SCHEDULING AND POWER DISTRIBUTION SYSTEM ON DIESEL POWER PLANT IN NORTH SULAWESI USING GENETIC ALGORITHM

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Abstract

Research regarding scheduling and power distribution system on diesel power plant in North Sulawesi using genetic algorithm has been done. This research was conducted to provide a new approach for scheduling and power distribution in North Sulawesi. Method of genetic algorithm is used in this study to address the problem of scheduling and distribution system of diesel power plant. Method of genetic algorithms is a heuristic search algorithm that mimics the mechanisms of biological system. Under this concept, the problem will be solved using the pattern of biological evolution. Solutions for solving problems will apply the method of *selection*, *crossover*, and *mutation*. Scheduling using genetic algorithm can optimize the scheduling done by by PT. PLN North Sulawesi, Minahasa System AP2B. Based on the results and the discussion it can be concluded that the genetic algorithm can be used as an efficient method for scheduling and power distribution system on the diesel power plants in North Sulawesi.

Keywords: *Genetic Algorithm, Scheduling, Power Distribution, Power Plant North Sulawesi.*

Abstrak

Penelitian menyangkut penjadwalan dan distribusi daya pada pembangkitan listrik tenaga diesel di Sulawesi Utara dengan menggunakan algoritma genetik ini telah dilakukan untuk memberikan pendekatan baru terhadap permasalahan pembangkitan ini. Metode algoritma genetik adalah algoritma pencarian *heuristic* yang meniru mekanisme evolusi yang terjadi secara biologis. Melalui konsep ini, masalah yang akan dipecahkan didekati dengan pola evaluasi biologi. Solusi pemecahan masalah yang terbaik menerapkan metode **seleksi**, ***crossover***, dan **mutasi**. Penjadwalan dengan menggunakan algoritma genetik dapat mengoptimasi penjadwalan yang dilakukan oleh oleh PT. PLN Sulawesi Utara, AP2B Sistem Minahasa. Berdasarkan hasil dan pembahasan ini maka dapat disimpulkan bahwa algoritma genetik dapat dijadikan metode yang efesien untuk penjadwalan pembangkit dan distribusi pembebanan pada sistem pembangkit listrik tenaga diesel di PLN Sulawesi Utara.

Kata Kunci: *Algoritma genetik, Penjadwalan, Distribusi Daya, PLN Sulawesi Utara.*

1. Introduction

Electric power in North Sulawesi is supplied by several types of power plants. One of the power plants mentioned above is the diesel generators.

There are two basic problems in scheduling the generation of the power system. The first is an *unit Commitment* that determines the scheduling of generating units in order to minimize fuel expenses for the system. The second is *economic dispatch* which is a major operation to determine the power that must be supplied from each unit to meet specific load generator, with the goal of decreasing operating costs [1].

In relating to the power scheduling, it is assumed that the power system load for each hour has been determined. On the initial conditions before generating units operated, the magnitude of the load is determined through estimation based on short-term load. Deviation estimation results will only be known after the specified time has elapsed. The deviation occurs due to the large power demand varies with time. On a large power systems, the deviation will significantly lead to lower savings of operating cost, so that the

problems growing is the uncertainty of the implementation of an agreement on the unit load.

Genetic algorithm (GA) approach that is being developed at this time could deal correctly with the issues regarding the uncertainty of the unit commitment operation [2]. *Genetic algorithm* will be able to contribute better in calculating the cost of operation of various power generation system to supply electrical power to the people.

Genetic algorithm is a search algorithm that is based on the process of biological evolution. *Genetic algorithm* mimics artificially the mechanism of natural selection and genetic process. Search for the global optimum in the optimization problem is done through shift an individual in former population to the existing population using operators that is similar to such operators in the genetic process. Each individual represents a candidate for optimization solutions.

The function of an individual evaluation, called *fitness function,* is a sign of the fitness value for each individual in a population. Fitness value is measured for a quality of individual. Basic optimization procedure includes processing individuals who *fit* in an effort to produce better individuals as the search progresses.

Basic cycle of *the genetic algorithm* includes four main processes: 1) fitness evaluations, 2) selection, 3) recombination, and 4) establish a new population. Reproduction includes making new offspring from two parent. *Crossover* operators is responsible for global search as one of the properties of the *genetic algorithm.* Two chromosomes, randomly chosen for *crossover* can produce two offspring [3].

Mutation operator is used to insert new genetic material into the population structure and applied to each new individual. *Objective function* is used to give the value of how an individual has entered the domain of the problem. In connection with the problem of minimization, the most fit individuals will have the lowest value of the *objective function.* Value of the *fitness function* is usually used to change the value of the *objective function* to measure *the relative fitness* [3].

The success of *a genetic algorithm* depends on: 1) *mapping* problem that includes of the transformation of the solution to the problem of representatitve chromosome and 2) the design of *fitness function* as the representative of the quality of the solution. Each chromosome in the population represents a solution to offer.

In an attempt to solve *the schedulling and power distribution* problem through the implementation of *genetic algorithm,* it is required a chromosome that shows an offered schedulling. The output power *(power output unit)* is used as the main variable of a decision, and each *loading* unit is represented by the actual value. Representation on chromosome indicate the minimum and maximum loading limit because the real representation is made just to cover the value between the minimum and maximum limits.

Siregar [4] presents a problem solving of schedulling and power distribution in power systems by also using *a genetic algorithm.* In this method, generating units have some limitations *(constraints)* which should not be exceeded the maximum and minimum limit of power output of the generator.

This study is limited to testing the fuel costs as variable costs as input data on *genetic algorithms* for scheduling and the ammount of that power must be supplied from each generator unit in order to reduce the cost of diesel power plants operating in North Sulawesi.

1.1. Problem Statement

In order to provide a new approach to power system operation in North Sulawesi, the problem statement of the study are as follows:

a. How can scheduling and distribution of power at each generator unit be operated with minimal operating cost and in the proper system?
b. How will *genetic algorithm* based software be used as a controller in the economical operation of power system in order to achieve a minimum operating costs?

1.2. Research Objectives

Based on the explanations mentioned above, this study explore the use of *genetic algorithms* to minimize operating costs through the optimization of power system scheduling and load distribution in among operated generating units.

2. Materials and Methods

The data required in this study were obtained from PT PLN (Persero) Regional Sulutenggo, AP2B System Minahasa. Data analysis was performed using Mathlab Program 7.12.0.635 (R2011a).

2.1. Genetic Algorithm Applications

There are 4 steps of the application of genetic algorithms:

a. develop population consisting of several strings.
b. evaluation each string (fitness value),
c. selection process to obtain the best string,
d. Genetic manipulation (mutations) to create new population of strings.

Structure of diesel power plant for GA are as follows:

a. state fitness f unction (Rp/KWh)
b. state constrains Function (Min-Max Mwatt and input power and diesel)
c. get Minimum Value → genetic algorithm (@ Fitness fuction,@ Constrains function)
d. plotting Result.

Scheduling is done on both a 70 KV and 150 KV power sub-system. Scheduling is performed on Wednesday, January 19, 2011.

3. Results and Discussion

This study successfully developed a genetic algorithm program which is a search program for distribution optimization and analysis of economic operations at PT PLN power plant in North Sulawesi. Figure 1 shows a dialog box of a genetic algorithm for the determination of program scheduling and distributio of electric power generation.

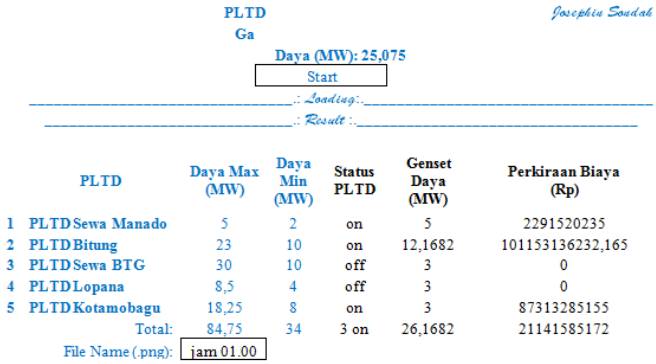

Fig 1. *Dialog Box* of *genetic algorithm* program of diesel power plant of North Sulawesi at 01.00 am on January 19, 2011.

3.1. Scheduling and Distribution Analysis

Data of daily Load Power Plant in North Sulawesi on January 19, 2011 can be seen in Table 1. Results of analysis by using *genetic algorithms* provide different results with scheduling done by PT PLN North Sulawesi (Table I).

From these results it can be seen that the scheduling done by PT PLN North Sulawesi is different compared to scheduling performed by *a genetic algorithm.* For example, when the load is 25.08 MW at 01.00 am, by PLN, the active power plant is the power of 1, 3, and 5. While by the *genetic algorithm,* active power is 1.2, and 5. Consequently, scheduling with ***genetic algorithm*** method produces can decrease daily generation cost as low as **6.64%** (data not shown)**.**

TABLE I
DAILY LOAD OF POWER PLANT IN NORTH SULAWESI ON JANUARY 19, 2011

Jam	Daya yang dibangkitkan pada 5 pembangkit (MW)					Total (MW)
	1	2	3	4	5	
1	2		18		5	25.08
2	2		16			24.06
3	1		11			18.06
4	1		10		5	16.37
5	1		12		5	18.37
6	1		19		5	25.47
7	1		19		5	25.47
8	1		21		5	27.47
9	4		26		13	43.19
10	5		30	2.285	13	50.47
11	5	2.628	30	2.285	12	52.71
12	5		30	2.285	13	50.57
13	5		30		12	47.10
14	5		30		14	49.08
15	5		28		14	47.18
16	5		30		12	47.20
17	5	2.724	30	5.56	14	57.96
18	5	16.281	27	5.56	14	68.76
18.30	5	21.652	29	8.035	14	78.61
19	5	21.652	30	8.035	18	82.77
19.30	5	21.652	30	8.035	18	82.77
20	5	21.652	30	8.035	17	82.37
21	5	21.652	30	8.035	17	82.37
22	5	12.044	30	5.56	14	67.03
23	5		30	5.56	14	54.99
24	4		27		7	38.74

Note:
1. Diesel Manado
2. Diesel Bitung
3. Rent Bitung
4. Diesel Lopana
5. Diesel Kotamobagu

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