

AC 2010-679: AUTOMATED LUGGAGE TRACKING SYSTEM

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Automated Luggage Tracking System

Abstract:

The Automated Luggage Tracking System (ALTS) implements Radio-Frequency Identification (RFID) to read the tag on a piece of luggage as it is being loaded onto a plane. In the real world application, an airline employee enters a passenger's information into the system and then he will associate it to a unique tag. Every time a luggage with the tag passes through an RFID reader, the location status in the airline database will be updated for tracking. This system allows the passenger to check if his luggage has made it safely onto the plane. It also provides inventory control to the airlines in order to improve their services.

During check-in, the passenger data such as name, address, phone number, flight number, destination and unique tag identification per luggage is inputted into the airline database. If requested, the passenger is provided a handheld device to check the current location of his luggage. Every time a luggage passes through an RFID reader, its information is transmitted wirelessly to the airline database as well as the handheld device built around a 16-bit Motorola microcontroller (MC68HC12). RFID is a growing technology that could be used to reduce number of mishandling luggage which was reported by the Department of Transportation to be over 1.1 million between January to June 2009².

Introduction:

There are many Automatic Identification and Data Collection (AIDC) technologies that have been used throughout the years 1930s and 1940s. The most pervasive ones are barcode, magnetic stripe, and Radio-Frequency Identification (RFID). Many experiments have been conducted when the barcode was first introduced in the 1940's. The first patent of the barcode was in 1949 by Bernard Silver and Norman Joseph Woodland⁸. The first major application of the barcode was in the late 1960s in a rail car tracking system. In the 1970s when the Universal Product Code (UPC) was introduced, it transformed the barcode technology into a business juggernaut⁴. The barcode technology has been used widely in many industries and organizations. The other use of AIDC was with the magnetic stripe. The magnetic stripe has been widely used on credit, debit, or ID card. During World War II, British Army with their radar systems utilized RFID to identify an allied aircraft from enemy aircraft⁴. Since then, RFID has been used to identify animals, automatic toll collection, access control, security, equipment tracking, payment at variety of retail outlets, and many other applications. RFID is a growing technology that can be used for a wide variety of applications from security to inventory control. This technology utilizes "radio waves to automatically identify individual item"⁷. The basic elements in an RFID system are the tags, reader, antenna, and a computer network⁴.

Currently bar coding has been implemented in the airports to sort, track, and identify people's luggage. With the bar coding system, there have been a large amount of mishandled luggage. In the August 2009, U.S. Department of Transportation announced that, the total number of mishandled baggage reported between January to June 2009 by U.S. airlines is over 1.1 million².

With the RFID system, there can be a significant decrease in the amount of mishandled luggage. There are different types of RFID tags and readers in the market. The tags are the main components of the system because they contain unique identification numbers. The tag can be active with an internal power supply, or passive, which draws power directly from a reader.

Table 1 is a quick reference to several available RFID technologies.

Frequency	Type	Application	Range
125 KHz – 148 KHz	Passive	Animal tracking, access control, and OEM applications.	Ranges from 0.5 inch to one foot.
13.56 MHz	Passive	EAS (anti-theft), book and document management, access control, and OEM applications.	Ranges from inches to several feet, depending on reader hardware and tag type.
433 MHz (and 2.5 GHz)	Active	Highway toll payment systems, vehicle/fleet management, asset tracking, and so on.	Typically 30 feet, but can range up to hundreds of feet.
915 MHz	Passive	Supply chain tracking and OEM applications.	10 feet from a single antenna and 20 feet between two antennas. Longer ranges can be realized with special hardware.

Table 1: RFID Frequencies, Applications, and Typical Ranges ⁵

System Description:

The ALTS implements RFID to read the tag on a piece of luggage as it is being loaded onto a plane. In the real world application an airline employee will enter a passenger's information into the system and he associates this information with the tag's unique ID. There is a Graphic User Interface (GUI) that is strictly for the employees to enter this information and add the tag. Another GUI is provided for the passengers to confirm their flight and check their information. A receipt would printout for the passenger with their name, tag ID, departing and arriving airports.

Once the luggage is ready to be loaded onto the plane, the RFID reader will identify the tag and changes the status location in the airline database to "on the plane - flight #xxxx". The passenger will use his laptop, mobile phone, or 68HC12 handheld controller to search for where his luggage is located. It is a tracking system that allows for the passenger to find an updated report on the location of his luggage. Another possibility is to allow the passenger to know that his luggage is on the plane by sending a text messages. In this system, there is going to be more than one reader to track a piece of luggage at multiple points throughout the terminal to ensure even

more accurate inventory. This system in particular has three check points: check-in, plane, and baggage claim.

The type of RFID tags utilized in this design is read-only. There is a database in order to match the tag to a passenger. Information about a passenger, such as name, address, phone number, flight number, and destination, would be inputted into the database with the unique tag identification. Figure 1 shows a block diagram of the system. The Phidgets RFID reader is connected by USB to a computer. The reader gets the data from a tag and compares it to the tracking information. Passenger could access some information wirelessly using his laptop, mobile phone, or 68HC12 handheld controller.

Block Diagram

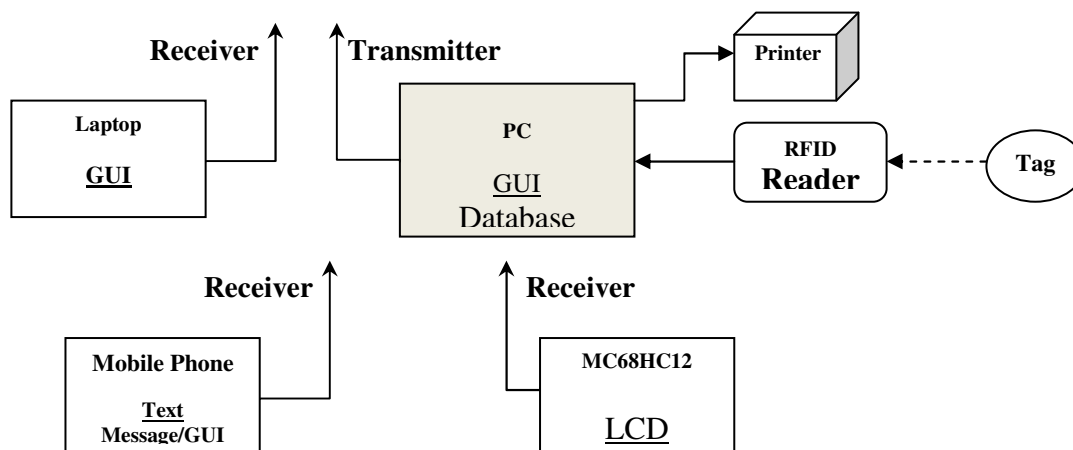


Figure 1: Block Diagram

Design Specifications:

Graphic LCD Display ³:

Power Supply – 4.5V to 5.5V

Supply Current – 11.8 ma

Supply Current – 11.8 ma

Dimension – 3.67” x 2.76” x 0.48” (93mm x 70mm x 12.1mm)

Viewing Area – 2.44” x 1.299” (62mm x 33mm)

Receiver ¹:

Power Supply – 7.5Vdc to 15Vdc

Current – 10 ma

9600 bps, 8 data bit, No parity, 1 stop bit

AM Frequency – 315 MHz and 433 MHz

Range – 300ft

Transmitter ¹:

Power Supply – 7.5Vdc to 15Vdc

Current – 12 ma

9600 bps, 8 data bit, No parity, 1 stop bit

AM Frequency – 315 MHz and 433 MHz

Range – 300ft

RFID Reader (Phidgets) ⁶:

Antenna Output Power – <10 μ W

Antenna Resonant Frequency – 125 kHz to 140 kHz

Read Update Rate – 30 updates/second

Supply Voltage – 5Vdc

Supply Current Limit – 400 ma

USB-Power Current Specification – 500 ma max

RFID Tag (EM4102 protocol I) ⁶

Read-only

Passive

30mm Disc Tag – read distance 6cm (3”)

Cost List:

Part	Manufacturer/Distributor	Part No.	Cost
RFID Kit – reader (USB) and tags	Phidgets	RB-Phi-32	\$80.70
Receiver	Abacom Technologies	ARX8-9600	\$49 (\$15 shipping for rec. & trans.)
Transmitter	Abacom Technologies	ATX8-9600	\$49
Graphical Text LCD 128x64	Samsung	KS0108B	\$23.90
Microcontroller	Motorola	MC68HC12	\$150

Estimated total cost of parts is \$367.60.

Motorola 68HC12 Microcontroller:

The CMD-9S12DP512 is a low cost full-featured development system⁹ with on-board USB BDM development port for the free scale MC9S12DP512. The board provides operation in Single-Chip Mode or Expanded Wide Mode with memory bus available for expansion and development memory access. System is supplied with a powerful IDE software suite (AxIDE4) with GNU “C++” compiler and assembler, and the USB BDM debugs support for a seamless development environment. The integrated USB-BDM provides background development control of the HCS12, optional board input power, and for single point connection to the host computer there is an optional serial communication via the USB port. Development software is Windows

XP compatible and provides source code level development support, selection of target operation modes, target code loading, target flash memory programming, and multiple window views for target registers and data. When not required for development use, the USB BDM port may still be optioned as a USB serial port. The Axiom CMD-12DP512 development system provides a full seamless hardware and software application development environment. The onboard BDM circuit allows the user to locate code in the on-board RAM or HC12 Flash, set break points, step code, and display or modify registers and / or memory. After application is operational the user may apply the board for dedicated operation of new software. I/O port headers provide easy connections to breadboard area or user option components with 24GA solid core jumper wires (provided). Pin headers may also be installed to apply IDC ribbon or other connections. The Keypad and LCD ports are compatible with the Axiom HC-KP 16 key (4x4) keypad and HC-LCD 80 character (4x20) LCD module.

CML12S-DP256 Specifications

Upward code compatible with 68HC11
4K Bytes EEPROM
512K Byte Flash EEPROM
14K Byte SRAM
2 Enhanced SCI Ports
3 SPI Port (Synchronous Serial)
5 CAN 2.0 A or B Interface
Two 8 Channel 10 Bit Analog Converters
Background Debug Port
Enhanced 16 bit Timer w/ 8 channels
16 Bit Pulse Accumulator
8 PWM Channels
Two 8 bit Key Wake-up ports
PLL Clock Oscillator Support
RTC and COP features
Up to 91 I/O
4Mhz reference oscillator for up to 24MHz operation.
External Memory: 256K Bytes (128K x 16) SRAM
COM1 Port – HC12 SCI0 w/ RS232 and DB9S connector
COM2 Port – HC12 SCI1 w/ RS232 and 3 pin header
INDICATORS – Power and RESET.
BUS-PORT – 40 Pin Socket Header
MCU I/O PORT - 60 pin Socket Header
Analog Port – 20 pin Socket Header
CAN PORT – CAN 0 I/O with 1M Baud Transceiver
LCD Module and Keypad Ports
Easy Power Connection and Tap points'
Back Ground Debug (BDM) Port – 6 Pin standard
Power Specifications: 7 to 25VDC input to 5V Power Supply
Operating Power: 60ma @ 5V

Data Flow Diagrams:

This project has at least three processes. The first process is for reading the tag and sending information to the database. The second process is when the tag is located at one of the three readers. The third process is a GUI allowing a passenger to search his name or tag (Figure 2).

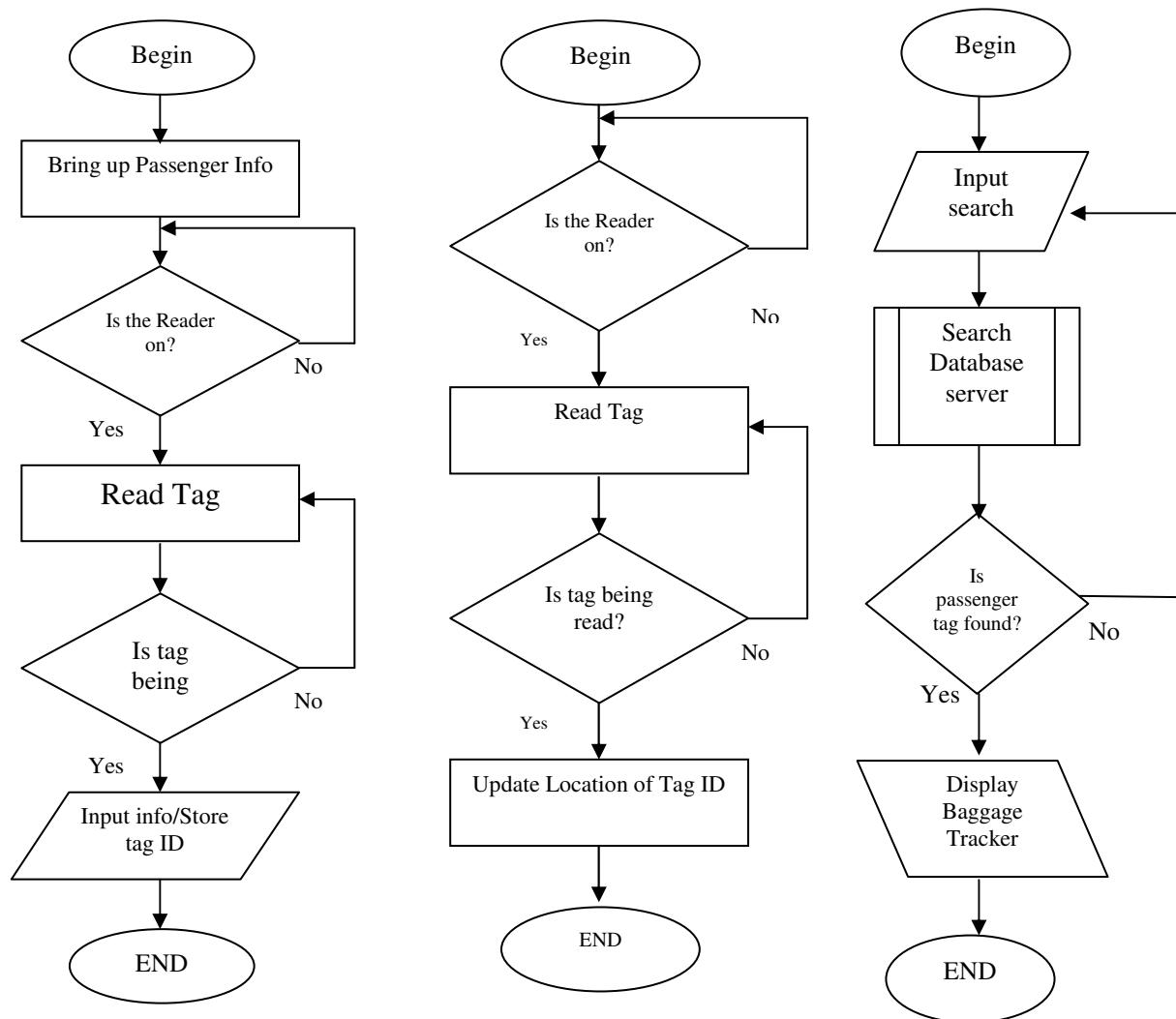


Figure 2: Flow chart of the processes

Results:

In the implementation of this project, the first process has a GUI interfaced with a database. This GUI created in java with the following fields: tag, name address, phone number, flight number, and flight destination. In this process, passenger's data will be entered into the database and a unique tag ID will be assigned. The second process identifies the tag and searches the database to find the passenger's information. Once the information is found, the passenger's name, flight number, and destination are transmitted wirelessly to a database. With regards to the database

server, MySQL 5.1 was installed onto the computer. This database is called “RERAirlines” and currently has at least five tables: flight information, passenger information, airports, confirmation, and tag information. To link Java programs to the database server, a JDBC driver (MySQL Connector/J) is installed. The java program has to go through the JDBC driver to connect to the MySQL database (Figure 3).

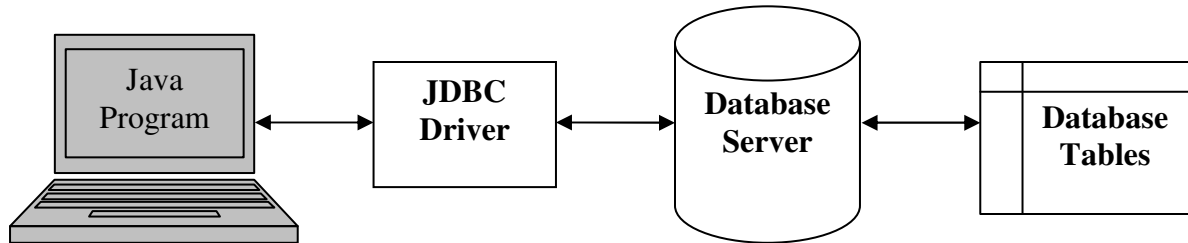


Figure 3: The JDBC Architecture



Figure 4: RFID Software Design

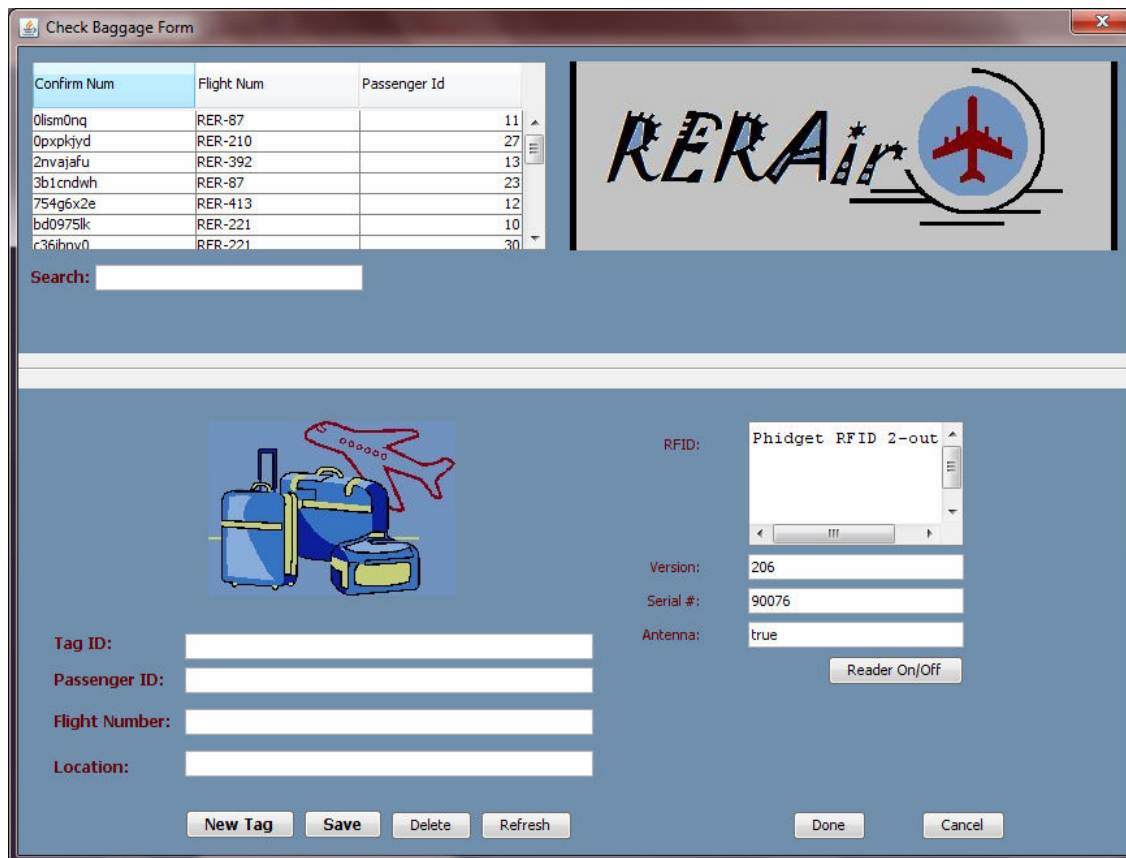


Figure 5: Screen shot of the GUI

Future Expansion:

This project was designed with a low frequency (LF) RFID reader, limiting the range and type of the ID tags. The system can be expanded to use a high frequency (HF) or even an ultra high frequency (UHF) RFID reader, giving more range and more features such as read/write ID tags. A wrist mounted reader can be implemented, allowing the tag to be read, as each item is loaded onto the plane. As a result, this ensures that the scanned items are sent to the proper destination. This system could replace the outdated scanner system with a modernized RFID system that tracks luggage from the time it is handed off by the passenger until it is claimed at its final destination.

Conclusion:

The design of ALTS based on RFID technology provides an efficient solution for tracking baggage to minimize baggage-handling errors and misplacing of luggage in the airports. If this project is adopted by airlines, the new system will save both airports and airline companies over millions of dollars, through the prevention of time wasting of finding and replacing lost luggage.

With RFID tags, tracking of passengers' luggage will be simpler and better in comparison to the current bar coding system. With this technology, passenger will be able to feel relief knowing where his luggage is located. Upon check-in, each luggage is scanned by the RFID reader at the airport; all the information needed to arrive at its destination will be recorded in the airport database. Once the luggage has been retrieved from the baggage claim, the tag ID will be deleted from the database and will not be reentered in the database until the customer returns for another flight.

Design of ALTS project is complete and running. One of the main features of this project is that MySQL database is able to create, save, update, retrieve, and delete data from the tables. The system is able to update the database for the location of the tag when luggage passes through a reader. The RFID reader is interfaced to the GUI, and is able to save the tag ID to the database and identify the current location of the reader. The GUI in Java is able to connect to the database using the JDBC connector.

As in any system, there are going to be risks involved. One of the main risks when using RFID technology is the privacy and security issues. In the current market, there are handheld RFID readers available to general public. With the correct reader and range, any person would be able to have access to the luggage ID tags. This project resolved this issue by utilizing read-only ID tags containing only the unique tag identification number. Read-only ID tags are different from the general purpose tags with memory, such as active tags. These tags can hold more information such as passenger data, making the system less secure. If active ID tags are used in ALTS, the security issue can be resolved by facilitating data encryption.

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