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A MODEL OF SMART ENVIRONMENT FOR E-LEARNING BASED ON CROWDSOURCING

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Abstract
This paper deals with the application of the concepts of Internet of Things and its application in creating smart environments. The specific goal is to design a smart environment for enhancing the teaching and learning processes at universities. The environment should integrate adequate concepts of smart buildings and smart classrooms with e-learning systems, in order to provide students with advanced e-learning services and services that improve the overall quality of students' experience. In addition, the model is based on the concept of crowdsourcing, where students actively participate in gathering the information, designing and implementing the e-services. Finally, the paper describes a prototype of the designed smart environment implemented at the Department for e-Business, at University of Belgrade.

Keywords: smart environment, internet of things, crowdsourcing.

1 Introduction

E-learning and distance learning are terms which have existed over hundred years. The founder of e-learning was Sir Isaac Pitman (1813 – 1897) who organized the first shorthand course delivered by correspondence via postal system (Tait, 2003). E-learning can be defined

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as learning delivered on a digital device (i.e. computer, tablet, smart phone) (Clark & Mayer, 2011). Nowadays, using information and communication technologies in education becomes inevitable, especially at universities. In 2010, 31 percent of U.S. college students took at least one online course (Bell & Federman, 2013). New technologies allow personalization and customization of courses, according students' needs. Adaptive e-learning systems can be described as personalized systems which allow adaptive delivering of courses, interaction, collaboration and support, in spite of creating personalized content (De Bra et al., 2013).

Modern learning systems require permanent innovations and also tracking information about students' preferences, affinities, abilities and preferences. Internet of Things improves teaching and learning processes by introducing sensors, actuators and other smart devices to a smart learning environment. The best known smart environments are smart classrooms.

Crowdsourcing is a paradigm which becomes essential nowadays in many fields, especially in computer science, informatics and education. It is online and distributed problem solving model which includes a large number ("crowd") of people as participants (Brabham, 2008).

This paper presents an approach of introducing Internet of Things concepts and technologies together with crowdsourcing concepts to a higher education institution.

2 Smart Environments

The main objective of smart environments as a part of broader term, Internet of Things, is to make everyday life easier. For example, when people drive cars, they want to be able to get the latest information about the road conditions, traffic congestions, to change the radio stations they are listening to etc. With a help of modern sensors, actuators and smart devices which combine all of this, only with their voices, people can check weather on the Internet, see the traffic accidents near them and know which roads are the best to go with a least traffic (Husnjak, Perakovic, & Jovovic, 2014).

Smart environment include smart houses, smart classrooms, smart offices and other smart areas (Lucke, Constantinescu, & Westkämper, 2008). Today's number of smart devices and environments is expected to increasingly grow due the recent advances of smart energy distribution usage in the form of smart grid (Farhangi, 2010; McDaniel & McLaughlin, 2009) Mark Weiser's vision of smart environments is that, one day, in everyday life, smart devices and smart environments will be available for everyone to help performing any task needed (Weiser, 1991).

Three main goals in Smart environment are to learn, to reason and to predict. In other words, smart environments need to learn how their environment works and thinks and to know exactly how to react when some action or signal happens. A smart environment (also known as SE) can be described "as one that is able to acquire and apply knowledge about the environment and its inhabitants in order to improve their experience in that environment" (Fernandez-Montes, Ortega, Alvarez, & Gonzalez-Abril, 2009).

Talking about algorithms and protocols used within the smart environments and with Internet of Things (IoT), there are a lot of protocols which goals are to balance energy consumption, make systems work faster and make them more reliable (Zhang, Zhu, Zhao, & Dai, 2012).

Some of protocols that are common in smart environments are ZigBee, DECT, IEEE 1451 and others.

ZigBee protocol has become one of the most used home wireless protocols because it is a great solution for devices with low data rate and for devices which need a long battery life which is very popular in home network applications. One of major problems of ZigBee is because it introduces coexistence problems, sometimes falling to fulfil the response time required by the home network applications. This problem can be overcome with controlling the WLAN when the ZigBee transmission is ongoing (Hong, Lee, & Lee, 2014).

DECT is a protocol with low power consumption characteristics and integrated support for direct conversation terminal architecture. DECT is basically a radio access technology (Drosos, Dre, Metafas, Soudris, & Blionas, 2004).

IEEE 1451 standard improves scalability of electronic devices and reduces the cost of network transducers. These groups of standards give us an open platform for the development of network electronic modules using different physical links. These standards make connectivity of sensors and actuators be very easy and fast. Also IEEE 1451 offers some plug and play benefits for a lot of sensors and actuators (Barrero, Toral, Vargas, & Becerra, 2012).

3 Smart Classrooms

Modern technologies, information and communication systems have made a great changes for teachers and for students. As well as 50 years ago, nowadays teaching and learning in classrooms are totally different processes for everyone. New technologies allow students to learn faster and achieve better knowledge and help teacher to easily teach students (Kubiatko & Haláková, 2009).

Great thing about smart classrooms is that they allow teachers to see how students actually want to learn and smart classrooms allow teacher to give the knowledge to students on the way students want it. It makes both benefits for teachers and students. Another important thing about smart classrooms is that they allow students to see a real purpose for using technology and everyone easier learn when they see a true purpose of some technology (Firmin & Genesi, 2013).

Thanks to Internet, laptops and smart devices students can get any information in few seconds. But this is not enough. Next step will be to get information about the students before they clicked the button and typed how they are feeling. With a help of modern sensors and actuators this will be possible to perform in smart classrooms (Santana-Mancilla, Echeverría, Santos, Castellanos, & Díaz, 2013).

With smart classrooms where smart things as cameras, microphones and many other sensors, which can measure how students are satisfied with the things they are learning about term, can be found, classroom management becomes very simple and easier to understand than without smart devices. Term “classroom management” represents a way how a teacher achieves order in his/her classroom. With a help of smart devices teacher can know when to take a break, when to talk louder and when the concentration of students is falling down (Rytivaara, 2012).

Some examples of sensors and actuators which can be used in smart classrooms are temperature sensors, sensors for walking in front of table which check if teacher is present in classroom and if is, some actuator turns on projector, some noise sensors which show how students are talking and so on. With some cheap sensors and a lot of imagination, powerful and interesting smart classroom could be built, which can really help students to learn easier and through fun (Santana-Mancilla et al., 2013).

4 Using Crowdsourcing in Learning Environments

Over the years, the Internet has evolved into a network which is present in each sphere of the modern society – from personal to professional activities of people. In early 2000s, the Internet entered into a new phase, better known as “web 2.0”. Before web 2.0, the Internet was a presentation platform. The interaction process between sites and visitors was limited (Venkatesh, Croteau, & Rabah, 2014). By introducing web 2.0, this has been changed. The visitors became active participants, able to post different kinds of informations, photos, videos and other content. Web 2.0 is a precursor of a new concept, crowdsourcing, which is significant in many different areas.

Traditional Internet philosophy defines the Internet as a medium where a relatively small group of people creates contents and the majority of people consumes it. Recently, a reverse paradigm was invented, where millions of people are involved into creating different contents for an organization. This phenomenon is known as crowdsourcing. Crowdsourcing involves a group of people who try to provide common goods for communities. In e-learning, common goods can be videos, music or encyclopedic knowledge which are freely available to everyone (Brabham, 2008; Yuen, King, & Leung, 2011).

The term “crowdsourcing” was firstly used by Jeff Howe and Mark Robinson in 2006. They defined crowdsourcing as a business act where the functions of employees and IT outsourcing are moved to undefined and large network of people in a form of an open invitation. One of main benefits of crowdsourcing is including a possibility to collect a large number of solutions and a lot of information with relatively small costs (Howe, 2006; Rosen, 2011).

Crowdsourcing systems can be used for archiving different assignments. For example, people from the “crowd” can be invited for developing some new technology, designing new products (which is known as distributed participatory design), executing algorithm phases, systematization or analyzing big data.

Crowdsourcing is dependent on the Internet. Features of the Internet, such as its speed, anonymity, opportunity for asynchronous involvement in projects and various types of media contribute to the realization of the crowdsourcing concept.

Crowdsourcing models rely on collective intelligence. Pierre Lévy defines collective intelligence as a form of universally distributed intelligence, permanently improved, coordinated in the real time and leading to effective mobilization of skills (Lévy, 1994).

In education, the primary use of crowdsourcing used to be limited to logistics, rather than learning and teaching processes (Bradley, Lancashire, Lang, & Williams, 2009). However, using crowdsourcing in learning and teaching processes can lead to pedagogical innovations and to improve learning skills and professional abilities of students. In educational point of view, crowdsourcing includes following aspects: groups of people (students, teachers, administrators) who represent information sources, rather to be just passive listeners of authorial figures; team work which is focused on all team members who can contribute with their knowledge; tools which can be used for managing ideas where all members of the team can contribute with their own ideas.

There are three main phases in deploying crowdsourcing to educational systems: collecting, processing and implementation (“Crowdsourcing Class,” 2014). In the first phase, ideas and different points of view are collected from team members. In the second phase, a panel discussion about possible solutions is performed. In the final phase, each idea is given a priority and funding and resources are assigned.

Crowdsourcing cannot entirely replace the traditional learning but it can improve learning and teaching process in e-education and make them more transparent. It also adds more innovations and testing quite different ideas by students.

5 A Model of Smart Environment for e-Learning Based on Crowdsourcing

For improving learning and teaching processes, several parameters regarding students’ needs, abilities, preferences and knowledge should be collected. These parameters can be subjective and objective. When students fill out surveys about different aspects of education processes, subjective parameters are collected. Objective parameters represent some physical measurements, such as temperature, pressure, voltage etc. and they can be collected by using different sensors.

In the Figure 1, a model of smart education institution is shown. Improving the overall learning environment and customizing it to students' needs are the objectives of the model. A typical smart education institution consists of several different components. The main components of smart education institutions are unambiguously smart classrooms which represent learning and teaching cores of institutions. Two smart classrooms shown in the Figure 1 use different approaches. One classroom uses students' subjective parameters and the other one uses objective parameters.

Students take surveys about their current lectures in classrooms which use the subjective approach. Each student can evaluate the quality, interestingness and content of classes. If they are not satisfied with any of these aspects, students can give their suggestions to improve classes. Crowdsourcing concept can be used by allowing other students to rate these suggestions. By using crowdsourcing, teachers are not the only persons who are involved in the teaching process. It also encourages students to participate in creating teaching materials.

Objective parameters which can be measured in classrooms are useful for analyzing the correlation between environmental factors and students' satisfaction. Different sensors, such as temperature sensor, humidity sensor, heartbeat sensor, photo sensor, can be used. Crowdsourcing can be used for collecting data about optimal values of temperature, humidity or brightness. For example, if the most students prefer temperature of 23 degrees, air conditioning or heating can be turned on to reach that value. Heartbeat sensor can be used for measuring student's stress level during the exam. If a heart rate value is higher than hundred beats, student is nervous.

Smart corridors can be equipped with info boards. Students can connect their smart phones or tablet computers to info boards using wireless technologies, such as NFC or Bluetooth to get the latest information about studies, classes and exams.

Finally, all collected data are processed in datacenters. Datacenters are equipped with several different servers which collect and process data from sensors. Also, servers for learning management systems and database servers are located in datacenters. All collected data can be processed and results can be posted to social networks.

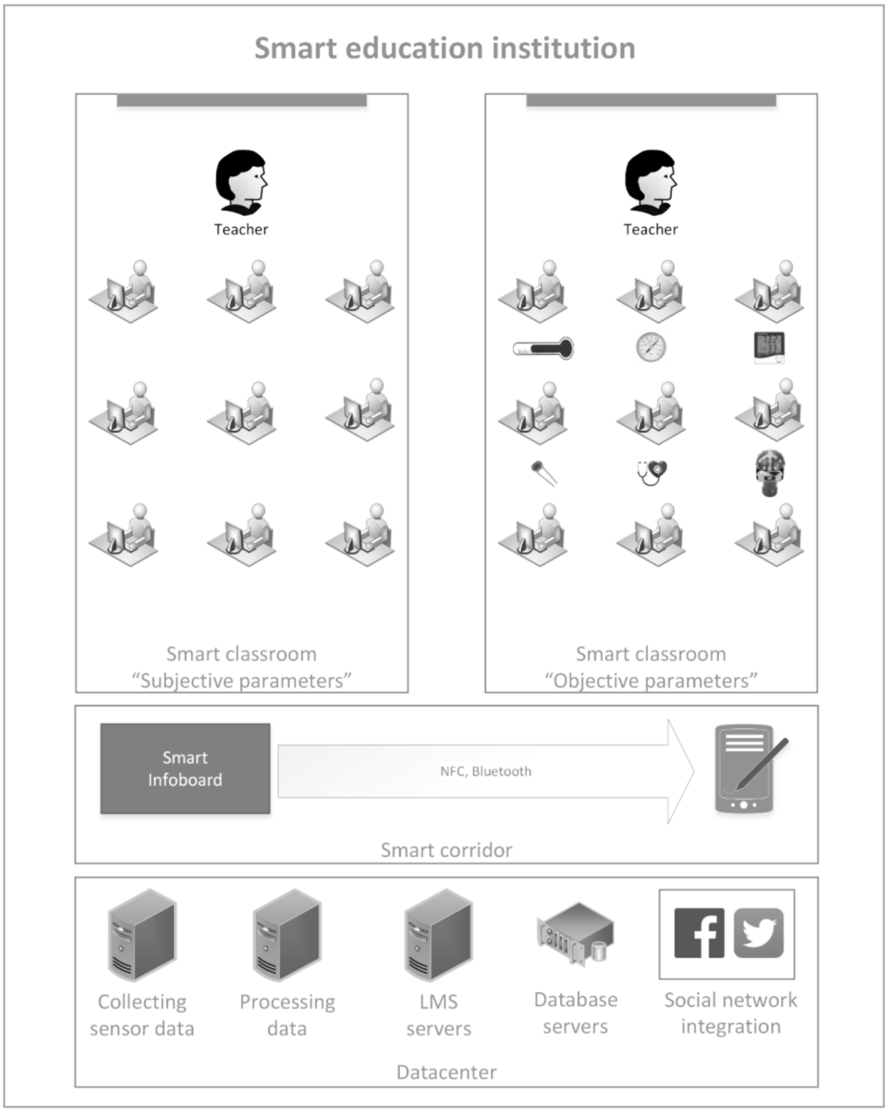

Figure 1. A model of smart education institution

6 Conclusion

Crowdsourcing is a relatively new concept which is not widely used in education. Using smart devices and crowdsourcing can improve learning and teaching processes. The model proposed in this paper uses previously mentioned concepts and technologies for creating a smart education environment. This model can be improved after thorough testing and evaluation.

The proposed model is important to students, as well as to teachers and to the broader community. It contains innovative approaches for improving education processes which is useful for e-learning systems as components of broader term – e-government.

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