INTERNATIONAL JOURNAL OF ADVANCE RESEARCH AND DEVELOPMENT

(Volume3, Issue4)
Available online at: www.ijarnd.com

Climatology lab for airports

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ABSTRACT

The task of the Air Traffic Control (ATC) is to optimize the use of air space and to avoid collision among aerial vehicles. Air space can be defined as a set of infinite number of planes, direction, routes etc.

In last few decades there has been many problems related the safe landing of Airplane and their accidents due to various reasons like bursting of tier, poor visibility, lack of synchronization between the plane and the base station. These result in the accident of airplanes. We have developed a "Climatology Lab for Airports" to solve the above mentioned problems and ensure the safety of passengers.

The main objective of our project is to avoid these type of accidents by proper synchronization between the base station and Airplane. Our project is also used to increase the air quality traffic and to reduce the down time of activities i.e. the time required for identifying each and every climatological condition like pressure, humidity, temperature etc. is reduced since a single device gathers all the necessary information at a time using sensors. Using this system various collision and problems related to air traffic control has been minimized.

The system uses internet of things (IOT) technology and will prevent the malfunctioning or damage of the equipment used so the risk factor that the sensor might stop working is minimized. Here we would like to provide an economic and affordable solution for the perfect takeoff and landing system for airports with physical ambient conditions of the atmosphere with an audio visual networking.

Keywords: *Air Traffic Control, Climatology, Aerial vehicles, Internet of things, Accident, Aerospace Control, Aero plane Parameters, Automatic control, Computer simulation, climatological conditions.*

1. INTRODUCTION

Due to heavy congestion problem on ground-based transportation that predicted to be worse in future, an alternative transportation solution is a necessity. One of the main goals of an air traffic controller is to keep the separation among flights and resolve conflict among them. With increased number of aerial vehicles in a sector, it may become very difficult, if not impossible, for human controllers to perform these operations efficiently. Considering this scenario we propose a new method of conflict resolution where aircraft will communicate with each other to resolve any conflict without the intervention of ATC. In this approach when two aircrafts reach a certain level of closeness (e.g. twice the minima of separation) then they transmit contextual information of flight such as route, timing, speed, cruising altitude, etc., to other flights. Based on this information, flights resolve the conflict (if any) mutually.

The paper addresses technical aspects of aircraft collision avoidance realizing that the FFA must implement procedural changes to assure flight safety. Airplane landing control system using Zig Bee is a service provided by ground-based controllers who direct aircraft on controllers and can provide advisory services and can provide advisory services to aircraft in non-controlled airspace. The primary purpose of ATC is to prevent collision, provide information and all other information for pilots. ATC enforces traffic separation rules, which ensure each aircraft maintain a minimum amount of empty space around it.

In many counties ATC provides security to all private, military and commercial aircraft operating within its airspace. Depending upon the type of flight and number of passengers the ATC provides instructions for the pilots. The pilot in command will be the final authority for safe operation of aircraft and in case of emergency ATC may not obey so for that an advanced method is used here for safety purpose. The main goals of the researches, conducted on the stand, are: approbation of pilot and air traffic controller interaction; approbation of new cockpit and ATC system interfaces; approbation of new airborne functions; assessment of changes in air traffic characteristics in case of using CNS capabilities

The dominant meteorological factors are temperature, relative humidity, wind speed, wind direction, visibility, fog through which we can get physically consistent multi-variate information, Based on embedded system which enables, high operating speed, inbuilt on-board temperature sensing and a safe mode during high i/o of voltage and current.

2. EXISISTING SYSTEM

In the past decade there were many systems that has been develop to solve the problems of Aeroplane landing System and helping also In controlling the air traffic. Using all wireless antenna which was very helpful to solve traffic and landing problem. In existing system, the lab is entirely of mechanical climatology laboratory. There is only possible of analog and digitals in read out form. There is no application of internet of things in the existing system. This results in the major disadvantage of reliable information not reaching the pilot at a fast rate or the possibility of a delay in transmitting the information.

In terms of measuring parameters used in the climatology labs, the instrument used to measure wind was a simple tubular cloth hoisted upon a pole [1]. Depending on the direction of the wind, the cloth moves. Although this inarguably indicates the wind direction, it is not of the desired accuracy. It suffers from another disadvantage of being impractical in times of rain and snow. Another good example is the instrument used to measure fog/visibility. The current system being used is a very visual system. We simply make use of cameras or basic visibility sensors [2] to check for any fog or lack in visibility to make for safe landing conditions. This too lacks the precision we require to ensure safe landing.

Figure 1- Tubular cloth method

Figure 2- Visual and sensor method

3. PROPOSED SYSTEM

A. A computational system replaces the existing analytical system in our proposed model. Real-time, accurate and reliable weather information will be available at hand to cope with all kinds of weather related changes. This is because of the effective protection of sensors and other equipment from extreme conditions. This there is no compromise on efficient performance even in demanding and varying climates.

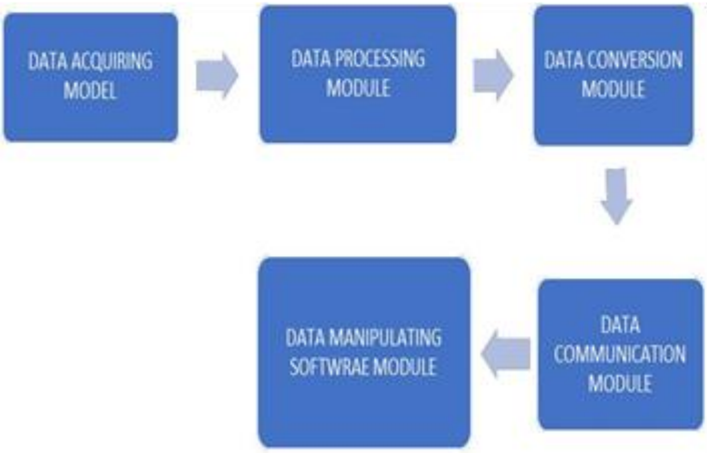
A visual servicing scheme is proposed to control an airplane during its landing. A desired trajectory which takes into account the airplane dynamic is designed. Coupling this trajectory and the control law enables the airplane to join its desired path. Then the airplane is controlled to follow the glide path, realize the flare maneuvers and finally touchdown. Simulation results are obtained with a quite realistic flight simulator which is based on a nonlinear airplane dynamic model. They show that the airplane is able to land automatically by using visual data in future development. The system is most importantly safe from any possible attempt of intrusion.

With respect to the two parameters we have discussed in the existing system, the improvised version used in the proposed system includes a ball movement system [3] to measure wind direction. This system comprises of a 4 directional apparatus and a ball. According to the direction of the wind, the ball moves and hits a switch notifying us on the direction of the wind. The system used for visibility measurement, is a pair of IR sensors- An IR emitter and an IR detector [4], placed facing one another. The emitter discharges a signal. The signal cannot be picked up in the case of hazy conditions, therefore indirectly declaring the runway unfit for landing until the visibility improves.

Figure 3- ball movement system

Figure 4- IR sensor method

4. SYSTEM ARCHITECTURE AND WORKING



- Data Acquiring Module is used to acquire the inputs from the ambient parameters using various sensors
- Data Processing Module is used to process the input data using op-amp and filters
- Data Conversion Module is an embedded system that includes PIC controller to interconnect the hardware kit and the PC.
- Data Manipulation Software Module contains the software tools for animation.
- Data Communication Module is used for communication using IOT

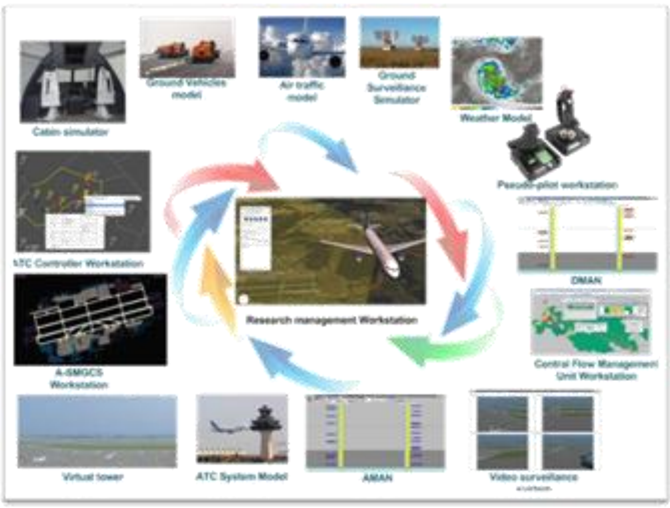


Figure 6- Research Stand Components

We make the following realistic assumption to explain our scheme.

- An aircraft must have a long range two way data communication link that is capable of air to ground communication as well as air to air Communication.
- Every aircraft must be equipped with a computer to perform analysis of the data received from other aircrafts or ground support system and compute the conflict resolution. (All modern aircrafts have some sort of computer onboard).
- The ground support system will provide trajectory prediction information to aircrafts and will provide support in establishing communication between aircrafts.

A. Flight Plan Approval:

On ground flights will collect data from all flights within communication range and satisfy the following conditions

a) Flights those are not airborne and have clearance for their flight plan.
b) Flights those are preparing flight plan for approval.
c) Flights those are recently airborne.

B. Taxing/Takeoff from Airport or Remote Location:

a) If flight departing from an airport, it will communicate with all the flights that taxing for takeoff and flights that are preparing for takeoff.

b) Based on a neutral algorithm a mutual decision for a queuing in for takeoff will be taken.

c) While preparing for takeoff the flight will communicate with all flights that are airborne and are in communication range (this applies for flights taking off from remote location as well.)

d) It will collect contextual information from these flights. Based on gathered information, it will detect for any conflict exist for takeoff (here conflict refers to violation of separation minima regulation by FAA

e) In case of any conflict, it will either make a mutual solution with conflicting party or will delay the takeoff to avoid conflict.

C. Cruising / Decent / Landing:

Here we propose an automated conflict resolution system independent of ATC.

a) Detect all other aircrafts in 50 NM (nautical mile) range with or without help of ground based trajectory prediction system. The range of detection can be modified based on separation minima regulation in that region. It should be at least twice of separation minima.

b) Establish communication with each of these aircrafts and transmit the following contextual information:

>>Unique flight ID >>Current Cruising Speed

>> Current cruising Altitude

>> Estimated trajectory for next 20 minute (can be changed based on situation), in 4-tuple of <time, altitude, relative ground position

(longitude/latitude), cruising speed>. These 4-tuples should be generated for every 10 second time interval.

>>Any constraint, e.g., limit on cruising altitude.

c) Gather contextual information from other aircrafts in the range and detect if a conflict exists. If there is one then calculate possible solutions and communicate it to related parties with a solution for the conflict.

d) It may be possible that in one pass the parties do not agreed with mutual solution, but in couple of passes they will agree on a mutual solution. If all the parties involved in conflict are using the same algorithm then it is very likely that they will agree on mutual solution in one pass.

e) If there is any change in route plan of an aircraft as a result of conflict resolution, inform to ATC system for automated approval.

Challenges:

The ideal flying conditions are not always available. Many times situation occurs when normal flight operations are difficult to perform. In this section we present some of the extreme situation which needs to be handled separately.

A) Extreme Weather Conditions:

Reliable communication is one of the key features in self-synchronization. In current scenario all flights depend only on communication from ATC during bad weather. The same approach can be taken when it is not possible to communicate with conflicting flight due to bad weather. The Self Synchronization algorithm can also help in improving the flight experience by avoiding high turbulence areas based on information provided by ATC system.

B) No Fly-Zone Management:

At present no-fly zones are taken care by ATC system. If any flight request for a route passing through no-fly zone, the ATC rejects it. With proposed automated clearance approach all no-fly zones can be configured in ATC response system. If any request for flying through these zones arrives, the system will reject this route clearance request and will response with suitable response code or description. In addition to this automated approach, human air traffic controllers can monitor all the activities performed by automate system. In case of emergency or special condition human controllers can take control and override any decision made by automated system.

The approach presented in this paper requires communicating contextual information between flights with unique id to identify a flight. At the same time it is required to maintain anonymity of flights for security purpose. Therefore, for keeping the confidentiality, it is essential to hide the identity of a flight. This can be achieved by generating new unique virtual id for flight for each new connection. This virtual id can be generated using a cryptographic one way hash function providing original id as key to the generator. Cryptographic hash function has the property that no two keys can generate same results and the key can't be obtained using result. So a virtual id generated using this technique will be unique for the flights at the same time will maintain the confidentiality of that flight.

C) Security:

Security is another major concern of air traffic control systems. The proposed automated ATC system will provide an excellent support in this regard. Based on ground-based trajectory prediction system and communication with AFMS, if any flight doesn't follow the approved flight plan or fly in unauthorized zone it can alert security agencies as well as human traffic controllers.

HARDWARE:

A: Temperature Sensor:

A thermistor [7] is a type of resistor whose resistance varies significantly with temperature, more so than in standard resistors. Thermistors are widely used as inrush current limiter, temperature sensors (NTC type typically), self-resetting over current protectors, and self-regulating heating elements. Thermistor of 10 k is used which is negative temperature coefficient resistor. Value of the resistor changes with temperature. Potential divider is used and the junction output is given to ADC. As temperature will increase, value of resistor will decrease and so voltage will increase with respect to temperature.

Figure 7-Thermistor

B: Anemometer:

An anemometer [8] is a device used for measuring the speed of wind, and is also a common weather station instrument. At airports, it is essential to have accurate wind data under all conditions, including freezing precipitation. Anemometry is also required in monitoring and controlling the operation of wind turbines, which in cold environments are prone to in-cloud icing. Icing alters the aerodynamics of an anemometer and may entirely block it from operating. Therefore, anemometers used in these applications must be internally heated. Both cup anemometers and sonic anemometers are presently available with heated versions.

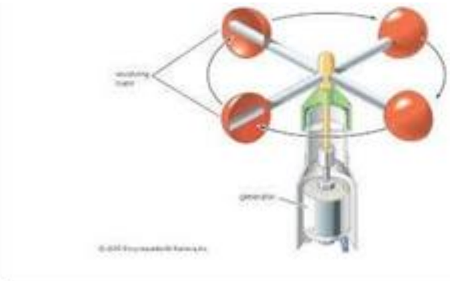


Figure 8-Anemometer

C: MEMS (Microelectromechanical systems):

In aerospace applications, MEMS can be widely used as actuators and sensors. MEMS Accelerometers and MEMS gyroscopes in remote controlled, or autonomous, helicopters, planes and multi rotors (also known as drones), used for automatically sensing and balancing flying characteristics of roll, pitch and yaw. MEMS magnetic field sensor (magnetometer) may also be incorporated in such devices to provide directional heading. MEMS are also used in Inertial navigation systems (INSs) of modern cars, airplanes, submarines and other vehicles to detect yaw, pitch, and roll; for example, the autopilot of an airplane.

D: RS 232 Controller:

In telecommunications, RS-232, Recommended Standard 232 is a standard introduced in 1960 for serial communication transmission of data. It formally defines the signals connecting between a DTE (data terminal equipment) such as a computer terminal, and a DCE (data circuit- terminating equipment or data communication equipment), such as a modem.

Table 1- RS-232 logic and voltage levels

Data circuits	Control circuits	Voltage
0 (space)	Asserted	+3 to +15 V
1 (mark)	De-asserted	−15 to −3 V

E: Low Pass Filter:

A low-pass filter (LPF) is a filter that passes signals with a frequency lower than a certain cutoff frequency and attenuates signals with frequencies higher than the cutoff frequency. The exact frequency response of the filter depends on the filter design. The filter is sometimes called a high-cut filter, or treble-cut filter in audio applications. Low-pass filters exist in many different forms, including electronic circuits such as a hiss filter used in audio, anti-aliasing filters for conditioning signals prior to analog-to-digital conversion, digital filters for smoothing sets of data, acoustic barriers, blurring of images, and so on.

F: Wheatstone bridge:

A Wheatstone bridge is an electrical circuit used to measure an unknown electrical resistance by balancing two legs of a bridge circuit, one leg of which includes the unknown component. The primary benefit of a Wheatstone bridge is its ability to provide extremely accurate measurements (in contrast with something like a simple voltage divider). Its operation is similar to the original potentiometer.

G: Power supply:

This unit will supply the various voltage requirements of each unit. This will be consists of transformer, rectifier, filter and regulator. The rectifier used here will be Bridge rectifier. It will convert 230 V AC into desired 5V/12V DC.

SOFTWARE:

A: Visual Basic (VB):

For displaying the output on the pc we are using Visual basics which is an event driven programming language and associated development environment from Microsoft for its

COM programming model. VB has been replaced by Visual Basic .NET. The older version of VB was derived heavily from BASIC and enables the rapid application development (RAD) of graphical user interface (GUI) applications, access to databases using DAO, RDO, or ADO, and creation of ActiveX controls and objects. Weas programmer can put together an application using the components provided with Visual Basic itself. Programs written in Visual Basic can also use the Windows API, but doing so requires external function declarations.

Table 2- System parameters

	ATC Radar	LTE	Systems
		eNodeB	*UE*
Frequency	1.3 GHz	1.3 GHz	
Transmit Power	60 KW	40 dBm	23 dBm
Scan Rate	5 rpm	-	-
Azimuth Beamwidth	1.4 deg	120 deg	360 deg
Background Noise	-106 dBm	30 m	1.7 m
Antenna Gain	38 dBi	18 dBi	0 dBi
Tolerable INR	-10 dB	-	-
Front to Back Ratio	40 dB	-	-
Transmitted Waveform	NLFM	18 dBi	SC-FDM
Bandwidth	1.3 MHz	1.4 MHz	1.4 MHz
Pulse Duration	90 us	-	-
Noise Figure	4 dB	5 dB	5 dB
Antenna Height	30 m	30 m	1.5 m
FDR (20 MHz Separation)	60 dB	55 dB	40 dB
Maximum Input Level	-	-	-25 dBm

5. APPLICATIONS

1. With the help of monitoring ambient parameters like temperature, humidity, wind speed & its Direction, can avoid confusion in arrival & departure of the aircrafts.
2. By checking the position of Lever, the chance of accident (caused by pilot fault) can be reduced.
3. This monitoring systems reduces time consumption and increases the flow of air traffic.
4. The project titled 'CLIMATOLOGY LABS FOR AIRPORTS' helps Air Traffic Services [ATS] for controlling smooth Take-off and Landing of many aircrafts in the airport based on climatic conditions.

6. CONCLUSION

The Aero plane landing control system in today's world is one of the most important system in air traffic whatever disadvantages where there in the past like collision, bursting of tier due to heat, crashing of the aero plane due to poor visibility, accidents due to unclear runway, all this can be avoided with proper co-ordination between pilot and the person sitting in base station.

We can also predict that this approach will significantly reduce the work load from ground based ATC system because it distributes and automates most of processes performed by ground based ATC system. It provides an excellent air traffic monitoring tool and an override facility for human air traffic controllers therefore in emergency human controllers can take over automated system.

Communication is based on the proposed self-synchronization scheme so improvement in two way air-ground data communication is a necessity and would be a future research topic. The proposed approach requires accurate trajectory prediction by AFMS as well as ground based trajectory prediction system. So this area is also open of any future research. We proposed an automated flight management system that can take control of flight from human pilots. This also leads to auto pilot general aviation flights. This is another topic for future research.

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