Application of PIMOGA for Optimization to Upgrade Drainage Gates in Network

Prudtipong Pengsiri
Faculty of Science and Technology,
Computer Science Division,
Rajamangala University of Technology Suvarnabhumi,
Huntra Campus, Phra Nakhon Sri Ayutthaya, Thailand
prudtipong.p@rmutsb.ac.th

Abstract **- This article presented the application of PIMOGA method (Partition of Initial Population for Multi-objective Genetic Algorithm) for optimization to upgrade drainage gates in network. Seasonal influences had been implicated in using the Fitness Function with the Holt-Winters' Exponential Smoothing method, and the results focused on finding the answer to the wide drainage suitability (Global Solution) and calculated for upgrading the floodgates. The experiments showed that the PIMOGA method was able to determine the suitability of the flood gates for efficiency improvement. The results of the estimation were based on the MAPE tolerance of 0.033, so this research would enhance the performance of the responsible officer.**

Keywords **- Optimization, PIMOGA, Drainage Gates in Network**

I. INTRODUCTION

From the past, it was found that the estimation of the water flow in the Irrigation Department project was a complex calculation method of the parameters used to calculate the amount of water to be drained properly. The input data must be clearly defined so that it was suitable for drainage at one time. It also needed to be reminded of the factors influencing the seasonal influences on drainage. The researcher has studied the solution to the problem of finding the appropriate Multi-objective Optimization Problems (MOOP) [1]. Partition of Initial population for Multi-objective Genetic Algorithm: PIMOGA [2] was applied to find the appropriate estimation of drainage sufficiency by focusing on the results of seasonal water intake and calculating the upgrading of the floodgate, which would be in line with the performance of the project officers.

II. OBJECTIVE

The PIMOGA method was applied to determine the appropriateness of drainage and to calculate the upgrading of the floodgate in the water delivery network.

III. LITERATURE REVIEWS

A. PIMOGA [2]

PIMOGA was the lartition of Initial population for Multi-objective Genetic Algorithm using the random population data and demographic division by means of K-means Clustering. The process was shown in Fig. 1.

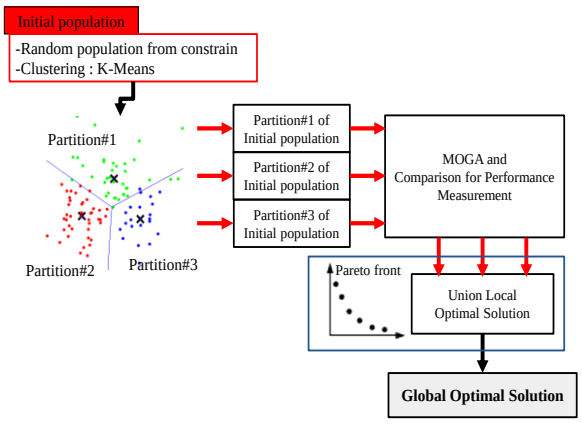

Fig. 1 PIMOGA Process

TABLE I
PARAMETER SET FOR PIMOGA

Parameter	Set value	Details
k	3	Initial Population
Fitness Function Holt-Winters' Exponential Smoothing [3]	α = 0.882, β = 0.051 and γ = 0.312	The predictive equation used in the fitness function was consistent with the trend and seasonal component. The results of α, β and γ were derived from the experiment.
Objectives	S_1, S_2, and S_3	Initial drainage value
Date Time	*dd/mm/yy*	Set the date range for drainage estimation with PIMOGA method.

Based on past research on PIMOGA method [4], we had determined the initial parameters before finding the answer. Therefore, in order to meet the appropriateness of upgrading the floodgate, the parameters were set as follows TABLE I.

B. Comparative PIMOGA. Finding the Multi-Purpose Appropriateness

Comparisons with algorithms for finding appropriateness were consisted of 3 steps: Multi-Purpose Genetic Algorithm Multi-objective Genetic Algorithm: MOGA, [5] Multi-Objective Particle Swarm Optimization Algorithm (MOPSO), [6] and Multi-Objective Evolutionary Algorithm: MOEA) [7] The summary can be summarized in TABLE II.

TABLE II
PIMOGA COMPARISON RESULTS

Objectives Average	PIMOGA	MOGA	MOPSO	MOEA
Min (m^3/s)	-8.235	-8.235	2.152	-2.161
Max (m^3/s)	97.748	97.748	355.770	1.387
Range (m^3/s)	105.983	105.983	353.618	3.549
SD	40.970	40.970	86.109	0.865
Test Activity Measured Time	0.002	0.003	0.003	0.005
Last Generation	113	182	122	122

TABLE II showed that the PIMOGA method had resulted in activity time of 0.002 and the last generation was 113, which is the lowest value compared to MOGA, MOPSO and MOEA. This showed that PIMOGA can be used to effectively calculate to find the upgrade of flood gates in multiple-objective genetic algorithms.

C. Estimation of Drainage Suitability

This was the method of detecting the error of the prediction to find the appropriateness of finding the drainage suitability model by measuring the expected value with MAD MAPE and RMSE.

IV. RESEARCH METHODOLOGY

A. Study the Information about Drainage in the Network

This research drew on the drainage data from water and forest preservation project, Irrigation office 11 [8], Royal Irrigation Department, Ayuthaya since 1995 to 2015, calculated the average daily drainage of each year, which was the initial process of the PIMOGA method.

B. Floodgate Properties in the Drainage Network

Based on preliminary drainage data [9], which correlated in the estimation of upgrade of flood gates and number of flood gates. The

details of the information include: name, width, height, number of gates, maximum capacity (m^3/s) as shown in TABLE III.

Determining the appropriate drainage will depend on the upgrade of the floodgate. Based on PIMOGA's estimated drainage method, It can be calculated using the percentage ratio of the drainage results by comparing with Maximum Capacity. This made it possible to calculate the number of floodgates, and to upgrade the drainage gates. The sixth flood gates data of the project was reviewed such as Rama VI Dam, Narai, Phra Mahinthra, Phra Ekathotsarot, Phra Si Silp, Phra Si Saowaphak. The data for each gate was used from January 1, 1995 to December 31, 2015, totaling 7,670 days.

TABLE III
FEATURES IN EACH FLOOD GATE

Name of flood gates	Width (m)	Height (m)	No. of drainage gates	Maximum Capacity (m^3/s)
Rama VI Dam	12.5	7.8	6	1600
Narai	4.2	3.56	8	250
Phra Mahinthra	5.5	4	6	200
Phra Ekathotsarot	3	3.8	12	190
Phra Si Silp	3.5	3.5	4	85
Phra Si Saowaphak	3.5	3.5	4	85

Application of Optimal Solution, which was the result of each method according to each set of data used in the PIMOGA method, then calculated the average data of each day of the year to refer to the seasonal influence factors in calculation of fitness function, and estimated upgrade of Flood gates with following data features: 1) Estimation of water drainage through PIMOGA method in cubic meters per second (m^3/s), 2) Estimation of the upgrade of floodgate in meters (m), and 3) The number of channels of the floodgate.

V. RESULT OF RESEARCH

A. The Result of Application of Optimal Solution by Using

PIMOGA method in drainage network Based on the daily drainage data of the project in calculating the fitness function to set as the default values for the predictions for drainage such as S1, S2, and S3 (m^3/s) and seasonal influential predictions in Date / Month / Year format (eg 25/01/18) by random selection the testing date and drainage at different locations, as shown in TABLE IV.

TABLE IV
ESTIMATED RESULTS BY USING PIMOGA METHOD

Name of flood gates	Date	S_1 (m^3/s)	S_2 (m^3/s)	S_3 (m^3/s)	Estimated values with PIMOGA (m^3/s)	Rate (%)	Upgraded drainage gates (m)	Opened gates
Rama VI Dam	6/6/2018	120.2	110.2	101.5	125.249	7.8281	0.428	3
Narai	1/11/2015	80.11	90.5	92.33	83.456	33.382	1.395	4
Phra Mahinthra	1/2/2003	61.24	54.23	45.12	63.796	31.898	0.966	3
Phra Ekathotsarot	12/10/2014	100.6	123.2	133.3	104.758	55.136	0.835	11
Phra Si Silp	12/10/2017	65	73.21	62.32	67.713	79.663	1.382	4
Phra Si Saowaphak	31/12/2016	35.25	48.52	22.12	36.721	43.201	1.499	2

B. The Results of the Assessment of the Appropriateness of Upgrading the Flood Gates

In this test, all models and predictive equations were predicted with the data in the year 2015, the last year data was collected by the researcher, and the parameters of each forecasting model were determined. The average daily deviation of the year was calculated as shown in TABLE V. The results of the estimation of drainage suitability were compared with actual drainage data as recorded by the project. As shown in the Fig., the drainage and MAPE values are shown in Fig. 2 and Fig. 3, respectively.

TABLE V
AVERAGE ERROR IN YEAT 2015

Average of Error	Fitness Function of PIMOGA with Holt-Winters
MAD	0.46
MAPE	0.033
RMSE	0.632

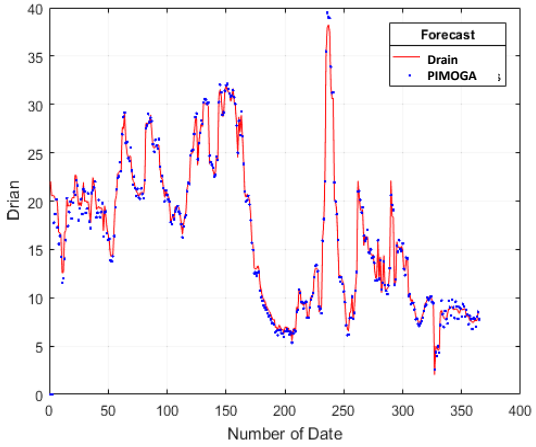

Fig. 2 Estimation of Appropriateness for Upgrading Flood Gates in 2015.

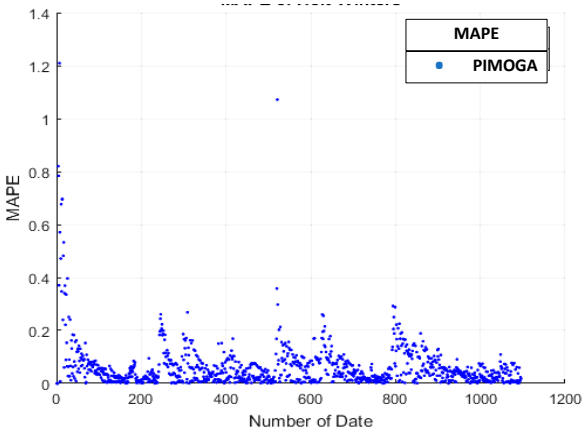

Fig. 3 MAPE Deviations in 2015

VI. CONCLUSION

Application of suitable values for flood gate upgrading by PIMOGA (m^3/s) had brought the findings which was the Global Solution, and calculated the results such as water volume and drainage route, water drainage estimation using PIMOGA method, and estimated value for upgrading flood gates and number of floodgates. If the results of this research are

used to support the water resources management system, it will be more effective.

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(Arranged in the order of citation in the same fashion as the case of Footnotes.)

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