

# Life Log Platform for Continuous and Discrete Recording and Retrieval of Personal Media

Datchakorn Tancharoen<sup>1</sup>, Member, Waythit Puangpakisiri<sup>2</sup>,  
Toshihiko Yamasaki<sup>3</sup>, and Kiyoharu Aizawa<sup>4</sup>, Non-members

## ABSTRACT

In this paper, we propose an efficient life log platform to record and retrieve personal media experiences. An integration of desktop experiences from MyLifeBits and real life experiences from our life log system is operated in a personal computer. MyLifeBits project is one of the successful researches and we also have been developing a life log system. MyLifeBits provides an excellent database framework, but it seems mainly concerned about desktop activities using personal computers. Although SenseCam, a wearable camera which is one of the MyLifeBits project components, it can capture only still images being triggered by environmental change to represent personal discrete experiences. In order to achieve an idealistic Memex vision, we have been developing a life log system aiming at capture and analysis of continuous video using wearable computers in conjunction with various wearable sensors. In this paper, we present our life log platform for recording and retrieval of personal media in real life experiences by the life log system, SenseCam and MyLifeBits. We summarize our life log functionalities, an integration function with SenseCam for discrete experiences and MyLifeBits for an efficient database system.

**Keywords:** Life Log, Recording, Retrieval, Personal Media, Wearable Video, Multimedia Experiences.

## 1. INTRODUCTION

Nowadays, digital imaging devices are more effective in various aspects such as smaller size, more capacity, better resolution, and also cheaper price. Thus, many people can have their own digital imaging devices to capture personal media such as digital videos and photos to represent personal experiences. To store and manage personal media is an important issue because all media can be manipulated in a good

manner to find a good way to access the amount of media data.

Due to the development of wearable sensors and computers, there have been presently a few researches to record and retrieve our daily lives to realize Memex, which was predicted by Vannevar Bush in 1945 [1]. Previously, we tried to capture our experiences as wearable video [2] which can represent the events we see and hear. It is necessary to have the efficient retrieval technique to help retrieve the desired parts of experiences from the great amount of video data. We proposed the life log system which allows various capture devices to record personal experiences and recall the experiences from available media including wearable video, ordinary digital videos/photos, etc. from our life time [3].

There have been some researches on recording and retrieval of digital media experiences. MyLifeBits project [4] tried to collect and store any digital information about a person including documents, photo, music, video, etc. StartleCam [5], a sensor-triggered wearable camera, used skin conductivity to record personal desired events. SenseCam [6], a passive capture camera, could capture the images automatically based on motion, light condition, personal contact, and time interval. In [7], context data from wearable sensors were used such as motion sensors, brain wave analyzer to navigate the desired events in wearable video. In [8], GPS data were analyzed to extract key frames by speed, direction, time and distance. A number of practical wearable video indexing techniques were also implemented based on voice, motion, environments to extract the semantic key frames [9], [10]. We attempt to consider the system both of capture and retrieval to make it close to the concept of digital memory as we called "life log system".

Recently, we have received MyLifeBits software and SenseCam for Microsoft research project as called "Digital Memories" [11]. Thus, we attempt to examine the advantages of these devices to integrate with our life log system to develop an efficient life log platform for recording and retrieval of personal media in daily life.

---

Manuscript received on February 28, 2007 ; revised on June 30, 2007.

<sup>1</sup> The author is with Department of Information Technology, Thai Nichi Institute of Technology, Thailand., Emails: datchakorn@ieee-u-tokyo.org

<sup>2</sup> The author is with Department of Frontier Informatics, The University of Tokyo, Japan., Emails: waythit@ieee-u-tokyo.org

<sup>3,4</sup> The authors are with Department of Information and Communication Engineering, The University of Tokyo, Japan., Email: yamasaki@ieee-u-tokyo.org and aizawa@ieee-u-tokyo.org

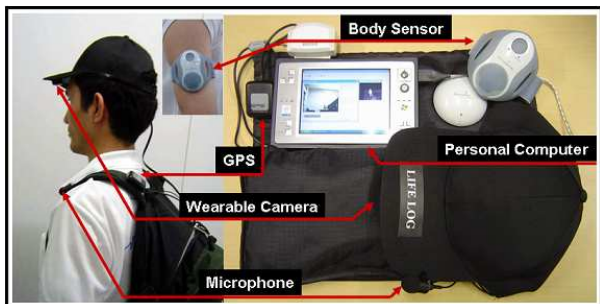


Fig.1: Life Log Capture System.

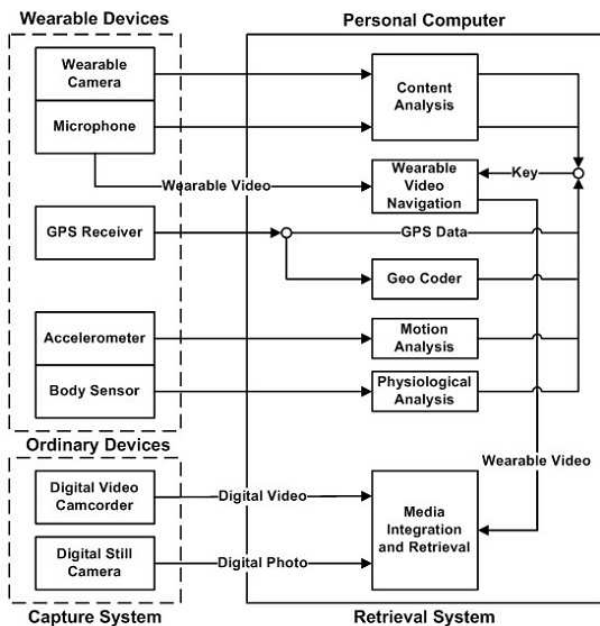


Fig.2: Block Diagram of Life Log System

In this paper, we present the life log platform for recording and retrieval of personal media. Retrieval functionalities of wearable video and also various kinds of media are demonstrated. MyLifeBits and SenseCam are summarized and integrated in the life log platform for continuous and discrete recording and retrieval of personal media experiences.

**2. LIFE LOG SYSTEM**

We implemented the wearable video system which contains various devices including a compact personal computer, wearable camera, small microphone, motion sensor, GPS receiver and body sensor as shown in Fig. 1.

We applied wearable camera, and microphone to capture video and audio information. The video and audio signal is analyzed by ordinary content based processing. GPS receiver was used to track the user's location at the time of recording video. Body media armband was used to record physiological data such as skin conductivity, skin's temperature, environmental temperature and heat flux. This body sensor contains accelerometer to analyze physical activities, as

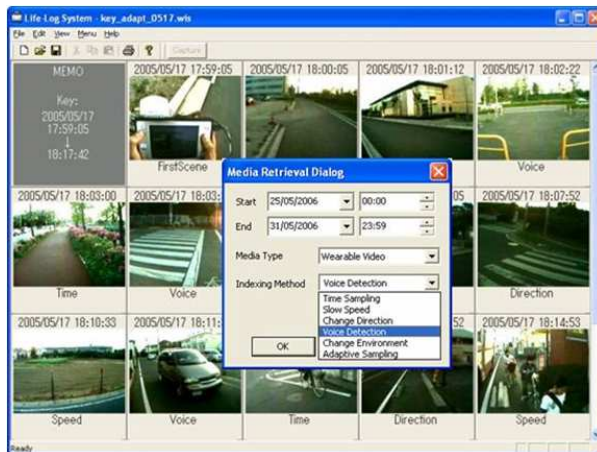


Fig.3: Life Log Retrieval System

well. Audio visual data are transmitted through USB and GPS data is transmitted through PCMCIA port to a compact computer and analyzed for life log retrieval system. The block diagram of life log data is shown in Fig. 2. GPS receiver records location data including speed, direction, latitude and longitude. Geo coder can translate GPS data from latitude and longitude coordinates to meaningful address. Body sensor gives motion data and physiological data for feature analysis. The video size is 320x240 pixels and the frame rate is 30 frames per second. GPS data are taken every second in the format of Recommended Minimum Specific (RMC) defined by National Marine Electronics Association (NMEA). Synchronization among the data is taken by comparing time stamps given by the system. Moreover, ordinary capture devices were also integrated to use in our system. Digital video and digital photo from ordinary devices are integrated into the media integration system with wearable video to represent and complement personal experiences.

**3. LIFE LOG RETRIEVAL**

Currently, we developed the life log system to retrieve various kinds of media including wearable video, digital video, digital photo, physiological data, and electronic documents from media storage in a personal computer. The life log retrieval system interfaces are demonstrated in Fig. 3 and 4 including retrieval dialog, key frame dialog and replay dialog and map dialog.

**3.1 Retrieval Methodology**

To retrieve wearable video, we applied video retrieval techniques by investigating the advantages of video summarization and key frame extraction, in which each key frame can represent the related part of wearable video. Personal experiences can be retrieved by determining date and time interval and desired indexing method in retrieval/indexing dialog



**Fig.4:** Location Based Retrieval.

to extract semantic key frames. We can extract the key frames to summarize the contents of video and present in key frame dialog. Desired video scene can be replayed by selecting one of the extracted key frames then video scene is demonstrated in replay dialog. Video indexing techniques are proposed based on available life log contents and contexts. Key frames are extracted from GPS data, audio/visual contents, and physiological data. The user can select one of the indexing methods or the combination of them based on user's preferences to extract the favorite key frames from wearable video.

In addition, the extracted key frames can be presented as the event's location on the map as key labels if GPS signal is available. In contrast, we can click at a key label on the map to display the video key frame. The key labels by using an indexing method are demonstrated in Fig. 4. Replay dialog also presents the information of date, time, latitude, longitude coordinate and address of selected video.

### 3.2 Location Based Retrieval

Besides wearable video, the location of each event is recorded by GPS receiver and represented by latitude and longitude information. The map of Japan and necessary software are installed into the system to translate latitude and longitude coordinates into addresses with hierarchical structure. User's positions are plotted on the map as the moving tracks of user. This location based retrieval is very useful to recall the experiences based on the event's location. By selecting the area displayed on the map, we can retrieve the video associated with that area. The user can also order the map to display other area by choosing at arbitrary addresses. The user can watch the desired scenes by choosing an arbitrary point of footprints. Fig. 4 demonstrates the location based retrieval and user's position on the map. Additionally, the system can record the location based on latitude and longitude. Hence, we can retrieve the video from the event location. We can resize the scale of map from city to country and quickly search the desired



**Fig.5:** Key Frames Based Retrieval.

location. We can review our experiences from the recorded video by clicking at the location on the map.

### 3.3 Key Frame Based Retrieval

We investigate wearable video retrieval by using key frame extraction which each key frame can represent the moving video. The retrieval methodology using key frame extraction is shown in Fig. 5. In this section, we describe the importance of key frame extraction techniques to detect key events from personal experiences based on user's preferences.

#### 3.3.1 Audio Based Retrieval

Video scene with voice is an impressive scene for human's interest. The scenes containing voice can present the massive information and voice data is convenient to record by using an attached microphone. In our system, user's voice is detected to extract the key frames for video indexing.

#### 3.3.2 GPS Based Retrieval

We analyze contexts from GPS data including latitude, longitude coordinates, speed, and direction. Key frames can be extracted by speed detection at low speed to indicate the interesting place when people stop or slow down speed. Direction is also acquired from GPS data. We detected direction change from differentiate direction in every second.

#### 3.3.3 Body Sensor Based Retrieval

Environmental change can be detected by using physiological data from body media armband including heat flux, temperature and motion data. We analyze and process this data then keep the result as an index to use in retrieval process. To retrieve the video, we can select video sequence and a favorite indexing method to present personal experience following the user's preference. An example of video retrieval techniques based on environmental change is demonstrated in Fig. 5. We can see the key frames which presented the scenes with some hints for the user while moving from a place to another place anot-



Fig.6: SenseCam Wearable Camera.

-her place in different environments such as indoor to outdoor or one room to another room.

### 3.4 Personal Media in Daily Life

In our life log system, we allow the system to retrieve various types of media including wearable video, ordinary digital video, digital photos, body media data, and electronic documents by the timeline.

Personal media can be retrieved by selecting time interval and media type. The desired media will be retrieved from the available data in personal computer. In our experiments, a wearable video system is not completely continuous and limited at present because of the limited battery life. Digital cameras and other capture devices can be used to capture the events regardless of existing of wearable video. Thus, our life log platform is flexible to allow the users to record personal experiences by using their available capture devices [15].

## 4. LIFE LOG PLATFORM

In our life log platform, it is possible to record and retrieve both of wearable video and ordinary digital media in personal computer. To extend the scope of life log platform for continuous and discrete recording and retrieval of personal media, we attempt to develop and integrate our life log system with digital memories project [9] including SenseCam, a wearable camera which captures images based on sensors' trigger, and MyLifeBits system, which can manage and retrieve various media in personal computer, into an efficient life log platform.

### 4.1 SenseCam

SenseCam is a small digital camera that is designed by Microsoft Research Cambridge to take photographs automatically without user intervention. It is fitted with a wide-angle lens that maximized its field-of-view. In addition, a number of different sensors are built into the SenseCam. These include a light intensity and color sensor, a passive infrared detector, a temperature sensor and a tri-axis accelerometer.

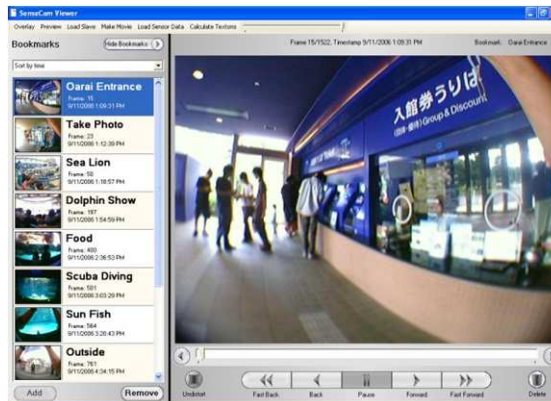


Fig.7: SenseCam Image Viewer.

These sensors are monitored by the camera's microcontroller, and changes in sensor readings can be used to automatically trigger the camera shutter. Additionally, an interval timer may be used to trigger the shutter. SenseCam also has a manual trigger button that lets the wearer take pictures in the more traditional manner.

#### 4.1.1 Capture Images by SenseCam

SenseCam can be worn on a cord around the neck and captures images from the user view point. SenseCam and how to wear it are demonstrated in Fig. 6. Images are captured automatically based on sensor's trigger and time interval. For example, a significant change in light level or the detection of body heat (infrared) in front of the camera can be used as triggers. Additionally, an internal timer may be used to trigger the shutter automatically every 30 seconds. The maximum possible rate is an average of around one photo every 5 seconds. The user can also use a manual trigger button to take some preferable pictures.

Images are stored as compressed JPEG file format in VGA resolution on an internal memory card. The typical image size is around 30k bytes and currently 1G bytes card is fitted in the camera. The memory card is also used to store a log file, which records the sensor data each time the sensors are read and the reason for taking each photo file.

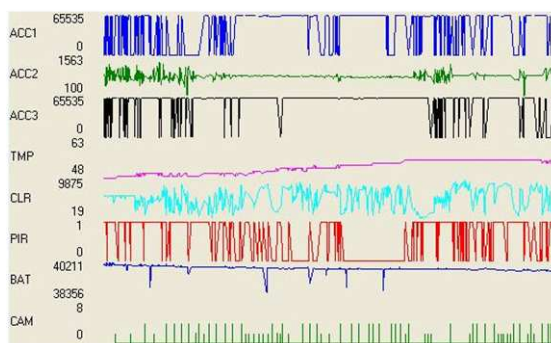


Fig.8: SenseCam Sensors Data

#### 4.1.2 SenseCam Image Storage and Retrieval

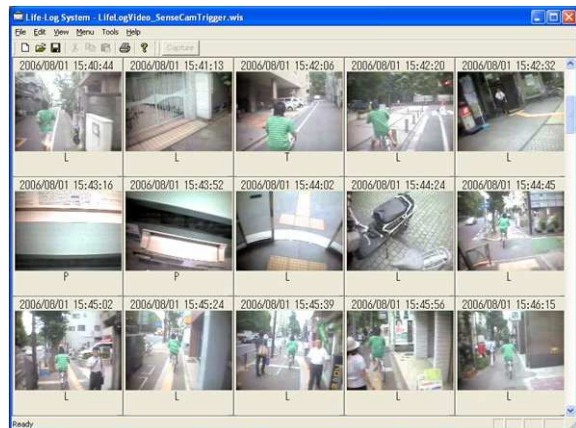
The SenseCam software comprises two main applications including the SenseCam Image Importer, which can be used to transfer images and sensor data and the SenseCam Image Viewer, which can be used to view previously imported data. The SenseCam Image Viewer is shown in Fig. 7. The image sequence can be replayed slowly using the “Play” button or more quickly using the ”Fast Forward”. The mouse can be used to manually drag the slider to a particular position. It is also possible to play the image sequence in reverse. Any images in a sequence which are unwanted may be removed by using the “Delete” button. With long image sequences, it can be useful to associate ”Bookmarks” with certain images which can represent as image key frames. The bookmark will appear as a thumbnail on the left-hand side of the display.

The sensor data can be loaded with the image sequence and plots each type of data as a graph on timeline as shown in Fig. 8. The sensor data includes acceleration, temperature, light level, passive infrared, and trigger signals. There is a signal to show the reason for each photo capture including timer, passive infrared (PIR) detector, light level and manual capture. The sensor data can be used to retrieve some desired images that were triggered by passive infrared, light level change, and manual triggers as shown in Figs 9 (a), (b) and (c), respectively. The in-

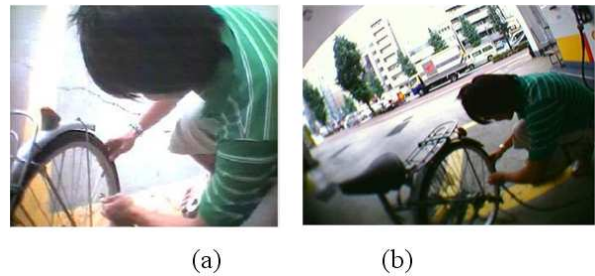
frared detector is triggered by heat from hand or machine and people who close to its range. The camera takes a photo when light level change higher more than twice or lower less than a half. Manual capture is performed by user on some desired time. We can see some examples of captured images in Figs. 9. In the experiments, the number of captured images by passive infrared was highest and followed by captured images by light change, time and manual trigger, respectively. A result that most images were captured by passive infrared is because user’s hands were detected by infrared while using a camera to take a picture. The others were taken occasionally based on light, time, and manual trigger.



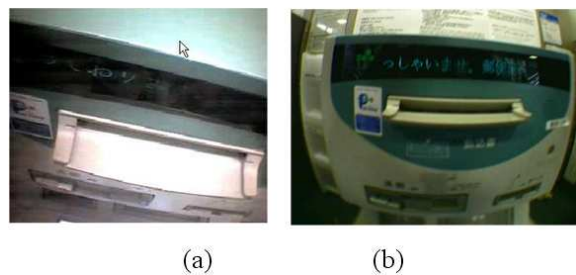
**Fig.9:** SenseCam Image Sensor Triggering (a) Passive Infrared (b) Light Change (c) Manual



**Fig.10:** Video Key Frames from SenseCam Sensors



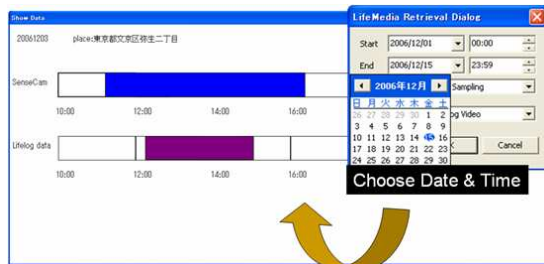
**Fig.11:** View Angle (a) Wearable Video (b) Sense-Cam



**Fig.12:** View Point (a) Wearable Video (b) Sense-Cam

**Table 1:** The Comparison of Life Log and SenseCam.

Comparison	Life Log	SenseCam
View	View point	Wide angle
Position	Head level	Chest level
Media Type	Moving image (MPEG)	Still image (JPEG)
Direction	Vary on head	Straight on chest
Size	Large (1GB/hour)	Compact (30KB/image)
Continuity	Continuous	Discrete



**Fig.13:** Life Log and SenseCam Data Timeline.

**4.2 SenseCam Image and Life Log Video**

The experiment was set up for life log platform to capture SenseCam images and life log video at the same time to compare and compliment each other for information retrieval. The SenseCam sensor’s triggers were applied to extract the key frames from life log vide. The key frames are demonstrated in Figure 10, where, P is the passive infrared (PIR) key, L is the light level change key, M is the manual triggering key, and T is time interval key.

We also compare the images captured by SenseCam and key frames from life log video which were extracted by SenseCam sensors. Fig.11 and Fig. 12 show the differences of view angle and view direction between life log video and SenseCam image. These Figs. show that the fish-eye len of SenseCam can give wide angle view and different point of view. In Fig. 12, SenseCam gave an image from the front view but life log video showed a key frame from top view. The integration of life log video and SenseCam image for continuous and discrete experience representation is shown in Fig. 13. We can retrieve media experiences from the retrieval dialog of life log system and display SenseCam and life log data on timeline that is precise for media selection. The comparison of data from life log system and SenseCam is shown in Table 1.

**4.3 MyLifeBits System**

MyLifeBits system is designed to store and manage a lifetime’s worth of everything that can be digitized. It is inspired by Memex, a

personal store envisioned by Vannevar Bush in 1945. MyLifeBits is a database of media resources and links. A link indicates that one resource anno-



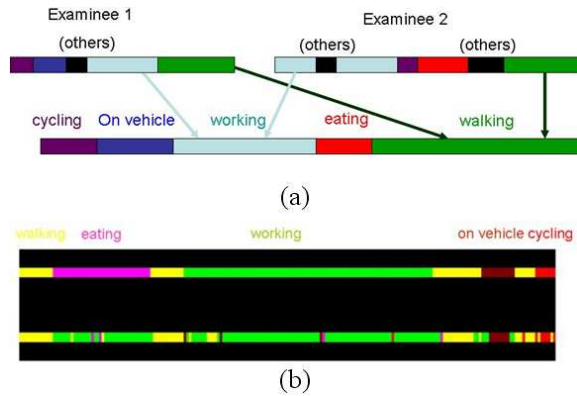
**Fig.14:** MyLifeBits Shell: Image Thumbnail Retrieval.

tates another. The system uses SQL Server with Index Server supplying full-text search. The database scheme is very simple: there is one table for resources, one table for annotation links and one table for collection links. Resources have a number of standard properties including type, size, creation date, last modified date, and a short description.

The system can store personal media in computer such as videos, photos, music, emails and electronic documents. Visited webpages are also recorded by the system. We can search and retrieve personal media by MyLifeBits Shell. Fig. 14 shows MyLifeBits Shell and personal media in timeline in daily life usage. The digital photos are retrieved following the taken date and presented as image thumbnails. Webpages which were visited at least once can be acquired from the system even though they are not available in the current state. The media can be demonstrated as simple list, thumbnails or timeline which is useful to understand personal life time. The timeline visualization is shown in Fig. 15 for visited webpages. We can select the media from timeline as shown as a thumbnail and retrieve the media by associated software. Furthermore, both of wearable life log videos



**Fig.15:** MyLifeBits Shell: Visited Webpage Timeline.



**Fig.16:** Activity Classification Methodology (a) Training (b) Classifying

and SenseCam images are also integrated and possible to view and retrieve by MyLifeBits system to represent personal experiences and related media in daily life.

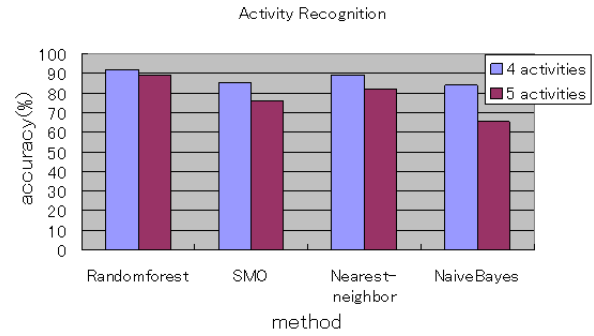
## 5. SENSECAM EXPERIMENT

This section is an experiment for SenseCam. We applied SenseCam to record user's activities in daily life by using SenseCam sensors because human activity is one of the most important ingredients of context information. We can retrieve SenseCam images based on physical activities. Thus, we attempt to classify the user's activities based on wearable sensors in SenseCam.

### 5.1 SenseCam Sensors

SenseCam sensors are monitored by the camera's microcontroller and changes in sensor readings can be used to automatically trigger the camera shutter. For example, a significant change in light level, or the detection of body heat in front of the camera can be used as triggers. Additionally, an internal timer may be used to trigger the shutter, for example causing an image to be captured automatically every 30 seconds. The maximum possible rate is an average of around one photo every 5 seconds. SenseCam also has a manual trigger button that lets the wearer take pictures in the more traditional fashion, albeit without the use of a viewfinder.

The memory card is used to store images and a log file, which records the sensor data each time the sensors are read. The log file also records the reason for taking each photograph (e.g. manual shutter press, timed capture or significant change in sensor readings). The log file is in a comma separated value (CSV) format suitable for importing directly into Microsoft Excel and many other data manipulation tools. The SenseCam has a built-in real time clock that ensures the timestamps of all files on the storage card are accurate. Timestamp information is also recorded in the log file along with each entry [12].



**Fig.17:** Activity Classification Results.

## 5.2 Activity Classification

We employed sensor data from SenseCam to classify user's activity. We choose SenseCam for analysis user's activities in daily life because it is easy to wear for recording personal experiences for long-term. Moreover, SenseCam can record experiences much longer than life log video which is limited by battery of computer.

The sensor data is stored in a comma separated value (CSV) file, where every line represents one piece of sensor data. With sensor readings, the 3-letter sensor code is followed by the time that the reading was taken in hours (24 hour clock), minutes and seconds. Then they are followed by the value of reading data. Since each sensor entry only logs the reading time, we periodically log the time and date. In addition to environmental sensing, we also periodically check and log the internal battery terminal voltage. Whenever an image is captured, the time of capture and the filename used to store the image are recorded in the log file. In this experiment, the data from SenseCam that is used including Acceleration x, y and z, light sensor and passive infrared detector.

### 5.2.1 Classification Methods

Because of the limitation of our sensor which has a sampling frequency at one Hz, features were computed in every minute. One set of features is composed of mean, standard deviation and threshold crossing rate (set threshold value at the mean of each data), features were extracted for activity recognition. In the experiment, 1200 sets of features (1200 minutes) were computed. Around 90% of examples were used for training, and the rest were used for testing. In the experiment, five subjects were requested to wear a SenseCam sensor and do various activities.

Ten activities were studied for this research including walking, bicycling, eating, working on desk, sitting in vehicle, watching TV, running, lying down, talking and standing were considered. In this paper, we tested four and five physical activities in the experiments as shown in Fig. 16 (a). In case of four activities, there are walking, cycling, eating and sit ting. In case of five activities, there are the ac-

tivities including walking, bicycling, eating, working on desk, and sitting in vehicle. Mean, standard deviation and threshold crossing were extracted from SenseCam. Activity recognition on these features was performed using NaiveBayes, Nearest Neighbour, Sequential Minimal Optimization (SMO) and random forest classifier found in Weka Machine Learning Algorithms Toolkit [13]. The results are shown in Fig. 17. The activity classifying results and ground truth are presented in Fig. 16 (b). We can notice that eating is classified as working because the main features are acceleration sensors. Thus, we need to use other sensors and content based processing to classify and increase the accuracy of this activity.

### 5.2.2 Discussion

In the experiments, overall recognition accuracy is highest for Random Forest classifiers with 89.30% for five activities (work on desk, walk, eat, sit on vehicle and bicycle). The Nearest Neighbor is the next high accuracy. Random Forests can run efficiently on a large amount of data, and can give estimates of what variables are important in the classification [14]. This algorithm could be considered as one of the most suitable classifiers in this research. However, we found that the classification accuracy is decreased when we add the number of classifications. It means that we need more features for effective retrieval system.

## 6. CONCLUSIONS

This paper presented the life log platform including the wearable video system, life log retrieval techniques based on wearable sensors and indexing methods to present the wearable video. Additionally, SenseCam and MyLifeBits system are also integrated to record and retrieve user's activities and personal media experiences. This integration can support the preference of life log platform for continuous and discrete recording and retrieval of personal media both of real life experiences and desktop usage experiences. We also demonstrated the functions to search and retrieve personal media and visualization of life log system to represent personal media experiences in our life time. that of the benchmark scheme.

## References

- [1] V. Bush. *As We May Think*, The Atlantic Monthly, 176(1), July 1945, 101-108.
- [2] K. Aizawa and K. Ishijima, "Summarizing Wearable Video," *Proc. of ICIP*, Vol. 3, pp. 398-401, 2001.
- [3] D. Tancharoen, T. Yamasaki, K. Aizawa, "Hierarchical Approach for Personal Life Media Retrieval", *Proc. of IEICE*, March 2006.
- [4] J. Gemmell, G. Bell, R. Lueder, S. Drucker, and C. Wong, "MyLifeBits: Fulfilling the Memex Vision," *ACM Multimedia*, pp. 235-238, 2002.
- [5] J. Healey and R. W. Picard, "StartleCam: A Cybernetic Wearable Camera," *Proceedings of the Second International Symposium on Wearable Computing*, pp. 42-49, 1998.
- [6] J. Gemmell, L. Williams, K. Wood, G. Bell and R. Lueder, "Passive Capture and Ensuing Issues for a Personal Lifetime Store," *ACM Workshop on CARPE*, pp. 48-55, 2004.
- [7] T. Hori and K. Aizawa, "Context Based Video Retrieval System for the Life Log Applications," *Proc. of ACM SIGMM MIR Workshop*, pp. 31-38, 2003.
- [8] K. Aizawa, D. Tancharoen, S. Kawasaki and T. Yamasaki, "Efficient Retrieval of Life Log Based on Context and Content," *Proc. of the 1st ACM Multimedia Workshop on CARPE*, pp. 22-31, 2004.
- [9] D. Tancharoen, T. Yamasaki and K. Aizawa, "Practical Experience Recording and Indexing of Life Log Video," *Proc. of the 2nd ACM Multimedia Workshop on CARPE*, pp. 61-66, 2005.
- [10] D. Tancharoen, T. Yamasaki and K. Aizawa, "Practical Life Log Video Indexing Based on Content and Context," *SPIE-IS&T Electronic Imaging Conference*, Vol. 6073, pp. 60730E1-60730E8, 2006.
- [11] Microsoft Digital Memories (Memex) Project, [http://research.microsoft.com/ur/us/fundingopp/RFPs/DigitalMemories\\_Memex\\_RFP.aspx](http://research.microsoft.com/ur/us/fundingopp/RFPs/DigitalMemories_Memex_RFP.aspx)
- [12] A. Aris, J. Gemmell, and R. Lueder, "Exploiting Location and Time for Photo Search and Storytelling in MyLifeBits", *Microsoft Research Technical Report MSR-TR-2004-102*, Oct. 2004.
- [13] I. H. Witten and E. Frank, "Data Mining: Practical Machine Learning Tools and Techniques with Java Implementations", *Morgan Kaufmann*, 1999.
- [14] L. Breiman, "Random Forests, Machine Learning," Vol. 45, pp. 5-23, 2001.
- [15] D. Tancharoen, T. Yamasaki, and K. Aizawa, "System Development for Capture and Retrieval of Life Log," *The Journal of the Institute of Image Information and Television Engineers*, Vol. 61, No. 5, pp. 681-686, May 2007.



**Datchakorn Tancharoen** received the B.Eng. and M.Eng. degree in electrical engineering from Chulalongkorn University, Thailand in 1998 and 2001. He received Ph.D. degree in electronic engineering from the University of Tokyo in 2007. Currently, he is a lecturer at Thai Nichi Institute of Technology, Thailand. His research interests include multimedia processing, storage and retrieval of personal media, and

wearable computer.



**Waythit Puangpakisiri** received the B.S. degree in electronic engineering from The University of Tokyo in 2006. He is currently a Master student at Department of Frontier Informatics, The University of Tokyo. His current research interests include multimedia processing, machine learning and wearable computer.



**Toshihiko Yamasaki** received the B.S. degree in electronic engineering, the M.S. degree in information and communication engineering, and the Ph.D. degree from the University of Tokyo in 1999, 2001, and 2004, respectively. He is now an Assistant Professor at Department of Information and Communication Engineering, the University of Tokyo. His current research interests include 3D video processing, wearable media, and VLSI design.

media, and VLSI design.



**Kiyoharu Aizawa** received the B.E., the M.E. and the Dr.E. in electrical engineering all from the University of Tokyo in 1983, 1985, 1988 respectively. He is currently a Professor at the Department of Electrical Engineering and Department of Information and Communication Engineering, the University of Tokyo. He was a visiting assistant professor at University of Illinois from 1990 to 1992. His current research interests

are image coding, image processing, image representation, video indexing, multimedia applications for wearable and ubiquitous environment, capturing and processing of person's experiences, and multimedia processing for WWW.