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ADAPTIVITY FOR GAME-BASED LEARNING

Personalized Adaptive Learning for Military Image Interpretation

Personalized adaptive learning for aerial image interpretation is essential for optimizing reconnaissance processes. Game-based learning concepts, e.g. serious games, could deliver a substantial contribution when combined with face-to-face training courses. With the "E-Learning A.I. (ELAI) Framework" Fraunhofer IOSB has developed a system to enhance existing simulations and serious games. The interoperability approach permits input analysis over multiple systems for adaptivity to users' skills, knowledge and needs. The design of the *ELAI Framework* facilitates easy transfer to other game engines, computer simulations or serious games.

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Task description

The interpretation of aerial and satellite images is one of the most important processes in the military Intelligence Cycle. It requires the detection, recognition, identification and analysis of structures and objects, according to a given task based on optical, infrared and radar imagery. Besides highly developed assets, sensors and image exploitation systems, the success of a reconnaissance mission depends on the interpreter's analysis performance. Special face-to-face training courses blended with technology-enhanced learning tools, such as E-Learning courses, simulations and serious games, ensure that image analysts are qualified to a high standard. For optimum results, the training process must be well-adapted to the knowledge, skills and needs of the interpreter. Our application scenarios therefore focus on intelligent assistance and e-learning systems which help users to perform their image interpretation tasks effectively and efficiently. Adaptive serious games and computer simulations help to keep users motivated and ultimately improve the learning or training outcome. For simulations and games, user engagement can be enhanced by adapting the simulations and games to the user's individual needs and by keeping the user immersed, e.g. by balancing the adaptivity inside the *Flow Channel* [1, 2].

Result description

Fraunhofer IOSB developed the "E-Learning Artificial Intelligence" (*ELAI*) Framework [2] based on the 4-process adaptive cycle for adaptive learning systems. At its core, the ELAI has an intelligent tutoring controller which interprets the collected data (analysis phase) and adjusts the simulations or games accordingly (select phase) [2]. The captured interaction data is transformed into machine interpretable information in the interpretation engine by applying
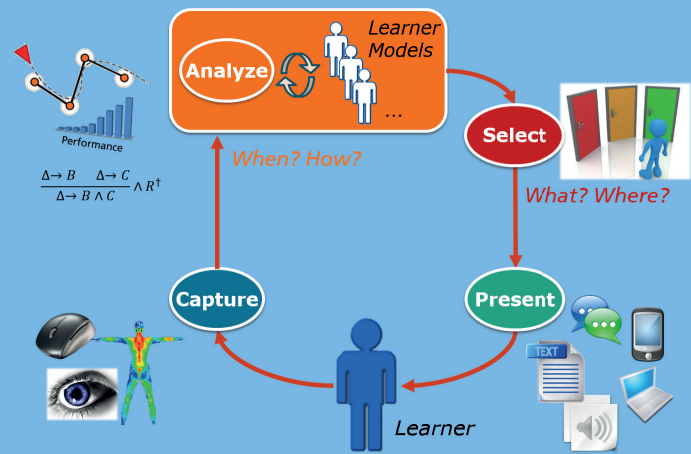
Lost Earth
Revised Bridge

2

Performance

$$\frac{\Delta \to B \quad \Delta \to C}{\Delta \to B \wedge C} \wedge R^{\dagger}$$

Analyze — Learner Models …

Select — *What? Where?*

When? How?

Capture

Present

Learner

3

so called Didactic Factors and artificial intelligence techniques like clustering and collaborative filtering. Based on this information the influence engine selects pre-defined adaptation strategies to adapt the game to the current user state. Dynamic difficulty adjustment is one typical adaptation strategy in the area of image interpretation, e.g. increase difficulty by covering more of the image with dynamically created clouds.

The ELAI Framework consists of an ELAI game engine adapter and an externalized ELAI Controller which hosts the actual e-learning "intelligence" with an interpretation and an influence engine. Since most of the actual e-learning logic can be externalized, only a minimal-invasive adapter has to be implemented. The underlying principles are based on commonly accepted standards, like the Experience *API* (xAPI) or the *High Level Architecture* (HLA), and on effective adaptive interoperability designs from *Learning Management Systems* (LMS) [3].

The ELAI adapter has been realized for the Unity, Havok and VBS3 game engines, however, the results are easily transferable to other game engines and applications.

Project description

Over recent years Fraunhofer IOSB has developed operational serious games as well as innovative game-based learning systems for the German armed forces:

Lost Earth 2307 is a 4X-strategy game for optical, infrared and radar image interpretation. It is in operational use at the German training center for military image analysts. [4]

EXTRA (Exercise Trainer) is a concept as well as an implementation for modular, Web-based training tools for complex, multi-institutional joint forces exercise scenarios. [5]

SaFIRa (Seek and Find for Image Reconnaissance, adaptive) is a prototype implementation of an adaptive seek-and-find game for image interpreters. The game's objective is to find objects (e.g. buildings, vehicles, etc.) in an interactive, geographic map from a top "aerial" view. [2]

The ELAI Framework has been applied to instances of these tools to investigate the concepts of interaction data capture, analysis, selection and presentation. Initial user studies verified the feasibility of the architecture and future work could include further A.I. technologies and other games or simulations. The externalization of the user model and its interoperable characteristics allows for further learning analytics on the collected data. For instance, the A.I. techniques of clustering and collaborative filtering are used to automatically identify learner profiles and detect suitable learning materials or gameplay recommendations based on multiple user interaction profiles.

The framework's development continues and will include further application areas, e.g. extended adaptivity for the Exercise Trainer EXTRA and for a distributed image-sensor computer simulation. This also involves the extension to adaptive Virtual Reality (VR) assistance systems for aerial image interpretation.

1 *ELAI Framework.*

2 *Lost Earth 2307.*

3 *Adaptivity Cycle.*

Customer

Bundeswehr Technical Center for Information Technology and Electronics (WTD 81) in Greding

Project execution

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