



Smart Technologies for Smart Campus Information System

Nathan Nachandiya^{1*}, Yusufu Gambo¹, Neil's B. Joel² and Philemon Dawwar³

¹Adamawa State University, Mubi, Nigeria.

²Department of Computer Science, Adamawa State University, Nigeria.

³Federal Polytechnic, Idah, Nigeria.

Authors' contributions

This work was carried out in collaboration between all authors. Authors NN and YG designed the study. Author NBJ managed the literature searches. Author PD produced the Manuscripts. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AJRCOS/2018/v2i228738

Editor(s):

(1) Dr. Shah Nazir, Assistant Professor, Department of Computer Science, University of Sawabi, Pakistan.

Reviewers:

(1) Hermes José Loschi, State University of Campinas (UNICAMP), Brazil.

(2) Anthony (tony) Spiteri Staines, University of Malta, Malta.

Complete Peer review History: <http://prh.sdiarticle3.com/review-history/27852>

Original Research Article

Received 06 September 2018

Accepted 12 November 2018

Published 19 December 2018

ABSTRACT

The increasing development of intelligent technologies offer opportunities for objects in the real world to communicate using sensors and communication networks. One of the application areas is the smart campus for the smart information system. The construction of the smart campus based on smart technologies such as Bigdata, cloud computing, mobile computing, network infrastructure needs the understanding and the exploration of these technologies in the development process. This conceptual paper explored the roles of smart technologies in developing a smart campus. Analysis of the key concepts; the architectural layers for the smart campus were proposed hoping to promote smart campus information system for a sustainable intelligent campus. The concept could be a platform for developing smart city in a developing context.

Keywords: Bigdata; cloud computing; network; smart campus; campus; city.

*Corresponding author: E-mail: nachandiya@yahoo.com;

1. INTRODUCTION

The progress in smart technologies have influenced the educational sphere and offered opportunities for objects in our conventional campus to communicate with each other via communication technologies. Intelligent campus (i-campus) refers to a holistic intelligent environment, in which technologies such as cloud and mobile-powered learning, mobile apps, RFID (Radio-Frequency Identification)-based security management are established to support holistic e-learning, networking, administration, and governance. These objects like doors, windows, printers, projectors, books, poles, benches, and complex objects like buildings, campus, laboratories and parking are converted into smart objects by attaching sensors and are given a level of intelligence to communicate to each other [1,2]. Smart campus creates an environment for learners, teachers and learning devices to interact for learning. The rise of information and communication technologies in education has quietly changed the traditional role of teachers, with a shift of emphasis towards autonomous and innovative learning, and a fusion of diverse pedagogical methods and strategies [3,4].

The development of a local area network (LAN) on campus makes it much easier and efficient to get the needed service and desired requirements [5]. However, campus technologies are limited to providing direct communication between objects. The idea of objects making sense and communicate with each other refers to the internet of things. The Internet of Things (IoT) is a rapidly growing network of a variety of different connected things. The use of IoT in campus is like a new wave of change that has brought new opportunities and possibilities for the improvement of both teaching-learning process and educational institutions' infrastructure [6]. The number of connected devices is increasing enormously, and many predictions have been made with this concept [7].

The IoT technology has a great impact on campus. IoT has not only changed the traditional teaching practices but has also brought changes in the infrastructure of educational institutions [8]. It adds values to students, teachers and other academics to enhance communication to improve learning on smart campus. A smart campus may have many other features like, smart parking, smart inventory, smart lighting, and smart tracking of students, goods, and

equipment using RFID technology [9,10]. The smart education institute can have a smart campus, smart corridors with info boards and data centers for processing all types of data [4]. At present, the design and construction of the smart campus are still at the exploration stage. A number of studies have proposed different models for the smart campus. Many advanced and innovative concepts are being proposed or introduced in education. The introduction of IoT with Bigdata technology in e-education has proved to be effective for improving learning and teaching processes and communications in smart campus.

The paper is organised as follows: Section 2 presents the conceptual technologies; section 3 presents related works; section 4 presents the components of smart campus design and conclusion in section 5.

2. IDEA OF A SMART CAMPUS INFORMATION SYSTEM

A Smart campus is a subset of smart city embedded with sensors and intelligent terminals on the concepts of cloud, Internet of things technology and related technologies synthesis. The idea is for administrators, teachers, and students through a more sophisticated environment smartly communicate to enhance learning, share experiences and effectively communicate [11,12]. A typical smart campus is depicted as shown in Fig. 1, where each of the devices can communicate with each other remotely using smart apps.

The related technologies of smart campus are built on the following smart technologies:

2.1 Smart Apps

This is mobile as well as a web application that facilitates communication between devices in a smart campus. The smart apps act an interface between the user and the devices to facilities communication and sensing.

2.2 The Internet of Things

The Internet of Things are sensors, controllers, machines, people, and things organized in way to realise intelligent identification, location, tracking, monitoring, and management. It integrates intelligent sensing, identification technology, wired network and mobile Internet for smart communication.

Features of Smart Campus



Fig. 1. Smart School, 2014

2.3 Cloud Computing

Cloud computing as a new model of computing that has brought a paradigm shift in education. This new technology attracts the interests of academics and industrial experts. Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction.

Cloud computing was built on existing technologies as like grid computing, high-performance computing, parallel computing, distributed computing, powerful integrated computing, only the use of open, integrated, collaborative information architecture and dynamically configurable resources, high scalability, on-demand services that can provide communication in a smart campus setting [12,13].

2.4 Big Data

Big data is the driving force for mass data storage, analysis, and processing. A Smart campus is connected with different intelligent technologies and terminals, information systems and sensing devices generate a large volume of data. This new technology can collect such large data, store, analyse and process for intelligent applications and devices for smart

communications to support decision-making processes.

2.5 Smart Knowledge Management

Knowledge management is the prime technology of smart campus. It is the most important and the most common activity of knowledgeable person and campus. This is the planning and management, creation, processing, and application knowledge.

3. RELATED WORKS

Sagar R et al. [14], developed an android academic web portal for the smart campus environment to help in interaction. The proposed system helped the college to manage records and save natural resources. Job were done in less time compared to an existing system. Users get the information without delays because of real-time use of the proposed system. It helps to reach every student and faculties in the college in very less time. The data stored on database helps the management forecasting and decisions making.

In creating smart learning environment, one needs to understand the characteristics of such environments, combine formal and informal learning, and take learners' perceptions and learning behaviours into account. Explore more effective learning methods, tools, and design space for more appealing, personalised and autonomous learning [15]. The Smart learning

environment is not simply about the application of technology, but more significantly enables the fusion of pedagogy and technology to create an ecosystem in which educators and learners are able to interact more efficiently. There is a need for pedagogical innovations to support smart learning as well as emerging technologies that offer endless learning opportunities and communication in a smart campus environment [16].

The Smart education deals with better learning in a digital age. A conceptual framework of smart education was proposed, containing three essential elements: smart environments, as technological support; smart pedagogy, as methodological support; and smart learner, as the goal of smart education [17]. The authors studied the impact of smart campus, a major role in building re-education system, transforming universities to be part of the e-society vision. The positive aspects include developing new talents, shifting education towards democracy, enabling learners to apply theoretical knowledge into practice, and boosting blended learning. However, there are some considerations as well, such as a need for redefining educational models and the ability to make use of the smart design [18].

Antevski K et al. [19] Presented an approach to encourage group collaborations in smart libraries by creating study groups through a mobile application, locating the groups using hybrid Bluetooth Low Energy technology and Wi-Fi indoor positioning system, and recommending the groups to other students via a server-based infrastructure. A prototype of a campus-wide supersensory network was developed and deployed around the campus of the University of Glasgow to support different groups of end users including staff, faculty, and students. The supersensory has more powerful computing capability, and are believed to empower more flexible data collection, processing, and reaction [20]. This technology offers a smart campus environment for smart education.

Sruthi C et al. [21]: proposed Smart Campus Using Android based Smart Phone, the idea of constructing a "Smart field" implies that the establishment can adopt advanced ICT (Information Communication Technologies) to mechanically monitor and manage each facility on campus. The Smart campus includes portal

architecture, management, service, smart management, infrastructure, etc. The Smart campus system integrates hardware device of digital school, and cloud storage as the means of data storage to enhance communication in a campus. The results of the simulation show that the system can be accessed without the internet, possess a low power consumption, user-friendly, mobile controllable, and fault detection can be easily identified within a short span of time.

The above literature shows that smart campus is in the process of development, experimentation, and implementation. This new computing paradigm offers a more intelligent environment to enhance intelligence on campus. A number of architectures have been proposed each having a degree of design with different layers of implementations. The next section discusses the five layers conceptual architecture for a smart campus.

4. CONCEPTUAL DESIGN LAYERS FOR A SMART CAMPUS

A typical smart campus integrates the physical space and the digital space [12,11]. The big data interface between the smart devices (intelligent device layer & application layer) and the communication layers (cloud computing and network layer) to achieve personalised and collaborative interaction for the business of smart campus information system. Fig. 2 shows the proposed smart campus model. The layers of the proposed model are discussed as follows:

4.1 Smart Device Layer

Smart campus integrates smart devices and existing application systems to use the application layer to achieve a smart campus information system. A variety of terminal access technologies, including traditional mobile apps, web-based, PCs, smart terminals, self-service devices, and wearable devices, provide users with a seamless, adaptive environment, personalised human-computer interaction model for specific application scenarios based on different environments, enhanced user access to campus information, service experience for campus information technology applications to provide integrated, seamless access and support [13].

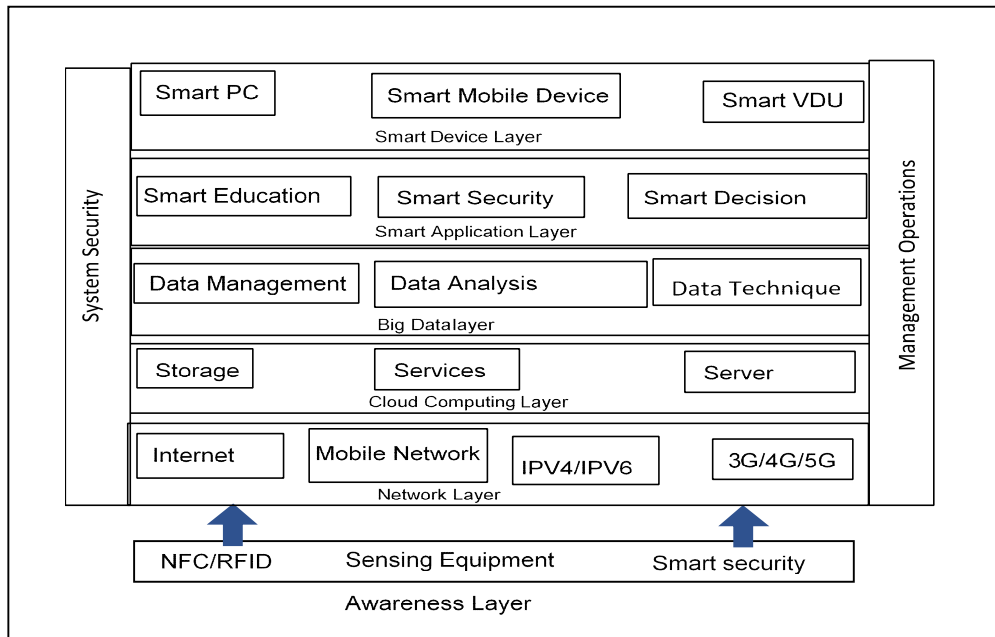


Fig. 2. Proposed smart campus model

4.2 Smart Application Layer

The smart applications provide students and teacher with an opportunity to learn and provide campus management with comprehensive and appropriate service functions, management decision, smart security, and smart campus facilities for the smooth smart campus functionalities [4].

4.3 Cloud Computing Layer

This provides a computing paradigm based on related technologies such as virtualisation, distributed computing, high-performance computing, centralised storage, distributed storage and other storage technologies to achieve efficient, transparent and reliable infrastructure. The campus's big data processing and intelligent applications provide universal, on-demand computing and storage support (Wang, 2017).

4.4 Big Data Layer

The Big data layer is a prime mover toward smart campus. The information gathered in the campus environment, activities, business, interaction, and other information needs to follow the information standards and standardisation, establish the data sharing and exchange mechanism, the database infrastructure theme, the unified data platform

application construction, connect in cyberspace and campus Intelligent virtual images [13]. This technology provides the capturing, storage, analysis and processing of data for the decision-making process in a smart campus environment.

4.5 Network Communication Layer

This comprise of campus wired network, WIFI wireless network, 4G mobile network and other communication technology. The intelligent perception layer is saddled with responsibility of collecting various types of environmental and activity data for teachers and students anytime, anywhere, the Internet provides high coverage transmission services for high-speed access services [13]. This layer provides communication in a smart campus environment.

4.6 System Security and Operations

These segment provides safety operations and security for a smart campus environment. The support system is the basis for the continuous provision of high-quality services. The components include the information security system that ensures campus information security and reliability, and also the operation and maintenance service system that ensures the stable operation of the park infrastructure and application system. The safe, stable and efficient operation is to provide practical protection [13].

4.7 Awareness Layer

This connects everything through RFID, sensor, QR code and real-time positioning technology can realise the intelligent identification, location, and management for the smooth smart campus operations.

5. CONCLUSION AND FURTHER WORK

The construction of a smart campus requires the understanding of conceptual design, structural analysis from the perspectives of smart technologies. This becomes possible if the elements of Bigdata technology for the storage, analysis are integrated into decision-making within the confine of an intelligent environment. The construction of a smart campus also requires smart devices, network, smart applications, and the cloud computing technology to produce information services and management for effective campus - information - system. The integration of these related technologies to design a smart campus to achieve a sustaining campus Information system becomes necessary as many things including human tend to communicate with smart technologies to create a smart and intelligent environment for effective communication and decision-making process in a learning environment.

This conceptual paper proposed a five-layer architecture for manageability and security. In the future, a mobile apps smart campus will be developed based on these layers to understand the applicability and practicability of smart campus.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Kwok L. A vision for the development of i-campus. *Smart Learning Environments*. 2015;2(2).
2. Available:www.slideshare.net/SmartSchooling/smart-campus-features-and-benefits-of-smart-technology-in-school-campus, 2014. [Retrieved 20th September 2017]
3. Klimova B. Teacher's role in a smart learning environment-A review study. In V. L. Uskov, R. J. Howlett, & L. C. Jain (Eds.), *Smart education and e-Learning*, Springer International Publishing. 2016;51-59.
4. Gambo Y. The applications of smart technologies in a Smart classroom: towards a smart campus Information system. *Journal of Basic and Applied Research International*. 2017;23(4):172-178.
5. Bernabas A, Sengupta J. Internet of Things (IoT) Driven Design and Implementation of Smart Campus, *International Journal of Computer Science Trends and Technology (IJCTST)*. 2017; 5(4):2-6.
6. Gul S, Asi M, Ahmad S, Yasir M, Majid M, Malik S. A survey on role of the internet of things in education. *International Journal of Computer Science and Network Security*. 2017;17(5).
7. Elyamany F, Alkhairi A. "IoT-academia architecture: A profound approach," 2015 IEEE/ACIS 16th International Conference of Software Eng. Artificial Intelligent Network Parallel / Distributed Computer. *SNPD 2015 - Proc.*; 2015.
8. Mohanapriya M. IOT enabled Futures Smart Campus with effective E-Learning: i-Campus. 2016;3(4):81-87.
9. Cata M. Smart university, a new concept in the Internet of Things, in 2015 14th RoEduNet International Conference - Networking in Education and Research (RoEduNet NER). 2015;195-197.
10. Kaushal R. Incorporation of smart campus practices in Indian Teacher Education Programme: Avant-Gardism Harnessing The Potential Of ICT In Learning and Pedagogy. *International peer review and Referred Scholarly Research Journal for Interdisciplinary Studies*. 2015;40-46.
11. Jianqing F, Fang H, Liu H. Challenges of bigdata analysis. *Journal of National Science Review*. 2014;(02).
12. Kumar S. E-learning and role of smart classrooms in education in the new era of technology; 2017. (Retrieved September 20, 2017) Available:http://www.academia.edu/5429654
13. Wang, Feng-Ling. The applications of Bigdata in the Construction of Smart campus Information. *Proceedings at the Asia-pacific Engineering and Technology Conference (APETC)*; 2017.

14. Sagar R, Shashank C, Sachin P, Akshay V, Sanket K. SMART CAMPUS–An Academic Web Portal with Android Application, International Research Journal of Engineering and Technology (JET). 2016;3(4):2-6.
15. Gros B. The design of smart educational environments. Smart Learning Environments. 2016;3(15).
16. Kinshuk J, Chen N, Cheng I, Chew SW. Evolution is not enough: Revolutionizing current learning environments to smart learning environments. International Journal of Artificial Intelligence in Education. 2016;26(2):561–581.
17. Zhu Z, Yu M, Riezebos P. A research framework of smart education. Smart Learning Environments. 2016;3(4).
18. Aguilar J. The smart campus at the universities as one of the pillars of the e-society. In Proceedings of 2016 third international conference on e-Democracy & e-Government (ICEDEG). Information Systems Research Group, University of Fribourg; 2016.
19. Antevski K, Redondi AEC, Pitic R. A hybrid BLE and Wi-Fi localization system for the creation of study groups in smart libraries. In Proceedings of 2016 9th IFIP Wireless and Mobile Networking Conference, IEEE. 2016;41-48.
20. Hentschel K, Jacob D, Singer J, Chalmers M. Supersensory: Raspberry Pi devices for smart campus infrastructure. IEEE; 2016.
21. Sruthi C, Siva K, Sivaraman S, Meenakshi S. Smart campus using android based smart phone. International Journal of Trend in Research and Development. 2017;3(2):1-3.

© 2018 Nachandiya et al.; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:

*The peer review history for this paper can be accessed here:
<http://prh.sdiarticle3.com/review-history/27852>*