INTEGRATED AIRCRAFT LANDING WITH TOUCHDOWN AVIATION

[1]A.T. Madhavi, [2]K.Rohini, [3]R.Theepalakshmi, [4]R.Vinodhini
Assistant Professor[1], Final Year UG Student[2,3,4]
Department of Electronics and Communication Engineering, Easwari Engineering College, Chennai.

Abstract
Automatic and advanced Landing System is fundamental for the current airports to reduce layoff schemes in enhancing the quality of the air traffic. Touchdown aviation is essential to reduce accidents during end state of flying called landing. This system integrates the existing system, which is widespread in the airports today to offer an economic affordable solution for perfect takeoff and Landing with physical ambient parameters like temperature, humidity, wind Speed, direction and visibility with audiovisual networking. It provides fastest data collection and establishes communication between Metrology, Runway, Air Traffic Control (ATC) and the Aircraft. To have a real time demonstration, Embedded Controller Technology is employed. Multimedia is used along with visual basic software for audiovisual effects. Precise point of the touchdown zone is examined by using piezoelectric crystals, then the power can be generated using the vibrations produced which is a distinct step for energy generation system.

Index terms: Energy conservation system, Piezoelectric crystals, Touchdown aviation, Visual basic software.

I. INTRODUCTION

The technology had gone in-depth to almost all the fields of automation like mechanical, automobile, spacecrafts and aircrafts. But, still some essential areas of airports are not fully automated, like aircraft handling system. In India, we still use conventional **I**nstrument **L**anding **S**ystem (ILS) for all of our airports to land a flight on the runway. In present system of ILS, there are three essential department that works simultaneously to get an aircraft on the runway properly, they are Metrology, Mechanical and ATS. The draw backs of the ILS are slow landing process, possibilities of manual error, too many network involves in landing and all the networks are not integrated which uses conventional physical parameter measurement system. Some of the primary requirements are measurement of Visibility, Pressure, Wind speed and Direction, Temperature, Humidity and Precipitation. The pilots and aviation personnel make use of the meteorological equipments at airports for making critical decisions.

It is essential to determine the touchdown point of an aircraft to avoid accidents and to reduce communication delay during landing.An innovative concept is implemented using piezo electric crystals arranged in matrix format on the runway touchdown zones (approximately100meters). Lucid information of landing is important to take decision on speed deceleration of aircraft by employing various brake methodology. To obtain this information piezoelectric crystals are used. The information must be obtained at fastest rate by the Air Traffic Control (ATC) room and it is communicated to the aircraft to control its actuators to reduce speed in accordance with the local wind speed, direction and pressure. Network intrusion is a major issue in airports, so employment of dedicated operating system with ultrahigh speed is highly required. Monitoring the movement of an aircraft after touchdown is essential to locate its physical position on the runway before calling another aircraft for landing.The demand for power in our routine life is rising in an alarming rate.

This increase in demand for electricity has forced to find alternatives for power generation for future use. For all developing countries, an effective energy harvesting system is indispensable. In most cases, energy is harvested by wind source which is seasonal based on the weather conditions and will have unpredictable power quality. To resolve this and to produce reliable power with an enhanced power quality, low power wind turbines are used.

II. SYSTEM ANALYSIS

A. EXISTING SYSTEM

CLIMATOLOGY

India's airspace extends from the Ladakh, Leh Airport in the Himalayas in the North to the Agatti Aerodrome in the South West. Chennai is the fourth busiest airport in India after Delhi, Mumbai and Bangalore. The Air Traffic Service (ATS) ensures safety in the operations of flights and the Air Traffic Control (ATC) is a service used to coordinate the activities of Ground (or) Apron Control Room, metrology, radar and aircrafts. It is essential to measure and convey the ambient parameters like visibility, temperature, humidity for smooth landing.

The term 'visibility' generally indicates the distance to which human visual perception is limited by atmospheric conditions. The physical mechanisms that influence visual perception during the night in distinguishing the runway lights differ from those in the day time in distinguishing objects illuminated by daylight. Visual range is determined by an observer and is defined as the maximum distance at which an object or low intensity light can be distinguished. Visual range and visibility are used here interchangeably. The "Visual range" of the runway lights can be calculated from the Allard Law :

$$E = \frac{I.T^{X/V}}{X^2} \quad ......(1)$$

Where, E - Resulting illuminance on this surface

I – Intensity of the incident light in the direction of measurement

T - Atmospheric transmission factor

X - Distance of the surface from the light source

V - Meteorological visibility

To ensure safe takeoff and landing of an aircraft it is essential to obtain accurate observation and measurement of surface wind at airports. The wind speed direction information forms part of the airports Automatic Weather Observing System (AWOS). Wind direction is always given as a radial measure in degrees stating the direction from which the wind is blowing. Wind speed is given in either knots (nautical miles per hour) or metres per second depending upon the procedures of the State concerned. A wind sock is used to indicate the wind direction and the relative wind speed. Wind speed of greater than 25km/hr is not ideal for takeoff and landing. The landing speed is a sum of the flight speed and the wind speed. So the pilot should adjust the speed of the plane with respect to the wind speed.

Fig.1Wind Stock

At the standard height of 10 metres above the surface there is usually more than one sensor (anemometer) position but all measure the wind velocity. The wind velocity rarely remains the same, unless the wind is completely calm. The mean wind speed is directly proportional to the variation in speed and direction. It is due to the effect of terrain friction which depends upon wind characteristics. The airports situated in areas of uneven terrain will experience greatest effect. The maximum allowable takeoff weight of an aircraft is predominantly controlled by temperature and airport elevation by changing the surface air density and the lift produced at a given speed. Climate change raises mean temperatures at all airports and also significantly increases the frequency and severity of extreme heat. Especially at airports with short runways, these changes will adversely affect aircraft performance, leading to increased weight restrictions.

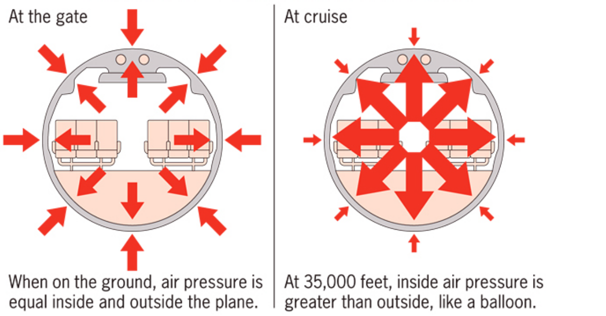

Fig.2 Illustration of temperature pressure relationship

When there is an increase in altitude or temperature, the optimum performance of an aircraft is decreased. The change in pressure accompanies the change in humidity which affects the way an airplane flies. The air pressure for a given volume of air goes down as the humidity goes up. This shows the wings have fewer air molecules to affect as they are pushed through the airmass. The aircraft is a pressurized vessel. The pressure is adjusted so that the body temperature of the plane is maintained at -56 to -2250 C. The fuel used should not shrink or expand with respect to the temperature. Hence we use cryogenic fuels. Eg : Liquid Nitrogen.

A radar is used to monitor the positions of all the aircrafts within the Radar Loop of an Air Traffic Control Centre. This loop has a radius of 200 km. An inner loop of 18nm is called the ATS loop. The radar has an international standard frequency of rotation of 12.5 - 13.5 rpm.

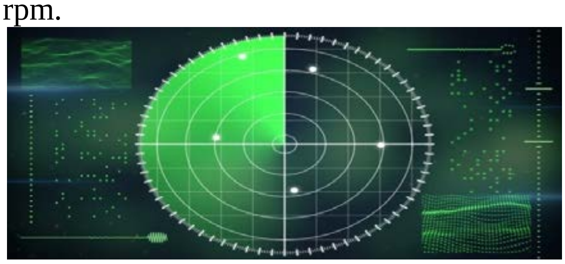

Fig.3 Radar Evaluation

AEROMACS COMMUNICATION AND RUNWAY POWER GENERATION

The Aviation industry uses a basic technology AeroMACS to enhance communications on the airport surface. This is done by producing increased transmission of Air Traffic Control (ATC) and Airline Operations Communications (AOC). This is to mitigate traffic, congestions, delays and to support the safety and regularity of flights. It is based on a specific commercial profile of the Institute of Electrical and Electronics Engineers (IEEE) 802.16 standard known as Wireless Worldwide Interoperability for Microwave Access or WiMAX.

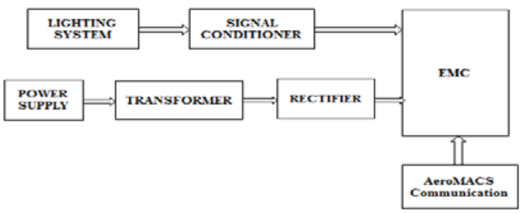

Fig.4 AeroMACS Communication

AeroMACS operates in the protected and licensed aviation spectrum band from 5091 MHz to 5150 MHz based on the mature WiMAX standard (IEEE 802.16e). This system controls and measures speed and distance travelled by aircraft and also manually monitor the touchdown operations. Runway power generation is done with the normal distribution generation supply from the substation, feeders and transmission lines. Airport runway airstrips need more energy during the night time lighting for the aircraft landing and takeoff. When more power is consumed then there will be an energy demand crisis for the commercial and residential purposes. There are so many alternative methods for generation of power but those have become seasonal with the weather. More advancement must be made to have an alternative source of energy. Normal power supply is rectified and given to the Embedded Microcontroller to light the runway lighting system.

DRAWBACKS OF EXISTING SYSTEM

The three departments of the ILS are located in different areas and they have their own network that exchanges data manually and automatically. The main drawback of the existing system is that too many network involves in landing and all the networks are not integrated which causes time delay and there is a high possibility of manual error in the physical parameter measurement system. Manual error, parallax error, improper communication and understanding leads to panic. Behavior of the camera differs from day and night. During rainy season or fog the camera may not work and behaves much abnormal.

B. PROPOSED SYSTEM

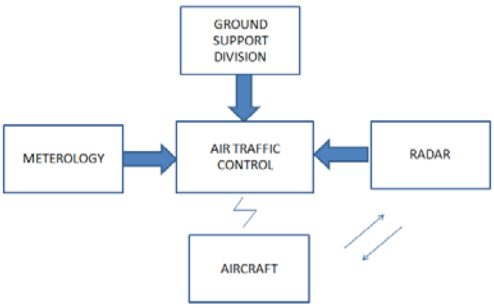

Fig.5 Incorporation of ILS departments

The proposed system consists of an ad-hoc type system where all the three departments of the

ILS is integrated which will guide the aircraft for safe landing. It uses embedded technology and audiovisual effects to demonstrate the system. It integrates the wide spread airport network to avoid panic situation in a regular and emergency basis. Aircrafts movement on the runway will usually be around 400 nautical miles per hour. To gain power
during aircraft landing and takeoff the LPWT can be fixed on both sides of runway.
During the movement on the runway huge air velocity will be created and the same will be sufficient to drive small micro wind turbines. This power created from the runway can be used in the taxi-way and also for other purposes.

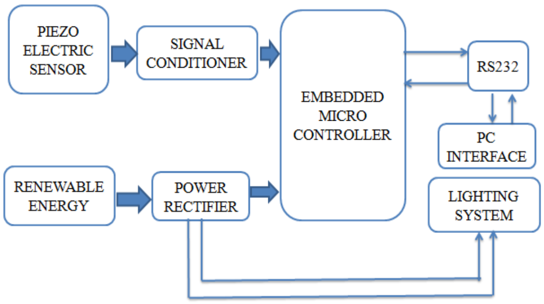

Fig.6 Touchdown Block Diagram

The touchdown point of the aircraft first touches the runway during landing. The touchdown point was analysed anually in the existing system. Achieving communication between the pilot and monitoring room is very difficult on the runway as it may lead to angle deviation from the point. Incorrect monitoring of the touchdown point can lead to crashing of aircrafts on the runway. Without getting accurate touchdown points it is not possible to obtain high rate and safety in C-Band. The Embedded Micro Controller (EMC) is used and automated for achieving the exact point of touch down in the proposed communication system that is required for the future needs of Air Traffic Control and Air Traffic Management.
The touchdown point can also be used for power generation. With the help of the vibrations created during the landing and takeoff the power can be generated with the help of accurate touchdown point. To produce voltage for the runway and taxi-way power generation is done by using the piezoelectric material which uses a piezoelectric crystal. Large amount of pressure is employed on the runways during takeoff and landings. If the piezoelectric crystals arranged in matrix format are placed here then this mechanical energy can be converted to electrical energy. Several layers of piezoelectric clusters which forms a stacked structure can be used to improve the efficiency of the system. Due to which it has the capacity to handle very huge amount of pressure. For an airbus aircraft (A380), the maximum takeoff weight is 560 tones. It can produce 224 KV. A large amount of energy could be produced if one considers the total number of landings in the runway. Approximately 8138 kWh energy could be produced which can be used to light upto 12207-16276 homes.

III. HARDWARE IMAGE

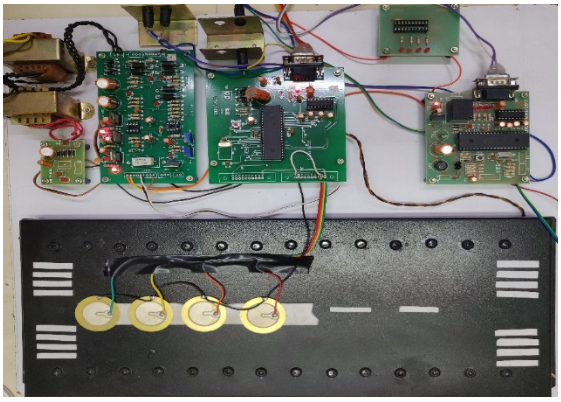

Fig.7

IV. RESULTS AND DISCUSSION

Fig.8

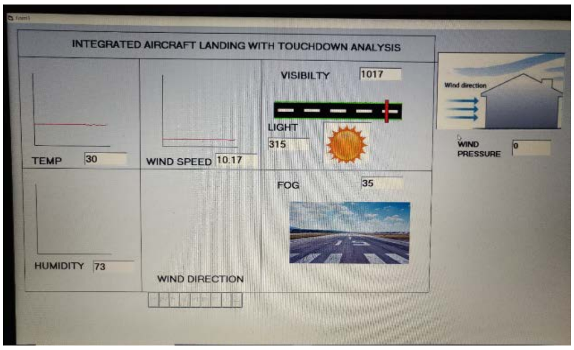

Fig.9

V. CONCLUSION

Integrated aircraft landing with touchdown analysis helps Air Traffic Services [ATS] for controlling convenient Take-off and Landing of numerous aircrafts in the airport. Confusion in arrival and departure of the aircrafts are avoided by monitoring ambient parameters like temperature, humidity, wind speed and its direction. Time consumption can be reduced by integration of these monitoring systems. Proper monitoring of touchdown points, can reduce collisions. It is an efficient alternative method of power generation. The concept is completely analyzed and evaluated with the software used. It can also be equipped in metro airports for smart and safe energy harvesting system with the self-powered runway. This project would be a complete solution for the existing system with the upgraded efficiency and automation for the social and safety welfare of the country.

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