Implementing Eye-Based User-Aware E-Learning

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We propose an e-learning scenario where eye tracking is exploited to get valuable data about user behavior. What we look at — as well as *how* we do that — can in fact be used to improve the learning process, revealing information which would otherwise remain hidden. The *e5Learning* project takes into account both the user's "emotional states" and the way learning activities are carried out, employing such data to adapt content presentation in real-time

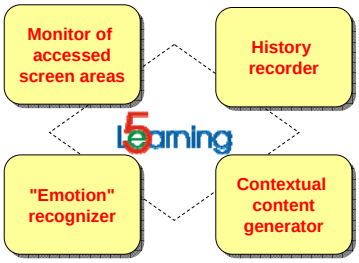
The offer of e-learning courses is increasing at an unrestrainable pace. However, the learning experience is often perceived by the user as a one-way communication process, where the "emotional" part of the interaction characterizing the relationship between teacher and learner is totally missing

In a computer-mediated tutoring system, eye monitoring can disclose important information concerning *what* the user is doing, as well as interesting data about *how* and *when* certain actions are being (or have been) performed

An **eye tracker** is able to detect where the user is looking at, measuring how infrared light is reflected by the cornea and by the retina through the pupil

Commercially-available devices look almost like ordinary LCD screens, and allow a relatively high freedom of movement

Tobii 1750 eye tracker



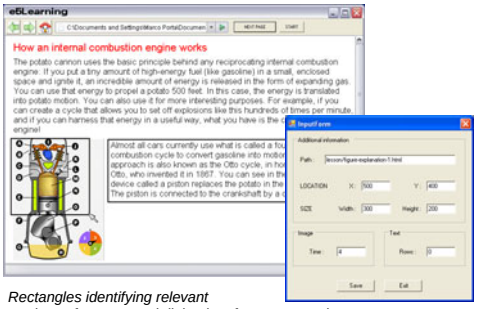
The aim of the ***e5Learning*** project (**e**nhanced **e**xploitation of **e**yes for **e**ffective **e**Learning) is to implement an e-learning environment characterized by four main components: a **monitor of accessed screen areas**, a **history recorder**, a **contextual content generator** and an **"emotion" recognizer**

Monitor of accessed screen areas

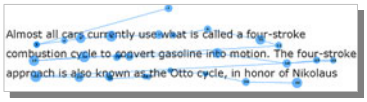
The author of the e-learning course can decide "how much attention" the user must pay to certain portions of content

In our prototype, a course is made up of web pages. Through an ad-hoc-built web browser, the author can define screen rectangles — corresponding to relevant pieces of content — and impose (through a dialog box) constraints on them

For textual areas, the system tries to understand whether they have been actually read by the user. For non-textual elements (e.g. images or animations), the course author simply specifies how much time the user should look at them



Rectangles identifying relevant portions of content and dialog box for parameter input

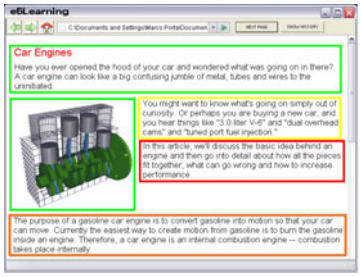


Example of reading scanpath

History recorder

The *History recorder* module relies on the *Monitor of accessed screen areas* and keeps track of which portions of content (defined by the author) have been accessed by the user, as well as "how much"

When the user presses the 'Next' button to load the next page in the course, if in the current page there are portions that have not been fully read/observed, the system emphasizes them by means of colored rectangles



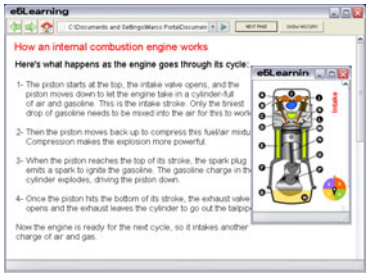
History recorder

■ *= fully accessed,*
■ *= partially accessed,*
■ *= very little accessed,*
■ *= not at all accessed*

Contextual content generator

The creator of the course can associate new content to rectangular screen areas, and indicate the requirements for the additional information to be displayed

Requirements are typically the minimum number and length of eye fixations inside the areas, or, for text portions, the detection of a reading process

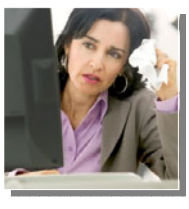


A new content window displayed when the user starts reading the first portion of text in the numbered list

"Emotion" recognizer

Several studies (mainly carried out in the Psychology and Physiology fields) have found correlations between eye behaviors and emotional states

Within regular time intervals, we consider the number of blinks n_b, the number of eye fixations n_f and the arithmetic mean of pupil diameters p_d. We try to identify two main user conditions:



1. **high cognitive load** and/or **understanding problems**
   if between two successive time intervals a decrease of n_b, an increase of n_f or an increase of p_d is noted, then the user may have gone through a high workload or non-understanding phase; the occurrence of more than one of these cases can be considered a further confirmation of that
2. **tiredness**
   considering a certain number of successive intervals n_{int},lasting a certain time t (e.g. 2 minutes), for each one of them we compute p_d and n_b; if the last n_{int} values obtained for p_d are monotonically increasing, then this may be interpreted as a tiredness sign. To confirm such a possibility, we check if also the last n_{int} values obtained for n_b are monotonically increasing

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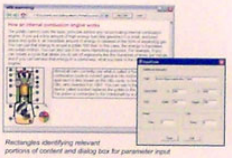

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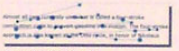

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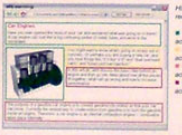

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