

DESIGN AND IMPLEMENTATION OF INFORMATION RETRIEVAL SYSTEM FOR LABORATORY EQUIPMENTS

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ABSTRACT

Getting information relating to user's search criteria on equipment within a University laboratory has posed many challenges since there is no specific system to serve this purpose. It is difficult to handle the whole system manually. The aim of this paper is therefore to design and implement a web-based information retrieval system for University Laboratory equipment. This system offers a powerful internet-based search engine for locating and identifying equipment within a University laboratory while eliminating all unrelated content that a general-purpose search engine would retrieve. The method used involved collecting information needed from the technologist on various equipment in the laboratory and inserted into the retrieval system using SQL server to make query on the database to manage the data and a PHP programming language was used as the server-side scripting language for establishing an efficient querying of information from the database. Java scripting was also used as client-side scripting language for the purpose of adding more interactions to the proposed system. The developed system having been evaluated and assessed thoroughly was found to be efficient, easy to use for locating laboratory equipment in a University.

Keywords: Information retrieval, Laboratory Equipment, Web-based, Civil Engineering Equipment.

1.0 INTRODUCTION

It is crucial that modern day laboratories have a single unified repository system, which aims at centralizing all the information about equipment that are in the laboratory, their current status and every other data needed to effectively run a laboratory. This repository, in this case would be implemented with a web-based integrated information retrieval system for laboratory equipment. Information retrieval (IR) is the activity of obtaining information resources relevant to an information need from a collection of information resources (Information Retrieval, 2015). Information retrieval system have been developed to solve problems in some domains however, getting information relating to user's search criteria on laboratory equipment within a University has posed many challenges since there is no specific system to serve this purpose. (Information Retrieval, 2015).

This paper therefore developed a web-based integrated Information retrieval system for University laboratory equipment, in this case targeted at the equipment in the laboratory of the Department of Civil Engineering, University of Ilorin. The system offers a powerful internet-based search engine for locating and identifying equipment within the laboratory. It provides fast, reliable and up-to-date retrieval of information on specific laboratory equipment, while eliminating all unrelated content that a general-purpose search engine would retrieve. The tool will display technical and

administrative information on the equipment in the laboratory, accepts end-user requests and then generates a list of results based on the user's need as well as provide access to information irrespective of location.

2.0 RELATED WORK

Nowadays, the resources available on the web increases significantly. It then has a large volume of information, but without mastery of content. In this immense data warehouse research of current information retrieval systems do not allow users to obtain results to their requests that meet exactly their needs. This is due in large part to indexing techniques (key words, thesaurus). The result is that the user of the web wasting much of his time to examine a large number of Web page by searching for what he needs, because the Web does not provide service in this direction. The Semantic Web is the solution; this new vision of the web is to make web resources not only understandable by humans but also by machines.

To improve the relevance of information retrieval, Lachtar, (2014) proposed an approach based on the use of domain ontology for indexing a collection of documents and the use of semantic links between documents in the collection to allow the inference of all relevant documents. The work involves the implementation of a system based on the use of OWL ontology for research pedagogical documents. The descriptors are not directly chosen in the documents but in the ontology and are indexed by concepts that reflect their meaning rather than words are often ambiguous. To perform a search based on meaning, documents and their descriptors are stored in OWL ontologies describing the documentary features of a document. The objective is to design two types of OWL ontologies: document ontology reserved for storage of all pedagogical documents and domain ontology reserved for well-structured of documents stored in the level of the document ontology and each document is indexed by its keywords and their synonyms.

Fang et al (2007) proposed and implemented query expansion method which combines domain ontology with the frequent of terms. Ontology is used to describe domain knowledge; logic reasoner and the frequency of terms are used to choose fitting expansion words. By this way, higher recall and precise can be gotten as user' query results. Experimental results show that compared with the results of common query expansion, the method described in this paper can get statistically significant improvement in recall and precise combination.

Nicola, (1998) argue in the paper that so-called ontologies present their own methodological and architectural peculiarities: on the methodological side, their main peculiarity is the adoption of a highly interdisciplinary approach, while on the architectural side the most interesting aspect is the centrality of the role they can play in an information system, leading to the perspective of ontology-driven information systems.

In order to improve the search speed and accuracy of recruitment information in online recruitment of "low carbon recruitment", Cao et al, (2012) designed the online recruitment information retrieval system. The recruitment information retrieval system developed by J2EE platform and RIA technology. And it used for the retrieval of recruitment information and the personal circumstances of applicants for companies. Firstly, this paper described the purpose of developing this system and some related retrieval technology. Secondly, it introduced the overall design and detailed design. Finally, it provided applicants with a friendly user interface so that applicants can quickly apply for jobs and thus achieved the purpose of energy conservation and emission reduction.

Working of knowledge intensive organizations like consultancy services, consultancy and supply services, data processing services etc. are dependent on the information which has been gathered from various resources of information which may be inside the organization and/or external resources like the internet. This is very important to the organization to make the best use of gathered information from these sources. Knowledge intense organizations can do the knowledge management, which deals in the field of various phases of knowledge life cycle: identification, acquisition, development, sharing, use and preservation of organization knowledge Deepika et al (2014). Thus a system is designed for gathering the information for such tasks and the system developed is web based Webocrat system. Webocrat can interact at the knowledge level with the help of language. This language has been provided to the system by ontology with syntax and semantic rules. Use of ontology enables to define concepts and relations representing knowledge about a particular document in domain specific terms Deepika et al (2014).

An increasing number of recent information retrieval systems make use of ontologies to help the users clarify their information needs and come up with semantic representations of documents. Many ontology-based information retrieval systems and models have been proposed in the last decade. An interesting review on IR techniques based on ontologies is presented in Dridi (2008), while in Tomassen, (2006) the author studies the application of ontologies to a large-scale IR system for web purposes. A model for the exploitation of ontologybased knowledge bases is presented in Castells et al, (2007). The aim of this model is to improve search over large document repositories. The model includes an ontology-based scheme for the annotation of documents, and a retrieval model based on an adaptation of the classic vector-space model Salton et al (1975). Another information retrieval system based on ontologies is presented in Hattori et al (2006). The authors propose an information retrieval system which has landmark information database that has hierarchical structures and semantic meanings of the features and characteristics of the landmarks. The implementation of ontology models has been also investigated by using fuzzy models Calegari & Sanchez (2007). In IR, the user's input queries usually are not detailed enough, so the satisfactory query results cannot be brought back. Query expansion of IR can help to solve this problem. However, the common query expansion in IR cannot get steady retrieval results. Ontologies play a key role in query expansion research. A common use of ontologies in query expansion is to enrich the resources with some well-defined meaning to enhance the search capabilities of existing web searching systems. In Fang et al (2007) the authors propose and implement query expansion method which combines domain ontology with the frequency of terms. Ontology is used to describe domain knowledge; logic reasoner and the frequency of terms are used to choose fitting expansion words. This way, higher recall and precision can be gotten as user's query results. In D'iaz-Galiano et al, (2007) the authors present an approach to expand queries that consists in searching terms from the topic query in an ontology in order to add similar terms.

3.0 MATERIALS AND METHODS

To aid the efficient implementation process of the system, information needed was collected manually from the Technologist in Civil Engineering Department Laboratory and was inserted into the system for retrieval. The technologies that will be used for this work include:

(i) SQL Server

This is a strong database system that will manage all the data in the database. It will be used to form a relational database system consisting of tables that store data for further reuse or re-query. Also, the use of SQL Server will make querying the database easier for the users.

(ii) PHP

PHP will serve as the server-side scripting language for establishing an efficient querying of information from the database. Also, JavaScript will be used as client-side scripting language for the purpose of adding more interactions to the proposed system.

The paradigm used in the development is the web application paradigm where we have a Database Server, a Client Browser, a Web Server and a Middleware for communication between the Web Server and the Database Server. The Waterfall Model was used throughout the Software Development Life Cycle (SDLC).

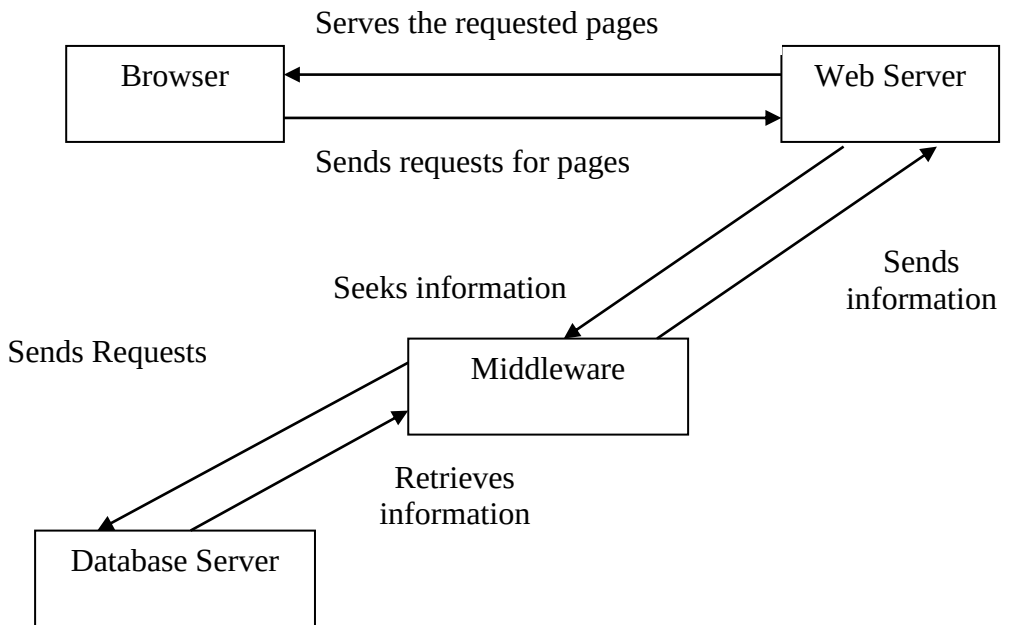


Figure 1: The Web Application Paradigm

In figure 1 above, the user's client browser sends a request to the web server, which retrieves requested data from the database server through the middleware and serves the requested pages back to the user.

Various modules were used in the implementation of the web-based information retrieval system and they include:

- a) Search module
- b) Login module

a) Search Module:

The search module of the application follows the following pseudo-code

```
Get search keyword
Check selected columns in database for matching data
Retrieve records with matching columns
Display records.
```

b) Login Module:

The login module of the application follows the following pseudo-code

```
Get user data, username and password
Check selected columns in database where username matches the password provided
Retrieve user data
Create session.
```

3.1 Unified Modeling Language

The Unified Modeling Language (UML) is a general-purpose modeling language in the field of software engineering, which is designed to provide a standard way to visualize the design of a system. ("Unified Modeling Language," 2015)

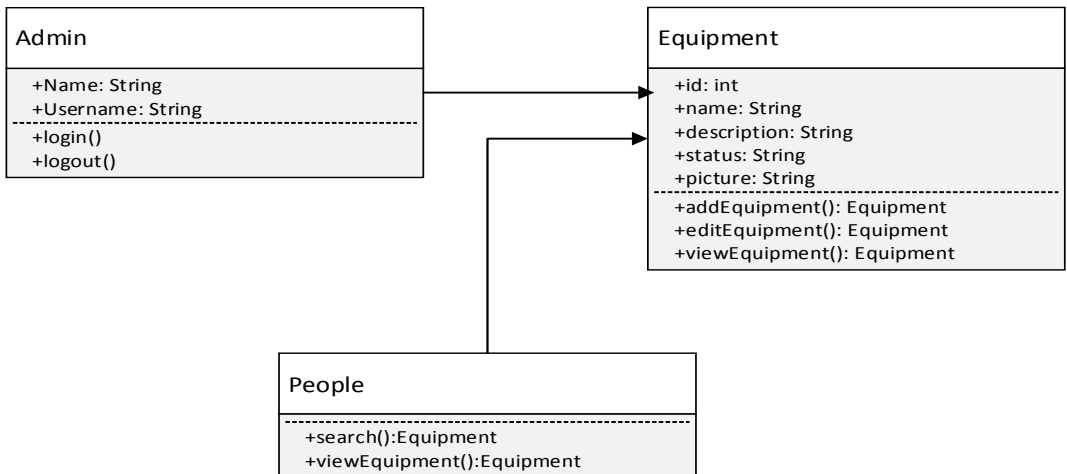


Figure 2: Class Diagram

3.2 Use Case Diagram

Use cases identify the individual interaction between the system and its users or other systems. Each use case is documented with a coded description. A use case identifies the actors involved in the interaction and names the types of interactions. Below is the Use Case Diagram that depicts the portal.

There are basically two actors in this Use Case;

- The Administrator
- The User

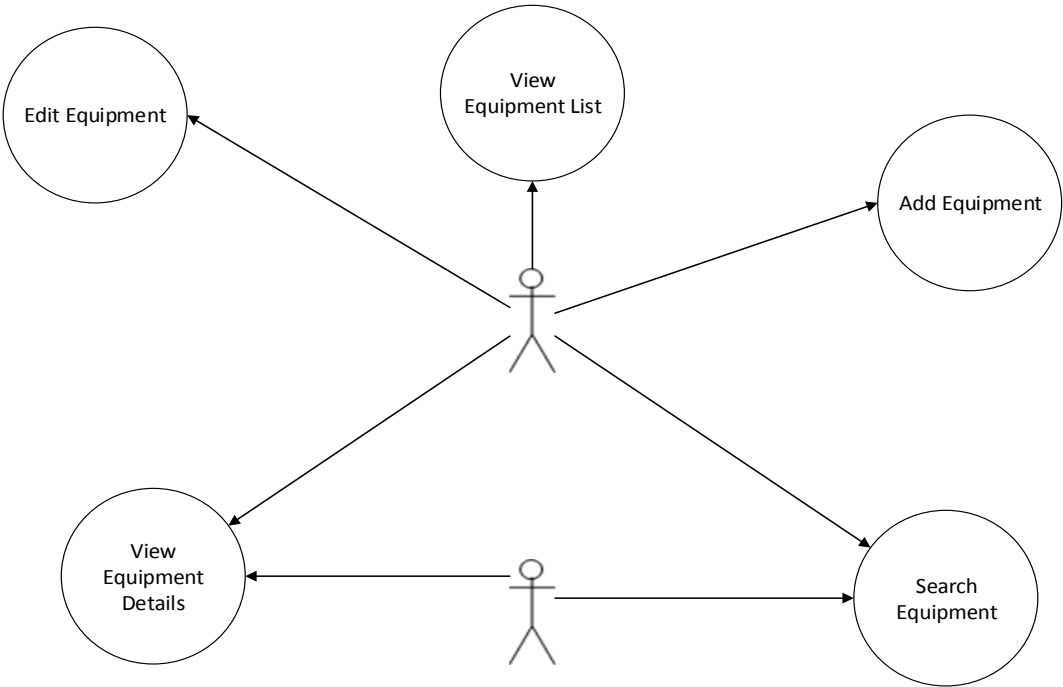


Figure 3: Use Case Diagram

Table 1: Use case table

Actor	Description	Interaction
Administrator	Probably a computer literate backend staff of the Laboratory trained to handle the application.	• Add new Equipment to the database • View Equipment listing and Edit equipment • Update Equipment Details
User	Anybody from anywhere	• Perform a keyword search on the platform • View related equipment results • View equipment details.

3.3 Activity Diagram

The Activity Diagram can help to describe the flow of control of the target system, such as the exploring complex business rules and operations, describing the use case also the business process.

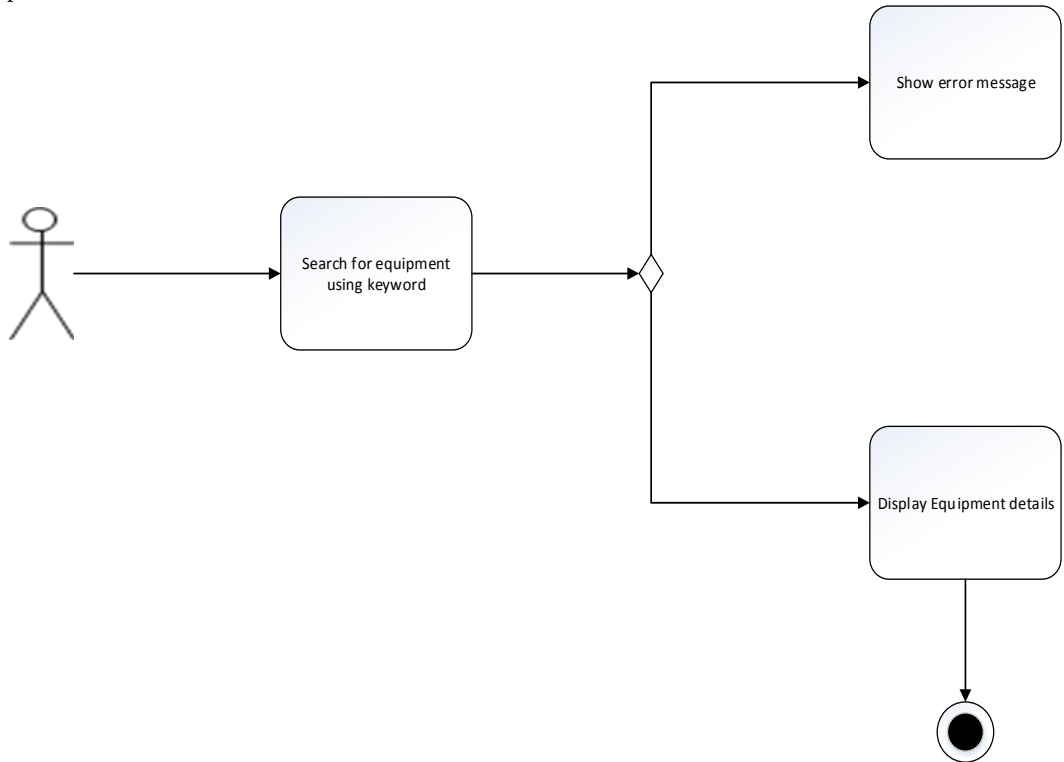


Figure 4: Activity Diagram for Users

3.4 Pseudo-codes of the modules

a) Search Module:

The search module of the application follows the following pseudo-code

- Get search keyword
- Check selected columns in database for matching data
- Retrieve records with matching columns
- Display records.

b) Login Module:

The login module of the application follows the following pseudo-code

- Get user data, username and password
- Check selected columns in database where username matches the password provided
- Retrieve user data
- Create session.

2.5 Program Flowchart

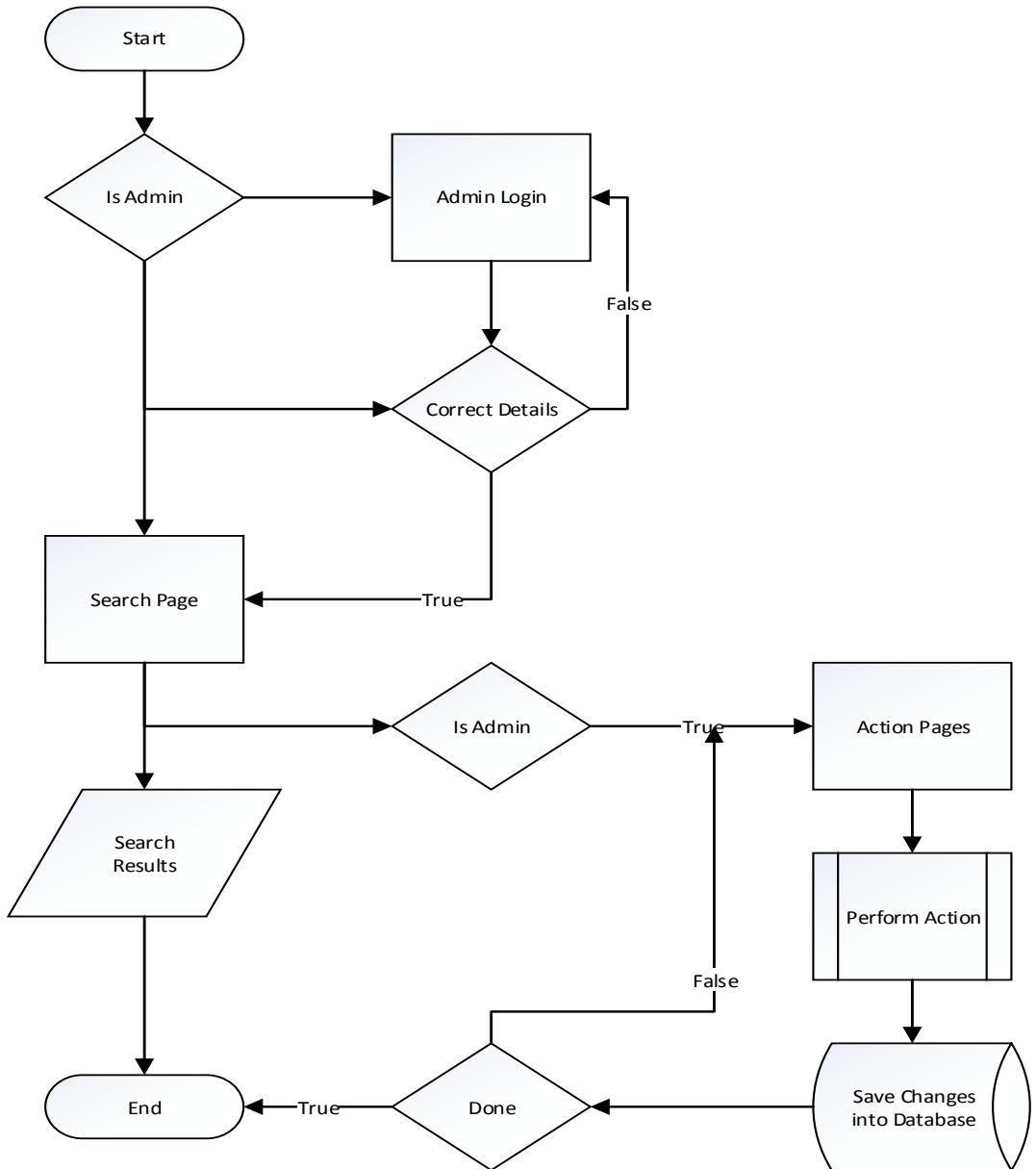


Figure 5: Program Flow chart

2.6 Database Design

The database design for the system is done using MySQL which serves as the backend database. A database refers to a collection of interrelated data known as tables which contain different fields. The tables in the database are related through entity relationship. The database design recognizes two entities via:

1. Admin; which has the following fields
 - a) 'id', which is the number used to uniquely identify the user.
 - b) 'name', is the name of the user
 - c) 'username', represents the login name of the user
 - d) "password", stores user password in SHA encryption form
2. Equipment; which has the following fields
 - a) 'id', stores the number used to uniquely identify the user
 - b) 'name', stores equipment name
 - c) 'laboratory', stores the name of the laboratory the equipment is used in.
 - d) 'e_status', indicates if the equipment is active or not
 - e) 'picture', stores the path to the equipment picture.
 - f) 's_number', stores the serial number of the equipment
 - g) 'manufacturer', stores the manufacturer name or model number of the equipment
 - h) 'purchase_date', stores the year the equipment was purchased

2.7 Structure of tables

Admin Table: This table captures the user's login information into the database and it contains fields such as id, username and password.

Table 2: Admin Table

Field Name	Type	Width	Description
Id	Int	11	This is used for auto increment
Name	Varchar	40	This is used to capture the user's name
Username	Varchar	25	This is used to capture the user's username
Password	Varchar	64	This is used to capture the user's encrypted password

Equipment Table: This table captures information about available equipment into the database and it contains fields such as id, name and description.

Table 3: Equipment Table

Field Name	Type	Width	Description
Id	Int	11	This is used for auto increment
Name	Varchar	255	This is used to capture the equipment name
Laboratory	Varchar	255	This is used to capture the equipment description
S_number	Varchar	255	The serial number of the equipment
Manufacturer	Varchar	255	The manufacturer name or model of the equipment
Purchase_date	Year	4	This stores the year the equipment was purchased
E_status	Varchar	25	This is used to capture if the equipment is active or not
Picture	Varchar	255	This is used to capture the path to the equipment picture

2.9 Entity Relation Diagram (ER-Diagram)

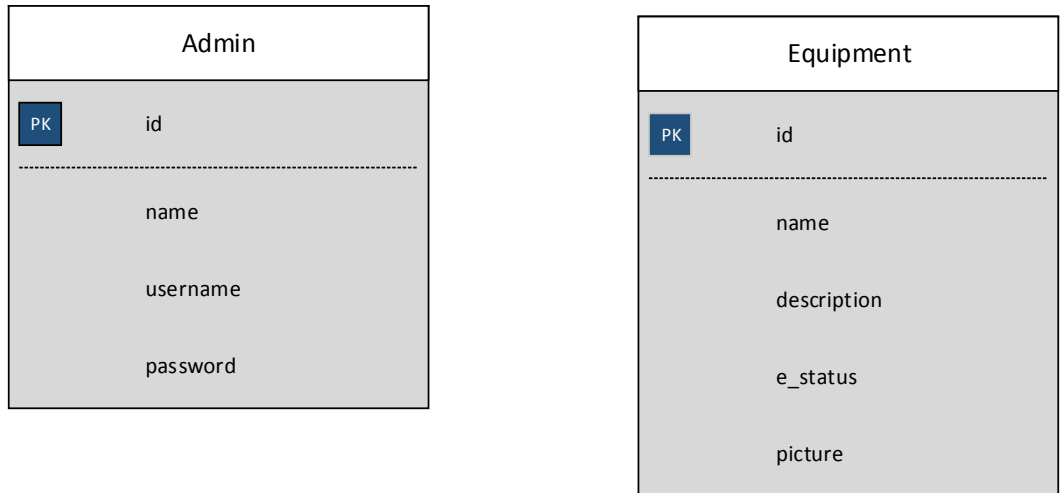


Figure 6: ER Diagram

4.0 RESULT AND DISCUSSION

Input Design

The input design of the system is the link between the information system and the user. The input design contains the various interfaces where relative information are entered by the user into the system through forms.

The user enters most of the input used by the system into tables that have been design to store them. The tables contain fields that correspond to columns and rows of data in the database.

The inputs to be extracted from the system are as shown below:

(1) Search Page: This is also the index page that allows the user to search for equipment available in the system.

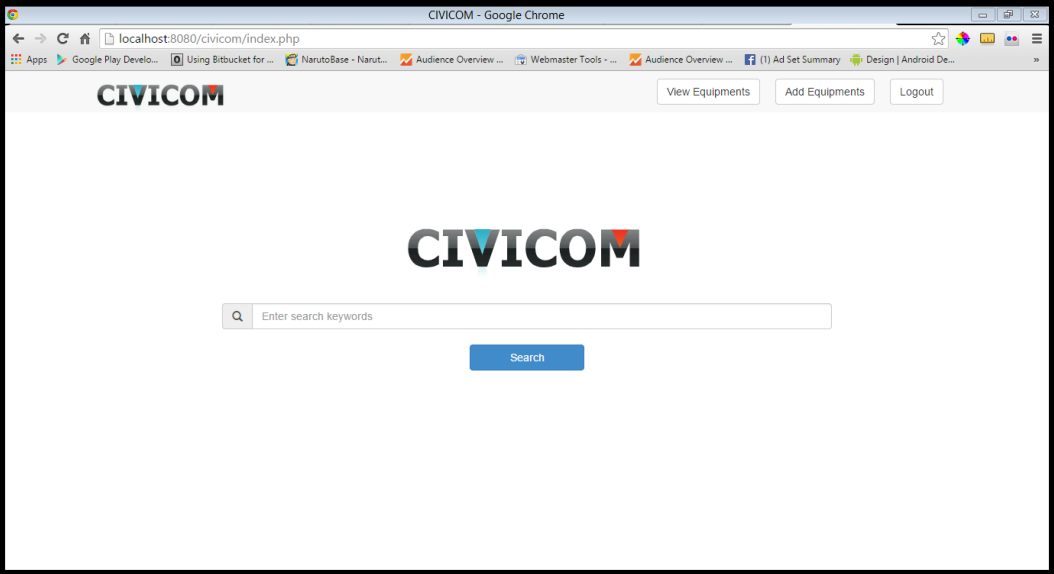


Figure 7: Search page

Add Equipment: The Add Equipment page allows admin to add new equipment to the system.

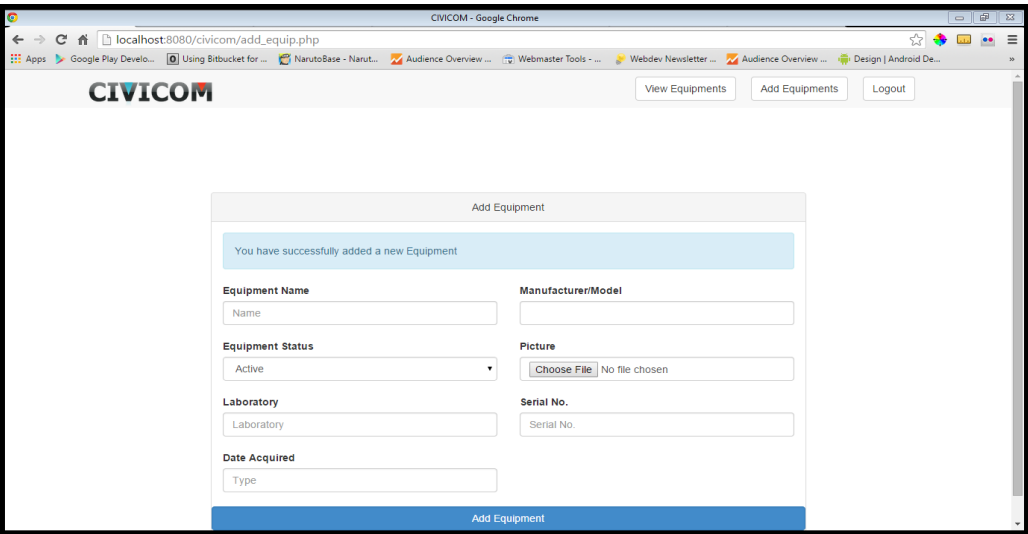


Figure 8: Add Equipment Page

- (2) **Edit Equipment:** The Edit Equipment page allows admin to update data regarding existing equipment

The screenshot displays a web browser window titled 'CIVICOM - Google Chrome'. The address bar shows the URL 'localhost:8080/civicom/edit Equip.php?id=1'. The page features a header with the 'CIVICOM' logo and three buttons: 'View Equipments', 'Add Equipments', and 'Logout'. The main content area is a form titled 'Add Equipment'. It contains three input fields: 'Equipment Name' with the value 'Splinter Cell', 'Equipment Description' with the text 'A device used by the great sam fisher to carry out his various stealth missions around the world. He is', and 'Equipment Status' with a dropdown menu showing 'Active'. A blue 'Update Equipment' button is positioned at the bottom of the form.

Figure 9: Edit Equipment Page

Output Design

Output design is a process that involves designing necessary outputs in the form of reports that should be given to the users according to the requirements. Efficient, intelligible output design should improve the system's relationship with the user and help in decision making.

The output to be extracted from the proposed system is as shown below:

- (3) **Search Results Page:** This page returns a list of matching results based on the user's search terms.

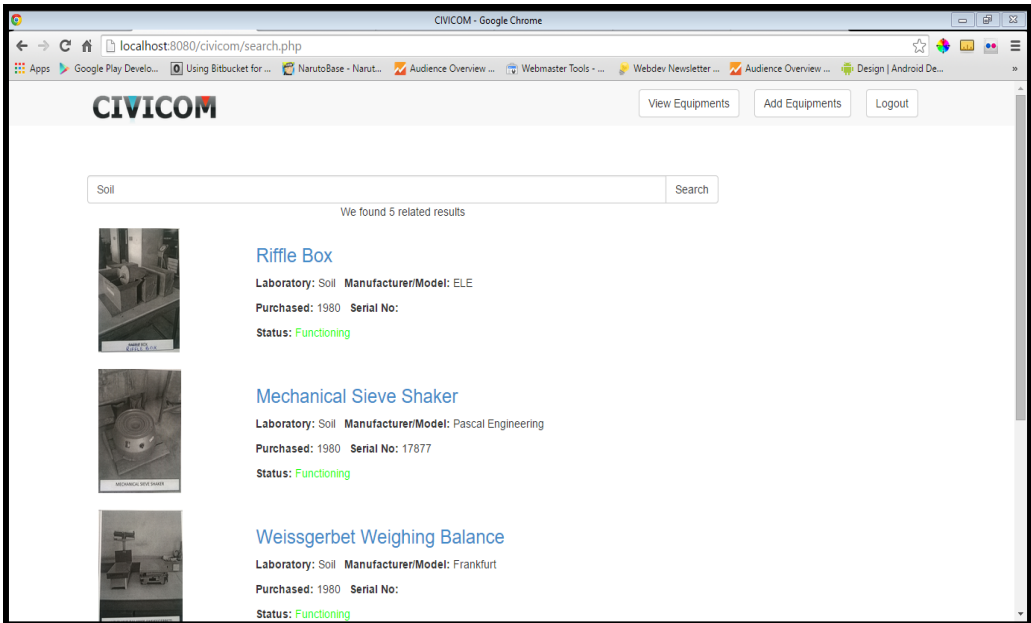


Figure 10: Search result page

(4) View Equipment Page: This is a page accessed by the admin to view a list of available equipment in the system.

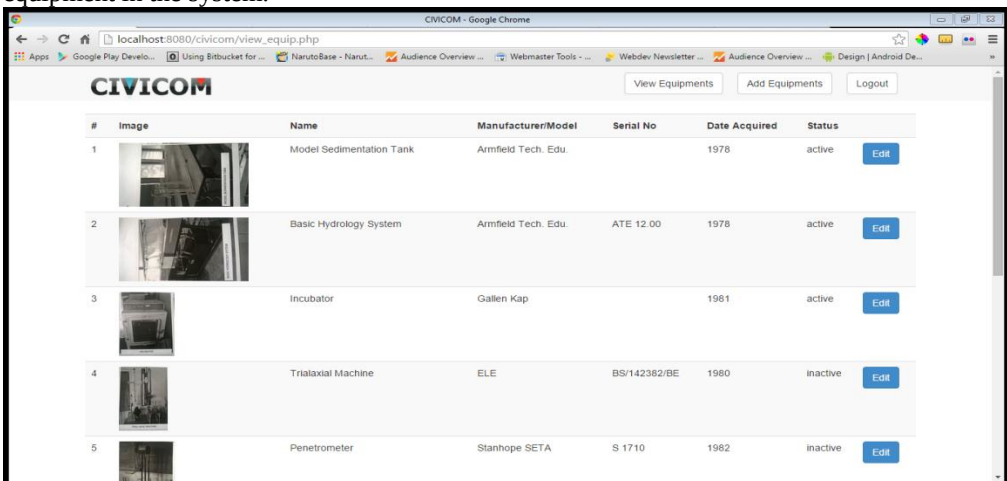


Figure 11: View equipment page

5.0 CONCLUSION

The CIVICOM system was characterized as an innovative concept that brings significant added value to the process of laboratory equipment information retrieval.

Searching for equipment resulted in a list of matching equipment. The searching procedure was easy to use, even by persons without specific computer experience. The resulting lists of matching equipment never contained equipment that should not be included. In comparison to the previous methods, the CIVICOM system proved to be more effective, efficient, and more users friendly.

Researching the overall competition to the CIVICOM system shows that there is no other that offers these same services asides from the manual method of storing and retrieving equipment information.

This web-based integrated Information retrieval system is for computerizing the manually operated record-keeping work in the University laboratory, case study of laboratory of the Department of Civil Engineering, University of Ilorin. The offers a powerful internet-based search engine for locating and identifying equipment within the laboratory. It provides fast, reliable and up-to-date retrieval of information on specific laboratory equipment, while eliminating all unrelated content that a general-purpose search engine would retrieve.

REFERENCES

- Lachtar N., (2014). Design and Implementation of Information Retrieval System based Ontology, Multimedia Computing and Systems (ICMCS), 2014 International Conference, Pp 500-505.
- Nicola G., (1998). Formal Ontology and Information Systems, Amended version of a paper appeared in N. Guarino (ed.), Formal Ontology in Information Systems. Proceedings of FOIS'98, Trento, Italy, 6-8 June 1998. Amsterdam, IOS Press, pp. 3-15.
- H. J. Cao, P. Zhang, Z. Q. Zhou, (2012). Design and Implementation of Recruitment Information Retrieval System Based on Low-Carbon Online Recruitment, Advanced Materials Research, Vols. 403-408, pp. 1883-1887.
- Deepika S,Kirti C and Sandeep K.P., (2014). Design And Implementation of Context Based Information Retrieval System, International Journal of Engineering, Management &Sciences (IJEMS), Pp. 15-19.
- P. Castells, M. Fern´andez, and D. Vallet (2007). An adaptation of the vector-space model for ontology-based information retrieval. IEEE Trans. Knowl. Data Eng., 19(2):261–272.
- S. Calegari and E. Sanchez (2007). A fuzzy ontology-approach to improve semantic information retrieval. In F. Bobillo, P. da Costa, C. d’Amato, N. Fanizzi, F. Fung, T. Lukasiewicz, T. Martin, M. Nickles, Y. Peng, M. Pool, P. Smrz, and P. Vojt’as, editors, URSW, volume 327 of CEUR Workshop Proceedings.
- O. Dridi (2008). Ontology-based information retrieval: Overview and new proposition. In O. Pastor, A. Flory, and J.-L. Cavarero, editors, RCIS, pages 421–426. IEEE, 2008.

- M. D'íaz-Galiano, M. G. Cumbreiras, M. Mart'ín-Valdivia, A. M. R'aez, and L. Ure~na-L'opez (2007). Integrating mesh ontology to improve medical information retrieval. In CLEF, volume 5152 of Lecture Notes in Computer Science, pages 601–606.
- T. Hattori, K. Hiramatsu, T. Okadome, B. Parsia, and E. Sirin. Ichigen-san, (2006). An ontology-based information retrieval system. In X. Zhou, J. Li, H. Shen, M. Kitsuregawa, and Y. Zhang, editors, APWeb, volume 3841 of Lecture Notes in Computer Science, pages 1197–1200. Springer.
- G. Salton, A. Wong, and C. Yang, (1975). A vector space model for automatic indexing. Commun. ACM, 18(11):613–620.
- S. Tomassen, (2006). Research on ontology-driven information retrieval. In R. Meersman, Z. Tari, and P. Herrero, editors, OTM Workshops (2), volume 4278 of Lecture Notes in Computer Science, pages 1460–1468.
- F. Wu, G. Wu, and X. Fu, (2007). Design and implementation of ontology-based query expansion for information retrieval. In L. Xu, A. Tjoa, and S. Chaudhry, editors, CONFENIS (1), volume 254 of IFIP, pages 293–298.
- Afolabi A., W. A. (2010). User Interface Design: A software Engineering Approach. Nigeria: Glorytune Publishers.
- Group, T. P. (2001). Retrieved from What is PHP: <http://www.php.net>Information Retrieval. (2015, February 10). Retrieved from Wikipedia: http://en.wikipedia.org/wiki/Information_retrieval.
- MDN. (2005). A re-introduction to Javascript. Retrieved from <http://www.developer.mozilla.org/en/docs/JavaScript>.
- Unilorin. (2015, March 4). Civil Engineering Department History. Retrieved from University of Ilorin: <http://www.unilorin.edu.ng/index.php/en/departement-of-civil-engineering>
- W3Schools. (n.d.). Introduction to SQL. Retrieved from W3Schools: http://www.w3schools.com/sql/sql_intro.asp
- Wendy Chang, D. M. (n.d.). The Design of A Web-based Multimedia Information Retrieval System.