A Student Project Applying Automatic Identification and Data Capture for Inventory Management

by

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Abstract: Automatic Identification and Data Capture (AIDC) has evolved to describe methods of automatically identifying objects, collecting data about them, and entering that data directly into computer systems. Technologies typically considered as part of AIDC include bar codes, Radio Frequency Identification (RFID), biometrics, magnetic stripes, Optical Character Recognition (OCR), smart cards, and voice recognition. AIDC is also referred to as Automatic Identification, Auto-ID and Automatic Data Capture. AIDC is the process or means of obtaining external data, particularly through analysis of images, sounds or videos. This article briefly describes an inexpensive inventory management system using an established tracking technology developed by students.

I. Introduction

Inventory Management System Components

An inventory management system is an integrated package of software and hardware used in warehouse operations and elsewhere, to monitor the quantity, location and status of inventory as well as the related shipping, receiving and picking processes. Modern inventory control systems rely upon Bar Codes, RFID tags and other technologies to provide automatic identification of inventory objects. Combined with management software, an inventory management system can use bar codes, RFID tags or other technologies to automatically identify an inventory item, track the location, reorder stock and generate billing/shipping information on the inventory item.

Bar Codes

Inventory tracking is nothing new; however, the need for increased speed, increased data content and reduced errors is constantly evolving. Bar codes appear to be the first technology developed for inventory tracking. Research began in 1948 by Bernard Silver in response to a request from a local food store chain owner from Philadelphia, PA for a method of automatically reading product information during checkout [1]. While the concept was first researched in 1948, it was not commercially viable until 1974 with the scanning of a pack of Wrigley's chewing gum in Troy, Ohio [2].

Bar codes utilize optical machine-readable representation of data. First generation bar codes represented data in the widths of lines and spaces. This was referred to as linear or 1D (1 dimensional) symbology. The next generation in bar code technology involved patterns of squares, dots, hexagons and other geometric patterns within images termed data matrix symbology or 2D (2 dimensional) symbology. Even though, no bars are present in 2D symbology, it is still referred to as a bar code [3].

Figure 1. Linear bar code [12]

Figure 2. Data matrix bar code [13]

Today, bar code technology is considered mature and has universal applications. Within the industry, bar code technologies are considered the most reliable and affordable form of AIDC technology. To complete data transfer to a computer system, the bar code must be "read" by an optical scanner. The main disadvantage of such a system is that it is line-of-sight based [4].

Radio Frequency Identification (RFID)

Radio Frequency Identification (RFID) is the latest development in AIDC technology. While the technology has been available for several years, it did not become cost effective until the late 1990's. Similar to bar codes, RFID systems require a tag (bar code) and reader (bar code scanner) in order to operate. The advantages of RFID systems are that line-of-sight not required, increased data capacity, limited human interaction and increased read speeds when compared to bar code systems.

Disadvantages of RFID systems are increased cost, read range limitations, metallic interference, security concerns and lack of global standards which impact worldwide adoption of this technology when compared to bar code systems. RFID has found its largest application in large retail vendors such as Wal-Mart and Target and with government agencies such as the Department of Defense and the Department of Agriculture [5-6].

Figure 3. RFID tag inlay [14]

II. Student Project

This project was offered as a special project course for electrical engineering students at the University of Louisiana at Lafayette in the College of Engineering. The course was supervised by the authors who are faculty in the Department of Industrial Technology in the College of Engineering.

Within most public universities, an annual equipment audit is required by the state to verify assets. At the authors' institution, this is a very laborious process that involves multiple faculty and staff to perform an annual, manual audit of all capital equipment items assigned to the department's inventory account. Capital equipment is defined as any item greater than or equal to $1000 in acquisition cost. While this amount does not seem significant, it was only a few years ago that many states required institutions to account for any item greater than $50 in value.

While some university departments have only a small number of items that would be considered capital equipment, science, engineering and technology departments tend to be heavily populated with such items. Performing a required 100% annual audit of these items usually requires several days to complete with a minimum of two faculty or staff. The greatest amount of time during a manual audit typically involves locating items that have been moved, misplaced or stolen.

During a typical manual audit, inventory tag numbers are located by one faculty or staff member and ”called-out” to a second member that locates the tag number on a hardcopy printout. Many times these numbers are not sequenced, and the staff member must “flip” pages to locate the tag number. As tag numbers are located, each item is “checked-off” the hardcopy to indicate that it has been identified. The location “room number” may or may not be verified during the audit. If a tag number that was “called-out” was not located on the hardcopy printout, it is usually be overlooked because it is assumed that the tag number was deleted from inventory. At the end of the audit, this information is transferred to a master hardcopy and returned to the inventory control office of the university.

Sometimes predefined tag number descriptions are required by a university’s inventory control office. This is usually because of a state policy and can create problems when trying to locate tagged equipment. An example could be a description of “laboratory apparatus”. This could be anything mechanical, electrical or part of a larger system. Without more information, much time can be wasted trying to locate the tag number. Additional, delays can occur if tagged equipment was moved or if tag numbers were lost or damaged.

To reduce the time required to complete the annual audit at the authors’ institution, the authors directed a student project to develop an automated inventory management system. The student project was divided into phases. Students first completed a literature review to research different types of commercial inventory management systems and to develop familiarity with industry terminology. Once the literature review had been completed, the students moved to the second phase of the project that involved the selection of a software development environment for the inventory management application.

The authors established project requirements that included correctly reading a university bar code on an inventory item and comparing the item to a database that contained the “correct” location of the inventory item. The “correct” location was defined as the official location listed in the university’s inventory database. The inventory location would be scanned, as well as, all contents within the location. If a scanned item was not located within the location or if a scanned item was not supposed to be in the scanned location, an error report would be generated. Other features were to include an edit function to change inventory information for such factors as data entry error, item deletion from university inventory or update inventory location. The database would also contain data fields for item cost and item description.

To contain project cost, an in-house bar code scanner was used for data collection. The bar code scanner was a commercial unit donated by a local company. The scanner brand was an Intermec model Sabre 1551 laser scanner. Through experimentation, students determined that the university inventory labels were readable with the in-house scanner.

Figure 4. Intermec model Sabre 1551 scanner [15]

Software Development

Any student project will have issues that must be resolved and is considered part of a student learning. For this project, no limitations were set to restrict the students' software options other than the university must own the software, or the software must be in the public domain. While not required, it would have been helpful if the students had an understanding of a software programming language [7-9].

After several false starts, the students selected the MySQL community server for the database engine, a Java complier, a Java2 standard edition (J2se), and a Java Run Time Environment (J2re) for the client interface [10-11]. These selections were based upon cost restrictions and local expertise.

The greatest amount of time required for the project was the manual creation of the inventory database. Once entered, several corrections were required to correct input errors. An electronic copy of the departmental inventory would have greatly reduced the development time of the project. After manually developing the database inventory, the next step was to develop the client interface program that would retrieve the details of a scanned item.

Software Operation

When the software application is launched, a window opens requesting a user name and password. Once the user name and password are entered, the application's menu shown in Figure 5 is displayed. The "edit database" function shown in Figure 5 allows the database to be modified by adding, deleting or editing an item in the database.

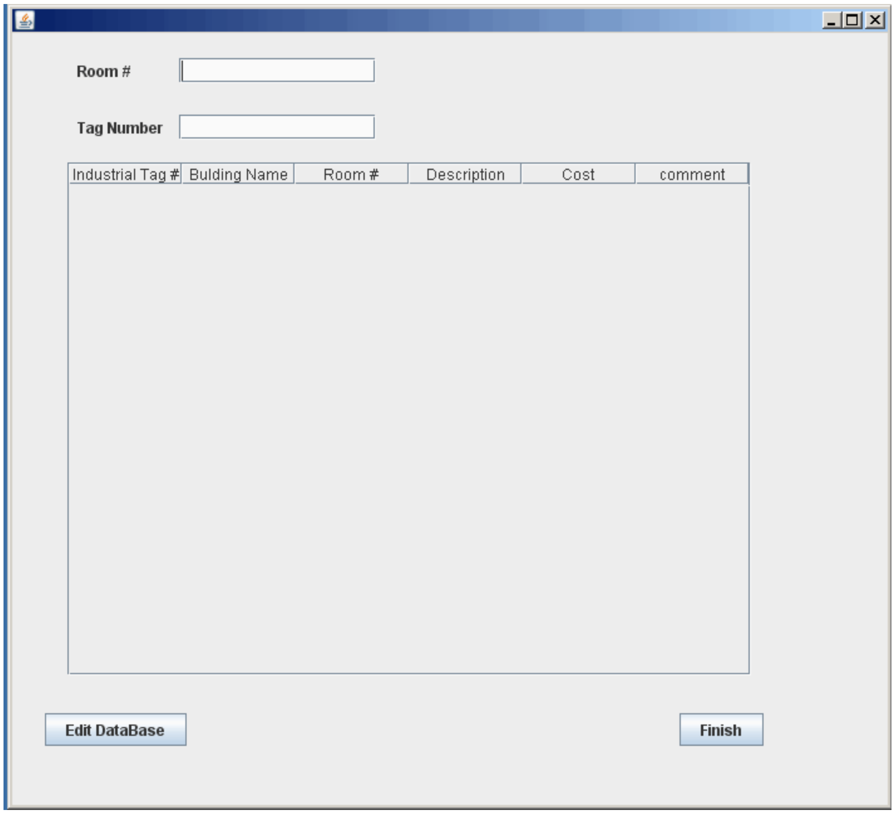

Figure 5. Application menu

When a room location number is scanned, the contents of the room location are displayed. When an item present in the room location is scanned, it is compared with the list of known items in the database. If a scanned item matches the room assignment, a message “correct place” is displayed in the comment section. If a scanned item does not match the room assignment, an error message “wrong place” is displayed in the comment section. f a scanned item is not located, a message “Missing” is displayed indicating that the scanned item was not found in the location. Examples of these comments are shown in Figure 6. If a scanned item does not match the database, a message box appears for the operator with the option to add the item to the database. If the operator does not add the item, it also permits the operator the opportunity to “manually tag” the item for future reference.

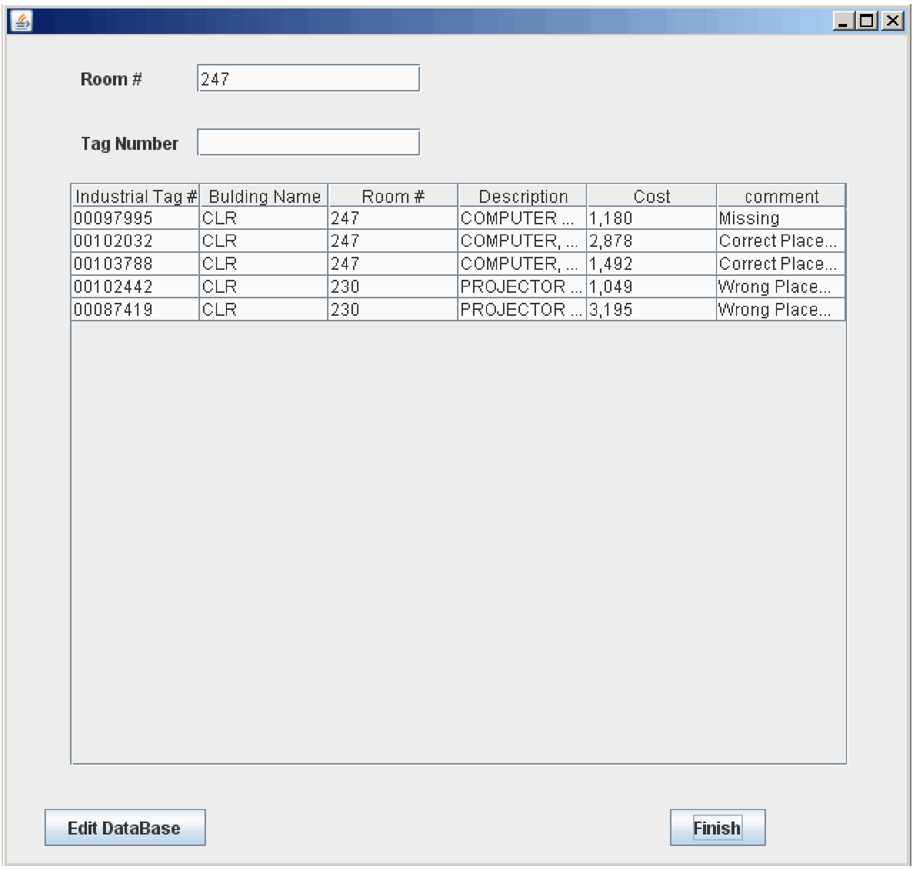

Figure 6. Application menu with comments

After scanning all items in a location, the “finish” button is selected. If items were not located, the comment “missing” appears opposite the item in question. Each time a location is completed, the operator has the option to save the “missing” or “wrong place” items in a text document. The saved file only contains the list of “missing” or “wrong place” items, and allows the operator to quickly identify them. Items reported in the wrong location can be moved to the correct location, or the database can be edited to update the item location. Missing items not located are reported to the proper university office.

III. Limitations, Future Developments

As previously mentioned, the project was completed in phases. In phase one, student research was conducted. In phase two, students developed the database, the software application client and pilot tested the application. After the pilot study, limitations were identified. These limitations included:

- The application software could not differentiate between rooms that contained a number and number/letter combination. For example, the application software could not differentiate between room numbers such as 276, 276A or 276B.

- The application software could not save each room's anomalies in different text documents. The application could only save the anomalies of all the rooms as a single text document and the document could not be renamed.

Third phase required students to correct the identified limitations and provide a user/installation manual. The revised application software was used by the Industrial Technology department for the departmental inventory in the fall of 2008 and 2009. The audit of over 500 items was completed in four hours and was considered successful by the faculty and staff using the software application.

A major limitation of the project was the selection of the software development package. To use the package, a significant knowledge of the package is required. The greatest limitation of the application software is the lack of a user friendly interface for the database. As an example, a specific procedure must be utilized to make a copy of the database.

Future student projects will address these limitations as well as the selection a different software development platform that will utilize an easy-to-use database. After completion, the inventory management system will be distributed to other departments in the college of engineering.

IV. Conclusion

Beyond traditional research, this project provided an opportunity for faculty to work with students to address an internal departmental problem. Unlike a traditional lecture course, students in the special problem course were tasked with developing a real application and demonstrating a working prototype within a specified time period. Students were exposed to an industrial model were managers assigned goals with firm deadlines which student were required to meet. Weekly meetings with the authors servings as "project managers" allowed the students to develop skills of working as a team, develop time management skills using GANT charts, perfecting "five minute" presentation skills to summarize weekly progress and writing skills for different target populations, e.g. user and technical professional.

The vision of the project was to develop a software application to track departmental inventory easier and more accurately than a manual process. An automated inventory management system is a given in any large business; however, inclusion in an academic environment can be a new experience. The authors believe that this type of software application would be very helpful to other institutions where inventory tracking is done manually.

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