International Journal of Scientific Research in Science and Technology
Print ISSN: 2395-6011 | Online ISSN: 2395-602X (www.ijsrst.com)
doi : https://doi.org/10.32628/IJSRST229490

Methods of Air Traffic Management Using Artificial Intelligence in India

Prathapagiri Harish Kumar*[1], Mohammed Nasser Hussain[1], Kotha Nikhil Reddy[1], Shankesi Laxmi Sai Deep[2]
[1]Department of Computer Science and Engineering, Kakatiya Institute of Technology and Science, Hanamkonda, Telangana, India
[2]Department of Civil Engineering, SR Engineering College, Hanamkonda, Telangana, India.

Article Info
Volume 9, Issue 4
Page Number : 01-05

Publication Issue
July-August 2022

Article History
Accepted : 05 August 2022
Published : 22 August 2022

ABSTRACT

Artificial intelligence (AI) has been recognised as having a broad potential to reduce human workload or increase human capabilities in complex scenarios; however, it is now clear that AI also plays an important role in transforming our lives by promoting more efficient existing services or completely new services. AI is already assisting managers (airlines/airports managers, air traffic management) and operators in a wide range of aviation and air traffic system applications (pilots, air traffic controllers, airport operators, flow controllers). The aviation and air traffic management (ATM) sectors are now confronted with new interconnected challenges: energy transition, increased environmental protection, increased capacity flexibility, integration of new components into air traffic (drones), and system resilience to large traffic perturbations (economic crises, pandemics). AI should help to discover effective solutions to all of these problems. The capacity and safety of the airspace system are heavily reliant on the competent coordination of air traffic control System (ATCS) and flight desk employees. This indicates that aviation traffic will expand at an exponential pace, causing substantial congestion, flight delays, and pollution. Maintaining safe spacing between aircrafts, directing them during takeoff and landing from airports, guiding them around adverse weather, and ensuring that traffic moves smoothly with minimum delays. The goal of this Research Topic is to develop and apply new AI techniques to solve new aircraft operations and air traffic management problems, with the goal of making air transportation operations (including air traffic) more efficient and safe than they are today, while new aviation technologies and new airspace organisation concepts are introduced, and the main goal of this research is to provide automatic communication between the airport and the aircraft. The Problem of manually checking climatic conditions, runway parameters, air traffic, and various other information can be solved by using GSM technology. To reduce the manual efforts and human errors. Before landing, the arrival time of the aircraft is announced automatically.

Keywords: Aircraft, Air Traffic control System, pollution, Traffic Flow, Artificial intelligence.

I. INTRODUCTION

Particularly interesting are AI methods for data collection, estimate, interpretation, modelling, reasoning, and decision-making, including via intelligent optimization methods. For single agents, many agents, or flows, techniques from the domains of data mining, machine learning, causal and Bayesian networks, non-classical logics, fuzzy modelling and fuzzy calculus, genetic algorithms, intelligent control, and nature-inspired optimization methods are all welcome. The airport and aircraft are now only communicating manually at Indian airports. The airport staff will manually examine the weather, runway specifications, aviation traffic, and other information before reporting it to the pilot. Once the pilot has all the runway information, he or she chooses whether to land right away or wait a little. Human mistake may occur throughout this laborious procedure, which might result in catastrophes.

Therefore, some kind of automated system is required to monitor all the parameters and the efficiency of the interactions between the pilot and the airport staff in order to eliminate manual labour and human mistake. With knowledge about the airport, the automation system ought to be able to regulate air traffic. It has to gather flight data, check it against previously recorded data, and then conduct the necessary landing manoeuvres.

Using the Global System for Mobile Communication Technology, the air traffic controller and the pilot are able to communicate (GSM). The term "air traffic management" (ATM) refers to the procedures necessary for each nation's national air system to be operated safely and effectively. Air traffic management (ATM) and air traffic control (ATC) are the two aspects of ATM that are often covered [1]. For collision detection, the ATC system mostly uses tactical judgments (like the real-time separation approach). To deliver ATC services and aid air traffic controller operators in the operation of traffic control and flight separation by ATCs, the NAS is organised into numerous areas. The procedures used in air traffic control to reduce aircraft delays and interference are a key problem in the use of ATM [1]. Additionally, fleet fuel costs, airport delays caused by flights, and other expenses place a heavy financial burden on airlines.

Airlines and aviation/airport corporations take into account the aircraft arrival schedule [2], focusing on airports with higher ATM performance. The covering of many airports by a single ATM while each airport may have multiple pattern regions for its ATM presents another problem to flight control [3]. Moreover, each airport may have a number of parallel or non-parallel runways, and the traffic or pattern regions of surrounding airports may be dependent or independent. In this aspect, traffic on crossover runways is dependent, although it may be dependent or independent on parallel runways. Every airport may have a different landing and takeoff runway, or they may both be used [3, 4]. Additionally, each runway could feature a number of landing and takeoff techniques with independent and dependent traffic. These problems exhibit the problem modeling's high level of complexity. The complexity level is greater with an increasing number of categories within each class, taking into account the enormous quantity of air traffic data (big data amount) in the classification learning process. Furthermore, it is very hard to pick the essential elements using conventional data mining techniques. For anticipating daily delay status in [5], researchers employed deep learning architectures such stacked auto encoders, convolutional neural networks, and recursive neural networks. The purpose of the current research was to estimate the daily delay at each airport and, using the findings, determine the delay for a particular aircraft. We first estimated the mean delay of the incoming and departing flights and added the calculated value to a recursive neural network, along with the weather data as a sequence, which was added to the output after determining the weight and bias of the separate data. This allowed us to predict the daily delay. The processes of biassing and weighting are repeated, and each replication step calculates the cost function's value using the stacked memory cell structure (LSTM), with the Sigmoid and Tanh functions being substituted by the RNN's structure. As a consequence, each buried layer's data was saved, which improved the effectiveness of the model. The suggested method's weakness, nevertheless, was the omission of round-specific information about the control of ground delays for aircraft flight preparation. Lack of a deeper LSTM structure in a time-based prediction framework, which improved accuracy, was another problem.

II. RELATED WORK

By conducting a literature survey, we examined a large number of studies. We learned from studying these articles that, for all estimate methodologies, the non-linear Coordinated Turn model performs better than the linear Uniform Motion model. We also looked at how various window widths affected how well the adaptive filters performed. In our studies, we learned about ATC and ATFM (Air Traffic Flow Management). According to RMSE [*6*] findings presented by Aiman Javed, the non-linear Coordinated Turn model performs better than the linear Uniform Motion model for all types of estimating methodologies. For adaption objectives, a g-Adaptive approach based on scaling factors has been used. It has also been investigated how various window widths affect how well adaptive filters operate. In the airspace controlled by an airport's ATC (Air Traffic Control), Aakash Desai presented a revolutionary way for managing and routing aeroplanes. The most effective combination of runways in terms of total fuel consumption is determined by the system after taking into account a number of factors like the present wind conditions, air time, taxi time, type of aircraft, etc. Airport ATC (Air Traffic Control) is planned to use an automated fuel-optimal air traffic management system. Air traffic flow management (ATFM), which Kai-QuanCai suggested and is crucial to the operation of air transportation systems, seeks to simplify the usage of airspace and airport resources. This study tackles the issue of concurrently minimising aircraft delays and airspace congestion in ATFM [*7*]. In [*8*], the ATM issue was solved using a mix of clustering and neural networks, with the major goal being to reduce the anticipated delay as well as the order of the flights. Clustering-based forecasting and multi-cell neural network (MCNN)-based forecasting were the two parts of the combined approach. After cleaning, filtering, and re-analyzing the data, the route vector's variable dimensions were reduced in the first stage using principal component analysis (PCA). A clustering method was then used to group the pathways into various patterns. The MCNN model was used to anticipate the four-dimensional (4D) component of the density path during the forecast phase. Each route partition also has a predictor, which contained a NN-based learning cell. A collection of connected pathways and a related prediction model were used to train each exclusive learning cell. The suggested model in the current research was stronger, more precise, and more effective for making short-term forecasts, according to the findings. However, some of its flaws were the small data size and the absence of very precise learning techniques (e.g., deep machine learning). Using a massive data volume and the deep learning approach, these problems were solved. At [*9*], the researchers discussed several data mining techniques and evaluated their effectiveness in the airport lounge. Three different forms of air transportation data were used to evaluate the suggested approaches, and a flight recorder was used for the first time to give flight recording data. The unofficial name for the flight data recorder is the "black box." Up to 500 variables of data, including time, altitude, vertical acceleration, and vertex, are typically recorded each second in an aeroplane with a flight recorder. The others may be continuous even if some of these variables are discrete. The second kind of aviation information was artificial data. The material was concentrated on unusual flying behaviour. This idea was purposefully included into the data to test the algorithm's capacity for anomaly detection. These anomalies might be an unexpected pattern of occurrences or a strange gap in the pattern of events. The second category of data is aviation accident reports, which are not subject to any tight regulations and do not need any special operating conditions from the pilot. Due of their disunity, a mechanism should be developed to identify the important data. Diseases, dangerous settings, and autopilot were some of the causes of flying mishaps. The time warp edit distance (TWED) and k-means algorithms were utilised by the researchers to increase the accuracy of the flying characteristics [*10*]. In order to exclude the impact of the exit point, the researchers first evaluated a dataset of flights with the required time in the situation of flight routing with the same origin and flight destination. Then, an altered version of the k-means algorithm was suggested, in which the TWED method was used to estimate the distance between different pathways rather than the k-means algorithm's standard elastic similarity measurement. The greater accuracy of the algorithm and better effectiveness of employing the restricted airspace for air traffic management were two advantages of the suggested strategy in this study. On the other hand, one of the method's major drawbacks was failing to take into account the huge size of the data and usage of massive data, which resulted in the algorithm's greater accuracy. Additionally, the suggested model could forecast the flow distribution at different flight altitudes in the flight controlled environment, improving ATM. The suggested model can effectively learn the spatial and temporal transmission patterns of the flight flow in the ATM system, according to an investigation of the distribution of prediction errors on different space cells, flight levels, and prediction of the samples. On the other hand, the suggested model might foresee the adoption of the best ATM strategies to boost system performance and effectiveness. Bidirectional long short-term memory (BLSTM) was employed by the researchers in [*11*] to identify the system using performance data from air transportation management. The system's BLSTM was capable of recreating the nonlinear temporal series and producing accurate forecasts. Aside from managing complex nonlinear temporal series and learning to rebuild them using multidimensional inputs, neural networks in deep learning techniques may also store their knowledge of how observation datasets behave. These are some of the other conclusions of the aforementioned research.

III. AI-POWERED PLATFORM TO OPTIMIZE AIR TRAFFIC MANAGEMENT

Air traffic control systems are being transformed by artificial intelligence. The SkyGrid platform, which is based on AI, adopts a more intelligent method of aerial movement. In order to avoid dangerous situations, for instance, SkyGrid's AI algorithms assess critical data such as airspace traffic, local circumstances, ground dangers, flight limitations, and weather predictions. With AI, in-flight monitoring to guarantee secure operations and the best routes is feasible[12]. Additionally, our technology tracks drone flights in real-time, alerts operators to abnormalities, and automatically creates alternative routes around obstructions or prohibited areas. Using pre-flight and in-flight deconfliction capabilities, AI-powered air traffic management allows intelligent deconfliction of flights based on real-world factors by detecting and avoiding other aircraft and objects. With fleet performance recommendations, continuous fleet health monitoring and predictive maintenance improve drone fleets and decrease time to service. Our AI-based solution manages all drones, flight logs, and service records in a single dashboard, automatically produces maintenance tickets, and allocates them to technicians upon arrival at a site. Blockchain technology reduces the possibility of human mistake in the aviation industry. Blockchain, when enhanced with smart contracts, is the key to guaranteeing that unmanned aircraft adhere to the laws and regulations governing the use of the airspace.

It is simple for operators to communicate precise flight plans in real-time and uphold high standards of auditability in an airspace system based on blockchain technology. Our blockchain-based system gives each drone a distinct ID and keeps track of its status, flight information (such as altitude, location, and operator), and maintenance history in real time. This is important because historical flight logs are also essential for ensuring the security and integrity of data exchanged between operators, authorities, and service providers. Cryptography links each flight log to the preceding entry to prevent retroactive changes[13].

Since there isn't a single database that a malicious party can corrupt, the decentralised structure of a blockchain system also offers more security than conventional, centralised storage. Using this method, officials may study flight data and pinpoint an exact timeline of what happened. It provides businesses with a safe, precise record of their flights so they can assess performance and streamline procedures.

IV. METHODOLOGY

The pilot will sends a message via GSM transmitter requesting for the runway for its landing. This message is received by the aerodrome controller GSM receiver. The aerodrome controller analyses the flight information, and compares it with the pre-defined values. The controller shall check for the authenticity of the arriving flights with the stored database of all the flights and pilots. The message sent by the pilot would consist of pilot identification, flight identification, flight class, number of onboard passengers, and flight technical details. To this message, the ground based air traffic controller would reply with the parameters with which the flight has to approach the runway, and the exact geographical location of the runway, and the time at which it has to descend. The controller could add miscellaneous information about the climatic conditions, and the condition of the runway. During this process, the controller simultaneously has to announce the arriving flight name, and its time. Using the GSM MODEM, the air traffic controller communicates with the pilot. Every pilot in his aircraft is provided with another GSM MODEM for retrieving and sending the messages. The GSM MODEM is interfaced with the controller using RS-232 interface, using LM 232.

V. DESIGN CONSIDERATIONS

Our motivation is to build an embedded system where airport and the aircraft are monitored and controlled continuously and automatically, the LCD is used to display the messages. The micro controller will sense the runway and send the availability (condition) of the runway and platform numbers etc. The main feature used in our Project is GSM Technology. We have also designed using Microcontroller which will sense the runway and the availability of the runway Parameters. For the checking of Climatic Conditions we are using LDR circuit, Relay circuit and Sensors. For Displaying of the messages we are using LCD display.

VI. BLOCK DIAGRAM

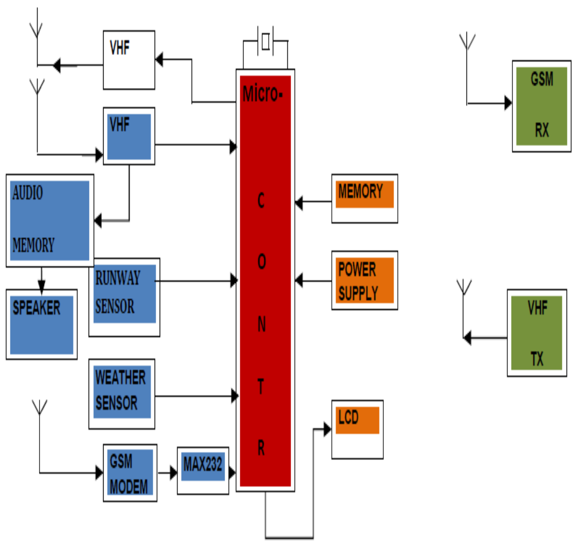

Figure. 1: Block Diagram Representation of Aircraft Traffic Controller

A. Microcontroller

In this project we use an 89S52 micro controller, which belongs to the Intel 8051 family Architecture, it plays an important role and can also be called as 'heart of our project' and this function are controlled by standard AT commands of GSM technology[14]. It contains a ROM burner to burn program into the microcontroller. ROM burner can erase the flash ROM in addition to burning a program into it.

B. VHF Transmitter and Receiver

We are mainly using very high frequency modulation called, FREQUENCY MODULATION technique in our approach. It is working under 27 MHZ of frequency. It contains RF amplifiers for amplification purposes. Its main purpose is to transmit the message through an antenna from the transmitter part and receives the message through an antenna by the receiver part.

C. GSM Modem and Max232

These two units help in sending and receiving of messages. GSM stands for GLOBAL SYSTEM FOR MOBILE COMMUNICATION. The main feature of MAX232 is it converts RS232 logic to TTL logic while transmission, TTL logic to RS232 logic while reception.

D. LCD (LIQUID CRYSTAL DISPLAY)

Here we are using 2X16 LCD display to display the message of 2lines and 16 characters. The contrast of the LCD can be varied through the variable resistor.

E. Runway Sensor

For runway sensing purpose we are using IR rays, which helps in checking the runway availability. If the runway is free it sends particular signal to the microcontroller.

F. Weather Sensor

In this we are using LDR (light dependent resistor), which forecasts the weather conditions. If the conditions are satisfied for landing it sends positive signal to the If the runway is free it sends particular signal to the microcontroller.

G. Audio Memory Amplifier And Speaker

As soon as the aircraft lands the arrival time of the aircraft will be announced automatically through the speakers. The audio memory amplifier contains many recorded messages in its memory. Before announcing it amplifies the message.

H. Memory And Power Supply

Here we use memory to store different pilot's information messages, which are required for announcements etc. Here we use AC 220V power supply from which we can derive +5V and +12V of power supplies respectively. +5V is required for LCD and the microcontroller and +12V is required for other devices.

I. Solid State Voice Recording And Playback Circuit

When the aircraft reaches the vicinity of the airport, there should be provision for automatic announcement for the benefit of passengers. So this circuit provides that mechanism of automatic announcement. In this circuit we have partitioned the memory depending on the number of messages required. There is the presence of switches connected to the APR 9600 for the 8 messages to be stored. The AGC circuit automatically controls the gain .As the distance from the mouth and mike varies, there is signal variation, the AGC produces constant output irrespective of the variation, which is required for the microcontroller [15]. Voltage is regulated as required by the components connected by voltage regulator. Opamp acts as amplifier. The amplified signal is carried through speaker. The block diagram of the solid state voice recorder and playback circuit is shown in Figure.2.

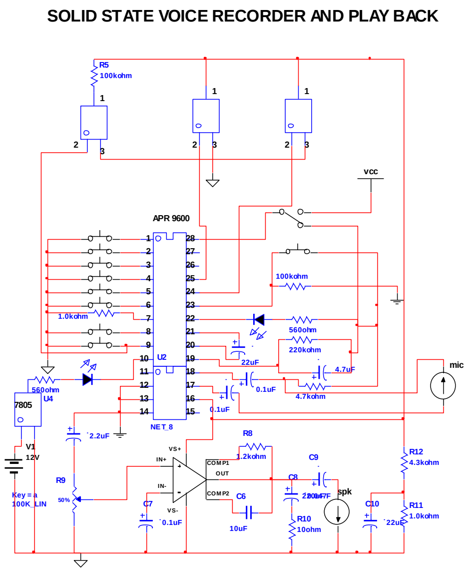

Figure.2: Solid State Voice Recorder And Play Back

J. IR Receiver

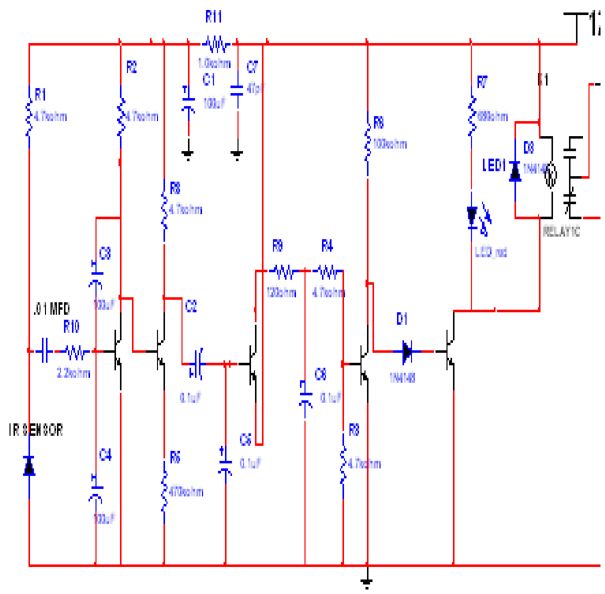

Figure: 3: Circuit Diagram Of IR Receiver

The above figure shows the block diagram of the IR receiver. In receiver there are 5 transistors in this circuit. Transistors 1-4 are used as amplifiers and transistor 5 is used as a driver circuit to drive the relay and it provides negative voltage to the relay through emitter to collector.

K. Working

The base of transistor Q1 contains the receiver IR LED (photo transistor). Transistor Q1 amplifies the infrared signals that are received, and the output is then taken from the collector and applied to the base of transistor Q2. The output from the collector is fed to the base of transistor Q4 through resisters R8 and R9, acting as a coupler, and transistor Q5 receives the output from the collector through the diode D1. The transistor Q2 amplifies the input signal and feeds it to the base of transistor Q3 through coupling capacitor Q4, while the transistor Q3 receives the output from the collector.

The transistors get a positive half cycle from the diode D1. utilised as a polarity diode is the diode D2. From the emitter through the collector to the relay, the negative voltage extends. Negative voltage is provided to the relay when there are no input signals since transistors 1-4 are not conducting and transistor Q5 is not operating either. The relay coil is wired with one end directly linked to the positive terminal and the other end attached to the transistor Q5's collector, which supplies the relay with negative voltage to activate it. The transistors Q1 to Q5 are in forward bias when there is no input signal, and the transistor Q5 will create a negative voltage from its emitter to collector, activating the relay.

The received signal is amplified by the transistors Q1 to Q4 and sent to the base of transistor Q5 via a diode, which de-operates the transistor Q5 and prevents a negative voltage from the collector when the IR sensor receives the input signal from the transmitter. Therefore, the relay receives no negative signal and is in perfect working order (de activated).

L. Transmitting of Dual tone Multi-frequency

The DTMF IC No. 91214 produces a variety of 16 tones that are modulated in the modulator section and then broadcast by the antenna after being amplified by the RF section. Both an RF amplifier and modulator are used with transistor BC 494.

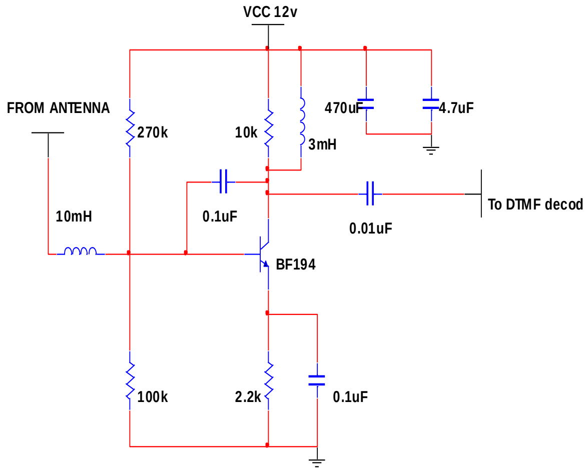

Figure: 4: Circuit Diagram of FM Receiver

FM receiver receives the FM modulated signal from the antenna and it is modulated by the transistor BF194. Then it is transmitted by the antenna to the DTMF decoder for further operations.

The received FM signal (27 MHz) is de coded by the DTMF de coder is send to the micro controller then appropriate driver section for activate the motor. IC 8870 is used as DTMF de coder and all twelve transistors are working as driver to drive the DC motor. Here we use pre amplifier and Darlington amplifiers to give more amplified version of signal at the relay input.

It is difficult to accurately detect and identify DTMF. Although a working solution for DTMF transmission and reception by a microprocessor (often a PIC) exists, specialised Integrated circuits are frequently employed. It is only sometimes used since it is rather difficult.

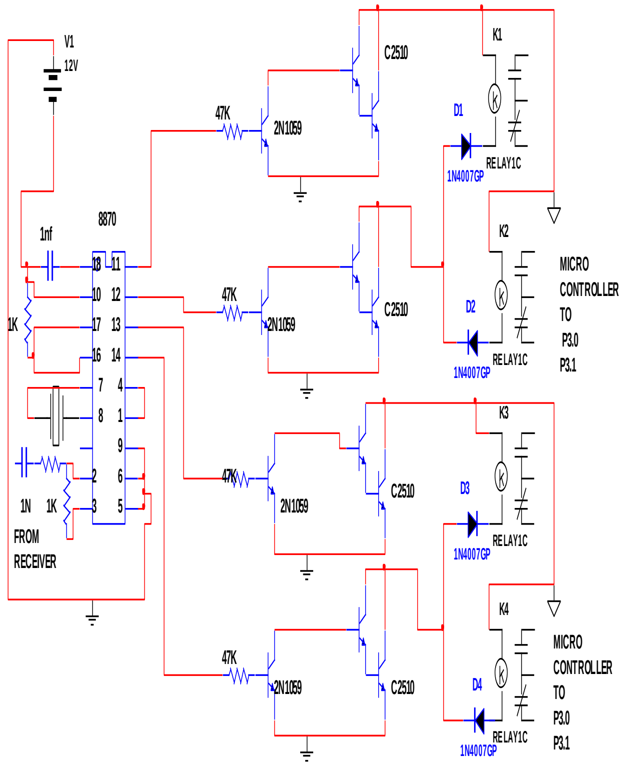

Figure.5: Circuit Diagram of DTMF DECODER

A MT 8870 or a similar circuit would be utilised the majority of the time. The majority of decoders simply pick up the sine waves' rising edges. Therefore, DTMF produced by rectangular pulses and RC filter functions effectively. Two 6th order band pass filters with switching capacitors are used in the MT 8870 previously described. These generate flawless sine waves with suppressed harmonics even from distorted input.

VII. RESULTS AND DISCUSSION

As a consequence, there will be a well-organized system in place to ensure that there are no faults during takeoff or landing. The air traffic controller might direct the pilot towards a safe landing of the aircraft and could first approve approaching planes for their landing. Additionally, there would be guidance for both the outgoing travellers and the guests who are coming with their bags. There will be more work done in the future. The automation in our prototype will be enhanced to address the shortcomings in conflict identification and resolution found in this research and to offer the extra capabilities the controllers have requested. The function distribution between the air and the ground, automation, and controllers will continue to be improved via research, technology, and method development. Off-nominal conditions and mixed-equipage procedures will also be researched.

VIII. CONCLUSION

This study makes a suggestion for increased accuracy in ATM management issues. ATM has all the components required for the safe and effective operation of the National Aviation System, which is now one of the most difficult issues facing our nation's airports. For our customer from various locations across the globe, we are providing an air traffic control system (ATCS) in this paper. We need some kind of automated system to check all the metrics and the efficiency of the links between the pilot and the airport staff if we are to eliminate manual labour and human mistake. Within the constrained resources and budget of this research project, we constructed a prototype model of an airport automation system. Using cutting-edge methods, the system may be subjected to further development.

V. REFERENCES

[1]. Aiman Javed, Javadpur and Nilanjan Patra, Kolkatta Electrical Engineering Department,Published in India Conference (INDICON) 2016 ,IEEE Annual.

[2]. Aakash Desai Department of Computer Engineering, Vidyalankar Institute of Technology, Mumbai, India published in Recent Trends in Electronics Information and Communication Technology (RTIECT), IEEE International Conference on May 2016.

[3]. Kai-Quan Cai School of Electronics and Information Engineering, Beihang University, published in IEEE Transactions on intelligent Transportation Systems on March 2017.

[4]. R. Jain, F. Templin, and K.-S. Yin, "Analysis of L-band digital aeronautical communication systems: L-DACS1 and L-DACS2" in Proc. IEEE Aerosp. Conf., Mar. 2011.

[5]. Allendoerfer, K. R., Mogford, R. H., & Galushka, J. J. (1999). Comparison of the Plan View Display and Display System Replacement system baselines.

[6]. Cardosi, K. M., & Murphy, E. D. (1995). Human factors in the design and evaluation of air traffic control systems (DOT/FAA/RD-95/3). Washington, DC: Federal Aviation Administration Office of Aviation Research.

[7]. Federal Aviation Administration. (1996). Project configuration management guidelines. Unpublished manuscript. Atlantic City International Airport, NJ: DOT/FAA William J. Hughes Technical Center.

[8]. Federal Aviation Administration. (1997). Human factors job aid. Washington, DC: Office of Chief Scientific and Technical Advisory for Human Factors.

[9]. Galushka, J., Frederick, J., Mogford, R., & Krois, P. (1995). Plan View Display baseline research report (DOT/FAA/CT-TN95/45). Atlantic City International Airport, NJ: DOT/FAA Technical Center

[10]. Vossen T, Michael B. Optimization and mediated bartering models for ground delay programs. Naval Research Logistics, 2006.

[11]. araka RE, Chen RC, Supatmanto BD, Tahmid M, Toharudin T. Employing moving average long short term memory for predicting rainfall. In: 2019 international conference on technologies and applications of artificial intelligence (TAAI). IEEE. 2019, November. pp. 1–5.

[12]. Reitmann S, Nachtigall K. Applying bidirectional long short-term memories (BLSTM) to performance data in air traffic management for system identification. Springer International Publishing AG 2017 A. Lintas et al. editors. ICANN 2017, Part II, LNCS 10614, pp. 528–536, 2017.

[13]. Zhang H, et al. Airport delay prediction based on spatiotemporal analysis and bi-LSTM sequence learning. 978-1-7281-4094-0/19/$31.00 ©2019 IEEE. 2019.

[14]. Naessens H, et al. Predicting flight routes with a Deep Neural Network in the operational Air Traffic Flow and Capacity Management system. 17 December 2017 EUROCONTROL Maastricht Upper Area Control Centre Horsterweg 11, NL-6199 AC Maastricht Airport. 2019.

[15]. Choi S. A multi-level predictive methodology for terminal area air traffic flow. Georgia Institute of Technology. 2019.

Cite this article as :

Prathapagiri Harish Kumar, Mohammed Nasser Hussain, Kotha Nikhil Reddy, Shankesi Laxmi Sai Deep, "Methods of Air Traffic Management Using Artificial Intelligence in India", International Journal of Scientific Research in Science and Technology (IJSRST), Online ISSN : 2395-602X, Print ISSN : 2395-6011, Volume 9 Issue 4, pp. 560-569, July-August 2022. Available at doi : https://doi.org/10.32628/IJSRST229490

Journal URL : https://ijsrst.com/IJSRST229490