Harnessing Edutainment in Higher Education: an Example of an IoT Based Game

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Abstract

In this paper the authors study the problem of designing new tools and approaches for a higher implementation of edutainment into formal e-learning. The main goal is to design an educational game in order to effectively support the teaching process in higher education. The developed game is based on Internet of things technologies and implemented as a part of a smart classroom. It includes IoT infrastructure for solving assignments within a course, a mobile application that students use to interact with the game and a component for integration with Moodle LMS. The game has been implemented within the educational process at Faculty of Organizational Sciences, University of Belgrade.

Keywords: Internet of things, game based learning, smart learning environments.

1 Introduction

Modern life is strongly influenced and rapidly changed by the development of technology and transition to the digital world. While older population finds this change hard and challenging, the younger one is growing with the technology and considers technology as an integral part of life. The young are living in a world of computers, smart phones, cameras, video games, and other devices which give them possibilities to communicate, entertain themselves and multitask.

Due to the rapid development of information technologies and Internet, education is also getting a new modern form, which significantly increases the efficiency of the educational process. Numerous innovations in modern e-education lay in the fields of smart educational environments and internet of things applications. There is an obvious ubiquity of using mobile and smart technologies in education, both formal and informal, as well as increasing interest of the academic community for research in this field. The main idea is to achieve a level where mobile devices and applications are not considered as a distraction but as a tool for improving the practice of teaching and learning (Stojanović et al, 2016).

A smart environment is the one made of objects that can communicate, interact, compute, and make decisions, with the goal to automate different repetitive actions (Cook and Das, 2005). Smart learning environments are adapted to the needs of educational processes, while at the same time they present a comfortable environment for teaching and learning. These environments can be adapted dynamically with respect to the needs of the participants, the process itself, or any other criteria.

Smart environments are developed using the technologies of the internet of things (Knežević et al, 2016). Internet of things is a global network infrastructure that enables connecting physical and

virtual objects to the Internet, mainly using wireless and mobile technologies (Tan and Wang, 2010; Gubbi et al 2013). In education, internet of things enables the application of modern internet and mobile technologies, which leads to a more active approach in learning. In this way, we can develop environments and tools that enable students to learn more efficiently, with an increased interest, compared to traditional methods of education.

In the research presented in this paper, we are set out to develop a smart learning environment located outside of the classroom, but integrated with educational services of the classroom. The developed environment is equipped with various sensors, devices, and software that support the learning process. In such an environment, we have developed an educational game that aims to increase the interest and motivation of students to study the field of the internet of things (Simić, 2015), and to enable them to learn quickly in an augmented reality environment, outside a traditional classroom. In a "treasure hunt" game, students are testing their knowledge in the internet of things and learning new things in a fun way.

2 Literature review

2.1 Educational games

Educational games are getting more and more used in education (MyounJae, 2016). Physical educational games are based on physical objects, and they have been used in education for a long time. However, different mobile technologies are becoming available and ubiquitous, which makes the development and application the mobile educational games easy (Ly-yi and Yan-lin, 2010). Internet of things has enabled communication between physical objects and the digital world (Xiang and Xin, 2012). Harnessing new technologies makes traditional games more interesting and adapted to new trends (Tiejun, 2007; Yan-bin and Ning, 2012)

Augmented reality and Internet of things enable design and development of hybrid games, where the elements of the physical and digital world are connected, with the goal to improve the performance and effects of traditional games. These technologies are helping teachers to create educational environments anywhere, and to adapt them to characteristics of the educational process or to students' needs (De La Guía et al, 2013).

Games easily attract attention. Their potential for application in education comes from the fun and curiosity they produce (Griffiths, 2013). Games can help the students (players) to set their goals, to exercise, to get feedback and track their progress throughout the course, while teachers can monitor students' behavior (Griffiths, 2013). Analyses have shown that there are several parameters that can be used to evaluate the quality of an educational game (Aslan and Balci, 2015):

- Acceptability: the level of completion of the learning goals;
- Challenge: the level of motivation of students;
- Clarity: the level of understanding;
- Interactivity: the level of interaction between the student and the game;
- Reward: it enables the student's satisfaction after the completion of goals.

Research has proven that playing 2D educational games gives more learning than playing 3D commercial games, which confirms that educational games do not need to be developed using expensive commercial tools and platforms (Koops et al, 2016).

2.2 Smart learning environments

Many classrooms today are connected to the Internet and have the advanced technological equipment, such as tablets or interactive boards. This type of classroom is called the smart classroom.

In a smart classroom, there is face-to-face communication, but there is virtual communication as well. Smart classroom blends human interaction, technology, and traditional learning methods, forming the environment which is innovative, flexible and motivating (Sevindik, 2010).

The smart classroom can be defined as a classroom equipped with modern technologies (for example 3G, 4G, IoT) for interactive learning, audio and video transmission, content producing and publishing, etc. Smart phones and tablets are also adequate for use in smart learning environments, so the learning can happen anywhere (Alelaiwi et al, 2014). A smart classroom is rich in technology; it connects physical and virtual learning environments and gives support, tools, and contents for different types of learning. It can also collect a vast amount of data in order to support the pedagogical decision. In addition, by using mobile and IoT technologies, a smart classroom can surpass the physical space of a traditional classroom (Petrović et al, 2016). In this way, learning can be performed anywhere in a physical or virtual world, in a smart learning environment.

An important technology for the realization of game based learning in smart environments is augmented reality. Contrary to virtual reality, where everything happens in the virtual world, augmented reality enables enriching the physical world with the information from the virtual world. The application of augmented reality in education enables students to (Liou et al, 2017):

- understand the educational content better
- consider the problem from multiple angles,
- connect the theory and practice,
- learn in real-life situations,
- achieve higher motivation and satisfaction with the educational process.

3 Game design

3.1 Project requirements

In this research, we have set out to develop a system that would enable students to learn in an interesting and motivating way, using an IoT based educational game. The game is organized in tasks, which students solve in a specific order. In order to complete the game, a student has to solve all the assigned tasks. Each task is designed to test the student's knowledge in the studied field. Each task is solved using a specific workstation places in a physical environment and integrated with smart classroom services.

The student starts the game from a starting point, where they get the first task. After solving the first task, they get a clue to reach the next location, where a workstation with the second task is located. This repeats until the last assigned task is solved.

3.2 Architecture

The architecture of the system includes a mobile application used by students, an application for administration of the system used by a teacher, equipment on the locations of each task (hardware and software). All the software components communicate through web services. Moodle learning management system is used for user management, task management, and grading.

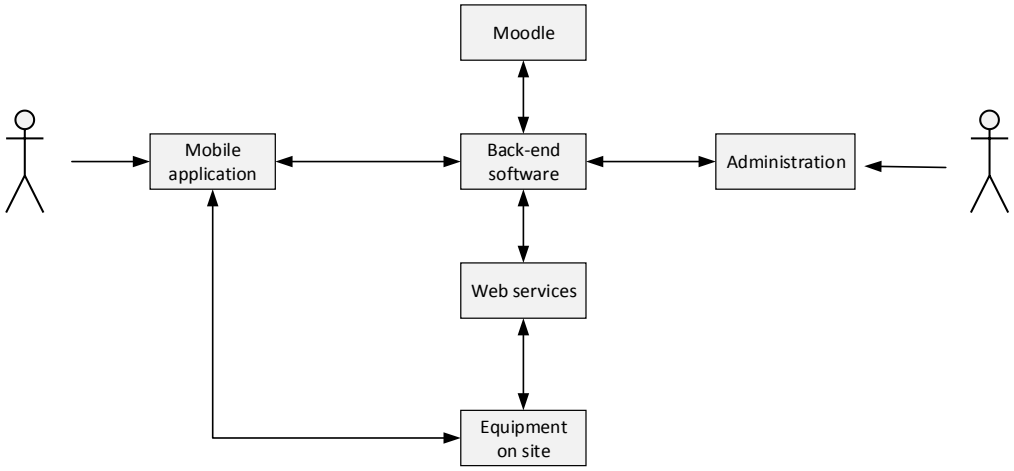

Figure 1 – The architecture of the game

3.3 Designing smart environment

For the realization of the game, it is necessary to organize a smart learning environment. This environment includes workstations on multiple locations and equipment for students.

Students' equipment consists of an android mobile device (a smart phone or a tablet) that a student uses to play the game. The device with the installed game is prepared in advance and given to the student at the beginning of the game. The student logs in with their Moodle account and interacts with the game only through this mobile interface.

Equipment on site is used for defining and solving the tasks through the game. The game is played at multiple locations, and each location has one task. Location can be anywhere, in the classroom, in the faculty building, or outside. For example, a task can be related to measuring the temperature, and the equipment can be placed in a classroom. Or, a task can be related to plant watering, so the workstation will be placed in the garden.

There are several tasks implemented within the game so far. All the tasks are related to studying the field of the internet of things and its applications:

1. A system for measuring temperature and air humidity. The student connects to the system using the mobile device and sets the parameters of the system according to the requirements.
2. A system for light control. The student connects to the light control and sets the lights as required in the task.
3. A system for movement detection. A movement is detected using a sensor, the LED screen shows the information, and a timer is started. In a defined time, the student is required to perform an action defined in a task.
4. A system for measuring the distance. An ultrasonic sensor is used to measure the distance and shows the measured value on an LED screen. The student is required to do a movement that will cause the reaction of a sensor, as defined in the task.

Besides the equipment necessary for solving tasks, each location is equipped with:

- Wireless internet. Components communicate through a wireless network.
- Hosting service. Each location has its own local database and services necessary for the hosting and realization of a specific task.
- RFID system for monitoring the progress of the students.

- The system that informs students about their progress. The yellow color is used to note that the system is in the ready state, waiting for a student to come. The red color is used to note that a system is performing an action, and no interaction with a student can be done at this time. The green color is used to signal the student that they can perform the required action.

3.4 Game scenario

After login to the mobile application, the student is shown the home screen. The student starts the game and the timer starts. The screen shows the text of the first assignment. An example of the assignment is shown in figure 2. The student is required to solve the function shown in the screen. The result should be put in the remote control on the site, so to set the temperature at the value calculated through the function.

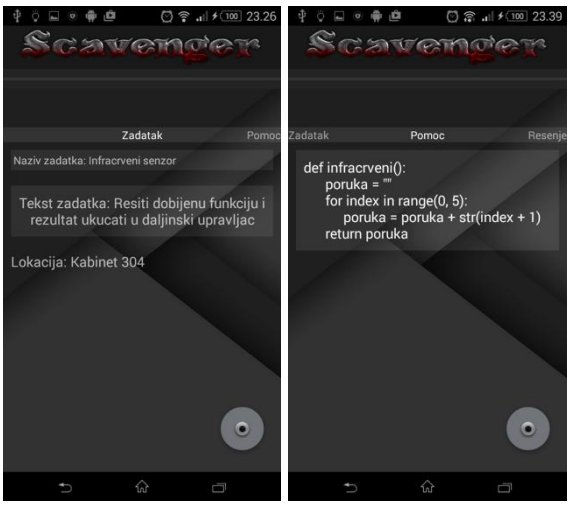

Figure 2 – An example of a task and a solution

If a solution is correct, the student checks the RFID tag and activated the next assignment. After solving the assignment, the student gets a clue how to reach the location of the next assignment. If the answer is wrong, the student is assigned another task, in a random order. The process is repeated, until the student reaches the end of the game, and solves all the tasks, or if the time elapses. The game scenario is shown in figure 3.

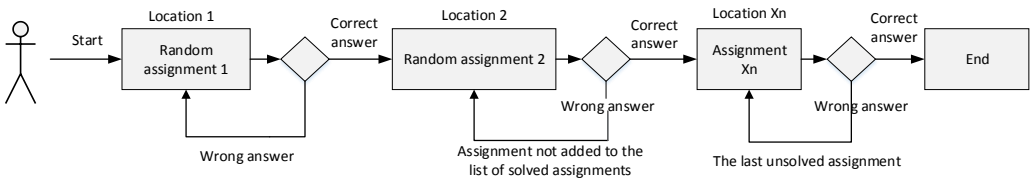

Figure 3 – The game scenario

Throughout the game, the student can review the solved assignments. After completion of all the assignments, or after the time has elapsed, the score that student achieved is calculated, shown to the student, and inserted into the administration application and Moodle.

Conclusion

This paper presents a model of an interactive game based on the internet of things. The game has been developed at the Faculty of organizational sciences, University of Belgrade. The goal was to motivate students to learn about IoT and smart environments. The main advantages of the game are related to the simplicity of use, low costs of equipment and interactivity.

Future work will be directed towards the development of a higher number of tasks, further integration with Moodle and complete technical and educational evaluation of the system.

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