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A Community Information System for Ubiquitous Informal Learning Support

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***Abstract*—There are many mobile apps supporting informal learning tasks like sense-making out of multimedia materials. However, regardless how well these have been implemented, their scope and scalability is limited either by over-specialization and consequently limited transferability or by over-generalization – with a lack of informal learning support for most Web 2.0 apps. Our cloud-based mobile Web information system approach is theoretically founded and designed for scalability in informal learning. As a proof of concept we present a semantic video annotation scenario for supporting informal learning at workplace. As the approach has been designed for community learning analytics, we can present results from a preliminary evaluation. We conducted our research with a strong commitment towards open source software development, so that our solutions are already available and can have impact beyond the usual scope of a funded project.**

***Keywords*-ubiquitous multimedia information systems; informal learning; workplace learning; semantic video annotation;**

I. Introduction

Informal learning has always played an important role in education. In this paper we present a cloud-based *Community Information System (CIS)*, offering mobile and Web solutions for scaffolding informal learning as well as integrated means for community reflection [1] and analytics [2]. Due to the proposed combination of applications and services, core concepts of informal learning [3] can be supported such as examining own practice, learning activities and processes (e.g. reflection), exchanging practices and achieving shared meaning through collaboration, giving & receiving feedback. Mobile and Web clients offer a seamless user interaction across multiple platforms and devices. The service layer offers scaffolding backend functions and ensures data synchronization. Moreover, our system offers explicit facilitation of *Communities of Practice (CoP)* [4]. Based on these, further informal learning support can be achieved using analytics of the community data for reflective purposes. As proof of concept, we describe a semantic video annotation application suite in the next sections.

II. Background and Related Work

An important concept for enabling informal learning is peer production in workplace communities, where members create, share and promote content. It implies more learner freedom than in formal settings and thus requires a wider range of configuration, especially contextual information [5]. Communities should have the choice to use familiar systems for their tasks [6]. This results in multiple presentation and interaction types, built on top of a scalable infrastructure and based on a shared data model, a concept widely adopted by major IT companies such as Google and Amazon.

In the construction industry, slow adoption of information technology has been observed [7], along with a lack of technology for supporting informal learning. However, due to an increase in physical tagging technologies (e.g. RFID, NFC, QR) and the emergence of portable technologies such as smartphones, wearable cameras and smart glasses, new ways of providing CIS for learning purposes are emerging. As a specific example, given an increase in the produced videos, semantic annotations can be very useful in improving the learning support and the search for data. There are many existing annotation standards and video annotation tools [8]. In our work, MPEG-7 [9] is used for storing the metadata generated from our semantic video annotation systems. However, there is no cloud-based and community oriented multimedia information system environment specifically built for providing support for informal learning and that can be adapted to specific domains.

III. Scenario and Requirements

Informal learning is just-in-time, social, multi-episodic, problem-oriented and about situations [10]. Videos represent a fast way to capture episodes from daily work which may be used for learning purposes (e.g. by sharing interesting facts with coworkers, guiding materials for novices, pass current practices to new employees). Here, the problem of taking into account the rich context of a learning episode arises. By recording the episode as a video the context is stored as information that is easy to process by coworkers.

As a proof-of-concept we applied our semantic video annotation system to workplace settings at construction sites. The user requirements were gathered from users working for small and medium enterprises in the construction industry, using dedicated workshops, user interviews, paper prototypes, etc. In our resulting scenario, workers carry a mobile

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device, a smartphone or a tablet that they use to record a short clip when encountering an interesting situation.

The learning benefit in this scenario comes from 1) forming a habit of recognizing and acting on situations with potential for learning, 2) learning from the content of the videos and 3) making learning visible to others to increase the peer production and sharing.

The specific requirements for a workplace-oriented informal learning mobile application are:

- The action of recording should have minimal influence on the workflow. To support the habit of acting on potential learning situations, the recording should be an activity based on a conscious decision.
- The app should be clear about its purpose – to record learning situations – and ask the user to do that.
- The main actions shouldn't require fine or detailed touch interaction, since the app will be used in difficult conditions and with minimal preparation.
- The benefit from recordings shouldn't depend on video quality (due to environment conditions).
- The annotation, improvement and uploading of recorded clips should be performable at a later, more suitable time.

IV. Ubiquitous CIS Technologies

The CIS we propose for semantic video annotation is based on a three-tiered architecture which is presented in Fig. 1. The Client Applications tier is composed of browser-based Web applications (*SeViAnno*) and mobile apps (*AnViAnno* and *Ach so!*). The Cloud Services tier consists of scalable annotation and video cloud services to enable features such as storage, transcoding, streaming, annotation, data analysis, annotation management and usage tracking. Finally, the Persistence tier contains a database for the annotations (saved as MPEG-7) and a shared video repository.

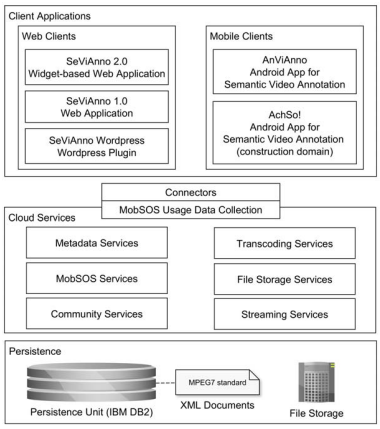

Figure 1. Architecture of the semantic video annotation CIS

The metadata services are running in a lightweight environment that can act as a server container for different services. Connectors exist for various protocols, paradigms, programming and runtime environments, thus enabling the development of both mobile and Web applications. The cloud environment offers scalable and flexible services which can easily cope with expensive operations such as video transcoding and streaming.

Such an environment fulfills the requirements for a fast and flexible deployment of services in a service-based technology platform. Our efforts are available as open-source to the development community. The source code of the apps is published under an Apache 2.0 license.

A. Web Application and Mobile Clients

SeViAnno 1.0 is a tool for semantic video annotation which allows adding metadata to uploaded videos using plain text tags and several types of semantic annotations (*Places*, *Objects*, *Agents*, *Concepts* and *Events* can be added to video segments). Starting from its main use cases, several other clients oriented for better usability in workplace (with focus on construction industry) evolved. Such clients are SeViAnno 2.0, a widget-based Web application and a responsive app implemented as a Wordpress plugin, which was requested by construction industry users due to their familiarity to this system. The SeViAnno 2.0 application supports near real-time collaboration for adding the annotations. Due to widget properties such as customization and portability, this application can be used both in browser and on mobile devices. Moreover, for handling complex tasks, the interface can be distributed on multiple devices.

We implemented two Android mobile apps for recording and annotating videos. AnViAnno is a general solution following the SeViAnno annotation use-cases. Ach so! is specifically designed for workplace learning in construction scenarios, customized according to elicitated user requirements. It suggests four genres for recordings: *Problem*, *Trick of trade*, *Good work* and *Site overview*. Annotations in Ach so! differ from the SeViAnno and AnViAnno schema by using free text without semantic categories. Videos can also be tagged in a spatial dimension by selecting a location on the screen with an orange rectangle. The mobile clients can capture videos on-site and synchronize the metadata with the cloud services. In Ach so!, when playing back an annotated video, it pauses at each annotation for three seconds before continuing, to allow marking features in moving scenes that the viewer needs to focus on. Additionally, touchable markers in the timeline point to specific annotations.

Ach so! enables tying clips to a certain context or a place: videos can be browsed by proximity, using a device's location services or by reading available QR-codes or barcodes from the environment. Videos can be associated with these codes; upon reading them, Ach so! shows other videos linked to that code. This is to support creating ad-hoc learning resources, e.g. for heavy machinery. These

associated codes are part of Ach so!'s metadata sent to server and are simply used as search keys.

B. Reflection on CIS Success

Our CIS infrastructure provides CoP with means for reflecting community success. In particular, CoPs need constant assessment and awareness on CIS success, i.e. how well CIS services do/could support their particular practice. The development of valid CIS success models is an essential prerequisite for the reflection of CIS service use in CoP.

We employ *MobSOS* [11], a comprehensive approach for reflection on CIS success, integrated in the CIS (cf. Fig. 1). MobSOS considers CIS services as community artifacts, where relevance is given by concrete CoP requirements. Data collection includes *context-aware CIS usage monitoring* and the *management of online surveys* on CIS service success. By design, MobSOS data sets are joinable with other data sets such as user-generated content (MPEG-7), thus e.g. allowing the inclusion of community-specific metrics in an overall CIS success model. MobSOS services are accessible to CoP, thus fostering awareness and supporting the exploration and development of success models and indicators. In particular, MobSOS query visualization fosters the interactive exploration and creation of data visualization widgets and dashboards.

V. Evaluation

The presented CIS was evaluated from both technical and usability perspectives. SeViAnno 1.0 and AnViAnno were evaluated in the context of a cultural heritage project, with the focus of comparing collaborative multimedia annotations of experts and amateurs. SeViAnno 2.0 was evaluated concerning the near real-time metadata collaboration perspective and the user preferences for widget distribution with very good overall usability results. Ach so! has had use experiments in the field (in environmental water measurement practices) as parts of its design process [12]. Some analytics on the produced data were also performed. After tagging a small number of construction videos, a graph of the existing keyword annotations was generated, and an overlapping clustering algorithm applied. The results are promising for detecting videos which are part from more categories of annotations, which were quite easy to detect from the gathered data. Moreover, system usage data collected by MobSOS allows the exploration of community success indicators.

VI. Conclusion and Future Work

In this paper, we presented a scalable (mobile and Web) CIS for supporting informal learning, customized for deployment in scenarios from construction industry. Our initial feedback shows that using such heterogeneous CIS in construction sites for information gathering and meaning making can offer great support for learning. The heterogeneous clients for semantic video annotation point the advantages which a seamless user experience can offer. Moreover, by focusing on an open-source and scalable infrastructure, this type of support can be offered in various environments (e.g. construction site, office, home, etc.) and as a final goal can be implemented and used across enterprises and customized according to specific learning goals. This is facilitated by the customization potential and the self-reflective and analytic features of the presented CIS. As future work, we plan to complete the evaluation of the Ach so! mobile tool and to conduct user evaluation in a construction company, in the context of the described scenario.

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