Climatology Lab for Airports

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Abstract

Automatic Advanced Landing System is the most essential and required for the most modern airports to reduce downtime of activities to improve the quality air traffic controlled by ATC. The Existing system has been integrated which is widespread in the airports today and leads to misguiding of aircrafts. This paper presents an economic affordable solution for perfect takeoff and Landing System for airports with physical ambient conditions of the airport with audio visual networking. For having a better reality demonstration of our idea, the state of art Embedded Controller Technology along with the associated hardware component for input an output. The angular position of the aircraft is developed from mid of runway, demonstration of diagonal antenna function, Rotation techniques of RADARs , Landing angle of an aircraft, Ambient parameters like Temperature, Humidity, Wind speed, Wind direction, Visibility, Fog. For audio and visual effects, multimedia is used along with VB software.

Keywords*-Air Traffic Control room, RAdio Detection And Ranging and Visual Basic*

I. INTRODUCTION

This paper addresses the technological aspects of aircraft collision avoidance realizing that the FAA must implement procedural changes to assure flight safety during landing and takeoff conditions. Normally aircrafts have three stages for every movement of upwards, turn left and right and downwards. Totally it has twelve positions and it also has a lever to change the position of the flight. Aircrafts should be in pre-defined position while just before take-off and landing. If not, it may cause any accidents. So , the position of the lever has to be found. For this criterion, pullup resistors at both the ends in every position are used. 10ohms resistor is used here. It is used to verify the input of the pre-driver stage is low.

When the IR sensor which has been used here is not conducting properly then collector to emitter will be high. Now the input at the pre-driver stage may be high or low. But it should be low for practical purposes. To make it sure, pull down resistor is used. Whenever the lever crosses over the sensor, as soon as corresponding sensor will give the output (high), from this effect the lever position of the aircraft has changed in the monitoring system according to the real time position of the lever. This is the normal functioning of the aircrafts.

The Airport all over the world is broadly classified into four main divisions. They are Climatology, ATC\ATS, RADAR, GSD. This paper keenly addresses only on the division of Climatology. The ultimate aim of the Climatology lab is to monitor and detect the weather conditions of the aircraft before landing. RADAR plays a key role in intimating the data collected from the lab to the pilots in the aircraft. RADAR has only one antenna which serves as both as transmitter and receiver.

Normally, the runway in the airports has two different loops- RADAR loop, ATC\ATS loop.ATC \ATS loop will extend for 18nm (32Km).This is the inner loop of the runway. Next will be the RADAR loop which extends for 200Km. This loop will detect the number of flights landed off and took off from the concerned airport. ATC will monitor the flights in the metropolitan cities whereas the ATS will monitor the flights in the non-metropolitan cities. GSD (Ground Support Division) which will provide air ducks and busses after the flight has been landed off. This also divides the runway for the airplanes to land. Generally , when any object is travelling at a faster speed(350Km\hr) in an height of 40,000ft or more ,temperature of that object will be decreased. This Einstein law is followed in aircrafts.

RADAR is placed both in the ground level and in the aircrafts. RADAR will rotate at the speed of 12.5rpm-13.5 rpm. The nose of the aircrafts will have RFID through which the authorized and unauthorized flights are verified. Normally, flights travelling at the height of 25,000 ft will be under the Indian sky limit .Within the height of 20,000ft the aircraft will come under the ATC loop and above 20,000ft it comes under the RADAR loop. Airplanes pressure will be reduced slowly and speed should be increased while landing in order to cheat the gravity. Since gravity is the important factor to be considered during landing. Because mass increases during landing of the airplanes. At those conditions applying of brakes will lead to severe problems. Only 10-15% of brakes are applied in air by releasing and closing of flaps in the airplanes.ATC does not act autonomously.

II. PROPOSED SYSTEM ARCHITECTURE

The proposed system for climatology lab will have five different modules. They are Data acquisition system, Data processing system, Data conversion module, Data manipulation system and Data communication system. These systems are very much important in analyzing the data collected which is shown below in the **Figure 2.1.**.These process are followed in the same way in atmost all the airports.

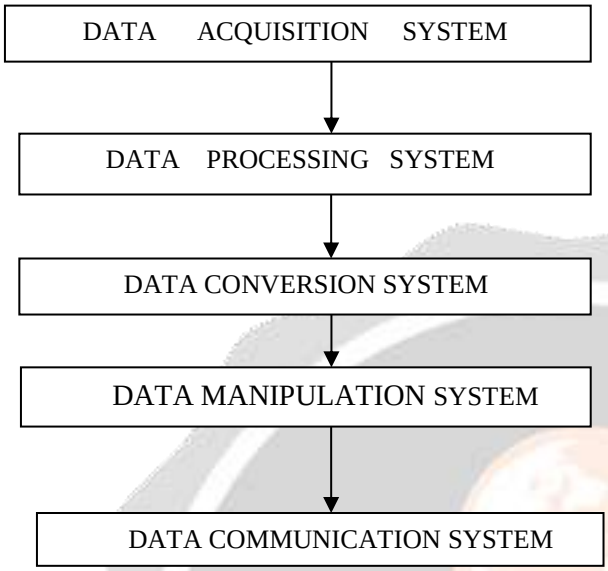

Figure 2.1

2.1 DATA ACQUISITION SYSTEM

In this system, the data from various sensors in the runway in airport is collected and intimated to the airplanes for safe landing. The various data collected are temperature, humidity, fog, visibility, wind speed and wind direction.

Temperature & Humidity-The temperature & humidity are the only parameter which will be informed to the passengers during landing. The temperature and humidity is measured by thermistor or Rtd. These values are converted into Milli volts. With these values, we are converting into ºC (Room Temperature) by manual calculation. For Humidity, one thermistor is inserted into water, & other Thermistor is kept in room so that to sense & display room temperature and water temperature. The formula for Humidity is

$$\text{Humidity} = \frac{T_{water}}{T_{room}} * 100\ \%$$

Wind speed and wind direction- In this paper , the wind direction is just like that simulation. Normally, the wind direction is measured by switches which is shown in **Figure 2.2**

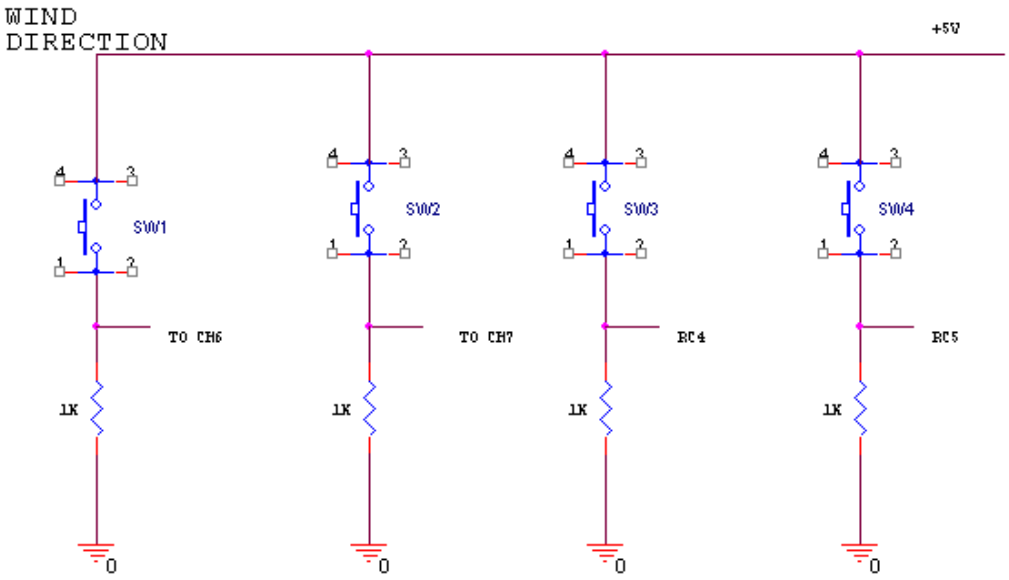

Figure 2.2

Generally, the flights will land opposite to the direction of wind. Wind speed is measured by fans(micro wind turbines) kept in the runway showed in **Figure 2.3.** Wind speed should not be more than 25Km/hr. Wind direction will depend upon the monsoon changes. Landing speed of the flight is calculated by

Landing speed of the airplane = Airplane speed+ Velocity of the wind

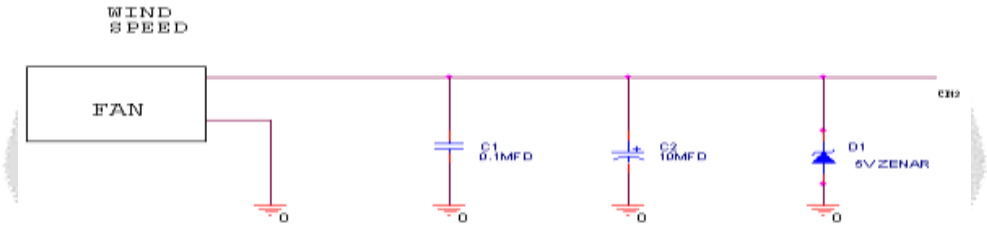

Figure 2.3

Fog and Visibility- For FOG & Visibility, IR Sensors are used. IR Sensors consists of IR Emitter and IR Detector. Positive Voltage is given to IR Emitter. Using this voltage, it transmits IR rays continuously & IR Detector collects these rays. If there is any obstacle between emitter & Detector, the amount of rays that is collected by Detector will be reduced depends on the obstacle.

For FOG, IR Emitter & IR Detector is placed face-to-face so that IR Detector collects rays passed by IR Emitter. If there is any obstacle between Emitter & Detector, the amount of rays collected by Detector will be reduced depends on the obstacle like FOG given in **Figure 2.4**

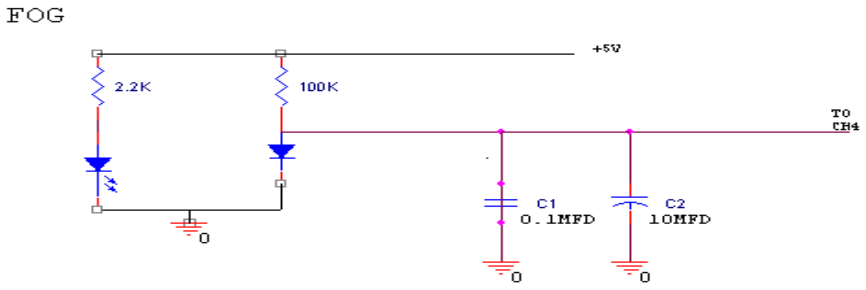

Figure 2.4

For VISIBILITY, IR Emitter & IR Detector is placed parallel so that rays passed by IR Emitter is collected by IR Detector which is shown in **Figure 2.5.** If there is any obstacle between Emitter & Detector, the amount of rays collected by Detector will be reduced depends on the distance of obstacle from IR Emitter. If distance increased, the amount of rays collected by Detector will be reduced. From this value, the increase in visibility value is known to them (i.e.) visibility increases with decrease in the rays' collection.

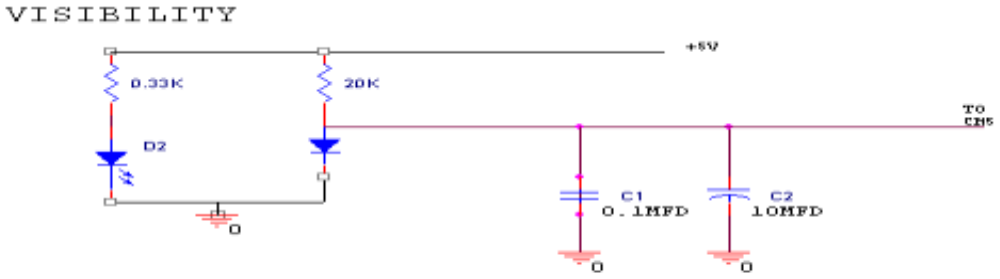

Figure 2.5

2.2 DATA PROCESSING SYSTEM

This system will have the components like Low Pass Filter, Wheatstone bridge, Operational amplifiers. In this system noises from the acquired data are removed and then finally processed in such a way that the datas are suitable for further processing in further modules. Here this have potential dividers to make the sensor signal to be around 0V-5V.Anything after the data processing should not be more than 5V.The function of bridge rectifiers used here is to convert AC to DC. Capacitors and Diodes used here will act as High Pass Filters to remove ripples from the signals. The stepper driver logic consists of buffer, opto coupler, pre-driver and driver. Buffer interface 8255 with high-level circuits (such as MOS.) for driving high current loads.

An opto coupler consists of Opto-emitter &Phototransistor. An opto coupler is essential to prevent the computer from hazardous conditions like voltage transients, back emf, and high voltage spikes. The dc Stepper motors are used for our robotic applications.

Normally when passing dc current to a coil it will get Electro magnetized, when withdrawing the dc source & also it won't get demagnetized. If it is not demagnetized, back EMF is produced which can create kick back current to the subsequent devices or associated circuitries .The block diagram for the above is given below in **Figure 2.6.**

The main principle of the driver is to amplify the current. It amplifies the 50mA current to2A, which is needed to drive the motor. This cannot directly couple the TIP122 (NPN) to the opto coupler since it requires large current for driving. The driver SL100 is used to boost the current level. The control logic consists of an SL100 and relays. Whenever the stepper motor has to be rotated , the input of high level is given through PA7 of PPI to SL100 70msec before. So SL100 produce logic low. Now the coil is energized and the 24v is connected to the coil of the driver by the relay.

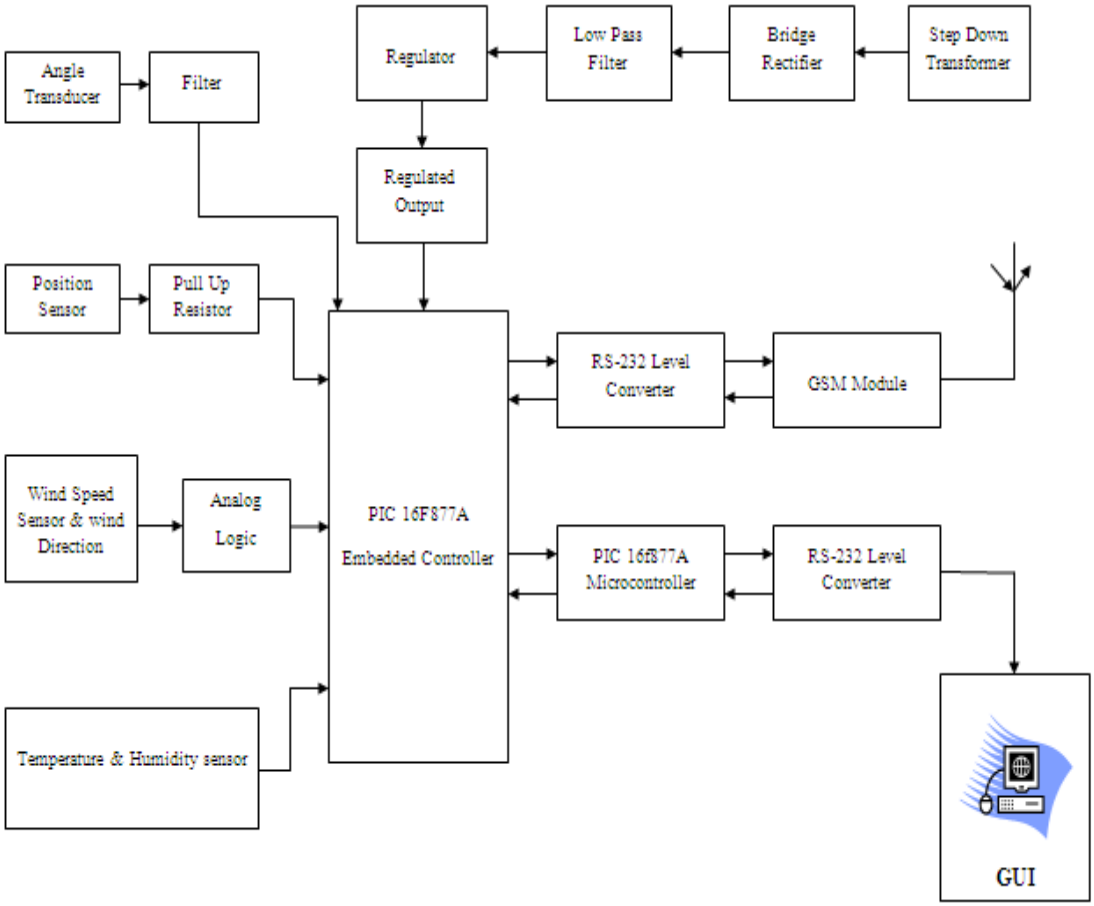

Figure 2.6 BLOCK DIAGRAM

2.3 DATA CONVERSION SYSTEM

In this module, PIC 16F877A and RS-232 Converter is used. Peripheral Interface Controller (PIC) is enhanced version of Microcontroller. It is an embedded controller. PIC Micro controller has the several advantages over Microprocessor and Personal computer, like Fast Data acquisition, Compactness, Accuracy. It has some inbuilt I/O ports to connect the peripheral devices like personal computer, ALS kit, etc.To perform the various operations and conversions required to switch, control and monitor the devices a processor is needed. The processor may be a microprocessor, micro controller or embedded controller. In this project an embedded controller has been preferred because of its industrial advantages in power electronics like built in ADC, RAM, ROM, ports, USART, DAC.The embedded controller selected for this project is PIC16F877A due to its various features which is shown in **Figure 2.7**

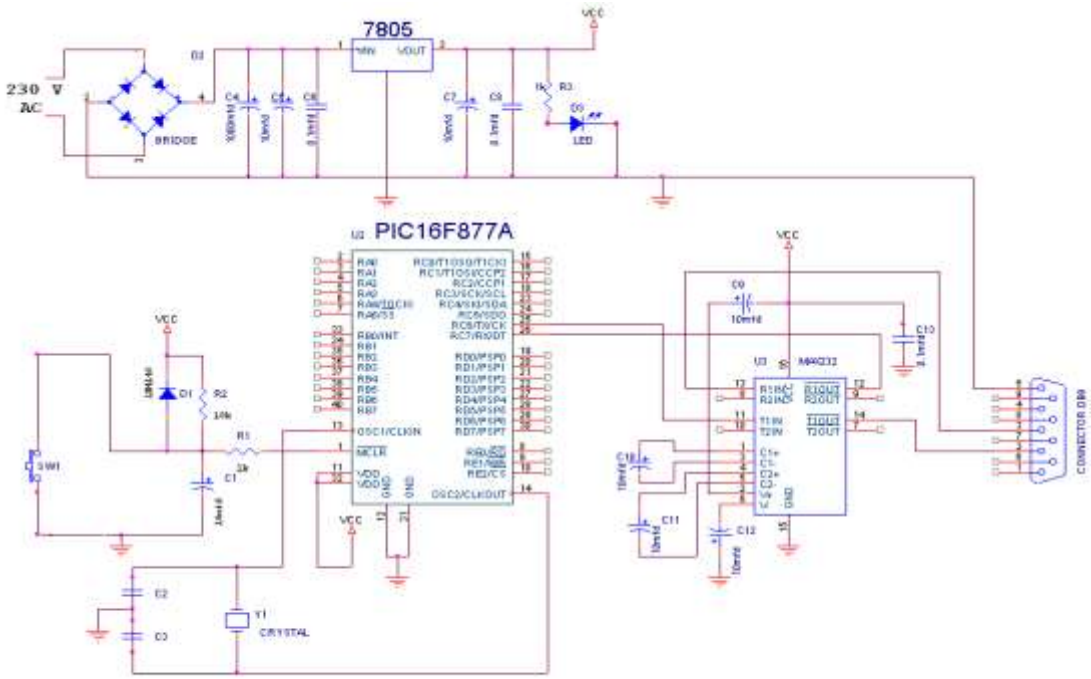

Figure 2.7PIC CIRCUIT DIAGRAM

CIRCUIT DESCRIPTION :

From the circuit it can be seen that the reference analog supply after being regulated by the 9v regulator enters the zener diode through the resistance R1 where it is again regulated to 5v since the zener diode used here has a cut off of 5v. Thus a double regulated completely filtered analog reference source is used. R2 is a potential divider used for setting the dynamic response range of the reference supply. This means that the reference 5v can be used as it is or it can be made into a fraction of the 5v for example 1v so that readings in this range can be read with more precision. This is because the ADC has 10 bit resolution which can be totally used for representing the 1v rather than 5v.

The pins 2-5, 7-10, 35 and 36 are used as the 10 channels of the ADC. To these pins the analog inputs to be processed by the ADC are given. Y1 is the crystal oscillator used. It is of 10 MHz and gives a baud rate of 9600 bits/s. The capacitors C2 and C3 are used as decoupling capacitors to remove the high frequency noise signals.

The capacitor C1 is in the off condition when power is switched off. When the power is switched on or reset then this capacitor gets charged through the resistor R2 and then through R1 this appears at the MCLR pin of the PIC. This is the memory clear pin and thus the memory is cleared and is ready for use as soon as power is switched on. S1 is the synchronous switch which is also used for the same operation and for PC and PIC synchronous operation.

FEATURES OF PIC16F877A:

High-performance RISC (Reduced Instruction Set Controller) CPU is the main advantage of PIC. This Consists of only 35 single word instructions to learn. All single cycle instructions except for program branches which are two cycle. Operating speed: DC - 20 MHz clock input and DC - 200 ns instruction cycle. This consists of 4K x 14 words of Program Memory (EPROM) and 256 x 8 bytes of Data Memory (RAM)and Interrupt capability (up to 14 internal/external interrupt sources).This has eight level deep hardware stack. Direct, indirect, and relative addressing modes are present in PIC.

12-bit multi-channel Analog-to-Digital converter On-chip absolute band gap voltage reference generator. Universal Synchronous Asynchronous Receiver Transmitter , supports high/low speeds and 9-bit address mode (USART/SCI).

REQUIREMENTS OF PIC16F877A:

A separate power supply for digital and analog supplies must be provided to prevent affecting the quality of analog measurement due to digital current fluctuations. Double regulated completely filtered analog reference supply is used. It needs external power on reset and CPU synchronization switch. External quartz crystal to be used for frequency stability.10 MHz for 9600 baud rate.20 MHz for 19200 baud rate.RS232 converter is used to

link it with the computer. For all the analog inputs voltage should not exceed 5V.For digital outputs, it should not consume current beyond 25mA.All the logical inputs must reach PIC16F877A as a perfect square waveform.

RS-232 CONVERTER:

RS – 232 Converter is used for PC application. The serial port converts the output of PC, which is in parallel form into serial data for transmission. The external converter Quadruples the incoming 5V (from PIC) and gives 20 V output i.e. –10V to +10V . Similarly the incoming 20 V from (from PC) is reduced as 5V by the converter which is shown below in **Figure 2.8**

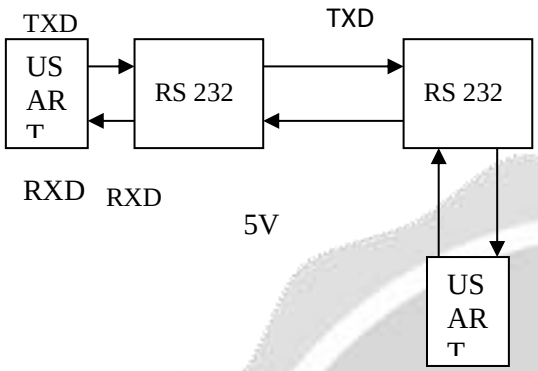

Figure 2.8

2.4 DATA MANIPULATION SYSTEM

In this system, Visual Basic software with Animatronics and database is used. Animatronics is the combination of animation and electronics. Generally, no computer will accept no parallel data. Similarly no embedded system will deliver serial data. Therefore, Analog data is first converted into the suitable digital format . Then the digital data is then converted into the serial form using UART and then given to the RS-232.

Design Features:
Individual power supply for Analog and Digital circuits is required to avoid drift on analog portion. Double regulated filtered reference source is needed to ensure safest ADC operation.External clock source must be used which enables the user to design the required speed.External CPU Synchronous circuit must be designed incase of PC requirement. Switch is used to synchronize the Embedded Controller with the PC to get COMOK signal**.**RS-232 should External be used for data conversion.

VISUAL BASIC:

Visual Basic is a third-generation event-driven programming language and integrated development environment .Visual Basic was designed for an easy learning curve. Programmers can create both simple and complex GUI applications. Programming in VB is a combination of visually arranging components on a form specifying attributes and actions

CHARACTERISTICS OF VISUAL BASICS:

- Improved performance
- A data base creation tool
- Visual data access with the data control so that it is possible to create data browsing application without writing code.
- A new OLE (object linking and embedding) control that allows in place editing.
- A collection of common dialog boxes that streamline common user interface tasks.
- The ability to create pop-up menus anywhere in the application.

2.5 DATA COMMUNICATION SYSTEM

In this system, the information so far gathered and processed are intimated to the ATC room via the wireless channels. From there, the information is passed to the pilots in the aircrafts through RADAR. Climatology can be seen from every airport. Information about the arrival of flights must be intimated to the two major airports located at New Delhi and Chennai. These two airports will have all the details and list of airplanes flying across

the Indian sky limit. They will gather the information from other regional airports through IOT. These two airports will have the overall control of all the regional airports through IOT. They control through IOT.

These data can be seen visibility in the ATC room. These data can be shared to the authorized ATC People through screen leap technique where the VB screen with the collected weather data can be shared to that authorized persons mobile phone.

III. RESULTS AND CONCLUSION

The data collected from the runway are processed through several stages and interfaced with system through RS-232 UART. The collected data are thus seen in the VB screen plot against a particular characteristics. The data about the Temperature, Humidity, Wind Speed, Wind Direction, Fog and Visibility are shown in the **Figure 2.9**.

This paper based on **"Advanced landing System"** helps **A**ir **T**raffic **S**ervices [**ATS**] for controlling smooth Take-off and Landing of many aircrafts in the airport. With the help of monitoring ambient parameters like temperature, humidity, wind speed &its Direction, can avoid confusion in arrival & departure of the aircrafts. There might be a chance of accident due to abnormal position of flight during landing. By checking the position of Lever, the chance of accident (caused by pilot fault) can be reduced. Integration of these monitoring systems reduces time consumption and increases the flow of air traffic. By using this project, **ATS** can monitor and control the air-traffic more efficiently.

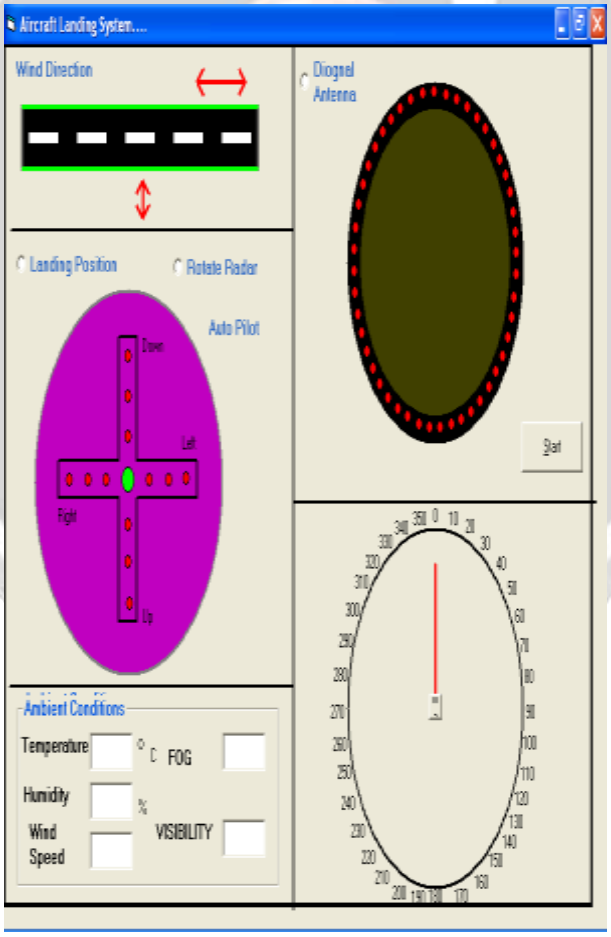

Figure 2.9

References :

1.Deener, S., "Garmin begins shipping GDL 84 ADS-B datalink. General Aviation News", Lakewood,WA,October2014.
http://generalaviationnews.com/2015/03/07/garmin begins-shipping-gdl-84-ads-b-datalink/

2. Davis. A., "Introduction to ADS-B. TRIG Electronics",Edinburg,UK. http://www.trigavionics.com/knowledgebank/ads-b/introductionto-ads-b/.
3. Kochenderfer, M.J. and Chryssanthacopoulos, J.P., "Robust Air Aborne Collision Avoidance through Dynamic Programming," MIT Lincoln Laboratory, Project Report ATC-371, 2011.
4. Krastev, A., "ACAS-X SKYbrary Aviation Safety", EUROCONTROL, Brussels, BE. http://www.skybrary.aero/index.php/ACAS_X
5. Kuchar, James K. and Drumm, Ann C., "The Traffic Alert and Collision Avoidance System". vol 16, no 2, 2007, Lincoln Laboratory Journal, 277.
6. Martinez, P., "Better Collision Aviodance with NextGEN", FAA, Washington, DC, http://www.faa.gov/NextGEN/snapshots/stories/?sli de=27.

7.Orlando V.A., Drouilhet P.R. (August 1986). "ATC-42 ModeS Beacon System: Functional Description (Rev D)" (PDF). Lincoln Laboratory. Retrieved March 29, 2014.
8. Skolnik, Merrill I. "Radar Handbook" McGraw Hill Publishing 1990.
9. Willis, Nicholas J. and Griffiths, Hugh D., Editors, "Advances in Bistatic Radar", Scitech Publishing, 2007.
10. AN/AAQ-37, "Distributed Aperture System (DAS) for the F35", Northrop Grumman 18FEB2015. http://www.northropgrumman.com/capabilities/ana aq37f35/pa ges/default.aspx .
11. "Collision Avoidance for Unmanned Aircraft: Proving the Safety Case", MITRE # MP060219 and MIT Lincoln Laboratories 42PM ATC-329, October 2006.
12. "Changes to the TIS-B Service Beginning in Late 2015." Federal Aviation Administration. FAA, 13May2015. https://www.faa.gov/NextGEN/programs/adsb/medi 7 a/TISB_service_change_summary_final_508_5-13- 15-webV2.pdf .
13. FAA AC20-165A, "Airworthiness Approval of Automatic Dependent Surveillance-Broadcast" (ADS-B Out 21 May 2010).]
14.Global Positioning System Wide Area Augmentation System (WAAS) Performance Standard, 1st ed, 31 Oct 08, Technical Operations Navigation Services, FAA, Washington, DC.
15..HQ111358 "Introduction to TCAS II", Version 7.1, FAA, February 28, 2011.
16. "International Standards and Recommended Practices, Annex 10 to the Convention on International Civil Aviation", Volume 4 Surveillance and Collision Avoidance Systems, 5 ed, July 2014, ICAO Standard. http://www.afeonline.com/shop/icao-annex-10- volumeiv.html.
17. "Mode-S Enhanced Surveillance – Assessment of Aircraft Capability," European Organisation for the Safety of Air Navigation, 2005. http://www.eurocontrol.int/sites/default/files/conten t/documen ts/nm/surveillance/surveillance-mode-sinformation-paperehs-capability-assessment20050516.pdf
18."NextGEN Implementation Plan 2015". FAA Office of NextGEN,." Federal Aviation Administration. FAA, 1 May 2015.https://www.faa.gov/NextGEN/media/NextG EN_Imple mentation_Plan-2015.pdf.
19. "Principles of Mode-S Operation and Interrogator Codes," European Organisation for the Safety of Air Navigation, 2003. https://www.eurocontrol.int/sites/default/files/publi cation/files/surveillance-modes-principles-ofmodes-operation-andinterrogator-codes20030318.pdf
20. Unmanned Systems, October 2015- Association for Unmanned Aerial Vehicles International, www.auvsi.org.
21. "Unmanned Aircraft System MQ-9 Predator B", U.S. Customs and Border Protection, Department of Homeland Security, Oct 14, 2015. http://www.cbp.gov/newsroom/factsheets