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RFID-BASED INTELLIGENT BOOK-SHELVING SYSTEM

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A dissertation submitted in partial fulfilment of the requirement for the degree of Master of Science in Mechatronics Engineering

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ABSTRACT

Searching and sorting misplaced books is a difficult task often carried out by the library personnel. Quite often, librarians are busy with searching misplaced books which are left in wrong locations by library users. It is quite difficult and almost impractical to place back all books to their assigned locations daily. To overcome this, Radio Frequency Identification (RFID) based Intelligent shelving system has been proposed to provide an efficient mechanism of books management monitoring through wireless communication between the RFID reader and the books. It is quite essential for the proposed system to have a smooth motion for the RFID reader during the shelving operation; otherwise acquired data will have no value due to inconsistency in reading the tags. Consequently, in this thesis, the performance of RFID reader motion and tags data management such as retrieving information, matching with database, sorting out the order and displaying the status of books locations are discussed. A prototype consisting of monitoring PC with embedded controller, two dc motors with drivers, RFID reader and aluminum frame stick on rack have been developed. The performance of the proposed system has been investigated and found to be satisfactory. It has a lot of potential applications, especially in its ability to alleviate the intensive labors and efforts in shelving library books.

ملخص البحث

فإن البحث والتنقيب عن الكتب التي وضعت خطأ في أماكنها عمل شاق إلا علي شخص مكتبي متخصص. وفي الحقيقة , فالمكتبيون منشغلون عن بحث الكتب التي وضعت في أماكنها خطأ من قبل مستخدمي المكتبة . فإن إرجاع الكتب إلي موقعها يوميا صعب جدا والتي قد لا يمكن تطبيقه. وفي سبيل التغلب علي هذا , اقترح جهاز الراديو المتكرر للتعرف علي ترفيف الكتب لكي يزود بالآلية الفعالة لمراقبة تدبير الكتب عبر الاتصال اللاسلكي بين قارئ ر ف ا د و الكتب . فإن النظام المقترح مهم لإيجاد حركة مستمرة لقارئ ر ف ا د أثناء عملية الترفيف : وإلا فإن البيانات المكتسبة ليس لها قيمة بسبب التباين في قراءة البطاقات . وأخيرا , في هذه الدراسة ,فإن اجراءات حركة قارئ ر ف ا د و بطاقات إدارة المعلومة مثل استرداد هذه المعلومة , الإيصال بموقع المعلومة , التسلسل و استعراض وضع الكتب كلها أيضا قد نوقشت . فالنموذج الأصلي المتكون من مراقبة ب س مع أداة الضبط المطوق, المحركان الاثنان د س مع آلة التحريك , قارئ ر ف ا د وعصية إطار الألومنيوم علي ماسك كلها قد طورت أيضا .وقد فتشت اجراءات النظام المقترح ووجدت أنها مقنعة. وكان لها كثيرالتطبيقات الكامنة, وخصوصا في قدرتها لتسكين الجهد الشديد والمجهودات في ترفيف الكتب المكتبية.

APPROVAL PAGE

I certify that I have supervised and read this study and that in my opinion; it confirms to acceptable standards of scholarly of presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Master of Science in Mechatronics Engineering.

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DECLARATION

I hereby declare that this dissertation is the result of my own investigations, except where otherwise stated. I also declare that it has not been previously or concurrently submitted as a whole for any other degrees at IIUM or other institutions.

Thein Moe Win @ Shamsudin

Signature:…….. Date: ……..

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Affirmed by: Thein Moe Win @ Shamsudin

…….. ……

Signature Date

"To my beloved parents and my wife with gratitude for their guidance, continuous support, and for facilitating me to be where I am today"

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LIST OF ACRONYMS

b	rack damping coefficient
e	back emf
F	summation external forces for linear motion
g	gravity
J	mass moment of inertia
Jm	moment of inertia for armature motor
Jo	total of moment inertia
Jp	moment of inertia of rack-pinion
K	kinetic energy
Ki	Integral
Kd	Derivative
Kp	Proportional
Kt	artificial system parameter
Kg	gear ratio constant
Km	motor constant
Kload	kinetic energy of the load
L	inductance
M1	mass of the motion frame
M2	mass of the load
n	number of rules
P	potential energy
R	resistance

r	pitch radii of rack-pinion
t	time
T	summation external torques for rotational motion
Tm	torque
uo	fuzzy control output
up	difference actual error rate and NCT
ur	input to the actuator
V	voltage
Vl	velocity of the load
Vt	velocity of the trolley
Vl/t	velocity of the load relative to the trolley
x	displacement

LIST OF ABBREVIATIONS

G.U.I.	Graphical User Interface
N.C.T.F.	Nominal Control for Trajectory Following
O.D.A.	ActiveX Data Object
P.C.I.	Programmable Control Interface
P.I.D.	Proportional Integral Derivative
R.F.I.D.	Radio Frequency Identification
R.T.W.T.	Real Time Windows Target
D.A.Q.	Data Acquisition Card

CHAPTER ONE

INTRODUCTION

1.1 OVERVIEW

A library houses various collections of educational materials. People are normally relying on those collections to gain more knowledge. Library system is also the gateway through which communities' diverse needs can be met by combining the traditional role of the library with the development opportunities in the world. In order to meet the current diverse communities' needs, Library system should provide the educational, recreational, cultural and intellectual information. In order to maintain all those above-mentioned information, librarians have huge responsibilities to provide very good efficiency while making available to the public for them to get easy search and access. In particular, processing new acquired and returned books, searching all misplaced books and retrieving them are some of the essential works carried out daily by the library personnel. Searching of misplaced books are the most difficult task as well as time consuming.

Consider a typical library, in which each book has its own assigned location in order to get easy assessment. However, library users would often remove books from perhaps multiple shelves and browse them through to search for intended ones. Then, it will not be easy to place them back to their original locations which make them unreachable. A similar situation arises in many retail stores where customers would try out things before buying them. Eventually, those items will be mixed up without putting them back to their proper places. Consequently, searching and sorting misplaced books becomes a difficult task often carried out by the library personnel.

Moreover, for instance, the student or the library user is looking for the book which is urgently required and unfortunately it has been misplaced or missing from original assigned location. In the mean time, the staffs have not yet started for searching process. So who will help those students or library users to find out their intended books? The university has made such huge effort by implementing the best facilities to develop up to this stage for the library users to be pleasant in studying, discussion as well as reading the books. However, if that situation is persisting every day, the solution has to be found out to overcome those problems.

Many approaches have been suggested on how to restore books or stocks to their actual locations. These procedures differ with respect to the technology, accuracy, frequency of updates, and the costs of installation and maintenance. For instance, the university library has a system in which, anyone would have to hold scanner to search for any misplaced books. The alarm would be raised up whether any misplaced books are found (Chichester 2004). However, the efficiency is very low since it requires more or less manpower that can make human error during the searching operation due to fatigue. Furthermore, the scanner is expected to be half inch close to each and every book otherwise the data tags will be left out from the reading range. The Figure 1.1 below shows how books are arranged and shelves are placed in the library.

Figure 1.1 Books arrangement in the Library

Since library has wide range of information to support the University's instructional, research, and public service activities, it is very much essential and significant to have all books to be in their assigned locations otherwise, people will be facing in finding them elsewhere though the system is showing the book's assigned place. Especially in the big library, it could be worse to search the intended books if those are not properly placed back where it is supposed to be.

1.2 PROBLEM STATEMENTS AND ITS SIGNIFICANCE

- Libraries are suffering from budget shortfalls as never before. With cuts to state and local governments, it is difficult for libraries to remain staffed and open. RFID is seen as a way to address the staff shortages by increasing the number of circulation that can be processed with less staff.
- The library staffs will have to be busy searching for the misplaced books at least twice a day in that 5 stories library building. Therefore, reduction of repetitive stress injuries among staffs will become another reason (Integrated 20006). The repetitive motion associated with checking out books using optical scanners is believed to be more problematic.

- Current manual re-shelving or scanning with handheld scanner will have man fatigue and reduce accuracy in repeating processes.

Therefore, missing or misplaced books will still exist and library users will frequently feel annoyed in searching intended ones.

1.3 RESEARCH OBJECTIVES

The main objectives of this dissertation are as follows:

- To design and develop RFID-Based intelligent book-shelving system..
- To produce a prototype in order to verify the performance.
- To develop the graphical user interface software.
- To integrate the hardware prototype and software interface.
- To evaluate the system performance in terms of smooth motion, operating time, user friendly and cost-effectiveness.

1.4 RESEARCH METHODOLOGY

This research work has been done in five phases namely, review of literature, prototype design, controller implementation, software development andtesting.

a) **Literature review** - in this phase, collection of previews and current information related to this thesis is carried out. Those materials are mostly obtained from different books, articles, and journels. The collected materials are studied and reviewed so that this thesis can provide new solution to an identified problem that is not addressed in the previous works. The literature review is discussed in detail in Chapter.

b) **Design** -this phase of the research work is divided into two parts: hardware and software designs. The hardware design involves the