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An Interactive RFID Based Bracelet for Airport Luggage Tracking System

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Abstract: Radio Frequency Identification (RFID) is a promising technology that has been implemented lately in airports. RFID tags are used to identify and track the location of passengers' luggage. This paper investigates the use of an interactive bracelet that communicates with the RFID system by mean of a database application. The database system interacts with the bracelet using messages that inform the passenger about his luggage status. The proposed database design and implementation are also discussed to describe the different functionalities of the application.

Keywords: RFID; Tracking System; Luggage; Travelers; Database System.

I. INTRODUCTION

In the light of the increasing number of airline users, many initiatives have been undertaken to enhance customers' satisfaction. These include the implementation of RFID luggage tracking system in airports. This system is still facing some challenges as it does not involve the passenger in the luggage tracking process. Consequently, an efficient luggage handling system is required. The use of an interactive RFID-based bracelet luggage tracking system would make the process of baggage handling easier and faster as it would reduce the passenger waiting time when a mishandling error occurs. The currently used baggage handling system causes a large number of mishandled bags. Mishandled baggage generates big losses to airline companies. The average loss behind a delayed bag is USD 21.90, USD 92.27 when the bag is damaged, and USD 348, 70 if the bag is lost. Those losses are estimated by an average value of USD 100 per bag [1]. RFID implementation in airports becomes very useful since it enhances the ability of luggage tracking, and increases customer's satisfaction. Yet, many improvements were done on the RFID system to optimize its results. In [2], the implementation of an intelligent RFID reader was done to provide various computing and logging operations, but also support the deployment of real-time tasks, execution control and automatic update of check-in and check-out information. The authors in [3] discussed an RFID equipment tuning and configuration methodology developed to support baggage tracking and feed dashboards with real time status of service level agreements between the airport, the airliner and the ground operators.

A passive UHF tag configuration is explained for suitcase identification and tracking in airport-handling applications in [4]. The evolving applications of RFID in airports, demonstrates a need for a new application that would involve the passenger to reduce his anxiety about the location of his luggage. The proposed luggage tracking system operates under three situations. The first case is when the passenger is on board and his luggage has been embarked. The second scenario is when a mishandling error occurs. The third case is concerned with a multi-stop flight. These scenarios will be further explained in a later section showing how the database system needs to react with each case. This paper is organized as follows. Section II analyzes the system components. In Section III, the interaction between these components is described. Section IV presents the system's cost analysis. Finally, Section V brings to a close the paper.

II. RFID-BASED TRACKING SYSTEM ANALYSIS

A. RFID Description

The RFID system is used to record and track the movement of a luggage in the airport through radio frequency communication. This system is composed of two parts: the reader and the transponder. This latter is also known as the tag. It is made up of an antenna and a silicon microchip [5]. It has a unique identification number and carries information. This data represents the personal information of the passenger, or an identity code that is stored in binary format. Tags can be either passive or active. The proposed system uses passive tags due to their widely use and cheap price. These tags do not have a power source but rather they get power from the incident electromagnetic field [6]. When the tag is in the RF field, it draws power used to get and transmit the stored information in the memory. In this way, the tag sends the traveler's information to the reader. Then, the reader converts the reflected waves sent by the tag into digital data for computer processing. Once the data is processed, the database system sends appropriate messages to the passengers.

B. The Interactive Bracelet Description

The interactive bracelet that is used to support the RFID in luggage tracking system is worn around the passenger's arm. The bracelet is made up of silicon and has a graphical LCD display module. The cost of this bracelet is included in the flight ticket and is handed to passengers in the checking process. This bracelet has a unique ID and receives text messages from the database application. This application processes the RFID signals, and then sends text messages to the passenger's bracelet whenever the luggage moves from a station to another. The bracelet has a button that can be used by the passenger to transmit an emergency message. There are two emergency cases when the passenger can send a warning message. The first case is when the passenger is on the flight and does not receive any message. He can send an emergency message to request information from the administrators of the system. This functionality is enabled by the airline staff when the boarding finishes. The second case is when the passenger arrives to the conveyor and does not find his luggage. He can send a warning message to notify the system administrators. At the end of the trip, passengers are required to return these bracelets back to the airline company. This interactive bracelet involves the passenger in the luggage tracking process as it informs him about the location of his baggage throughout his trip.

C. Database System for Data Processing

The database application that is used in this system considers C sharp as a programming language. C sharp includes functional, object-oriented and component-oriented programming disciplines. The Database Management System (DBMS) is relational. It displays the results of data processing in tables composed of rows and columns. The system also uses Oracle9i because it is commonly used in airports. The desktop application that tracks the RFID signals manages different functionalities which are: the management of passengers, luggage, flight, messages, and bracelet.

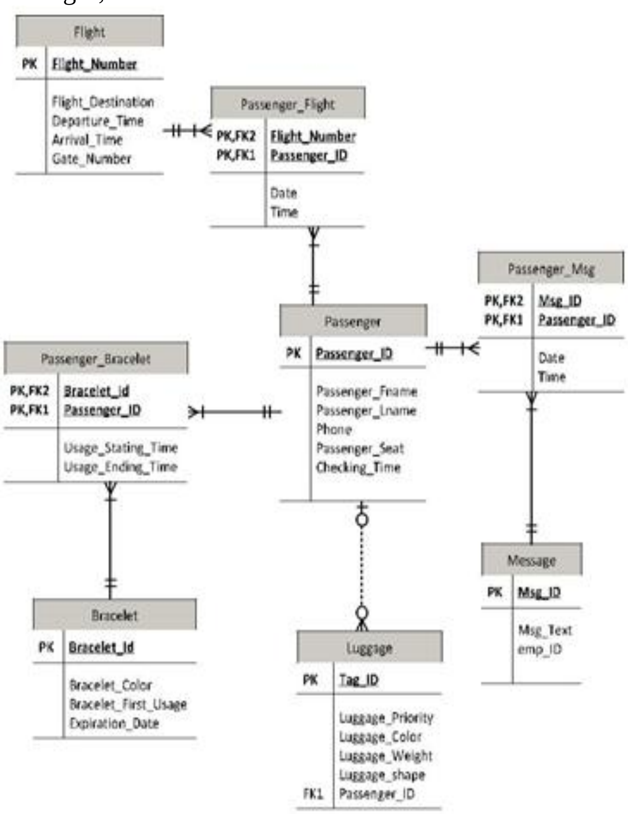

Figure1. Entity relationship diagram for the database system.

The passenger management would help the administrator keep track of all the passengers as well as the information about them (passenger ID, first name, last name, phone, email, class, seat, checking time). The flight management functionality stores data about the flight (flight number, destination, company name, departure time, arrival time, number of passengers, gate number). The luggage management functionality enables the system administrator to identify the following information about the luggage (Tag ID, color, luggage priority, weight, shape). The bracelet management function keeps track of the attributes (bracelet ID, bracelet color, first_usage_date). The messages management functionality is responsible for storing specific messages that matches appropriate situations. Those situations will be explained in the next section. The attributes that defines this functionality are (Msg_ID, date and time). Fig. 1 represents the entity relationship diagram using Cross Foot Model. This diagram shows the different entities along with their relationships. The relationship between a passenger and luggage (is one to many) relationship since a baggage can be owned by only one passenger while the passenger can have more than one baggage.

The passenger-flight relationship is (many to many) relationship since a flight can have many passengers on board while a passenger can travel on a many flights. Thus, a bridge entity called Passenger-Flight is needed. This bridge entity contains Flight_Number and Passenger_ID as a primary key. This entity keeps record of a specific passenger along with the flight he took. The passenger-message relationship is a many to many relationship since the same message is sent to many passengers and a passenger receives many messages during his flight, so a bridge entity is required as it is called *Pass_Msg*. This bridge entity contains as a primary key the respective primary keys of the two entities passenger and message. Finally, the relationship between a bracelet and a passenger is (many to many) relationship s ince a passenger can have one to many bracelets and a bracelet can be worn by one to many passengers since these late r are required to return them back to the airline company at t he end of the trip.

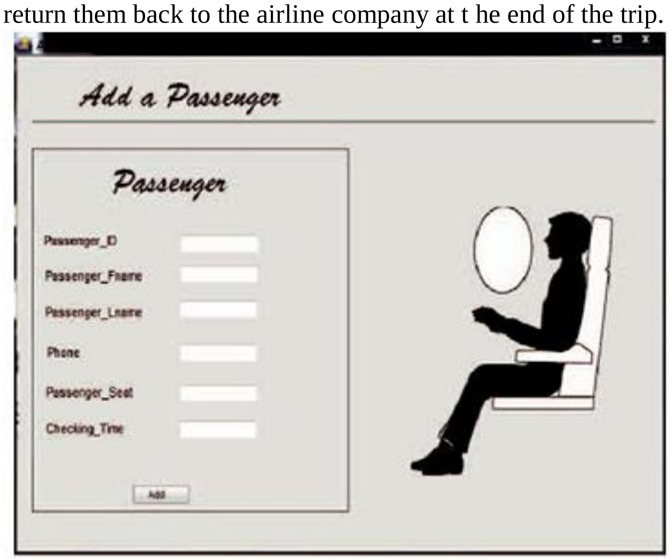

Figure2. Graphical User Interface of the function add a passenger.

The administrator can perform several functions on each of the building of the database, e.g., adding a passenger to the list. Fig. 2 is a Graphical User Interfac e that allows the user to perform this functionality. He c an also modify passenger information, delete a passenge r from the list, search for a specific passenger and view the list of all the passengers along with their information. These functions can be handled in flight, luggage, bracelet and messages functionalities. Concerning the application structure, a user-friendly interface is implemented. The Graphical User Interface (GUI) is a very important component of the application since it represents the way by which the user communicates with the system. Therefore, it is importa nt that the user interface should be friendly, clear, and easy to understand in order that the user can benefit fully from the services the system provides. Fig. 3 represents the GUI for the function "Add a Flight". This functionality allows the user to enter the different attributes of a specific flight such as Flight_Number, Destination, and Departure_Time.

Figure3. Graphical User Interface of the function add a flight.

III. HOW THE RFID-BASED TR ACKING SYSTEM WORKS

The implemented system organizes every step of the luggage handling process. In the check-in process, the passenger chooses one of the two options which are to get information about his luggage either through his phone or via the bracelet that could be handed to him upon request. In case the passenger does not have a phone or have a discharged battery, he would be obliged to opt for the second option. The passenger is then informed about the bracelet operating instructions. When the luggage is placed on the conveyor, the reader collects the tag data and records the beginning of the trip. As the bag moves through the conveyor, the RFID keeps track of the luggage in order to m ake sure that it would be delivered to the right gate and flig ht. At the same time, the database system processes the data sent by the RFID system and retrieves from it the passengers ' information in order to know the bracelet ID and be able to send the appropriate message. Fig. 4 shows this interaction. As stated before, there are three scenarios where the system operates. In the first scenario, when the passenger's luggage has been embarked, the passenger should receive a message stating that "Your luggage has been embarked successfully".

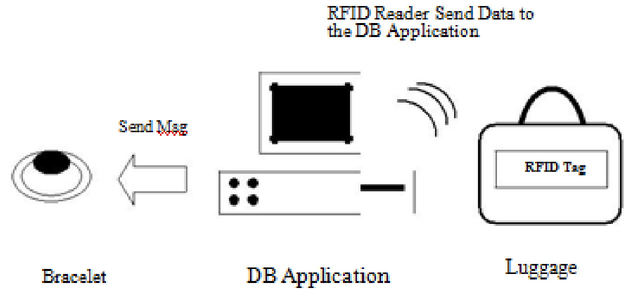

Figure4. Interaction between the RFID-based system components.

Figure 5. Database table for the proposed system.

The role of this system is mostly important in the delivery process as it allows the bag to be easily located and delivered to the right traveler. Again the passenger receives a message informing him that his luggage arrived to the delivery conveyor. There are two other scenarios when the database application operates differently. In the first case which is a multi-stop flight, the passenger receives a message each time his luggage arrives to a different airport. The advantage of this feature is that the passenger never worries about the location of his luggage. The second case is when a mishandling problem occurs; the passenger does not receive a message so he sends an emergency message to the system that checks the location quickly. Then, the system administrates try to fix the problem as soon as possible. Fig. 5 shows a Graphical User Interface (GUI) that presents the relationship between the entities' attributes. This table is in first normal form (1NF). The database matches each passenger who is identified by a unique ID with the corresponding flight numb er and bracelet to which a message is sent. For instance, the passenger whose ID is '13338' receives a text message stored in the database through the bracelet ID: '528'.

IV. COST ANALYSIS

The cost of RFID implementation has decreased significantly due to the increasing availability of RFIDs in the market as they are used in thousands of applications. This cost depends on many factors such as the size of the installation and the type of the RFID system. Table I presents a draft cost estimation (in USD) of the considered RFID system [5] along with the bracelet [6]-[7]. The implementation of the proposed system in airports appears to be expensive. With this technology, airlines companies would save millions of dollars related to mishandling errors and baggage losses that occur frequently.

Table I: System Compo Nents Cost

Parameter	Estimated Cost
RFID Passive Tags	Generally, $0.07 to $0.15
RFID Printer tags	Range from $1,600 to $1,800
RFID Fixed Readers	Range from $500 to $2,000
Silicon Bracelet	$ 1
Graphic LCD Display Module	$5 to $10
Total Cost	$2106. 07 to $3811.15

V. RESULTS

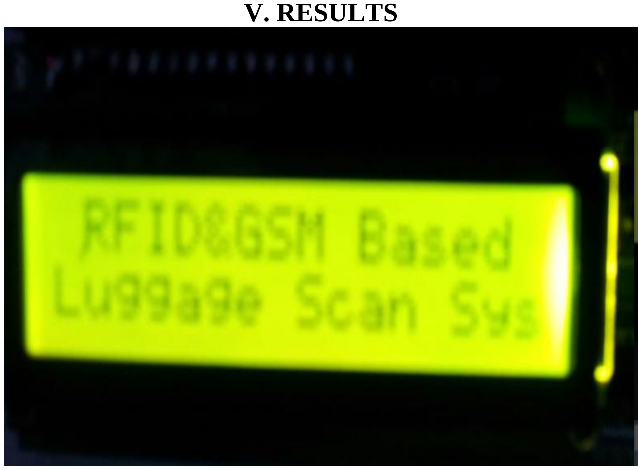

Figure6. RFID & GSM Based Luggage Scan system.

Figure7. Uploading a Message.

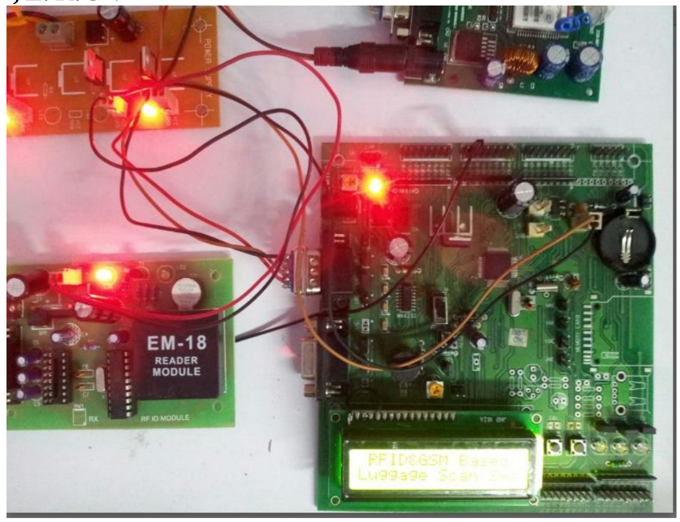

Figure 8.Hardware of .RFID & GSM Based Luggage Scan system.

Figure 9. Luggage delivered to the valid person.

VI. CONCLUSION

In this paper, an interactive RFID-based luggage tracking system was proposed. The suggested bracelet involves passengers in the luggage tracking process. An analysis of the overall system's interaction was presented. Furthermore, the design and implementation of the considered system were also discussed. With this solution, customers' satisfaction in airports would be increased and mishandling cost would be lowered.

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