System Architecture for Device and Content Independent Application including 3D Imaging and Virtual Reality Implemented in Collaborative Language Learning Game

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***Abstract*— Network landscape of recent time contains many different network technologies, a wide range of end-devices with a large scale of capabilities and power, and an immense quantity of information and data represented in different formats. Research on 3D imaging, virtual reality and holographic techniques will result in new user interfaces (UI) for mobile devices will increase their diversity and variety. In this paper software architecture has been proposed to establish device and content format independent communication including 3D imaging and virtual reality data as content. As experimental validation the concept is implemented in collaborative Language Learning Game (LLG), which is a learning tool for language acquisition.**

Keywords-content formatting; device independency; virtual reality; 3D imaging; collaborative learning;

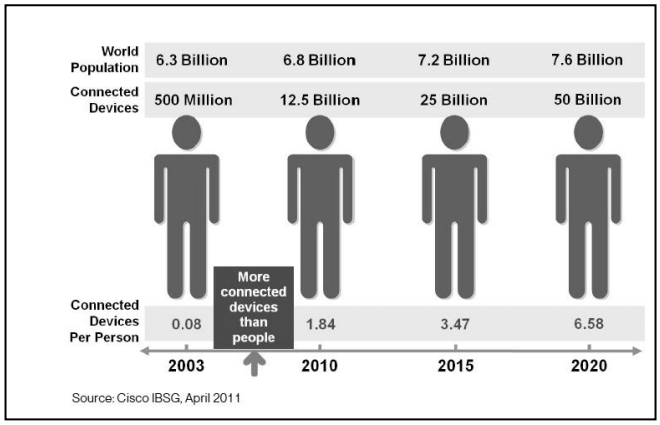


Figure 1. Estimation of connected devices by 2020

I. INTRODUCTION

According to CISCO IBSG, (April 2011) by 2020 approximately 50 billion connected devices will be used by approximately 7.6 billion of world population, which means 6 to 8 connected device per person (Figure 1). We have so many different ways to communicate to each other that it becomes a complex task to maintain all these different systems. Additionally new methods to communicate not only with human beings but also with machines have arisen. This has included a range of applications from simple Web-based software up to the voice-controlled household. As we know, the speed of development brings benefits together with problems. Two main issues can be identified: on the one hand, a user uses several devices to use the different methods of communication, and on the other hand, the Content and User Interfaces are big issues because they could include different kinds of data formats such as text, image, audio, video, 3D Virtual Reality data and other upcoming formats. A very suitable and useful example of the use of such a system is mobile learning because of the large amount of varying devices with significantly different features and functionalities. This is true not only to support different learners, e.g. all learners within one learning community, but also to support the same learner using different equipment in parallel and/or at different times. These applications may be significantly enhanced by including virtual reality content presentation. Whatever the purposes are, it is impossible to develop and adapt content for all kinds of devices including those that are mobile individually due to different capabilities of the devices, cost issues and the author's requirement. A solution needs to be

found to enable the automation of the content adaptation process.

In order to realize such a system three major requirements have to be fulfilled a) Identification of the connected device b) Generation, structuring and storage of generalized content and c) A transformation process from generalized content to optimized and device dependent content[1]. This idea is implemented in a helping tool for language acquisition for adult learners named Language Learning Game (LLG).

According to Critical Period Hypothesis (CPH) after a certain age it is not easy for most people to learn a new language. Moreover language acquisition needs interaction with others to practice it often which is very difficult for an adult due to other responsibilities in social and professional life. In this regard an adult learner needs a helping tool which is always available with him that he may learn and interact with others any time anywhere he wants. Nobody is carrying a high-end device like a laptop all the time and will not be motivated to open it somewhere for learning purpose just for couple of minutes. The only device that appears to be a potential solution to these problems is a small mobile device like a mobile phone, which is always switched-on and everybody is carrying it everywhere with himself.

The Language Learning Game (LLG) is the helping tool which is providing the user with an easy and efficient way to improve their knowledge level of a desired language by using exclusively their mobile phone. LLG is an example of a suitable tool for adult learners because it is a device independent application where different kinds of devices and data formats are presented for collaborative learning [2]. The main idea of this game is to create a short story in a foreign language by exploiting mobile devices. The story is developed by a group of participants by exchanging sentences/data. This way the participants can learn from each other by sharing their individual knowledge without the need of a constant support from a tutor and without the fear of making mistakes [3], because the group members are anonymous.

II. SYSTEM OVERVIEW

A. Description of the Game

There are some prerequisites to get benefit out of LLG. This is not useful for a beginner but for such a person who has basic knowledge of the desired foreign language. The game requires a supervisor who has very good knowledge of the foreign language to perform overall check at the very end.

The instructor or supervisor will create the game and provide instructions; decide about the total number of group members in each group and the game end condition. In this stage the instructor is the learning content provider or author and he may use any kind of data format as per necessity or availability or convenience, for example instruction could contain text, picture, audio, video, 3D image or a virtual reality scene or a combination of different data formats. Group members will be collected randomly. Each group should contain no more than three to five members. Slavin showed that groups with two or three members usually would do better than groups with four or more members [4]. In LLG since the participants are improving by knowledge sharing it makes more sense to build a group with at least three students instead of two. Now it is not possible to say which member is going to use which kind of device; moreover each user may use different kind of device in different time or parallel. Participants will write sentences and the aim is to build a short story in the desired language. When a group member writes and sends a sentence the other members of the group will have a chance to dispute by proposing another version of the sentence or they can simply agree with it. They are only allowed by the rule of the game, to change spelling or grammatical mistakes in their proposed version. Afterwards all group members will receive the proposed sentence and possible corrected versions. At this stage every group member has to decide at which version he agrees and vote for that one. The sentence with the most votes gets elected. In case of equal votes the first submitted one wins. A group member has to create one sentence in one round. Typically the game is finished after fifteen to twenty rounds. The final short story is sent to all group members as well as to a supervisor who will perform an overall correction. After that all the participants will receive corrections of all the mistakes done by them while playing the game made by the supervisor. This overall correction is necessary because there might be a situation when the majority of members of a group agree with a wrong sentence. At the end the correction made by the supervisor will help them to learn correctly.

As mentioned before this game is an example of m-learning which should be able to be played by using any kind of device for example desktop computer or mobile phone. So the very first responsibility of the system is to identify the end user´s device along with device capabilities as soon as the user logs in to the system. It is a basic right of the user to be able to see the instructions of the game on their used devices to be able to play the game. There might be a necessity of translating the instruction based on the end user´s device capabilities.

B. Identification of the Connected Device

Wireless Universal Resource File (WURFL) [5] is selected for the description of the features of mobile devices and browsers because WURFL model is an XML configuration file which contains information about capabilities and features of many mobile devices in the wireless world. Also, the repository of device in WURFL is updated every day by contributors in the world. So it is an up to date specification that brings reliability in device data manipulation. Our system works with a combination of WURFL and a local database. Figure 2 below shows a simplified version of the whole process. First, it is detected whether the user is connecting to the system via mobile device or by desktop device by analyzing the user-agent

parameter of the HTTP-header. In case of mobile devices, the local database is checked whether the device is listed and the available information is up-to-date. Outdated device information is determined by using the WURFL.

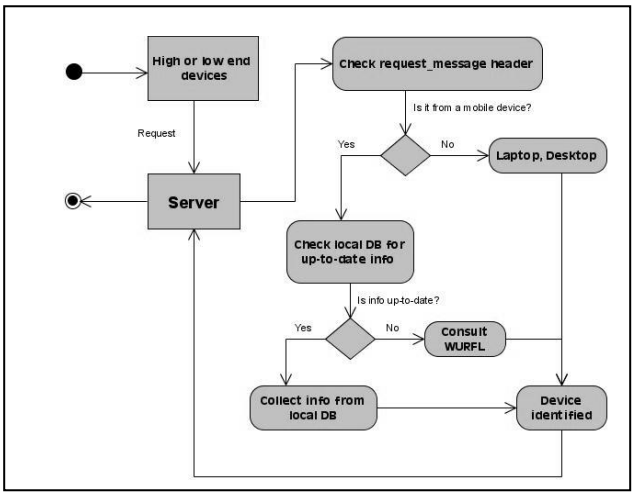


Figure 2. Device identification with capabilities

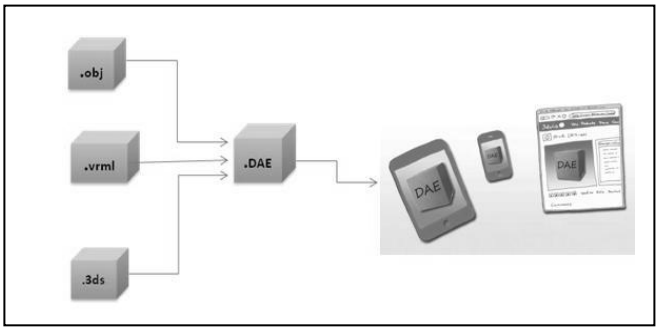
C. *Generalized Content*

A device independent system is able to deliver content to any device in such a way that the received content can be presented. This task can be approached in two following ways: either content for every device exists in the system, which is very time, cost consuming and labor intensive, or the system is able to adapt content for each device. In case the system is capable of adapting content to a device dependent presentation, the content has to be available in the system in a generalized form. Additionally, such a system should support a device independent authoring process where the author can focus on the content generation and not on device dependent content adaptation, for example while creating game providing instruction in LLG . XML has been chosen for generation, structuring and storage of generalized content. For 3D data .dae format is used due to compatibility with maximum number most used other 3D data formats and .dae is extended from XML [7].

D. *ContentAdaptation*

In order to optimize the content presentation on different devices, the generalized content has to be adapted or translated in to a device dependent manner. W3C in W3C-MBP (2008) [6] has categorized three approaches where the adaptation is taking place: 1) client-side, 2) server-side and 3) proxy-side. It is intended to use both the server and proxy side approaches based on necessity. For example for a 3D picture or a virtual reality scene as an instruction of a game, it is advantageous to use proxy based approach [8]. When a mobile device requests a specific 3D Virtual Reality file, the device has to inform the proxy about the device capabilities, such as processing power, screen resolution, supported sound formats and so on. On the proxy side, the specific file is requested from a target server. By parsing this file, the proxy creates an object oriented representation of that scene. Additional resources (e.g. links to other files) can be detected and preloaded. The proxy will remove unneeded and unsupported content according to the mobile device specification. If the identified device has lower processing power then from a 3D Virtual Reality scene additional content such as fog, texture, light source etc could be excluded. If the mobile device does not have the required capabilities to provide this information it does not make sense to transmit the data over the wireless network. This information can be removed at the proxy without any loss at the client side. The 3D Virtual Reality scene is transformed into the correct modeling language while mentioned methods are taken into account to reduce the content. For the devices with higher processing power it is not necessary to go through proxy server. In this case a direct communication is established between client device and server. The idea of making generalized 3D data is pictured below in figure 3.

Figure 3. Process of displaying 3D data



III. TEST RESULTS

Five prototype-tests, for three different languages having 17 groups with 3 members on an average in each group, are done. At fifth field test all the participants had complete freedom to choose high-end and/or low end device according to their convenience. Since it is not predictable who is using what kind of device, what kind of communication medium, what is participants personal context or situation for example is he in a class room, meeting room or in supermarket and when is he going to use the system (LLG), all sort of notifications and alerts are sent as *Short Message Service* (*SMS*) and *Electronic mail (e-mail).* From the previous tests participants' opinion along with corresponding language courses´ professors has been collected by providing a questionnaire which included open questions as well. With the help of prototype all the important functions and features were tested. Findings based on the overall statistics of the game are very positive. 89% of the users liked the game, 92% thinks the tool is very helpful to learn a new language, 82% can imagine playing the game by using their mobile phone. Not only the participants but also the corresponding teachers are also very interested to accept this game as a part of their course.

IV. DISCUSSION

In LLG students/participants help each other and in doing so build a supportive community which raises the performance level of each member. Their critical thinking skills increase and their retention of information and interest in the subject matter improve. This in turn leads to a higher self esteem of all the participants [9]-[11], which is the ultimate goal of LLG. In other words the goal of this project is to provide a Language Learning tool as a game where all the participants will be able to improve their language level by knowledge sharing by using a mobile device, for example a mobile phone that we all are carrying everywhere along with us all the time. It facilitates the participants to access the system as per their convenience without time and place constraint. The collaborative story building process of LLG makes each participant bound to interact with his team members every now and then to deal with a real-life situation which is not predictable. For example it is not possible to guess what sentence is going to be written by the team member, among couple of proposals which one is going to be accepted as a part of the story, what kind of data format is going to be used by the supervisor as instruction of the game. Even though LLG requires very active participation and as a result none of the participant has to wait or feel stressed because for all sort of required activities participants will be notified. LLG is providing a comfortable environment and taking good care of participants´ emotion to ensure participants´ maximum level of benefit. Since the game is played anonymously there is no possibility of occurring problems regarding cultural differences or knowledge level differences or personal feeling. Various research results show that learners learn from their mistakes too [12]. It is a way of analyzing personal improvement.

Even if a proposal made by a participant was not accepted as a part of the story, it will remain saved in the database. Any time a participant can see and compare his proposal with accepted sentence and at the end with supervisor´s correction.

V. FUTURE IMPROVEMENT

Primarily the idea is tested with text and .jpg data format in platform type Connected Limited Device Configuration (CLDC)/Mobile Information Device Profile (MIDP). CLDC – 1.1 and MIDP – 2.0 was used with some optional packages like Mobile 3D Graphics 1,1, Wireless Messaging 2,0 etc. So far device detection, generation, structure and storage of generalised content and translate and transfer of the generalised content according to detected device´s capabilities with above mentioned data and device profile is working. Still it has to be improved and tested with other possible devices and data formats, especially with 3D data and VR scene. Not only different devices powered by same operating system but also different operating system such as iOS, Windows Smartphone/Pocket PC, Linux, Android, BlackBerry OS, Bada, webOS etc. The experimental validation could be conducted between 2 or 3 Virtual Reality Systems including 3D image by polarization separation on large size and cellular phone including 3D capacities with micro lens filter or other technology. Mainly our focus is to use polygonal modeling instead of Non-uniform rational basis spline (NURBS) due to the comparative easiness of dealing with the data [13].

VI. CONCLUSION

From the given answers of the provided questionnaire we know that participants think it is a creative way to learn a new language because

- They can practice the grammar and learn new vocabulary,
- Everybody can evaluate himself by comparing with the other group members,
- This game is highly interactive which is very important to learn a new language,
- At the same time everybody is a teacher and a student,
- They can write without fear of making mistake and nobody was feeling shy because they were playing anonymously,
- In the vote state everybody can compare and then select the correct sentence.

This evaluation shows that participants were provided with a comforting learning environment where their affective state was taken into account, LLG was a supportive tool, this tool did not require any new or unknown digital device assistance because the students were able to use either their own mobile phone or own computer or PDA, anonymity was a factor that gave them the freedom to give their best effort which enhanced peer assistance and as a result collaborative performance.

The aim of this research is to establish anytime anywhere learning independent of place, time, device, data format of the learning content and end user´s status. To achieve this goal first step is to identify connected device to know its capabilities, second step is to prepare generalized content from the learning material provided by the author, then third step is to translate and transfer generalized content according to the capability of end user´s device. To make the process more realistic it is also a necessity to support different devices owned by same user used parallel or at different times.

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