American Journal of Engineering Research (AJER)
e-ISSN: 2320-0847 p-ISSN : 2320-0936
Volume-10, Issue-8, pp: 51-68
www.ajer.org
Research Paper Open Access

The Importance of Network Security in Control System with PID Controller

Lecturer, Tarek Ibrahim H. Melad,
Training Management of Libyan Army

ABSTRACT
The network security is very important in control systems which are, generally speaking, constructed from three units, the missile flight control structure, the target tracking structure, and the guidance law. The planned homing technology is capable of pursuing and striking any target actually by defining the rocket flight time demanded. In our thesis, we are dealing with the general concept of homing guidance systems, types of navigation systems, and the simulation of different models with three different inputs as sight angles. The main calculation is done to find the miss distances in meter (m) and acceleration demands in (m/s^2) with deferent target accelerations (non-maneuvering and maneuvering target) with deferent homing head error to find the optimal stabilization of homing head guidance by using PID controller and gyros as rate gyro or free gyro models, and makes comparison between all results to get the best performance from control parameters point view. The simulation of homing scenario with proportional navigation, comparisons have been prepared to evaluate proposed control and stabilization system relative to an ideal homing loop guidance system. SIMULINK and Mat Lab software's are used to simulate the processes of the homing guideline assembly in deferent structures with deferent targets parameters. The simulation results show the precision and performance of the guided-missile system using a proportional navigation system by applying a PID controller with a different mode of gyros. Finally, as described in this paper the improvement of the Performance of a Homing-Head control system Used for the Proportional Navigation Method with a PID controller has been done concerning to the previous simulation results and making comparing the results.

KEYWORDS: *network security, proportional navigation homing head, guidance, rate gyro, free gyro, and PID controllers. SIMULINK and Mat Lab software's are used for simulations.*

Date of Submission: 18-07-2021 Date of acceptance: 03-08-2021

I. PERFORMANCE SIMULATIONS IN INFORMATION SECURITY SYSTEM

The task

The task aims to make simulation of proportional navigation homing head guidance using (PN) of an ideal homing loop(with differential), structure (1) and structure (2), as head stabilization and to make comparison between all of it, in the miss distances in meter(m) and an acceleration demands in (m/s^2) with deferent target accelerations (non- maneuvering and maneuvering target) with different homing head error as sight angle with proper types of controller (P,PI,PID) for structure (1) and structure (2) by using Mat Lab and Simulink software's.

Derivation of Pitch Angle (θ)

To find the transfer function of pitch angle witch used in structure 2, we have to lock about the transfer functions characterizing longitudinal motion as represented in the equations below:-

The transfer functions characterizing longitudinal motion.

$$\frac{\Delta \vartheta}{\Delta \delta_V}(s) = G_\delta^\vartheta(s) = \frac{K(T_1 s + 1)}{s(T^2 s^2 + 2\zeta T s + 1)} \quad \text{............. (1)}$$

$$\frac{\Delta \Theta}{\Delta \delta_V}(s) = G_\delta^\Theta(s) = \frac{K}{s(T^2 s^2 + 2\zeta T s + 1)} \quad \text{............. (2)}$$

$$\frac{\Delta \alpha}{\Delta \delta_V}(s) = G_\delta^\alpha(s) = \frac{K T_1}{(T^2 s^2 + 2\zeta T s + 1)} \quad \text{............. (3)}$$

$$\frac{\Delta n_z}{\Delta \delta_V}(s) = G_\delta^{n_z}(s) = K\frac{V}{g}\frac{1}{(T^2 s^2 + 2\zeta T s + 1)} \quad \text{............. (4)}$$

By dividing eq. (4) and eq. (1)

The obtained transfer function represents the pitch angle and equal $= \frac{1}{v}\left(\frac{T1\,s+1}{s}\right)$.

In the simulation model is used as appeared in structure = $\frac{1}{vm}\left(\frac{Tm\,s+1}{s}\right)$ .... (5)

Closing velocity can be approximated as:

$vc = Vm \pm vt$ .... (6)

General Assumption of Simulation Parameters

Missile velocity v_m= 300 m/s. , closing velocity v_c= 600 m/s.

Flight time (t_F) = 10 second. T_m =1 sec., navigation constant (N-prime) =3.

acceleration demands of target (nt) (nt_1= 0 , nt_2 = 2 , nt_3 = 4).

Homing head errors (He) are (He1=0, He2= 0.1, He3= 0.17) in radian.

The Network Security Homing Guidance Systems

The network security systems in simulation of the ideal homing loop

Proportional navigation with an ideal homing loop is displayed in fig. (1) and fig. (2)

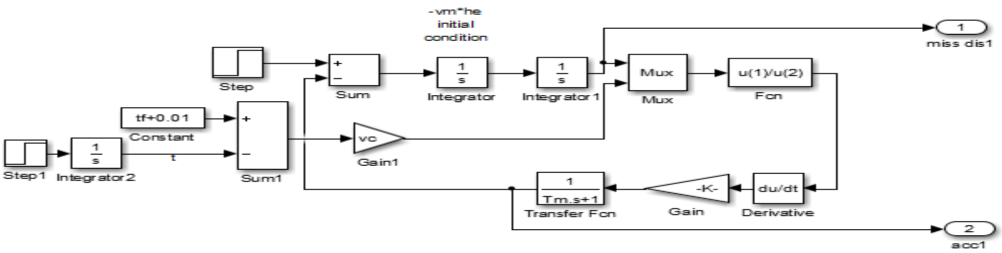

Fig.1: Proportional navigation an ideal homing loop

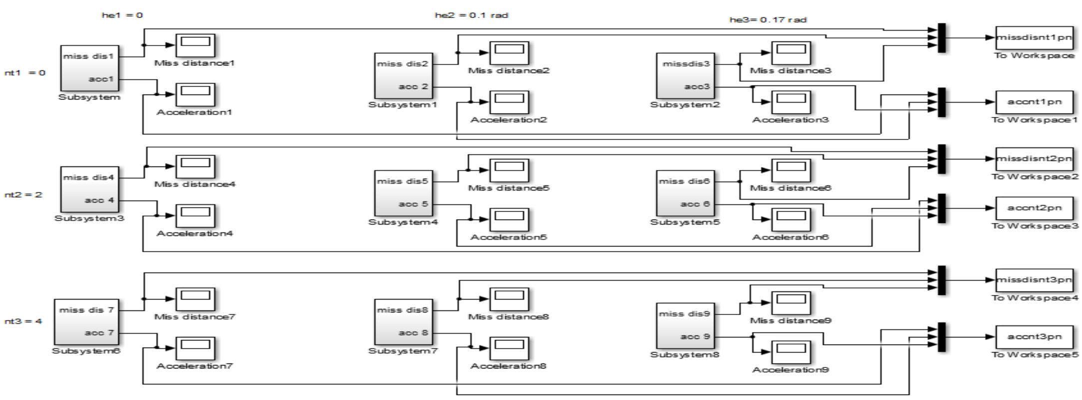

Figure2: Full Simulink diagram of proportional navigation an ideal homing loop

The simulation results of PN the ideal homing loop

- The miss distance(m) with nt = 0 and, He (0, 0.1, 0.17) in radian as seen in figure(3)

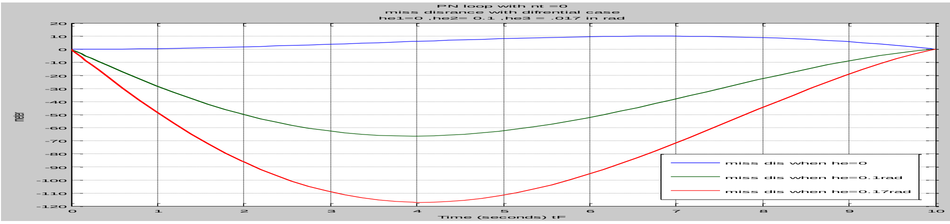

Figure 1: Miss distance(m), nt = 0, He (0, 0.1, 0.17) of an Ideal homing loop.

- The acceleration demands(m/s^2) with nt = 0 and He (0, 0.1, 0.17) in radian, as exposed in figure(4)

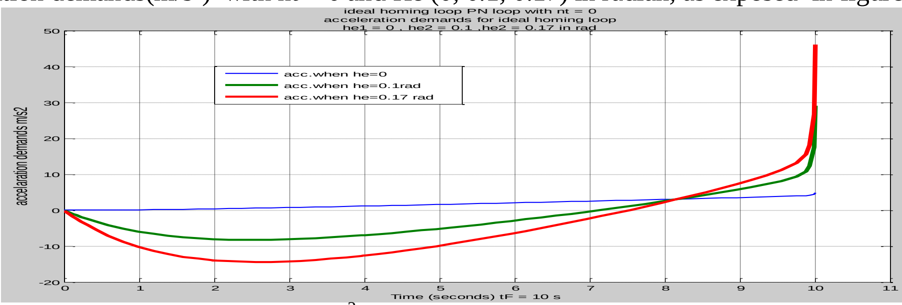

Figure 2: Acc. demands (m/s^2), nt = 0. He (0, 0.1, 0.17) of Ideal homing loop.

Table (1) shows the comparing between main parameters ,when the target acceleration (nt = 0) and head error has He = (0, 0.1, 0.17) in radian.

Table: 1: Miss-distance and acc. demands, nt = 0 with different He, at ideal loop

nt = 0	Miss distance	Peak value of miss.dis	Time of Max. miss dis	Acc. at the end
He_1 = 0	0.076 m	10 m	6.7 s	4.925 m/s^2
He_2= 0.1 rad	0.066m	66.43 m	4 s	29.15 m/s^2
He_3 =0.17 rad	0.058m	117.15 m	4 s	46.1 m/s^2

- The miss distance (m) with nt = 2 , (maneuvering target), and He = (0, 0.1, 0.17) in radian as displayed in figure (5)

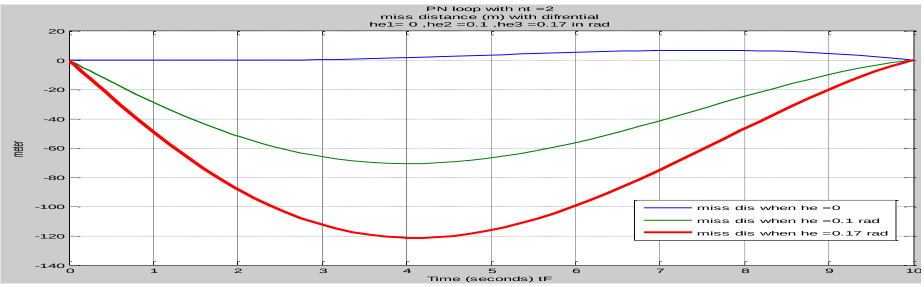

Figure 3: Miss distance(m), nt =2, He (0, 0.1, 0.17) of Ideal homing loop

The acceleration demands(m/s^2) with nt = 2 and He = (0, 0.1, 0.17) in radian. Figure(6) is displayed the results of the simulation.

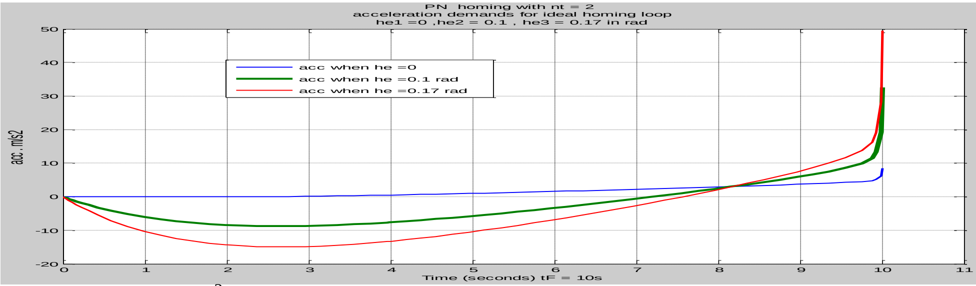

Figure 4: Acc. demands(m/s^2), nt = 2. He (0, 0.1, 0.17) of Ideal homing loop. Table(2) shows the comparing between main parameters, when the target acceleration (nt = 2) and head error has (He1 = 0 , He2 = 0.1 rad , He3 = 0.17 rad).

Table: 2: Miss-distance and acc. demands, nt= 2 with different He, at ideal loop

nt = 2	Miss distance	Peak value of miss.dis	Time of Max.miss dis	Acc. at the end
He_1 = 0 rad	0.086m	6.86 m	7 s	8.41 m/s^2
He_2= 0.1 rad	0.076m	70.65 m	4 s	32.52 m/s^2
He_3 =0.17 rad	0.068m	121.37 m	4 s	49.5 m/s^2

- The miss distance(m) with nt = 4 (maneuvering target) and, He = (0, 0.1, 0.17) in radian, as displayed in figure (7).

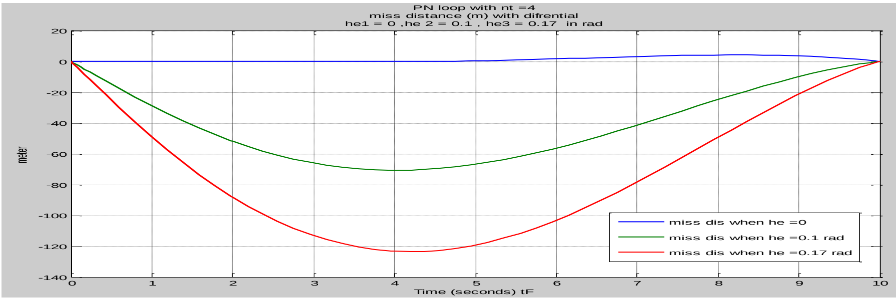

Figure 5: Miss distance(m), nt = 4, He (0, 0.1, 0.17) of Ideal homing loop

- The acceleration demands(m/s^2) with nt = 4 and He = (0, 0.1, 0.17) in rad.
  Figure(8) shows the simulations

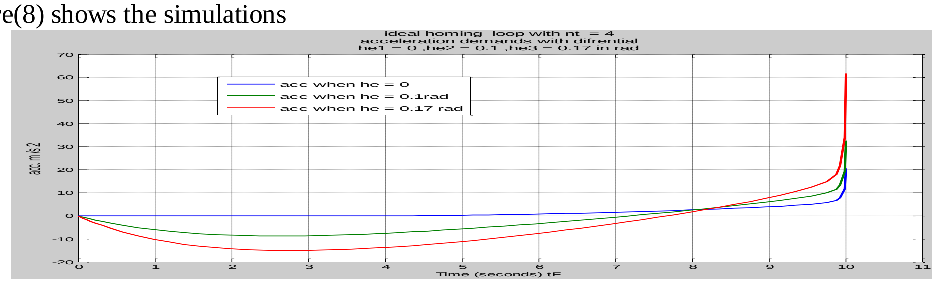

Figure 6: Acceleration demands, nt = 4. He (0, 0.1, 0.17) of Ideal homing loop.

Table(3) shows the comparing between main parameters ,when the target acceleration (nt = 4) and different head error

nt = 4	Miss distance	Peak value of miss. dis	Time of Max. miss dis	Acc. at the end of t_F
He_1 = 0 rad	0.144m	4.884 m	8.2 s	20.52 m/s^2
He_2= 0.1 rad	0.134m	70.646 m	4 s	44.73 m/s^2
He_3 =0.17 rad	0.128m	123.5m	4.2 s	61.6 m/s^2

Table: 3: Miss-distance and acc. demands, nt= 4 with different He, at the ideal loop

Simulation of Proportional navigation homing guidance with rate gyro and PI controller as stabilization of homing head for Structure 1

The figure(9) and figure(10) shown that.(Structure 1).

The value of controlers are :- P controller =1.31827 and I controller = 11.153057

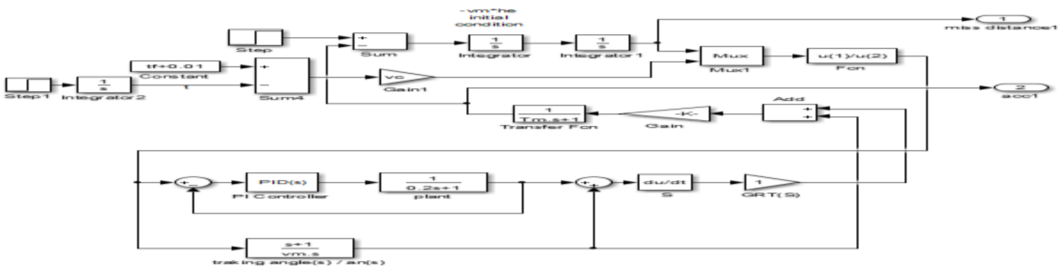

Figure 7: Structure 1

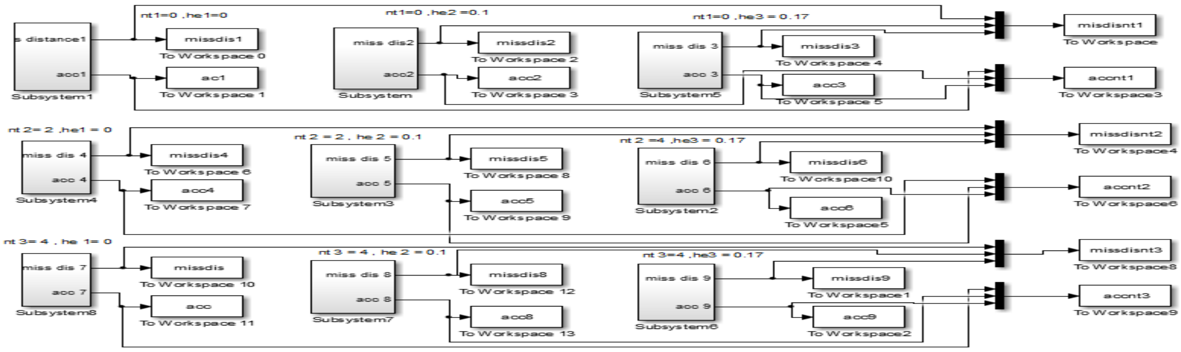

Figure 8: Simulink diagram of PN with rate gyro and PID controller .Structure 1

The simulation results of structure 1

- The miss distance (m) with nt = 0 and He = (0, 0.1, 0.17) in rad as shown in figure(11)

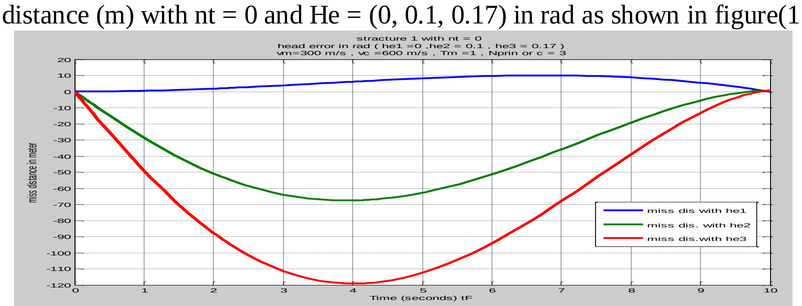

Figure 9: Miss distance (m), nt = 0 ,deferent Head errors , structure 1

- The acceleration demands(m/s^2) with nt = 0 and, He (0, 0.1, 0.17) in rad. The resultes are displayed in figure(12)

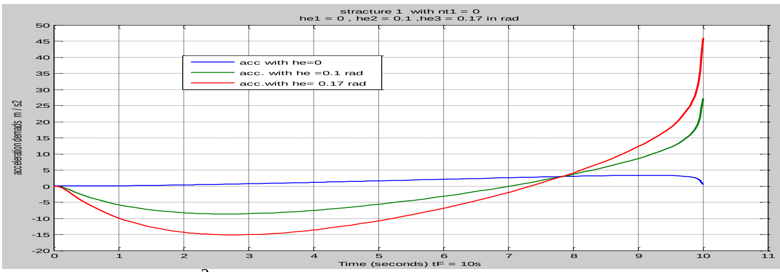

Figure 10: Acceleration demands(m/s^2), nt = 0 deferent Head errors , structure 1 Table(4) shows the comparing between main parameters ,when the (nt = 0) and head error has (He1 = 0 , He2 = 0.1 rad , He3 = 0.17 rad).

Table: 4: Miss-distance and acc. demands, nt = 0 , different He, at structure 1

nt = 0	Miss distance	Peak value of miss. Dis	Time of Max. miss dis.	Acc. at the end
He_1 = 0 rad	0.0427m	10.093 m	6 .8 s	0.505 m/s^2
He_2= 0.1 rad	0.4656m	67.59 m	4 s	27.258 m/s^2
He_3 =0.17 rad	0.82m	119.12 m	4 s	45.98 m/s^2

- The miss distance (m) with nt = 2 and, He (0, 0.1, 0.17) in radian. The simulation results are performed in figure(13).

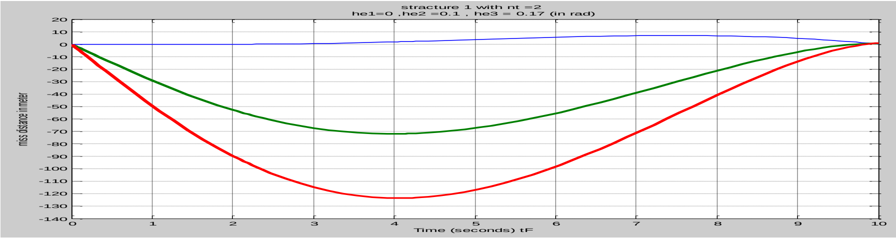

Figure 11: Miss distance (m), nt = 2 deferent Head errors, structure 1.

- The acceleration demands(m/s^2) with nt = 2 and, He (0, 0.1, 0.17) in radian, Figure(14) display that.

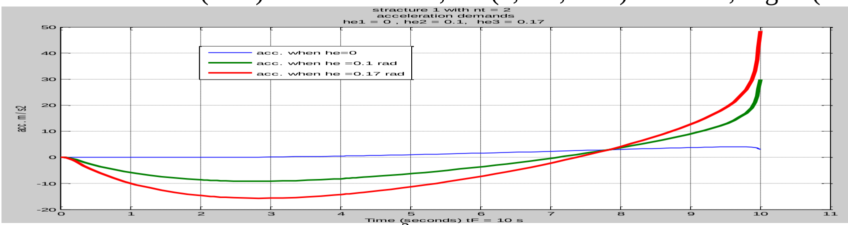

Figure 12: Acceleration demands(m/s^2), nt = 2 deferent Head errors, structure 1.

Table(5) shows the comparing between main parameters ,when the target acceleration (nt = 2) and head error has (He1 = 0 , He2 = 0.1 rad , He3 = 0.17 rad).

Table: 5: Miss-distance and acc. demands, nt = 2 with different He, at structure 1

nt = 2	Miss distance	Peak value of miss. Dis	Time of Max. Miss. Dis	Acc. Demands in the end
He_1 = 0 rad	0.012m	7 m	7.4 s	3.03 m/s^2
He_2= 0.1 rad	0.52m	71.5 m	4.2 s	29.75 m/s^2
He_3 =0.17 rad	0.875m	123.5 m	4 .04s	48.5 m/s^2

- The miss distance (m) with nt = 4 (maneuvering target) and He = (0, 0.1, 0.17) in radian, as shown in figure (15)

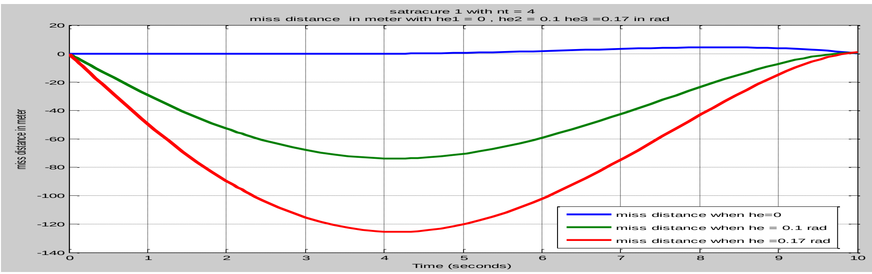

Figure 13: Miss distance (m), nt = 4, deferent Head errors, structure 1.

- The acceleration demands(m/s^2) with nt = 4 and, He = (0, 0.1, 0.17) in rad. as displayed in figure (16)

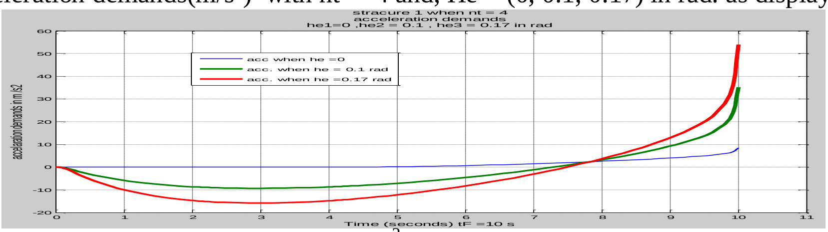

Figure 14: Acceleration demands (m/s^2), nt = 4. deferent Head errors, structure 1

Table(6)] shows the comparing between main parameters ,when the (nt = 4) and head error has (He1 = 0 , He2 = 0.1 rad , He3 = 0.17 rad)

Table: 6: Miss-distance and acc. demands, nt = 4, different He, at structure 1

nt = 4	Miss distance	Peak value of miss. Dis	Time of Max. miss dis.	Acc. at the end of t_F
He_1 = 0 rad	0.159m	4.45m	8 s 0f t_F	8.45 m/s^2
He_2= 0.1 rad	0.665m	73.1843 m	4.15 s	35.2 m/s^2
He_3 =0.17 rad	1.02m	125.5 m	4.2 s	53.93 m/s^2

Simulation of Proportional navigation homing guidance with free gyro and P controller for stabilization of homing head. Structure 2

The figure (17) and figure (18) represents (structure (2).The type of controller which is used for the simulation of structure (2) is P controller tuned and equal **(1.567231).**

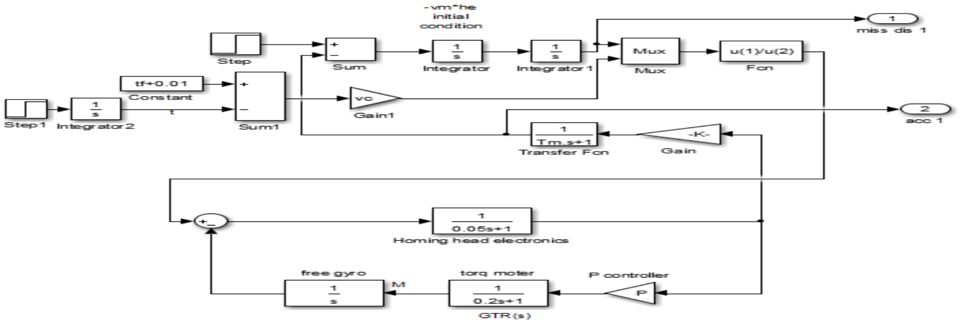

Figure 15: Block diagram of PN homing with free gyro. Structure 2

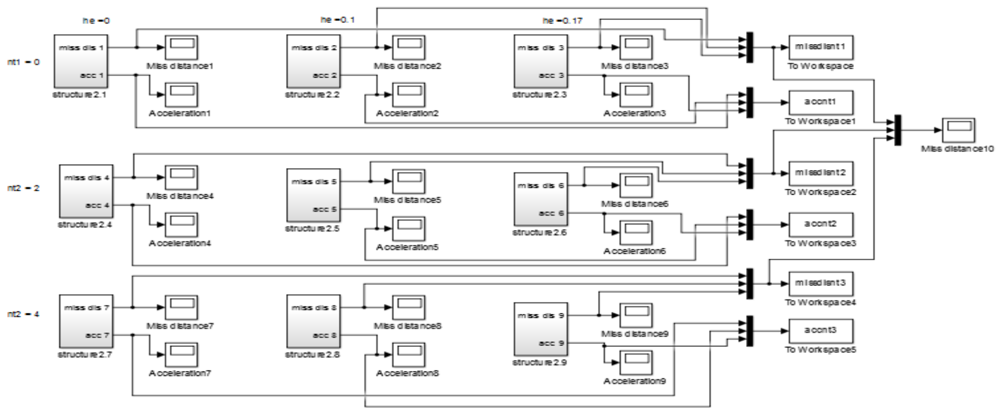

Figure 16: Simulink diagram of PN homing loop.Structure 2

❖ The simulation results of structure 2

- The miss distance(m) with nt = 0 and He = (0, 0.1, 0.17) in radian, as shown in figure(19).

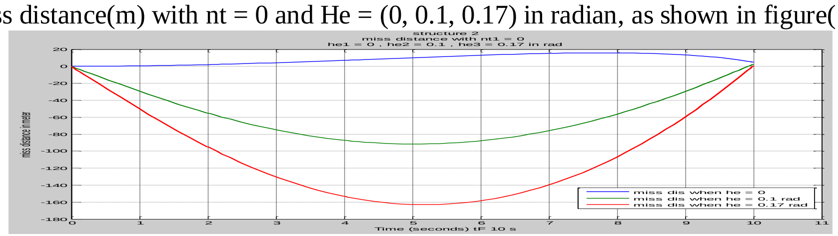

Figure 17: Miss distance (m), nt = 0, deferent Head errors, structure 2.

- The acceleration demands(m/s^2) with nt = 0 and He = (0, 0.1, 0.17) in rad as displayed in figure(20).

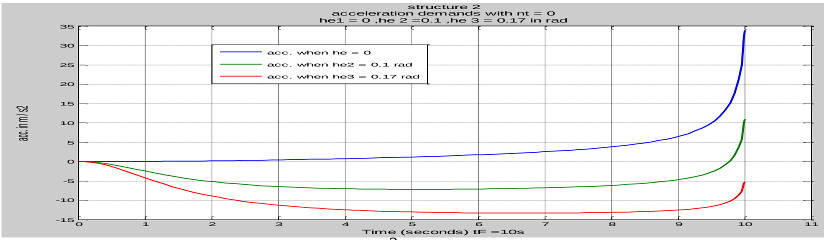

Figure 18: Acceleration demands(m/s^2), nt = 0, deferent Head errors, structure 2

Table(7) shows the comparing between main parameters ,when the target acceleration nt = 0, and head error ,(He1= 0, He2= 0.1, He3= 0.17) rad

Table: 7: Miss-distance and acc. demands, nt= 0 , different He, at structure 2

nt = 0	Miss distance	Peak value of miss. Dis	Time of Max. Miss. dis.	Acc. at the end of t_F
He_1 = 0 rad	4.847m	15.8 m	7.71s	33.93 m/s^2
He_2= 0.1 rad	2.3547m	91.65 m	4.9969 s	10.91 m/s^2
He_3 =0.17 rad	0.6047m	16.14593 m	5.1331 s	5.2 m/s^2

- The miss distance (m) with nt = 2 and He = (0, 0.1, 0.17) in rad .as in figure(21)

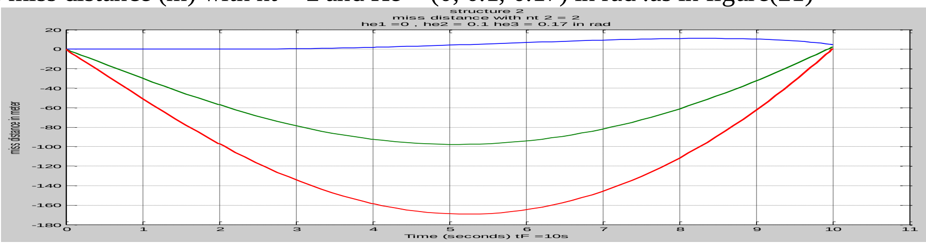

Figure 19: Miss distance (m), nt = 2, deferent Head errors, structure 2

The acceleration demands (m/s^2) withnt = 2 and He = (0, 0.1, 0.17) in radian, as displayed in figure (22)

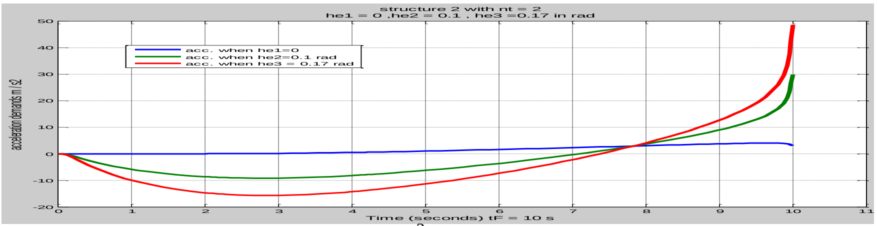

Figure 20: Acceleration demands(m/s^2), nt = 2, deferent Head errors, structure 2.

Table(8) shows the comparing between main parameters ,when the target acceleration (nt = 2) and head error has (He1 = 0, He2 = 0.1, He3 = 0.17) rad.

Table: 8: Miss-distance and acc. demands, nt = 2, different He, at structure 2

nt = 2	Miss distance	Peak value of miss .dis	Time of Max. miss dis	Acc. at the end of t_F
He_1 = 0 rad	4.645m	11.06 m	8.325 s	32 m/s^2
He_2= 0.1 rad	2.1449m	97.706 m	5.133 s	8.99 m/s^2
He_3 =0.17 rad	0.395m	169.27 m	5.2665 s	$m/s^2$7.128

- The miss distance (m) with nt = 4 (maneuvering target) and He = (0, 0.1, 0.17) in radian, as shown in figure (23)

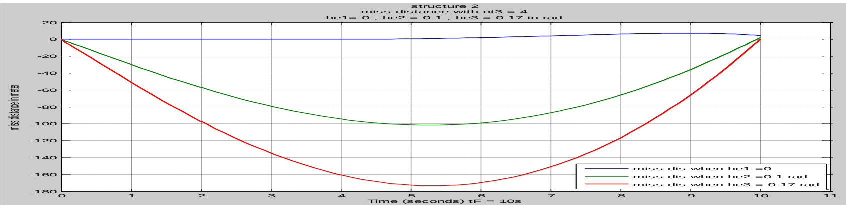
Figure 21: Miss distance (m), nt = 4, deferent Head errors, structure 2

- The acceleration demands (m/s^2) with nt = 4 and He = (0, 0.1, 0.17) in radian, as displayed in figure (24)

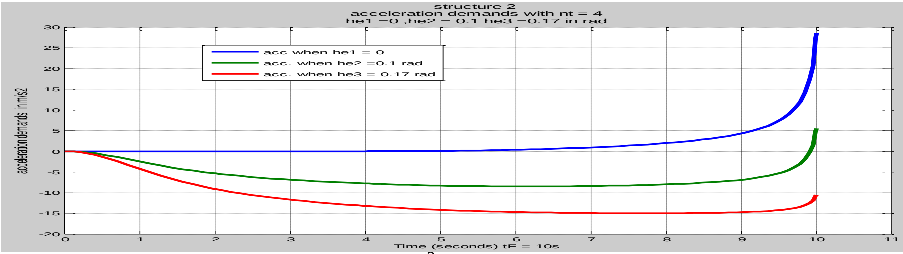
Figure 22: Acceleration demands(m/s^2), nt = 4, deferent Head errors, structure 2

II. CONCLUSION

From the simulations in this paper, we can make a comparison of practical results as the following:
Comparing between the miss distance and acceleration demands for the ideal loop homing case, structure (1) and structure (2) with deferent target acceleration and deferent values of head errors as sight angles.
- When nt = 0 (non-maneuver case), as displayed in Table (9)

Table:9: Simulation results of ideal PN loop, structure 1 and structure 2 at nt = 0

nt = 0	**Miss distance in meter**			**Acceleration demands in m/s^2**		
Head error	**Ideal PN**	**Struc. 1**	**Struc.2**	**Ideal PN**	**Struc. 1**	**Struc. 2**
$He_1 = 0$	0.076	0.0427	4.847	4.925	0.505	33.93
He_2= 0.1 rad	0.066	0.4656	2.3547	29.15	27.258	10.91
He_3 =0.17 rad	0.058	0.82	0.6047	46.1	45.98	5.2

- The case of He_1 = 0 , the minimum miss distance (0.0427m)and minimum acceleration demands (0.505 m/s^2) have occurred with structure (1)
- The case of He2 = 0.1 rad. , the minimum miss distance(0.4656 m) has occurred with structure(1),but minimum acc. demands(5.2 m/s^2) has obtained by structure (2)
- The case of He_3 = 0.17 rad. ,the minimum miss distance(0.6047 m) and minimum acceleration demands (5.2 m/s^2) is obtained with structure (2), where the acceleration demands for the others is high .
- When nt = 2, (maneuver case), as presented in Table(10)

Table: 9: Simulation results of an ideal PN loop, structure 1 and structure 2 at nt = 2

nt = 2	**Miss distance in meter**			**Acceleration demands in m/s^2**		
Head error	**Ideal PN**	**Struc. 1**	**Struc. 2**	**Ideal PN**	**Struc. 1**	**Struc. 2**
$He_1 = 0$	0.086	0.012	4.645	8.41	3.03	32
He_2= 0.1 rad	0.076	0.52	2.1449	32.52	29.75	8.99
He_3 =0.17 rad	0.068	0.875	0.395	49.5	48.5	7.128

- The case of He_1 = 0 , the minimum miss distance(0.012 m) and minimum acceleration demands(3.03 m/s^2) has obtained with structure(1) .
- The case of He_2 = 0.1 rad. , the minimum miss distance (0.5 m) has occurred with structure (1),but minimum acc. demands (8.99 m/s^2) has obtained with structure (2).
- The case of He_3 = 0.17 rad. , the minimum miss distance (0.395 m) and minimum acceleration demands (7.128 m/s^2) is occurred with structure(2), where the acceleration demands for the others is high .
- When nt = 4, (high maneuver case), as presented in Table(11).

Table: 10: Simulation results of ideal PN loop, structure 1 and structure 2 at nt = 4

nt = 4	**Miss distance in meter**			**Acceleration demands in m/s^2**		
Head error	**Ideal PN**	**Struc. 1**	**Struc.2**	**Ideal PN**	**Struc.1**	**Struc. 2**
$He_1 = 0$	0.144	0.159	4.25	20.52	8.45	28.58
He_2= 0.1 rad	0.134	0.665	1.75	44.73	35.2	5.565
He_3 =0.17 rad	0.128	1.02	0.43	61.6	53.93	10 .556

- The case of He1 = 0, the minimum miss distance (0.159 m) and minimum acceleration demands (8.45 m/s^2) has occurred with structure (1) .
- The case of He2 = 0.1 rad. , the minimum miss distance (1.02 m) has occurred with structure (1), but the minimum acc. demands (5.565m/s^2) was occurred with structure (2).
- The case of He3 = 0.17 rad., the minimum miss distance (0.43) which is the best and minimum acceleration demands (10.556 m/s^2) has occurred with structure (2) where the acceleration demands for the others is too high.

Structure (1) :

The proportional navigation homing guidance with rate gyro and PI controller as stabilization of homing head has high performance at all different modes of target acceleration (non maneuver target), where the miss distance and the acceleration demands are acceptable.

Structure (2) :

The proportional navigation homing guidance with free gyro and P controller as stabilization of homing head, has acceptable performance for non maneuver target modes and high performance with maneuver target .
Finally, bout structures can be considered as the best homing guidance models from the performance and the stability point view. and the chosen of one of them is depending on the type of target and its motion characteristics.

Improving the network security systems in performance for previous structures

Simulation of rate gyro and PI used of improvement structure 1

This simulation is done by different values of PI controller's to get best results from miss distance point view for the system have as parameters with different modes of the target moving (non - maneuvering(nt = 0), maneuvering (nt =2) and, high maneuvering (nt = 4) with different values of heading errors (He).

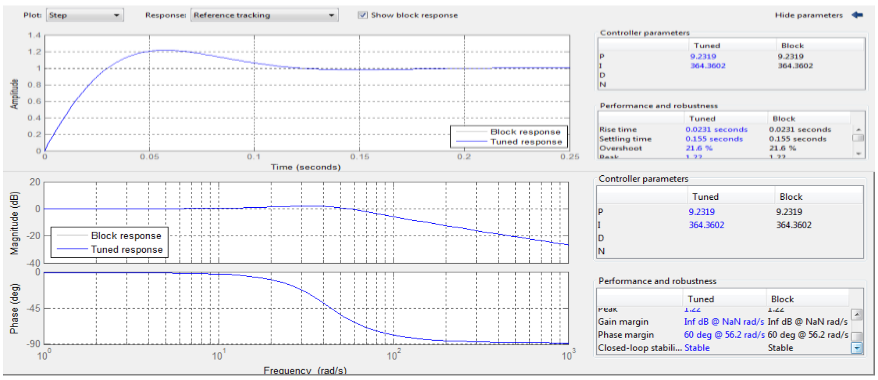

Figure 23: Time and Frequency response of PI controller of structure 1

By tuning of PI controllers, where P = 9.2319 and I = 364.3602 ,the structure 1 can be optimized as shown in the table (12) below.

N prime = 3	Without optimization P= 1.1827 and I = 11.153057		With optimization P =9.2319 and I= 364.3602	
Head error radian (rad)	Miss distance (m)	Acc. demand (m/s^2)	Miss distance (m)	Acc. demand (m/s^2)
nt = 0, He1= 0	0.0427	0.505	0.0056	-3.5812
He2 = 0.1	0.4656	27.258	0.1443	31.2677
He3 = 0.17	0.28	45.98	0.2413	55.6535
nt = 2, He1= 0	0.012	3.03	0.0227	-0.1587
He2 = 0.1	0.52	29.75	0.1709	35.6991

He3 = 0.17	0.875	48.5	0.2745	60.7968
nt = 4, He1= 0	0.159	8.45	0.0793	8.4620
He2 = 0.1	0.665	35.2	0.2208	44.8809
He3 = 0.17	1.02	53.93	0.3197	70.3734

Table: 11: Comparing of miss distance and acceleration demands with N prime =3

Simulation of rate gyro and PID used for improvement with different values of N prime

Figure (26) shows the time and frequency response of PID parameters which used for the compering between the effect of different value of N prime to choose the best behavior of the structure and to make comparing between the all simulation results for the process of improving it.

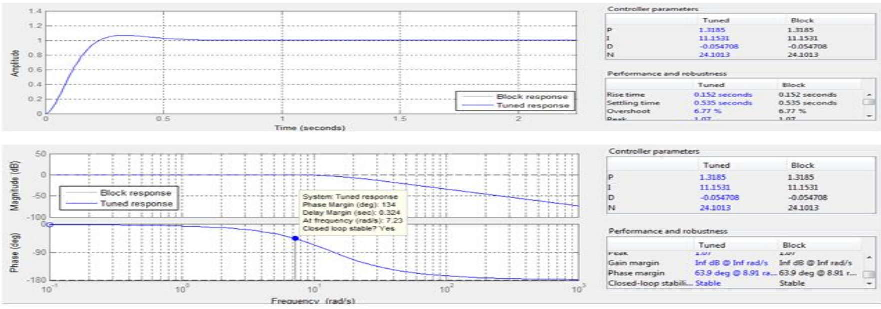

Figure 24 :Time and frequency domain of PID parameters and different values N'

❖ Case 1 at nt = 0

Figure (27) shows the effect of varying N prime on Miss distance (m) and acceleration demands if the he1 =he2 =he3 =0 rad , Tm 1s , vc = 600 m/s , vm = 300 m/s , tf = 10 sec ,nt = 0 as non-maneuvering target.

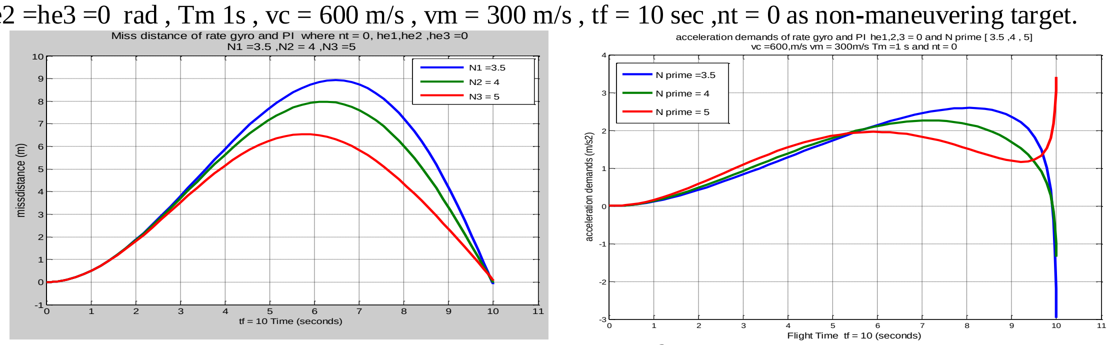

Figure 25: Miss distances and Acc. demands (m/s^2), nt = 0, N'= [3.5 ,4 ,5].he = 0

Figure (27) shows the effect of varying N prime on Miss distance (m) and acceleration demands of structure(1) if the he1 = he2 = he3 = 0.1 rad, Tm 1s , vc = 600 m/s , vm = 300 m/s , tf = 10 sec , nt =0 as non-maneuvering target.

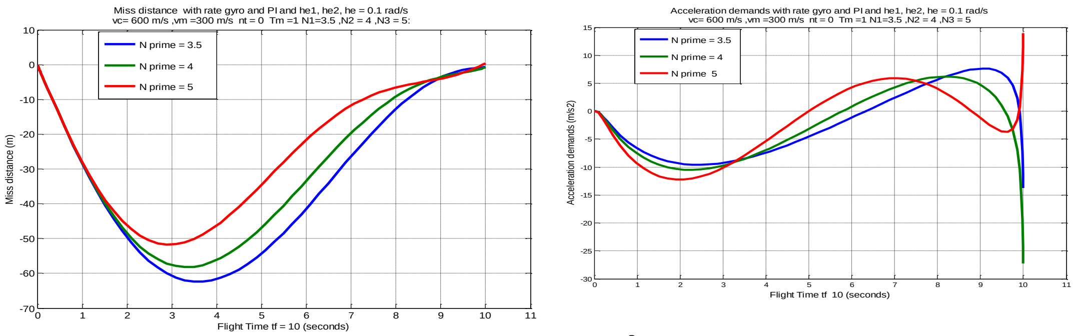

Figure 26: Miss distances and Acc. demands (m/s^2), nt = 0, N'= [3.5 ,4 ,5].he = 0.1rad

Figure (28) shows the effect of varying N prime on Miss distance (m) and acceleration demands of structure(1) if the he1 = he2 = he3 = 0.17 rad, Tm 1s , vc = 600 m/s , vm = 300 m/s , tf = 10 sec. nt = 0 as (non - maneuvering target).

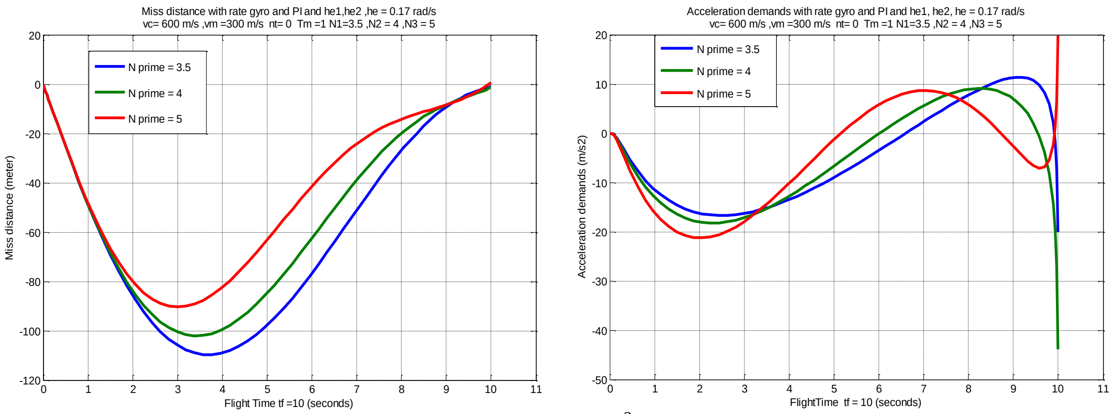

Figure 27: Miss distances and Acc. demands (m/s^2),nt = 0, N'=[3.5 ,4 ,5].he= 0.17 rad

❖ Case 2 at nt = 2 (maneuvering target)

The changing in miss distance (m) and acceleration demands of rate gyro and PI with N prime is and he1 =he2 =he3 =0 rad ,Tm 1s , vc = 600 m/s , vm = 300 m/s , tf = 10 at case of nt =2 , are displayed in Figure (29).

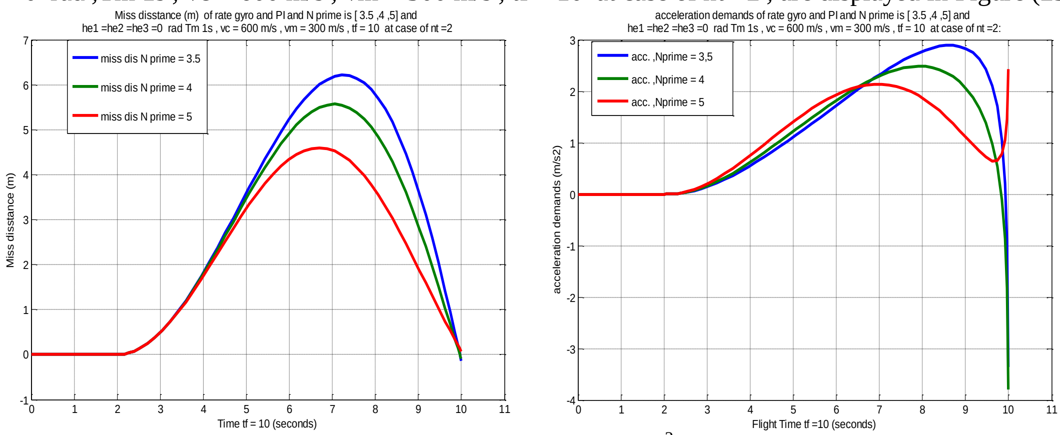

Figure 28: Miss distances (m) and Acc. demands (m/s^2), nt = 2, N'= [3.5 ,4 ,5], he = 0

Figure (30) represent the miss distance (m) and acceleration demands of rate gyro and PI ,if N prime is and he1 =he2 =he3 =0 .1 rad ,Tm 1s , vc = 600 m/s , vm = 300 m/s , tf = 10 as a case of nt =2

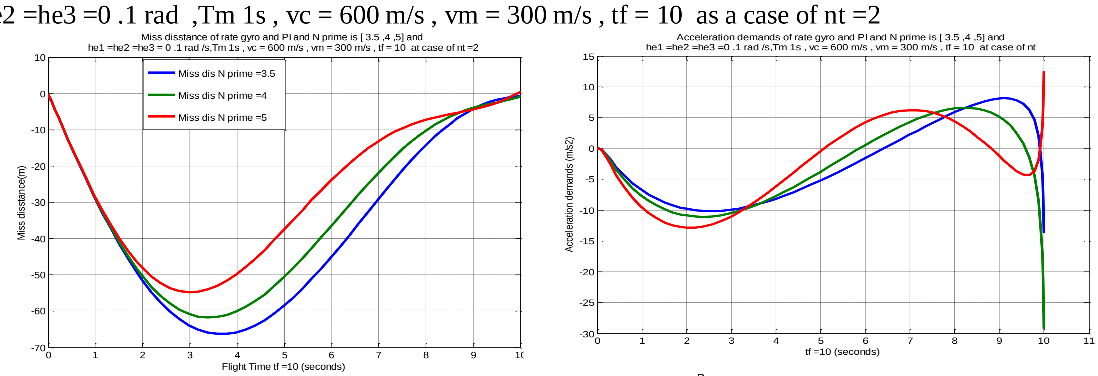

Figure 29: Miss distances and Acc. demands (m/s^2), nt = 2, N'= he=0.1rad

Figure (31) is represent the miss distance (m) and acceleration demands of rate gyro and PI ,if N prime is and he1 =he2 =he3 =0 .17 rad,Tm 1s , vc = 600 m/s , vm = 300 m/s , tf = 10 at case of nt =2.

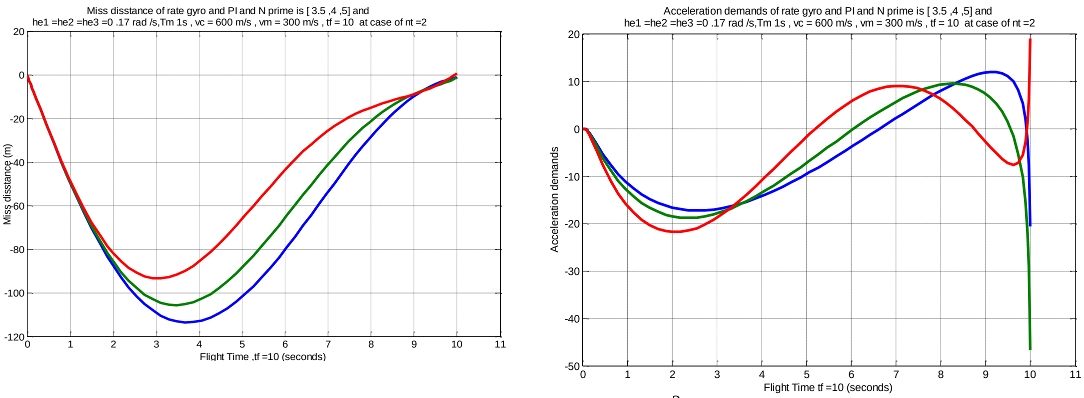

Figure 30: Miss distances and Acc. demands (m/s^2), nt = 2, N'= he=0.17rad

❖ Case 3at nt = 4 as (high maneuvering target)

Figure (32) is represent the miss distance (m) and acceleration demands of rate gyro and PI ,if N prime is and he1 =he2 =he3 =0 ,Tm 1s , vc = 600 m/s , vm = 300 m/s , tf = 10 at case of nt = 4

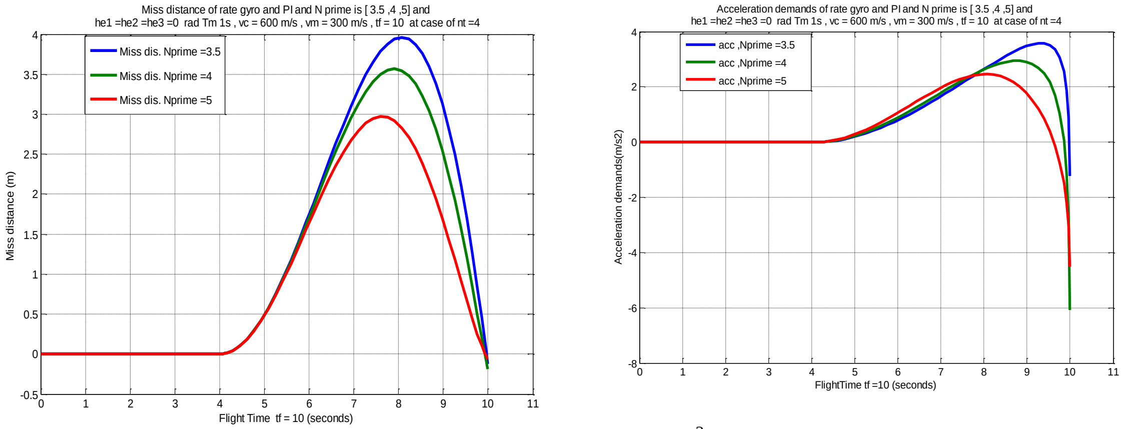

Figure 31: Miss distances and Acc. demands (m/s^2), nt = 2, N'=, he= 0 rad

Figure (33) is represent the miss distance (m) and acceleration demands of rate gyro and PI ,if N prime is and he1 =he2 =he3 =0 .1 rad,Tm 1s , vc = 600 m/s , vm = 300 m/s , tf = 10 at case of nt =4

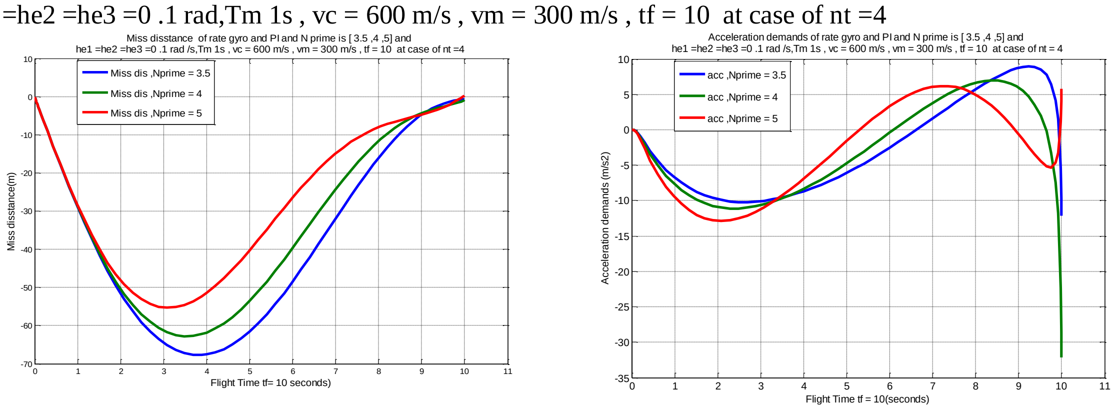

Figure 32: Miss distances and Acc. demands (m/s^2), nt = 2, N'= he=0.1rad

Figure (34) is represent the miss distance (m) and acceleration demands of rate gyro and PI and N prime is and he1 =he2 =he3 =0 .17 rad,Tm 1s , vc = 600 m/s , vm = 300 m/s, tf = 10 at case of nt = 4

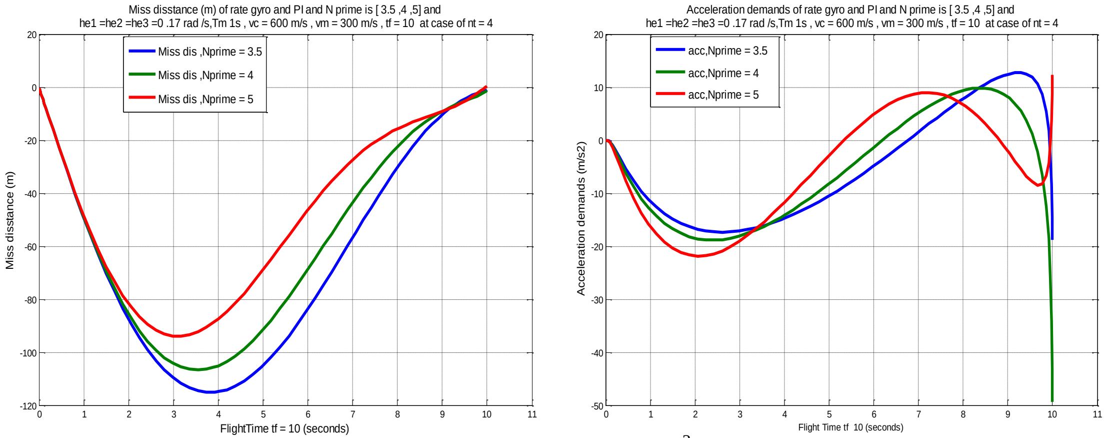

Figure 33: Miss distances and Acc. demands (m/s^2),nt = 2, N'= he=0.17rad.

Improvement of the performance of Structure 1

The improvement is done by chosen new PI parameters which make the miss distance and acceleration demands in optimal condition. In this case the PID parameters are tuned in the model , until the phase margin ,rising time and settling time are in good results at the output of PID controllers due to all conditions and cases for the structure(1) of homing head by using rate gyro and PID controllers, which have same parameters of simulations and velocities, and he1 = 0 , he2 = 0.1,he3 = 0.17 rad, Tm = 1s , vc = 600 m/s , vm = 300 m/s , tf = 10 at case of nt = 0,2,4.e parameters of PID as displayed in table (7.15).

Table:14 : PID parameters used for improvement of structure 1 and N prime =5

P	I	D	Phase margin in deg	Over shoting (%)	Rissing time (sec)	Settling time (sec)
4.1965	8.0179	-0.07	66.3	6.43	0.0551	0.178

Table (14) PID parameters used for different value of N', used for improvement.

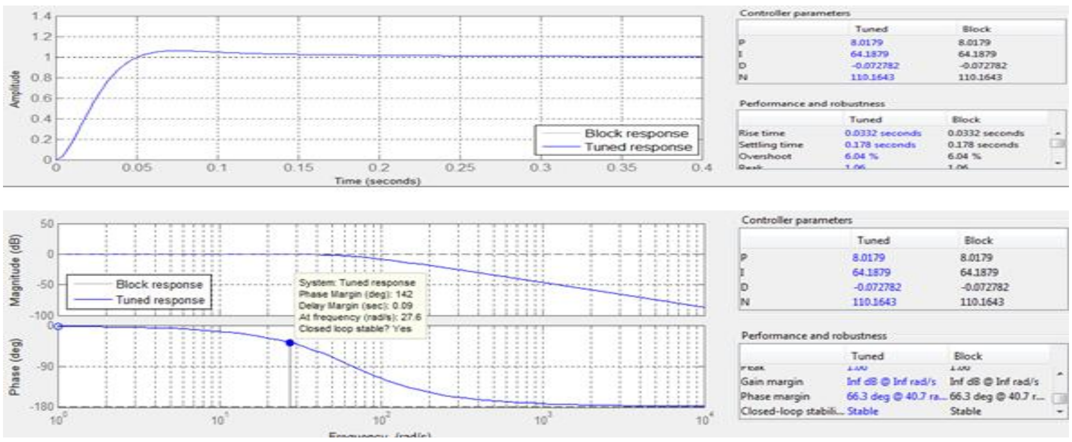

Figure 34: Time and frequency response of PID used for N prime = 5,used for improvement.

❖ Case 1with nt = 0

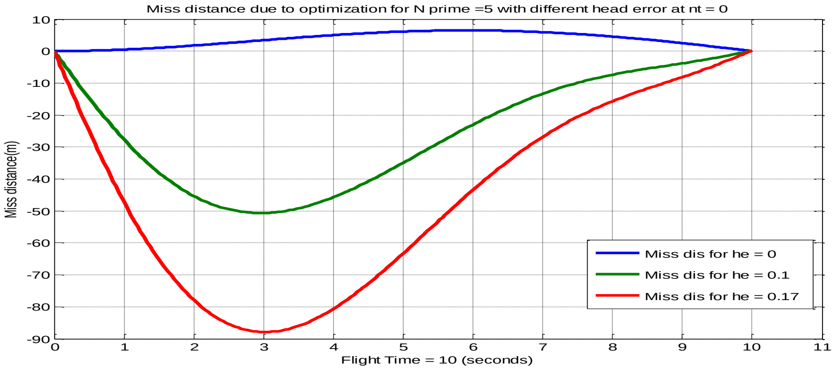

Figure 35: Optimal miss distances nt = 0,N prime =5,with different head errors

❖ Case 2with nt = 2

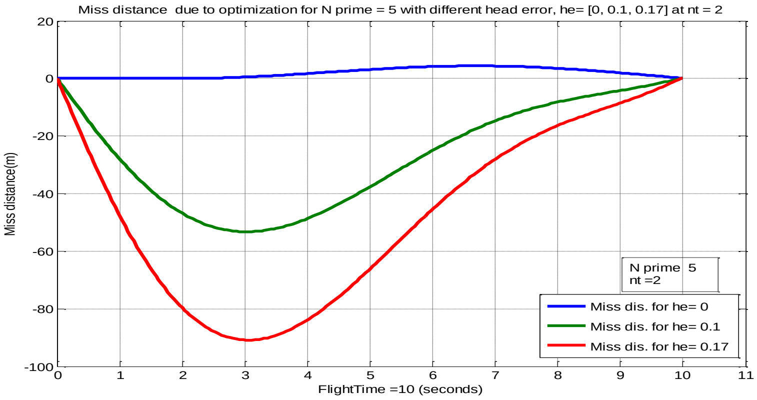

Figure 36: Optimal miss distances nt = 2, N prime =5, with different head errors

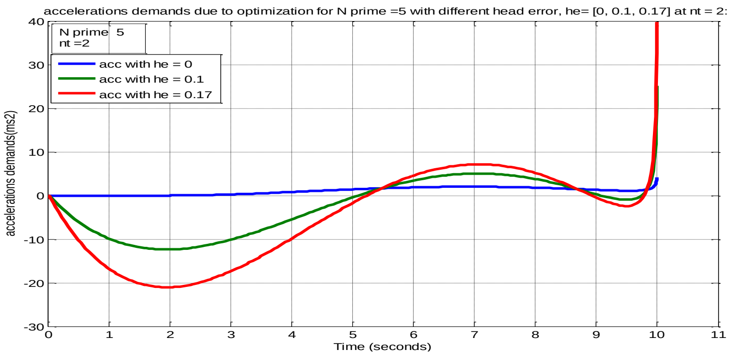

Figure39: Optimal Acc. demands, nt = 2, N prime = 5, with different head errors

- Case 3with nt = 4

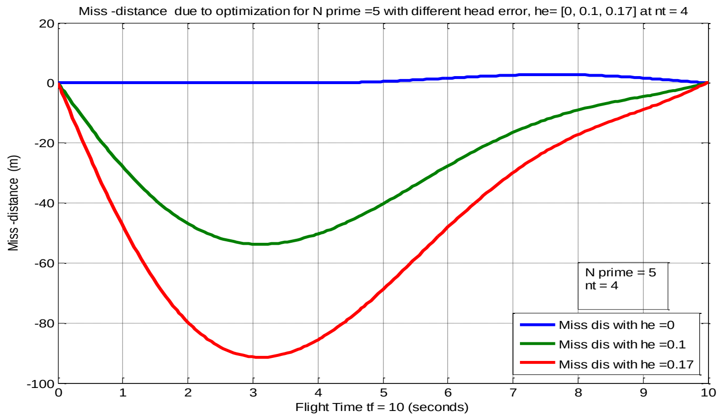

Figure 37: Optimal miss distances nt = 4, N prime = 5, with different head errors.

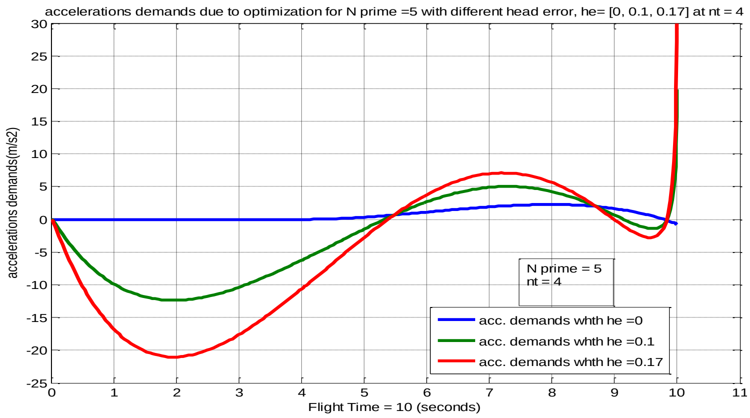

Figure 41: Optimal Acc. demands, nt = 4, N prime =5, with different head errors

- **Comparting results of Nprime = 5**

Table:14: Comparison for structure 1 with and without optimization

Nprime = 5 nt = 0	Miss dis. (m) with optimization	Miss dis. (m) without optimization	Acc. demands m/s^2 with optimization	Acc. Demands m/s^2 without optimization
He1= 0	0.0375	0.0727	4.0309	3.4176
He2= 0.1	0.1222	0.3991	34.2647	13.960
He3= 0.17	0.1849	0.5981	55.4283	19.8089
	N prime =5 ,nt = 2			
He1= 0	0.0406	0.0696	5.2354	2.4293
He2= 0.1	0.1263	0.39427	34.7406	12.4907
He3= 0.17	0.1864	0.5906	55.3955	18.9795
	N =5 ,nt = 4			
He1= 0	0.0096	0.0601	-1.1533	-4.5059
He2= 0.1	0.0954	0.2698	25.3374	5.8122
He3= 0.17	0.1349	0.4633	43.8846	12.3133

- Comparing between N prime = 5 and N prime =3 with optimization.

The table (15) is represented the comparing between N prime =3 and N prime =5 of structure (1) at optimal mode by tuned PI controller parameters as presented.

Table:15: Comparion results of Nprime = [3 and 5] with optimization of structure 1

Structure 1		Optimization of N = 3 P = 9.2319 and I = 364.3602		Optimization of N = 5 P = 9.2319 and I = 364.3602	
Head error radian Nt		Miss distance (m)	Acc. demands (m/s^2)	Miss distance (m)	Acc. demands (m/s^2)
nt = 0	He1= 0	0.0056	-3.5812	0.0375	4.0309
	He2 = 0.1	0.1443	31.2677	0.1242	34.2647

	He3 = 0.17	0.2413	55.6535	0.1849	55.4283
nt = 2	He1= 0	0.0227	-0.1587	0.0406	5.2354
	He2 = 0.1	0.1709	35.6991	0.1263	34.706
	He3 = 0.17	0.2745	60.7968	0.1864	55.3955
nt = 4	He1= 0	0.0793	8.4620	0.0096	-1.1533
	He2 = 0.1	0.2208	44.8809	0.0833	25.3374
	He3 = 0.17	0.3197	70.3734	0.1349	43.8846

The figure (42) is describing the time and frequency domain for PI parameters which used for the optimization of rate gyro with PI controller for homing head stabilization process.

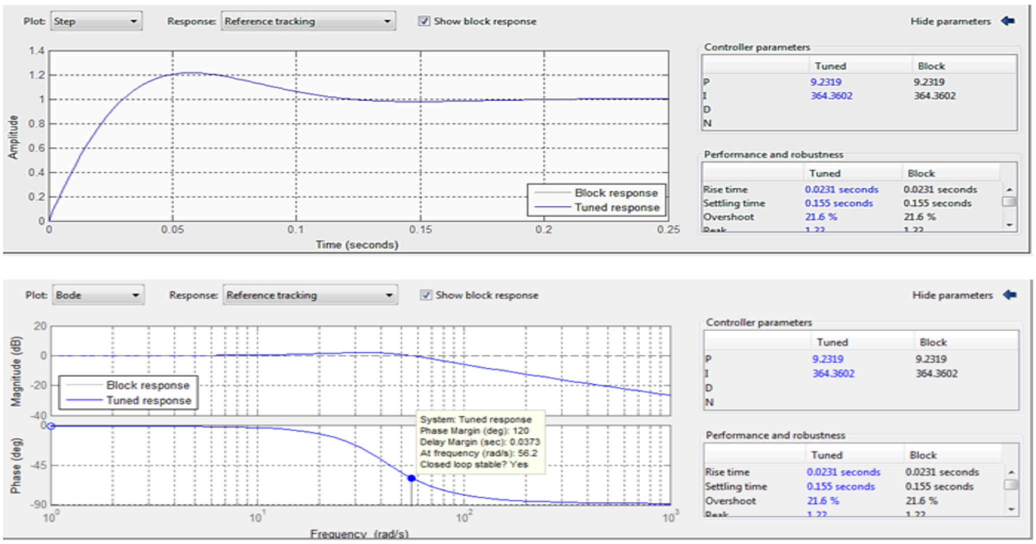

Figure 42: Time and Frequency domain of PI parameters used to improve strucure1

III. CONCLUSIONS

The network security in navigation structure is a critical part of the design of homing missiles and UAVs. It is important to have an on-board navigation algorithm to achieve the final destination under controlling and with high accuracy.

The study presented the importance of network security systems in proportional navigation guidance law and the differential geometry concepts. PN is often used in missiles which are controlled by guidance systems. PN guidance has benefited from the miss distance and lateral acceleration point of view that needed for the projectile, which means both the regular acceleration necessary and the miss distance are comparatively small.

The main goal was to improve the performance of the homing head used proportional navigation method and PID, by tuning of PID controller until got improved results from miss distance and acceleration demands of the missile at the end of flight time to attacks the target. It has proven after many simulations of different structures with different parameters have been done by using appropriate types and values of the PID controller with N prime = 5.

The effective navigation ratio is a very important parameter for modern control systems that used a proportional navigation method for guiding and homing missiles.

The tuning of the PID controllers is important for improving the performance and stability of the homing head due to applying the proportional navigation method to get optimal results of miss distance and acceleration demands at the final destination of the missile to attack the target.

From a practical point of view, it's possible to do the simulation of different structures by using gyros and PID controllers to achieve good results for the stabilization of homing head using PN law.

The improving of homing head missile guidance was done by choosing the appropriate type and value of the PID controller.

Due to the simulation of both structures used for stabilization of homing head, the N prime =5 is compared by N prime =3, and the final results are improved by used N prime = 5, and tuned controllers.

All simulation results are acceptable from electronic, electrical models and mathematical points of view.

It is possible to apply the results in a full homing missile system, but the advanced PN system techniques need more detail, such as estimating the approximate time-to-go and the relative target positions and movements.

Also, the noises must be considering and because of that, some filters must be applied to remove the noises. The Kaman filters often use in the actual missile guidance system.

IV. FUTURE RECOMMENDATIONS

The guidance by using the proportional navigation technique is a wide area for scientific researches and it's a hot topic to improve or to find a new idea which is helping and benefit to upgrade this technology.
The recommendations for future work can be mentioned the following:
This work can be improving by introducing some noises and filters due to the complete missile control model.
May it can use N prime as a varying parameter, which may control by some loop with flight time or velocities to make it varying in time of flight.
For more benefits, it is a better way to make the complete scenario of the actual missile by searchers team and from other branches of engineering and tactical to works as groups or scientific teams to cover all side views.
My hope for future work is to apply the idea of proportional navigation into medical treatment, to attack the diseases, by electronic equipment.
Finally, my recommendation is to use this technique to spread peace in the world.

REFERENCES

[1]. P. Zarchan, *Tactical and Strategic missile guidance*, Sixth editon. Reston, Virginia: American Institute of Aeronautics and Astronautics, Inc, 2012.
[2]. R. Fonod and T. Shima, “Wingman-based Estimation and Guidance for a Sensorless PN-Guided Pursuer,” *IEEE Trans. Aerosp. Electron. Syst.*, pp. 1–12, 2019.
[3]. R. A. Duhri, R. A. Sasongko, and Y. D. Laksmana, “Design and Simulation of Air to Air Missile Homing System,” *Insist*, vol. 2, no. 2, p. 75, 2017.
[4]. C. Li *et al.*, “Overview of Missile Control Method,” *Adv. Comput. Sci. Res. Vol. 58*, vol. 58, no. Msota, pp. 348–350, 2017.
[5]. S. Graovac, *Automatsko voenje objekata u prostoru*. Belgrade: Akademska misao, 2005.
[6]. A. Yunes Sh. and E.-B. Gamal M., “Modeling of Target Tracking System for Homing Missiles and Air Defense Systems,” *Incas Bull.*, vol. 10, no. 2, pp. 129–135, 2018.
[7]. Rafael Yanushevsky, *Modern Missile Guidance*, 2nd editio. Taylor & Francis Group, LLC, 2019.
[8]. B. Özkan, M. K. Özgören, and G. Mahmutyazicioglu, “Performance comparison of the notable acceleration- and angle-based guidance laws for a short-range air-to-surface missile,” *Turkish J. Electr. Eng. Comput. Sci.*, vol. 25, no. 5, pp. 3591–3606, 2017.
[9]. N. A. Shneydor, *Missile guidance and pursuit. Kinematics , dynamics and control*. Woodhead Publishing Limited, 1998.
[10]. B. Pan, U. Fareed, W. Qing, and S. Tian, “A novel fractional order PID navigation guidance law by finite time stability approach,” *ISA Trans.*, vol. 94, no. xxxx, pp. 80–92, 2019.
[11]. S. Mobeen and U. I. Bhatti, “Cooperative Guidance Laws for Flight of Multiple UAVs Using Arrival Time Control,” *Proc. 2019 16th Int. Bhurban Conf. Appl. Sci. Technol. IBCAST 2019*, pp. 431–439, 2019.
[12]. S. He and C. H. Lee, “Optimal Proportional-Integral Guidance with Reduced Sensitivity to Target Maneuvers,” *IEEE Trans. Aerosp. Electron. Syst.*, vol. 54, no. 5, pp. 2568–2579, 2018.
[13]. S. Yang, J. Guo, and J. Zhou, “New Integrated Guidance and Control of Homing Missiles with an Impact Angle against a Ground Target,” *Int. J. Aerosp. Eng.*, vol. 2018, pp. 1–10, 2018.
[14]. D. Ranajit, S. C. V., and C. M. Kumar, “Homing Guidance Design Challenges for Tactical Missile,” *IFAC-PapersOnLine*, vol. 51, no. 1, pp. 36–41, 2018.
[15]. B. Wicaksono, A. Halim, and Kurdianto, “Performance evaluation of proportional navigation methode during target pursuit with disturbance,” *6th Int. Semin. Aerosp. Sci. Technol.*, no. 1, pp. 1–9, 2018.
[16]. P. Kumar, P. N. Dwivedi, A. Bhattacharya, and R. Padhi, “Variable Gain Predictive PN Guidance for Interception of High Speed Re-entry Targets,” *IFAC-PapersOnLine*, vol. 51, no. 1, pp. 64–71, 2018.
[17]. H. Wang, J. Wang, and D. Lin, “Generalized optimal impact-angle-control guidance with terminal acceleration response constraint,” *Proc. Inst. Mech. Eng. Part G J. Aerosp. Eng.*, vol. 231, no. 14, pp. 2515–2536, Dec. 2017.
[18]. D. A. James, *Radar Homing Guidance for Tactical Missiles*. 1986.
[19]. Rarael Yanushevsky, *Modren missile guidance*, 1st editio., no. Book. Boca Raton London New York: Taylor & Francis Group, LLC, 2008.

Lecturer, Tarek Ibrahim H. Melad. "The Importance of Network Security in Control System with PID Controller.”*American Journal of Engineering Research (AJER)*, vol. 10(8), 2021, pp. 51-68.