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Smart Flight Security in Airport Using IOT
(Case Study: Airport of Birjand)

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ABSTRACT

Flight safety in airports is related to passenger authentication and controlling their loads. In this study we evaluated our proposed mechanism of using IOT in airport of Birjand in South Khorasan Province of Iran to increase the efficiency of flight security. Our proposed mechanism used RFID tags for passengers and their loads. The process of enhancing flight safety designed using a networked system (RFID readers and software client-server applications). Whole of proposed process simulated using Matlab software, and results compared with real data collected from airport of Birjand' passengers and flight staff. Results showed that the proposed mechanism increased response time in various tasks including authentication, load processing, entering waiting room, entering airplane, loading airplane, but except finally returning loads to passengers in destination in comparison with previous method. So using IOT method for enhancing flight safety could be recommended to airports.

Keywords: *IOT, RFID, Flight Security, Airport of Birjand.*

1. INTRODUCTION

Airport is a complicated and large system with many components including passengers, staff, devices etc. Flight security is a challenging process in airport management. Internet of things (IOT) is a new wave of technology which has the ability of mobilizing the sensing and processing tasks and could be used in authenticating passengers and working with their loads. The flight security requirements are important tasks which are time consuming and makes servicing passengers slow and hard and unsatisfactory.

Airports in Iran do not use IOT thus using the old methods for authenticating passengers and labeling loads are time consuming, error prone and bores passengers. In current method a passenger arriving to airport must pass a normal security check at entering to terminal and wait for his/her flight to be announced, then the passenger goes to his/her specified airline gate and deliver loads and get flight card. Then the passenger enters waiting room and a new security check by controlling the identity documents and flight card carries out and passenger enters waiting room, and finally when the airplane gets ready, the final security check carries out and passengers going for departure. After the flight reached to destination, a non-formal process of delivering loads waits for passengers to come and find their loads and finally exit from airport. In this final step, the loads are randomly checked by passenger's documents. It obviously seemed that the current process of flight security is very boring and time consuming.

Based of predictions in Gartner's 2014 Hype Cycle for Emerging Technologies, the IOT technology will be completed in 5 to 10 years and is one of the most important technological advances in human history [1].

Using IOT in airports suggested in many studies. Researchers in [2] showed that using IOT in airport services leads to suitable development. In [3] researchers suggested a software architecture which uses RFID and IOT technologies to advance normal airports to smart airports. Researchers in [4] showed that using IOT could predict flight delay based on real-time data.

In this study a new method designed for enhancing flight security tasks using IOT and RFID to increase the security and decrease the response time and wasted time of passengers. Our design uses RFID tags and a client-server networked software system which uses RFID readers for collecting information from passengers in various stages (from entering airport to exiting destination airport).

The rest of this article structured as follows: #

2. DESIGN

Our proposed method's main subjects were decreasing passenger and load authentication times and improving the processes included in flight security to compensate human mistakes and in the other words making flight security checks smarter and more automated. So using RFID and IOT altogether considered as main idea for designing new process. Components of our proposed design described in the following subsections.

2.1 Main Architecture

The main architecture of our design consists a client-server networked framework which connects various RFID readers across the source airport (in this case Birjand airport), airplane, loading site and destination airport. In this architecture for every RFID reader, there is a software client which connected to IOT server using internet and by exchanging data with server, automates many authentication and controlling identity documents tasks.

In out proposed process, passengers arriving to airport) must first go to the flight card issuing unit and get their unique premade RFID tags and deliver their loads. In this stage every separately delivered load of passenger gets a unique RFID tag and manual authentication of identity documents carries out. Then the passenger is freed up from his/her loads and can easily spent some time in airport up to announcing his/her flight number. After that the passenger goes to waiting room and automatically (using RFID readers) his/her security parameters including flight number, flight date, and flight ticket were checked. After a while the airplane gets ready and passengers called for their flight gate for departure. In this step also authentication carries out automatically and passengers getting on their flight's airplane. Also their loads using RFID readers automatically checked and loaded in the correct airplane. Finally the captain could see the final report of his/her flight's passengers and their loads in airplane cabin. After reaching to destination, the passengers take their loads and at exit final automated authentication carries out and RFID tags delivered to destination airport staff and the process ends.

In the above process, using printed flight card removed from the ordinary process. So the passenger's stress for various sources including keeping their flight cards, preserving their loads from theft and lost, and losing their flight because of deep sleep and other causes decreases dramatically. For ease of use, RFID tag of passengers designed as a tiny light weight card which could be pinned to their clothes or be worn as a necklace. These RFID tags are read-only and every tag stores a unique 128 bit number.

The IOT server has a database table which includes all RFID tag id numbers and treats them as active or inactive. The tag id numbers are inactive by default and will be activated when assigned to a passenger or load. Finally when they returned by passenger in destination, will be deactivated again and all transactions of them stored for some months for security reasons.

In the proposed architecture RFID readers will be installed in various situations including: a) flight card issuing gate, b) entering to waiting room, c) entering to departure gate, d) entering airplane for passenger, e) entering airplane load unit for passenger loads, f) exit of destination airport.

Every RFID reader has a software client which specified for its special purposes including:

- Flight card issuing unit: reading inactive ready tags and submitting them as active for passenger or loads and entering flight number, flight time and date, passenger identity information and linking them.
- Entering waiting room: reading tag id number, showing passenger info to staff, checking conformity of passenger's flight with next flights in the list and showing alarms if required.
- Departure gate: reading tag id number, checking conformity of passenger info with flight, showing passenger info to staff and showing alarms if required.
- Entering airplane: reading tag id number, checking for conformity of passenger with flight.
- Pilot Cabin: showing the passengers in airplane and stuffed passengers (who were in airport based on their issued RFID tag but not get into the airplane) and loads.
- Exit of destination airport: reading tags and checking their linkage and showing alarms if required, and deactivating read tags.

Generally for expanding the architecture, the IOT server may be placed in higher organizational level for example in Iran Civil Aviation Organization and connect whole clients in various airports to server via internet. This consideration requires many changes but in this study we evaluated a small sized version of our approach to be tested.

2.2 Software Design

As mentioned above, a client-server topology suggested in this study. So an IOT server and some clients needed to do or assist in the flight security tasks. These entities are including as follows:

2.2.1 IOT Server

IOT server: The software entity which stores a database containing active/inactive RFID tag id numbers, passenger's personal information, passenger's flight information, passenger's loads, and their current and previous status. This server also replies the queries of other clients. This server connected to its clients via internet or internal network of airport. This server interacts with its clients in various operations including:

- Activating and deactivating RFID tags for passengers and loads
- Various passenger authentications
- Various load authentication and etc.

The IOT server takes backups from information of previous flights and moves them to secondary database. This server normally is in ready mode and takes actions in replying to calls from its clients.

2.2.2 RFID Tag Issuing Client

This client does several important operations which aids our flight security process. At first after manual control of passenger's identity documents and checking his/her flight tickets, a process of activating some RFID tags for passenger and his/her loads starts. In this process the staff uses a RFID reader and manually reads id of every RFID tag and activates it via this client. Then the staff stores the passenger's personal and flight and loads information using this client on the IOT server.
After completing this step, the passenger and his/her loads are completely under automatic authentication and could be traced in airport, airplane and destination.
The RFID tag of passenger could be pinned to his/her cloth like an identity card or used as a necklace. The RFID tag of loads is a tiny label which enveloped in a tight plastic card.

2.2.3 Entrance of Waiting Room Client

When passengers pass through the gate to enter waiting room, their RFID tag id will be automatically read by RFID reader without enforcing passengers to show their identity documents or flight card, etc. and this client queries IOT server for information of this passenger. Then passenger's info showed to the security staff. Also some controls made automatically. For example the passenger is permitted to enter waiting room in 30 minutes to departure. If client become aware of any incompatibilities it warns security staff.
This client also sends the status of entering passengers to IOT server and IOT server updates their current status.

2.2.4 Exit of Waiting Room Client

When the airplane gets ready, the passengers are informed about it and they must go to correct gate and pass final security check and exit waiting room and enplane. This client like the previous one reads automatically the RFID tag id of passengers, then queries information attacked to it from IOT server and shows information to security staff and also alarms security staff about incompatibilities in passenger's flight information and the gate which he/she wants to pass.

2.2.5 Airplane Entrance Client

This client only send information of passenger's RFID tags to IOT server. The IOT server updates status of passengers. This client does not check incompatibilities and only uses for collecting information from passengers who correctly enplaned.
2.2.6 Pilot Cabin Client
This is the only client who does not attached to any RFID reader. It shows the final status of current flight's passengers and loads to the pilot. So the pilot will be aware of the passengers who did not enplaned or their loads did not correctly loaded.

2.2.7 Transportation Client

This client uses its RFID reader to ensure every passenger's load is transporting via correct flight. The staff sets the flight number and loads are passed through a RFID reader and client checks the consistency with IOT server and alarms if required.

2.2.8 Airplane Loading Client

This client like the previous one is designed to ensure loading airplane with correct passenger loads and vice versa. Once loads are loading to airplane, this client using RFID reader checks consistency of loads with flight number and shows alarms if required. The other usage of this client is when a passenger exits in a middle destination and

2.2.9 Airport Exit Client

This client designed to finally checking consistency of loads and passengers taking them. In this stage the RFID tag number of passengers and loads were checked and their consistency controls. Finally the tags returned to airport staff and deactivated by connecting to IOT server.

2.3 Hardware

Our design uses some standard hardware which widely used in industry. The most important hardware are RFID tags and RFID readers. The RFID tags must have some features including: readability in 1 meter distance, light weight, thin, easily attachable, and durable. The read-only memory of RFID tags is short as 128 bits and encoded in production factory. The tags are passive so there is no need to expensive tags. We used the tags made in Omni-Id Corporation [5] named IQ 100 which was compatible with requirements of this study. They also are operational in semi-hard industrial situations (-40 to +80 centigrade degree, IP68 protection, MIL STD 810-G standard). The physical shape of these tags are like labels which showed in Figure 2.

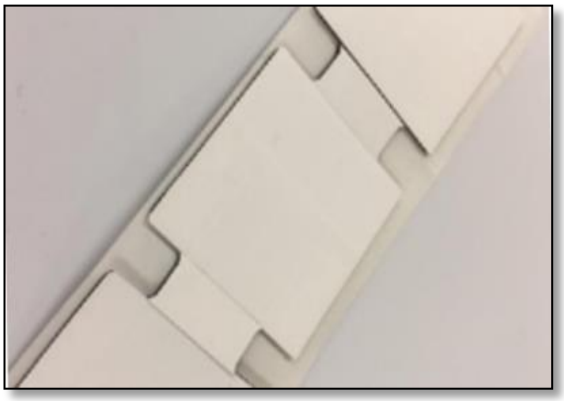

Fig. 2. IQ-100 RFID tags.

The RFID readers must be operational in 1 meter distance from tags and durable enough for industrial use. We used RFID readers of Omni-Id Corporation named OMNI-NGW-2. These RFID readers have good features for our study including: standard 10/100 Mb Ethernet connections, active in -40 to +60 centigrade degree, IP50 penetration standard, and resistant to hard conditions). Figure 2 shows this RFID reader.

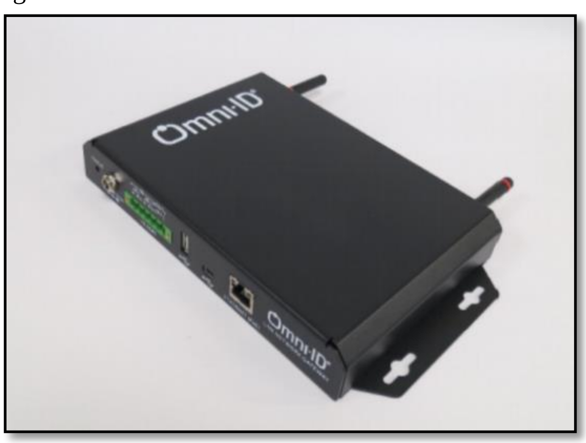

Fig. 2. OMNI-NGW-2 model RFID reader.

3. SIMULATION

We simulated our design using Matlab software to ensure its performance. The flight data of Birjand airport from 27 March 2017 to 21 December 2017 including flight number, number of passengers, planned and actual departure time, and total passenger load's weight get from airport management office. Also a simple survey conducted via passengers and some important items asked them to be compared with results of simulation.
We used day to day simulation. It means that every 24 hours simulated separately. It was due to working conditions of Birjand airport which its first flight is about 6:00 A.M. and its final flight is about 23:00 P.M. so there is no conflict between flights of every 24 hours. Birjand airport is not a busy airport and has several flights per week.
Simulation uses a straightforward method which its pseudo code showed in Figure 3. In simulation the waiting time (min, max and average) of passengers for authentication, and spent time (min, max and average) for authentication process calculated. Figure 4 shows overall process which used in our proposed design.

```
Start
Read Birjand Airport Data and Initialize Base Variables
Loop1 SelectedDate=StartDay to EndDay
        Generate random data for flights, passengers, loads, entering times, etc
        Generate random action list for passengers
        Set StartTime and EndTime
        Loop2 Time=StartTime until  EndTime
                Simulate all actions & calculate parameters
        End Loop2
End Loop1
```

Fig. 3. Pseudo code of simulation algorithm.

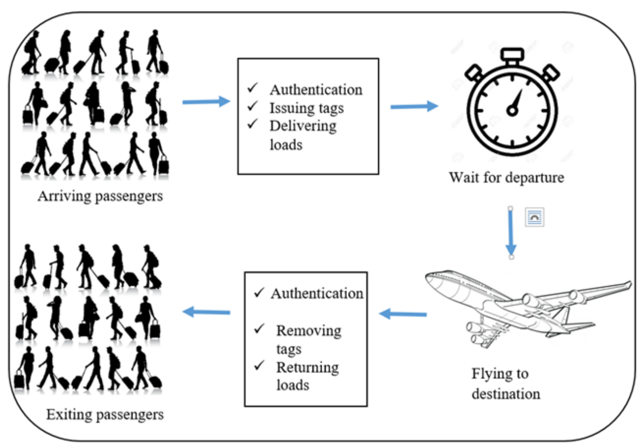

Fig. 4. Overall process of proposed method.

Some methods used for simulation including: authentication, issuing RFID tag, loading in source, enplaning, and returning passengers' loads. For completing the simulation process we defined some events which randomly occurred including: arriving to source airport, referring to RFID tag issuing gate, do not

entering waiting room, do not exiting waiting room, sleeping in airport, eating and drinking, using lavatory etc. These events randomly occurs for passengers to make results more realistic.
Some other random features added to simulation including time of entering airport, total load weight for every passenger, number of passenger load bags and their weight.
The delays in send and receive messages between clients and IOT server and query response time ignored for ease of calculations. Also the passengers who lost the flight did not considered in simulation.
For every step (day) of simulation, first the information of that step (day) flights used for randomly generating the loads for every passenger, their arriving time, their referring time to RFID tag issuing gate, and other parameters. Then simulation carried out step by step using a time-step (about 30 seconds) to simplify the simulation process and at each step the situation of all variables checked and their status updated. At every step (day) of simulation our evaluation variables including wait-time of passengers for flight security tasks (min, max and average) and security-tasks (min, max and average) calculated and stored in tables. At the end of simulation (for 9 month period) the data of these times averaged as three min, max and average times to be used in final results.
Note that for calculating the spent times these times must be calculated at every step (day):

- Waiting time in authenticating queue
- Waiting time in delivery loads queue
- Waiting time for enplaning
- Waiting time for returning tags and exit

4. RESULTS

Our findings showed that in all calculated parameters except waiting time for exiting airport in destination, using the proposed mechanism decreased and the improvement in performance of flight security tasks and decrease in passengers' waiting times in various situations obtained. The results showed in Table (1) which compares results of simulation with results collected from passengers experience.

Table 1: Results of Simulation.

Parameter	***Average Time (Simulated) (minute)***	***Average Time (Reality) (minute)***
Waiting time in first Auth. and delivering loads	13	50
Waiting time for next Auth. tasks	7	20
Waiting time for departure	4	10
Waiting time for exit	16	5

5. CONCLUSION

Findings showed that using the suggested IOT based method improved performance of flight security tasks and decreased waiting times in various stages for passengers. This method also showed that using IOT based approaches could decrease the stress of passengers due to keeping their flight card, identity documents in safe and easily available condition to be used by security staff. Using this method also decreases the fatigue of passengers in comparison with old method. Because of freedom of passengers in new method which lets passengers to deliver their loads at arriving to airport and it is more important for passengers who were patient, have movement disabilities or have children or old age fellow traveler.
The proposed method improved all flight security tasks except for final checking the passengers' loads in exit of destination airport. It could be addressed by adding various exit gates for checking loads and returning RFID tags.
The other important note is that airport of Birjand is not a busy one. So good performance of proposed method in this airport could result in better performance in highly busy airports which have many flights and passengers.
Finally it could be concluded that using IOT and RFID technologies in Iran airports is a good idea which provides freedom and comfort for passengers.

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