Incorporating a Web-based System to Implement Services and Recommendation System for International Students in Northeastern University (NEU)

Kometa Denis Mbowoh

Department of Computer Science, HTTTC Kumba, University of Buea, Kumba, Cameroon

ABSTRACT

China has become a major study destination for many international students who come to study in many higher institutions at different levels. NEU is one of these higher institutions and as a result seeks to make life comfortable for the international students who come to study there. It is in this vein that this system has been designed with the objective of enabling any new foreign student arriving NEU to acquaint themselves with the new environment and integrate it in less than no time thereby overcoming the fear of the new environment which grips every new comer. Key technologies, tools such as Spring MVC/Security, JSF Prime Faces, etc. were carefully chosen for the development of the project. The system development followed the system development life cycle, specifically using the agile methodology. Testing proved that the proposed system is a very responsive and could run well on most browsers.

KEYWORDS

Service and Recommendation, International Students and Staff, Friend Recommendation; Spring MVC.

1. INTRODUCTION

1.1. Background

Given the present trend of things, it cannot be disputed that the People's Republic of China has become one of the most solicited study destinations in recent times by international students. Many international students come to China to study in different higher institutions at different levels all over China [1]. China's current economic and technological boom is the major reason for this quest. The Northeastern University is one of those higher institutions in China that has witnessed a yearly increase of foreign students coming to study there. The university like many other universities in China that play host to international students, has been using different methods to ensure that these students get used to their new environment soonest as soon as they arrive. The NEU administration is yet to fully address all the needs of the international students coming to study there using efficient methods.

China is still trying to fully internationalise its educational curricula and therefore some of the aspects that should carter for the needs of the increasing number of international students are being progressively put in place. NEU have over the few past few years witnessed a tremendous increase in the number of international students who come to study there. Statistics gotten from the NEU School of International Exchange indicate that the number of foreign students who come to study in NEU over the past few years have been on the increase [2]. The staff of this

office have acknowledged the difficulties they encounter trying to attend to all the foreign students especially upon arrival. Their worry is shared with the NEU general administration as well as other research departments who all wish to see that the worries expressed by the international students should be well taken care of.

There are diverse systems that have been developed as there are specific needs, these systems are tailored to meet specific needs which could be in research, administration, teaching, social networking, campus navigation, recommendation, among others. Though most universities in China are still using a paper-based systems, it would be of great importance to start making the change to proper web-based management systems to be able to meet the needs of the heightening number of international students who come to study China. The situation in NEU is not very different. In spite of the efforts put in by the NEU School of International Exchange every start of the academic year to welcome new students, the challenges remain enormous. Students coming to study in NEU over the years have been faced with a number of challenges. Traditional methods have been employed to handle a number of these problems but have proven not to be effective. Most students who arrive university campuses in China for studies most often have to depend on the older students on campus to put them through almost everything and generally this is not always easy especially for students who prior to coming do not know anyone on campus. These challenges contributed to serve as a source of inspiration and motivation for this research.

This research work is therefore in line with the solutions that are being sought for to address some of the issues that the international students face when they come to study in NEU. The implemented system is a web-based Service and Recommendation System for International Students and Staff on NEU Campus which has features such as: Login, The Registration and Management of Student/Staff information, Friend Recommendation, Campus News, Campus Notices, Campus Map, Students Learning World- Forum, and User Profile. This system is therefore viewed as a panacea for international students to cure the fear of acquainting themselves with the NEU Campus environment and integrating it soonest when they arrive the NEU campus; as well as bringing administration closer to the students.

1.2. Related Works

There are several service and recommendation systems that have been developed to assist users take care of one need or the other. Recommender and service systems defines most suitable services or items to specific users by predicting their interests based on related information. Such systems like ours make things less challenging and simpler for the user as most relevant information and services from a huge amount of data are provided as personalised services. Most common recommender systems make use of recommendation techniques such as content-based (CB), collaborative filtering (CF), and knowledge-based (KB) techniques, with each technique having their merits and demerits. This has led to the of the advent of many other advanced recommendation approaches such as context awareness-based recommender systems, computational intelligence-based recommendation systems, fuzzy recommender systems, social network-based recommender systems, and group recommender systems [3].

Recently, it has been observed that application study has become the main research focus of current recommender system research especially in this age characterised by big data such as: learning materials recommendations, films, music, tourism scenic spots, television programs, books, documents, websites, conferences, amongst others [4]. Clusters of eight main domains namely: e-commerce, e-learning, e-library, e-government, e-tourism, e-resource services and e-group activities are some of the application areas which these recommender systems involved in [3]. Our system is a hybrid system (e-education) which combines aspects linked to e-learning, e-tourism and e-group activities; e-library could also be part of it.

The main aim of e-learning recommender systems is to assist learners to choose the courses and learning materials that interest them as well as their learning activities. This type of systems has seen dozens of its applications developed with the knowledge-based technique being the dominant technique used due to the weaknesses of the other techniques. These systems are mainly focused on pedagogical aspects to assist learners achieve their learning objectives [3]. Our system being an e-education system definitely borrows some aspects of it as students arriving the NEU campus will have to meet their learning objectives as they get settle, though it would not help them immediately they just arrive the campus. Generally, e-tourism recommender systems are developed to provide suggestions for tourists with some of them focusing on attractions and destinations, while others offer tour plans that include transportation, restaurants and accommodation. The degree of complexity and requirements of their recommended items usually warrant the application of different recommendation techniques that are well suited [3]. Students arriving the NEU campus will want to get acquainted to the community soonest, thus, systems like these could be of great assistance. However, taking a tour of the campus is not enough to make a student integrate the NEU community faster. Students arriving the NEU campus will want to join some specific club(s), church group or association; and while in the group, some recommendations could be made. The last of the recommender systems our system borrows from are the e-group activity recommender systems. Amongst these, some do not give the opportunity to the users to explicitly specify their preferences or some scenarios in which users need to negotiate online to engage in an activity together. In such cases, the users will require online decision support systems for a whole group [3]. Traditional recommender systems only make suggestions for individual users; thus, group recommender systems (GRS) are proposed to combine and balance the individual expectations of group members to produce satisfying recommendations to the group.

2. METHODS AND MATERIALS

2.1. Tools

To systematically implement this system, it was incumbent on the researchers to take a look at the key technologies, tools (software as well as hardware) which helped in the different tasks of the project. The design of the application followed a 3-tier architecture: Data Access Layer, (Business Layer, Control Layer) Middle Tier Layer and Presentation Layer, the web app was developed with tools suited for the development of each layer. Generally, the related background technologies included: HTTP, Java 8, JDK 1.8+, Maven, Java2EE (Spring MVC, Spring Security, JSF PrimeFaces), Eclipse Luna, Tomcat 8.0+, MySQL, JPA Hibernate, HTML, and CSS.

Front-End Technologies

The following tools were also used to build the front-end of the project:

JSF PrimeFaces

PrimeFaces is a popular open-source framework for JavaServer Faces featuring over 100 components, touch optimised mobilekit, client-side validation, theme engine and more. There are two types of support available to us: the first is PrimeFaces ELITE, which provides access to maintenance releases and gives rights in the PrimeFaces issue voting system; the second is PrimeFaces PRO, which offers full support [5][6].

HTML

HTML (Hypertext Markup Language) is the fundamental technology used for creating web pages. It describes the structure of web pages using markup, its elements are the building blocks of HTML pages represented by tags and tags label pieces of content such as "heading", "paragraph", "table", and so on. Browsers do not display the HTML tags, but use them to render the content of the page [7].

CSS

Cascading Style Sheets (CSS) is a style-sheet language used to describe the presentation of a document written in HTML or XML (including XML dialects such as SVG or XHTML). CSS describes how elements should be rendered on screen, on paper, in speech, or on other media [7].

JavaScript

JavaScript is a lightweight, interpreted, or just-in-time compiled programming language with first-class functions that adds interactivity to your website (for example: games, responses when buttons are pressed or data entered in forms, dynamic styling, and animation) [7].

JQuery

jQuery is a fast, small, and feature-rich JavaScript library. It makes things like HTML document traversal and manipulation, event handling, animation, and Ajax much simpler with an easy-to-use API that works across a multitude of browsers. With a combination of versatility and extensibility, jQuery has changed the way that millions of people write JavaScript. It is free, open-source software. jQuery's syntax is designed to make it easier to navigate a document, select DOM elements, create animations, handle events, and develop Ajax applications. jQuery also provides capabilities for developers to create plug-ins on top of the JavaScript library [7].

Bootstrap

Bootstrap is the most popular HTML, CSS, and JavaScript framework for developing responsive, mobile first projects on the web. Bootstrap makes front-end web development faster and easier. It is made for folks of all skill levels, devices of all shapes, and projects of all sizes. Bootstrap is open source as it is on GitHub that it is hosted, developed, and maintained [7].

Back-End Technologies

Java

Java is a programming language and computing platform first released by Sun Microsystems in 1995. Java is fast, secure, and reliable. From laptops to datacentres, game consoles to scientific supercomputers, cell phones to the Internet, Java is everywhere! making it one of the best application development languages [8]. Java is: object-oriented; platform independent; simple; secure; architecture-neutral; portable; robust; multithreaded; interpreted; high performance, dynamic, and distributed [9]. It can be classified under three categories: Java SE (Standard Edition) for developing desktop applications, forms the core/base API; Java ME (Micro Edition) for applications which run on resource constrained devices (small scale devices) like cell phones; and Java EE (Java Enterprise Edition) for applications which run on servers, for example web sites or web applications and it has the client-tier, the web-tier, the business-tier and the data-tier. The different layers in a java application gives birth to what is known as separation of concerns.

The direct interaction with the components of Java EE often ends up giving so much redundancy in code written and boilerplate code. The way out for this huddle now becomes a supplication to frameworks and one of such frameworks used in this project is the Spring framework [10].

Spring MVC

The Spring Framework is a Java platform that provides comprehensive infrastructure support for developing Java applications. Spring handles the infrastructure so you can focus on your application. Spring enables you to build applications from "plain old Java objects" (POJOs) and to apply enterprise services non-invasively to POJOs. This capability applies to the Java SE programming model and to full and partial Java EE [11].

Spring Security

Spring Security provides comprehensive security services for J2EE-based enterprise software applications. There is a particular emphasis on supporting projects built using the Spring Framework, which is the leading J2EE solution for enterprise software development [11].

Maven

Maven is a project management tool which encompasses a project object model, a set of standards, a project lifecycle, a dependency management system, and logic for executing plugin goals at defined phases in a lifecycle. When you use Maven, you describe your project using a well-defined project object model, Maven can then apply cross-cutting logic from a set of shared/custom plugins. This is a tool used to build deployable artifacts from source code [12].

Apache Tomcat Server

Tomcat is an open-source server from the Apache Software Foundation. It is a Web Application server that comes ready to support programming using Java Server Pages (JSPs) and servlets [13].

MySQL

MySQL is the most popular open-source relational database management system developed, distributed, and supported by Oracle Corporation. The MySQL Database Server is very fast, reliable, scalable, and easy to use because it has high performance compared to other relational database systems. MySQL is cross platform which means it runs on a number of different platforms such as Windows, Linux, and Mac OS etc. MySQL Server can run comfortably on a desktop or laptop, alongside your other applications, web servers, and so on, requiring little or no attention. MySQL Server was originally developed to handle large databases much faster than existing solutions and has been successfully used in highly demanding production environments for several years [14].

Java Database Connectivity

Java Database Connectivity (JDBC) is the JavaSoft specification standard application programming interface (API) for the programming language Java, that allows Java programs or a client to access database management systems. These Java APIs enables Java programs to execute SQL statements and interact with any SQL compliant database. The JDBC API consists of a set of interfaces and classes written in the Java programming language. It is part of the Java Standard Edition platform, from Oracle Corporation [15].

Structured Query Language (SQL)

The Structured Query Language is a standardised programming language that is used to communicate with the database. SQL is regularly used by database administrators, as well as by developers writing data integration scripts [16].

JPA (Java Persistence API) Hibernate

Hibernate is an implementation of JPA and uses common standards of JPA. It is the standard that allows developers to perform database operations smoothly. It is a standard approach for Object-Relational Mapping (ORM). It is an open-source persistent framework. A persistent framework is an ORM service that stores and retrieves objects into a relational database. ORM is a programming technique for converting data between relational databases and object-oriented programming languages such as Java, C#, etc [15].

2.2. Methods

Analysis and Design

This system was developed following the system development life cycle (SDLC), specifically using the agile methodology. This system provides the users with an interface that will enable them to login, register to the system and navigate to see places on NEU Campus, Read the updates or NEU Events/News, Read Notices, enter the NEU Students Learning World, get Friend Recommendations (being a major feature of the system), View User's profile and of course mange the entire system as shown in Figure 1.
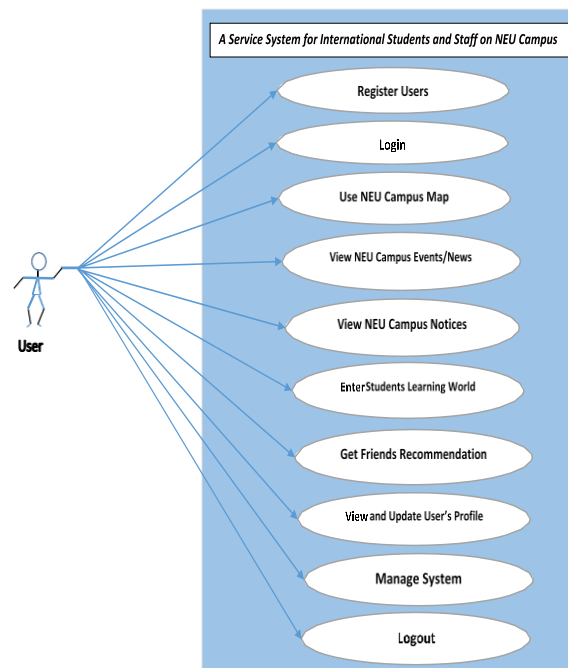

Figure1. High Level Use case of Our Proposed System

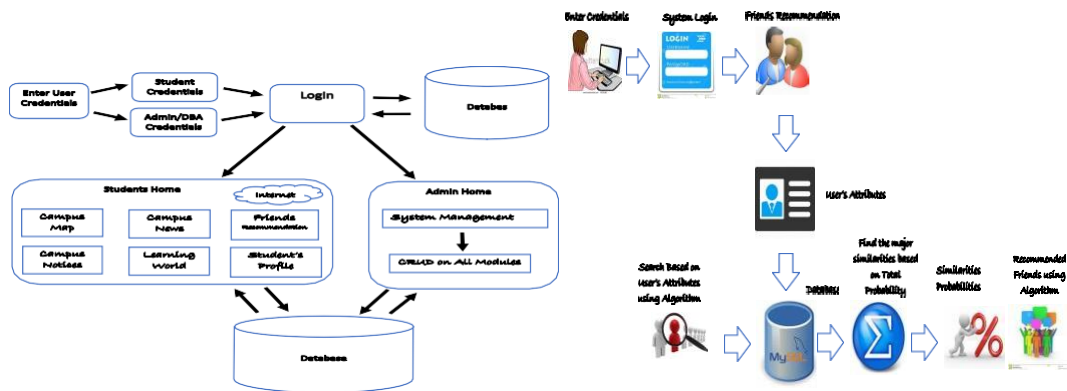The system architecture in shown in Figure 2.

Figure 2. (a) System Architecture Design (b) Friends Recommendation Module Architecture Design.

Figure 3 presents "Friends Recommendation" option based on the user's chosen attributes, he or she will be recommended with the friends who have similar interest as his or hers and hence he or she has the choice to make friends them or not.
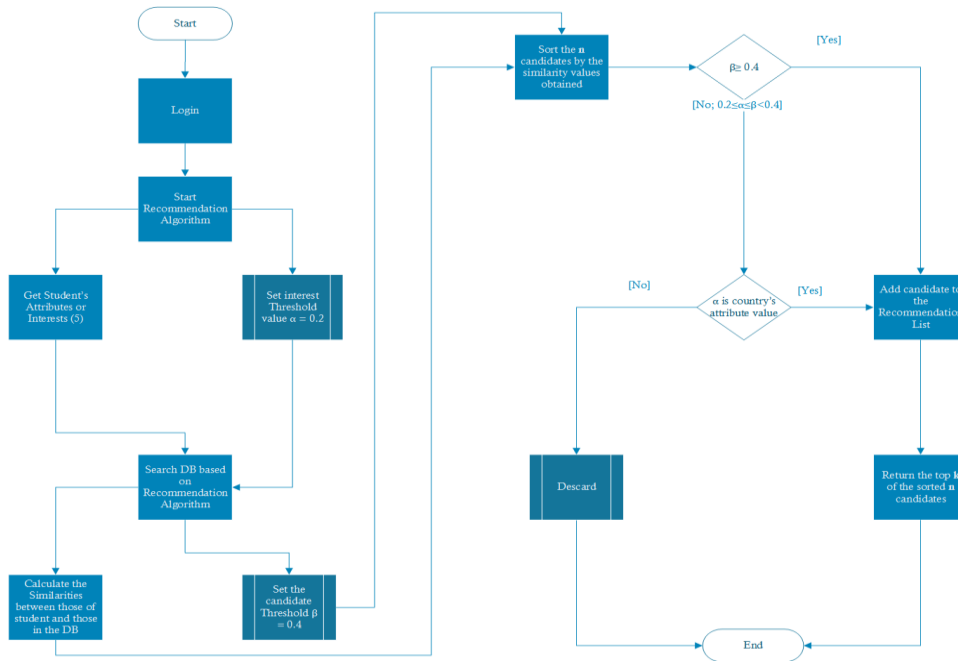

Figure 3. Recommendation Algorithm Flow Chart.

Table 1 presents the algorithm that makes this possible.

Table 1. Pseudo-code of Friends Recommendation Algorithm for our Proposed System

Nº	Step Description
1	**Input**: The users database with user's details.
2	Determine and select the *m* attributes of the user you want to categorize as user interest.
3	Calculate the probability of interest of each user.
4	Set a threshold of user's interest say α (alpha) = 0.2.
5	With user's interest known, the similarity between the users in our database system can be found using hybrid technique (that combines collaborative filtering and content-based filtering equations).
6	Multiply the array results obtained from these equations to get a final array with the similarity values in it. In the resultant array, the number of rows and columns are considered the number of users that are stored in the database. Every user in a row is compared against every other user across the column.
7	Again, set a threshold value say β (beta) = 0.4. When comparing if any value or the count value is greater than this β value, that particular user is being recommended to the user in the row.
8	Sort the *n* candidates by the value of the similarity value obtained, if any value is less than the threshold value set (β (beta) = 0.4), that candidate is dropped; the exception if for a candidate has a threshold of β (beta) < 0.4 but α (alpha) = 0.2 and this α (alpha) happens to be that of "country", that candidate is added to the list.
9	**Return**: The Top *k* of the sorted *n* candidates as a list of recommended friends arranged in a descending order of the calculated values obtained.

3. RESULTS AND DISCUSSION

3.1. System Implementation

The system implementation made use of the tools described earlier and followed the analysis of the requirements and the design of the various modules. Figure 4 presents some of the user interfaces.
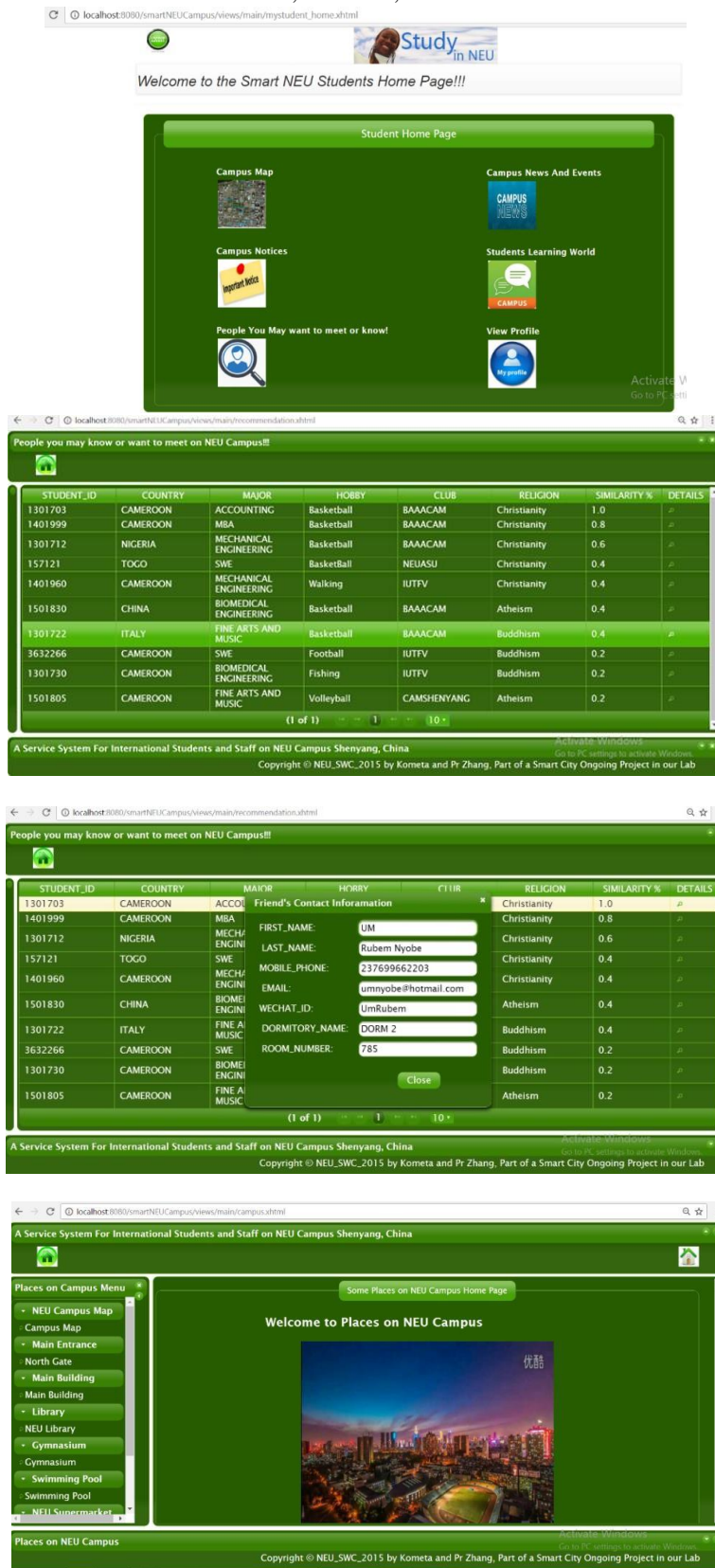
Figure 4. User Interfaces.

3.2. System Testing, Verification, and Evaluation

The system was verified and tested. All testing steps were followed from unit testing to system testing. The system modules are able to communicate among themselves reliably and run on most browsers. Testing proved that the proposed system is a very responsive and could run well on most browsers.

3.3. Limitations

The system was developed, tested, validated and seemed to be perfect. Despite of the near perfection observed after testing, its specifications are most likely to have some limitations. Even though our system will change the narrative for foreign students arriving the NEU campus for studies, there will always be room for improvement. It did not cover everything about students' arrival, such as school/police registration, visa processing etc.

4. CONCLUSIONS AND FUTURE WORK

The system has been tested, validated and proven to work. It can be concluded that the system as a whole achieved the main objective. One of our main interests in this work was to implement a friends recommendation algorithm based on the total probability of the similarity that exist among the students to enable them get recommended friends from the system. Given a set of attributes predetermined, the system extracts these attributes from the student who wants the system to recommend him/her friends. Our proposed system could be described as coming to reduce the problem of unnecessary paper work as well as queues in front of notice boards and offices and old-fashioned methods, it will save time, reduce dependency, unite and network students, enhance learning, serve as a base for other research areas, and above all add something new to the field of research in NEU.

The working system implemented is web-based which is responsive. However, with ubiquitous computing, for future developments it can be enhanced by developing the mobile app to make it handier. Given that the needs of students as well as those of the staff keep changing, therefore, solutions should be sought to make life comfortable for all the stakeholders on the NEU university campus most especially for foreign students arriving NEU for their first time to study.

REFERENCES

[1]   Project Atlas Team, "International Students in China", [Online], October 5, 2021. Available: http://www.iie.org/Services/Project-Atlas/China/International-Students-In-China#.WFZ2btxS0gs
[2]   全国夹留学生简明统计, (2016) "National Statistics of international students", Northeastern University China.
[3]   W. Nafutali, S. Twaibu, M. Davis, L. Badru and G. Gilibrays (2021) "Web-Based Irrigation Monitoring and Control System", International Journal of Computer Science, Engineering and Information Technology (IJCSEIT), Vol.11, No.1/2/3/4/5/6, December 2021.
[4]   J. Hurwitz, A. Nugent, F. Halper, and M. Kaufman, (2013) Big Data for Dummies, John Wiley & Sons, Inc., Hoboken, New Jersey.
[5]   PrimeFaces Org, "New Maintenance Policy", [Online] October 10, 2021. Available:http://blog.primefaces.org/?p=2443.
[6]   PrimeFaces Org. "Developing Rich Web Applications with PrimeFaces in Java EE", [Online] October 11, 2021. Available: http://www.primefaces.org/documentation/https://drive.google.com/file/d/0B7kPrfCRft_qZzZyeUh mWlVXZU0/preview?pli=1.
[7]   J. Duckett (2014) Web Design with HTML, CSS, JavaScript and jQuery Set, Wiley.

[8]   B. Burd (2014) Beginning Programming with Java for Dummies, New Jersey: John Wiley & Sons, Inc., 2014, 333-417.

[9]   Y. Daniel Liang (2013) Introduction to Java Programing, 9th Edition, Pearson Education, Inc., publishing as Prentice Hall., 2013, 236.

[10]   V. Layka (2014) Learn Java for Web Development, Apress Media, LLC &Springer Science Business Media Finance Inc., 2014, 5-11.

[11]   R. Johnson, J. Hoeller, K. Donald et al. Spring Framework Reference Documentation, 4.3.3. RELEASE [M], 2016, 474-530.

[12]   E. Redmond et al. (2011) Maven: The Complete Reference, Sonatype, Inc., 2011, 1-158.

[13]   Tomcat Apache Org. "Apache Tomcat 8.0+", [Online] October 20, 2016. Available: http://tomcat.apache.org/.

[14]   Oracle Org. (2021) "MySQL 8.1 Reference Manual Including MySQL Cluster NDB 7.5", Oracle and/or its affiliates, 2021, 4-384.

[15]   Wiki "Database Connectivity" [Online]October 20, 2021: Available: https://en.wikipedia.org/wiki/Java_Database_Connectivity.

[16]   B. Forta (2013) SQL in 10 Minutes a Day, Sams Teach Yourself 5th Edition, Pearson Education, Inc.

AUTHORS

Mr Kometa Denis Mbowoh is an Assistant Lecturer (Part-time) at the Department of Computer Science, Higher Technical Teachers' Training College (HTTTC) and the Department of Computer Engineering, College of Technology (CoT), all of the University of Buea, Cameroon. He holds a Master's in Software Engineering from Northeastern University (NEU), China, and a Bachelor's in Electrical Engineering from the University Institute of Technology (IUT-FV) Bandjoun of the University of Dschang, Cameroon. He is currently in search of a fully funded PhD position. He is interested in interdisciplinary research and his research interests include AI, Machine Learning, Data Science, Software Engineering, Cloud Computing, and other related areas.