

# Supporting Daily Reflection for Ubiquitous Learning Log Using SenseCam

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## Abstract

*A ubiquitous learning log (ULLO) is defined as a digital record of what a learner has learned in the daily life using ubiquitous technologies in our research. We proposed a model named LORE (Log – Organize – Recall – Evaluate) to describe the learning process of ULLO and developed a system named SCROLL to implement this model in our previous works. This paper focuses on Log among 4 factors in LORE and proposed a passive way to log ULLOs. We use SenseCam to capture a learner's learning activities and propose a system named PACALL to support reflection of what he has seen. This system filters bad photos that taken by SenseCam and helps learner find learning content. We use this system in language learning and help learners learn the foreign name of objects around.*

## 1. Introduction

Learning Log was originally designed for children as a personalized learning resource [1]. It was set by teachers to help their students record their thinking and learning. In this learning log, the logs were usually visually written notes of learning journals. We defined a ubiquitous learning log (ULLO) as a digital record of what a learner has learned in the daily life using ubiquitous technologies and proposed a model called LORE to show the learning processes in the perspective of the learner's activity [2]. Our previous works has developed a system SCROLL (System for Capturing and Reminding Of Learning Log) [2] that helps learners log their learning experiences with photos, audios, videos, location, QR-code, RFID tag and sensor data and share ULLOs with others. Also, learner can receive personalized quizzes and answers for their question. This system is implemented both on web and android smartphone platforms. With the help of built-in GPS and camera on smartphone, learners can navigate and be aware of past ULLOs by augmented reality view.

Miller and Gildea [3] compared the way that children are taught words from dictionary definitions and a few exemplary sentences with the way vocabulary is normally learned outside the school. They noted that people generally learn words outside school. It suggests that

using mobile devices is a good way for people to remember the vocabulary since people can use mobile devices anywhere and anytime.

Therefore, in our previous works, we used mobile devices such as smartphone and tablet PC with the aim of registering ULLOs whenever and wherever learners want to log. In other words, learners have to take photos and registering ULLOs manually. It means that learners must record their learning experiences consciously. This is an active mode to record the learning experiences. However under this active mode, learners cannot record all of the learning experiences in the system. For example they may forget to take some pictures when they learned some new words, or although they wanted to take photos but they are could not because they were too busy. As a result learning chances will be lost and forgotten.

A passive mode can be a solution of these problems. In this mode, learners are not required to record learning experiences actively, and all the learning activities will be recorded by some devices automatically. Therefore, we attempt to introduce the concept of life log into this system to record learning experiences in a passive way. The notion of life log can be tracked back at least 60 year [4]. It means to capture a person's entire life or large portions of life. It usually uses digital devices to record life log such as wearable cameras or video recorders. For example, in the early 1980s Steve Mann captured his life using a wearable computer and streaming video. He captured his everyday life 24 hours a day in order to see what he was looking at [5]. The life log brings us the data of whole life of not only learning but also other activities. However, if there is any way that we can extract the learning part from it, the learning will be more significant and more sufficient. Besides, our system captures the learning log beyond their consciousness and learners' burden will also be reduced. Microsoft's SenseCam [6] is an effective way to capture life logs. It is a wearable camera equipped with a number of sensors. The SenseCam is a device to record a series of images and capturing logs of sensor data.

In this paper, we propose a system named PACALL (PAssive CAPture for Learning Log) to capture learning logs passively using Microsoft's SenseCam. With the help of analyzing sensor data and image processing technology, it extracts the meaningful images for learning

from life and helps learners upload the learning content easily.

## 2. Related Works

### 2.1. Learning and cognitive theories

This research is advocated by the following theories:

- Authentic learning and situated cognition: We are learning from what happened in the real world, so-called, from the authentic environment [7]. Especially, we learn a lot of vocabularies from our conversations, TV, and other daily activities. Therefore, it is very important to capture what we learned and recall them to enhance learning.
- Encoding specificity: The same context reminds us of the things that we have experienced there [8]. For example, if s/he is in the upstairs and wants to bring something from the downstairs, s/he may forget in the downstairs. However, if s/he goes back to the upstairs, s/he recalls the thing that s/he wanted. Therefore, if the learner is in the same situation where s/he registered the ULLO, SCROLL automatically asks the user the quiz about the ULLO.
- Picture superiority: People can remember vocabularies with their pictures more than those without their pictures [9]. Therefore, SCROLL shows the picture of ULLO for a quiz.
- Repetition with increasing intervals: This is the learning method that uses increasing intervals of time between successive reviews of previously learned knowledge [10]. Based on this theory, SCROLL sends a quiz to the learner.

### 2.2. MyLifeBits

MyLifeBits [11] is a Microsoft's project. The aim of this project is to implement Bush's Memex model [4] by which he proposed to store everything that you saw and you heard.

MyLifeBits has a large amount of storage that can store email messages, web pages, books, photos, sounds, videos, etc. It also has a full-text search function to supply users with searching text, audio annotations and hyperlinks.

In addition, the MyLifeBits project team is also using SenseCam to have the passive capture of life logs and to upload the sensor information along with the photos to the MyLifeBits repository [12].

We have learned a lot from this system. In our previous works, we had made it possible to store the learned materials such as photos, sounds, videos and pdf files into the system repository. Besides, we have also implemented recall functions that use quizzes and contextual information to help learners to remember what

they have learned. However, all works that we have done are using active logging mode, not passive logging mode. It means that learners must record their learning experiences as learning material consciously. Comparing to the passive mode, in the active mode we are more likely to miss learning chances since we are not necessarily able to record what we have learned or sometimes we just forget to record it. Therefore, we planned to introduce passive capture in our project with SenseCam.

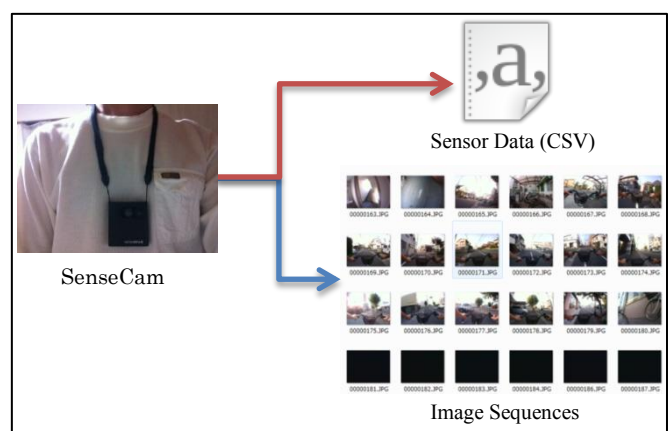
### 2.3. SenseCam Browser

SenseCam browser (Doherty, Moulin, & Smeaton, 2011) is a photo browser for SenseCam that supports users reviewing and organizing their life-log photos. This SenseCam browser uses a series of automatic content analysis techniques to classify all the life-log photos into several events and select representative images for each.

In the PACALL, we use the sensor data to analyze at the present and we plans to use image processing techniques in the future to classify and filtering all the life-log photos. The classification and filtering function in our system is similar with SenseCam browsing. Besides, we also designed several other functions for ubiquitous learning log system such as uploading as learning log and finding similar logs in the future.

## 3. SenseCam

SenseCam is a prototype device under the development of Microsoft Research (Hodges et al., 2006). In 2009, SenseCam was licensed to Vicon and is available as a product called Vicon Revue ("Vicon Revue | Memories for life", nd). The price of SenseCam is £299. It is a small digital camera that is combined with a number of sensors to help to capture a series of images of the wearer's whole daily life at the proper time and it can be worn around the neck (Figure 1). Originally this device is designed for memory aid.



**Figure 1. SenseCam and the record data**

There are two functionality of SenseCam:

- Recording sensor data and the status of SenseCam.
- Taking photos whenever the internal sensor is triggered by a change of environment.

The SenseCam itself has an algorithm for capturing images by a time trigger and other triggers that use sensor data. However, because SenseCam is designed for memory aid, it takes photos continuously even if it is dark or the situation is not been changed. The result is that there are so many photos that are duplicated or blurred or dark.

In this research, we focus on filtering the images with sensor data in order to help learners to select proper photos in a short time.

## 4. Research Design

### 4.1. Comparison between passive mode and active mode

Since this research is based on our previous works that use active mode to register ULLOs, we have to find out differences between active mode and passive mode in this research. We have compared both on features as Table 1 shows.

**TABLE 1.** COMPARISON BETWEEN ACTIVE MODE AND PASSIVE MODE

	Passive	Active
Number of photos within the same time	Many	Few
Photo quality	Poor (SenseCam)	Good (Camera /Smartphone/Tablet PC)
Recording time distribution	Continuous	Intermittent
Content completeness	High	Low
Content type	Poor (only image)	Good (image, audio, video, etc.)
Consciousness	Unconscious	Conscious
Reflection	Yes	No
Workload	Low(record) High(review&upload)	Little high

In the first three rows of Table 1, the two modes are compared in terms of photos. When we use SenseCam to have a passive way of learning, SenseCam takes photos continuously, while in the active mode, smartphone photos can only be taken at the time we want to. As a result, the passive mode brings more photos than the active mode. However, because of the storage problem and some other technology limitation, photos taken by SenseCam has lower quantity, but it is acceptable to be used as ULLO.

In the next two rows of Table 1, the comparison is made in terms of learning contents. When we use camera or smartphone, many learning contents are logged in the spare time, for example at lunch time. However when we use SenseCam, because the recording is processed continuously, we can get photos whenever in the classroom or on the street. So content is relatively complete. The content type in the active mode is richer than that in the passive mode because in this research the learning content type that we can get from SenseCam is only photo.

In the last two rows, the comparison is about learners. In the passive mode photos are taken unconsciously, while in the active mode learner must take photos consciously. When learners use SenseCam, they must review the whole learning process, and have a reflection on what they have seen and what they have learned and what they missed to learn. This process will help learners to remember learned contents.

By this comparison, we understand that passive mode has so many advantages over active mode for the language learning by photos. Only the quality of photos is low, but it is acceptable. However the biggest disadvantage is workload. SenseCam takes photos continuously. Consequently a huge amount of photos come out. More photos, the heavier the workload. If this workload is reduced, learners can learn language in the passive mode more easily. This is the key issue to use passive mode in language learning. In this research, we are focusing on reducing workload when reviewing the photos and propose a system that can filter the photos to help learners review and upload ULLOs easily.

### 4.2. PACALL and Learning Process

Our system is a sub-item of Ubiquitous Learning Log, and we named it as PACALL. It is short for passive capture for learning log. The whole process of passive capture happens unconsciously. However it is no doubt that the simple photo capture is not the whole process of learning. It is necessary for learners to look through the captured photos and find the learning contents with the help from our system. After entering the information of the image such as title and description, this learning content will be saved into SCROLL system as a ULLO.

Figure 2 shows the relationship between PACALL and SCROLL.

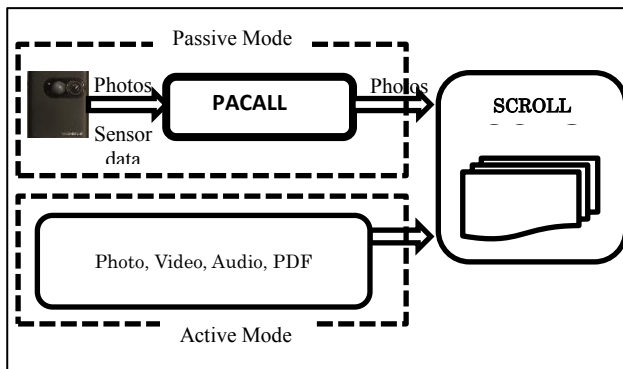


Figure 2. Relationship between PACALL and SCROLL

A process of passive capture includes capture, reflect and store.

- Capture: Capture a series of photos for life logs in daily life. The log includes all what learner has seen. Besides, massive redundant contents are also included in this log. We use SenseCam in the process of capture.
- Reflect: After capturing life log, a learner needs to have a reflection of what he has learned. In this process, since there are so many photos, we provide a system to filter the redundant photos by analyzing sensor data or image processing technology.
- Store: When a learner finds an important learned content, the content must be stored into main learning log system - SCROLL. During this process, he also needs to enter the information of learned content such as title, description or tags.

### 4.3. Photo Classification and Sensor Data

In PACALL, we use SenseCam to have a passive capture of learner’s daily life. However, since this device takes photos continuously, more than 3000 photos in one day. It causes problem of workload when using SenseCam and it is not easy to find important photos. Therefore, we propose a method to classify these photos by sensor data.

In order to reduce learner’s workload, we classify all photos into 5 levels based on importance – manual, normal, duplicate, shake and dark. PACALL analyzes sensor data, and classify photos automatically. The classifications and process in PACALL are:

- Manual: Manual means a photo taken by pressing manual button consciously. When a learner takes a photo manually, it means that this photo must be important from his point of view. Manual photos are selected by the sensor data with flag

CAM and the capture reason “M” (manual capture).

- Normal: Normal means a clear photo which can be used as a learning log object. Photos which remain after eliminating “Duplicate”, “Defocus” and “Dark” are judged as normal.
- Duplicate: Duplicate means the photos are duplicated. Duplicated photos usually have same conditions. We use CLR, TMP, ACC, MAG and timestamp of photo to detect photos that are taken under the same conditions and pick out them as duplicated photos.
- Shake: Shake means a photo which are out of focus. It usually happens when the light level is low and the camera shakes. The sensor data CLR help us detect light level and ACC help us detect camera shake.
- Dark: Dark means a photo taken with insufficient light and the photo is dark. It can be detected by CLR data.

## 5. Implementation

### 5.1. System Architecture

We use the SenseCam Vicon Revue in this research. Figure 3 shows the system architecture. PACALL is running on the server side. When this SenseCam is connected to the computer, if the software Vicon Revue Desktop (additional software of Vicon Revue) is already installed, all photos will be imported into computer. And then captured photos are required to be uploaded to server. After that, PACALL analyzes all the data including classifying photos and finding previous similar photos in SCROLL system by search engine - LIRE. Important photos will be tagged by system and help user find meaningful ones to register to SCROLL.

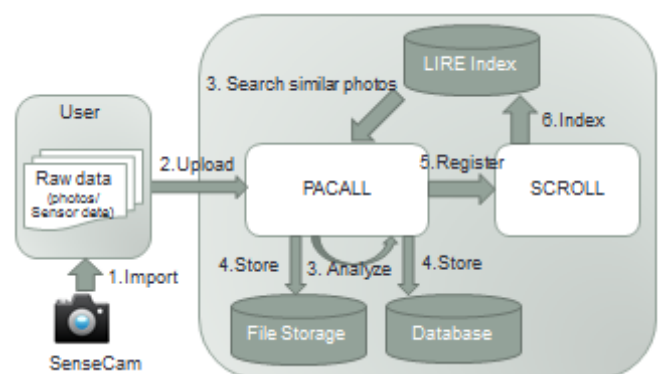


Figure 3. System Architecture

### 5.2. Functionalities and User Interface

This system provides 5 functionalities as follows:

- PACALL Uploader

PACALL Uploader helps learner upload all the photos after capturing. We want to make it easy to upload all the captured photos to the server. Because of the limitation of web technology, this process is not so easy in the past. However with HTML5, it becomes possible. When a learner wants to upload photos, he can drag photo folder and drop it into upload page, and all the photos are previewed in browser instantly (Figure 4). Once the learner click “Upload” button, all the photos will be uploaded to the server. Also, the file of sensor data – SENSOR.CSV will also be uploaded. A process bar will show the process of uploading.

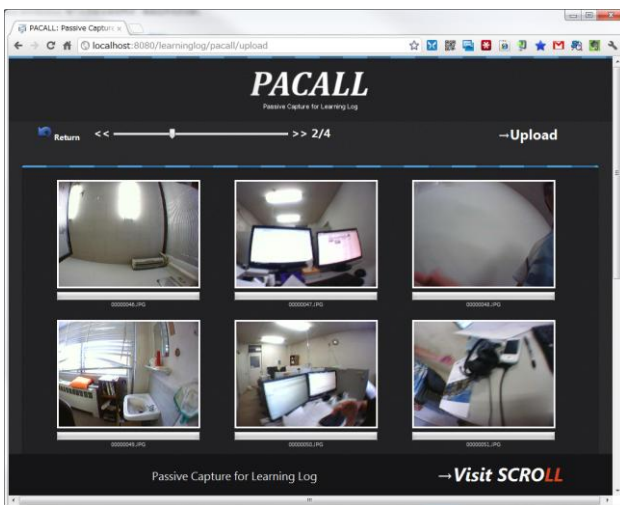


Figure 4. Interface of PACALL Uploader

- PACALL Browser

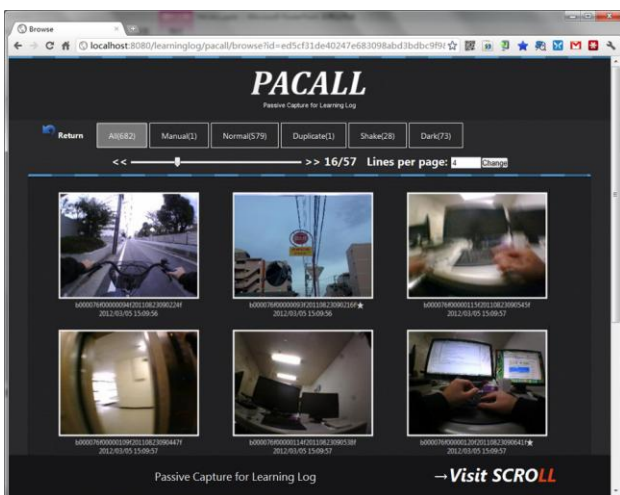


Figure 5. Interface of PACALL Browser

When all the photos are uploaded to the server, the learner can have a reflection of all the photos with the

help of PACALL. PACALL Browser is an interface of browsing all the photos, and it tags photos and provides some information of photos to help learner find important photos (Figure 5). Currently, we provide three main functionalities in PACALL Browser – PACALL Filter, PACALL Searcher and PACALL Recognizer.

PACALL Filter classifies all the photos into 5 categories - Manual, Normal, Duplicate, Shake and Dark. Manual means that photo is captured by pressing manual button of SenseCam. It usually happened when learner finds something valuable to record. Normal means that photo is not duplicated or blurred or dark. Duplicated means photo is duplicated with other photos. Shake means photo is blurred and it might be taken when camera shakes. Dark means the brightness of photo is bad. The learner can select appropriate photos only in Manual and Normal. With this functionality, workload is reduced.

As shown in Figure 5, the information texts under second and last photos are marked with stars. It means this photo has similar photos in our SCROLL system. This function is PACALL Searcher. We use a java search engine – Lucene with an image search plugin LIRE to do it. This functionality helps learner finding important photos because if the similar photo was uploaded to the server, this photo is probable an important photo. Besides, it also helps learner understand other usage of same learning content. However, if the similar photos are uploaded by same learner, it can help learner remember learning content.

Currently, PACALL Recognizer is in progress. This functionality detects objects in photo, for example characters or faces. With this functionality, the content of photo will be recognized, and this is very convenient for learner.

- One-click Register

Once a learner clicks a photo on PACALL Browser, the system will show a page to view the large photo and help him upload the photo. There are two buttons on this page – “Upload it” and “Close” on each photo. Similar photos are also shown on this page.

When learner clicks the “Upload it” button, the photo will be uploaded to the SCROLL system directly and the page will jump to the learning log registration page (Figure 6).

Figure 6 is the interface of ULLO registration in SCROLL system. On this page, a learner is required to input the title of the photo. The title is usually the name of the object in this photo. Location and other options are also supported on this page. When an object is registered to the system, SCROLL system will use “organize”, “recall” and “evaluate” model to help learner remember uploaded objects and vocabularies. For example, if a learner uploaded a photo and set the title as 消火栓 in Japanese, but he does not know how to speak it in English, then he can send a question along with the uploaded ULLO. SCROLL will send this question to all Chinese

users. After receiving the answer from Chinese users, this learner learned a new Chinese word. In the quiz module of SCROLL, learner can answer the quizzes that are generated by uploaded ULLOs. By answering these quizzes, learner's knowledge will be enhanced.

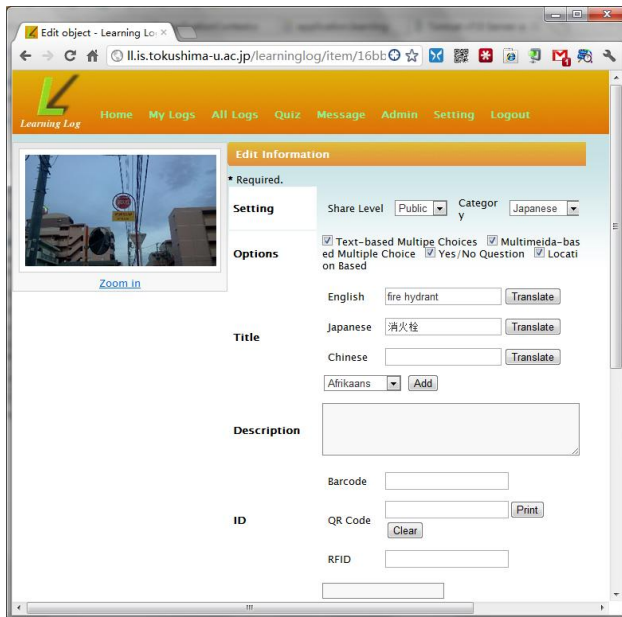


Figure 6. Registration of learning log

## 6. Conclusion

In this paper, we discussed how to support language learning using SenseCam. In order to do it, we used SenseCam to capture life-log passively and developed a system named PACALL to help learners to register learning log objects to SCORLL. We have designed a model of learning process in a passive capture mode including capture, reflect, store. The PACALL system has been also developed in order to support reflection and reduce the workload of reviewing photos. Through this research, we found that the SenseCam that was originally designed for memory aid could also be used to capture learning logs to help learners to learn vocabulary. However, it usually takes too many photos, and many of them are duplicated or dark. Therefore, we must introduce other technology to help learners find out important photos. Currently, we are using sensor data to help us do it. In the future, we will also use images processing technology to detect the contents of photos. Besides, the current algorithm and user interface need improvement. In addition, we plan to conduct an evaluation experiment in the near future.

## 7. Acknowledgment

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