Memorable Moment Extraction using the Pupil Dilation Analysis

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Abstract

These days, with the launch of Google glass, life-log which is recording videos and photos everyday has become reality. However, the stored data without indexing is meaningless and unattractive for users. Moreover, there is a problem that it is impossible to ensure storage for large amounts of data. Therefore, efficient meaningful data selection and automatic indexing will be important to be applied in practical use. In order to solve this problem, we propose a method that analyzing pupillary size variation through a camera device mounted on customized eye-glass. We use of the fact that if there are emotional changes, the pupillary size change. Recognition of emotional change is quite effective to extract a meaningful visual information automatically from the continuous recording of the view. Proposed system measures degree of expansion of the pupil diameter and picks a moment of rapid size change of pupil with camera. There are numerous studies to determine the emotional changes based on physiological signal processing such as EEG, ECG or GSR. Previous research usually attach the sensors to the body of the subjects in order to obtain a biological signal data although that is cause of discomfort. Hence, we propose new method to measure the size of the pupil only using lightweight camera. This has benefit that pupillary response time is much shorter than other signal and it can be reduced the analysis time remarkably.

Keywords: pupil dilation, wearable computing, life-log, video retrieval, content based retrieval

Introduction

Recent micro-sized camera can capture high resolution image and be embedded in wearable devices. With this technology, recording one's entire life possible was actualized. It is called "life-log"; collecting and saving all kind of multimedia-text, audio, and video. It will be recorded autonomously without intervention to user, and it could be recalled anytime. However, unclassified massive data will be problematic when searching and sharing it to others.

People can capture manually memorable events with their camera or audio recorder. Though, carrying those devices is not always available and capturing instant moment is also not possible. Life-log was suggested for restoring missed moments from the data that was recorded whole daytime. It is useful when user needs to save most of the data in their storage. However, if he wants to find a few memorable data from vast images or videos, searching and retrieving will be concerned. Remembrance of past events and thoughts is vague after long time and searching them is comparatively time-consuming. Current storage of portable devices can contain up to hundreds of gigabytes but is limited when saving entire video through several days.

For lessening user's cognitive load and utilizing data storage efficiently, we propose selective life-log recording system that can autonomously save memorable moment. Discrimination of memorable moments and useless record is conducted by analyzing physiological signal.

We choose pupil dilation, is well known for reflecting emotion, as effective selection method for index and retrieval of user's point of view with their wearable glasses.

Related works

One of the previous researches of life-log focused on interfaces for fast searching and classification of massive data [1]. If user wants to find specific moments that happened previously, organized data with those methods could be useful. However, they have no information of user's emotion. Also, this system contains plenty of useless files because people usually spend their most of the time in changeless and meaningless environment. Thus it is required extracting meaningful data from irregular and unexpected moments.

Hence, for selection of meaningful life-log, research about collecting from physical sensors has been conducted. Life Log video scenes were classified according to events detected by analyzing GPS, motion acceleration, gyro signal, and galvanic skin response (GSR) with carrying notebook computer [2]. This research has advantage to reflect user's physical activity but not emotional changes.

Another life-log research is conducted by analyzing human brain activities [3]. Using portable Brain-Computer Interface (BCI), multi-modal stimuli is captured in real time. One of the studies with this technology is using P300 signal which is event related potential (ERP). P300 evoked potentials, so called "A-

ha moments”, have high correlation with ‘meaningfulness’ [4]. P300 is emerged after 300ms from stimuli and used for extracting photo from video. It has advantage of non-intrusive and detecting emotions from brain directly. Recent EEG devices are reasonably light weight but they have to be attached to skin and feel uncomfortable.

Pupil dilation is reacted directly to visual stimuli. Moreover, research about correlation with pupil dilation and emotional changes has been accomplished several times [5,6,7]. It is generally believed that pupil dilation is significantly reactive to emotional mood changes. Unlike other methods, observing pupil dilation is non-intrusive and non-adhesive. Moreover, we expect wearable glasses will be widely spread in the near future so that our methods can be a most portable way to sensing physiological signal.

Based on previous researches, we propose life-log retrieval methods with portable devices with micro camera to capture memorable moments through real time recording.

Proposed methods

Existing life-log devices, attach one camera facing the same direction as the line of sight of the user. Then, the device is mounted on the brim of the hat, the HMD, or glasses. In this study, we use the glass which is the most portable among wearable devices. In order to determine gaze direction and pupil dilation, we install the inward camera toward the eyes of the user.

Figure 1. Proposed system architecture

In the scene recorded through the outward camera (A) at all times, is stored in the local storage (E). The inward Camera (C) for detecting variation of the users’ pupil (D) size is able to capture the moment when a highly arousing emotional changes are occurred. At this time, in order to distinguish the pupil dilation according to the emotional changes or depending on the brightness of the outside, we extract a degree of brightness of the environment from the obtained images by the outward camera. Further, we use aperture value of the outward camera in order to determine the highly bright light of the external environment which is difficult to judge in the image.

We use a machine learning technique to recognize the emotional changes with high accuracy. To create a classifier, we use pre-obtained pupil size data from the user. Then, it becomes possible to determine the pupil

dilation occurred by the brightness of the external environment or due to emotional changes via the classifier. Recognized emotional changes through the classifier, transmits a signal to the processor to allow the indexing correspondent time. All processes to determine the emotional change of the user in this way, it is possible to analyze for a second or so. The response time of pupillary Changes are faster than other biological signal, as the cause of it might be possible [5]. Furthermore, since there is only a single dimensional data of the pupil diameter to be analyzed, we can reduce the analysis time remarkably.

The outward camera is shooting continuously without pause for a while the user wants to record. The recorded videos are temporarily stored within the available space of the local memory. The final data is stored or marked separately only after going through an analysis of the size of the pupil and obtaining right information of emotional changes.

Figure 2. Flow chart for memorable moment extraction

We apply the method presented by Zhu, D *et al.* [8] which is able to obtain correct size of the pupil and the gaze direction without errors due to flickering eyes, overlapping eyes and collisions.

Discussion

The measurement of pupil dilation is the effective approach for the automatic determination of meaningful moment on the scene which is seen by the user. However, the expansion of the pupil diameter, not only respond to visual perception changes of the cognitive but it will respond actively to expand in the peripheral dimming. In order to eliminate the effect on it, we measure the brightness of the skin around eyes or the brightness of the collected peripheral light by the outward camera.

Conclusion

We proposed a system to extract the memorable moment automatically from the life-log videos through analysis of the pupillary changes. In order to extract the memorable moment, we applied the recognition of emotional changes and there are a number of previous studies which is analyzed emotional changes using

variance biological signal. Then, we selected the analysis the pupillary changes with the advantages such as fast response time and the device is miniaturized for portability. We expect to determine the effectiveness through the experiment and implementation.

Further plans of research include adding gaze detection to our already-existing pupil data, allowing us to analyze a correlated set of data for better results. The combination of the two data sets will allow us to determine what the user saw that triggered an emotional response. We will also be able to semantically index the video and gaze direction for analysis as well. Not only that, we expect to use of additional information through the physical sensor.

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