Application Ant Colony Optimization for Load Frequency Control in Wind Diesel Hybrid Power System

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ABSTRACT- Changes in frequency fluctuations greatly affect the quality of power in renewable energy sources wind turbines with diesel hybrid. Hybrid system is a network controlled from several renewable energy power generation such as wind turbines, solar cells, micro-hydro and so on. There are several problems that can increase low frequency oscillations, such as the setting is not optimal gain and the small time constant of the Automatic Voltage Regulator, too many transmission lines are long so the ability is weak (weak line). In application of wind-diesel system is controlled with a PID controller, but the tuning of PID gain values are still in the trial-error methods alone, making it difficult to obtain the optimum value of the PID. In this study applied to design control by using Smart method in finding the optimum value proportional integral derivative (PID) to set the frequency of the load with Matlab / Simulink. Modeling wind-diesel using a transfer function diagram of the wind turbine and diesel. Response system with Simulink / Matlab by comparing the uncontrolled system and method PID-Trial Error, indicating that a large overshoot and steady state response (Settling Time) on the controlled system ACO became less and faster.
Keywords: Wind-Diesel, PID, ACO, Frequency, Overshoot, Settling time

1. INTRODUCTION

In previous research studies discuss the operational stability of hybrid system frequency regulation techniques and discuss the combined technique of fuel cell systems and hybrid electrolysis to improve the system's ability mikrogrid in improving power quality of frequency fluctuation problem. Arrangements proposed and monitoring systems (monitoring) which dilakkan is to maintain power quality, as well as to maintain the stability of fluctuations in frequency due to power random in the generation as well as on the load side as well to maintain the stability of fluctuations in power flow in tieline power flow due to fluctuations in the frequency of hybrid systems interconnection.

Several studies have addressed the frequency setting on Wind-Diesel, among others, T.S. Bhatti, (1995), S.C.Tripathy. (1995), T.S. Bhatti, (1997), Thomas, P. (2003), Robandi, I. (2006), Abidin, Z. (2010), Mohit Singh. (2011), Tan Wen, (2011), Hou, J. (2012), Djalal MR (2015). Frequency of some regulatory issues that cause fluctuations in power flow in various types of hybrid systems connected generation, the researchers took the theme Setting Frequency In Hybrid Power System with Intelligent Methods Ant Colony Optimization (ACO).

2. HYBRID SYSTEM

The power system of hybrid diesel-wind turbines stand alone may be economically applied in some cases the provision of electrical energy in remote areas eg mountainous regions or islands where the level of wind speed was significant enough to drive a generator to produce electricity but for the supply of energy on a network system connected uneconomical , Abidin, Z. (2010). Expected results from the electric energy generation hybrid system Wind Turbine-Diesel can supply good service for the service of the burden to consumers, but it all depends on the type and characteristics of the control of generation. This means that the variation frequency of the system should be maintained stability so that the equipment can operate properly and efficiently. Different strategies can be implemented by reducing the differences of generation and load and set the system frequency deviation. The strategies that can be done by setting a mock load control, load control switching priorities, the use of flywheel, superconducting magnetic energy storage systems and batteries. To be able to display the detailed analysis of the study of diesel hybrid system of wind turbines and micro-hydro with a small transfer signal model. Selection of the optimal gain control of suggested using ISE techniques for case-control continuous and discrete control. Problems that occur in the generation of the oscillation frequency is low. It arises because:

- The high gain setting and low time constant of the Automatic Voltage Regulator (AVR).
- Too many transmission lines are long so the ability is weak (weak line).

To overcome the problem of high gain at AVR, before we discuss briefly the transfer function of the AVR to make it easier to understand the effect of the gain and time constant AVR. Basically a high gain on the AVR has a purpose:

- The higher the gain, the terminal voltage of the generator to be controlled properly, because the goal of the AVR is making the terminal voltage stable.
- The higher the gain on the AVR, it also raises the side effects, namely the weakening of the damping ability (negative damping) of the generator so that the potential emergence of low frequency oscillations.

Of the two reasons above, it can be concluded that setting the gain on the AVR is something very important, because if it is too low will cause instability monotik and if it is too high will cause low frequency oscillations.

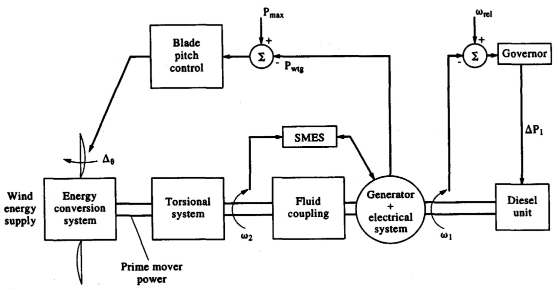

Figure 1. Model Concept Diesel and Wind Turbines

3. PID TUNING PID WITH ACO

Figure 4 shows a flow diagram of the PSO algorithm method used in this research to tune PID parameters. The objective function is used to Integral Time Absolute Error (ITAE)

$$ITAE = \int_{0}^{t} t\left|\Delta\omega(t)\right| dt \qquad (1)$$

PID parameters are tuned by the ACO is Kp, Ki and Kd. Here modeling for each model of control in Matlab Simulink, 2013, to Wind-Diesel without control, with PID-Trial, and the PID-PSO.

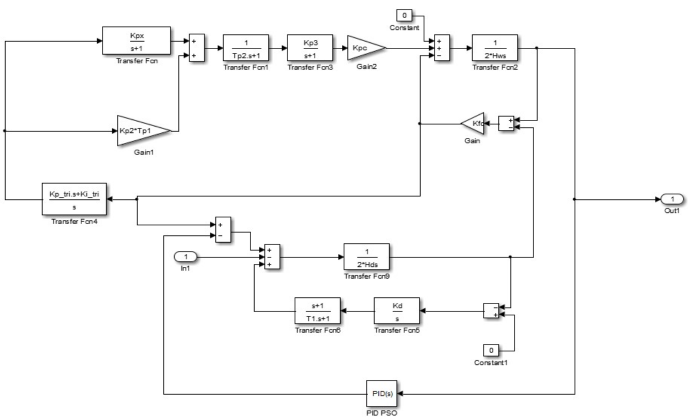

Figure 2. Modeling Simulink PID-ACO

4. RESULT AND ANALISYS

The data parameters following ACO.

Table 1. Parameter ACO

Parameter	Nilai
Node	100
Max_It	50
Alpha	1
Beta	2
rho	0.1
c	100
L_Best	Inf
T_Best	0

Here are the results of the optimization methods ACO.

Table 2. Results of Optimization PID with ACO

```
L_best =
  4.0799e-05
T_best =
  73.3716   43.6963    8.8183
kp_ff =
  73.3716
ki_ff =
  43.6963
kd_ff =
   8.8183
Elapsed time is 129.189948 seconds.
```

Results ACO optimization fitness function values obtained by 4.0799e-05, with 50 iterations.

Table 3. Results of CES-PID Parameter Tuning

Parameter	**Constraint**		**ACO Result**
	Lower	**Upper**	
Kp	80	90	73.3716
Ki	50	60	43.6963
Kd	10	15	8.8183

Wind-Diesel Frequency Response Using PID Controller-ACO

Next simulation using PID controller-ACO, from the simulation results obtained:

Can be seen from the image above, the results of the frequency response for Wind-Diesel system with PID controller-ACO. From the graph can also be seen that the value overshoot and settling time its value is as the following table.

Value overshoot on these systems become smaller, amounting -8.573e-05 until 1.094e-09 shows that when the system is experiencing changes in the load or disturbances, the system frequency insulated fell by -8.573e-05 pu, and will return on value her steady after having> 5.2 seconds. From the results that have been simulated, the following can be seen the comparison model has been simulated.

Tabel 3. Nilai *overshoot* dan s*ettling time* sistem dengan *controller PID-ACO*

Karakteristik	Overshoot (pu)	Settling time (detik)
Uncontrol	-0.0002344 & 2.15e-05	13,2
Trial Method	-0.0002227 & 1.076e-05	12,8
Ant Colony Optimization	-8.573e-05 & 1.094e-09	5,2

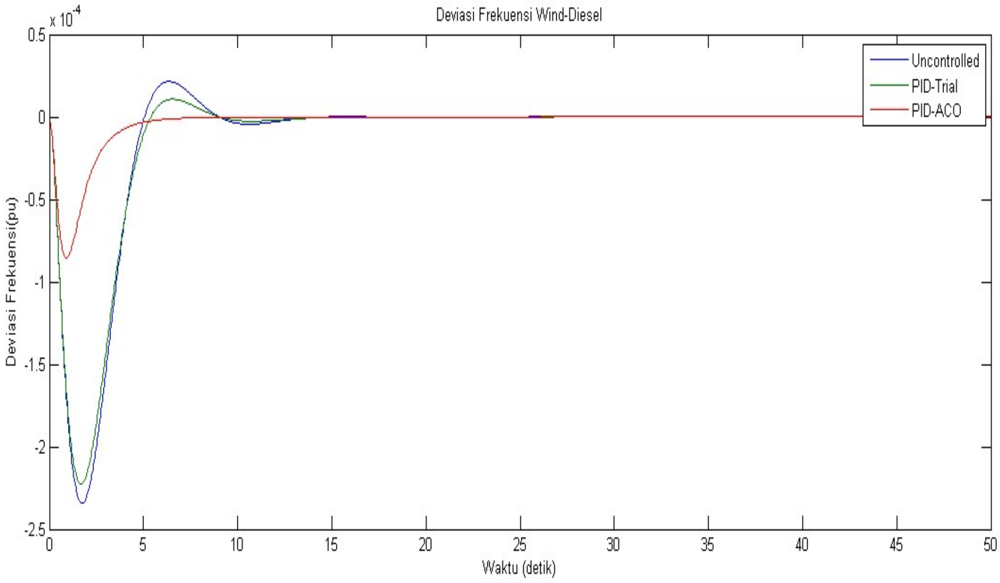

Figure 3. Graph comparing the frequency response of the four controllers

Of the three models of hybrid power generation system wind-diesel has been simulated, it can be concluded that a wind-diesel power plant controller as a damper requires absolute frequency oscillations caused by load changes. PID Controller-ACO proposed in this study had a significant influence on the oscillation damping and suitable to be applied to hybrid generating system Wind-Diesel, where to penalaannya method using intelligent methods Artificial Intelligent Ant Colony Optimization.

5. CONCLUSION

By using intelligent methods Ant Colony Optimization (ACO) as a method of PID controller tuning, parameter tuning results obtained optimum PID values where, Kp = 73.3716, Ki = 43.6963, Kd = 8.8183.

By using the PID-ACO on the control system Load Frequency Control (LFC) designed, can improve the frequency response of a system Wind-Diesel. This is indicated by the value of settling time of 5.2 seconds is the value of the fastest settling time and overshoot value of -8.573e-05 until 1.094e-09 pu which is the smallest overshoot value of the other controller models.

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