International Journal of Multidisciplinary Research and Modern Education (IJMRME)
ISSN (Online): 2454 - 6119
(www.rdmodernresearch.org) Volume I, Issue II, 2015

A SUPPORTING FUZZY LOGIC CONTROLLER BASED ON UAV NAVIGATION

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Abstract:

An unmanned aerial vehicle (UAV) is used to describe a flying machine, absent of humans. In this paper a two and three module fuzzy logic controller in an unmanned aerial vehicle is discussed. The fuzzy logic controller includes a separate error calculating box which is derived for autonomous navigation and control unmanned aerial vehicles demonstrating ability to fly over specified way points. Fuzzy logic controller is to safely operate UAV and minimize the risk of mid-air collision.

Introduction:

The UAV operators must be able to detect and track air-traffic to a level of safety. The two-module fuzzy logic controller is composed of the altitude-module and the latitude-longitude module; an additional error calculating box is also designed for fuzzy controller parameter tuning and flight adjustment purpose. To demonstrate fuzzy-logic based autonomous navigation and control of small manned-unmanned aerial vehicles are as shown in fig1.

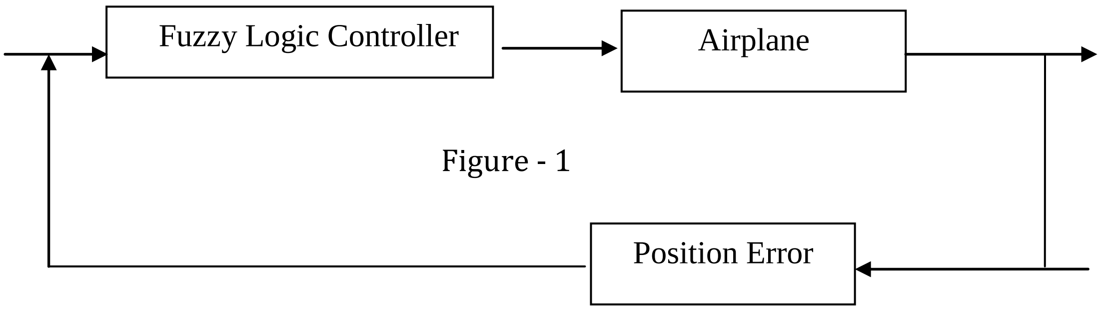

Figure - 1

Two Modules Fuzzy Control System:

The two fuzzy logic controller modules are responsible for altitude control and latitude-longitude control. All input and output variables have a finite number of values with membership functions; when combined, they may adequately navigate the aerial vehicle. The latitude-longitude controller has as inputs the heading error and the change of heading error. The heading error is the difference between the desired and the actual heading of the airplane. The output is the roll angle of the airplane. There are six sub systems represented as two module fuzzy logic controllers.

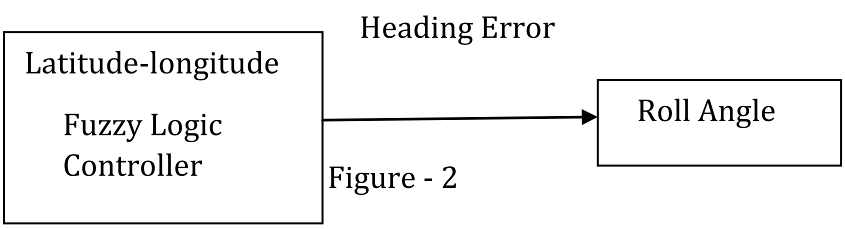

Figure - 2

Aircraft Model:

The Aircraft model is provided with the Aerosim block set. It is used to control the navigate.

Altitude Fuzzy Logic Controller:

This is derived from fuzzy logic controller module and helps to find the error.

Latitude-Longitude Fuzzy Logic Controller:

This controller finds the latitude-longitude angle and detects the error.

Data Input:

Data inputs depend on the commands, predefined trajectories and data from another plane.

Error Calculating Box:

The altitude error and the heading error are used to calculate the error.

Data Output:

The calculated values are recorded as output.

UAV Control System Three Main Parts:

A fuzzy logic system consists of three main parts, the fuzzifier, the fuzzy inference engine and the defuzzifier. The fuzzifier maps a crisp input into some fuzzy set . The fuzzy inference engine uses fuzzy if-then rules from a rule base to reason for the fuzzy output. The output in terms is converted back to a crisp value by the defuzzifier.

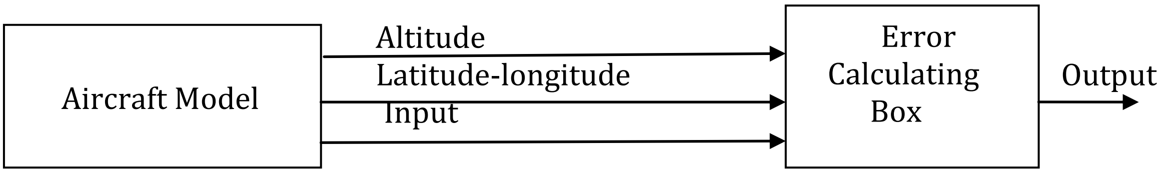

Figure - 3

In this, the given multi-input and single output fuzzy logic controller, has singleton fuzzifier. Using triangular membership function, algebraic product, product-sum inference and centroid defuzzification method, the output of the fuzzy controller has the following form,

$$Y_j = \frac{\sum_{l=1}^{M}\left(\prod_{i=1}^{N} \mu_{x_i}^{l}(x_i)\right) y_j}{\sum_{l=1}^{M}\left(\prod_{i=1}^{N} \mu_{x_i}^{l}(x_i)\right)}$$

When N and M represent the number of input variables and the total number of rules respectively. $\mu_{x_i}^{l}$ denote the membership function of the l^{th} input fuzzy set for the i^{th} input variable.

Three fuzzy logic controllers are designed for the navigation computer in order to control the heading, the altitude and the airspeed. These three controllers acting in combination enable the navigation of the aerial vehicle.

Consider 3 vehicles flying in the same region. The corresponding trajectories and their initial co-ordinates are shown in the table. The objective is that the "red" and "black" vehicles follow the "blue" one.

Plane	Latitude	Change in Latitude	Longitude	Change in Longitude
Blue	35.1	37.4	24.15	26.45
Red	35.15	37.45	24.2	26.5
Black	35.07	37.37	24.15	26.45

If there is any change in the vehicle, the collision may occur. So to avoid collision, the fuzzy logic controller is must in the unmanned aerial vehicle.

Conclusion:

This paper shows adequate by the overall performance of the controller. In UAV two, three, four and more fuzzy logic controllers are used to avoid collision. The purpose of the paper has been to demonstrate fuzzy logic based navigation and control of small aerial vehicles. The results show oscillations in the altitude, once the aerial vehicle reaches the desired or commanded altitude. This is because the controller is on human pilot experience and not on flight performance observations. In order to achieve better results, tuning is essential, then the small UAV helps us to secure more persons and things in the battlefield also. This controller is useful to perform not only navigation but also in collision avoidance.

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