

A study of Location based Air Logistics Systems with Light-ID and RFID on Drone System for Air Cargo Warehouse Case

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Abstract

Recently Drone technology is emerging as an alternative new way of distribution systems services. Amazon, Google which are global network chain distribution companies are developing an idea of Drone based delivery service and applied for patent for Drone distribution systems in USA. In this paper, we investigate a way to adopt Drone system to Air Cargo logistics, in particular, drone system based on combination of Light ID and RFID technology in the management procedure in stock warehouse. Also we explain the expected impact of Drone systems to customs declaration process. In this paper, we address the investigated limitations of Drone by the Korean Aviation Act as well as suggest the directions of future research for application of Drone to Air logistics industry with investigated limitations.

Keywords: *Drone, Air Logistics Systems, Air Cargo Systems, Light ID, RFID, AIRCIS, Aviation Act, OCC, IoT*

1. Introduction

Since the first international air cargo delivery service was served by PanAm(Pan American) airlines in 1927, the Air Express Service has been emerging as an important sector in airline business industry (Wells, 1999). The last decades, unmanned flight vehicle which is called “Drone” has been considered as a new way of delivery service, whilst some limitations of power resources for the Drone and strictly imposed government regulations are still unsolved. Even though that kind of limitations, some researchers studied drones to adopt delivery service industry.

In this study, we investigate the way of application to the air logistics systems including cargo warehouse management and suggest the way of use the drones as an alternative way of current RFID systems in cargo warehouse management. This paper propose the combination od Light ID combination with RFID for air cargo warehouse delivery service.

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2. Theoretical Background

2.1 Definition of Air Logistics

Logistics is defined as an activity related to the delivery of commodity from a place of production to last consumer. In detailed, logistics is included customer service, consumer forecasting, delivery information, warehouse management, order handling, selection of plant and warehouse location, packing, delivery, goods return, cargo delivery, loading and unloading in warehouse (NCPDM : National Council of Physical Distribution Management, 1960). Logistics is considered as an important business tool for the whole activity on the flow of products from production to consumption. To response to consumer's demand effectively, the whole process from the acquisition of resources for production of goods to the last consumptions are needed to be managed more efficiently and effectively. Logistics includes this whole process and is considered as an important business strategy.

Air Cargo is defined as a whole items transported by airplane excluding postal mail, passenger's luggage, and any items which are used in flight in the cabin of airplane and mishandled luggage (ICAO security manual 8973, 2002).

Air logistics is defined as a concept of air cargo and logistics service. Air logistics is the business activity for the process which is a cargo delivery process from supplier to consumer through export or import by air logistics agents using airplane based on the accurate forecasting of demands and supplies. Air logistics is a logistics service using air cargo transportation. In general, air logistics is considered as air cargo transportation (Jae-Rak, Chung, 2009).

2.2 Air Logistics Systems

Air logistics systems are established by Korean Government, Ministry of Land, Infrastructure and Transport. After that, the Incheon International Airport authority has been operating Air logistics systems AIRCIS(AIR Cargo Information System) based on the Government established air logistics systems since September 2009. The AIRCIS is shared information by airlines, freight forwarders, freight agents, ground handlers, delivery companies. The information on the flow of product delivery status is managed as a one-stop, one-site basis through the AIRCIS effectively.

AIRCIS has been expanding the global network by joining of foreign air carriers and Korean national carriers, and AIRCIS has served the location of cargo by actual time basis. It means that spending time and costs can be reduced by this logistics systems.

In addition, airlines and cargo transportation companies have been operating management systems such as ACPS (similar to Traxon Kr KTNET Network), CSP(Cargo Systems Partnership), KCIS, MFCS, AMS/EDI information, Logistics Management System(LMS), Transportation Management System(TMS), Warehouse Management System (WMS). The web based LMS system used in Air logistics is shown in Figure 1.



Figure 1. LMS (Logistics Management System)

CSP (Cargo Systems Partnership) is the cargo management systems operated by Asiana Airlines based on the information about all countries and customs regulations, and air carriers and freight agents. By CSP, we can make reservations, tracing, agents' fare, outcomes, billing amount, ground handler, use of barcodes, declarations of customs by transmission of EDI. The following Figure 2 describes the CSP Export Reception.

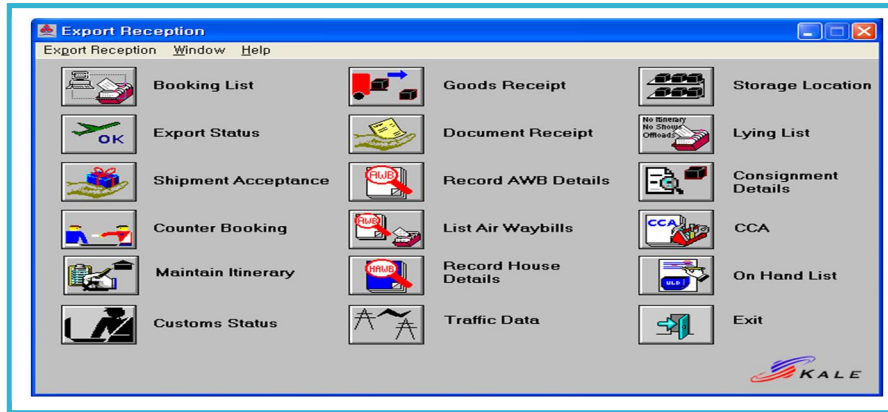


Figure 2. CSP (Cargo Systems Partnership) Export Reception

2.3 Flight Procedure of Drone

To fly Drone safely, the Drone operators should abide by the Aviation Act of the Republic of Korea as following procedure as shown in Figure 3.

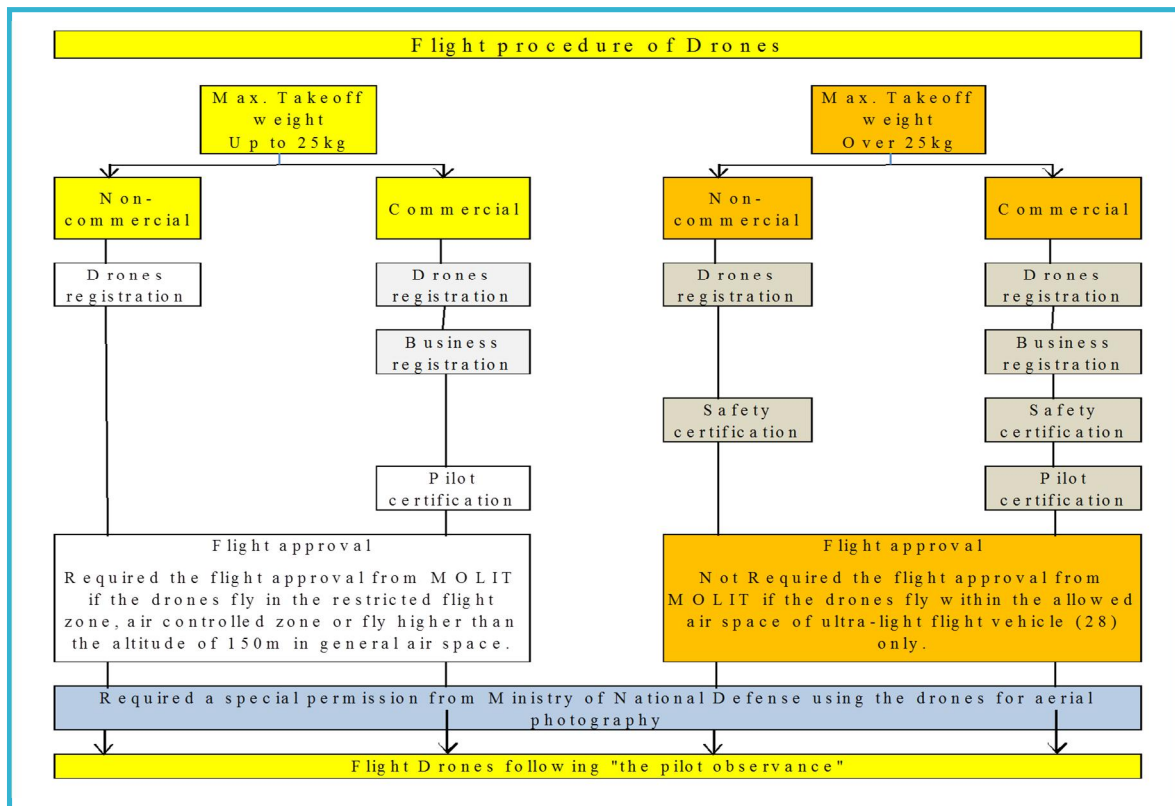


Figure 3. Flight Procedure of Drone

Drone is defined as a unmanned flight vehicle which is controlled by remote piloted by pilot on the ground or a unmanned flight vehicle flies as Auto-piloted or semi-auto-piloted by programmed flight route.

Although a unmanned flight vehicle with the weight of under 12kg for leisure, the Aviation Act specifies the regulations for safe flight which should be kept by all pilots. Regardless of weight or purpose of drone, this Aviation Act should be applied to all pilots. In the case of breach of regulations, penalty is imposed as maximum amount of 2 million Korean won. The purpose of this penalty is to prevent any potential damage of third parties from the drone collision with other drone each other or from the crash of drone.

2.4 Pilot Observance Regulations (Aviation Act 23, Enforcement Regulation 68)

The Curfew hours for service is night time (from sunset to sunrise) as per pilot observance regulation described in Aviation Act 23 and Enforcement Regulation 68. No-fly zones are the area within 9.3km radius from the airfield called controlled space, and the airspace specified by air route for airplanes which is higher than 150m altitude, and airspace over a densely populated area, and prohibited airspace by military requirement or security reasons (near DMZ, Seoul City Central, Nuclear Power Plant etc)

The prohibited things are the followings

- No-drop things from Drone during flight
- No-fly as pilots drunken
- No-fly when pilots are unable to see the drone directly.

To fly within the prohibited air space, the pilots should be granted a permission before flight, regardless the purpose of flight or weight of Drone.

Pilots, however, can fly drones without any permission if the drones fly inside of buildings which are walled. The drones can fly inside the building with appropriate lighting facilities at night. At all times, pilots keep attentions to fly safely to prevent any potential damage of property or human live. (Advanced Air and the Ministry of Land, 20 Dec. 2016)

The commercial Drone Manufacturers, DJI's and Parrot's support the flight data analyses Methods. The following table shows the details of the flight data analyses methods.

Table 1. Flight Data Analysis Methods of Drone

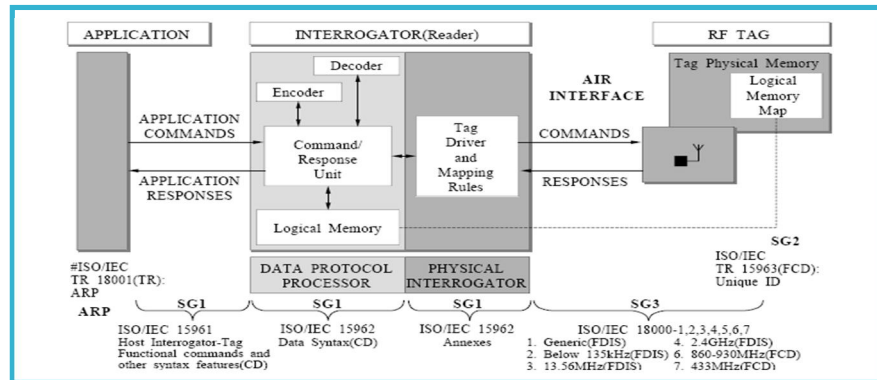
Manufacturer	Models	Analysis Method	Analysis type			
			2D Map	3D Simulation	Data Sheet	Graph
Parrot	Bebop	Flight Data Manager	O	X	O	O
	AR Drone		O	X	O	O
DJI	Phantom3	Healthy Drones	O	X	O	O
	Phantom4		O	X	O	O
	Inspire1		O	X	O	O

3. Prior Research and Research Method

Most of prior literature for air logistics systems focused on the RFID applied model on the international logistics and on the effective logistics information management for mobility, visibility, traceability of products in distribution center and customs warehouse based on RFID (Radio Frequency Identification) technology.

The RFID technology is widely used in a variety of industry (Garfinkel and Rosenberg, 2006; Y.H. Chang, 2007). In particular, the logistics industry by actual products flow of movement is the most popular industry of the RFID adoption and the RFID has been using as an important technology by logistics industry. The

RFID system internal structure is described in Figure 4.



Source : ISO/IEC JTC1/SC31/WG4

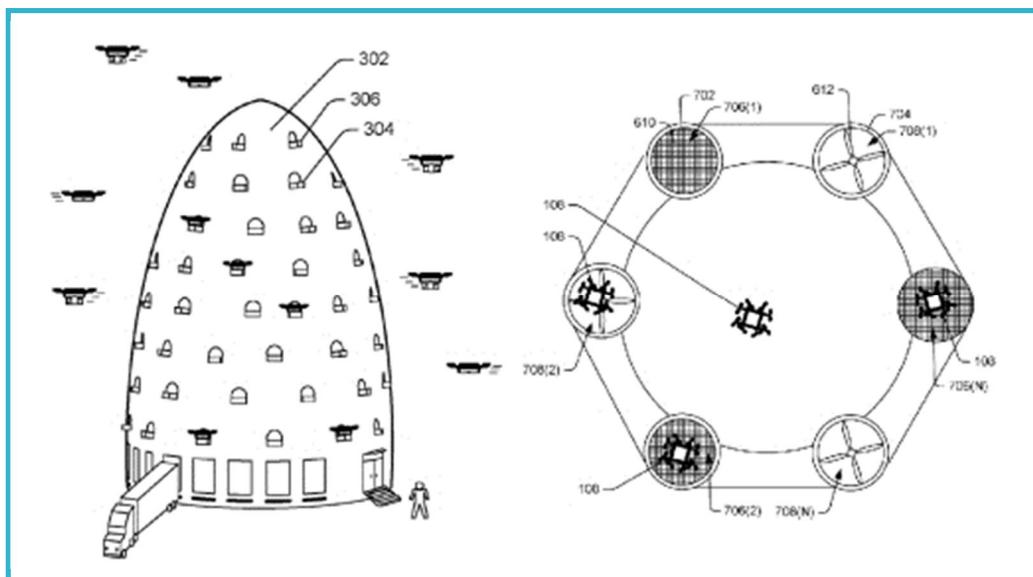
Figure 4. The structure of RFID system

The Korean Customs have performed the import and export procedure of cargo items using RFID at the Air Cargo Terminal at Incheon International Airport. The procedure of Air Import Cargo customs clearance is performed by RFID technology which scans the information of tag attached to the import cargo item in a distance without any disturbance. This technology can support 5S (Silent, Soft, Simplified & seamless & Saving) customs clearance procedure (Korea Customs Service Report, 25 June 2008).

In overseas, some global network companies like DHL, Google, Amazon have been considering the drone as a new way of delivery of goods, and trying to extend the usage of drone as commercial items, however, technological weak points of Drone and security concerns are still remained as agenda to be solved.

In case of Amazon, they applied for a permission to operate Drone for commercial service from FAA (Federal Aviation Administration) in 2015. In June 22, 2017, Amazon has applied for a patent for “multi-floor distribution center for unmanned airplane” to United States Patents and Trademark Office (USPTO).

According to the Patent, the Drone distribution center is shaped a long cylindrical building and designed that the dozens of drone can land or takeoff to pick parcels up and down at the same time through the dozens of exits for drone.



Source : United States Patent and Trademark Office(USPTO)

Figure 5. Design of Drone Distribution Center

In addition, Amazon introduced that their own drones can fly with 5 pounds parcels at the altitude of 400 feet, a speed of 70km/h. For the commercial drone delivery service, the flight control systems are required. To establish the flight control systems, Amazon has developed a flight control systems specified a low altitude flight to prevent collisions with other drones or trees, buildings by an aviation experts group based on machine learning, artificial intelligence (A.I.).

The Advanced Air and the Ministry of Land announced the Roadmap for support of invigoration of Drone technology concerning improvement of aviation regulations improvement (March 07, 2017).

Most of research for logistics in Korea have been focusing on the RFID technology based services. However, as a result of this research trends, they have some restrictions to explain the air logistics systems.

In this study, we suggest a standard for the way of using Drone technology with Light ID and RFID technology in the logistics of Air distribution systems at Air Cargo Terminal. The RFID based customs clearance on parcel takes long time because the RFID tag need to be near the RFID reader to read the RFID tag information to get approval confirmation and also need need the human assistance everytime.

In this proposed approach, the RFID tag information is transferred through Light ID and Light based optical camera communication receiver system can read the RFID tag information and manage the customs clearance of the air cargo by automated logistics systems without human assistance. This can make customs clearance and moving parcels more quickly and accurately. And we analysed the impact of Drone technology to air logistics system which gives more than 40% improved service on Air logistics industry.

4. Conclusion

Drone systems in Air logistics industry are operated as limited because of the Korean Aviation Act regulations for restricted air space. The Drone services need to follow the Advanced Air and the Ministry of Land regulation report, however, we can use drone inside of appropriate lighting facilities building without any permission. Therefore, if we use drone as a delivery tool in the air cargo terminal or inside of distribution center building, we think that the drone can contributes to expedite the development of air logistics industry.

The drone equipped by Light ID and RFID technology can manage the customs clearance procedure of air cargo by automated logistics systems more quickly and accurately. And, the RFID tag can be transferred through Light ID is used for customs declarations of bonded transportation, import or export of inland bonded area and contributes to encourage the logistics management competencies of import agent. We can expect to reduce the cargo handling time and national logistics costs by drone technology based on RFID and Light ID. As a result of use of this drone technology, we can expect that potential stock inventory cost of national logistics and transportation cost can be saved drastically.

Therefore, for the effective application of drone technology in the future, the economic effect, safety, accuracy, quickness of technological limitations should be investigated. After that, the drone technology can be adopted completely to Air logistics industry. For the long term evaluations of drone in logistics business, further investigations should be carried out for the investigation of needs of relevant companies, and the total efforts of organizational level, and established the enforcement systems for the encouragement of drone technology.

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