get confused sometimes.

C3: Photos and video clips will definitely helps. Carers will also need evidence to prove the patients have taken their meds and what they have done when we have away. Tracking lost things, track back good memories will sure helpful to sooth the emotions and keep them in positive pace. Given them video playback will get them assured with the reality but sometimes will also agitate them. If there is a situation that the patient wet himself and he deny it, as a carer perspective, we cannot show the video evidence directly as it will uncomfortable. But device can't judge whether it is good or bad, there should be some kind of program to prevent the bad situation from happen.

C7: This will leads to some ethical concerns. Some privacy and security access are prohibited and families might object the daily recordings of their love ones. You might need to issue a conscent letter before the experiment is actually carried out.

C12: Explicit memory hook to prevent the patients from confusion. Less choice, cascade touch screen, showing date and time on visual, highlights of the weeks to visualise the significant events. The intervention must be routine either before breakfast or dinner.

Q: Do you think you or the patient can use the device?

C1: It depends. I think nurses should be authorised to use the device. We are assigned with few patients each day and we are able to access their daily logs and some information backgrounds. The patients find difficulty using a smart phone although the phone is "idiot proof". I can't imagine how would they use technologies and how can they accommodate changes.

C2: I'm happy to use the device as long as the interface is easy to understand. Patients are welcome to do so if the device is locked in a place and not inclined to "sabotage". If you are planning to install it in nursing home, is that means you will have to prepare many devices? Sometimes if the patients are discharged from the hospital to have family gathering, will the device be able to track the moments of the family gathering.

C3: The patients aged 70-80 above will have problem with computer literacy. But in 10 years time, when persons who know operating smart phones are getting old, this should not be a problem.

C4: I think early dementia will have no problem with using the device but severe dementia will require assistance from us as they have lost their self-care ability.

C12: Concerning about personal identity violation, it is better if the device can set moderate safety and privacy and nominate a person to control the usage of device.

C10: Patients are unlikely encouraged to use the device but the clinical staff are allow to store and putting all information relevant to the patients to assist the clinical staff to obtain the patient history.

Q: This will relies on the interventions we are planning to use. In Flinders, we have MANA project which uses only screen without keyboard and mouse to interact with person, quite similar to iphone SIRI. So we hope to have some suggestion from you to assist our project like how you communicate with them and how to prevent their agitated behaviours. So, is there any nursing interventions that you normally used to guide the patients?

C1: Yes there are many of them. We give them constant reminder as they are very forgetful. We must perform judgements and understanding on behalf of them but use relaxed body language and provide them words to understand what they try to respond. We will try our best to study their mind, you are in a jackpot if you can synchronize what they are thinking. That will not be easy. It requires experiences.

C2: Always keep them positive. I try to show them that I am needed by them and they are not alone. Keep them companied and positive complements in any situation definitely helps. Give them a clap as encouragement to assure their confidence so they don't feel drawn from what they did.

C12: Reminiscence seems to be a good way; we use it most of the time. In early stage, reminiscence and continuous reality orientation is helpful. Interacting with positive language is required control the agitated situation. We also promote sleep hygiene intervention, by rescripting melatonine 3mg to help them sleep.

Q: What is their most significant memories? Can you listed some of them?

C1: Events that make them are happy or sad. Family visits, birthday celebrations, anniversaries, stories they have been told that make their days.

C2: Who is visiting, who is their clinical advisor, who are in charge of taking care their day plan; telling them time and dates and events organised from the facility and records the expressions and moments of them. Have they already taken their pills, the moments they telling their stories and photo flashbacks

C3: achievements, hobbies, daily habits, family visits, medication plan, daily activities: exercise, dining, having conversations with someone, special days…as long as it does not violates their privacy like taking a bath, going to washroom, changing clothes, key in codes and so on. Time and dates

C4: calendars, time, day and night, weather, special events i.e.: trips they have gone, friends visit

C5: Pictorial instructions to guide them to carry their physical plan within their capability. Reminder of the medication plan, events of the day, interesting brain training games: Sudoku, word guessing, find the pairs.

C6: What day is that day, time, year, what happened today that makes today special to you. What makes you feel good today.

C8: physical activities; hiking, walking; quote of the day to improve their moods; personal location tracking; where and when you done the activity.

C12: social occasion is good to recall, birthday, anniversaries, life experience such as sitting in a garden and enjoy the weather that gives you good mood.

C13: If the devices becoming their personal belongings, I hope it has good history records like phone calls, emails, photos on special events stated with date and times, personal belongings and access. Similar function with smart phones but automatically sets reminders to the patients.

Q: If the device is successful and ready to use, would you agree to use them in caring facilities?

C1: Would like to give it a try. Hopefully that would be handy.

C2: Yes, that would be some breakthrough in clinical background.

C3: Yes, I can see the future expansion of this new niche technology

C4: Most likely will have it in the facility

C5: Yes, do update me if the outcome is a success.

C7: Certainly. Let me know if there's more chance to co-operate

C10: Yes, that would definitely assist the people and the clinical staffs.

C13: I'd love to own it if the technology. We desperately need something that would ease our burdens

C15: I don't know yet. But that certainly is some breakthrough if it works

C16: Yes, if it pass the ethical issues

Appendix B

FFmpeg command to extract video thumbnails:

```
ffmpeg -i xx.mp4 Pictures%d.jpg
```

Above is the command to extract all frames and archives in jpg format. Video thumbnails will be renamed as Pictures1.jpg, Pictures2.jpg, Pictures3.jpg,…and so on;

```
ffmpeg -ss 1 -i xx.mp4 -vf "select=gt(scene\,0.5)" -
frames:v 5 -vsync vfr frame%d.jpg
```

Second command filters the video according to scene change and controlling the percentage (in this case is 50%). Video thumbnails will be renamed as frame1.jpg, frame2.jpg, frame.jpg,…and so on. In this case, first 5 frames of scene change will be archived.

Note: "xx" is named according to video file name.

```
ffmpeg -framerate 20 -start_number 2261 -i Pictures%d.jpg
-vframes 80 -c:v libx264 -r 30 -pix_fmt yuv420p output.mp4
```

Third command combining selected thumbnails to create short video clips. In this case, Initial thumbnails starts from Pictures 2261 and continually goes on for 80 frames. The video is rename output.mp4

Appendix C

Matlab Code:

```
% Resource reference from
% https://au.mathworks.com/help/vision/examples/face-detection-and-tracking-
using-camshift.html
% http://au.mathworks.com/help/vision/examples/face-detection-and-tracking-
using-live-video-acquisition.html

% Create the face detector object.
faceDetector = vision.CascadeObjectDetector();

% Create the point tracker object.
pointTracker = vision.PointTracker('MaxBidirectionalError', 2);

% Create the webcam object.
cam = webcam();

% Capture one frame to get its default size.
videoFrame = snapshot(cam);
frameSize = size(videoFrame);

% Create the video player object.
videoPlayer = vision.VideoPlayer('Position', [100 100 [frameSize(2),
frameSize(1)]+30]);

%  Initialise data objects
 runLoop = true;
numPts = 0;
frameCount = 0;

% Video frames processing loop will run for 1000 frames or until the video
player window is closed.
while runLoop && frameCount < 1000

    % Add in next frames.
    videoFrame = snapshot(cam);
    videoFrameGray = rgb2gray(videoFrame);
    frameCount = frameCount + 1;


    if numPts < 10
        % Detection mode.
        bbox = faceDetector.step(videoFrameGray);

        if ~isempty(bbox)
            % Find corner points inside the detected region using KLT
            algorithm.
            points = detectMinEigenFeatures(videoFrameGray, 'ROI', bbox(1, :));

            % Replenish the point tracker.
            xyPoints = points.Location;
            numPts = size(xyPoints,1);
            release(pointTracker);
            initialize(pointTracker, xyPoints, videoFrameGray);

            % Make a copy of the current points.
            oldPoints = xyPoints;

            % Convert the rectangle represented as [x, y, w, h] into an
            % M-by-2 matrix of [x,y] coordinates of the four corners. This
            % is needed to be able to transform the bounding box to display
```

```
            % the orientation of the face.
            bboxPoints = bbox2points(bbox(1, :));

            % Convert the box corners into the [x1 y1 x2 y2 x3 y3 x4 y4]
            % format required by insertShape.
            bboxPolygon = reshape(bboxPoints', 1, []);

            % Display a bounding box around the detected face of the subject
            videoFrame = insertShape(videoFrame, 'Polygon', bboxPolygon,
'LineWidth', 3);

            % Insert a bounding box around the object being tracked and
            % named the sucject
            videoFrame =
insertObjectAnnotation(videoFrame,'rectangle',bbox,'Esther');

            % Display detected features
            videoFrame = insertMarker(videoFrame, xyPoints, '+', 'Color',
'white');
        end

    else
        % Tracking eigenpoints using Viola-Jones Algorithm
        [xyPoints, isFound] = step(pointTracker, videoFrameGray);
        visiblePoints = xyPoints(isFound, :);
        oldInliers = oldPoints(isFound, :);

        numPts = size(visiblePoints, 1);

        if numPts >= 10
            % Estimate the geometric transformation between the old points
            % and the new points.
            [xform, oldInliers, visiblePoints] = estimateGeometricTransform(...
                oldInliers, visiblePoints, 'similarity', 'MaxDistance', 4);

            % Create a boundary box.
            bboxPoints = transformPointsForward(xform, bboxPoints);

            % Convert the box corners into the [x1 y1 x2 y2 x3 y3 x4 y4]
            % format required by insertShape command.
            bboxPolygon = reshape(bboxPoints', 1, []);

            % Face tracking of the subject with boundary box.
            videoFrame = insertShape(videoFrame, 'Polygon', bboxPolygon,
'LineWidth', 3);

            % Naming the subject around the boundary box
            videoFrame =
insertObjectAnnotation(videoFrame,'rectangle',bbox,'Esther');

            % Display tracked face features.
            videoFrame = insertMarker(videoFrame, visiblePoints, '+', 'Color',
'white');

            % Reset the points.
            oldPoints = visiblePoints;
            setPoints(pointTracker, oldPoints);
        end

    end

    % Display the annotated video frame using the video player object.
    step(videoPlayer, videoFrame);
```

```
    % Check whether the video player window has been closed.
    runLoop = isOpen(videoPlayer);
end

% All the programs and the workspace must be cleared to reinitialise the
% webcam
clear cam;
release(videoPlayer);
release(pointTracker);
release(faceDetector);
```

```
%% Multiple Face tracking
% Automatically detects and tracks multiple faces in a webcam-acquired
% video stream.
% Resource adapted from http://au.mathworks.com/matlabcentral/fileexchange/47105-
detect-and-track-multiple-faces

clear classes;

%% Instantiate video device, face detector, and KLT object tracker
vidObj = webcam;

faceDetector = vision.CascadeObjectDetector(); % Finds faces by default
tracker = MultiObjectTrackerKLT;

%% Get a frame for frame-size information
frame = snapshot(vidObj);
frameSize = size(frame);

%% Create a video player instance
videoPlayer  = vision.VideoPlayer('Position',[200 100 fliplr(frameSize(1:2)+30)]);

%% Iterate until we have successfully detected a face
bboxes = [];
while isempty(bboxes)
    framergb = snapshot(vidObj);
    frame = rgb2gray(framergb);
    bboxes = faceDetector.step(frame);
end
tracker.addDetections(frame, bboxes);

%% And loop until the player is closed
frameNumber = 0;
keepRunning = true;
disp('Press Ctrl-C to exit...');
while keepRunning

    framergb = snapshot(vidObj);
    frame = rgb2gray(framergb);

    if mod(frameNumber, 10) == 0
        % (Re)detect faces.
        %
        % NOTE: face detection is more expensive than imresize; we can
        % speed up the implementation by reacquiring faces using a
        % downsampled frame:
        % bboxes = faceDetector.step(frame);
        bboxes = 2 * faceDetector.step(imresize(frame, 0.5));
        if ~isempty(bboxes)
            tracker.addDetections(frame, bboxes);
        end
    else
        % Track faces
        tracker.track(frame);
```

```
    end

    % Display bounding boxes and tracked points.
    displayFrame = insertObjectAnnotation(framergb, 'rectangle',...
        tracker.Bboxes, tracker.BoxIds);
    displayFrame = insertMarker(displayFrame, tracker.Points);
    videoPlayer.step(displayFrame);

    frameNumber = frameNumber + 1;
end

%% Clean up
release(videoPlayer);
```

Appendix D

Research Proposal

VIRTUAL AGENTS FOR DEMENTIA: PERSONAL ASSISTANT, TRAINER AND THERAPIST

School of Computer Science, Engineering and Mathematics

Name of Supervisor: Professor David Powers

Researcher: Ying Ching, TIONG

AIMS&GOALS:

The goal of this project is to study and capturing the important daily events of the person with dementia, particular on remembering and naming visitors. The proposal is to develop a system that will create multimodal semantic memory "hooks" that will facilitate remembering these people and events. We are initially seeking input of the precise nature of the system and interventions to be developed by interviewing appropriate professionals in relation to dementia, including their own experience and/or research in this area, and what kinds of interaction and interface are appropriate for different kinds of patient, and both professional and familiar carers. Longer term we will hope these professional contacts will help us to access the volunteers suffering from dementia and carry out a formal evaluation of the system and interventions developed. The study may then involve not only professionals and patients with dementia in an institutional environment, but also possibly relatives/families and the home environment.

PROPOSED TASKS:

1. **Specs:** Specify a device (computer+software) for use in care/nursing home accessed by professionals and/or relatives of people with dementia – questions relate to who initiate recordings/interventions and/or provide names/tags for the events and decides which ones get replayed (patient, professional or relative).

2. **Events:** The system should record daily events in form of videos and photos displayed as key frames (organizing or clustering of image data).

3. **Evening Intervention:** The primary idea for the intervention is review and evaluation of photos and/or video in the evening to create multimodal semantic memory hooks, and set up of a reminder sequence for the morning.

4. **Morning Intervention:** Play an agreed reminder video on waking the next morning, possibly displaying photos/snippets and language information (text, voiceover or soundtrack) throughout the day to keep the subjects "fresh". Sound should probably be on demand or suppressible rather than automatic.

5. **Feedback.** Want to obtain feedback from professionals/families/patients in order to pursue possible solutions to achieve a user-friendly technology and ensure that is provides a helpful intervention without being overly intrusive. Eventually it would be

appropriate to set up a formal evaluation with controls. The evaluation should consider the possibility of both positive and negative outcomes (e.g. aggressive rejection of the system). We also need to consider what degree of daily involvement is appropriate from both professionals/staff and family/visitors, and what frequency of visits is expected and what periods need to be bridged between visits.

6. **Special Events.** Also we need to consider which events should eventually be removed from the system and which should be retained and accessible indefinitely. Also whether automatic assessment of long term memory of an event is made and influences replay of the event.

7. **Reinforcement/Reward.** The system needs to be rewarding and interesting for the person to use, and the appropriate timing found to reinforce memories before they are lost but without repeating too soon and creating a negative effect (boredom, anger due to being told what they already remember). Longer time it would be appropriate to develop and individual semantic modal of what is remembered in what timescale and with what distracters and what latencies for recovery from distraction, to ensure positive reinforcement and feedback for positive behaviours

8. **Interface.** Need to have an accessibility control panel to allow comprehensible platform for different patients, professionals and relatives according to what they are willing or able to do with the system. This includes sensitivity to both computer phobia/familiarity, typing skills and understanding of the intervention, time availability, patience and willing to work at the intervention, etc. How much is taken/managed automatically vs manually is part of this. E.g. do we want to have (require/allow) a photographer/videographer (to) upload material?

9. **Privacy.** What considerations of privacy come into play related to both patients and visitors, and who controls/manages this?

10. **Calendar.** Does there need to be a link to a (past/future) diary of events? e.g. a proposed visitor or planned medical procedure.

POSSIBLE USAGE OF SYSTEM:

1. Initiate human to machine interaction.
2. Filming daily activities performed by the subjects.
3. Setup face recognition to people related to the subjects.
4. Setup reminder and appointments with pictorial display of time and Calendar
5. Perform video/pictorial playback for memory hooks

POSSIBLE INTERVENTION:

- Daily events video recording/monitoring

- AV-Recording/Monitoring/Assessment of subjects in a controlled environment for future/manual (recording) or immediate/automatic (monitoring) use re
  - cognitive functioning, memory changes,
  + reminders/challenges/practice/prompts/tomts(TipOfMyTongue),
  - changes in thinking patterns, attentiveness, communication behaviour etc.
- Recorded video accessed by authorised people to preserve the privacy and confidentiality of the subjects and mark segments for particular purposes
- Trigger monitor alert if the subject is not within the confined environment for long period.
- Trigger timed reminders/replays/interventions as previously set up

- **Reality orientation +Reminiscence Therapy**
  - Using the video clustering and pictorial to organise the information relating to
  - Calendars and time
  - videoed/imaged people inc. visitors/family and carers/staff, with relevant date and time information
  + face recognition, recent events playback, past and future events reminder
  - Encourage/set up motivational event reminder using cues and recall platform through collected data
  - Interactive guidance to encourage fast retention of information re their important/relevant people/surroundings

- **Validation techniques + "Nursing" Conversational agent**
  - Equip with adjustable volume and speed of speaking to improve perception of understanding, use the slow tompting prompt technique.
  - Control lengths and rate of phrases eg. Pause between words, repetitive instructions, emphasizing consonants.
  - Remind/inform subject of forthcoming activities with one instruction at a time.
  - Don't force interaction - avoid rushing the patients whilst allow freedom by utilising entertainment such as games, video playback, music playback, photo albums etc.
  - Magic choice of conversation mode to engage positive reinforcement and feedback.

- **Regular daily schedule plan**
  - Adjustable reading and typing setting-ease of access
  - Allow caretaker to access and insert routine daily/weekly/monthly care plan
  - Allow machine to interact and to remind the list-to-do for the subjects
  - Maintain consistent scheduling to prevent confusion and agitation.
  - Accessing information to community services and health care facilities

- **Facial and Expression Recognition techniques**
  - Recognise the subject and pull out the relevant identity and information in storage to execute correct plan.

- Identify family members or supports for the subjects
- Monitor the react through recorded expressions such as smiling, crying, frowning, grimacing etc.

- **Rating and Feedback**
  - Documenting satisfactory of the usage of device from every individuals that involve via the device

EXPECTED OUTCOMES:

1. Assist the subjects on track with their daily schedule and care plan
2. Assist subjects to retain information promptly and flawlessly
3. Achieve user-friendly device that enhance machine to human interaction
4. Engaging the subjects to full use the fun features and games to improve their cognitive skills
5. Execute organised care plan and medication management
6. Ensure safety and recovery by alerting or locating the subjects or caretakers
7. Improve the performance and quality of life not only the subjects but also the caretakers
8. Promoting independent living whilst socially active