Developing the PETAL e-Learning Platform for Personalized Teaching and Learning

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Abstract. Mobile devices significantly reshape our various aspects of livings. Yet prolonged contacts with mobile devices may cause eye and/or muscle fatigues especially for young children. In this paper, we consider the integration of web cameras as image sensors available on most tablets or smartphones with an interesting tracking algorithm to continuously monitor and analyze the learners' responses through their facial orientations and eye movements to build the ***PE***rsonalized ***T***eaching ***A***nd ***L***earning, namely the PETAL, platform for nurturing the academic development of our young learners while protecting their eyesight. Through the in-depth studies of various Android programming toolkits with the Open Source Computer Vision library, we explore many possible ways to detect the viewers' responses to educational videos as a mean of self-learning. With the capability of notifying learners of their, possibly unconscious, reactions to such educational videos, our platform is targeted to promote a truly personalized approach for developing the next-generation e-learning systems.

Keywords: Eye Tracking Algorithms · Facial Recognition Techniques · Mobile Devices · Personalized Learning · Smart Sensors.

1 Introduction

As mobile and sensor technologies advance extremely fast each day, the usage of mobile devices, smartphones and tablets proliferates. Children of the new generation especially find themselves being engaged in various activities, possibly

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be playing games on a mobile phone, exercising with the Microsoft Kinect [7], or even learning through a video playing on a tablet, in such a fast-changing world of technological ubiquity. Given the frequent use of technology, especially in the classroom, we find an ever pressing problem: e-Learning [1, 2] seldom tailors itself to each individual child, thus making it more difficult to determine each individual's true grasping or understanding of the taught material. However, at the same time, we find that Computational Intelligence [5], specifically the facial feature detection and recognition techniques [3, 4], is advancing very rapidly. With the availability of relevant computing and sensing technologies, we hereby propose a possible solution to that challenging problem of determining each learner's actual progress and/or real-time response to any involved online learning materials possibly delivered through the next-generation e-learning systems [2].

Up to our understanding, none of the existing e-learning systems can satisfactorily address our concern. Therefore, in this paper, we explore the applications of the Android programming libraries and the Open Source Computer Vision (OpenCV) software to develop the ***PE***rsonalized ***T***eaching ***A***nd ***L***earning (***PETAL***) e-Learning system that can help to detect and also continuously monitor each individual student's real-time reaction to any online material, especially the downloaded or streaming video clips, for personalized learning or self-revision through the PETAL e-Learning system. Essentially, through the integration of web cameras as smart image sensors available on most tablets or smartphones with a simple-yet-efficient tracking algorithm run on the mobile devices to continuously monitor and analyze the learners' responses through their facial orientations and eye movements, the PETAL e-learning platform can provide a truly personalized learning experience to nurture the academic development of our young learners while protecting their eyesight. When any learner is facing too close to view the concerned online material or video, the PETAL system will quickly alert the learner with a pop-up message being displayed. While bringing in many technical challenges to more accurately analyze the individual learner's "real-time" response through his/her facial orientation and eye movements, it is obvious that the PETAL e-Learning system imparts new opportunities for many potential applications in e-learning or other areas.

This paper is organized as follows. Section 2 considers the prototype implementation and its empirical evaluation results. Lastly, Section 3 will summarize our work and shed light on many possible directions for future investigation.

2 Our Prototype Implementation and Empirical Evaluation

To demonstrate the feasibility of our proposed e-learning system, a prototype of the PETAL platform was carefully developed on the Android system (Version 4.3) with the OpenCV library (Version 2.4.5) and thoroughly tested in 6 man-months. Figure 1 gives the different diagrams showing the pupil detection and its use to determine the learner's distraction in various scenarios. There were some initial and positive students' feedbacks collected on our initial prototype and reported by a voluntary student group in HKU. For detail, refer to [6]. In addition, a more detailed evaluation and analysis will be carefully conducted in some selected courses in our Faculty of Engineering in the later part of 2014.

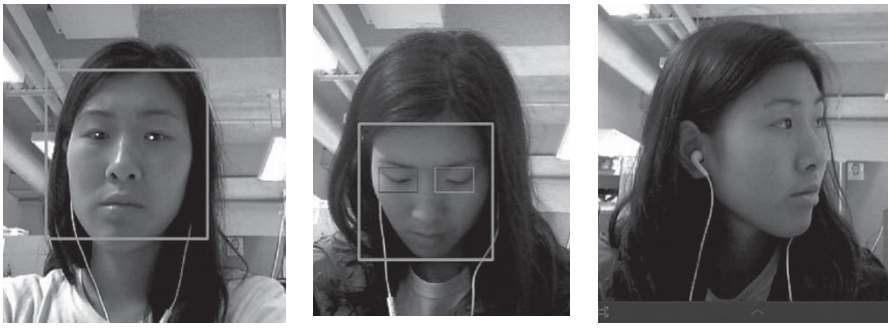

Fig. 1. Diagrams Demonstrating the Pupil Detection and Its Use to Determine the Learner's Distraction.

To provide more personalized learning experience to the user, our application also tracks at what time during the video the user was distracted, sleepy, or zoning out. At the end of the educational video, a summary will be generated for the user to view. The student can then use this summary to determine at what points of the video they were least focused and hence possibly most confused or uninterested in the presented material. At the bottom of the screen, the number of times the concerned learner was distracted, sleeping, or zoned out will be displayed to promote the self-evaluation of attentiveness after viewing each video.

3 Concluding Remarks

Mobile and sensor technologies advance so fast each day to continuously reshape the way we live and learn. In this paper, we consider an effective and interesting development framework of the PETAL e-learning system to build an interactive video player application fully integrated with sophisticated image processing techniques for detecting eye movement and head orientation on mobile devices enabling a new and personalized way of learning experience anytime and anywhere. In particular, our PETAL mobile application can alert any learner when his/her eyes are detected as being 'too close' to the mobile devices for protecting

the eyesight. Furthermore, as Android tablets are becoming more popular in the global market of mobile devices, our PETAL application can potentially reach an incredibly large number of learners, thus very influential.

There are many possible directions for future investigations. Examples include the porting of our current implementation to the *iOS* platform, and a thorough analysis on the pedagogical impacts of our proposed PETAL e-learning system on different learners both inside and outside of the classroom. Furthermore, future enhancements in both hardware, such as any further increase in the speed of image frames captured by the underlying camera, and software with more powerful versions of the *OpenCV* library or more accurate facial detection methods should be considered. Last but not least, further cascade training and enhancement in the pose detection algorithms may help to promote the capability of our PETAL system to detect other relevant types of student responses like their confusion or frustration.

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