SLMS: A smart library management system based on an RFID technology

Article *in* International Journal of Reasoning-based Intelligent Systems · January 2012

DOI: 10.1504/IJRIS.2012.051717

1 author:

Mohammed I. Younis
University of Baghdad
48 PUBLICATIONS **351** CITATIONS

SEE PROFILE

SLMS: a smart library management system based on an RFID technology

Mohammed I. Younis

Computer Engineering Department,
College of Engineering,
University of Baghdad,
Baghdad, Iraq
Email: younismi@coeng.uobaghdad.edu.iq

Abstract: Library staff handle a tedious task involve sorting, lending, returning, tagging, eyeing of books. In addition, library users encounter problems for finding, borrowing, localising, renewing the borrowing, queuing, and so forth. To overcome these obstacles, this paper proposes a smart library management system based on an RFID technology. Using low-cost passive tags in libraries reduces the cost of modernisation significantly. As such, integrating RFID into library management system makes both the library users and staff's task easy, smart, convenient, and practical.

Keywords: RFID; information engineering; software engineering; UML; database management; library system; automation; distributed system; tracing; tracking.

Reference to this paper should be made as follows: Younis, M.I. (2012) 'SLMS: a smart library management system based on an RFID technology', *Int. J. Reasoning-based Intelligent Systems*, Vol. 4, No. 4, pp.186–191.

Biographical notes: Mohammed I. Younis received his PhD in Computer Engineering from Universiti Sains Malaysia in 2011. He is currently a Senior Lecturer at the Department of Computer Engineering, College of Engineering, University of Baghdad, Baghdad, Iraq. His current research interest includes RFID development, distributed and parallel systems, combinatorial testing, software engineering, and algorithms.

This paper is a revised and expanded version of a paper entitled 'SLMS: a smart library management system based on an RFID technology' presented at the '2nd Conference on Computer and Information Technology (CCIT'2012)', Ramadi, Iraq, 4–5 April 2012.

1 Introduction

Radio Frequency Identification (RFID) technology is in use since the 1970s. RFID is a form of automatic contact-less data capturing technique using radio frequency electromagnetic waves. An RFID system is comprised of a transponder, reader and host computer (software application) which is usually connected to a distributed database. Readers are units that usually placed in certain places to recognise the transponders (Alani et al., 2009). RFID tags can be active, semi-passive and passive. A tag is a small device that can store information. Active tags contain batteries which power their internal circuits and transmit signals using battery power to an RFID reader within a range of 100 feet. With additional batteries, this range can be increased to 300 feet. Semi-passive tags have internal batteries which are used only to power its internal circuit. Passive tags don't have internal batteries. Semi-passive and passive tags draw their power to broadcast a signal from the reader. RFID reader is a device that can receive and transmit a radio signal. It is built to encode data stored in the tag's microprocessor. Because of the higher cost, active and semi-passive RFID tags are used for valuable long range asset tracking. In contrast, passive tags are cheaper and provide short ranges. When a passive reader tries to read data from a tag, its antenna emits electromagnetic energy which is received by passive tag's antenna. The tag's microchip uses this energy to emit a radio signal using the tag's antenna. The passive reader receives and interprets this signal and passes interpreted information to a computer network. This computer network can provide information about the items carrying the passive tag and their present status to a computer user (Robles and Kim, 2010).

Wide scales of applications are well studied in the literatures (Zhou et al., 2008; Ali and Hassanein, 2009; Behera and Kushwaha, 2009; Idris et al., 2009; Nambiar, 2009; Zhou, 2009; Ali et al., 2010). These applications involve: supply chain, production and manufacturing, healthcare and medical, construction, hospitality, parking management, transportation, attendance, tracing and tracking, etc. As so, RFID becomes cost effective as the price of individual tags reduces with volumes manufactured, other opportunities will be enabled as the technology develops (Zhou et al., 2008). Building from earlier work, this paper proposes the use of the RFID in developing a smart library management system.

Taking care of books from theft, making them available to the book readers and checking their availability remotely, tracing and tracking the persons who borrowed the books are important tasks. Most of the library staff's time is spent in recording information of incoming and outgoing books. Using RFID in libraries saves library staff's time by making their tasks with high degree of automation. An establishment that uses RFID library management saves a book reader, precious time that he would have been spent, waiting for his turn in a queue for borrowing, returning, or renewing the borrowing of a book, and even searching the availability of the books in the library. RFID tags manufacturers are trying to bring tag prices below 10 cents per tag (Harrop, 2010).

Hence, integrating RFID into library management system makes both the library users and staff's task easy, smart, convenient and practical.

Motivated by such a goal, this paper proposes the use of the RFID in developing a smart library management system (SLMS). The rest of this paper is organised as follows. Section 2 gives the RFID library system specification. Section 3 gives the architectural design. Finally, Section 4 states our conclusion.

2 SLMS specification

The SLMS features are stated as follows:

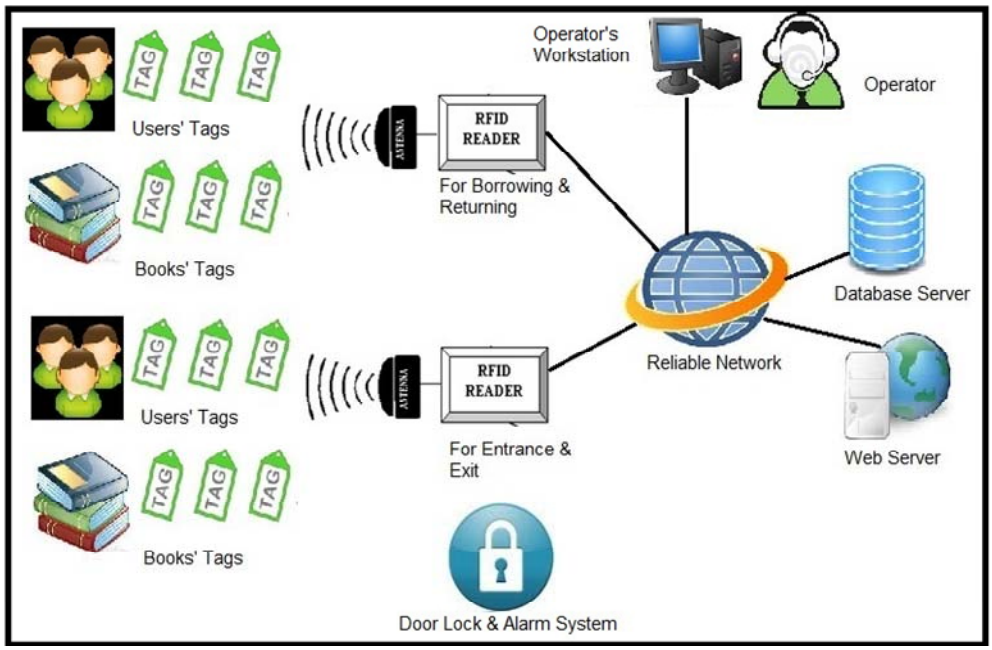
- Only authorised persons can enter the library.
- If an un-borrowed book outgoes from the library, an alarm system will start immediately. Next, the person in charge will take an appropriate action.
- The user should go to the borrowing counter, identify himself to the operator. The operator enters the books to be borrowed to the system that is, making the status of these books as borrowed. As such, when the user goes outside the library no alarm will be issued.
- Similarly, when the user wish to return the books that he has already borrowed, no alarm will be issued in the entrance door since these books are registered as borrowed. The user should go to the borrowing counter, identify himself to the operator. The operator enters the books to be returned to the system that is, making the status of these books as returned (i.e. unborrowed). As such, when anyone goes outside the library carrying these books, the alarm will be issued.
- The users can track the availability of the books remotely.

3 SLMS design

The SLMS consists of: users, operators, books, identification cards (tags), identification devices (readers, each reader attached to an antenna), door lock with alarm, and an operator(s) workstation(s) (PC) contains the system's modules and connected to a database server that can be accessed through a web server, and a reliable network that is shared by all system's parts, as depicted in Figure 1.

Here, each user has unique identification (user_id). This user_id is written on a passive tag (user_tag). Similarly, for books, each book is attached with a passive tag (book_tag). The PC is connected to the readers and door lock through a reliable network. Two sets of readers (each set can be one or more) are used. One is attached to the main entrance of the library. The other is used for borrowing/returning purposes.

Figure 1 The smart library management system (see online version for colours)



The system consists of the following modules.

3.1 User entry module

The user entry module is used for entering the name of the user, identity, affiliation, the maximum period of borrowing, the maximum number of books allowed to be borrowed, the username and password to access the web site, etc. The construction of the user entry table in the database is shown in Table 1.

Table 1 Construction of the 'User Entry' table

Name	*Identity*	*Affiliation*	*Max period of borrowing*	*Max no. of books*	*Username*	*Password*

3.2 Books entry module

The books entry module is used for entering the title of the book, a masking bit, and other information (author(s), publisher, identity, year, request for borrowing by users, the location of the book, etc). The purpose of the masking bit is to monitor whether the book inside the library and does not borrowed (true) or outside the library (false, that is, the book is borrowed). Initially, the masking bit is activated (set to true). The construction of books entry table is shown in Table 2.

Table 2 Construction of the 'Books Entry' table

Title	*Masking bit (true/false)*	*Authors*	*Publisher*	*Identity*	*Year*	*Request for borrowing*

3.3 Books borrowing module

The books borrowing module is used by the library operator for borrowing books operation. This module works as follows. When a user presents his/her tag, the module identifies the user and ask him to present the books. Next, the module receives the detected book_tags from the reader. After that, the module issues a query to the database to determine the legibility (whether or not there is a request for borrowing the book from other users). If the borrowing operation is allowed, the module displays the name of each book and its legitimacy for borrowing to the operator through graphical user interface (GUI). The operator selects the allowed books and changes their status to be borrowed (by updating the masking bit for each book to be borrowed in the database to false). The use case of the book borrowing module is shown in Figure 2.

3.4 Books returning module

The books returning module is used by the library operator for returning books operation. This module works as follows. When a user presents his/her tag, the module identifies the user and ask him to present the books. Next, the module receives the book_tags from the reader. After that, the module issues a query to the database to determine the borrowing period (whether or not the returning books within the allowed period). The module displays a GUI that issuing a penalty in case that the maximum period of the allowed borrowing is exceeded. Finally, the operator activates the masking bits (by updating the masking bit for each book to be returned in the database as true). The use case diagram of this module is depicted in Figure 3.

3.5 Books localisation module

The books localisation module enables the library staff to handle sorting of the returned books. The operator presents the book (book_tag) to the reader, and then the module receives the book identity, queries the database, retrieves the location (floor, shelf) from the database. Finally, displays the location of the book to the operator. The use case diagram of this module is shown in Figure 4.

Figure 2 The use case diagram for the books borrowing module (see online version for colours)

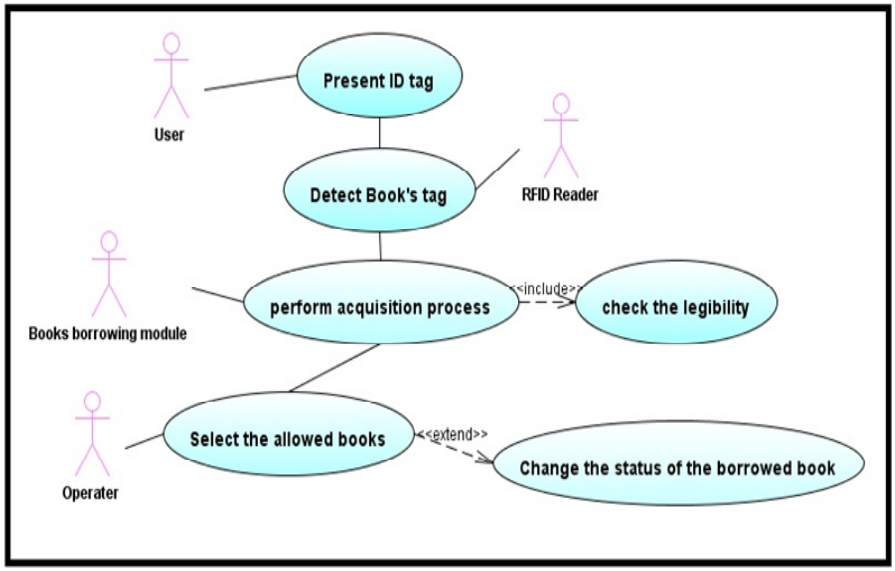
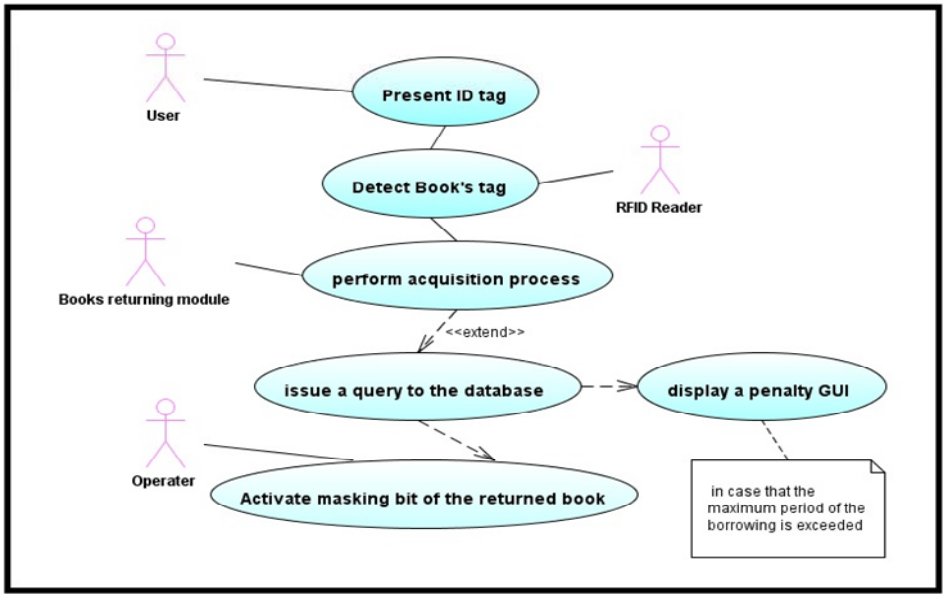


Figure 3 The use case diagram for the books returning module (see online version for colours)



3.6 Door lock module

The door lock module controls the person entrance to the library. When an authorised person (user, operator) presents his/her tag, the RFID reader detects the presented tag and sends the identity to the main server through the network. After receiving the detected identity, the door lock module queries the database and retrieves information regarding the authorisation of the person during this time. If the person is authorised, the module issues a command to open the door, otherwise; the door is locked. The use case diagram for this module is shown in Figure 5.

3.7 Books monitoring module

The books monitoring module is used to track the books at the exit door of the library (can be the same as the entrance door). Here, the module continuously reads the book-tags, queries the database, checks the masking bits of the books. If any masking bit is active (true), then the module starts the alarming system, and closes the exit door. The alarming is continuing until the operator removes the alarming state by issuing ignore command to the book monitoring module. The use case of this module is shown in Figure 6.

3.8 Remotely access module

The remotely access module is used by the user to access the library system remotely through WWW. Here, the user requires to login through his/her user name and password. After login to the system, the user can search for a certain book, check its availability, renewing the borrowing period (in the case that there is no request to borrow this book), and so forth. The use case diagram of this module is shown in Figure 7.

Figure 4 The use case diagram for the books localization module (see online version for colours)

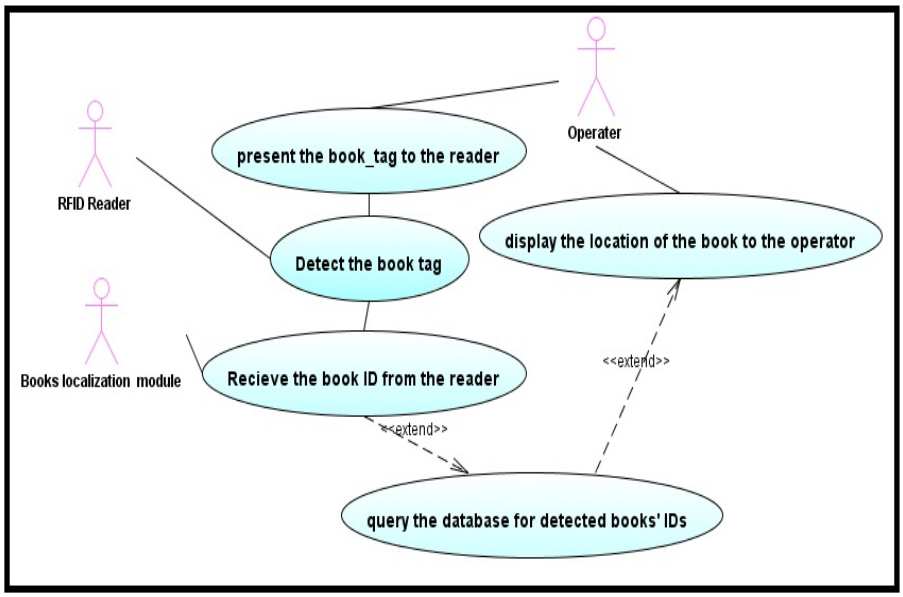


Figure 5 The use case diagram for the door lock module (see online version for colours)

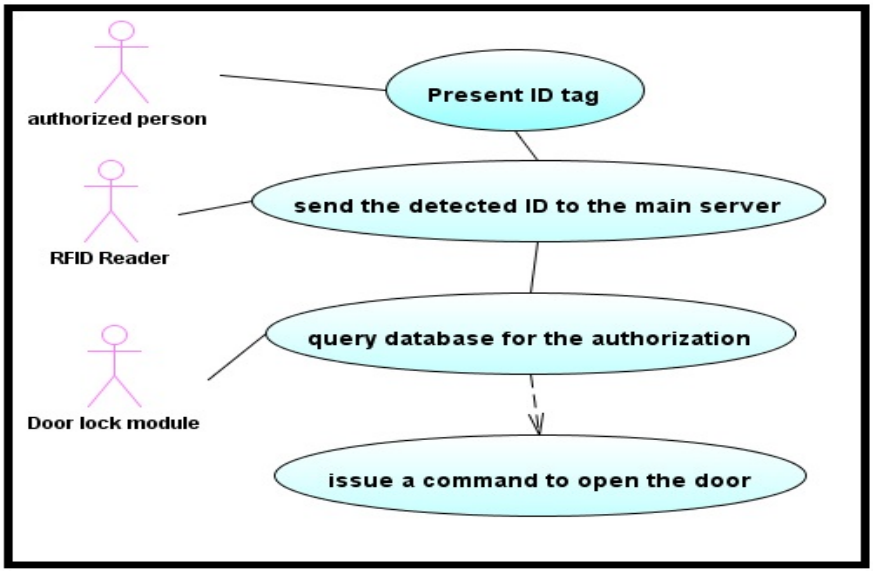


Figure 6 The use case diagram for the books monitoring module (see online version for colours)

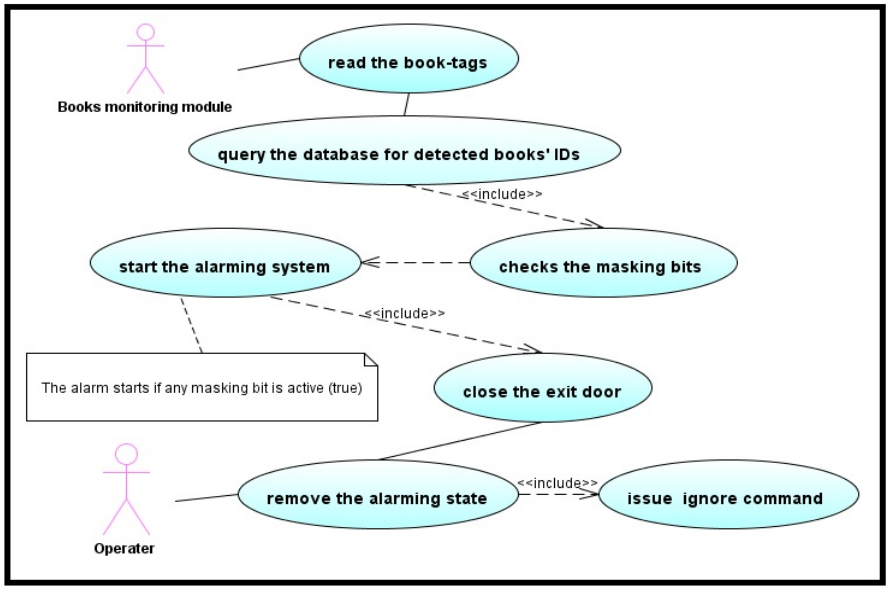
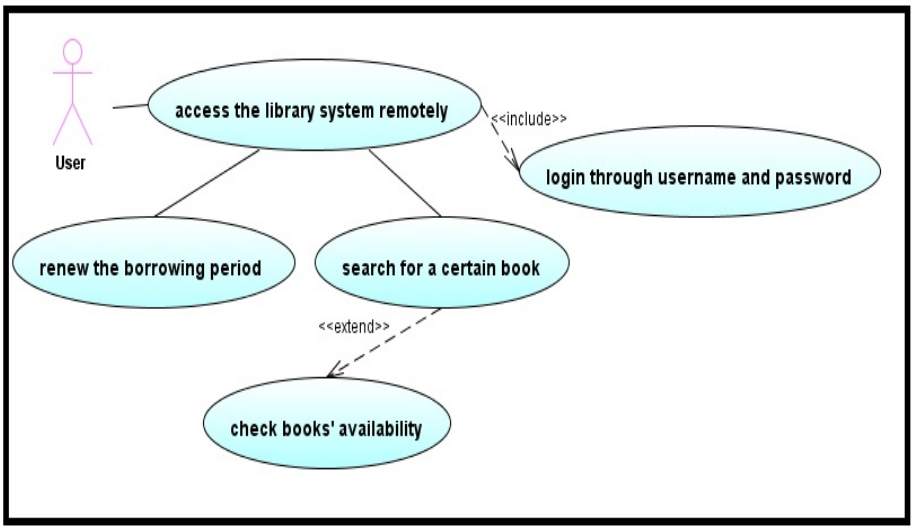


Figure 7 The use case diagram for the remotely access module (see online version for colours)



4 Conclusion

RFID system is an important part of the smart library management system. This paper proposed the integration of the passive RFID technology into a library management system. This integration makes both the library users and staff's task easy, smart, convenient, automated and practical. The proposed system enables the library staff to handle sorting, lending, returning, tagging, eyeing of books in such an easy and convenient manner. In addition, library users can find, borrow, localise, renew the borrowing period of books easily and remotely using the proposed system, Furthermore, the suggested door lock module ensures the security of the library and prevents books' thefts effectively. The design of SLMS is open and modular that can be extended for additional functionalities and upgrading purposes.

References

Alani, M., Ismail, W. and Mandeep, J. (2009) 'Active RFID system and applications', *Electronics World*, Vol. 115, No. 1877, pp.22–24.

Ali, K. and Hassanein, H. (2009) 'Passive RFID for intelligent transportation systems', *Proceedings of the 6th IEEE Consumer Communications and Networking Conference (CCNC 2009)*, Las Vegas, NV, USA, pp.536–537.

Ali, M.F.M., Younis, M.I., Zamli, K.Z. and Ismail, W. (2010) 'Development of Java based RFID application programmable interface for heterogeneous RFID system', *The Journal of Systems and Software*, Vol. 83, No. 11, pp.2322–2331.

Behera, S. and Kushwaha, R.K. (2009) 'RFID based people management system using UHF tags', *Proceedings of the 2nd Annual Seminar of CDAC Noida Technologies (ASCNT 2009)*, Noida, India, pp.231–238.

Harrop, P. (2010) 'Printed RFID in 2010', *Printed Electronic World*, January. Available online at: http://www.printedelectronicsworld.com/articles/printed-rfid-in-2010-00001961.asp?sessionid=1

Idris, M.Y.I., Tamil, E.M., Razak, Z., Noor, N.M. and Km, L.W. (2009) 'Smart parking system using image processing techniques in wireless sensor network environment', *Information Technology Journal*, Vol. 8, No. 2, pp.114–127.

Nambiar, A.N. (2009) 'RFID technology: a review of its applications', *Proceedings of the World Congress on Engineering and Computer Science 2009 (WCECS 2009)*, San Francisco, USA, pp.1253–1259.

Robles, R.J. and Kim, T. (2010) 'Review: context aware tools for smart home development', *International Journal of Smart Home*, Vol. 4, No. 1, pp.1–12.

Zhou, W. (2009) 'RFID and item-level information visibility', *European Journal of Operational Research*, Vol. 198, No. 1, pp.252–258.

Zhou, G., Jiang, P. and Zheng, M. (2008) 'Design of an RFID-based manufacturing data tracking system in plant production', *Proceedings of the 1st International Conference on Intelligent Robotics and Applications (ICIRA 2008)*, Wuhan, China, pp.688–696.