A New Approach for Secure Baggage Management at Airport using Encrypted Two-Dimensional Barcode

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Abstract*— One-dimensional (1D) barcode stores data in only one direction (horizontally), whereas in two-dimensional (2D) barcode, data is stored in both the directions (horizontally and vertically). Also, the amount of data that can be stored in 2D barcode is significantly greater than that stored in a 1D barcode. Here, we propose an approach for Baggage Management at Airport using 2D barcode for the first time, so that the baggage(s) of two passengers looking alike will not be interchanged and also misplaced or lost baggage(s) can be handled properly. This approach is also beneficial for the authentication of ticket, boarding pass as well as baggage(s) with the minimum use of the database. For the authentication, we use a unique ID like passport number, PAN number, etc., which is encrypted with a master key (issued by the Airport Authority) in the ticket barcode (encrypted 2D barcode on the ticket), boarding pass barcode (encrypted 2D barcode on boarding pass) and baggage(s) barcode (encrypted 2D barcode affixed on baggage(s)). At the time of check-out, this ID is extracted from the boarding pass barcode and the baggage(s) barcode. The Passenger is allowed to leave with baggage(s) only when ID from both the barcodes is same, otherwise not. If the baggage(s) is/are lost, the passenger has to produce missing baggage barcode (issued when passenger register a complaint for the same) in addition to baggage(s) barcode, at the time of check-out, so that he/she is allowed to leave. For the misplaced/lost baggage(s), authorized person will decrypt the barcode affixed on it to retrieve the contact and boarding details of the owner, so that it can be handed over to the right airport and then to the right person. For encryption and decryption of the barcode, the same master key is used everywhere. Here we use, Advanced Encryption Standard (AES) scheme for encryption/decryption and for the barcode we use Quick Response (QR) Code.

Keywords-2D Barcode, QR Code, Authentication, AES, encrypted 2D barcode.

I. INTRODUCTION

A barcode is a representation of the data about the object to which it is attached such that only machine can read [11]. Barcodes are of three types one-dimensional (1D), two-dimensional (2D) and three-dimensional (3D). In 1D barcode, data are represented by varying the widths and spacing of parallel lines, whereas in 2D barcode information is stored both horizontally and vertically. 3D barcodes do not use any barcode labels. They are embossed or engraved directly on the product during the manufacturing process.

Barcodes are scanned by special optical scanners called barcode readers and now-a-days softwares became available on devices including smartphones, so that anyone carrying a mobile phone with barcode scanner software can read the barcodes [11]. In general, there are two types of 2D barcodes: stacked 2D barcodes, such as Code 49 and PDF417, and Matrix 2D barcodes, such as Data Matrix and QR Code. The main application of barcode is in logistics management, ticketing system, authentication, business transactions, catering orders, security applications, etc.

Quick Response Code (QR Code) is one kind of two-dimensional matrix code developed by the Japanese Denso company in September 1994 [4]. QR Code increased by 20% than the other two-dimensional bar code on the efficiency of the character representation. In addition to the advantages of two-dimensional bar code, it also has features such as ultra-fast response, comprehensive reading, the portable offline application database, more efficient representation of numbers of letters, characters, images, etc. The complete specification of QR Code is documented in ISO/IEC 18004:2000 [3].

Figure 1. QR Code

Advanced Encryption Standard (AES) is a specification for the encryption of electronic data. It has been adopted by the U.S. government and is now used worldwide. The algorithm described by AES is a symmetric-key algorithm, meaning the same key is used for both encrypting and decrypting the data. The complete specification of AES is given in NIST FIPS PUB 197 [7].

Our approach uses QR Code for encoding of the data and AES for the encryption purpose. We have chosen QR Code because it is having maximum capacity among two-dimensional barcodes and AES scheme because it is faster and stronger than other schemes.

Here, we propose an approach for Baggage Management at Airport, so that the baggage of two passengers looking alike will not be interchanged and also misplaced or lost baggage(s) can be handled properly. This paper provides a

secure way for managing the baggage(s) at the airport. This approach requires the minimum use of the database, since maximum information is stored in the 2D barcode. For encryption and decryption, we use a master key everywhere, which is issued by the Airport Authority.

At first, we purchase a ticket (either offline or online), which contains encrypted passenger's journey and personal details in the form of a 2D barcode. Boarding Pass is issued to the passenger only when his/her encrypted ID of the ticket is matched with the produced ID Proof. The Boarding pass contains an encrypted 2D barcode having boarding details (which includes a number of baggage (s)). The ID details are encrypted in the ticket, boarding and baggage(s) details. For the identification of the owner of lost or missing baggage(s), we encrypt personal details in the baggage(s) details. In addition to personal details, we also encrypt boarding details in the baggage(s) details for the baggage management at airports. These encrypted details are encoded into the 2D barcodes to get encrypted 2D barcodes, which are then affixed on the boarding pass and individual baggage(s).

At the time of check-out, the passenger has to use his/her boarding pass barcode with the baggage(s) barcode for the authentication of the baggage(s). The passenger is allowed to leave with baggage(s) only when ID on his/her boarding pass barcode matched with ID on the baggage(s) barcode as well as the number of baggage(s) is/are same as mentioned in boarding pass barcode. If the baggage(s) is/are lost, the passenger has to produce missing baggage barcode (issued when passenger register a complaint for the same) in addition to baggage(s) barcode, at the time of check-out, so that he/she is allowed to leave. For the misplaced or lost baggage(s), authorized person will decrypt the barcode affixed on it to retrieve the contact and boarding details of the owner, so that it can be handed over to him/her.

The paper is organized as follows. In Section II, we discuss the related work. In Section III, we will describe our approach. In Section IV, we will show the implementation of our approach. Finally, we present our conclusion in Section V.

II. RELATED WORK

In recent years, new types of advanced 2D code (the specification of QR code is not in compliance) have been developed. Also, new types of application are evolved using these new types of barcodes. QR codes have been used and printed on Chinese train tickets since late 2009 [4]. Previously, we use barcode with a client/server model for authentication [8], but now QR Code can be used for authentication purpose using our own smartphones from where we capture, store and display it [6]. We can also store our card details in 2D barcode, which can be useful for payment through our smartphones [10].

Since, 2D barcode reader application is available on smartphones, so anyone can read the 2D barcode. But somewhere it is not desired that everyone can read it, like if it contains Credit Card details, username and password for an account or any personal information that is vulnerable to theft, should not be encoded in barcode directly. There must be some way to hide this information so that a normal reader cannot read or if read then user is not able to understand it. For this purpose we have to encrypt the information and then encode it and thus, encrypted barcode comes into existence.

Encryption and encoding are the two procedures that executed sequentially, first the input message is encrypted into an encrypted output, and then a redundancy is introduced by the error-correction algorithm [9]. The composition of the two procedures results in an encrypted message which is error resistant up to a certain degree. The inverse operations, decoding and decryption is done in two separate steps as well, in a reverse order, first decoding then decryption [9]. There are various types of encryption scheme available with their own advantages and disadvantages like DES, AES, Diffie-Hellman, RSA, etc.

Cryptcoding is a procedure in which encryption/decryption and error-correction coding/decoding are performed in a single step [9]. There are various sites where we can generate QR Code for our data. There are also sites where we can learn how to make QR Code generator [5].

III. APPROACH USED

For our approach we use QR Code to store and transfer the information and for encryption, we use AES scheme, which is faster and stronger than other schemes. Our approach uses encryption then encoding to generate an encrypted barcode for the data and this barcode is first decoded then decrypted to get the data. This is shown diagrammatically in Figure 2 below.

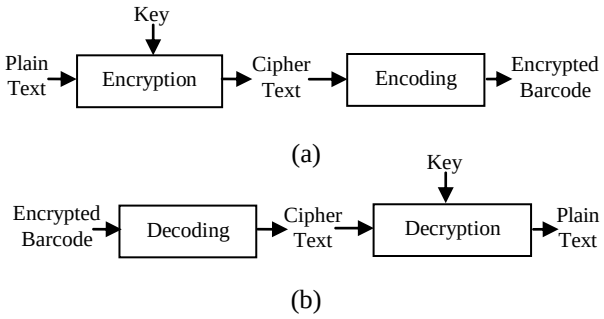

Figure 2: (a) Encryption and (b) Decryption in Barcode

For encryption and decryption, we use a master key everywhere, which is issued by the Airport Authority. Our proposed approach is shown in figure 3 below. Here, the barcode is encrypted 2D barcode. The steps of our proposed approach are as follows:

(1) At first, the passenger has to fill his/her journey, personal details with ID proof either online or go to

the counter for the ticket. He/she must have the same ID Proof with him/her that is required for authentication of the passenger at the airport.

(2) Now, the Ticketing System generates a ticket with encrypted 2D barcode for the passenger, which contains encrypted ID details of the passenger.

(3) At the Boarding Pass System, Passenger has to show his/her ticket barcode, baggage(s), ID Proof.

(4) Now, the system validates the ticket with the produced ID proof. If validation is successful, then the system issues him/her boarding pass for the respective flight mentioned on the ticket, otherwise not. The Boarding Pass contains encrypted 2D barcode having boarding details with the number of baggage(s), which he/she has given to the counter.

(5) The baggage(s) with details (ticket detail, boarding details, ID details) of the passenger are passed to the Baggage System. For the identification of the owner of lost or missing baggage(s), we encrypt personal details in the baggage(s) details. In addition to personal details, we also encrypt boarding details in the baggage(s) details for the baggage management at airports. These encrypted details are encoded into the 2D barcodes to get encrypted 2D barcodes, which are then affixed on the boarding pass and individual baggage(s).

(6) If a passenger posses any handbag and wants to keep with him/her, then it is returned to him/her for the journey.

(7) Remaining baggage(s) will go to the passenger's flight.

(8) Passenger boards to the flight for the journey by showing his/her boarding pass to the Boarding System, which is validated by the flight number.

(9) The passenger board-out from the flight after the journey.

(10) Baggage(s) from the flight go to the Baggage System.

(11) Passenger goes to the Baggage System to collect his/her baggage(s).

(12) Passenger's collects his/her baggage(s).

(13) If the passenger does not find all his baggage(s) then he/she has to go to the Missing Baggage System to register a complaint for missing baggage(s), which requires the boarding pass of the passenger and number of baggage(s) lost/misplaced.

(14) Passenger collects his/her missing baggage(s) barcode, which is encrypted 2D barcode storing passenger's boarding and personal detail.

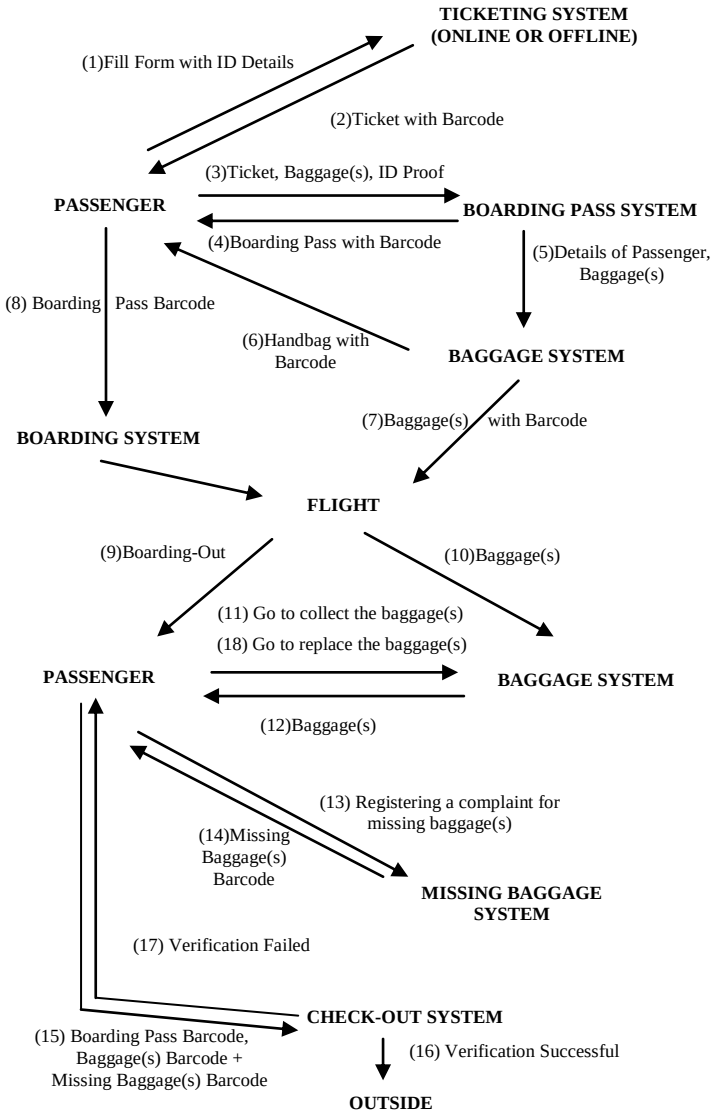

Figure 3: Our Proposed Approach

(15) Passenger shows his/her boarding pass barcode with the baggage(s) barcode to the Check-Out System. In addition to above barcodes, if the passenger misplaced/lost his/her baggage(s), then at the same time he/she has to show missing baggage(s) barcode.

(16) After verification is successful, he/she can leave the airport. For the verification, we extract the passenger's unique ID from the barcodes and match them.

(17) If verification is not successful, it means these baggage(s) are not belonging to him/her.

(18) Now, passenger has to go to the Baggage System to replace his baggage(s). After this, we move to step 12 and proceed again.

Since our approach is mainly focuses on storing the information on the two-dimensional barcode, thus, it is independent of the database. When any baggage(s) without any owner is found, its barcode is decrypted by some authorized person to get the Name, Contact and Address of the owner. Then, we inform the passenger about this and request to come along with address proof. So that passenger can take his/her baggage from the airport.

IV. IMPLEMENTATION

We implemented our proposed approach with Visual C# on Visual Studio 2008 with .Net Framework 3.5. The application consists of: Ticket Form, Boarding Pass Form, Boarding Form, Baggage Form, Check-out Form, Missing Baggage Form and Master Forms for Ticket, Boarding Pass, Baggage and Missing Baggage. Master Forms are used to extract details from ticket, boarding pass or baggage, if the same is lost.

The screen shots of our application with details are as follows:

1.) **Ticket Form:** Ticket form is used to collect the basic detail of the passenger with some ID Proof that he/she must have at the time of boarding on the flight. This form generates encrypted barcode for the ticket.

Figure 4: Ticket Form

2.) **Boarding Pass Form:** Boarding Pass Form requires ticket details for issuing Pass and ID Proof (for manually verification) of the passenger. After verification of the passenger, the pass is issued to him/her containing an encrypted barcode.

Figure 5: Boarding Pass Form

3.) **Baggage Form:** The ticket barcode and boarding pass barcode is then input to Baggage Form. This form also requires filling of baggage details like type, colour and weight for all the baggage. The barcode generated by this form is pasted on each and every baggage, so that at the time of leaving the airport we can verify this.

Figure 6: Baggage Form

4.) **Boarding Form:** Boarding Form requires boarding pass barcode and ID Proof (for manual verification), so that after verification of it, the passenger is allowed to board in the flight.

Figure 7: Boarding Form

5.) **Check-out Form:** Check-out Form requires boarding pass barcode with the baggage(s) barcode and/or missing baggage(s) barcode for the authentication of baggage.

Figure 8: Check-out Form

6.) **Missing Baggage(s) Form:** This form requires boarding pass barcode with the number of missing baggage(s) to generate missing baggage(s) barcode.

Figure 9: Missing Baggage(s) Form

7.) **Master Form:** This form requires authorized login to open. This form decrypts the details from the lost or missing baggage(s) barcode, so that we can contact with the owner of baggage(s) and handover the baggage(s) to him/her.

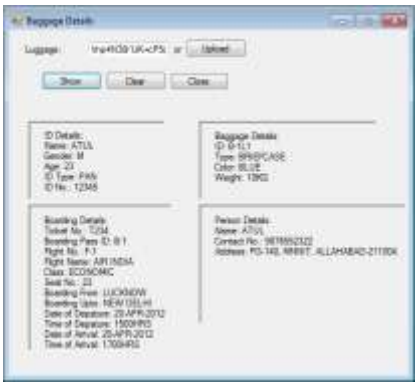

Figure 10: Master Form for Baggage(s) Details

V. CONCLUSION

This paper provides the authentication of ticket, boarding pass and baggage(s) at the airport with the help of barcodes affixed on them. The basic idea behind the authentication is the encryption of the unique ID of the passenger in the barcodes. Our proposed approach also handles misplaced/ lost baggage(s) properly. The encryption/decryption scheme and barcode we used here are AES and QR Code, respectively. Since, all information is stored in 2D barcode, this approach requires minimum use of the database. In the future, we will try to make this approach to be beneficial for authentication of supermarket or value stores items at time of billing.

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