# The Development of a Radio Frequency Identification based Interactive Academic Advising System

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## ABSTRACT

The advising process is a key ingredient in the success of engineering education and it is sincerely reviewed during the ABET accreditation visit. However, most universities do not have a system that prevents students from taking courses without having taken pre-requisite courses. Consequently, most engineering programs rely on the advising process to manually review students' audit systems to ensure that engineering students take courses in the correct sequence and gain the ultimate engineering education planned through each curriculum. This paper attempts to demonstrate how a Radio Frequency Identification based Interactive Academic Advising System (RFID-based IAAS) is developed and implemented to provide a robust system for the engineering advising process in an engineering program. This RFID-based IAAS system has provided the capability to retrieve each student's records in a real-time fashion when one student walks into the advisor's office. Then, the student's coursework, which is based on the ABET course map, automatically appears on the computer screen to facilitate the discussion between the faculty member and the student. This system allows faculty to select courses in future semesters for students. Finally, two copies of the results are printed and signed by both parties. The developed RFID-based IAAS system has been implemented and resulted in time savings and a reduction of advising training due to its user-friendly process. The implementation outcomes, the real time displaying and the systematic process of such a development will be demonstrated at the conference and presented in this paper.

## 1. INTRODUCTION

In today's academic environment, mentoring and the mentor-mentee relationship have attracted a considerable amount of interest in an academic scenario [1]. It has been identified that students who do not undergo advising have been found to have a lower grade point average, less units completed per semester, and a higher dropout rate than their mentored counterparts [2]. Some college students reported that they have difficulty in selecting a desired program through the maze of options without an experienced, trained, and caring academic advisor [3]. This situation

will only get worse for educators in the United States, as the domestic higher education system absorbs 1.5 million new students between now and 2015 [4].

Also, since factors with advising varies due to school requirements, such as course pre-requisites, course offerings in the semesters, student preferences like transfer credits, most academic advisors must spend most of their time on tedious and time consuming decisions, such as what course schedule would be ideal for each student, so that the student can complete graduation requirements without delays and also have preferences and pre-requisites satisfied. [5]

Furthermore, programs or universities, which want to be accredited by other organizations, such as the Accreditation Board for Engineering and Technology (ABET), have to give great concern on advising because student advisement regarding curriculum and career matters are important criterion during the accreditation[1]. Therefore, it is necessary to have an effective advising method.

According to Tuttle and Kuhtmann, academic advising is commonly structured into seven different institutional models: the faculty-only model, the satellite model, the self-contained model, shared-supplementary model, shared-split model, shared-dual model, and total intake model [6][7]. Even though the seven models mentioned above help the students in advising, students and faculty face the following problems in the advising process: (1) variation in the academic advising process; (2) unawareness of pre-requisites before taking protected courses; (3) time consuming process for advisors.

This paper proposes one RFID-based Interactive Academic Advising System (RFID-based IAAS. In the system, every student has a unique RFID tag code, which can be detected by an RFID reader. An Excel file stores student information, and a RFID reader can read the student file and display the data. The proposed RFID-based Interactive Academic Advising System could contribute to minimize error, to track a student's records, to reduce the advising process time, and reduce the quality variation in academic advising.

## 2. LITERATURE REVIEW

### 2.1 RFID Technology

Radio frequency identification (RFID) is an electronic informational technology, which utilizes wireless radio waves to transmit, identify, trace, and confirm various objects. [8] Typically, a basic RFID system consists of three components: transponder (RF tag) RFID tag, transceiver (with decoder) RFID reader (interrogator), and antenna or coil.

The RFID tag consists of an etched antenna and a tiny chip. Antenna in an RFID tag is a conductive element that permits the tag to exchange data with an RFID reader. The chip stores vital bibliographic data including a unique ID number to identify each item. Based on the resource of power, a tag can be classified as an active tag– having its own battery power source, a passive tag– having no power source of its own [9] [10], and semi-passive tag, which uses an

[1] . http://www.abet.org/DisplayTemplates/DocsHandbook.aspx?id=3142

internal power source to monitor environmental conditions, but requires RF energy transferred from the reader similar to passive tags to power a tag response[2].

Readers are generally classified as handheld, vehicle mounted, post mounted, and the hybrid reader. The first three types can read either active or passive tags but not both, whereas the hybrid reader can read both tag types [11]. RFID readers consist of a transmitter, receiver, antenna, and a decoder. RFID readers can communicate with, identify RFID tags, and retrieve data stored in tags.

The antenna broadcasts radio signals into its environment and reads and writes data into RFID tags. When an RFID tag passes through the electromagnetic zone, the reader can detect the signal from the tag. The reader decodes the data encoded in the tag's integrated circuit (silicon chip) and the data is passed to the host computer for processing. Usually, the RFID antenna can vary in size and structure, depending on the communication distance required for a given system performance. There are two types of antenna: long-range reader and medium-range reader.

### 2.2 Academic advising

According to the National Academic Advising Association, academic advising is a series of intentional interactions with a curriculum, a pedagogy, and a set of student learning outcomes[4]. Curriculum is what advising deals with, ranging from the ideals of higher education to the pragmatics of enrollment. Pedagogy is the process of what advising involves and how advising is carried out, and student learning outcomes are the result of academic advising[3]. Academic advising helps students make a good plan in order to achieve their individual academic goals and avoid some possible problems, such as choosing protected courses before finishing the related pre-requisite courses. And, according to Tuttle and Kuhtmann, academic advising is commonly structured into seven different institutional models: the faculty-only model, the satellite model, the self-contained model, shared-supplementary model, shared-split model, shared-dual model, and total intake model [6][7].

## 3. DEVELOPMENT OF THE RFID-BASED IAAS

The structural framework of the RFID-based IAAS is shown in Figure 1. The arrows indicate the information flow. The initial input information comes from the RFID tag, which reflects the analog signal to the RFID reader. Then, the RFID reader provides raw data as input for the central computer. After the computer's processing and the advisor's operation, the central computer outputs information.

### 3.1 Hardware setting of RFID-based IAAS

As shown is Figure 1, the hardware of this system consists of a metal folder box, students' files, RFID tags, RFID reader, one personal computer, and a color printer.

[2] http://www.morerfid.com
[3] http://www.nacada.ksu.edu/Resources/Clearinghouse/View-Articles/Concept-of-Academic-Advising-a598.aspx

In this system, we use ALN-9662 RFID tags, which are with a global operation between 860 - 960MHz and have an antenna with dimensions of 70mm x 17mm. This kind of RFID tags can be available in high-yield, high-capacity rolls for high-volume converting processes[4]. Each RFID tag has a unique code, which can be modified by programming. By owning this special characteristic, every tag could be traced and identified by a RFID reader. Every student's file is attached a ALN-9662 RFID tag and all the files are stored in a metal box in the administrative assistant's office in the Industrial & Manufacturing Engineering & Technology Department (IMET) of Bradley University. Because of the tags, each student's file has a unique ID, which contributes to distinguish one student's file from others'. To receive a signal from a RFID tag, an ALR-9650 RFID reader is used. The ALR-9650 RFID reader is an ideal solution for single-antenna RFID systems reading moderate numbers of tags. Because of its integrated antenna and power-over-Ethernet support, it is feasible to be used in a very low cost system for asset tracking. This equipment's center frequency band is 915MHz, which is between 860MHz and 960MHz[5]. There are two ways to connect the RFID reader to a computer (Dell desktop computer)—RS232 and wireless method. In order to ensure a stable data transmission, RS232 is used to connect the two equipments together. In order to get the final paper-based output result of advising, a color printer, Phaser 8860, is used in this system. And, the computer is connected to this printer through the Internet.

### 3.2 Software setting of RFID-based IAAS

The software part of the RFID-based IAAS is programed with Visual Basic (VB) programming language in Microsoft Visual Basic 2010 Express programming environment. Figure 2 indicates the data processing steps. For the first part, the interaction of the RFID tag and RFID reader produces tag information, and this information is transferred to a central computer by a RFID reader. After getting the initial input from the outside world, VB code software processes the row input data and generates a unique code, which is related to a certain tag. Because of this tag code, the central computer retrieves information from an Excel file, and after interaction between the computer and operator, the computer will output the results.

When the software is opened, the program first retrieves information from an Excel file, which stores all students' information. There are three kinds of sheets in the Excel book. The first has only one sheet, which records the relationship between the student's information sheet and the RFID tag code. The second kind of sheet also has just one sheet, which is the sample sheet used to build new sheets for new students, who do not have any information in this Excel file. The last kind of sheets are students' information sheets that record student's courses, grades, and the status of the course selection, and every student has this kind of sheet. Then, according to the information in the Excel file, a monitoring part is displayed on the screen, which is comprised of: Completed Advising, Pending for Advising, and Ready to Graduate. These items indicate students' advising status. The Completed Advising part displays the list of students, who have finished the advising for the current semester. The Pending for Advising part reminds the advisor

[4] http://www.alientechnology.com/tags/index.php

[5] http://www.alientechnology.com/readers/index.php

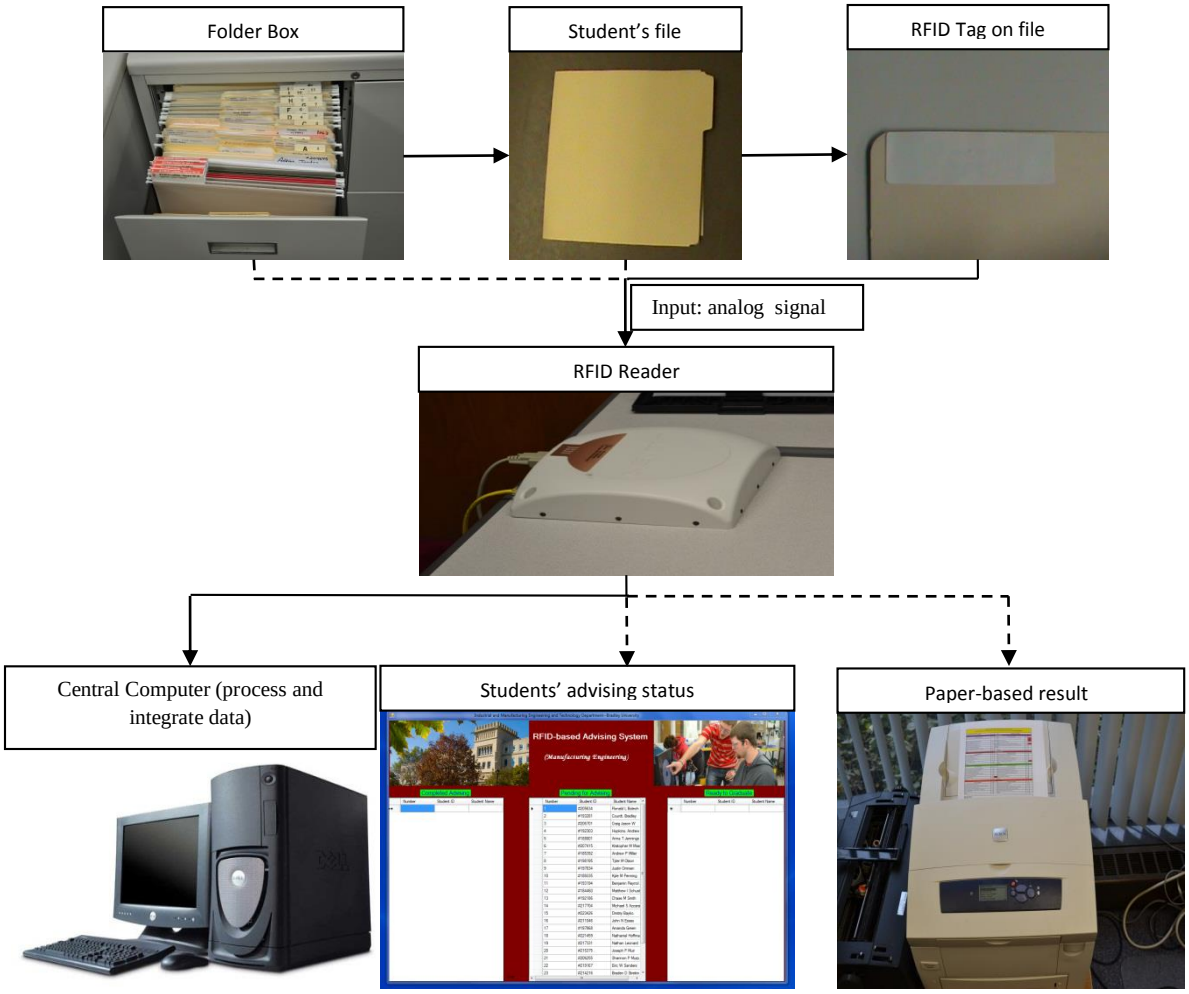


Figure 1: Structural framework of the RFID-based IAAS

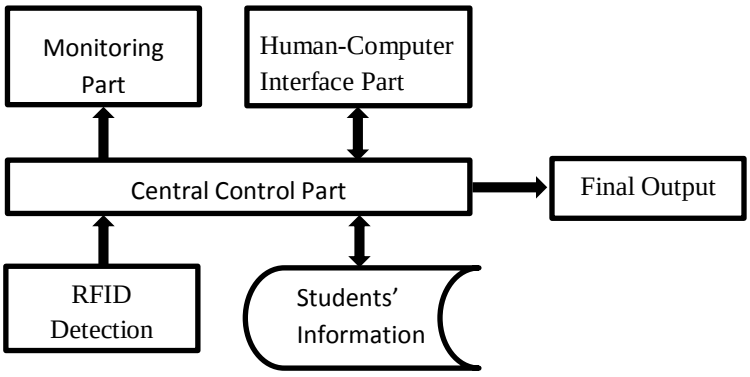


Figure 2: Architecture of RFID-based Interactive Academic Advising System

who has not received advising and are still pending for it. The students' name and ID can be found in the Ready to Graduate part if they are ready to graduate at the end of the current

semester and need not receive advising. All information will be updated once one student finishes advising. This information contributes to advisor scheduling advising.

The input information comes from a RFID tag. Every student's file is attached a RFID tag. All files are stored in a metal box in the administrative assistant's office. Every tag has a unique tag ID. Thus, the program can distinguish a different student's file by its unique tag code. The RFID reader reads information from its environment and sends results to the central computer at certain intervals, which can be adjusted by changing the control program. When a student steps into an advisor's office with his or her file, the related RFID tag appears in the reader's read range and the reader can detect it and give the result to the central control part.

Meanwhile, the program stops reader reading information. One thing needs to be mentioned, this result is just the raw data, which will be processed by the program. After the processing, the unique RFID tag code is separated and this tag code can be recognized by the software for further processing.

As soon as the software gets the tag code, the tag code is retrieved in the first kind of sheet in the Excel file in order to get the related sheet name, which helps to find the student's information sheet. The program will find the student's information sheet once it gets the sheet name. However, if the tag's code could not be found in the first kind of sheet, which stores all the tags' code, the program uses the second kind of sheet as an example to build an information sheet for this new student and then builds the relation between code and sheet name in the first kind of sheet. Finally, the program assigns the student's information from the related information sheet and displays it on a Human-Computer Interface.

Human-Computer Interface part is another important part of the RFID-based IAAS. Most of the operations, which are done by people during the advising process, occur in this part. Because of this interface between operator and computer, the advisor can change information in the Excel file and give commands to the Final Output part by clicking the related buttons on this interface. For example, the advisor can choose or change courses for students by clicking the course-buttons, the advisor can select the semester and academic year by clicking the ComboBox's items, and the print process and update information are triggered by clicking the "Finish" button on this interface. On the Human-Computer Interface, we can see an ideal course map, which takes the Manufacturing Engineering Program's educational goal and students' own interests into account. One important thing is that we integrate all the pre-requisite courses conditions into the VB program. So, if one student has not finished all pre-requisite courses of one course, the software will refuse to respond and the data in the Excel file will not be updated when the advisor selects this course for the student. At the same time, the advisor could not make any changes of the courses, which the student has finished or is taking in the current semester. The advisor needs to select "Semester" and "Year" before choosing courses. Otherwise, the interface and the Excel file will not respond.

After finishing the course selection, the advisor will click the "Finish" button on the Human – Computer Interface and the student's sheet information is sent to the color printer. The color printer prints two copies of the sheet automatically (one for the student, one for the advisor). Thus, they have both electronic version and paper-based version results. At the same time, all changes in the Excel file are saved and the information of the students' advising status is

updated. Then, a new reading cycle will be triggered after a one minute's time delay, which helps prevent the same tag to be detected for another time.

## 4. TESTS AND RESULTS ANALYSIS

To confirm the system has no errors and works smoothly, tests were performed. In this section, we show the test of the RFID-based IAAS and the experimental results. All hardware is set up in the department Chair's office in the Industrial & Manufacturing Engineering & Technology Department at Bradley University. As described in Section 3, all students' files are stored in the administrative assistant's office. Tests were conducted from October 22, 2012 through November 16, 2012, when the undergraduate students received academic advising for the Spring 2013 semester. There are totally 28 undergraduate students who received academic advising using the RFID-based IAAS.

There are six steps for the tests. First, the advisor opens the software, and the program retrieves information from the Excel file and displays students' advising status. Second, the student takes his or her file, in the box in the administrative assistant's office, and steps into the advisor's office. Third, once the RFID reader detects the tag on the student's file, the program tries to find the tag code in the Excel file. The fourth step has two different situations: one is the VB program can find the tag code in the Excel file, then the program will draw a course map for the student according to the student's information; the other is when the tag code could not be found in the Excel file, the program will build a sheet for the student and draw a course map for this student according to the ideal course map. Fifth, the advisor can now have discussions and make interactive operations on the Human-Computer Interface. Finally, all operations are finished and all results are outputted and saved.

From the tests, we have found three problems: 1) Even though some students finished the pre-requisite courses for the IME 331 course, they were not allowed to select this course. The reason is that we wrote this part of the VB program according to pre-requisite information that we got from the website of the department. However, the pre-requisite courses of this course had been changed. We solved this problem by changing the pre-requisite conditions of the Button-IME 331's VB program in the software, 2) Advisor could not open the Excel file normally some time. This was because a non-normal shutdown of the software was made by the operator and Excel was still opened even though the software was closed. In order to deal with this issue, we added a part of VB program to close and save the Excel file when a non-normal shutdown of the software is made, 3) One student's course map did not correspond to his real information. As for this problem, we found that it was because the format of this student's information sheet in the Excel file was changed and the program read his information from the wrong place.

Finally, after we made the changes above, the RFID-based IAAS worked very well. In an ideal course map, the intergrated rules in the VB program provide a standard academic advising process for the department. The pre-requisites based VB program protects some courses from being selected before the related pre-requisite courses are finished. And, since the RFID reader detects the tag, the program distinguishes information, so advisors need not to take all kinds of input and searching information operations. Thus, time is saved during the advising processes.

## 5. CONCLUSION

In this paper, we have presented an interactive academic advising system, which integrates Radio Frequency Identification (RFID) technology as an information input method. In this system, the monitoring part, which displays once the software is opened and is updated as soon as one student finishes advising, makes it possible for advisors to know all students' advising status. The RFID technique used in the advising system enables the system to get students' information from the Excel file and display information automatically. Furthermore, the inner conditions of the program protect protected courses from being selected before the perquisite courses are finished. And at the same time, the Human-Computer Interface makes it very convenient to operate the course selection. In general, the programmed process provides a standard advising process, helps save time for the advisor, and brings a great convenience for both the advisor and students.

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