Analysis of Automatic Aircraft landing Using Neural Networks and Signal Processor

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Abstract

This paper presents an adaptive neural network, designed to improve the performance of conventional automatic landing systems (ALS). Real-time learning was applied to train the neural network using the gradient-descent of an error function to adaptively update weights. Adaptive learning rates were obtained through the analysis of Lyapunov stability to guarantee the convergence of learning. In addition, we applied a DSP controller using the VisSim/TI C2000 Rapid Prototyper to develop an embedded control system and establish on-line real-time control. Simulations show that the proposed control scheme has superior performance to conventional ALS under conditions of wind disturbance of up to 75 ft/s. Automatic aircraft landing operation, depends upon the proper functioning of various networks related to it. The safe landing of aircraft is very much important. This project deals with the detection of various obstructions related to safe landing. This is achieved by using automatic landing system through neural network, in corporation with embedded system. The sensor is used to sense the real altitude ,altitude rate and command signal. Any one of these signal is fed to the reference trajectory and other signal is fed to ARAN controller from the there the signal is fed to error comparator and other signal for error comparator comes from the reference trajectory, both the signals are compared and the difference in signal is pitch command signal that signal along with disturbance signal is given to aircraft model. If there is any changes found in aircraft model again the signal is fed to real altitude block for further comparison. The ARAN controller is used for varying the weights.

Keywords: Neural networks, Automatic Landing system, Resource allocating network, Instrument Landing system.

1. Introduction:

This project deals with applied intelligent concepts such as neural networks and fuzzy systems to automatic landing systems, to increase the degree to which flight controllers could be adapted to various environments. Unfortunately, most of these researchers did not consider the robustness of the controller as it pertains to disturbances in wind patterns. A PD-type fuzzy control system was developed to control the automatic landing functions of both a linear and a nonlinear aircraft model, and adaptive control over a wide range of conditions was demonstrated. Wind disturbance was included but the neural controller was trained only for a specific wind speed. Robustness over a wide range of wind speeds made in which modern control theory has been applied to aircraft control under conditions of disturbance but the design of the controller involves complicated mathematical equations. Sequential learning technique using a time delay network or networks with back-propagation through time algorithms to control landing; however, the number of hidden units was determined by trial and error and the speed of convergence was slow. For sequential learning of the radial basis network, the resource allocating network (RAN), It began with no hidden units and grew by allocating new units based on the novelty of the observations that arrived sequentially.

If an observation lacks novelty, then the existing parameters of the network are adjusted using the least mean squares (LMS) algorithm to fit that observation. RAN has been used for several applications ranging from functional approximation to identification in nonlinear systems and its powerful approximation ability and fast convergence characteristics have been demonstrated. Thus, this study considers the RAN suitable for real-time control problems such as those involved in aircraft flight control. An ALS relies on the Instrument Landing System (ILS) to guide the aircraft according to its altitude, position, and approach angle during landing. The ILS utilizes localizer beam and glide slope beam systems to guide an aircraft down toward the runway. The guidance must be lateral and vertical in the landing phase. The localizer beam is used to position the aircraft on a trajectory so that it will intercept the centerline of the runway.

The glide slope beam guides the aircraft down a predetermined descent path . If the flight conditions exceed the preset envelope, the ALS is disabled and the pilot takes over, and an inexperienced pilot may be unable to guide the aircraft to a safe landing.

It is therefore desirable to develop an intelligent ALS capable of expanding the operational envelope to include safe responses under a wider range of conditions.

This project is to illustrate how our proposed intelligent ALS could relieve human operators and guide aircraft to a safe landing, even in environment of high wind-turbulence. Stability is the most important issue in control systems and engineering, because an unstable control system represents a latent danger. Control systems, whether linear or nonlinear, involve stability problems, which must be dealt with. In developed countries, and in some of the busiest airports in the world, voltage sensors are placed in every node which constantly monitor the voltage levels of the line and indicates during the fault. This system is possible only whenever airports are newly commissioned as it requires a separate data mission cable running parallel to the main line. This system is expensive at installation and also for maintenance.

Hence, a cheaper monitoring system, compatible with the present day airports, avoiding new installation of underground cables, with a simpler methodology for fault detection, location and its transmission in an efficient manner has to be developed.

3. Block Diagram

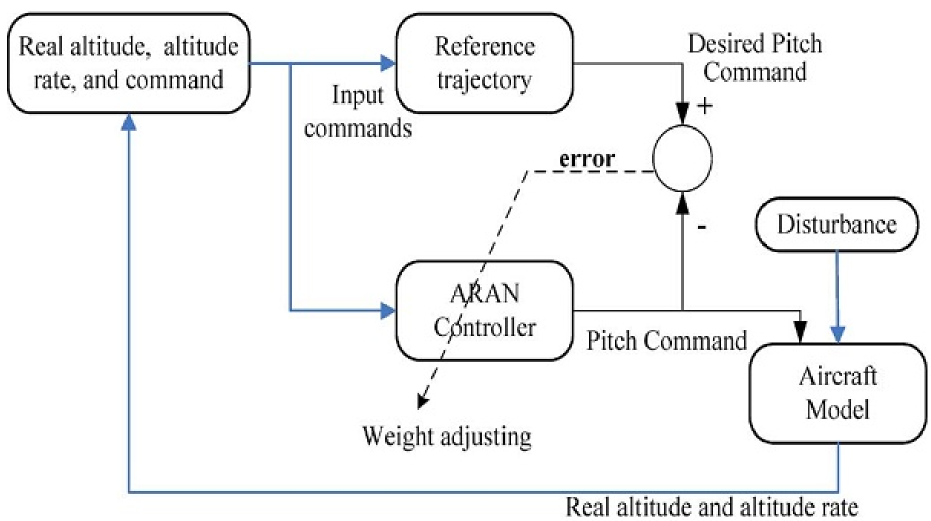

Figure 3.1:Basic block diagram of learning structure of ALS with ARAN.

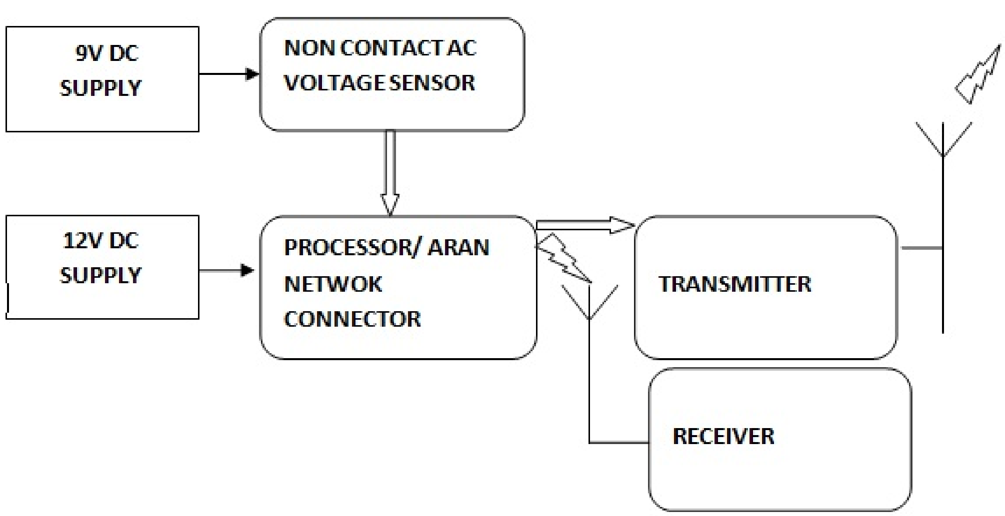

Figure 3.2: System block diagram

Figure 3.1 shows the ALS block. Pitch commands are generated by the reference trajectory. The reference trajectory acts as an experienced pilot. The inputs of the neural network are aircraft real altitude, altitude rate, altitude command, and altitude rate command. The output of the neural network is the pitch command, and the training process is performed in real time. In this learning structure, there are differential input signals in the system. The feedback signals are purely input signals, with none of the properties of feedback signals. Stated another way, feedback linearization method is not applicable to analyze the stability of aircraft landing systems.

Thus, a bounded-input and bounded-output stability theorem was utilized to analyze the stability of the aircraft landing system, which regards the ARAN as the main controller in the system. This study used a back-propagation algorithm as the updating law, the stability of which has been discussed. Stability is attained at the convergence of back-propagation algorithm; however, it only converges to a local region. Variations in the adjustable parameters of the network depend on the gradient descent and learning rate. The gradient descent method provides changes in the direction of variation, while the learning rate selects the size of the variation. Convergence is ensured with a small learning rate, but the speed of convergence may be slow or scattered. On the other hand, if a large value is given for the learning rate, the system could become unstable. Therefore, several convergence theorems for selecting appropriate learning rates are proposed. The discrete-time Lyapunov function is used to analyze the stability of the ARAN controller to obtain an appropriate adaptive learning rate to attain the optimal stable state. Based on the gradient-descent method, index performance.

The above figure 3.2 shows the basic block diagram of the entire project. This consist of 12V supply for processor and transmitter and a 9V supply for Non-Contact AC voltage detector. The voltage detector picks up the hum of AC voltage, which is sufficient to clock CMOS decade counter. During open circuit, absence of line voltage makes the last count to be stable, which is picked up by a Processor, which in turn activates transmitter to transmit the desired message to the control room receiver. This non contact AC voltage detector a CMOS IC based circuit which can be used to detect presence of mains AC voltage without any electrical contact with the conductor carrying AC current/voltage. Thus it can be used to detect mains AC voltage without removing the insulation from the conductor. Just take it in the vicinity of the conductor and it would detect presence of AC voltage. If AC voltage is not present, the display would randomly show any digit (0 through 9) permanently. If mains supply is available in the conductor, the electric field would be induced into the sensing probe. Since IC used is CMOS type, its input impedance is extremely high and thus the induced voltage is sufficient to clock the counter IC. Thus display count advances rapidly from 0 to 9 and then repeats itself. This is the indication for presence of mains supply. Display stops advancing when the unit is taken away from the mains carrying conductor. For compactness, a 9-volt PP3 battery may be used as supply to the gadget.

The above technique can be used in normal 220V perfectly. Under 5kV, the repetition of digits is faster. Hence the sensor must be placed in a considerable distance from the main line corresponding to the delay coded in to the processor. Among the seven segments, any one to four of randomly selected segments is taken into the processor for sensing. Power supply to the sensor is provided by permanently placing a battery at the site. A battery of higher ampere hour is provided, such that replacement of batteries can be made on yearly basis along with the line maintenance. The advantage of this sensor is that it is more cost efficient. It is highly inert to external radio/mobile frequencies. A water tight metal enclosure may be provided as a protection against moisture and also for its efficient operation.

2. Work Done

The proposed system is more cost efficient and simple to install. Installation and maintenance is simpler when compared with other techniques. This system can be further extended by providing a micro controller at the receiver side to filter the first message sent by the voltage processors, to distinguish the voltage sensor which first indicates the fault. The circuit can be sealed and kept inside the man holes, with the GSM antenna projecting over the surface. Hence, the circuit makes no change in the external appearance of runway and also no electromagnetic interactions with the instrument landing systems. In developed countries, voltage sensors are placed in every node which constantly monitor the voltage levels of the line and indicates during the fault. This system is possible only whenever airports are newly commissioned as it requires a separate data transmission cable running parallel to the main line. This system is expensive at installation and also for maintenance. This proposed project proved to be cheaper, having less circuit complexity. Thus this project provides reliable operation of fault detection and also location in runway lighting circuit, guaranteeing maximum security of operation of airplanes.

3. Future Enhancement

In phase I project duration the signals are transmitted to the aim craft device, this system can be extended future (i.e.,) phase II ; the transmitted signals will be received using sensors and the process will be taken place using controllers and process. This system is possible only whenever airports are newly commissioned as it requires a separate data transmission cable running parallel to the main line. This system is expensive at installation and also for maintenance. This proposed project proved to be cheaper, having less circuit complexity.