American Journal of Electrical Power and Energy Systems
2021; 10(6): 109-118
http://www.sciencepublishinggroup.com/j/epes
doi: 10.11648/j.epes.20211006.12
ISSN: 2326-912X (Print); ISSN: 2326-9200 (Online)

Modelling and Simulation of Intelligent Master Controller Model for Hybridized Power Pool Deployment

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To cite this article:

Kufre Esenowo Jack, Damian Obioma Dike, Matthew Olubiwe, Jude-Kennedy Chibuzo Obichere, Nkwachukwu Chukwuchekwa, Lazarus Okechukwu Uzoechi. Modelling and Simulation of Intelligent Master Controller Model for Hybridized Power Pool Deployment. *American Journal of Electrical Power and Energy Systems*. Vol. 10, No. 6, 2021, pp. 109-118. doi: 10.11648/j.epes.20211006.12

Received: November 21, 2021; **Accepted**: December 9, 2021; **Published**: December 29, 2021

Abstract: Every conceptual framework requires several developmental stages such as prototyping, preproduction and production stages. This paper considers prototype developmental stage which entails design, modelling and simulation for the conceptual system to determine suitable parameters and specifications before the production task is initiation. The inability to represent the conceptual control system with mathematical equivalence would hamper on the system operational efficiency, stability, controllability and observability; would not be guaranteed. This paper focuses on the modelling and simulation of intelligent master controller for hybridized power pool deployment. This is achieved using state space mathematical model, MATLAB/Simulink and proteus software. The state space model provides the mathematical equation for the system stability, controllability and observability criteria from the system transfer function. The MATLAB/Simulink software provides response trends and the Proteus software provides the virtual implementation platform for concept validation with its code written in Arduino (IDE). The system was demonstrated through simulation and the virtual results showed that the system capability in fostering intelligent control commands in the hybridized power pool scenario. The system stability was determined using Root locus, Nyquist and Routh Hurwitz criteria. Subsequent research efforts are being made towards implementing the design optimizable on the hardware using the design specifications.

Keywords: Deployment, Hybridized Power Pool, Intelligent Master Controller, Modelling, Simulation

1. Introduction

Transformation of any conceptual idea to physical reality in engineering product development is not possible without modelling and simulation [1]. This is where the fundamental concept detail would be unveiled, control loop parameter defined and transfer function formulated [2]. Intelligent master controller is a digital regulatory device developed for hybridized power system monitoring and control application. Providing a modelled-based environment for an engineering system development helps to understudy the system performance prior to the hardware building. The dynamic characteristic of the system is represented by several created models and these model aids in the evaluation of the proposed system performance from the different constituent of the subsystems [3]. Algorithms are developed for the system simulations as a way of confirming the system performance [4, 5]. The intelligent master controller model is novel and it would be difficult to arrive at its model parameter and variable. This would in turn help in the system prototype development. The conceptual model for hybridized power pool deployment is complex and requires mathematical representation to assist in its complexity reduction [6, 7]. The created mathematical model would unfold the system parameters and variables. An ability to simulate the system variables and parameters from the mathematical expression facilitates the physical prototype model implementation [8]. The aim of this work is to model and simulate an intelligent master controller model for hybridized power pool deployment and the objectives are: to develop a mathematical model for the intelligent master controller; to simulate the developed mathematical model and to analyse the simulated model. The contribution to the body of knowledge in this work is the developed model and simulation parameters for an intelligent master controller, these parameters are deployable in hybridized power pool system.

2. Literature Review

The importance of modelling and simulation over the years has played vital roles in product development, one of whose first stage is prototype model behavioral observation. The system dynamic characteristic would be determined before the model implementation. Some modelling and simulation approach are reviewed; the model was validated by investigating multi-terminal direct current (MTDC) system with three or more converter stations. The simulation results showed that the proposed control strategy and the MTDC control protection system meet the requirements of the MTDC transmission system's operation [9].

Investigation on the notion of a hybrid power control system was introduced for voltage control in power systems, and the research establishes the static hybrid automatic voltage control system. The operating procedure was designed using a hybrid hierarchical voltage control system model based on hybrid theory. In order to drive the system, the stability and economic events were specified, by which the synthetic objects of safety, stability, and economy were attained in multi-power source system [10, 3]. The validity of the system and the methodologies proposed in the research were demonstrated by computer simulation results. Parallel time domain simulation was one of the most dependable and promising ways for performing real-time online power system transient stability study [11]. The research proposes a new parallel calculation approach for power system transient stability analysis based on the waveform relaxation method. The practical system's test results showed that the new parallel method completely achieves on-line real-time or even over-real-time calculation speed and can be applied to the practical system's on-line transient stability analysis [12]. The simulation of a command-and-control system makes use of computer simulation technology. In a virtual environment, evaluation of the performance of the designed command post system environment, served as the foundation for a review or optimization of system of command posts. This study examined the weaknesses and flaws in present command and control system modeling and recommended an entity-relationship-based command and control system modeling. This study uses command and control system models for power system scenario analysis, in combination with the Lanchester model that considers command efficiency [13].

Michaels, L. *et al.*, carried out research on model-based control system design enhancing quality while also reducing development time, engineering costs, and rework. The time and money spent on hardware and software for each design iteration is saved by evaluating a control system's performance, functionality, and reliability in a simulation environment [4]. This work offers a software tool and approach that not only allows for a complete system simulation early in the design cycle, but also substantially simplifies model development by automatically integrating the components and subsystems that make up the model. The control system can be developed early in the vehicle or powertrain design cycle using this approach, which incorporates plant models, algorithm models, existing controller code, and architectural constructs to greatly speed up the creation of a system simulation that can be used for algorithm development, testing, and validation.

Naşcu, I. *et al*, carried out research on the model of a laboratory level control system. The model for each component in the system was based on both theoretical and experimental findings. This paper describes the steps involved in creating an accurate model of a laboratory level control system. A method to solve parameters of load model frequency characteristics was provided based on extensive research on frequency characteristics of power loads [14]. The weighted total of each static load component's power in the load station was used to determine the static load frequency factor. The load frequency parameters of power generators cluster in the entire load station were calculated using a combination of the statistic synthesis method and the fault fitting method. Simulation results demonstrated the efficiency of the proposed strategy [15].

Qing, K. *et al.*, carried out a study on the permanent magnetic linear generator, generator side converter, grid side converter, controller, and grid as part of a directly driven wave power generating system that is connected to a power grid. The following control strategies were presented based on the back-to-back converter structure: The generator side converter was subjected to vector decoupling management in order to maximize power extraction from wave energy; Grid voltage-oriented control was employed to make the current sinusoidal and achieve unit power factor control on the grid side converter. Due to the voltage fluctuation of the DC link when using the standard method, a power feed forward method was proposed to keep the DC link voltage steady and increase the system's dynamic response [16].

In Matlab/Simulink, simulation model for the entire system was created, and simulation results confirmed that the proposed control approach is practical and successful. Due to the high randomness of wind power, a higher demand for load frequency control in the power system was made. The load frequency control strategy is based on the wind power prediction by Kalman, filter was proposed to reduce the influence on the system frequency using the interconnected power grid with wind power as the research object. On the contrary, the Kalman filter technique was initially employed to estimate wind power. The load frequency controller was then designed using the expected wind power. A load frequency control model for an interconnected power system was also constructed [17]. This control strategy was applied to a four-area power system with integrated wind power (multi-energy injection for continuous energy harvest) in three areas [18]. The simulation results obtained using MATLAB/Simulink showed that the suggested load frequency control technique based on Kalman filter wind power prediction successfully reduced frequency fluctuation and kept the system frequency fluctuation within a narrow range. When compared to traditional PID-based load frequency control, simulation findings showed that it outperforms [19].

3. Methodology

This research considers modelling and simulation of an intelligent master controller model for deployment in hybridized power pool applications. The closed loop block diagram of the Intelligent master controller is formed and deduced into block format and mathematically represented (formular) in differential equation order to derive at the system parameters. This mathematical model uncovers the system parameter which is then simulated to validate the system internal behaviour. The suitable stability criteria of the system would also be considered.

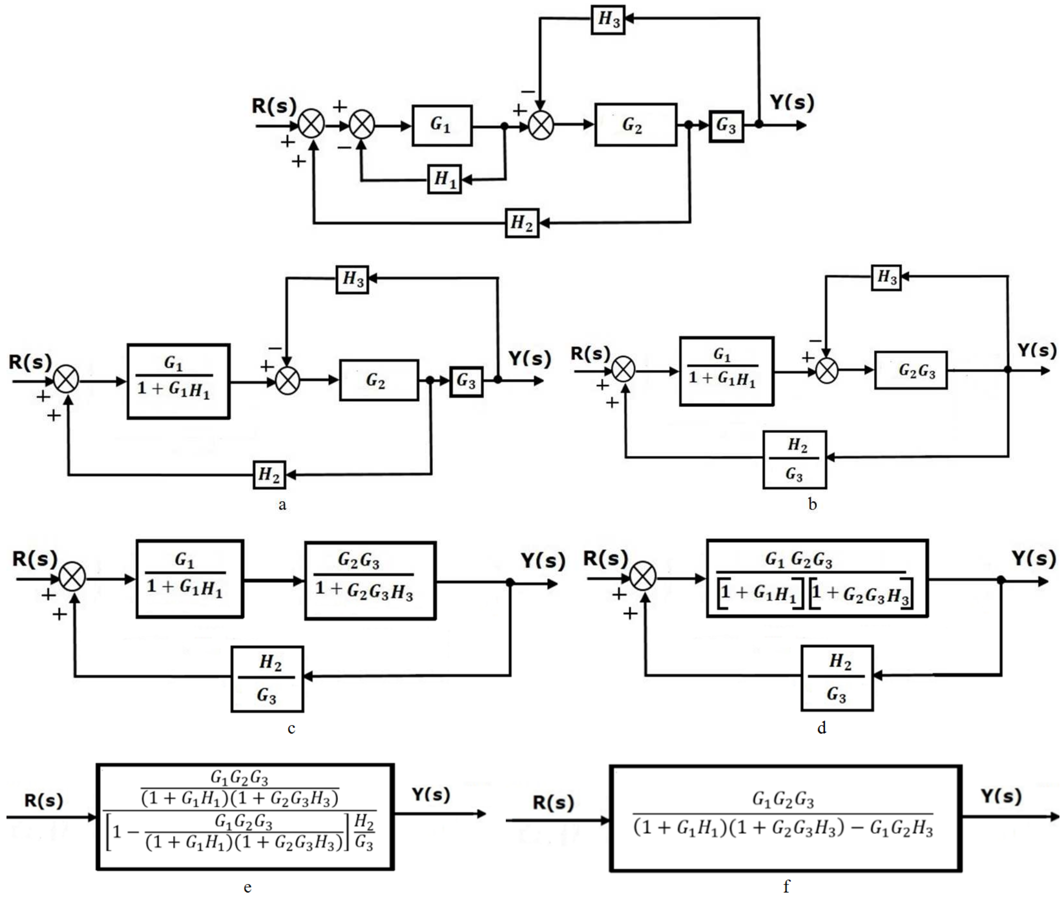

Figure 1. *Closed Loop Control Model for Intelligent Master Controller.*

G_1 represent input from Grid power supply
H_1 represent the loop gain from Grid power supply input
G_2 represent input from Renewable power supply
H_2 represent the loop gain from Renewable power supply input
G_3 represent input from Generating Set power supply
H_3 represent the loop gain from Generating Set power supply input

3.1. Modelling

Modelling entails the process of representing a system with block diagrams. The block helps to determine its sub-system parameters whereas differential equations are mostly used in modelling of control systems. This design takes into consideration the general closed loop system which comprises of the input, output, feedback, controller and the plant to model the intelligent master controller system. This system is designed using multiple input single output (MISO) model. it has three-input system that is reducing to a single system model with the block represented in Figure 1.

The reduced block diagram gives the transfer function for the intelligent master controller model.

$$Transfer\ Function = \frac{Y(s)}{R(s)} = \frac{G_1G_2G_3}{(1+G_1H_1)(1+G_2G_3H_3)-G_1G_2H_3} \quad (1)$$

The input follows the unit step function U(t)

$$u(t) = 1; t \geq 0\ and\ u(t) = 0; t < 0 \quad (2)$$

The controller is in the ON/OFF (digital system) mode. The feedback is given by $H = 1$ which is in s-domain = $\frac{1}{s}$ and in first order system; the transfer function is given as

$$TF = \frac{G(s)}{1 \pm G(s)H(s)} \quad (3)$$

whereas in the second order system, the transfer function

$$G(s) = \frac{\omega_n^2}{S^2+2\zeta\omega_n S+\omega_n^2} \quad (4)$$

and is adopted from the system model.

Equation (4) is substituted into equation (1), and this gives equation (5)

$$\frac{\left(\frac{\omega_n^2}{S^2+2\zeta\omega_nS+\omega_n^2}\right)\left(\frac{\omega_n^2}{S^2+2\zeta\omega_nS+\omega_n^2}\right)\left(\frac{\omega_n^2}{S^2+2\zeta\omega_nS+\omega_n^2}\right)}{\left(1+\frac{\omega_n^2}{S^2+2\zeta\omega_nS+\omega_n^2}\times\frac{1}{s}\right)\left\{1+\left(\frac{\omega_n^2}{S^2+2\zeta\omega_nS+\omega_n^2}\right)\left(\frac{\omega_n^2}{S^2+2\zeta\omega_nS+\omega_n^2}\right)\right\}\frac{1}{s}-\left(\left(\frac{\omega_n^2}{S^2+2\zeta\omega_nS+\omega_n^2}\right)\left(\frac{\omega_n^2}{S^2+2\zeta\omega_nS+\omega_n^2}\right)\times\frac{1}{s}\right)} \quad (5)$$

$$\frac{Y(s)}{R(s)} = \frac{\left(\frac{\omega_n^2}{S^2+2\zeta\omega_nS+\omega_n^2}\right)^3}{1+\left(\frac{\omega_n^2}{S^2+2\zeta\omega_nS+\omega_n^2}\right)\frac{1}{s}+\left(\frac{\omega_n^2}{S^2+2\zeta\omega_nS+\omega_n^2}\right)^3\times\frac{1}{s^2}}$$

$$= \frac{\left(\frac{\omega_n^2}{S^2+2\zeta\omega_nS+\omega_n^2}\right)^3}{\frac{1}{1}+\left(\frac{\omega_n^2}{S^2+2\zeta\omega_nS+\omega_n^2}\right)s+\frac{(\omega_n^2)^3}{s^2(S^2+2\zeta\omega_nS+\omega_n^2)^3}}$$

$$= \frac{S^2(S^2+2\zeta\omega_nS+\omega_n^2)+S\omega_n^2+(\omega_n^2)^3(S^2+2\zeta\omega_nS+\omega_n^2)^3}{S^2(S^2+2\zeta\omega_nS+\omega_n^2)}$$

$$= \left(\frac{\omega_n^2}{S^2+2\zeta\omega_nS+\omega_n^2}\right)^3 \times \frac{S^2(S^2+2\zeta\omega_nS+\omega_n^2)}{S^2(S^2+2\zeta\omega_nS+\omega_n^2)+\omega_n^2S+(\omega_n^2)^3(S^2+2\zeta\omega_nS+\omega_n^2)^2}$$

$$= \frac{(\omega_n^2)^3}{(S^2+2\zeta\omega_nS+\omega_n^2)^2} \times \frac{S^2}{S^2(S^2+2\zeta\omega_nS+\omega_n^2)+\omega_n^2S+(\omega_n^2)^3(S^2+2\zeta\omega_nS+\omega_n^2)^2}$$

$$= \frac{(\omega_n^2)^2}{(S^2+2\zeta\omega_nS+\omega_n^2)^2} \times \frac{S^2}{S^2+2\zeta\omega_nS^2+\omega_n^2+\omega_n^2S^2+\omega_n^2S+(\omega_n^2)^3(S^2+2\zeta\omega_nS+\omega_n^2)^2}$$

$$= \frac{(\omega_n^2)^2}{(S^2+2\zeta\omega_nS+\omega_n^2)^2} \times \frac{S^2}{\omega_n^2(S^2+3\zeta\omega_nS^2+S)+(\omega_n^2)^2(S^2+2\zeta\omega_nS+\omega_n^2)^2}$$

$$= \frac{S^2(\omega_n^2)^2}{(S^2+2\zeta\omega_nS+\omega_n^2)^2(S^2+3\zeta\omega_nS^2+S)+(\omega_n^2)^2(S^2+2\zeta\omega_nS+\omega_n^2)^2}$$

The equation (5) in S-Domain gives equation (6)

Assuming the initial value of the $\zeta = 0.5\ and\ \omega_n = 1$

$$\frac{Y(s)}{R(s)} = \frac{S^2}{(S^2+S+1)^2(2.5S^2+S)+(S^2+S+1)^2} \quad (6)$$

$$\frac{Y(s)}{R(s)} = \frac{S^2}{(S^2+S+1)^2(2.5S^2+S+1)}$$

$$\frac{Y(s)}{R(s)} = \frac{S^2}{(S^4+2S^3+3S^2+2S+1)(2.5S^2+S+1)}$$

$$\frac{Y(s)}{R(s)} = \frac{S^2}{2.5S^6+6S^5+10.5S^4+10S^3+7.5S^2+3S+1}$$

$$R(s) = X(S)$$

The system from the transfer function in equation (6) provides the polynomial characteristics equation for the intelligent master controller equation (7)

$$Y(S)[\,2.5S^6 + 6S^5 + 10.5S^4 + 10S^3 + 7.5S^2 + 3S + 1] = S^2X(S) \tag{7}$$

The higher order differential equation (7) for the model becomes equation (8);

$$2.5y^{''''''} + 6y^{'''''} + 10.5y^{''''} + 10y^{'''} + 7.5y^{''} + 3y^{'} + y = \ddot{x} \tag{8}$$

Converting equation (8) to state space gives:

$$x_1 = y$$

$$x_2 = y' = \dot{x}_1$$

$$x_3 = y'' = \dot{x}_2$$

$$x_4 = y''' = \dot{x}_3$$

$$x_5 = y'''' = \dot{x}_4$$

$$x_6 = y''''' = \dot{x}_5$$

The state space is given by

$$\dot{x}(t) = Ax(t) + Bu(t) \tag{9}$$

$$\dot{y}(t) = Cx(t) + Du(t)$$

$$U(t) = u$$

$$2.5x_6 + 6x_6 + 10.5x_5 + 10x_4 + 7.5x_3 + 3x_2 + x_1 = U\ddot{(t)}$$

$$\dot{x}_6 = \frac{6}{2.5}x_6 + \frac{10.5}{2.5}x_5 + \frac{10}{2.5}x_4 + \frac{7.5}{2.5}x_3 + \frac{3}{2.5}x_2 + \frac{1}{2.5}x_1 + u(t)$$

$$\dot{x}_5 = x_6 + 0 + 0 + 0 + 0 + 0 + 0$$

$$\dot{x}_4 = 0 + x_5 + 0 + 0 + 0 + 0 + 0$$

$$\dot{x}_3 = 0 + 0 + 0 + x_3 + 0 + 0 + 0$$

$$\dot{x}_2 = 0 + 0 + 0 + 0 + x_2 + 0 + 0$$

$$\dot{x}_1 = 0 + 0 + 0 + 0 + 0 + x_1 + 0$$

$$\dot{x} = 0 + 0 + 0 + 0 + 0 + 0 + x$$

State matrix gives

$$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\\ \dot{x}_3\\ \dot{x}_4\\ \dot{x}_5\\ \dot{x}_6\end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 & 0 & 0 & 0\\ 0 & 0 & 1 & 0 & 0 & 0\\ 0 & 0 & 0 & 1 & 0 & 0\\ 0 & 0 & 0 & 0 & 1 & 0\\ 0 & 0 & 0 & 0 & 0 & 1\\ -\frac{1}{2.5} & -\frac{3}{2.5} & -\frac{7.5}{2.5} & -\frac{10}{2.5} & -\frac{10.5}{2.5} & -\frac{6}{2.5}\end{bmatrix}$$

$$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\\ \dot{x}_3\\ \dot{x}_4\\ \dot{x}_5\\ \dot{x}_6\end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 & 0 & 0 & 0\\ 0 & 0 & 1 & 0 & 0 & 0\\ 0 & 0 & 0 & 1 & 0 & 0\\ 0 & 0 & 0 & 0 & 1 & 0\\ 0 & 0 & 0 & 0 & 0 & 1\\ -0.4 & -1.2 & -3 & -4 & -4.2 & -2.4\end{bmatrix}\begin{bmatrix}x_1\\ x_2\\ x_3\\ x_4\\ x_5\\ x_6\end{bmatrix} + \begin{bmatrix}0\\ 0\\ 0\\ 0\\ 0\\ 1\end{bmatrix}\ddot{U}(t)$$

$$y = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \\ x_5 \\ x_6 \end{bmatrix}$$

3.2. Stability

Whenever a bounded input gives a bounded output, the system is stable. This is a function of the output/input relationship in the system, whenever there are disturbances in the system, this relationship coordinates the internal performance of the system and decides its stability status. The following are methods for determining the stability of a system.

i. Root Locus

$$General\ Characteristic\ equation = 1 \pm G(s)H(s) = 0$$

$$TF = G(s)H(s) = \frac{numerator\ (Nr)}{denominator\ (Dr)} = \frac{K(s+a)(s+b)\ldots\ldots\ldots}{s^n(s+a_1)(s+b_1)\ldots\ldots\ldots} \quad (10)$$

Zeros are the value of S at the numerator, $when\ Nr = 0;\ s = -a, -b \ldots\ldots\ldots$
while poles are the value of S at the denominator, $when\ Dr = 0;\ s = 0, -a_1, -b_2 \ldots\ldots\ldots$

The equation would be split into two to determine the equating angles and the magnitude.

$$|G(s)H(s)| = 1; the\ magnitude\ creteria$$

$$< G(s)H(s) = 1; the\ angle\ creteria$$

ii. Nyquist Criterion

$$TF = \frac{G(s)}{1 \pm G(s)H(s)} = \frac{G(s)}{1 \pm L(s)}$$

$$L(s) = loop\ gain = G(s).H(s)$$

$$1 \pm L(s) = 0 \quad (11)$$

For the system to attain stability the poles will be on the left half of the s-plane.

iii. Routh Hurwitz Criterion

The characteristics equation for equation (3) is required for the R-H stability determination.

$$General\ Characteristic\ equation = 1 \pm G(s)H(s) = 0$$

$$1 \pm G(s)H(s) = 0 = a_0 s^n + a_1 s^{n-1} \ldots\ldots\ldots + a_{n-1} s^1 + a_n$$

$$Characteristic\ equation = a_0 s^n + a_1 s^{n-1} \ldots\ldots\ldots + a_{n-1} s^1 + a_n \quad (12)$$

Routh Hurwitz Criterion is further evaluated using the Routh Array (12)

(a) (b) Controllability

$$(A, B) = [B|AB|A^2B|\ldots\ldots|A^{n-1}B] \quad (13)$$

(b) (c) Observability

$$(C, A) = \begin{bmatrix} C \\ CA \\ CA^2 \\ \vdots \\ CA^{n-1} \end{bmatrix} \quad (14)$$

3.3. Simulation

The model was simulated in MATLAB/Simulink to obtain and validate the system parameters emanated from the mathematical model of the intelligent master controller. The Simulation result is presented and discussed in section IV.

4. Result of Intelligent Master Controller Modelling and Simulations

The result obtained from the modelling and simulation environment, MATLAB/Simulink, is presented in this section. In a bid to ascertain the system stability status, the following stability criteria were considered in view of selecting the most suitable outcome. Furthermore, the internal behavior of the systems was ascertained through the observation of the controllability and observability of the modelled system. The mathematical representation unveiled that the model has a high order differential equation showing that it is a higher order control system. Time response of the system showed that it was critically damped in view of its unit step function.

4.1. Intelligent Master Controller Stability Analysis

4.1.1. The Root Locus Plot

The stability of the intelligent master controller is described by the root locus plot in Figure 2. Condition for stability holds true when the poles of a system's characteristic equation lies on the negative half plane of the root locus to the magnitude of -0.5 and false for poles on the positive half. From the result obtained from Figure 2, the system can be said to be stable since the poles exist at the negative axis of the plot. The performance gain of the system can also be computed from the plot.

4.1.2. Nyquist Plot

Figure 3 shows the Nyquist plot of the complex margin gain (dB) of 8.32 and all frequencies of the phase (rad/s) of 1.13. This is an indication that the closed loop intelligent master controller is stable.

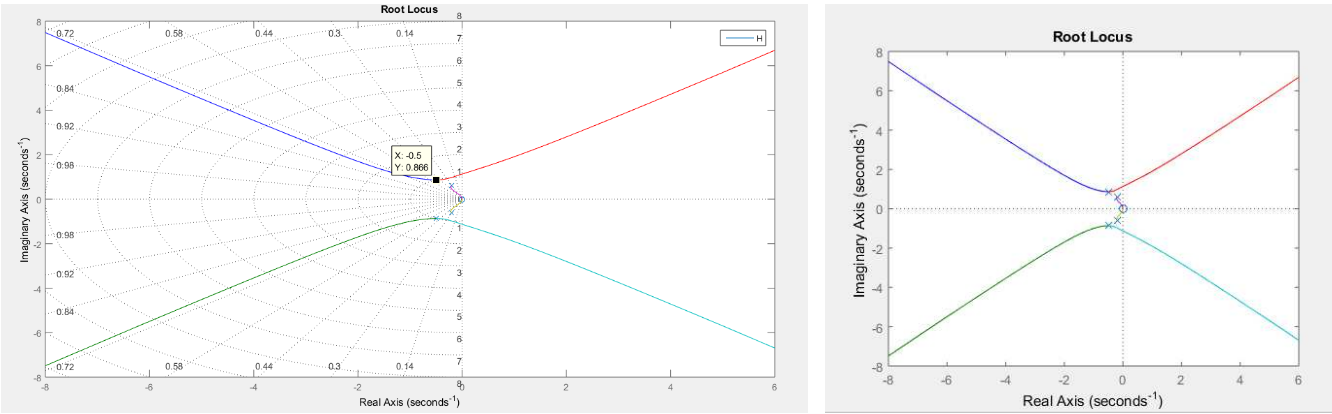

Figure 2. *Root Locus Plot of the intelligent master controller.*

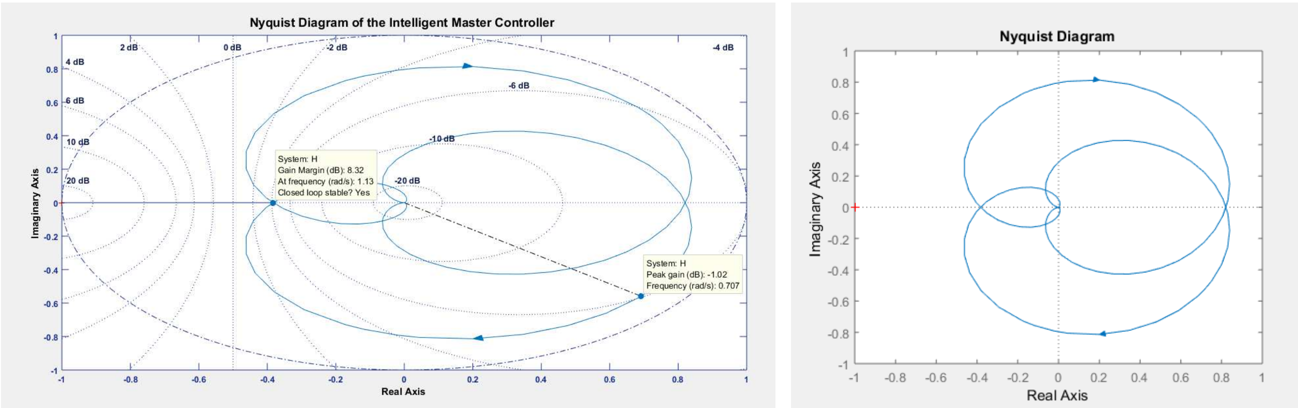

Figure 3. *Nyquist Plot of the intelligent master controller.*

4.1.3. Routh Hurwitz (RH) Stability Modelling

The denominator of the transfer function gives the higher order polynomial as its characteristic equation for the intelligent master controller model. The Routh Hurwitz (RH) stability test with the higher order polynomial equation (8) below gives the results in the Array in Table 1, this shows that the system is stable.

$$2.5S^6 + 6S^5 + 10.5S^4 + 10S^3 + 7.5S^2 + 3S + 1 = 0$$

All the coefficient of characteristic polynomial has same sign; thus, the equation has fulfilled the RH criterion for stability assessment.

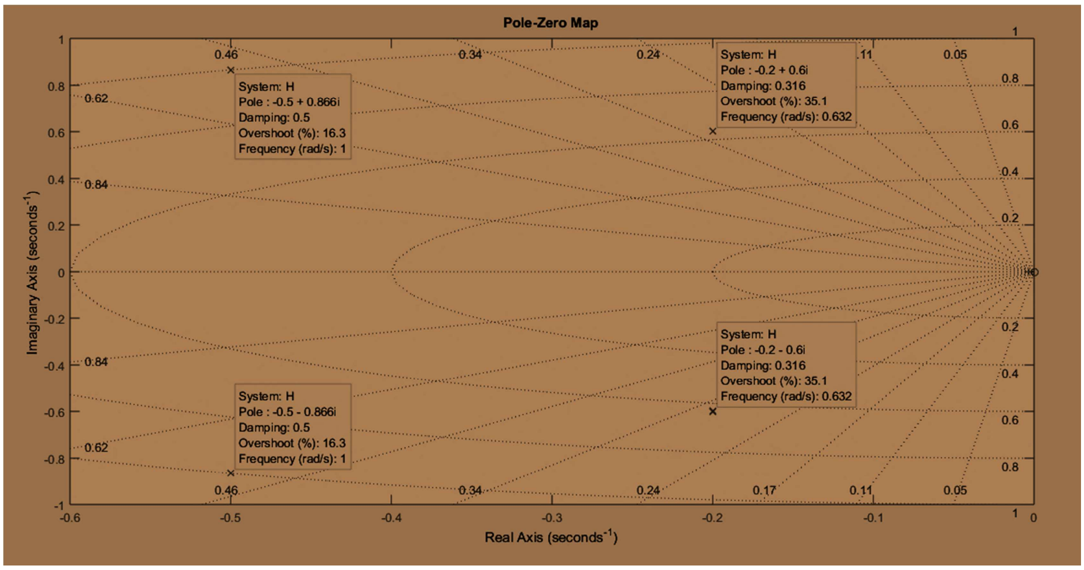

Figure 4. *Poles and Zero Plots of the intelligent master controller.*

Table 1. *The Routh Hurwitz Array.*

S^6	2.5	10.5	7.5	1
S^5	6	10	3	0
S^4	6.33	6.25	1	0
S^3	4.08	2.05	0	0
S^2	3.06	1	0	0
S^1	0.72	0	0	0
S^0	1	0	0	0

In Figure 4 the poles and zero plots for the intelligent master controller, the first two poles are located at the left-half S-Plane to the magnitude of -0.5 each with the damping of 0.5, the percentage overshoot of 16.3 and frequency of 1rad/s. The second two poles are located at the left-half S-Plane to the magnitude of -0.2 with the damping of 0.316, percentage overshoot of 35.1 and frequency of 0.632.

4.2. Controllability

The system Controllability test was carried out on the intelligent master controller model using MATLAB and the results shows that the develop system was stable. This result in Table 2, validates the controllability matrix condition in equation 13 and [17, 3].

Table 2. *Matrix Array of the Intelligent Master Controller System Controllability.*

Controllable Matrix is Co =					
0	0	0	0	0	1.0000
0	0	0	0	1.0000	-2.4000
0	0	0	1.0000	-2.4000	1.5600
0	0	1.0000	-2.4000	1.5600	2.3360
0	1.0000	-2.4000	1.5600	2.3360	-5.5584
1.0000	-2.4000	1.5600	2.3360	-5.5584	3.2890
Given System is Controllable					

4.3. Observability

The system observability test was carried out on the intelligent master controller model using MATLAB and the results shows that the develop system was observable. This result in Table 3. validates the observability Matrix condition in equation (14) and [3].

Table 3. *Matrix Array of the Intelligent Master Controller System Observability.*

Observable Matrix is Ob =					
1	0	0	0	0	0
0	1	0	0	0	0
0	0	1	0	0	0
0	0	0	1	0	0
0	0	0	0	1	0
0	0	0	0	0	1
Given System is Observable					

4.4. Step Unit Response of the Intelligent Master Controller with MATLAB

The unit step input response model in equation (7) presents the transient, steady state and disturbance status of the intelligent master controller. Figure 5 shows the output step response for a higher order system model, which is the time domain performance characteristic of the intelligent master controller model. The following parameters were deduced from the response, settling time of 29.5s, rise time of 0s, peak overshoot of infinite value at a time 6.91s, peak amplitude of -0.213 and a final steady state time of 0s. The stated data as collated from the figure 5, indicates the property of the system model to attain a settling time due to a delay in the transient response of the system. In conformity with the condition of critical dampness, the system roots of the intelligent master control provide stable result. This is in validation of the stability preposition by researcher in [11, 3, 7, 6] for the multiple power source scenario.

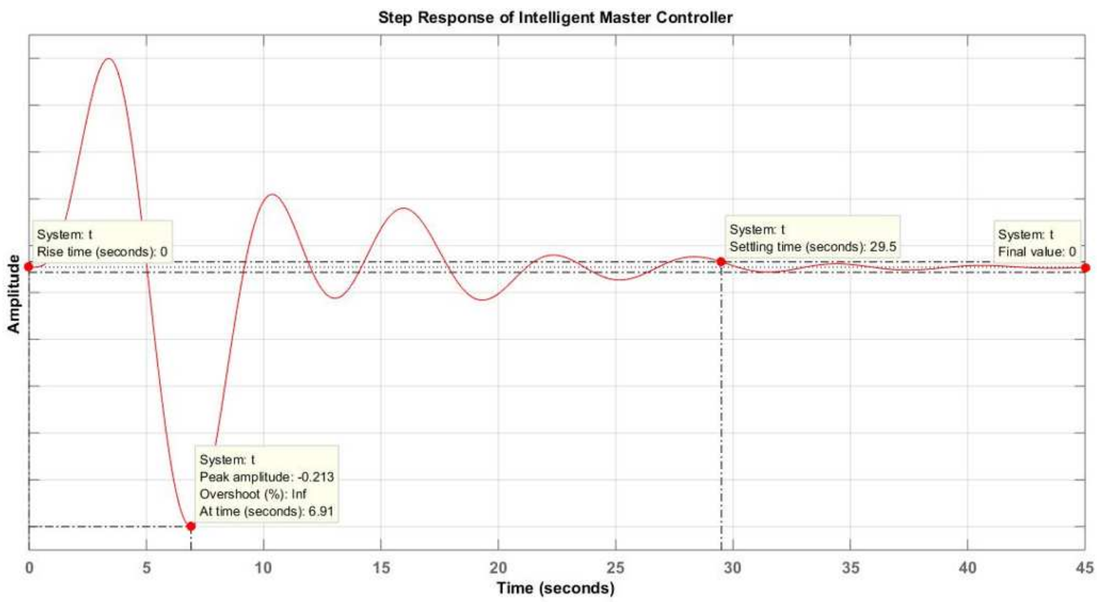

Figure 5. *System response of the intelligent master controller with MATLAB.*

4.5. The Intelligent Master Controller Model with Simulink

The unit step input response model in equation (7) was inputted into the Simulink model in figure 6 and the result from the scope is presented in Figure 7.

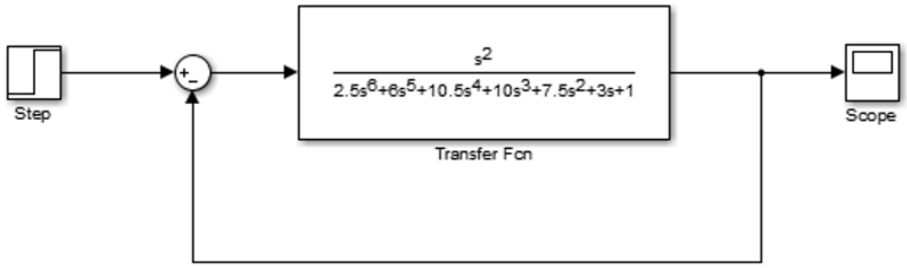

Figure 6. *System Model of the intelligent master controller with Simulink.*

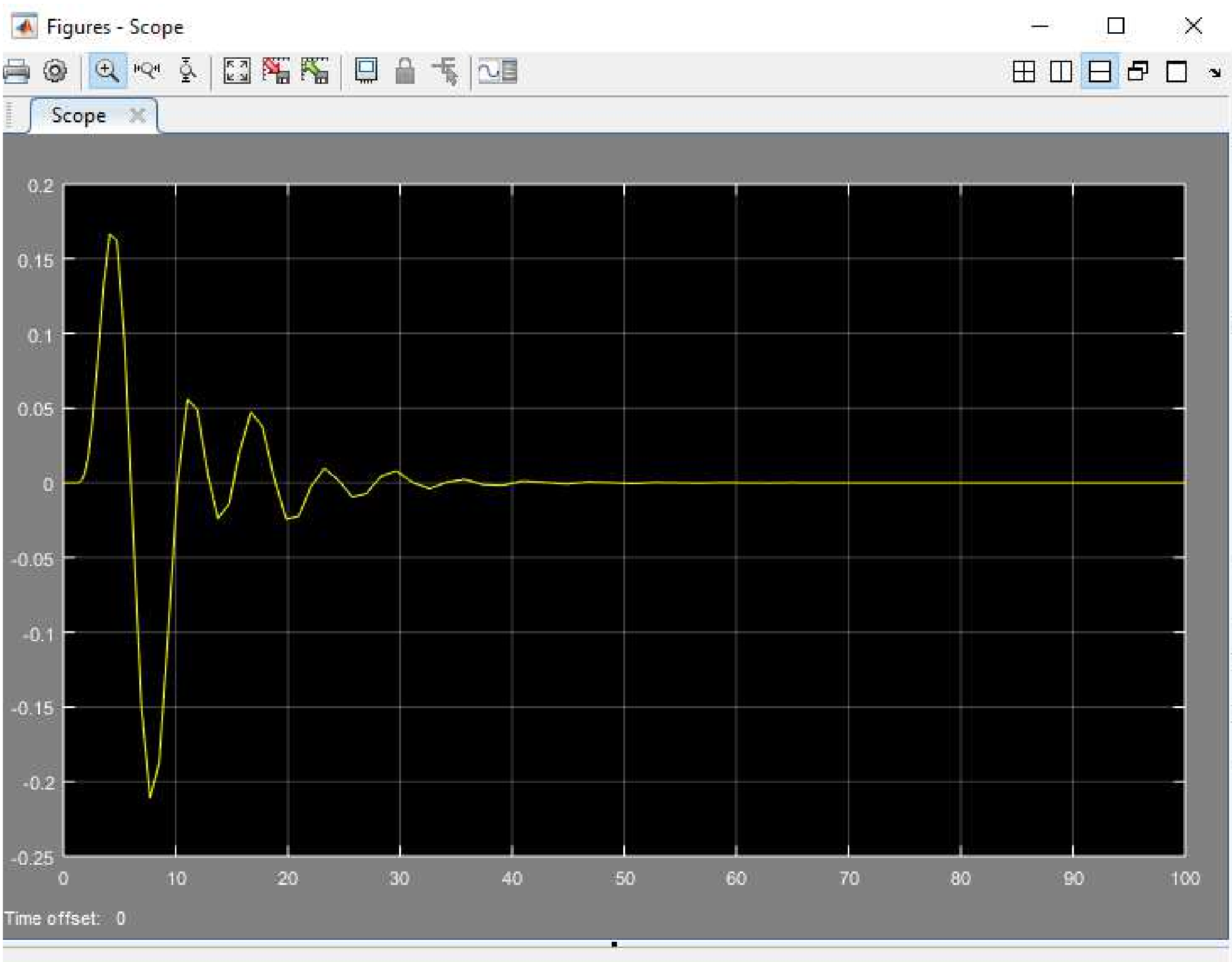

Figure 7. *System response of the intelligent master controller with Simulink.*

In Figure 5 and Figure 7, the System response of the intelligent master controller for both the MATLAB model and that of the Simulink are the same, this validates the performance of the system in term of its time response.

5. Conclusion

The intelligent master controller for hybridized power pool deployment was modelled. The mathematical model for the intelligent master controller to be integrated in the hybridized power pool deployment was derived, and simulations analysis were done using MATLAB/Simulink. The system stability was determined using Root locus, Nyquist criterion and Routh Hurwitz criterion. Furthermore, tests for observability and controllability that were carried out on the intelligent master controller model using MATLAB, shows that the system is stable.

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