

Secure Dual Screen Battery-less Electronic Tag

Background of the invention

The invention relates to a reusable dual-screen electronic tag that functions without a battery but instead use energy harvesting technique for electric power generation. The invention also takes into consideration the security and authenticity of all data communicated with it.

Before flights, individual traveller are given a unique identification tag to be put to their luggage. The tag is used by the handling and reconciliation system to trace and track, such that traveller's luggage will be directed to the correct flight and carousel, and return to the traveller upon their arrival at the destination. The tag comes in a form of a thermal or barcode printer printed on an adhesive thermal paper stock.

One major drawback of using the thermal paper tags is that traveller's personal information are printed on the tag and it consists of a layer of glue or adhesive, making it not reusable and difficult to be recycled. Recent years, the aviation industry has come strong in promoting environmental friendly measures. In 2019, Qantas Airways operated its first zero waste flight, with all in-flight products reused or recycled, or disposed of through composting. Other airlines are also taking steps to reduce single-use plastics. The thermal paper tags as one of the necessity for air travels and being difficult to recycle, is one of the major contributor of waste in air travel. The electronic tag being reusable is hence the next push by airlines' effort for sustainability.

Besides, flight information are printed onto the thermal paper tag using thermal printer, there is a possibility of having an unclear barcode due to poor printing quality, and this could result to an increase in the number of mishandled luggages. Every year, a significant number of the luggage is lost or mishandled , with Europe clocks up 7.29 mishandled bags per 1000 passengers annually, 2.85 in North America and 1.77 in Asia according to Society International Telecommunication Aeronautics (SITA). In 2015, according to SITA, it is estimated that mishandled luggages has cost the airline industry US\$2.3 billion, and the figure is expected to increase with the rise in passenger volume.

To support the aviation industry with their luggage handling solutions and to handle the continuous growth in air travel, new technology is required. The idea of a reusable electronic tag was conceived for the purpose of reducing long airport check-in queue time. In 2011, Qantas introduced their first permanent electronic bag tag (Q Bag Tags) in Australia to members of their Flyer program. The Q Bag Tag allows their members to check-in their luggage prior to arriving at the airport. A drawback from the Q Bag Tag is that it does not feature a screen and it can only be used at certain airports in Australia.

Apart from the Q Bag Tag, other electronic bag tags are introduced into the market, but they are assembled with battery to power up and update flight data onto the display. The existence of the battery has caused the adoption of these electronic bag tags to be low among airlines, especially with airlines that have strict regulations against the type and

quantity of batteries being carried onboard the plane due to concern over potential serious hazard situation.

In addition to having an onboard battery to power the electronic bag tags, the existing tags in the market has only one screen to display the barcode information. The tag is hence required to be fixed permanently or attached firmly onto the luggage to ensure the face with barcode is always visible. The requirement of permanently fixed to luggage reduce or eliminate the opportunity of sharing with other user.

Over the years, reliance on technology to collect and store personal data has been increasing across the globe, and this has led to an increase in the number of cyber-crimes or data breaches that impacted billions of users. In 2019, British Airways was reported to face a record fine of £183m for breach compromised data on 500,000 customers. While in 2021, Air India reported that about 4.5 million of their passengers' data were stolen by cyber criminals. The data stolen include passenger's name, credit card numbers and passport number. While reusable electronic tag provide an alternative to thermal paper tag, it is also crucial to incorporate data security controls, such as privacy protection and authentication to protect travellers' records against any data breaches.

In conclusion, it would be beneficial to have a battery-less, secure and reusable electronic tag that does not require firm or fixed attachment onto luggage, so as to help create a much more seamless travel experience for travellers.

Electronic Tag

An electronic tag is a device that passengers use to update their flight data and attach it onto their luggage prior to their flight, and it can be reset and reuse after every flight. The electronic tag could help to save traveller's time from queueing and printing luggage tag at the airport, giving them a more convenient, contactless and seamless travel experience.

Traveller will first check-in online via individual airline's application or webpage to acquire their boarding pass and luggage tag information. Following that, traveller updates the flight information to the electronic tag via Bluetooth Low Energy (BLE) or Near-field communication (NFC), and the flight information will be displayed clearly on the dual E-ink screens on the tag. The benefit of using electronic tag is that traveller can update their flight data and license plate in the form of barcode onto the electronic tag at any location as long as they have their boarding pass with them. Upon arrival at the airport, travellers can skip the check-in queues and counters, and proceed directly to the Automated Bag Drops (ABD) counters, saving the time spent on queueing. For airlines and airports, this would meant reduction in the number of essential staff, counters and self-service kiosks needed, hence creating significant time and cost savings.

Besides, flight information and barcode updated and displayed on the dual E-ink displays are more sustainable in comparison to barcode printed on the thermal paper which might become unreadable during the journey, and causes barcode scanning issue. Other than Barcode, RFID and NFC are incorporated together in electronic tag, ensuring that it is compatible with any luggage scanning and tracking technology in all airports. The electronic tag is more readable, reliable and in compliance with International Air Transport Association (IATA) resolution 753 that airlines must keep track of passenger's luggage at

four key journey time points, which are check-in, during aircraft loading, during transfers between aircraft, and on arrival.

In addition, the electronic tag is more eco-friendly as it is reusable and helps reduce the use of single-use thermal papers tag which is difficult to recycle. At the same time, electronic tag being reusable is also more cost effective comparing to single use thermal paper tag.

Summary of invention

The invention is a re-useable battery-less dual display electronic tag that comprises of a printed circuit board (PCB) with antenna to receive Radio Frequency (RF). The main components in the invention includes a Near Field Communications (NFC) chip which is part of the RFID technology family operating on the High-Frequency (HF) range of the radio waves and operates within close proximity between the reader and tag; Capacitors to store energy harvested; two processors that control the circuit flow and flight data updating onto the dual E-ink screens; an RFID chip to make it compatible with RFID scanning, tracking and tracing technology in airports; two screens connectors to connect the PCB to two E-ink screens which rest on top of the two surfaces of the PCB. The two E-ink screens display identical information, a barcode and flight data, a format that is backward compatible with the thermal paper tag that is commonly used in airports.

The invention displays traveller's flight information on the dual screens, but the information is stored simultaneously on RFID and NFC as well. Scanning via Barcode, RFID, BLE and NFC are available, ensuring scanning and tracking of the luggage is compatible with all airports. This fail-safe design feature also increase reliability of the tag and reduce case of mishandled luggage.

The invention is also a secure and shareable electronic tag, as it uses cryptographic protocol for privacy protection and authentication. It challenges and checks for authorised to access before exchange of data, protecting user's data and minimise the risk of data breach.

Brief description of Drawings

Features and descriptions are illustrated in the appended drawings to help in the explanation of the invention. However, the invention is not limited to the precise shown instrumentalities.

Fig.1 illustrate the front view embodiment of the electronic tag

Fig.2 illustrate the back view embodiment of the electronic tag

Fig.3 illustrate the alternative front view without flight information embodiment of the electronic tag

Fig.4 illustrate the side view embodiment of the electronic tag

Fig. 5 illustrate the top view embodiment of the electronic tag

Fig.6 illustrate the layered view embodiment of the electronic tag

Fig.7 illustrate an example of the components on the printed circuit board layer with detailed process flow embodiment of the tag

Fig.8 illustrate an example of the electronic tag attached to the luggage

Detailed Description of Drawings

Fig.1 and Fig.2 illustrate the front and back view of the electronic tag respectively. The invention has two 2.9 inch E-ink displays with one display 12 on the front side, and the second display 21 on back side. The displays can display variable information, such as the name of the passenger 15, the name of the departure airport 16, the name of the destination airport 17, the flight number 18, the date of the flight 19 and barcode 11. The content on both displays is identical to ensure the barcode scanners are able to read the data regardless of the face, and travellers can identify their luggage easily without the need to flip over for confirmation. The electronic tag can also be attached and detached easily onto or from the luggage without the need to fix permanently onto the luggage, and at the same time allowing current Automatic Bag Drop (ABD) to pick up the barcode seamlessly.

Fig.3 illustrates the default view on the dual displays when the electronic tag is not updated with flight data or when it has been reset. The default view on the displays includes name of the owner of the tag 32, for example the airline that is distributing the electronic tag, and a Quick Response Code (QR Code) 31 that contains Unique Identifier (UID) of the tag. Further to it, the displays can reprogram to display other relevant content as required such as images or text (alphanumeric).

When data is received by the electronic tag, it is compiled and converted by the main processor, and sent to the E-ink displays to show the views illustrated in Fig.1 and Fig.2.

Fig.4 and Fig.5 illustrate the side and top view of the electronic tag. The Printed Circuit Board (PCB) with the components 13 forms the middle layer, and the two E-ink displays stuck on top 12 and below 21 the PCB. The two displays, PCB and components are enclosed in clear harden resin 61 and is able to withstand high pressure and collision, providing good protection and ensures the electronic tag is not easily damaged or tampered with.

The electronic bag tag is designed to have two or four drilled holes 14a, 14b, 14c, 14d. The purpose of having more than one drilled hole is to increase the easiness of attaching the tag to the luggage, for example, traveller can choose either of these holes to attach the electronic tag to the handle of the luggage using a metal wire lock or detachable wire, and not restricted to a specific direction. The drilled holes are made possible due to the dual screen displays that are strategically placed on opposite sides, facing away from each other.

The electronic tag enclosed in clear hardened resin 61 has a dimension of 60mm by 100mm by 14mm. While the Printed Circuit Board (PCB) 13 has a dimension of 95mm by 58mm. The front and rear display is each 2.9 inches, and the drilled holes 14a,14b,14c,14d each has a diameter of 4mm.

Fig.6 illustrates an example of the layers of the electronic tag. The first layer 61 and the last layer 65 are the top and bottom of the electronic tag which is made up of clear resin. The second layer 12 and the forth layer 21 are the E-ink screens, and the information displayed on both screens are identical.

The third layer is the circuit board 13, and a more detailed illustration of the components can be found in Fig.7. This layer contains the RFID module, the integrated circuit module that controls the display of the screens, the management module, and the RF antenna.

Fig.7 illustrates the detailed process flow and component compositions of the electronic tag.

One important component of the electronic tag is the NFC module 73, which is ISO/IEC 14443 Part 2 and 3 compliant. It has 2k bytes of EEPROM and 64 bytes of SRAM for data transfer.

The electronic tag also consists of MCU 1 71 and MCU 2 75, the core processors of the tag that serve as the management module, and driver for the dual E-ink displays, as well as the communications with NFC chip via I2C. The Bluetooth module also presents in this component to allow for BLE communications between the tag and the external device. It has 64 kB ram and 512 kB of Flash memory, and operates on a minimum and maximum voltage of 1.7V and 3.6V respectively.

The electronic tag does not run on battery or local power supply, but harvest energy from the radio frequency (RF) interrogating signal. When RF signal is transmitted by external device such as mobile phone, the signal is picked up by the antenna 74 on the PCB, which is designed to receive and transmit RF waves on frequency 13.56 Hz. The antenna sends the signal picked to the NFC component 73 which will read the message from the signal, and at the same time, harvesting energy from the signal for storage into the capacitor 72.

When the capacitor begins to supply power, the MCUs 71 and 75, powers up to process the message read from the NFC 73, and the result is sent to the screen connectors 76 where the two E-ink screens will be updated and display the intended information.

Fig.8 illustrates an example of the electronic tag 81 attachment to the luggage handle 82. This configuration allows the tag to be attached freely to the handle, and is suitable to be used on any type of luggages with an attachment ring or handle.

Detailed Description Of The Invention

The invention is a battery-less, secure and reusable electronic tag. It comprises of RFID, MCU, NFC, BLE, Capacitor, Antenna, two bistable displays as part of the components. It is also secure and shareable with the use of cryptographic protocol for privacy protection and authentication, to challenge and check for authorise access before exchange of data, protecting user's data and minimise the risk of data breach.

One unique aspect of the invention is that it functions without a battery, and this makes it to be in compliance with the IATA guidelines (Subsection 2.3 of the IATA Dangerous Goods Regulations (DGR)) where it states that batteries are not allowed in the unpressurised baggage storage compartment of the aircraft as it poses serious fire hazard if it explodes.

The invention makes use of the radio frequency (RF) energy harvesting technique to provide electricity to power up the electronic tag. It works by harvesting power from an RF field through the RF component when transmission occurs between an external device such as mobile phone and the electronic tag. While transmission process continues, energy is harvested continuously to power up the components, to complete the cryptographic authentication protocols, and all the way until the two E-ink screens are updated with the flight and luggage data.

For example, when an external device carry out a Near Field Communications (NFC) writing operation (with cryptographic privacy protection and authentication), energy is being harvested concurrently from the RF signals and stored into capacitor to power up the processors. In this writing operation, flight data is write into the electronic tag's NFC chip's memory space which in turn is read by the main processor, and the data are then updated onto the dual E-ink screens. The dual screens on the electronic tag are capable of displaying the same information as a traditional paper tag, having a barcode and license plate number that can be read by barcode scanners in airports.

The barcode display functionality is added to this invention to allow for backward compatibility with existing tag tracking and tracing system when the luggages enter the conveyer belt after the Automatic Bag Drops (ABD) or check-in counter. At the same time, RFID, BLE and NFC are also added to this invention for backward compatibility with tracking and tracking system in all the different airports around the world.

The electronic tag can be reused by the user for his/her future flights, or handed over to other user to use as the data can be reset, and cryptographic protocols are integrated for privacy protection, as well as for authentication.

Data privacy protection and authentication are important aspect of this invention in protecting user's personal information from getting stolen or misused, and also ensures that the device is not accessible by unauthorised user during transit or if it gets stolen. When an external device tries to communicate with the tag, the cryptographic protocol works to do verify access before the exchange of any sensitive data, and vice-versa. It ensures changes or updates to the device is made by only authorised person(s). This cryptographic capability allows the tag to be shared with other users without the fear of any personal data being compromised, as well as restricts access to achieve reliable and secure system.

The electronic tag is reprogrammable wirelessly to allow any future upgrades as it has Device Firmware Upgrade (DFU) capability. This ensures that the tag will always stay up to date in the event of any changes made by the IATA requirements, thus preventing it from being obsoleted.

The battery-less and wireless reprogrammable features of the electronic tag make it sustainable and scalable. The electronic tag does not require a battery, but retains the ability to display the flight data throughout the flight journey. It is reusable for multiple flights, reducing the use of single-use paper tags and hence reduce waste. Being battery-less also means that it decrease the likelihood of fire hazard during flight, making the flight safer and permitted for use with airlines that have strict battery restrictions or guidelines. The wireless reprogramming capability makes the upgrading of electronic tag's firmware easy and manageable on a large scale, and at the same time allows it to remain relevant in the market. The ability to perform battery-less cryptographic protocols for privacy protection and authentication also make the electronic tag more secure

Claims

1. The invention can harvest sufficient energy wirelessly via RF signal transmitted by external device, and use the harvested energy to power up and support secure communications and computations, as well as to update the dual displays without the need of local power supply.

The embodiment of claim 1 states that the tag is able to harvest energy from RF interrogating signal to power up components on the circuit board, simultaneously establish and maintain two way wireless communications, perform cryptographic hash function for authenticity and key exchange protocols functions, and finally update license plate number in the form of barcodes that is in compliance with IATA barcode standard on the 2 E-ink displays. Through energy harvesting, the electronic tag can function without a battery or local power supply, ensuring that it is always in compliance with all airlines' battery restriction.

2. Cryptographic data protection measures are incorporated for any communication happening to provide data privacy, authentication and physical-digital verifications.

The embodiment of claim 2 states that communications between the electronic tag and external device are secured with cryptographic protocol. This feature works as a layer of security for users to ensure that their personal data and metadata are not sent in the clear and left exposed to cyber-attacks.

3. The invention is programmed to be able to authenticate identity of the electronic tag and the external device before commencing any form of communications, or exchange of data, providing additional layer of security against unauthorised updates.

The embodiment of claim 3 states that the electronic tag authenticates and challenges access before any communication with the tag can take place. Any unauthorised access attempting to change the flight data displayed on the electronic tag are not allowed. Upon arrival at destination, only authorised user after authentication can reset and cleared passengers' flight data displayed on the electronic tag without the use of battery to achieve a high level of privacy, hence ensuring no security breach.

4. The invention features two screens that are positioned to face opposite direction on the electronic tag, and the information displayed on both screens are identical. Identical information displayed comprise of barcode and license plate number that are in compliance to IATA standards [IATA Resolution 751].

The embodiment of claim 4 stated that electronic tag having two screens displaying identical information on opposite faces allow luggage handling systems to read the barcodes seamlessly. Passengers can also attach the electronic tag onto the luggage without having to concern over the positions of the screens. In addition, the electronic tag is not required to be permanently or semi-permanently fixed on to the luggage, allowing for easy sharing of the tag with other users. The barcodes and license plate number displayed on both screens being in compliance to IATA standards [IATA Resolution 751], ensures that the tag is backward compatible to be used in airports and flights around the world.

5. Aside from Barcode, RFID and NFC chips are found in the invention, allowing traveller's flight information to be simultaneously stored on the two chips.

The embodiment of claim 5 states that tracking and tracing of luggage is not restricted to Barcode scanning, but RFID and NFC scanning is available with the electronic tag, making the tag compatible with all airports' tracking and tracing system. This data storage backup on different chips also ensure that the tag is fail-safe.

6. The Electronic tag is integrated with multiple processors that harvest energy and conduct wireless communication via BLE and RF simultaneously providing a robust system.

The embodiment of claim 6 states that the tag is able to establish communication via multiple channels and harvest power from NFC simultaneously, enhancing the performance of the tag and reduces the time taken to update the two bi-stable screens.

7. The invention is incorporated with capability of over the air Device Firmware Update (DFU), allowing for reprogram. The data displayed on the two E-ink displays can be re-programmed to display any form of data as required.

The embodiment of claim 7 states that the firmware ingested into the MCU can be reprogrammed or update with new firmware version if required. The two E-ink displays can also display any form of data including images through programming. In the event if there is a change to IATA luggage tag standard, necessary change can be reprogrammed or updated by authenticated user into the tag, allowing it to remain relevant.