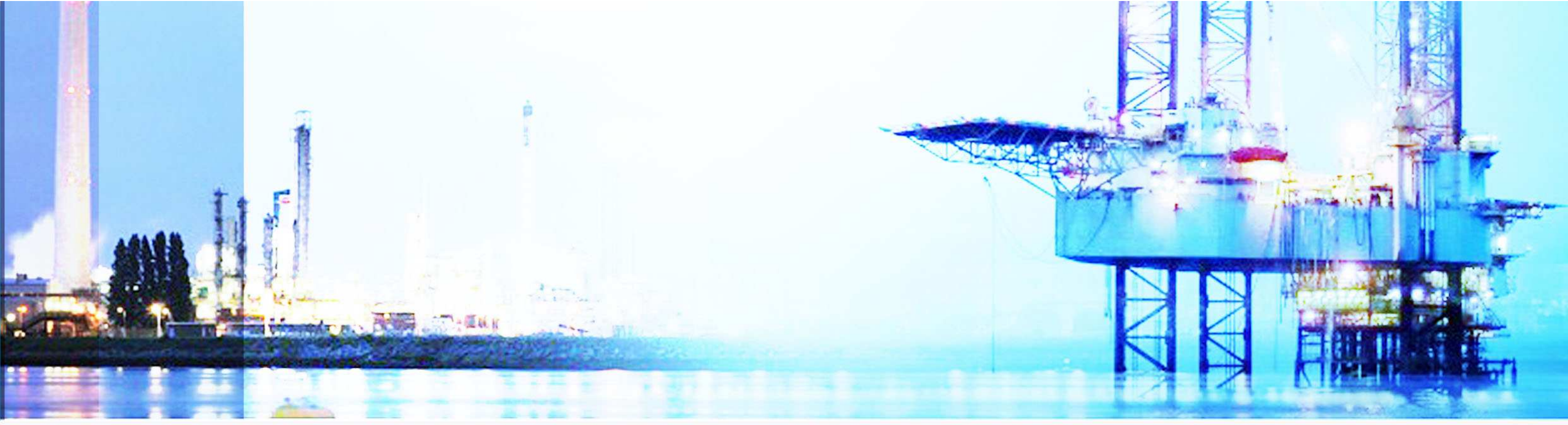

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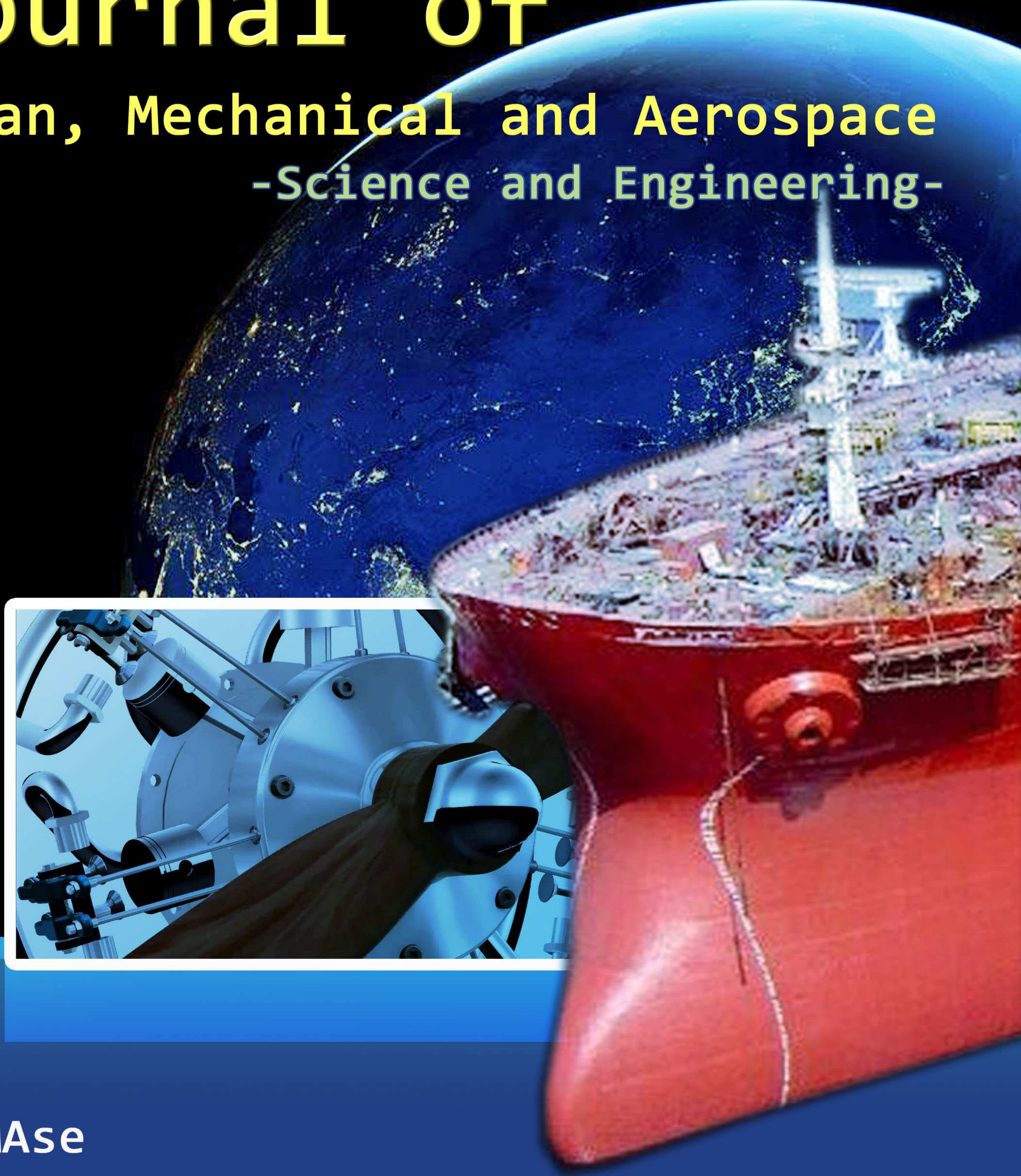

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Calculations of the Heave and Pitch RAO's for Three Different Ship's Hull Forms

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ABSTRACT

The research carried out in this article is to determine the RAO (Response Amplitude Operator) heave and pitch motions of three different ship's hulls forms. Ship is running at the head sea of the regular wave and its responses are obtained by modified strip theory using Maxsurf software. Three different ship's hull forms (Wigley-S60-DDG) are selected in order to predict the results. The obtained results of RAO heave and pitch motions are presented and discussed at various Froude numbers.

KEY WORDS: *Seakeeping; RAO; Heave and Pitch; Hull Forms (Wigley -S60-DDG).*

NOMENCLATURE

a_{ij}	Added Mass Coefficient
m	Ship Mass
$\ddot{x}_i$	Acceleration in i-Direction
b_{ij}	Damping Coefficients
$\dot{x}_i$	Velocity in i-Direction
c_{ij}	Restoring Coefficients
x_i	Motion in i-Direction
F_{w30}	Vertical Force: Diffraction + exciting
I_{55}	Longitudinal Inertia
ω_e	Encounter Frequency
γ_5	Encounter Angle of Wave with i Direction
F_{w50}	Pitch Moment: Diffraction + exciting
t	Time

1.0 INTRODUCTION

Prediction of ship performances in calm and rough waters is one of imperative concerns of naval architects and seakeeping performance is one of the most important aspects of ship design. The hull is designed in most cases need to be optimized.

It's important to know that all process of optimize hull needs to investigate seakeeping performance of vessels and all persons who works on hull optimization, determined seakeeping. Some researchers have considered two or three objective functions for optimizing hull form and some others only one objective functions. Bagheri et al. (2014) work on optimizing the seakeeping performance of ship hull forms using genetic algorithm, Scamardella & Piscopo (2014) use only one objective function in Passenger ship seakeeping optimization by the Overall Motion Sickness Incidence, Gammon (2011) uses three objective functions in Optimization of fishing vessels by multi-objective genetic algorithm, Biliotti et al. (2011) utilize two objective functions for automatic parametric hull form optimization of fast naval vessels, Özüm, S., Şener, B., Yilmaz, H. (2011) investigated the seakeeping qualities of fast ships, Teresa Castiglione (2011) investigate numerical analysis includes evaluation of ship motions, effects of wave steepness on ship response, Grigoropoulos and Chalkias (2010) use utilize two objective functions in Hull-form optimization in calm and rough water, Mousaviraad, Carrica, Stern (2010) developed a harmonic wave group (HWG) single run seakeeping procedure, by using an unsteady RANS solver, Bunnik et al.(2010) carried out CRS project that conducted a comparative study, like the ITTC Seakeeping workshop and the results from the different approaches have been compared. Zhang et al. (2010) have paper about Time-domain simulations of radiation and diffraction forces that studied large amplitude, time domain and wave bode interactions problems with forward speed and used an exact body boundary condition with linearized free surface boundary conditions. Zhang et al. (2010) also studied seakeeping computations using double body basis flow that free surface boundary conditions are derived based on a double body linearization and the mixed Euler-Lagrange time stepping techniques. Huang et al. (2009) the seakeeping tests and numerical predictions confirmed that even though sloshing impact pressures are nonlinear and stochastic, global tank loads and LNGC motions are deterministic, Bhushan, S. et al (2009) used the VOF scheme for numerical treatment of free surface in seakeeping investigation, Greco et al. (2008) investigate concern the further development of the numerical potential-flow method for seakeeping of a model in regular/irregular wave.

Simonsen et al (2008) carried out a motion analysis for the KCS ship hull in heave and pitch motion in regular head waves, Clauss, (2008) proposed a technique to generate a sequence of waves for the simulation of extreme seas for seakeeping tests. Sariöz, Sariöz (2006) proposed a new optimization procedure, based on a nonlinear problem solved by direct search techniques, Grigoropoulos (2004), Saha et al. (2004) employed different types of nonlinear linear programming as optimization techniques, Kukner & Sariöz (1995) optimized the seakeeping qualities of a high speed vessel, using the Lackenby method to generate several hulls, BAILEY, P. A. (2000) The NPL high-speed round bilge displacement hull series, Journee (1992) developed personal computer program based on both the ordinary and the modified strip theory method, Hearn, Hills, Sariöz (1991) Practical seakeeping for design, Besso and Kyozuka (1984) works on ship motion reduction by anti-pitching fins in head seas.

Given the variety of some hull designs used vessels, the extent to which overall design influences motion response is not clear. The objective of this paper is to investigate the extent to which hull design can influence the seakeeping response. In order to make such a comparison a computational method that is valid is required.

2.0 HEAVE AND PITCH MOTIONS

The basic of our calculation are the strip theory that is the standard tool for ship seakeeping computation. Strip theory is a frequency-domain method. This means that the problem is formulated as a function of frequency. This has many advantages, the main one being that computations are speed up considerably. However, the method generally becomes limited to computing the linear vessel response. The vessel is split into a number of transverse sections. Each of these sections is then treated as a two-dimensional section in order to compute its hydrodynamic characteristics. The coefficients for the sections are then integrated along the length of the hull to obtain the global coefficients of the equations of motion of the whole vessel. Finally the coupled equations of motion are solved. As is well known, strip theory remains a solid basis for seakeeping calculations and competes successfully with newer and more rigorous methods, even at high speeds, when compared with experimental and full-scale results. The ship is considered to be a rigid body floating in an ideal fluid: homogeneous, incompressible, and free of surface tension, irrotational and without viscosity. It is assumed that the problem of the motions of this floating body in waves is linear or can be linearized. For displacement vessels the range of under 0.4, where the heave motion show a resonant response with values of the heave RAO significantly in excess of unity. Whilst the introduction of ride controls has somewhat reduced the severity of motions in some cases, there has been considerable interest in the underlying effect of hull form on the ship motions. As a result of this, only the external loads on the underwater part of the ship are considered and the effect of the above water part is fully neglected.

The heave and pitch equations are coupled so that heave motions are influenced by pitch and vice versa.

$$Heave: (m + a_{33})\ddot{x}_3 + b_{53}\dot{x}_3 + c_{53}x_3 + a_{35}\ddot{x}_5 + b_{35}\dot{x}_5 + c_{35}x_5 = F_{w3}\,sin(\omega_e t + \gamma_3) \quad (1)$$

$$Pitch: a_{53}\ddot{x}_3 + b_{53}\dot{x}_3 + c_{53}x_3 + (I_{55} + a_{55})\ddot{x}_5 + b_{55}\dot{x}_5 + c_{55}x_5 = F_{w5}\,sin(\omega_e + \gamma_5) \quad (2)$$

However, the coupling is usually fairly weak and to a first approximate to the motions of two independent second order spring mass systems. The analogy is not rigorous because the coefficient in the equations is frequency dependent, in contrast to constant coefficients assumed in the classical equations. Nevertheless, we may define approximate natural frequencies for heave and pitch using equation (3):

$$\omega_3 = \sqrt{\frac{C_{33}}{m+a_{33}}}, \qquad \omega_5 = \sqrt{\frac{C_{55}}{I_{55}+a_{55}}} \quad (3)$$

Where the heave added mass a_{33} and the pitch added inertia $a_{55}$are to be evaluated at the respective natural frequencies.

The focus of this paper is the head sea seakeeping response of heave and pitch motions and no attempt is made to evaluate the efficiency of the designs considered with respect to resistance. In this paper, we tried to obtain response amplitude operator of ships motions in oblique waves and the damping factor of roll motion as non-dimensional is considered 0.15 but since the major issue of our calculations is investigation of heave and pitch motions, we preferred to ignore roll motion.

3.0 THREE SHIP'S HULL FORMS

The hull forms selected for this comparative study are Wigley model, S60 model and a modern ship. The main dimensions of these models are shown in Table 1. For simulation of ship motions and analysis we used Maxsurf motion module that is an application which may be used to predict the motion and seakeeping performance of vessels designed using Maxsurf.

The Wigley model is a popular model in ship hydrodynamics experiments. The Wigley Hull model tank test data is available were carried out at the Ship hydromechanics Laboratory of the

Delft University of Technology (DUT). The standard Wigley hull is a mathematical displacement hull form, the geometric surface of which can be defined as:

$$y = \frac{B}{2}\left(1 - \left(\frac{2x}{L}\right)^2\right)\left(1 - \left(\frac{z}{T}\right)^2\right) \qquad (4)$$

where B is the ship breadth, L is the ship length, T is the ship draft, and $-T \leq z \leq 0$. The Wigley model (Cm = 0.667, L=3m, L/B = 10) have been tested at three forward speeds: Fn=0.2, 0.3, 0.4 that shape of this hull form is given in Figure 1. Vertical motions of hull sections are predicted by the coupled strip theory and the Frank method. The hull form seakeeping is carried out at a single Froude number ($Fn = U/\sqrt{gL}$) that is constant for each model and that is 0.3 for the Wigley, where U and L are the speed and the waterline length of the model, respectively.

Table 1: Models dimensions

Parameters	Wigley	S60	DDG51
Midship coeff. (Cm)	0.6667	0.98	0.974
L/B	10	7	5.5
Length [m]	3	122	93.4
Breadth [m]	0.3	17.4	17
Draught [m]	0.1875	6	6.21
Displacement [m^3]	0.078	9605	3450
B/T	1.6	3	2.73
C_B	0.48	0.7	0.577

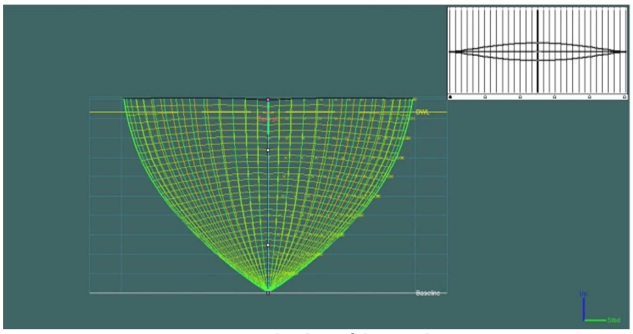
Figure 1: Body plan of the Wigley.

The second hull form is Series 60 model that is one of standard series for merchant ships. The S60 model properties that is discussed in this article are L=122 m, L/B=7, CB=0.7, B/T=3, and shown in Figure 2.

The third hull form is DDG. Models scaled by 1:24.824 of that vessel have been constructed and tested by the David Taylor Model Basin (model DTMB5415) and Istituto Nazionale per Studied Esperienze di Architettura Navale (INSEAN, the Italian ship model basin.

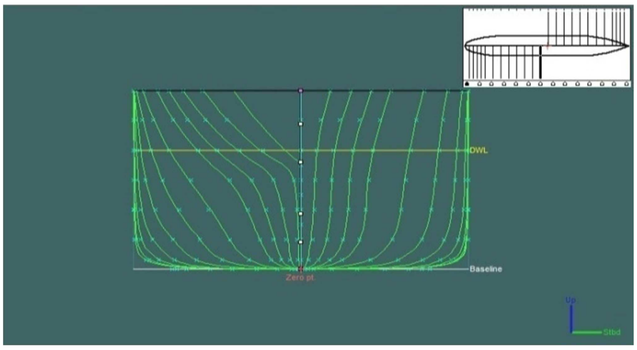
Figure 2: S60 body plan.

Model C.2340; Campana & Peri 2000). (L=93.4m, B=17m, CB=0.577, T=6.21m) that there is its other numerical and empirical results. Figure 3 is shown its body plan.

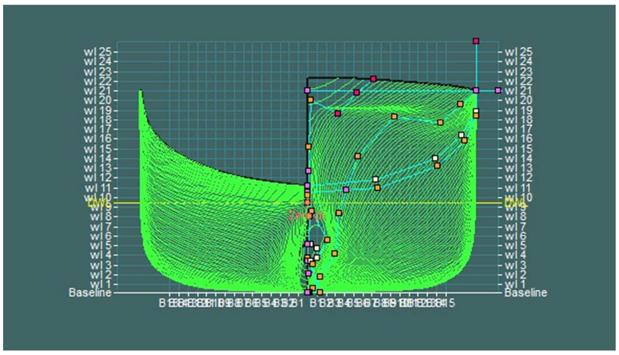
Figure 3: Body plan of the DDG.

4.0 RESULTS AND DISCUSSIONS

4.1 Wigley hull

The Ship hydromechanics laboratory of the Delft University of Technology has published experimental data on hydromechanics coefficients for heave and pitch, vertical motions, wave loads and added resistance in head waves of two Wigley hull forms. The wave is head sea with encounter angle of 180o and wave height of 2 cm for this test. Using main dimensions and equation (4) to calculate offset table then we draw the numerical model. Comparison between numerical results and experimental data at Fn=0.3 are shown in Figures 4-7.

As shown in Figures 4 and 5, the peak value of heave and pitch RAOs occur at λ/L=1.2 and is about 1.7 that means the ship has worst condition of floating. Based on the experimental and numerical charts the computational error rate is about 10%. Now, according to the low error rate of calculation can also be used to assess other environmental condition of vessel.

We can see in predicted charts of seakeeping performance that at low speeds, peak values of heave and pitch reduced and the difference between peak value of heave and pitch increased. At larger angle of attack the peak values of heave and pitch reduced too. Also at higher speeds the peak value occurs at λ/L >1.2. In general, the graphs illustrate that Heave and Pitch RAOs will increase with increasing velocity but at higher angle of the wave hit the ship is inversely related. Also the comparing charts showed the accuracy of experimental test and numerical errors. Figure 8 shows peak values of heave and pitch occur at λ/L=1 for Froude number 0.2 and the RAO's values reach to unit value at λ/L=3.5. Max values of heave and pitch are 1.3 and 0.95.Figure 9 shows heave and pitch for Froude number 0.4 that peak values occur at λ/L=1.3. The Froude number of this condition is for case that the speed is near to reach high speed vessels. Maximum values of heave and pitch are 2.6 and 2.3.The model at this speed will have sever shocks and due to maximum amount of RAO can be seen the ship simply move up and down until λ/L reach about 3 that the ship movement is smoothly. Numerical results of the RAO heave and pitch at various encounter angles that is the angle between wave attack and the ship motion are shown in Figures 10~12.

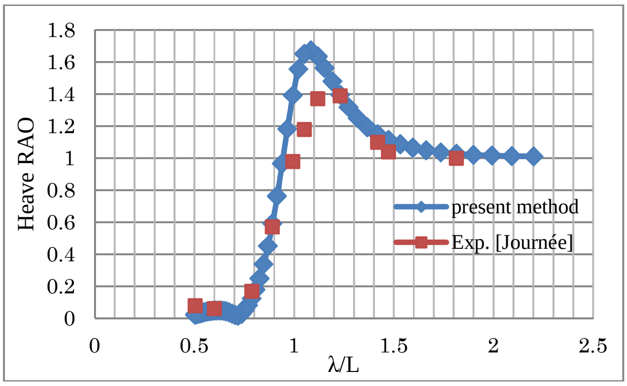

Figure 4: Comparison of the RAO heave for Wigley ($Fn = 0.3$)

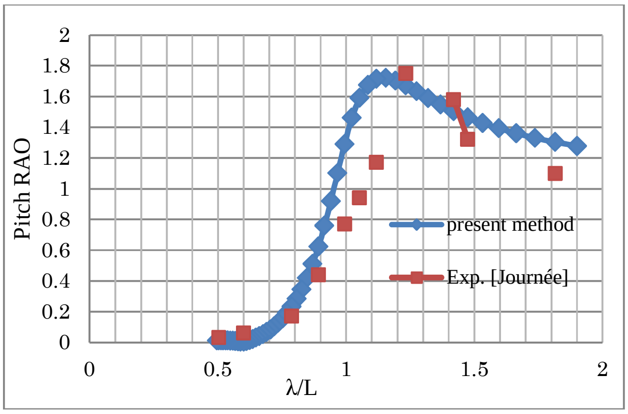

Figure 5: Comparison of the RAO pitch for Wigley ($Fn = 0.3$)

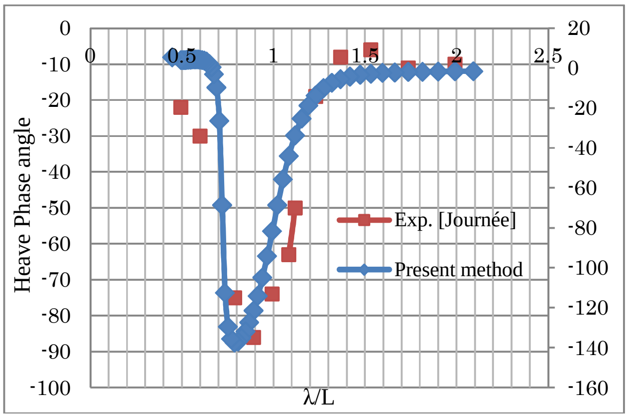

Figure 6: Comparison of the phase heaves for Wigley ($Fn = 0.3$)

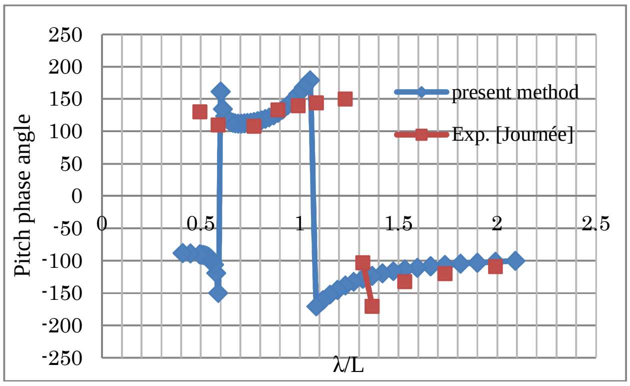

Figure 7: Comparison of the phase pitch for Wigley ($Fn = 0.3$)

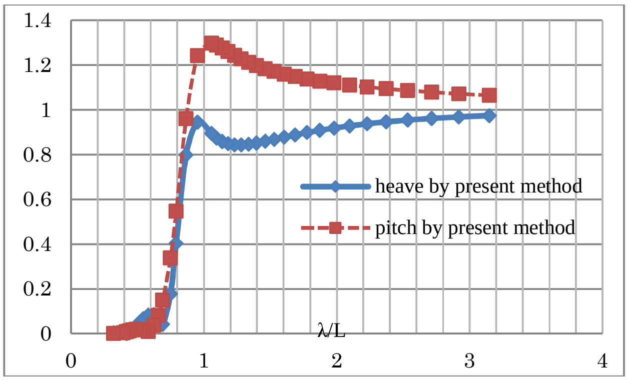

Figure 8: RAO Heave and Pitch for Wigley at ($Fn = 0.2$)

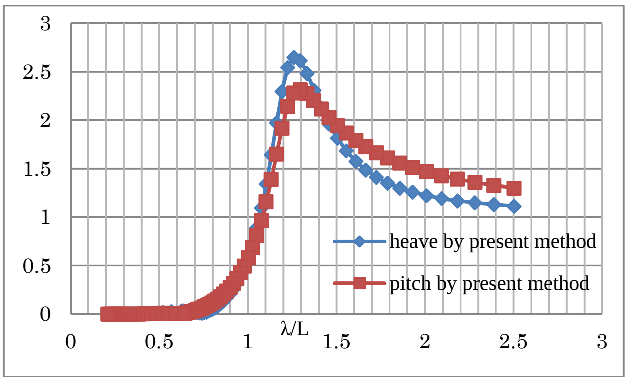

Figure 9: RAO Heave and Pitch for Wigley at $(Fn = 0.4)$

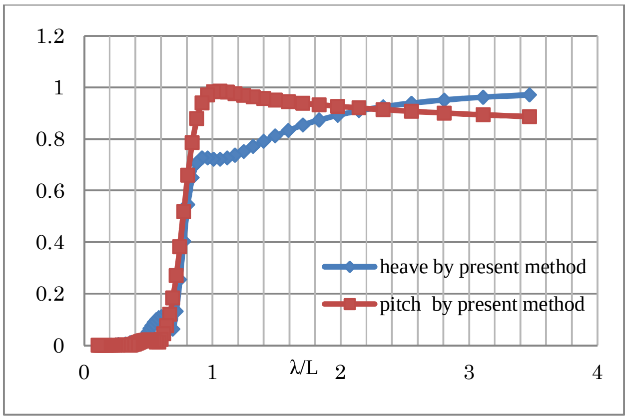

Figure 10: RAO Heave and Pitch for Wigley at $(Fn = 0.2)$ & $(\mu = 210°)$

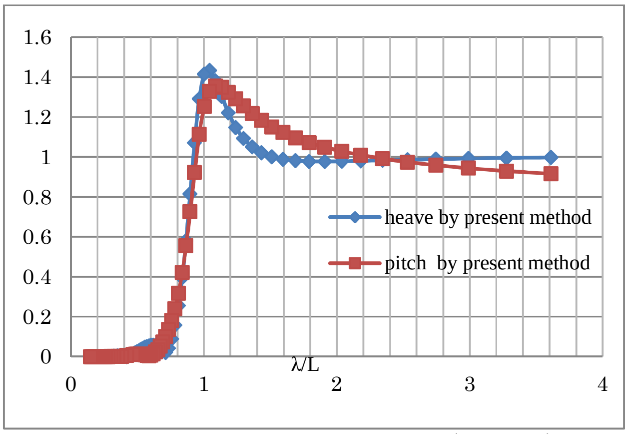

Figure 11: RAO Heave and Pitch for Wigley at $(Fn = 0.3)$&$(\mu = 210°)$

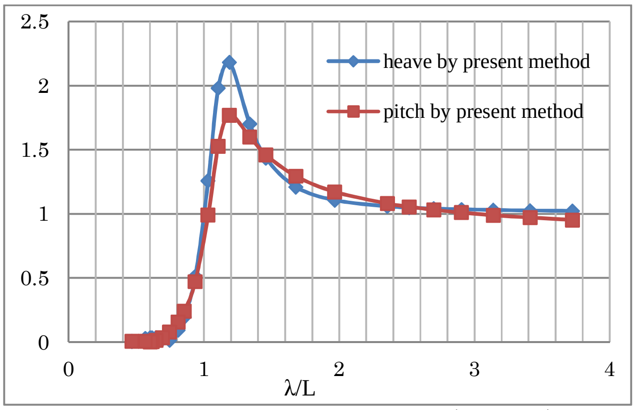

Figure 12: RAO heave and Pitch for Wigley at $(Fn = 0.4)$&$(\mu = 210°)$

4.2 S60 Hull

Using data for the S60 offset table and its dimensions, we draw our numerical model then compare Bagheri's RAO charts with present method. The wave is type of Param. Bretschneider head sea with encounter angle of 180°. According to charts of Figures 13 and 14, the peak value occurs at λ/L =1.2. Figure 15 shows heave and pitch for Froude number 0.3 in head sea that max value of heave RAO is 2.3 and occurs at λ/L=1.4, the max value of pitch RAO is 1.45 that occurs at λ/L=1.4. Figure 16 shows heave and pitch peak values of Froude number 0.4occur at λ/L=1.6 that is the case when the ship is like a fast ship. For heave, max value is about 2.8 and it's 1.9 for pitch graph. Figure 17 shows heave and pitch RAO at Froude number 0.6 that the ship starts planing. The peak values occur at λ/L=1.9 with heave and pitch maximum values of 3.9 and 3, respectively. Increase speed by higher Froude numbers causes peak values occur in further place of chart. In all cases the RAO reach to unit value at λ/L about 3.5. The last mode is shown, can't choose this type of hull as a high speed craft and it's only suitable for displacement vessels.

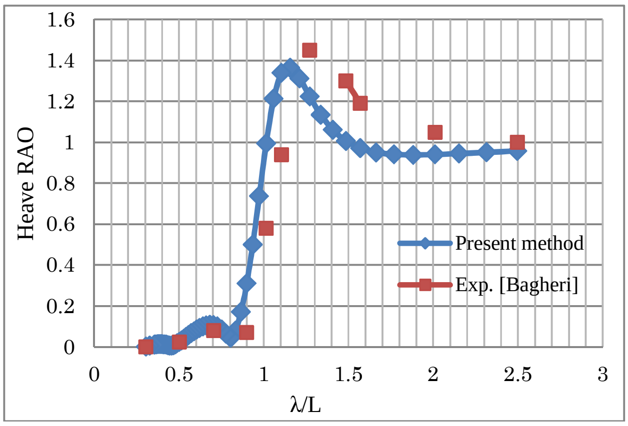

Figure 13: Comparison of the RAO Heave for S60 at $(Fn = 0.2)$

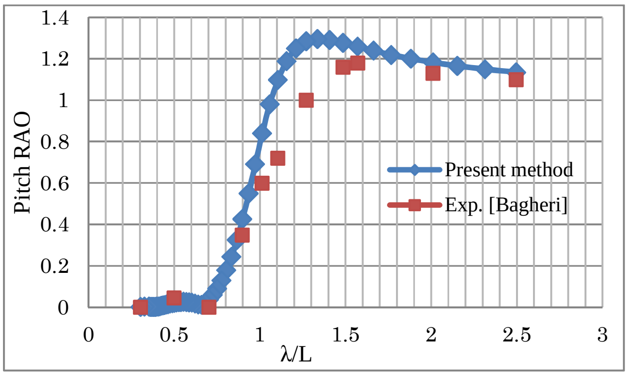

Figure 14: Comparison of the RAO Pitch for S60 at ($Fn = 0.2$)

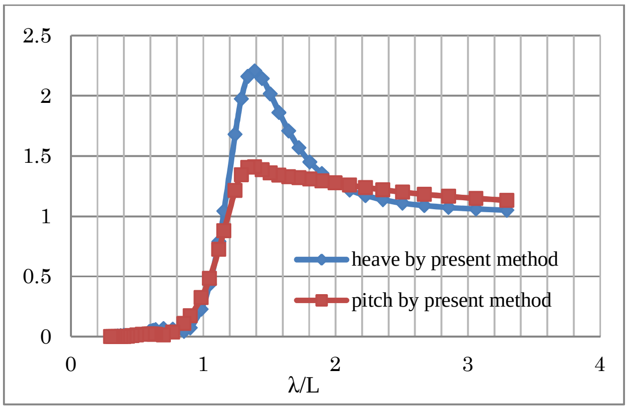

Figure15: Numerical results of RAO Heave and Pitch for S60 at ($Fn = 0.3$)

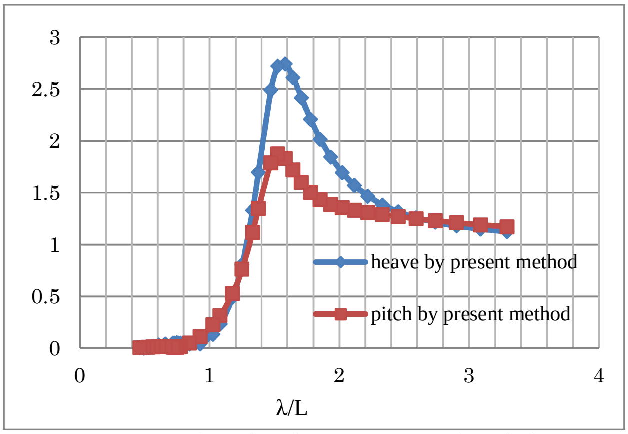

Figure 16: Numerical results of RAO Heave and Pitch for S60 at ($Fn = 0.4$)

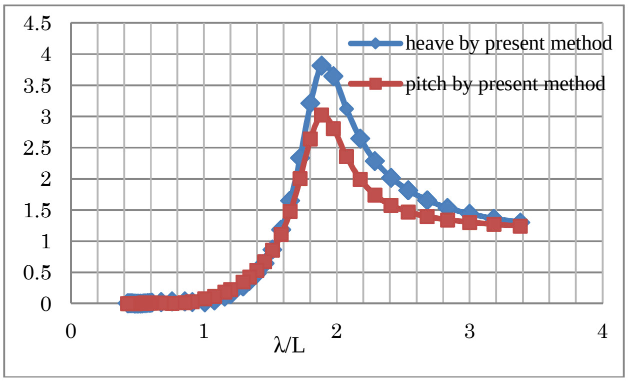

Figure 17: Numerical results of RAO Heave and Pitch for S60 at ($Fn = 0.6$)

4.3 DDG Ship

In this section, we focus on the seakeeping performance of DDG. The wave properties of model test are head sea and rough water with spectrum type ParamBretschneider and significant wave height $H_{1/3}$=1m and modal period 10s. Figures 18 and 19 show thecomparison of the presents results withother results. The results derived by strip theoryusing Frank (S-T-F) close-fit method are older than three-dimensional (3-D) panel code by SWAN2-2002, a modern time-domain 3-D Rankine source panel code, and strip theory using Salvesen method using in this paper. The heave graphs show that Frank calculation errors are more than other methods and our present method has error less than 5%. The peak values of heave and pitch charts occurs at λ/L about 1.4. By our negligible error of calculation, we predict modern DDG seakeeping performance for other Froude numbers as well as Fn=0.3, 0.4 and 0.7, in Figures 20, 21 and 22, respectively.

Figure 20 show RAO heave and pitch of Froude number 0.3 with peak values of 1.08 and 1.2 for heave and pitch that these values occur at λ/L about 1.2. At Froude number of 0.4 as shown in Figure 21, the RAO peak values occur at λ/L=1.3. Seakeeping performance of DDG is more smoothly at λ/L=3.2. Figure 22 show heave and pitch RAO for Froude number 0.7 that DDG will work like a planing craft and peak values occur at λ/L=1.6. Maximum values of RAO heave and pitch are 2.2 and 1.5 respectively.

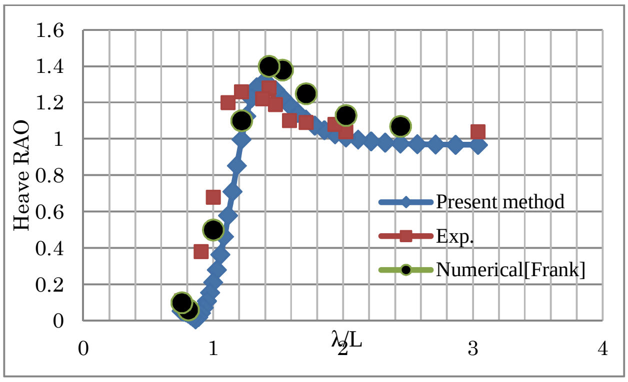

Figure 18: Comparison of the RAO Heave for DDG ($Fn = 0.237$)

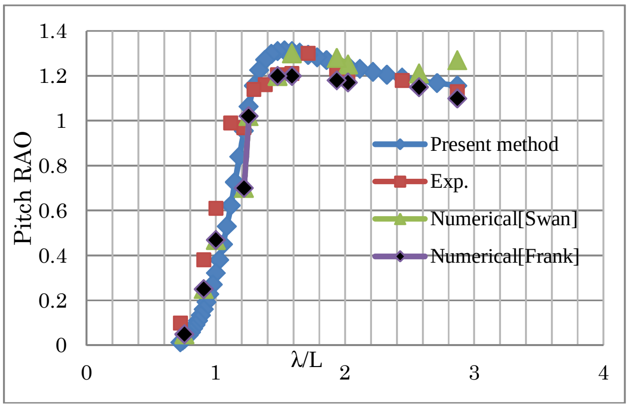

Figure 19: Comparison of the RAO Pitch for DDG ($Fn = 0.237$)

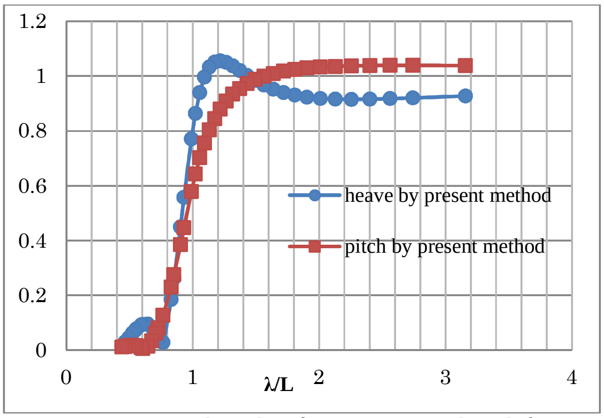

Figure 20: Numerical results of RAO Heave and Pitch for DDG at($Fn = 0.3$)

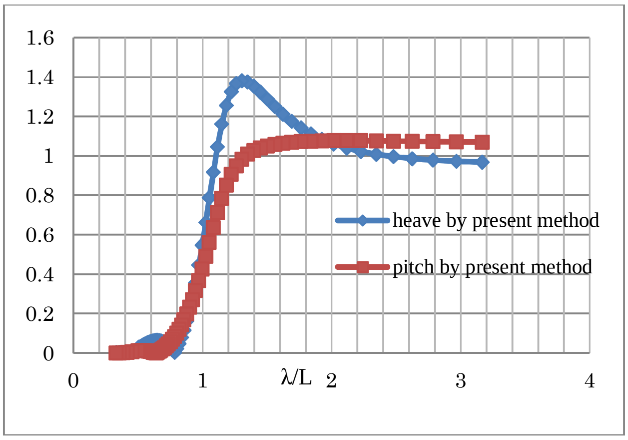

Figure 21 : Numerical results of RAO Heave and Pitch for DDG at($Fn = 0.4$)

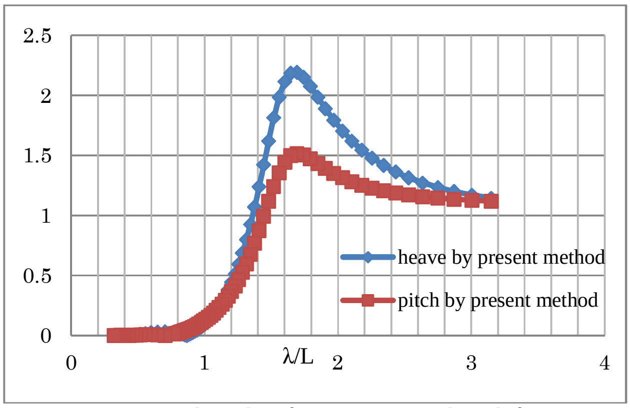

Figure 22: Numerical results of RAO Heave and Pitch for DDG at ($Fn = 0.7$)

5.0 CONCLUSIONS

Calculations of the RAO heave and pitch of the three different ship's hull at various Froude numbers are presented. These three different ships are Wigley, S60 and DDG. Some results are compared with experimental data and seem that the results are satisfactory. Froude number is from 0.2 to 0.7 applied, even at high Fn, the trend of the results are relatively well. Therefore, it is revealed that the present calculations method can estimate properly for the RAO of the ship motions.

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A New Engine Simulation Structure Model Applied to SI Engine Controlling

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ABSTRACT

High ratio emissions that outcome from incomplete combustion cause air contamination, poorer the performance of the spark ignition (SI) engine and raise fuel consumption. Because of engine configurations, engine wrong adjustment and engine subsystems, unfortunately completed combustion is not possible with SI engines .As a result of uncompleted combustion a high ratio of CO, HC, NO_X and PM harmful emissions such as come into atmosphere. Study has exposed that exact AFR control can successfully decrease emission of dangerous exhaust, such as CO, NO_X and unburned HC. To achieved this goal we need to make a correct engine simulation structure which it can be used to controlling AFR. Firstly, the existing engine simulation models and structures will be studied in this paper, where benefits and disadvantages of several simulation models and structures kinds are discussed. After that we will present our new engine simulation structure model.

KEY WORDS: *SI Engine; Structure Model; Emission*

NOMENCLATURE

mvem	mean value engine model
P_i	Pressure of intake manifold
n	Speed of engine
m_f	Flow rate of fuel to the intake valve
T_i	Temperature of intake air
m_{at}	air mass flow past throttle plate
m_{ap}	air mass flow into the intake port

1.0 BACKGROUND OF ENGINE SIMULATION MODELS

Late at 1970's, a model which is produced by [3] has been generally settled as a standout amongst the most widely recognized routines for the depiction of engine systems (SYS). Four fundamental segments of the SYS are incorporated in this model. They are exhaust gas recirculation (EGR), fuel, intake and ignition SYSs. Cassidy model give well execution in simulating procedure, be that as it may, because of its inconvenience, it is not proper for development and assessment of the engine control SYSs. Aftereffects of reenactment and tests are the premise of the model and it has a restricted notoriety. Linearization is utilized for acquiring a percentage of the mathematical statements and parameters of the model so that the dynamic attributes of engine can't be accurately reflected. From 1980s to now, the electronic controlled engine utilized both of static engine model and the semi static engine model [7, 9, 5].

It is conceivable to mirror a few engine presentation parameters in the stable conditions because of steady state examinations of engine are the source of model information. Two fundamental purposes behind putting these models separated and not utilizing them prevalently are:

They can't mirror the dynamic attributes while the engine is working under transient conditions.

They are absolutely needy to the experimental information so that require high measure of labour and material resources. For conquering the disadvantages of the aforementioned engine models and simulation of the qualities of dynamic, a model named the mean value engine model (MVEM) was arranged and got extra advancement by distinctive researchers [4, 8, 3]. Finally, Hendricks methodically compressed the mean model [5]. For the most part, for explaining the dynamic procedure of the engine, the mean value of variables included in cycle SYS of the engine is utilized as a part of this model. Accordingly, the engine dynamic qualities can be effectively reflected in the transient conditions. In this manner, researchers and analysts created and upgraded the MVEM overwhelmingly in the oil film are and in addition the torque models. Together with the science and innovation change, numerous researchers improved the MVEM; they have connected hybrid models and astute control also. The extent of the MVEM application has been spread by [6] since he connected this model to a turbocharged gas engine. The air/fuel effect and spark angle have been considered by [10, 11, 12] on the yield torque. Subsequently, by a low precision model mistake of beneath 5%, it is conceivable to apply the mean model to the lean burn engine. For displaying of gasoline engine, a hybrid model was set up by [2].

2.0 ENGINE SIMULATION STRUCTURE

Figure 1 outlines the structure of engine simulation structure proposed by [1] which has some crucial and fundamental constituting blocks. There are six engine model inputs as underneath:

- Speed of engine (N),
- Angle of the throttle (alpha),
- External temperature (T_e),
- Eternal pressure (P_e),
- Temperature of engine manifold (T_m),
- Time of fuel injection ($T_{i}-_{com}$).
-

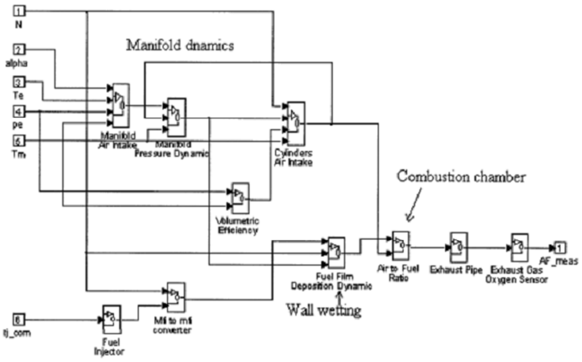

Figure 1: Engine Simulation Block (Alippi, Russis & Piuri, 2003)

The AFR can be spoken to by the simulation block output. Really, by method for gathering the block of manifold air intake, dynamic of manifold pressure and block of cylinder air intake, it is conceivable to perform the estimations of the air mass into the cylinder. Measure of fuel mass into the cylinder can be dictated by utilizing fuel injector and the dynamic of fuel film deposition, utilizing a proper physical driven model, two blocks. Identification with the AFR and exhaust pipe are characterized as engine AFR.

Figure 2 demonstrates the model of engine simulation which is introduced by [13]. There are two input variables (throttle open angle (u) and fuel flow rate (mfi)), and one output (AFR (air fuel ratio)) in this model of engine simulation. Symbols utilized as a part of this model are as per the following:

- P_i, Pressure of intake manifold
- n, Speed of engine
- m_f, Flow rate of fuel to the intake valve
- T_i , Temperature of intake air
- m_{at}, air mass flow past throttle plate
- m_{ap}, air mass flow into the intake port

By executing air mass flow and fuel into the intake port which is taken structure manifold pressure block and fuel injection block, the AFR is calculated in the AFR block.

In like manner, in the block of speed of engine, the engine speed is computed. Block of time delay is utilized for simulating the AFR time delay which is join in the counts amid the simulation of engine. Model of manifold temperature alludes to the air mass flow into the intake port, intake manifold pressure and air mass flow past throttle plate for processing the intake manifold temperature. Dynamics of Fuel film of the intake ports can be simulated by the fuel injection model.

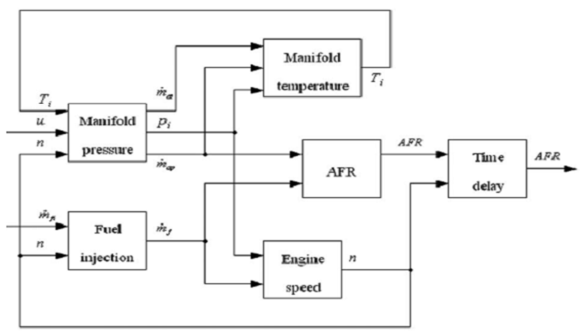

Figure 2: Engine Simulation Model (Wang & Yu, 2008)

Countless of SI engines can be simulated by an engine model (a nonlinear dynamic model) which is presented by [12]. Diverse variables which are incorporated in the engine simulation model are represented in figure 1.3. They are:

Input variables:

- angle of throttle (α),
- flow rate of fuel (m_{fi}),
- spark timing (SA),

Disturbance:

- load of torque (T_L),

State variables:

- mass of air in throttle (m_{at}),
- mass of air into cylinder (m_{ap}),

- air to fuel ratio (λ_c),
- engine brake torque (T_{br})
- mass of fuel in the fuel film (m_{fc})

Output variables:

- pressure of intake manifold (P_{man}),
- speed of engine (N)
- AFR time delay (λ_e).

Calculation technique is same as two past models. Mass of Air and fuel into the cylinder are initially calculated by the model. Besides, the engine AFR is processed. At long last, for Calculating torque of the engine brake, torque generation model is used. Rotational dynamics of the engine, intake manifold and fuel film are incorporated in the model of [12] and transport delays which are common in the four stroke engine cycles.

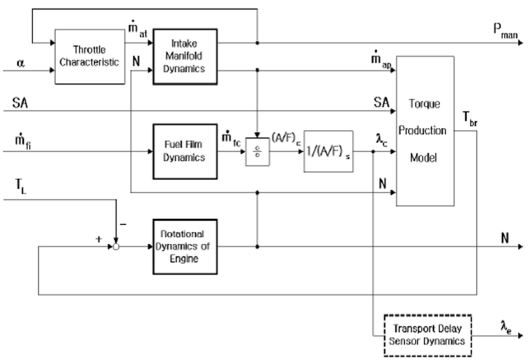

Figure 3: Nonlinear Dynamic Engine Model (Yoon et al., 2000)

Figure 4 demonstrates a nonlinear model of engine which is presented by [4]. There is no thermodynamic model included in their study for car IC engines. Be that as it may, the throttle dynamics, pumping wonders of engine, prompting procedure dynamics, SYS of fuel injection, torque of engine, inertia of rotating and EGR SYS dynamics are being spoken to in this simulation model.

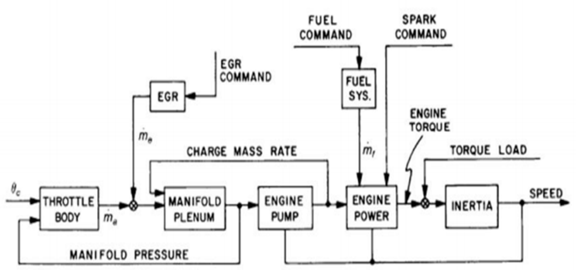

Figure 4: Nonlinear Engine Model (Cook & Powell, 1988)

A few diverse simulation model structures are exist that are excluded in this writing survey. This is on account of they may be like the examined models or lack adequate points of interest.

3.0 DISCUSSION

Some broad elements can be begun in four recreation models specified previously. As an illustration, the entire model can be isolated into three sections: computation of mass of air into cylinder is the first; the other one computes mass of fuel into cylinder, third part, at last, dissects speed of engine or torque output or the model of A/F based on the outcomes of first two parts. Be that as it may, Different qualities are incorporate in every model. Exhaust pipe dynamics is considered in Alippi's simulation model. The intake air temperature is recreated in Wang's model. Both of the sparking time impact and throttle progress are incorporated in Yoon's model. Powell's simulation model is the main model in which a block for the exhaust gas distribution SYS dynamic is exists. Developing AFR controllers is one of the primary goals of this paper. To accomplish this objective, it is obliged to utilize a bundle of engine simulation in which the intake air and fuel dynamics can be viably reproduced.

In view of the engine simulation models explored over, another model of engine simulation structure can be design.

4.0 PROPOSED ENGINE SIMULATION STRUCTURE

The greater part of the dynamic parts can be simulated well in the Wang's engine simulation model. Be that as it may, throttle body is not considered in this model. Due to this, we will consolidate this model with throttle body dynamic model. We utilized entire box of intake manifold dynamics rather than manifold pressure and temperature dynamics.so ,this new model of simulation incorporates three input variables: throttle angle (α), engine speed (N), injection fuel rate ((mfi)˙) and two outputs A/F ratio and torque of engine Figure 1.5 represents our new engine simulation structure.

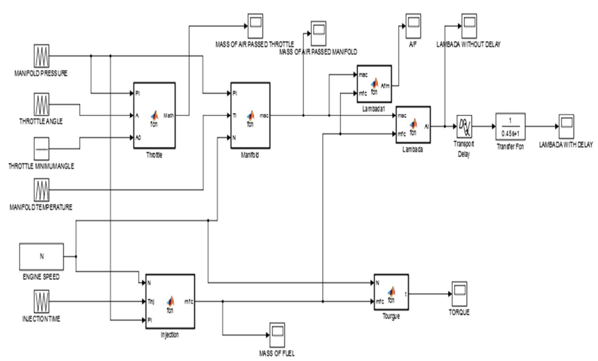

Figure 5: New Engine Simulation Structure

5.0 CONCLUSION

Study has uncovered that correct AFR control can effectively diminish emission of unsafe exhaust, for example, CO, NO_X and unburned HC. To accomplished this objective we have to make a right engine simulation structure which it can be used to controlling AFR. Firstly, the current engine simulation models and structures will be mulled over in this paper, where advantages and disservices of a few simulation models and structures types are discussed. After that we design our new engine simulation structure model which this model is exceptionally competent structure to utilizing in engine parameters controlling, for example, AFR and torque.

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