RFID Airport Luggage Scanning System

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Abstract *- National security of any country needs critical attention particularly the advanced countries that play an active role in counter terrorism. The major areas affected is that of airline security, most especially the procedure of checking luggage. In recent times, more research and security has been directed towards the detection of illegal materials been traffic such as dangerous and harmful weaponries and drugs that are hidden in passenger luggage. The main goal has been to provide the utmost security while reducing the adverse impact of operations at airports. In order to provide the best security, a much more advanced, dependable, and fast screening technique is needed for passenger identification and luggage examination. Modern security threats can evade the scanners easily, mainly due to lack of enhanced detection ability and the inability to easily incorporate any updated security information and algorithms into the detection mechanism. Hence the automated system of luggage scanning security system using the Radio Frequency Identification (RFID) technology, is important to be deployed in order to increase the effectiveness as well as automation and speed of the scanning process in the airports.*

Keywords – *RFID technology, Airline Security, RFID Tags, RFID Reader, Conveyor Mechanism*

I. INTRODUCTION

RFID technology provides enormous economic merits for both business and consumers alike, while simultaneously constituting one of the most invasive surveillance technologies threatening consumer privacy. Airline sector is just one of many sectors that could benefit from RFID technology. In the travel industry, the need to deliver better customer service has never been greater. Similarly, the need to reduce the cost of operation is equally significant. In modern aviation luggage handling application, the RFID tags are used to increase the ability for luggage scanning and tracking. Many pilot tests of RFID luggage and baggage scanning have been done at multiple U.S. and European airports. In U.S. RFID tags had more success due to its increased accuracy. A study in[1], [2], advocated implanting RFID tags in luggage tags, as it could substitute the need for manual inspection and sorting by luggage handlers. A network of readers placed along conveyor belts could read the tags' sorting information and giving appropriate feedback to a system that could then route the bags onto the correct destination. Improved and enhanced automated routing could reduce the quantity of misrouted bags, reducing costs and increasing customer satisfaction.

[3], described the design and implementation of a prototype system for RFID baggage scanning and handling in airports to enhance the management and tracking of passengers' luggage, thus improving airport security. An RFID luggage scanning system technology will increase the efficiency of customer luggage handling, especially when dual flight transfer is required. Passengers will be better alerted, and the baggage delivery status can easily be tracked. The integration of all these security measures will set the customer's mind at ease and increase his trust in the capabilities of the airline.

A. Background of the Study

The RFID system can be used to scan, store and track the movement of a luggage in the airport through radio frequency communication. This system, however, comprises of two parts; namely the reader and the transponder. The latter is also known as the tag. It is made up of an antenna and a silicon microchip. It has a unique identification number and carries information. The personal information of the passenger is usually stored as data with its own identity code stored in binary format. There are three (4) main types of tags; passive, active, and semi-passive. No internal power supply is needed in the Passive tag, while semi-passive and active tags require an external power source; such as battery. Passive tags are powered from electromagnetic field generated by reader antenna which has to transmit enough power to provide energy to the tag that transmits back data. Passive tags simply consist of a single transponder, antenna coil, and capacitors.

The RFID reader performs three specific functions, which include energizing, demodulating and decoding. The reader is composed of a coil antenna, a capacitor Cr, a resistor Ri, an alternative current source and a microchip for analog to digital conversion, modulation and demodulation. Also, the tag consists of an antenna, capacitors Cr and Cp along with a tag memory which contains the information to be communicated to the reader antenna which emits a low-frequency radio wave field to power-up the tag. For the RFID luggage scanning system to be effective, the intermediate part in an airport environment is important to make an RFID system work. The readers need to be able to communicate with the passive tags by sending and receiving signals. The encoder must be able to write data on the tag in the most precise form.

Another function of the middleware is a rules engine. A rules engine functions like an inference engine, it directs the computer to perform a specific action if something happens. If the luggage does not pass the checkpoint, an interrupt is engaged and the rule engine sends a message to the appropriate participant, and at every instance, an inference engine is employed which sorts the bags to their respective destinations, and at every checkpoint, the luggage is weighed repeatedly. During the re-weighing of the luggage at each checkpoint, the weight is compared to the former and if peradventure, the weight contrasts with the formerly recorded weight, the security system is engaged and the appropriate procedure is taken to check if illicit materials are present, or if things have been added or removed. Another function of the middleware is connectivity to other applications. The scanning system has to be able to connect with a provided database because, without a database, the verification ID is just a useless number so the database is necessary to confirm the customer's credentials and information which has to be connected to the airline servers so that the tags can contain the appropriate information.

B. Statement of the Problem

In recent times, there have been growth in the volume of customer baggage, along with the invention of global alliances and dual transfer flights, these facilitates major problems to the aviation sector. This is the case for airports which handles massive batches of passengers routinely. This put an innate strain on the existing luggage handling system which runs on an aging barcode system. This has brought about the need to engage a better and more efficient manner of handling the passenger increase and also increase in luggage volumes and the RFID technology has drawn the attention of the airline. Research into the development of accurate Computer Aided Screening (CAS) systems is important for the future of security screening. The main areas where computing technology may be applied is for the automated detection of dangerous drugs, explosives and concealed weapons. Although systems exist that analyses spectra from neutron-based techniques for explosives detection, but there is a distinct lack of research in combining multiple features and classifiers for recognizing illicit material. The proposed techniques address the problems identified above through the adoption and extension of pattern recognition techniques in innovative ways via the use of RFID technology.

C. Significance and Justification of the Study

Many initiatives have been undertaken to enhance customers' satisfaction for better service delivery in recent time as the number of airline users increases. The additional functionality of RFID allows information to be changed at different points in the airline system. This makes it possible to hold bags for security checking and release them for loading when checked, provided the RFID system is linked to the baggage reconciliation systems. Though the existing system is still facing some challenges as it does not involve the passenger in the luggage tracking process. However, an efficient luggage handling system is required; hence the use of an interactive RFID-based bracelet luggage scanning system would make the process of baggage handling easier and faster as it would reduce the passenger waiting time when a mishandling error occurs.

II. REVIEW OF EXISTING WORKS

The origins of Radio-Frequency-Assisted Tracking Technology go as far back as the 1940s when it was pioneered in World War II for identifying enemy aircraft. During the 1960 - 1970s, RFID systems were still considered a secret technology used by the army to control access into sensitive areas (nuclear plants etc.). Technological developments lead to the creation of passive tag [4]. The technology soon extended itself to cattle tracking and cargo using radioactivity and, in recent times, finds itself into bar-code technology in supply-chain management.

[5],[6], focused on the use of RFID technology in the US department of Transportation's international airport security initiative in Nigeria. One of the uses of RFID baggage tags, in conjunction with RF handheld readers and boarding pass readers, is to verify passenger boarding versus luggage loading for positive passenger baggage matching on flights departing for the U.S. and other international locations.

[7], discussed workers' safety concern due to radiation emissions from a recently installed 900 MHz RFID baggage handling system at Hong Kong International Airport. The study concluded that the operation of the RFID system is considered a safe system, as the E-field levels recorded for the whole system is well below the ICNIRP (International Commission on Non-Ionizing Radiation Protection) restricted level.

A studyconducted in[8], advocated the embedding RFID tags in luggage labels as it could eliminate the need for manual inspection and routing by baggage handlers. A network of readers placed along conveyor belts could read the tags' routing information and provide feedback to a system that could then direct the bags onto the correct path. Automatic routing could

reduce the number of misrouted bags, lowering costs and improving customer satisfaction.
It is unclear who will foot the bill for installing RFID systems because the responsibility for baggage handling varies around the world. Experts recommend that it will be more beneficial if the airports rather than the individual airlines adopt the system and address this issue by highlighting scenarios in the baggage handling process.

III. PROPOSED METHODOLOGY

The Research method adopted for this project is experimentation and implementation. This study considers the use of passive tags as they do not require a significant scanning range and relatively have a small size. These tags do not have a power source but rather get power from the incident electromagnetic field. When the tag is subject to RF field, it draws up power used to get and transmit the stored information in the memory. In this way, the tag sends the traveler's information to the reader. Then, the reader converts the reflected waves sent by the tag into digital data for computer processing. Once the data is processed, the database system sends appropriate messages to the passengers. The construction of the Radio Frequency Identification (RFID) security luggage scanning depends solely on the microcontroller.

A. The System Architecture

The system is made up of an RFID passive card which transmits radio frequency data collected by an RFID wired reader, which in turns transmits data to a filtering system. This filtering system filters data based on business rules and transmits that to the appropriate application, which is connected to a host of database, via the network. The database processes the data and sends it back to the appropriate application. This process works in the same way for baggage tags as well as for frequent flyer tags. While it informs airport staff of the presence of a premium member via the frequent flyer tags, it also ensures that the bag is directed to the correct belt by the baggage tag. The main critical point of the system is the sophisticated filtering algorithm which improves the performance of the system and makes it highly scalable as well. In other words, the system works with paralleling ability, and if the number of bags or passengers increases, there will only be a need for adding another filtering system, without any drastic change in the system architecture. While the tags on the baggage will be for a single use only, the cards for the members should theoretically be long lasting. Just to focus on how the RFID chips for frequent flyer members are programmed, the system will not be confused by different RFID cards because the system will respond based on the data written in a card which is the username and user id (which is the frequent flyer number) and response will be based on a set of clearly laid out business rules.

B. Software Specification

Oracle application servers are used along with an Oracle sensor edge Server as the middleware between the Oracle Database and the application. The main reason for using this technology is that the product has the proven ability to filter the data from sensor based technologies such as RFID, which collect unstructured data from the environment. One of the main factors for selecting Oracle products is that the airline is already using many Oracle products such as the Oracle ERP system e-business suite; therefore, the new system is compatible with the existing ones. The operating system is Oracle Enterprise Linux 4 which is free, open source and highly compatible with Oracle products.

C. The Message Alert Unit

The message alert unit is used to message the luggage owner when his/her luggage is being properly placed. This consists of a Global System for Mobile Communication (GSM) Module with a registered SIM card in it.

D. Overview of Hardware Requirements

The RFID Airport Security Scanning System was built using the following listed hardware/ components:

1) **The Power Supply Unit** – sources from rechargeable battery
2) **RFID Card Reader Module -** The RDM6300 125KHz card reader mini-module is designed for reading code from 125KHz card compatible read-only tags and read and write card as shown in Figure 1.

Fig. 1: Typical RDM6300 RFID Module

The RDM6300 RFID Module radiates 125 KHz through its coils and when a 125 KHz passive RFID tag is brought into this field it will get energized from this field. These passive RFID tags mostly consist of CMOS IC EM4102 which can get enough power for its working from the field generated by the reader. By changing the modulation current through the coils, tag will send back the information contained in the factory programmed memory array as shown in Figures 2 & 3.

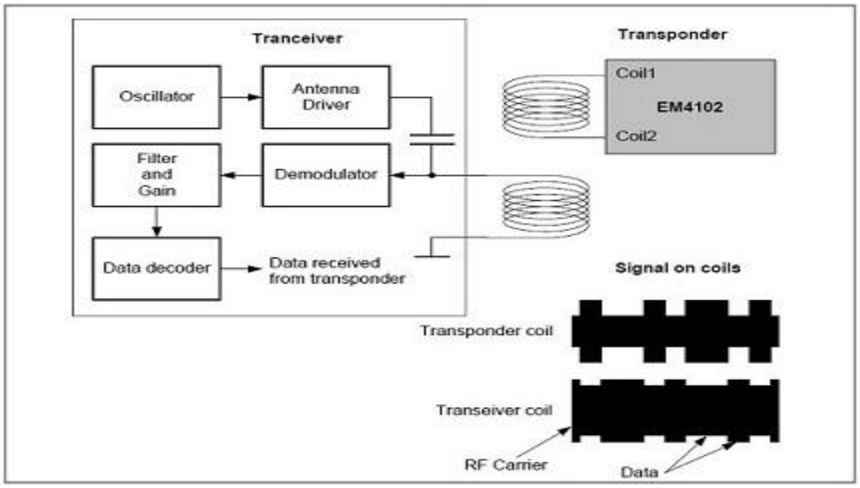

Fig. 2: The working block diagram of a 125 KHz RFID Reader

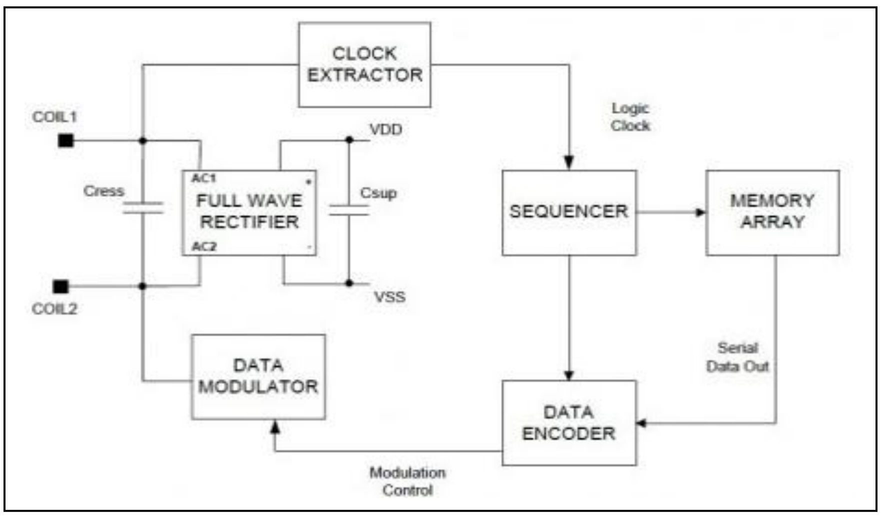

Fig. 3: Internal Layout of RFID Tag

3) **Stored-Value Card (RFID) -** RFID tagging is an ID system that uses small radio frequency identification devices for identification and tracking purposes. An RFID tagging system includes the tag itself, a read/write device, and a host system application for data collection, processing, and transmission. The tag usually consists of two parts: the chipset and antenna as shown in Figures 4 and 5.

Fig. 4: RFID Tag Types

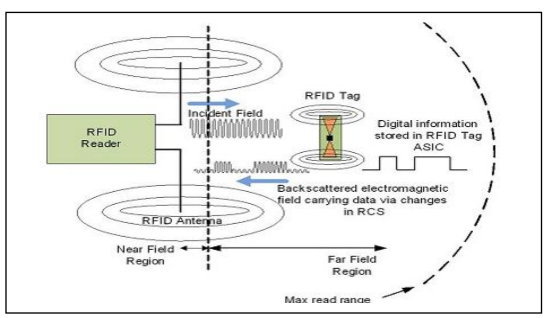

Fig. 5: The working block diagram of an RFID Tag

4) **The Chipset -** The chipset stores theunique data for the tag, determinesthe amount ofinformation it can**store**, and the available securityfeatures.

5) **The Antenna -** The antenna allows the chip to receive power and transmitinformation.

6) **The Luggage Destination Sort Unit -** This stage consists of dc motors, plastic gears and gear tooth driving belts. A DC motor is a mechanically commutated electric motor powered from direct current (DC). The stator is stationary in space by definition and therefore so is its current. The current in the rotor is switched by the commutator to also be stationary in space. This is how the relative angle between the stator and rotor magnetic flux is maintained near 90 degrees, which generates the maximum torque.

7)The Luggage Picking Arm Unit - This stage consists of two servo motors and a current controlled magnet. The servomotor is a rotator actuator or linear actuator that allows for precise control of angular or linear position, velocity and acceleration. It consists of a suitable motor coupled to a sensor for position feedback. It also requires a relatively sophisticated controller, often a dedicated module designed specifically for use with servomotors. The servo motor is specialized for high-response, high-precision positioning. As a motor capable of accurate rotation angle and speed control, it can be used for a variety of equipment.

- Tuning Free
- Compact and High Power
- Wide Variable Speed Range
- Standard or Planetary Geared Type
- Electromagnetic Brake Types

Fig. 6: A typical Servo Motor

IV. SYSTEM IMPLEMENTATION AND TESTING

The RFID airport luggage security scanning system will be implemented in phases based on the functionalities. Figure 7 depicts the block diagram of the entire system while Figure 8 shows the circuit diagram. The circuit contains all the necessary electronics to allow storing, deleting, and verifying tags. Stored tag numbers are retained even in the event of complete power failure or battery drain. This system utilizes an RFID Reader and RFID Tags technology to define the destination of every individual luggage's. In this project, the RDM6300 RFID Reader with plastic cards is used to enable identify the destination of each luggage. The microcontroller ATmega328p consist of the program code written in any language of understanding and compiled to get a hex code which is a machine language understood by the microcontroller. It is easy to add a tag, delete a tag and identify the tag. To add a tag, a tag is connected to the scanner, the system therefore requests and authenticate the admin password and then press the ADD key. Subsequently, the microcontroller will send the ADD command to the module and the module will add it into the memory. In the deletion of the tags the same principle as stated above also applies. The tag is identified once the reader and the tag matches, then the Relay is complemented. Also, the owner of the tag's identity is stored as well. When a registered tag is connected to the scanner, it reads the stored value, and sends a message to the microcontroller to access it then the luggage picking arm picks the luggage to the port, in which the microcontroller instructs.

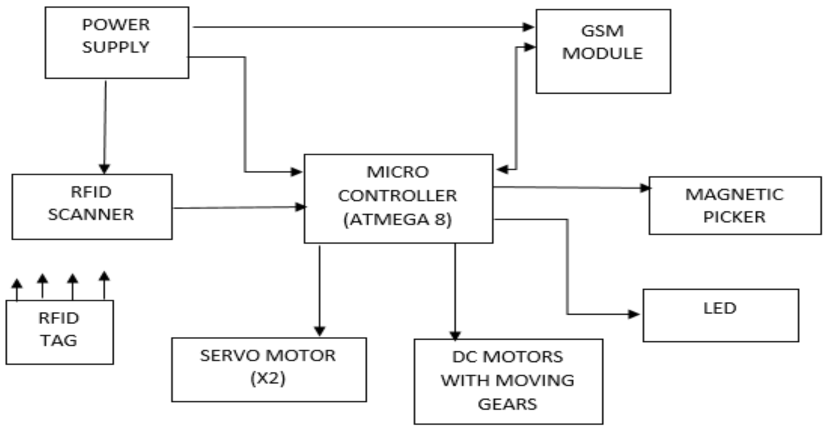

Fig. 7: Block Diagram of RFID Airport Luggage Scanning System.

1) **PHASE ONE**
The system will be implemented for RFID baggage tags between airport where the airline is based and key airports which already have RFID capability.

2) **PHASE TWO**
The system will be implemented for RFID baggage tags between airport where the airline is based and high value/volume destinations.

3) **PHASE THREE**
The system will be implemented for all destinations in the airlines network where passengers can use passengers' RFID tags at all stations in the network.

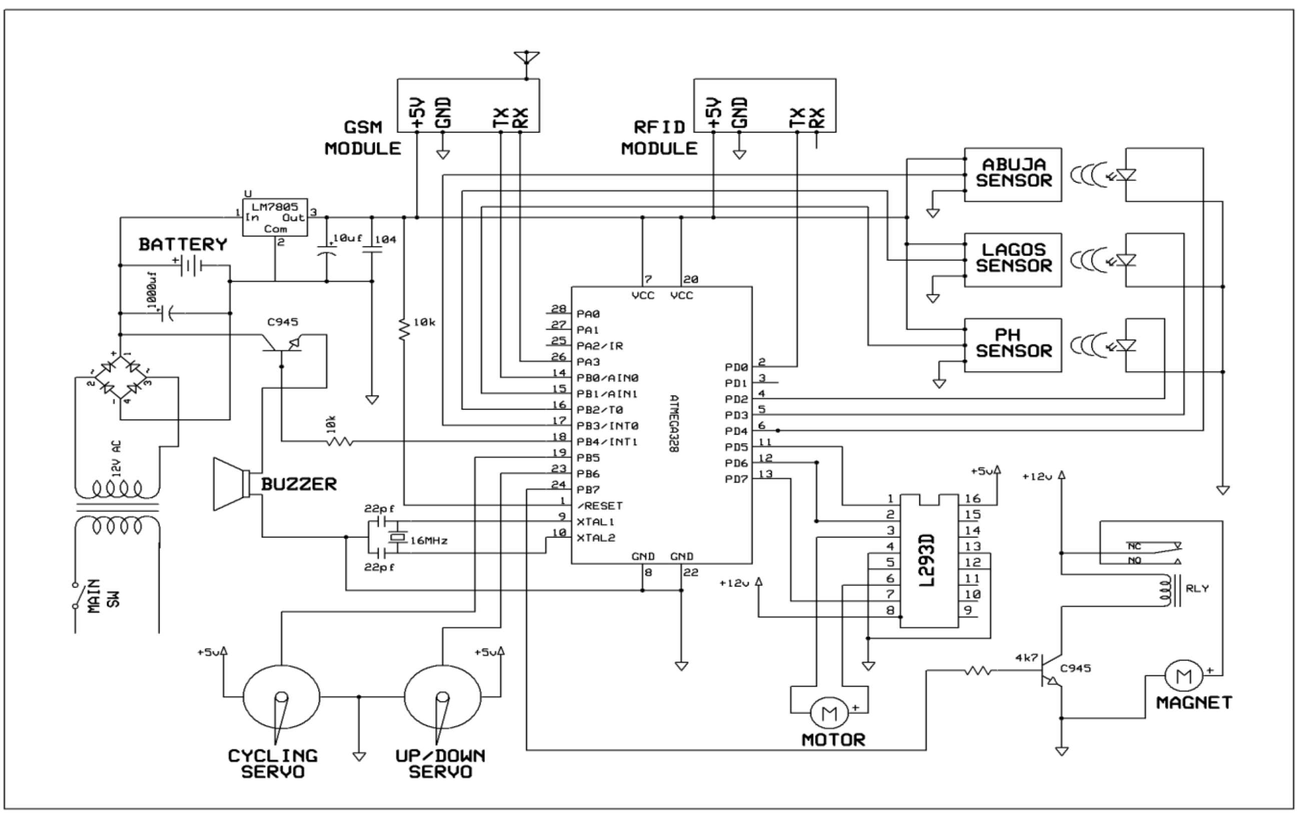

Fig. 8: Circuit Diagram of RFID Airport Luggage Scanning System.

A. Actual System Construction, Testing and Evaluation

Figures 9 to 13 show the actual RFDI Airport Luggage Scanner System in a step-by-step construction. Figure 9 depicts the control board, Figure 10 shows the RDM630 RFDI reader that enables easy communication with the system. Figures 11 and 12 show the sensory module that works hand-in hand with the conveyor mechanism for stop and start of the conveyor system, while Figure 13 depicts the complete assembly of the entire RFDI system.

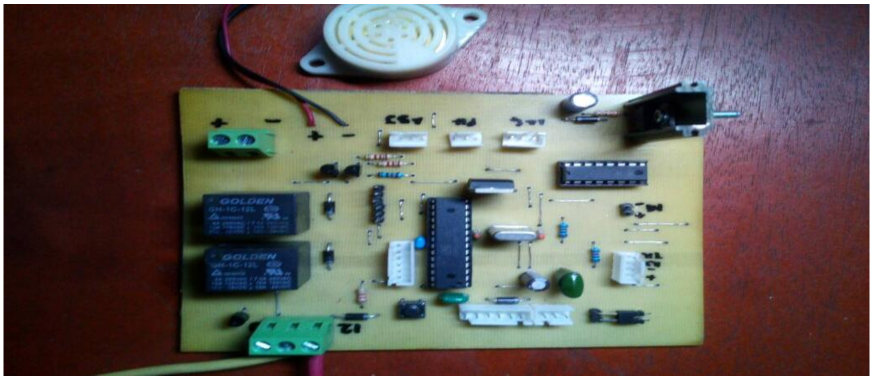

Fig. 9: Control Board

Fig. 10: RDM630 RFID Reader

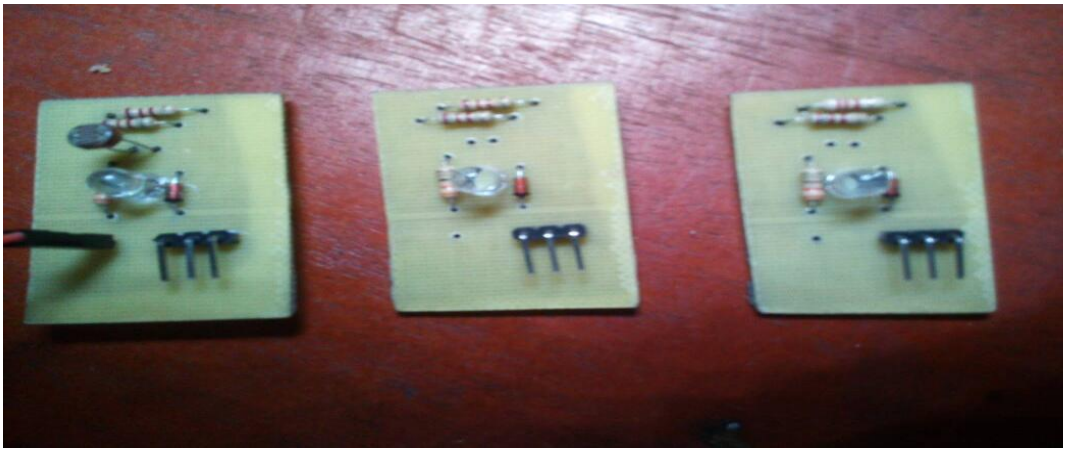

Fig. 11: Luggage Destination Sensors

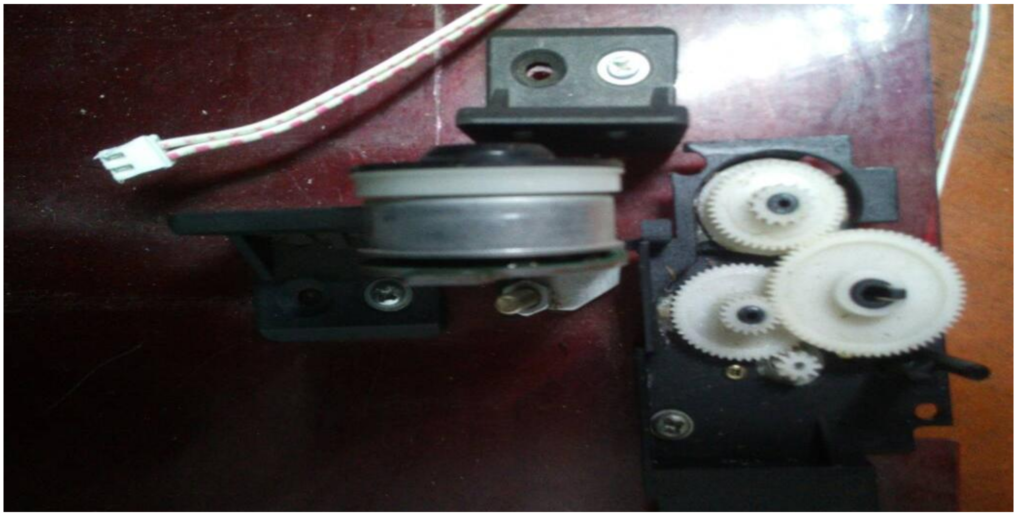

Fig. 12: Conveyor and Slider Parts

Fig. 13: Hardware Implementation of RFID Airport Luggage Scanning System.

V. CONCLUSION AND RECOMMENDATION

This study provided a coherent understanding of the design and a technological architecture of RFID in combating airport security risk. The study also reviewed the different communication mechanism of the RFID tags, its applications in different sectors and fields, such as surveillance, radio-tagging, and security among others. The actual experimentation and implementation of RFID airport luggage system was carried out with the aim of actualizing the design objective. During the implementation, the system was evaluated in other to ensure that it meet standard technological requirements and functionality.

The study has shown that the RFID technology is a technology with a promising future, even though there are still some problems and limitations that need to be resolved. These problems must be mitigated by aviation authorities, airports and the airlines before RFID can become an integral part of the airline industry. An international standard must be developed and evolved, which will require extensive testing. Currently, the emphasis is on limited trials involving pairs of airports and airlines. It is pertinent to note that RFID tags will be widely adopted only when airlines, airports and ground-handling staff can be convinced that they are a good idea. The cost of the switch to RFID will also have to be justified. Notwithstanding, in spite of some of the daunting, it should be reiterated that the successful implementation of an RFID baggage tracking system will have a positive impact on commercial aviation. With this system in place, airlines will reduce labour and loss of luggage costs while greatly increasing customer satisfaction. RFID is the next evolutionary step towards enhanced baggage-handling efficiency.

Future research and innovation in the field of data integration between hardware devices and software will help a great deal in the support and development of this system. A software design as a driven force needs be developed to enhance the efficiency and functionality of the system.

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