ISSN: 2277-9655
Scientific Journal Impact Factor: 3.449
(ISRA), Impact Factor: 1.852

IJESRT

INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

The Anti Aircraft Control By Using Fuzzy Control

Bazvand, Mohsen
Islamic azad univercity,Kouhdasht, Iran
Ms.bazvand@gmail.com

Abstract

In this paper the use of fuzzy logic to control the position of anti aircraft tube is offered. By processing the recived information from radar the action of tracking the target is done. It is supposed that the anti aircraft is fixed on a moving leg. In this form two completely seprated controller has been designed, that the first controller is to tracking the target permanently and the second controller is to stabilizing the anti aircraft tube against completely sudden vibration from leg movment.

Keywords: tracker, fuzzy controller, anti aircraft, stabilizing

Introduction

Target tracking in the long past has been one on of the most important case in the military crafts.tracking and following the object or path can be done manualy or automaticly.A target tracking means determine the output torques of motors proportional by new states of lateral and vertical angle. In this systems by target movment in the space, two motors regulate new state based on target's position that this process is done continuously.

Clooseloop system parts

The system closeloop parts and controlers form is shown in figure(1).the anti aircraft is a nonlinear and time invariant system that its nonlinearity is rather high so practically the classic controlers for moving type is difficult.

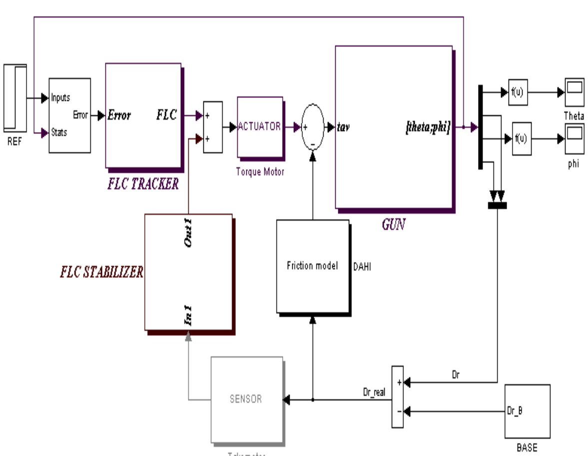


Fig. 1.the cloos loop system and controller

According to amount of comparative moving between base and gun variations of lateral and vertical angles in every moment has been determine.this comparative movement is applied to a tachometer.Output of tachometer applied to another fuzzy controller that its duty is stabilizing of gun.

The motors have a transfer function by equation (1) that in this $\omega_c = 6338.8$ and $k_c = 0.1$

$$H_m(S) = \frac{k_c.\omega_c}{s+\omega_c} \qquad -10 \le I_{in} \le 10 \qquad (1)$$

System dynamic equations is simplified as they have been in equation(2).

$$\theta'' = \frac{-3g}{2L}.\sin\theta - 0.5\phi'^2.\sin 2\theta - \frac{3f_a}{m.L^2}.\theta' + \frac{3\tau_a}{m.L^2}.i_a \qquad (2)$$

$$\phi'' = -\theta'.\phi' \cot g\theta - \frac{3f_e}{m.L^2.\sin\theta}.\phi' + \frac{3\tau_e}{m.L^2.\sin\theta}.ie$$

In order to get the system state space form, state variables are defined as they have been in equation(3).

$$X_1 = \theta, X_2 = \theta', X_3 = \theta, X_4 = \phi' \quad (3)$$

There fore equation(4) is prodused.

(4)

$$X_1' = X_2$$

$$X_2' = \frac{-3g}{2L}.\sin x_1 - 0.5X_4^2.\sin 2x_1 - \frac{3f_a}{m.L^2}.X_2 + \frac{3\tau_a}{m.L^2}.i_a$$

$$X'_3 = X_4$$

$$X_4' = -X_2.X_4 \cot g\theta - \frac{3f_e}{m.L^2.\sin\theta}.x_4 + \frac{3\tau_e}{m.L^2.\sin x_1}.ie$$

As you see the anti aircraft is a 4 degree system with two inputs and two outpots.

In this system the tachometer transfer function is as in the form of equation(5).

$$H_t(s) = \frac{\omega_t^2}{s^2 + 2\xi_t\omega_t + \omega_t^2} \qquad (5)$$

$$\omega_t = 2\pi(150) \qquad \xi_t = 0.7$$

The friction model that has been used has difrentioal equation in the form of equation(6).

$$\frac{d\tau_f}{dt} = \frac{d\theta_{Rel}}{dt}.\gamma.[(\tau_f)(\text{sgn}(\theta'_{Rel}) - \tau_{f0})]^2 \qquad (6)$$

$$\tau_{f0} = 0.5\max(\tau_f)$$

That τ_f is friction torque, θ_{Rel} is relative rotational speed between base and gun and t is reagent time. γ is a factor that show maximum curve ramp of τ_f and it is related to the material of contacte surface.

Controlers

Tracker fuzzy controller

In this section infact we have worked on a system with out platform consideration. We want to control a fixed anti aircraft. our opration criteria are error and variations of error in the tracking loop,Based on a trial and error method[1,2].The tracker controller rule base was determinate.This has been done according to the global knowledge about this system.

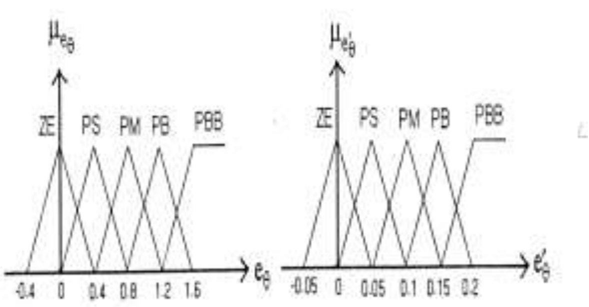


Fig.2. membership functions of vertical angle error and error variations

Membership functions that we have choosed for this refrence sets are all triangle type. For tracking error and error changes of vertical angle 5 linguistic variables are defined.this 5 variables are defined on the reference set e_θ, e'_θ are:

ZE = zero
PS = positive and small
PM = positive and medium
PB = positive and big
PBB = positive and very big

Membership functoins of error and error variations of vertical angle are shown in figure(2).

Therefore we have 25 control rules that shown in table(1).In the otherhand output of fuzzy controller for control the vertical angle is I_a that it is the current of armicher of the motor for control the vertical angle (θ).

According to motor's behavior 6 linguistic variables as follows are defined on the Ia reference set:

ZE = zero
PSS = positive and very small
PS = positive and small
PM = positive and medium
PB = positive and big
PBB = positive and very big

Table.1.rule base for vertical angle control

error	variations of error				
	ZE	***PS***	***PM***	***PB***	***PBB***
ZE	ZE	PSS	PSS	PS	PB
PS	PS	PS	PS	PM	PM
PM	PM	PM	PM	PB	PB
PB	PB	PB	PB	PB	PBB
PBB	PBB	PBB	PBB	PBB	PBB

Similary rule base for angle tracking loop control $(\phi)$is determined. Here also membership functions are triangular type and again 5 linguistic variables for reference sets e_ϕ, e'_ϕ are determined:

N = negative
ZE = zero
PS = positive and small
PM = positive and medium

ISSN: 2277-9655
Scientific Journal Impact Factor: 3.449
(ISRA), Impact Factor: 1.852

PB = positive and big

That are shown in the table(2).
In the same way fuzzy controller output of this loop is Ie that is current motor's armature for control the lateral angle that 7 linguistic variables are defined on its reference sets:

N = negative
NZ = negative and nearby zero
ZE = zero
PZ = positive and nearby zero
PS = positive and small
PM = positive and medium
PB = positive and big

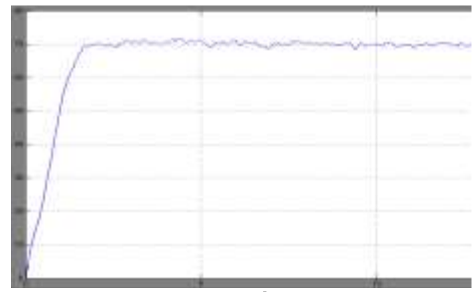
Table 2.rule base for lateral angle control

error	**variations of error**				
	N	***ZE***	***PS***	***PM***	***PB***
N	N	N	N	ZE	ZE
ZE	NZ	ZE	ZE	PZ	PZ
PS	PZ	PS	PS	PS	PM
PM	PS	PS	PM	PM	PM
PB	PM	PM	PB	PB	PB

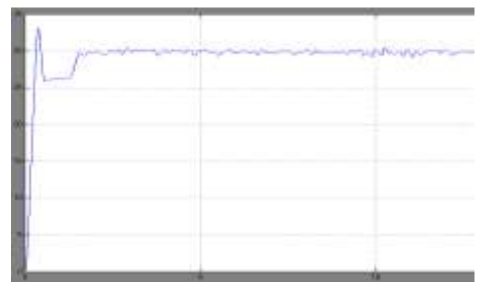
Stabilizer fuzzy controler

The ship angular movements are decomposed into vertical angle and lateral angle(θ,ϕ)[5,6]. These two will be mesured by ship horizontal gyroscope.In the simulation these two components be assumed two quite seperated random variables.According to the military crafts power spectrum dencity of this random variable can be reagent noise source of this components $\theta_{Base},\phi_{Base}$.in the worst conditions create 12(deg/sec)to 15 (deg/sec) in the ship position. Here also we use the error and error changes for rules regulation. Fuzzy rule for correction the lateral angle Ie is as below:

If e_t is ZE , e'_t is ANY Then Ia is ZE
If e_t is PB , e'_t is PB Then Ia is NB
If e_t is PM , e'_t is ANY Then Ia is NM
If e_t is PS , e'_t is PS Then Ia is NS
If e_t is NS , e'_t is PS Then Ia is ZE
If e_t is NM , e'_t is PM Then Ia is PS
If e_t is NB , e'_t is NB Then Ia is PB
If e_t is NB , e'_t is NS Then Ia is PM

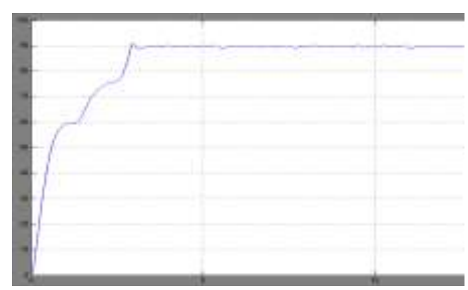


Phi

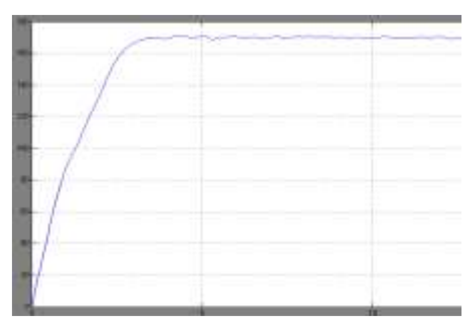


teta

Fig.5. system response with controlers for
$\theta = 30°, \phi = 70°$



teta



Phi

Fig.5. system response with controlers for
$\theta = 90°, \phi = 170°$

If e_t is NB , e'_t is PB Then Ia is PS

ISSN: 2277-9655
Scientific Journal Impact Factor: 3.449
(ISRA), Impact Factor: 1.852

And also fuzzy rules to correct the vertical angle is:

If ep is ZE , e'p is any Then Ia is NB
If ep is NB , e'p is any Then Ia is PB
If ep is PM , e'p is any Then Ia is NM
If ep is NM , e'p is any Then Ia is PM

System response with controlers for the moment position is shown in figure(5).
It is seen that the responses of tracking the given angles with negligible error. Also for moment position the system respons with controlers shown in figure(6).

Conclusion

In this simulation clearly it was seen that with forced constant torque of motor to gun the vertical angle will increase partly. After that the equilibrium between resistant and motive torque was created,in the specified point amount of vertical angle reach to a steady state. As well as this system is nonlinear
And nontimeinvariant.because the amount of nonlinearity is rather high thus the use of the classic controller for control
the movable type will be difficult. But with fazzy control we can control it by suitable way.

References

1. T.H Lee and H.K Lam,“A practical fuzzy logic controller for the path tracking of wheeled mobile robots”, Control Systems, IEEE, Vol:23,2003, Page(s): 60-65, Digital Object Identifier: 10.1109/MCS.2003.1188772
2. C.H.Chang and F.-H.Huang,. J.Y Cheung, “Design of a fuzzy controller using input and output mapping factors”, IEEE Trans Antennas and Propagation, Vol. 21, No. 5, pp. 952-960, 1991.
3. D. burkhart and p.p. Bunissone, “Automated fuzzy knowledge base generation and tuning” ,IEEE International Conference on fuzzy Systems, 179 – 188, 1992.
4. J.lee., “On methods for improving performance of PI-type fuzzy logic controllers”IEEE Trans Antennas and Propagation, Vol. 1, No. 4, pp. 298-301, 1993.
5. Y.Moon Park.,“A self-organizing fuzzy logic controller for dynamic systems using a fuzzy auto-regressive moving average (FARMA) model ”IEEE Trans Antennas and Propagation, Vol. 3, No. 1, pp. 75-83, 1995
6. I.H Altas," “A fuzzy logic controlled tracking system for moving targets”", Intelligent Control, 1997. Proceedings of the 1997 IEEE International Symposium on Publication, Page(s): 43-48, 1997.
7. Chun-Fei Hsu and Yi-Jen Mon,“ Self-organizing fuzzy learning CLOS guidance law” ,designAerospace and Electronic Systems, IEEE Transactions on, Volume: 39 , Issue: 4, Page(s): 1144 – 1151, 2003.

Author Biblography

Mohsen bazvand
Masters of Electrical Engineering in control Field and faculty member of Islamic Azad university branch of kouhdasht.
Email:
ms.bazvand@gmail.com