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Fabrication and Implementation of Airside Entry Access of Flight Crew Using RFID Technology

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ABSTRACT

Crew members of airlines are facing problems for accessing airside of airports through continuous checks and it is a time taking process. Radio Frequency Identification (RFID) is the promising technology which will reduces the access time and improves security and ensures safety in airport and as well as in many industries. In our proposed project, fabrication of Radio Frequency Identification (RFID) technological system will give the access or denial indication for particular crew member to enter the airside of the airport. When the RFID card is placed near the RFID reader, the information in the card will be checked with airline roster database and it will give the access or denial indication in the visual (monitor) and aural display if the aircrew's name is not on the duty roster. This proposed system prevents unnecessary movement of aviation staff in the airport. Also, this proposed system will reduce the access time to airport for their duties. The functional system of airport administrative department will be reduced burden for accessing of crew member if they are not on duty and will not be given entry access. This enhances the safety and security of airport and reduced time access of duty staff access to airfield area. This proposed system works excellent by comparing theoretically and practically.

Keywords: *Airfield, airport, entry access, crew member, radio frequency identification (RFID).*

INTRODUCTION TO RFID

RFID is the technology that is used to transfer data, security access, identify objects, people, animals etc. Radio Frequency Identification is the wireless technology which is developed for supply chain management by replacing barcodes. RFID works on the principle of Inductive Coupling.

Radio Frequency Identification is the cost-effective and reliable technology (Dabhi Manishaben Dahyabhai and B. K. Mehta 2014). RFID technology uses the combination of RFID tag and RFID reader for identification.

RFID is a major and modest innovation that empowers wireless information transmission (Md Mostafizur Rahman Komol, Amit Kumar Podder, Md Nesar Ali, Shariar Mohammed Ansary, 2018). Time management is one of the challenging tasks for smooth operation in airport.

Nowadays in airport many technologies have been implemented to minimize the rush time and improve the safety of passengers, personnel and the entire airport, in which RFID plays the important role as the security measures.[1-5]

The security challenges being encountered in many places require electronic means of controlling access (Jonathan A. Enokela and Michael N. Tyowuah, 2014). Security checking for airline personnel, especially for pilots and flight attendants can be done in reduced time and with improved safety, with the help of RFID technology. RFID can read information without line of sight.

This RFID technology is more effective with longer read range (Davinder Parkash Chechi, Twinkle Kundu, Preet Kaur 2012). RFID reader reads the information from RFID tags and checks that information with airline database and gives access to authorized personnel.[6-10]

HISTORY OF RFID TECHNOLOGY

In history RFID is considered as one of the most pervasive computing technologies. In fact, RFID technology is not a new concept. First time in the world it was introduced in World War 2.

From 1940-1950 to distinguish allied aircraft from the enemy aircraft, British Air Force used this technology using radar. In next ten years RFID application is used in the research laboratories, military sectors and in major commercial enterprises.

From 1960-1970 technological advancements made the way to creation of passive tag, and the initiative of animal tracking, and factory automation took place.

In next ten years RFID tags has been manufactured by many American and European companies.

In various part of the world, this decade became full of implementation RFID technologies (J. Landt, 2005). In early 2003 there was a boom, due to demand by Wal-Mart and the US Department of Defense (US DOD), that by the beginning of 2005 their suppliers should adopt and implement this RFID technology.

Later then this technology has been used in many applications such as luggage tracking system in airport, antitheft systems, electronic toll collection system, etc. (Linda Castro, Samuel Fosso Wamba, 2007).[11-15]

AIRLINE CREW ROSTERING

Airline crew roistering is the process of scheduling the duty for personnel, especially for pilots and cabin crews on particular days of the month in the year. Crew scheduling in airlines consist of lots of factors.

Airline crew scheduling is of great significance to airlines, which mainly consists of two stages: crew pairing and crew rostering (Shu-Zi Zhou, Zhi-Hui Zhan, Zong-Gan Chen, Sam Kwong, Jun Zhang, 2021).

Problems with airline crew rostering involve creating monthly schedules for crew members by assigning those pairings, rest periods, annual and sick leave, training times, union activities, and so on to comply with collective bargaining agreements and security regulations.

(Paola Cappanera, Giorgio Gallo, 2004). Details and duty time of personnel can be stored in airline database and checked with particular pilot or cabin crew while they enter into the airport with the help of RFID technology.[16,17]

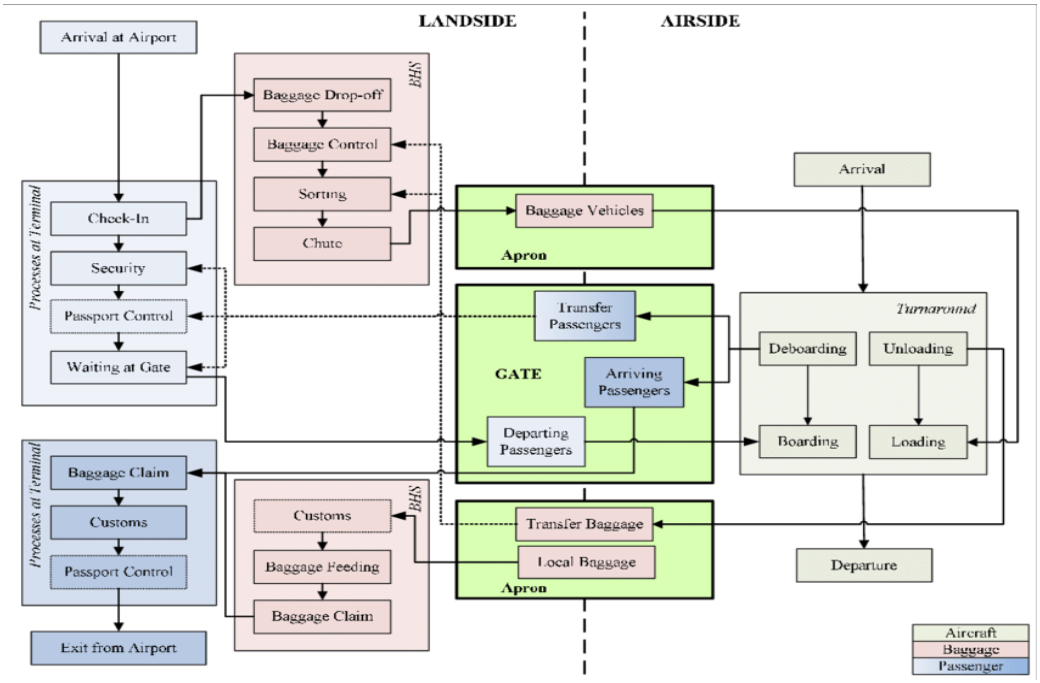

Fig. 1: *Airside and landside of an airport.*

AIRSIDE OF AN AIRPORT

Airside implies the portion of an airplane terminal straight forwardly included arrival and departure of aircraft, counting runways, taxiways, aprons and ramps. Airside is the area where there is no access to general passengers.

Airside of an airport consist of very sensitive and dangerous equipment and vehicles such as transporters, refueling trucks, Ground Power Unit (GPU), air starters, aerobridge etc. Authorized person only has the access to airside of an airport.

At commercial airports, airside operations include activities such as safe and efficient aircraft movements on approach to the airport, landing on a designated runway, taxiing to the airfield destination (a designated gate or ramp), provision of services on arrival for subsequent departure, release from the gate or ramp location, taxiing to the designated departure runway, and takeoff into a sector of airspace appropriate for the next destination.(Schulte 2014).

RADIO FREQUENCY IDENTIFICATION

RFID belongs to the group of technologies referred to as Automatic Identification and Data Capture (AIDC). Radio frequency identification is one of the cost-efficient and reliable technologies.

This RFID technology is nowadays used by many sectors in the world through different applications like airline baggage reconciliation, animal tagging, postal tracking, etc. RFID system primarily consists of two main components, transponder or RFID tag and the interrogator or RFID reader. This RFID supports tag reading with no line-of-sight. It also removes the risk of human error.

RFID tag is a small device equipped with microchip. This carries data and antenna. This RFID ranges from less than a millimeter to several inches or feet. Tags are classified into active type and passive type. Active type tags are also called as Read only tags and passive type tags are

also called as Read/write tags. The unique serial number is allocated to each tag to retrieve the additional descriptive data like name of personnel, designation, company name, etc. The encoded data cannot be changed (Dabhi Manishaben Dahyabhai and B. K. Mehta, 2014).

RFID reader reads data from the tag. Readers can be hand held or mounted in strategic location to ensure that the tag passes through the interrogation zone. The area within which a reader can reads the tag is called interrogation zone. RFID readers are also known as Proximity Coupling Device (PCD). At certain frequency, reader reads the tag's data through RFID antennas (K.Srinivasa Ravi, G.H.Varun, T.Vamsi, P.Pratyusha, 2013). Readers can be available in different shapes and size. Based on the customer's requirements, reader manufacturing companies has their own set of standards and functionalities. Some RFID readers are available with in-build LCD lights for visual indication and buzzer for aural indication.

The communication between tags to reader is known as uplink and the communication between reader to tag or antenna is known as downlink.

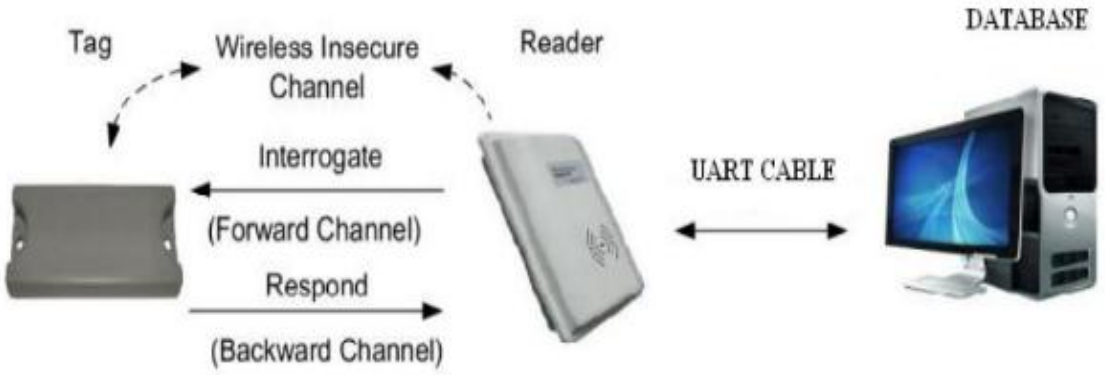

Fig. 2: *Basic RFID system.*

WORKING PRINCIPLE OF RFID

RFID tag contains an integrated circuit and an antenna, which are used to transmit data to the RFID reader also known as interrogator. In case of LF and HF tag, inductive coupling is used by the tag to gather energy from RF signal and UHF tag use backscattering coupling.

The RFID reader then converts the radio waves to the most usable form of data. Information collected from the tags is then passed through a communication interface to a host computer system, where the data can be stored in a database and analyzed.

Inductive Coupling

The inductive coupling tags always operate passively. A single microchip and a large coil that functions as an antenna are the electronic devices that consisted of tags.

A strong electromagnetic field which penetrates through the area of the coil is produced by the reader's antenna coil. Due to induction, the transponders antenna coil generates voltage by the small part of emitted field. The power supply for the microchip is rectified by the voltage. This is possible only when the tag and reader are placed within the interrogation zone.

Backscattering Coupling

Backscattering is well known from the RADAR technology, that electromagnetic waves are reflected directly back towards the radar antenna. In RFID technology a portion of incident RF energy is transmitted by tuned receiving antenna. If it is in the direction of original transmitter then this retransmission is known as backscattering. This backscattering can be detected by another antenna (Davinder Parkash Chechi, Twinkle Kundu, Preet Kaur 2012).

APPLICATION OF RFID TECHNOLOGY IN MANUFACTURING INDUSTRIES

The use of RFID technology in manufacturing industries helps to avoid errors due to human factors like manual and visual verification of each product received. Worldwide many manufacturing industries uses RFID technology to reduce the consumption of time and to minimize the human error. Demand planning and forecasting can be improved by the great potential of RFID.

Some of the RFID applications in manufacturing industries are: Boeing is the leading flight manufacturing company in the world. Boeing was headquartered in USA. For maintenance activities optimization and to speed up access to information regarding maintenance history, parts pedigree, etc. RFID tags are used on airplane parts.

Toyota is the car manufacturing industry based in South Africa. This industry uses transporters that are tagged to vehicles for tracking. To hold the vehicles maintenance history these tags are intended to remain with the vehicle throughout its life.

Herding is the filter manufacturing company based in Germany, which uses RFID technology to track quality control, production and shipment of new and reconditioned filters.

To improve vehicle's location process, Volkswagen uses RFID technology by tracking the finished vehicles.

RFID technology is used at manufacturing plant of Ford industries in USA for improvement of labor productivity. At Brazilian factory HP printers are tagged to track them through reverse logistics and shipping.

Michelin is one of the leading tire manufacturing industries in the world. Michelin is headquartered in North America. Michelin also provides tires to many airlines in the world. To comply with TREAD (Transportation, Recall, Enhancement, Accountability and Documentation) act and recall management, tires are tagged with RFID technology.

To reduce the loss of keg, Scottish Courage based in UK uses low frequency tags to track 1.9 million kegs.

APPLICATION OF RFID TECHNOLOGY IN HEALTHCARE DEPARTMENT

- To improve patient care and safety, Chang-Gung hospital in Taiwan uses RFID enabled passive wristbands. This helps to identify surgical patients and their operations.
- In Germany, Jena University uses RFID system to track medication. This ensures that patient gets correct **doses** of the right drugs.
- Cardinal Health Inc. in USA uses RFID tags on all surgical equipment. This ensures that all tools used during an operation have been removed from the patient's body.

- RFID based real time location system (RLTS) are used to track medical assets in Harmon Hospital at USA, to locate assets seamlessly.

RFID READER

RFID reader is a main component in Radio Frequency Identification technology that is used to read information or data from the RFID tags. This reader is also called as interrogator or scanner. The interrogator includes an antenna and transceiver with decoder. Radio signals are emitted by interrogator in the range from one inch to one hundred feet or more (Michael A. Hughes, Richard M. Pratt, 2004). With the help of antennas, reader sends and receives the RF data from the tag. Sometimes this reader will have multiple antennas. These antennas are in charge of both transmitting and receiving signals. Reader confirms the presence of tagged item to the data processing system. Few factors affect the read range of RFID reader. Frequency used, antenna gain and orientation of antenna will affect the read range of RFID reader.

In the interrogation zone, RFID reader reads the data from the tags of particular flight crew. Then the data is checked with database of airline and gives access to authorized personnel.

Fig. 3: *RFID tag.*

Classification of RFID Readers

Based on their design and technology used and fixation of device, RFID readers are classified into four types. They are Read, Read/Write, Fixed and Mobile.

RFID Tag

RFID tags are contactless cards or also known as Proximity Integrated circuit card (PICC). The RFID tags usually consist of simple silicon microchip and antenna. These tags are classified into: Active tags, Passive tags and Semi-passive tags. Active tag has their own power supply and passive tags need to depend on power supply from RFID reader by the process called inductive coupling. Semi-passive tag is the hybrid type. Each tag has a unique serial number or identification number. Information from the tag is collected by the microchip and transmitted wirelessly with the help of RFID reader.

RFID tag can be provided to flight crew with unique identification number for security measures. Necessary details of the particular pilot or flight attendant can be stored in airline database with the respective identification number of the

RFID tags. The data can be decoded with the help of RFID reader.

Classification of RFID Tags

RFID tags are basically classified by the tag's power source, memory type, frequency and wireless signal used for communication between reader and the tag.

Active tags

Active tags are powered by internal battery. This is used as the power for tag and antenna. Active tags consist of microcontrollers, transceivers, antenna and battery. After one cycle of use, some tags are replaceable and some tags are not replaceable. The batteries must be replaceable periodically.

This tag generally uses longer read range than passive tags. Range of the system is increased by built-in batteries presented in active tag. Electromagnetic field of RFID reader is not necessary in order to activate the tag (Konstantinos Domdouzis, Bimal Kumar, Chimay Anumba, 2007). Active tags are more expensive than passive tags and semi-passive tags. Signals are transmitted and received by transceivers, power supply is produced by battery, data transaction is controlled by microcontrollers and media is converted to electromagnetic wave using antenna. Active tags have larger data storage. Scanning of up to 20 tags moving at more than 100 miles/hour is possible.

Passive tags

Passive tag is least complex in design. These tags are less expensive. Passive tag does not have an internal power source. When compared with active and semi-passive tags, passive tag gives weaker response. Passive tag does not have any sensors. It ranges from 10 cm to few meters. Passive tag induces operating power from RFID reader. The internal circuit gets power by electromagnetic field transmitted by receiver. Passive tag does not rely on a transmitter. Data is transmitted back to the reader by backscattering (Vipul Chawla and Dang Sam Ha, 2007). The passive RFID tags operate with reduced power and become uplink. To amplify the signal, amplitude modulation is used by passive tags and the signal is demodulated to get the transmitted signal from the tag.

Semi-passive tags

Semi-passive tag operates similarly like the other passive tags. But compared to well-known class of passive tags, semi-passive tags are higher class of RFID tags. The term "semi-passive" means batteries are employed to supply the functional circuits for data storage and signal processing. But the tag still operates in a passive manner in that they use backscatter mechanism for uplink (tag to reader) communication and use "reader talk first" mode. Power strength received by semi-passive tags are less compared with passive tags. The qualities of semi-passive tags make them highly expected in many applications in the world.

This tag has better read range and readability performance. For transmitting signals power amplification method is not used by semi-passive tags. To make them commercially competitive in price, cheap thin film batteries with small power capacity is employed (Che Wenyi, et al, 2010). The semi-passive RFID reader includes a receiver, processor and also a back scattered modulator which is coupled to a processor. It has the range of hundreds of meters. Semi-passive tag has longer potential shell life and less expensive compared to active RFID tags. The semi-passive tags transmit signal by backscattering the carrier wave from the reader. The battery power source captures all energy from reader and that is used to

reflect the RFID signal which improves data transfer rate and read distances (M Zaman Tanim, 2016).

Low frequency RFID tags

Low frequency tag works in a low frequency range. Low frequency tags are cheaper compared to high frequency tags. This tag has short reading range. Low frequency RFID tags mostly uses frequency of 125 to 134 KHz. In this low frequency, electromagnetic waves penetrate water but not metal. They are least affected when there is an obstacle like metal and fluid. The speed of data transfer is typically less than 1 Kbits per second.

High frequency RFID tags

High frequency tags are operated in high frequency range. The range and transmission rate are higher in high frequency tag. The data transfer rate for this high frequency tag is approximately 25 Kbits per second. These tags are expensive than low frequency tags. High frequency tags work at frequency of 13.56 MHz Electromagnetic wave of this frequency can penetrate through water but not metal. Applications related to access and security is used by this high frequency tag.

Ultra-high frequency RFID tags

Ultra-high frequency tags are operated in ultra-high frequency range. Logistics application uses this frequency range. Transmission rate is very higher for this frequency. This allows reading a single tag in very short period of time. This feature is very important where tagged entities are moving with high speed and remain only for a shorter time in an interrogation. Ultra-high frequency tags are very expensive than any other tags. These tags are severely affected by fluid and metals (Christoph Jechlitschek, 2010). UHF tag offers longer reading range. The frequency range of UHF tag is between 433 to 956 MHz The speed of data transfer rate is 100 Kbits per second.

Fig. 4: *Ultra-High Frequency RFID Tags.*

CURRENT SECURITY CHECKING TREND FOR FLIGHT CREW

Security checking is one of the most important tasks in the airport. It consists of many procedures starts from checking the pilots and cabin crews arrive at the airport to till they reach their flight gate. Aviation regulatory body of each country assigns skilled personnel at security checking area. They check the passenger, baggage, personnel of airport and airline or anyone who enters the airport with or without the authorization.

Flight crews are instructed to carry valid documents for every flight they operate.

The documents include flight crew's license, medical license, government issued photo ID, etc. These documents are checked by security personnel and they give the access to authorized personnel to enter into the airport.

FABRICATION

Fabrication of RFID

Fabrication of RFID based security system using Raspberry Pi-4 computer includes electronic components like RFID reader and RFID tag. Combination of JavaScript and python codes are used to process the data. Installation Of Raspberry Pi OS Raspberry pi is the mini computer. RPI-4 is the main hub which connects all other electronic components to process the entire data.

Raspberry pi hardware can be only operated by installing the Raspberry pi operating system into it. Without the OS raspberry pi is simply the inoperative hardware. To boot the RPI OS, memory card is needed with sufficient storage based on the data usage or purpose of the project. In this project, memory card with 8GB storage is used to boot the OS.

The raspberry pi OS is booted to memory card with the help of Raspberry pi imager software. Raspberry pi is the simple and quick way to install the Raspberry Pi OS and other operating systems to a microSD card that can be used with the Raspberry Pi. This is the only software to boot the RPI OS into memory card. Initially any computers or laptops are used to boot the OS into memory card.

In raspberry pi imager, options are provided to choose and install different software into memory card. In this project 2022-04-04-raspios-bullseye-armhf.img.xz OS is used. RPI imager also allows us to choose the required storage to boot the program. The microSD card must be the formatted before booting the program. Otherwise, while booting the data in the memory card will be deleted automatically. After selecting the OS and storage, time zone and location is updated. Finally, after finishing all setup OS is ready to write into memory card. Installation will take some time and after writing is completed the removal of SD card prompt will be displayed.

- Initial Setup
- Power Supply

Raspberry pi-4 computer model B is connected to power source by type-C cable with minimum of 5V power supply. Less than 5V power supply will slow down the speed of the Raspberry Pi computer and leads to malfunction of the hardware and output will not be displayed properly.

If the power supply is connected properly the red LCD light will be indicated in Raspberry Pi computer. If the OS starts running, then green LCD light will be indicated.

Fig. 5: *Power Supply Port.*

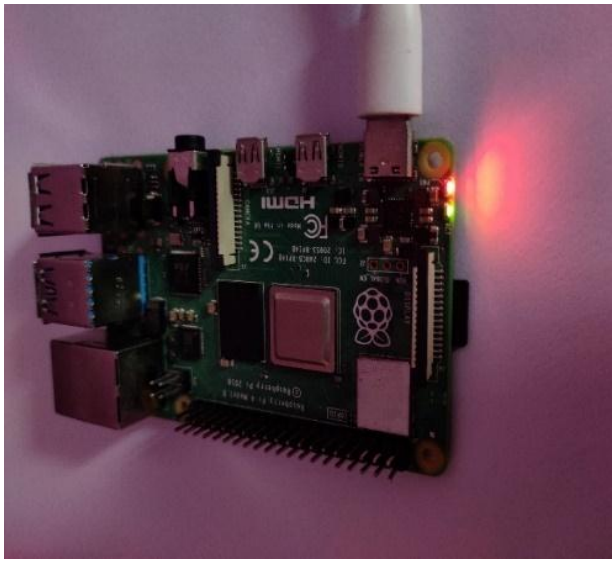

Fig. 6: *Memory Card Installation.*

Memory Card Installation

To run the installed OS, the booted memory card is inserted into the Raspberry Pi computer. The memory card should be inserted in such a way that contact pin of memory card plugged correctly into the socket of raspberry pi without any improper adjustments. If the memory card is not inserted properly the OS will not be able to run by the raspberry pi-4 computer.

RFID Tag

RFID tag is used to store the data. Universally each RFID tag or card has their unique ID or tag number. Frequency of 125KHz RFID card is used in this project. Since it uses radio waves to communicate, RFID tag does not need line of sight. The unique number of the RFID tag is linked with the programming of this project. And the details of each flight crew are linked with the individual card number.

Installing RFID Reader

RFID reader is used to read the data from the RFID tag. The collected data is then transmitted to raspberry pi computer.125KHz RFID reader is used in this project for better reading speed of RFID card. When the RFID card is place near the reader, beep sound will be indicated from the buzzer of the RFID reader. RFID reader is plugged-in to USB portal 3 of the raspberry pi. This portal can be mentioned as hidrawl or hidraw1in RPI computer. Java scripts and python programs are programmed into the RPI-4 to read and process the data coordinating with RFID reader.

LCD Display Setup

3.5-inch LCD screen display is used in this project. This LCD screen is used to display the details of each flight crew of an airline with respect to airline roster database. And also displays the airside and admin access/denial indication with red and green color.

Initially once we plugin the LCD screen into pre-soldered 40 pin GPIO (General Purpose Input/Output), the screen will display the simple white background. This LCD screen cannot be displayed until the separate program for this screen is programmed into the raspberry pi computer.

With the help of separate monitor or television which can receive and display

the output of the raspberry pi computer, we can do the programming for LCD screen to display the data using HDMI cable. After programming, automatically the data will be displayed in the LCD screen instead of the separate monitor or television which we used. Separate revert code is used to display the details again in the television or monitor instead of LCD display.

DEVICE PROGRAMMING

The constructed RFID based security system is programmed by various java scripts and python codes. All programs were programmed into raspberry pi computer.

Java script programming language is used to store the details of each flight crew with respect to their airline roster database. Python programming language is used to display the details of flight crew in the server. Hyper Text Markup Language is used to modify how the details of flight crew should be displayed in LCD screen.

We can modify the color, size, font of the text and size of the photograph to be displayed in the output.Finally, the combination of all these three programming languages is used to map the details of each flight crew with their separate RFID card and display the details in the LCD screen.

Details Programmed for the Flight Crew

The details of flight crew which is programmed to display in LCD screen are photograph, personal and professional data which includes:

- Name
- Designation
- D.O.B
- AEP Number
- Passport No
- Nationality
- CPL validity
- Medical validity

RESULT AND CONCLUSION

RFID based security system identifies and displays the details of the flight crew practically with raspberry pi-4 computer which consist of 3.5inch LCD screen display, RFID tag and reader.

Once the power supply is connected, both green and red LCD light indicated in the RPI computer, which ensures the power supply is in good condition and OS is started running. The RFID reader is connected to the RPI computer.

The reader has the very good reading capacity. Once we placed the RFID tag from the particular distance, the RFID tag number is read by the reader with the beep sound from buzzer of RFID reader. Then the data is transmitted to the raspberry pi computer.

The program which is already programmed in the RPI started running and received the RFID card number of the particular flight crew from the RFID reader. Then the program fetched the detail of the particular flight crew which is already linked with the RFID card number.

Also, the duty roster of the particular flight crew is checked. Finally, the details of the particular flight crew are displayed in the screen of the 3.5inch LCD display. The airside and admin access/denial indication are also displayed with respect to their airline roster database. Also, we have checked dummy RFID card which is not linked with this system. Once we placed that dummy card near RFID

reader, unauthorized user prompt was displayed in the LCD screen. In this way we can ensure that only an authorized person can have the access to entry. This RFID based security system is designed in such a way that it could be user friendly for the flight crew of the airlines. By implementing this technique security personnel could identify the details of the flight crew quickly and easily. This enhances the safety and security of the airport and reduced time access of duty staff access to airfield area.

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