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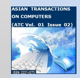

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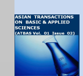

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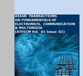

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Asian Transactions on Engineering

Volume: 01, Issue: 03, June 2011
ISSN 2221-4267

Title: A study of periodic and stochastic modeling of monthly rainfall from Purajaya station

Authors: A. Zakaria

Digital Object Identifier: ATE-70104028

Pages: 1-7

Abstract: A study was done using monthly rainfall data with long data 25 years (1977-2001) of Purajaya station. The goal of this research is to study periodic and stochastic models of data series of the monthly cumulative rainfall. Based on daily rainfall data, monthly cumulative rainfall data series was calculated. The series of rainfall is assumed to be free of trend. Periodicities of rainfall data were presented using 125 periodic components. Stochastic series of rainfall data are assumed as residues between rainfall data with periodic rainfall model. Stochastic components were calculated using the approach of autoregressive model. Stochastic Model presented in this research is using the fourth orders autoregressive model. Validation between data and the model is done by calculating the correlation coefficient. For this study, the correlation coefficient between the data and the model of the cumulative monthly rainfall is 0.9992. From the results of this study can be inferred that the model of the monthly rainfall from Purajaya station gives highly accurate approach.

Full Text: PDF (1007 KB)

Title: Wireless Sensor Networks and nodes information collecting ability

Authors: Elma Zanaj, Indrit Enesi

Digital Object Identifier: ATE-60129037

Pages: 8-13

Abstract: The efficient use of energy in Wireless Sensor Networks represents one of the most important constrains for the management of long term communications. In this paper, we propose a new definition that of node information collecting ability. Numerical simulations will show how this parameter will influence in the network lifetime, reliability and in the quantity of information that the network collects.

Full Text: PDF (458 KB)

Title: STRATEGY TO ENGINEER LACTOBACILLUS PENTOSUS TOWARD DEVELOPMENT OF MICROBIOENERGY IN INDONESIA

Authors: Budi Saksono1 and Muhammad Kismurtono

Digital Object Identifier: ATE-80101039

Pages: 14-22

Abstract: Technologies for the production of biofuels have increased attention due to the rising cost of petrol and global warming. One such technology under development is the use of Lactobacillus pentosus for biofuels production. Lactobacillus pentosus is lactic acid bacteria which able to metabolize both of pentose and hexose, and to grow on media containing hydrolyzed biomass. Thus it has many advantages as host for multiple purposes such as micro bioenergy development. To develop the strain, we already cloned gene pdc and adh2 from zymobacter palmae and Lactobacillus plantarum, respectively. In this paper, we will report our strategy to develop those microbioenergy and our recen research progress.

Full Text: PDF (414 KB)

Title: **UNPROCESSED OTA KAOLIN AS A WEIGHTING ADDITIVE IN DRILLING FLUID**

Authors: **Adebayo, Thomas A. and Ajayi, Olusola**

Digital Object Identifier: ATE-20106033

Pages: 23-26

Abstract: Drilling fluid cost and effectiveness are two key factors in drilling fluid selection. Kaolinitic clay is of the family of bentonite and investigation was carried out to check the effect of partial replacement of expensive bentonite in drilling mud with cheap Nigerian kaolin. Two types of kaolin, kaolin1 and kaolin2, were sources in deep wells at Ota, Ogun state, Nigeria at depths between 100ft and 120feet. The two types of kaolin were used naturally in unprocessed state. It was discovered that the apparent and actual viscosities of the mud reduces significantly with increasing kaolin1 and kaolin2 content. Replacement of bentonite with kaolin1 resulted in 85.7% reduction in the mud viscosity while that of kaolin2 gave a corresponding 83.33% reduction. This is an indication that bentonite is more effective than the two kaolin as a viscosifier. The density of the mud slurry increased significantly with more kaolin1 and kaolin2 addition with a 25% and 27.25% increase respectively at 100% kaolin. The volume of each of the kaolin was doubled at total replacement of bentonite and an increase in weight was observed. This is an indication that the two types of kaolin are good weight additives. A replacement of 50% of the bentonite with any of the kaolin resulted into zero gel strength for the mud. The research indicated that the unprocessed kaolin serves as both colloidal and weighting additive but there will be need for a secondary viscosifier to be added if any of the kaolin is to be used for total replacement of bentonite in the mud. Moreover, a gelling additive must be added to the mud when the kaolin is to be used. Since the two types of kaolin tend to partially replace the bentonite and barite components of the water-based mud, their application in drilling mud is expected to reduce the cost of the mud as the additives are far cheaper than either bentonite or barite. This research is expected to extend to the second part which will involve the processing of the kaolin types and their application on the drilling mud properties and also investigate the possibility of enhanced gelling properties of the kaolin.

Full Text: PDF (345 KB)

Title: **Laminar flow heat transfer of a dilute viscoelastic solution in flattened tube heat exchangers**

Authors: **Ismail, Z., Karim, R**

Digital Object Identifier: ATE-50107036

Pages: 27-41

Abstract: Results of studies on heat transfer of viscoelastic solution in flattened tube exchangers were presented. Effect of aspect ratio on the heat transfer performance in exchangers with 0.635 cm and 1.27 cm original diameters and 50 cm to 76 cm lengths were carried out. Five flattened-tube heat exchangers with four thermocouples soldered at regular intervals on the outside wall were placed in turn in the experimental circuit to determine the heat transfer coefficients. Hot water was used as the heating medium; and dilute solution of polyacrylamide in water was used as the viscoelastic solution. Heat transfer increase as a result of flattening the tubes could be as high as 101% while the effect due to secondary flow had a maximum increase of about 86% at an aspect ratio of 1.6.

Full Text: PDF (342 KB)

Title: **Instream Flow Requirement of Dudhkumar River in Bangladesh**

Authors: **M.M. Hossain and M.J. Hosasin**

Digital Object Identifier: ATE-80109039

Pages: 42-49

Abstract: Dudhkumar is an international river shared by Bhutan, India and Bangladesh. Bangladesh being the lowermost riparian country, the water of the river is very vital for the sustenance of livelihood of the people, planning of new water resources projects including evaluation of existing projects and her natural resources at desired level. In-stream flow requirement of Dudhkumar river using three methods of hydrological approaches viz., the Mean Annual Flow, Flow Duration Curve and Constant Yield method have been conducted. All available data on water level and discharge for the period from 1965 to 2008 were utilized in this respect. The study showed that for most of the months during low flow season given due consideration to various demands, there were a deficit or shortage of water in the river, while during flood season most of the demands could be met and duration of deficit period was shorter.

Full Text: PDF (484 KB)

Title: **Engine Performance and Oil Analysis of Biodiesel from Bulk Oil**

Authors: **Annisa Bhikuning**

Digital Object Identifier: ATE-70122038

Pages: 50-54

Abstract: Biodiesel is one of the alternative fuel made from vegetable oil, friendly for environment and has no effect on health and can reduce the emission compared with diesel fuel. To obtain Biodiesel, the vegetable oil or animal fat is subjected to a chemical reaction termed transesterification. In that reaction, the vegetable oil or animal fat is reacted by catalyst with an alcohol (usually methanol) to give the corresponding methyl esters. In this study, Biodiesel are made from bulk oil, and used two catalyst; KOH and NaOH. And then, Biodiesel Bulk Oil blended 20% (B20) with petrodiesel. In oil analysis showed that cetane number for B20 using catalyst KOH (B20KOH) is higher 3.71 % than using B20 catalyst NaOH (B20NaOH). Experiment was conducted in one hour engine running test. Test fuels are petrodiesel as a datum, B20KOH,B20NaOH, pure bulk oil with catalyst KOH (B100KOH) and pure bulk oil with catalyst NaOH (B100NaOH). The results, in minimum load to 60% load, B20KOH and B20NaOH are more efficient up to 11.6% than petrodiesel. In contrary, for maximum load (80%), Petrodiesel is more efficient 0.5 % than B20KOH. And B100KOH is the most inefficient compared with other fuels.

Full Text: PDF (675 KB)

Title: **Remote Operation of Oil and Gas production installations in the Niger Delta**

Authors: **Francis .E Idachaba**

Digital Object Identifier: ATE-70105038

Pages: 55-59

Abstract: The current security challenges posed by the militancy in the Niger Delta region of Nigeria and the need by

the International Oil and Gas Companies(IOC) operating in these areas to deploy both local and expatriates personnel for mandatory site visits both for operations, maintenance and upgrades make it necessary for the evolution of more effective operation strategies. The IOCs have resorted to the use of armed military escorts for staff to and from the sites and this has yielded some reduction in the risks but has still not totally eliminated it. This paper presents a robust communication configuration which is designed to enable remote operations, control, maintenance and upgrades by experts from a secure location away from the site. The system is implemented using appropriate sensors, communication links, topologies and plant operators. The advantages of this system include the reduction of staff exposure to the risks currently associated with traveling to these remote locations in the Niger delta region. It also ensures significant OPEX cost savings for the IOCs in terms of logistics costs and also allows for an increased effectiveness of the experts in terms of deployment time and the number of sites the can handle.

Full Text: PDF (420 KB)

Title: **Analysis of traffic engineering parameters while using multi-protocol label switching (MPLS) and traditional IP networks**

Authors: **Faiz Ahmed and Dr. Irfan Zafar**

Digital Object Identifier: ATE-80115039

Pages: 60-64

Abstract: Traffic Engineering is a subject which ensures the utilization of your resources at their optimum level. In order to uplift the traffic engineering in our today networks, Multiprotocol Label Switching (MPLS) is being used which is very helpful for reliable packets delivery in recent internet services. It ensures high transmission speed, efficient utilization of bandwidth and lower delays during delivery of packets from one location to another. The purpose of MPLS in traffic engineering is to employ the networks as well as network resources efficiently. Based on lower network delay, capable forwarding means, scalability and expected performance of the services given by MPLS technology indicates its significance for implementing real-time applications i.e Voice & video. The salient of the thesis is to indicate the shortcomings of traditional IP networks vis-à-vis benefits of MPLS networks. The comparison analysis is based on the traffic engineering parameters such as delay variation, effective utilization of bandwidth, Jitter, Quality of Service (QoS), data loss and congestion etc. The results of the comparison revealed that traffic engineering through MPLS networks has enhanced reliability, scalability and other parameters as compared to traditional IP networks. In this thesis, Graphic Network Simulator (GNS3) has been used for simulation purpose to ascertain the results of both networks.

Full Text: PDF (590 KB)

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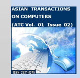

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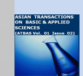

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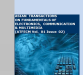

ATFECM Journal (ISSN 2221-4305)
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LEMBAR PENGESAHAN

Judul	:	**A study of periodic and stochastic modeling of monthly rainfall from Purajaya Station**
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Instansi	:	Fakultas Teknik, Universitas Lampung
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A study of periodic and stochastic modeling of monthly rainfall from Purajaya station

A. Zakaria

Abstract— **A study was done using monthly rainfall data with long data 25 years (1977-2001) of Purajaya station. The goal of this research is to study periodic and stochastic models of data series of the monthly cumulative rainfall. Based on daily rainfall data, monthly cumulative rainfall data series was calculated. The series of rainfall is assumed to be free of trend. Periodicities of rainfall data were presented using 125 periodic components. Stochastic series of rainfall data are assumed as residues between rainfall data with periodic rainfall model. Stochastic components were calculated using the approach of autoregressive model. Stochastic Model presented in this research is using the fourth orders autoregressive model. Validation between data and the model is done by calculating the correlation coefficient. For this study, the correlation coefficient between the data and the model of the cumulative monthly rainfall is 0.9992. From the results of this study can be inferred that the model of the monthly rainfall from Purajaya station gives highly accurate approach.**

Index Terms—**monthly cumulative rainfall, periodic and stochastic, FFT, autoregressive model.**

I. Introduction

Irrigation water requirements for designed, detailed information regarding rainfall in conjunction with time is required. To prove a series of record-keeping of rain is very difficult, so sometimes to predicted, or add the data recording of rainfall, a synthetic rainfall data is required. Various methods have been developed by researchers in the field of engineering and science to prove this information. Most widely used methods that now there is a method of deterministic and stochastic methods [2][4][6][7][8][9]. When the preceding method does not prove the influence of random input data parameter, the method was last applied the concept of probability, where the characteristics of rainfall based on the time neglected, and this calculation is only benefit when data are processed fairly long. But the method is not much used anymore because this method is not sufficient to answer the problems that exist.

In nature, the rainfall is having periodic and stochastic parts, because rainfall is influenced by climate parameters such as temperature, wind direction, humidity and so on, which also is periodic and stochastic. These parameters are transferred into the periodic and stochastic rainfall components. The rainfall can be counted to determine both, periodic and stochastic components. Determines all factors are known and it is assumed that the rainfall is as a function of the periodic and stochastic variation of climate. Next, analysis of periodic and stochastic rainfall time series will produce a model that can be used to calculate the periodic and stochastic and can also be used to predict the monthly rainfall variation on that to come.

For a few years ago, some researchers have been conducting rainfall research in order to study periodic and stochastic modeling of time series data, such as in [3][4][6] [7][8] and [9].

The goal of this research is to produce a model of periodic and stochastic monthly rainfall from the station Purajaya. With periodic and stochastic models, synthetic monthly rainfall can be simulated more accurate than the simulation only applying periodic model. This Model can be used to produce synthetic rainfall data accurately and realistic for planning of irrigation or water resources project for the Purajaya area.

II. Research Methodology

A. Area Study

The study of the research is an area of Purajaya. This area is one of the towns in the Western Province of Lampung, Lampung, Indonesia.

B. Rainfall data collection

Daily rainfall Data of Purajaya is taken from the Indonesian agency for meteorology and Geophysics of Lampung Province. The Data used for the study of rainfall with a period of 25 years (1977-2001). Mathematical procedures taken to formulate a model that predicted will be discussed in the next. The purpose of the principle of this analysis is to determine a realistic model for calculating and outlines the rainfall time series into various components of frequency, amplitude, and phase of rainfall.

In General, the time series data can be parsed into a deterministic component, which can be formulated into a value in the form of a component which is the exact solution and components that are stochastic, which this value is always presented as a function that consists of several functions of the data series of the time. Time series data, presented as an $X(t)$ model that consists of several functions [4][6][7][8][9] as follows ,

$$X(t) = T(t) + P(t) + S(t) \quad (1)$$

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Where, $T(t)$ is the component of trend, $t = 1, 2, 3, \ldots, N$. $P(t)$ is the periodic components, and $S(t)$ is the stochastic components.

In this research, the rainfall data is assumed to have no trend. So this equation can be presented as follows,

$$X(t) \approx P(t) + S(t) \quad (2)$$

(2) is an equation to obtain the representative periodic and stochastic models of monthly cumulative rainfall series.

C. Spectral Method

Spectral method is one of several transformation methods is generally used in many applications. This method can be presented as Fourier transformation method [5][7][8][9] as follows,

$$P(f_m) = \frac{\Delta t}{2\sqrt{\pi}} \sum_{n=-N/2}^{n=N/2} P(t_n).e^{\frac{-2.\pi.i}{M}.m.n} \quad (3)$$

Where $P(t_n)$ is a series of rainfall in the time domain and $P(f_m)$ is a series of rainfall in the frequency domain. Based on the frequency of rainfall resulting from (3), amplitudes as a function of the frequency of rainfall can be generated. Maximum amplitude can be determined from the amplitudes of the result as significant amplitude. The frequencies of rainfall from significant amplitudes used to simulate synthetic rainfall are assumed as dominant rainfall frequencies. A series of dominant frequencies resulting in this study, in the form of angular frequencies were used to determine periodic rainfall components.

D. Periodic Component

Periodic component of $P(t)$ with regard to a displacement that oscillate for a specific interval [2]. The existence of $P(t)$ is identified by using the Fourier transformation method. The part that shows the presence of an oscillating $P(t)$, using a period P, some periods with peak amplitudes can be estimated by using Fourier transformation. Frequency obtained from the spectral method is clearly shows the existence of variations that are periodic. The periodic component of $P(f_m)$ can also be written in the form of angular frequency. Then an equation can be expressed in the form of the Fourier series [3][4][6][7][8][9] as follows,

$$\hat{P}(t) = S_o + \sum_{r=1}^{r=k} A_r \sin(\omega_r.t) + \sum_{r=1}^{r=k} B_r \cos(\omega_r.t) \quad (4)$$

The (4) can be organized into the following equation,

$$\hat{P}(t) = \sum_{r=1}^{r=k+1} A_r \sin(\omega_r.t) + \sum_{r=1}^{r=k} B_r \cos(\omega_r.t) \quad (5)$$

Where $P(t)$ is the periodic component, $\hat{P}(t)$ is the periodic component of the model, P_o = Ak + 1 is the mean of the rainfall series ω_r is the angular frequency, A_r and B_r are the coefficients of Fourier components.

E. Stochastic Components

Stochastic components formed by a random value that can not be calculated precisely. Stochastic models, in the form of autoregressive model or Marcov scheme can be written as the following mathematical functions [2][4][6][9],

$$S(t) = \varepsilon + \sum_{r=1}^{p} b_r.S(t-r) \quad (6)$$

The (6) can be decomposed into,

$$S(t) = \varepsilon + b_1.S(t-1) + b_2.S(t-2) + \ldots + b_p.S(t-p) \quad (7)$$

Where, b_r is the parameter of the autoregressive model. The ε is the constant of random numbers. $r = 1, 2, 3, 4\ldots, p$ is the order of stochastic components.

To get the parameter of the autoregressive model and the constant of random number, least squares method can be applied.

F. Least Squares Methods

Analysis of periodic components

In the approximation method, as a solution approach from periodic components of $P(t)$, and to determine the function of (5), a procedure that used to get periodic component model is least squares method. From (5) can be calculated the sum squares of error between the periodic data and model [3] [7] [8] [9] as follows,

$$\text{Sum Squares of Error} = J = \sum_{t=1}^{t=m} \left\{P(t) - \hat{P}(t)\right\}^2 \quad (8)$$

Here J is the sum squares of error. It depends on the value of A_r and B_r. J coefficient can only be minimum if it satisfies an equation as follows,

$$\frac{\partial J}{\partial A_r} = \frac{\partial J}{\partial B_r} = 0 \text{ with } r = 1, 2, 3, 4, 5, ..., k \quad (9)$$

By using the least squares method, the A_r and B_r coefficients of Fourier components can be obtained. Based on the Fourier coefficients can be generated the following equations,

a. mean of rainfall,

$$P_o = A_{k+1} \quad (10)$$

b. amplitude of the harmonic components,

$$C_r = \sqrt{A_r^2 + B_r^2} \quad (11)$$

c. phase of harmonic components,

$$\varphi_r = \arctan\left(\frac{B_r}{A_r}\right) \quad (12)$$

The mean of rainfall, the amplitude and phase of harmonic components can be inserted into an equation as follows,

$$\hat{P}(t) = S_o + \sum_{r=1}^{r=k} C_r.Cos(\omega_t.t - \varphi_r) \quad (13)$$

(13) is a periodic model of monthly cumulative rainfall, which fetched based on the rainfall data from station Purajaya.

Analysis of stochastic components

Based on the results of the simulations obtained from periodic rainfall models, stochastic components S (t) can be generated. The stochastic components are the difference between rainfall data series with calculated rainfall series obtained from periodic model. Stochastic series as a residual rainfall series, which can be presented as follows,

$$S(t) \approx X(t) - P(t) \quad (14)$$

(14) can be solved by using the same way with the way that used to get periodic rainfall series components. Following (8), stochastic models (7) can be arranged to be as follows,

$$\text{Sum squares of Error} = J = \sum_{t=1}^{t=m} \left\{S(t) - \hat{S}(t)\right\}^2 \quad (15)$$

Where J is the sum squares of error. It depends on the ε and b_r values, where the coefficients can only be minimum if it satisfies the equation as follows,

$$\frac{\partial J}{\partial \varepsilon} = \frac{\partial J}{\partial b_r} = 0 \text{ with } r = 1, 2, 3, 4, 5, ..., p \quad (16)$$

In the next, by using (16) stochastic parameters ε and b_r of the residual rainfall data can be calculated.

III. Results and Discussion

To test the characteristics of rainfall from rainfall data, time series with long daily rainfall data of 25 years (1977-2001) of Purajaya station. Characteristics of the annual average and maximum daily rainfall series can be calculated. Fig. 1 shows the daily rainfall time series from Purajaya station.

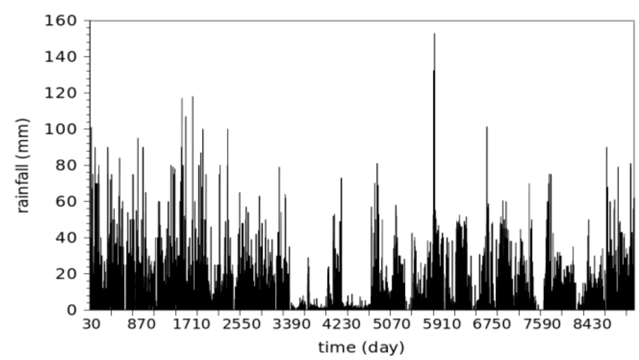

Fig. 1. Daily rainfall time series for 25 years from Purajaya station.

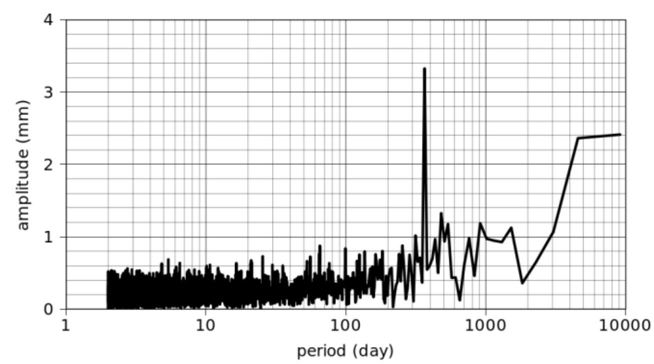

Fig. 2. Variation of daily rainfall periods for 25 years data from Purajaya station.

Daily rainfall data based on the average daily rainfall had annual varies from 2.00 mm in 1986 be 12.5 mm in 1977. The annual maximum daily rainfall varies from 35 mm in 1986 became 152.9 mm in 1992. This variation is likely caused by changes in nature due to climate change. The cumulative annual rainfall of Purajaya shows the value of a minimum of 552.5 mm in 1989 and a maximum of 4308.9 mm in 1996, with a cumulative average annual rainfall of 2553.5 mm.

Based on the daily rainfall data and by using the method of FFT (Fast Fourier Transform), a periodogram of daily rainfall time series can be generated. The transformation result of the daily rainfall data for over 25 years can be calculated by using the method of FFT such as presented in Fig. 2.

From Fig. 2 can be seen that the maximum amplitude of the periodogram is 3.3255 mm for a period of 365.2 days or one year. This shows that the annual components of daily rainfall data are very dominant in comparison with other periods. The spectrum above was presented in the rainfall amplitudes versus rainfall periods. The spectrum presented in Fig. 2 is produced using the FFT method of Matlab.

To estimate the presence of the periodic component of the monthly cumulative rainfall time series and to get dominant frequencies of the rainfall, Fourier transformation method can be applied. To produce the dominant Frequencies, the procedure applied is use an algorithm proposed [1] where the amount of the data *N* is analyzed as the square of 2, for example $N = 2^k$.

Based on the daily rainfall data of all 25 years from Purajaya station, monthly cumulative rainfall series is calculated. The monthly cumulative rainfall series can be seen as in Fig. 3 below,

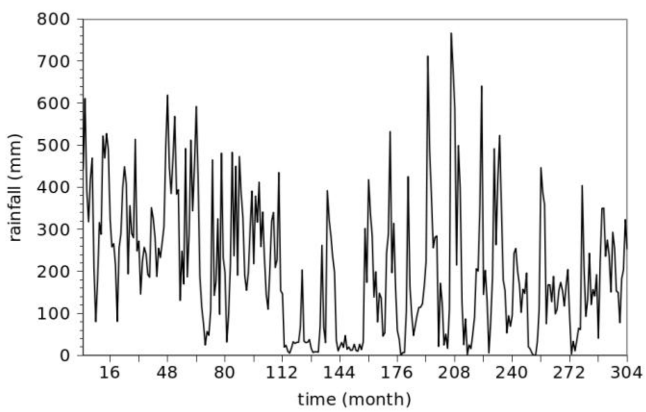

Fig. 3. Variation of monthly cumulative rainfall from Purajaya station.

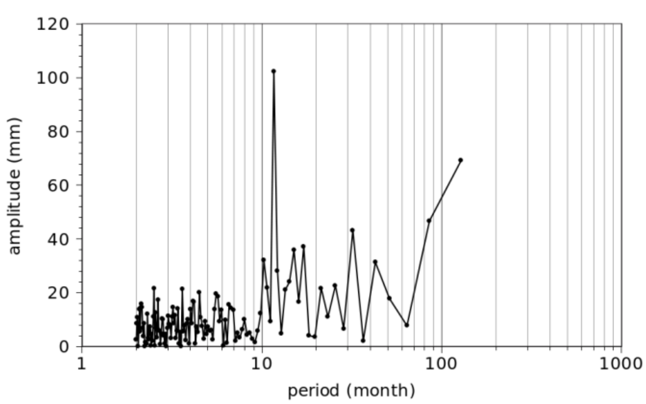

Fig.4. Variation of monthly cumulative rainfall periods.

Based on the monthly cumulative rainfall data can be calculated monthly cumulative rainfall spectrum such as presented in Fig. 4. Using the monthly cumulative rainfall data from Purajaya station, 125 dominant frequencies were estimated. By applying the 125 frequencies as in Fig. 4, then Fourier series (5) can be fitted to the monthly cumulative rainfall data in order to simulate a synthetic rainfall time series as presented in Fig. 5.

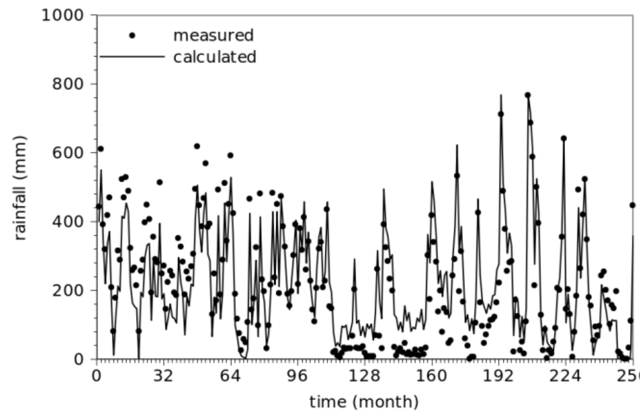

Fig. 5. Variation of monthly cumulative rainfall from station Purajaya between measured and calculated rainfalls using periodic model

The 10 periodic components ordered from the maximum amplitudes of 125 periodic components used in this research can be seen in Table 2 below,

TABLE I
10 PERIODIC COMPONENTS OF THE CUMULATIVE MONTHLY RAINFALL MODEL

r	Frequencies (^{o})	amplitudes (mm)	phases (^{o})
1	29.53	103.81	38.81
2	2.81	47.03	176.76
3	9.84	45.09	173.63
4	22.50	44.22	347.01
5	8.44	40.9	95.35
6	19.69	38.95	182.68
7	11.25	37.40	90.9
8	28.13	32.67	58.82
9	21.09	32.53	80.26
10	33.75	32.28	38.12

Based on the results obtained such as shown in Fig. 5, residual monthly rainfall between the data series and the synthetic rainfall series can be calculated by using (2). The residual series of rainfall are errors of the periodic rainfall model. The periodic errors are assumed as stochastic components of the monthly cumulative rainfall. The stochastic components of the monthly cumulative rainfall can be seen as in Fig. 6 below,

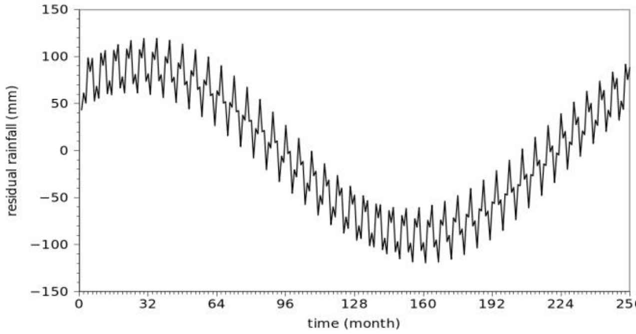

Fig. 6. Variation of stochastic component of the monthly cumulative rainfall from Purajaya station

By using the least squares method such as that presented in (15) and (16), the autoregressive model can be fitted to the stochastic components of the monthly cumulative rainfall as shown in Fig. 6. Parameters of the autoregressive model and the independent random number can be produced. For the stochastic components of the monthly cumulative rainfall from Purajaya station, the 4th order autoregressive model parameters are used to approximate the stochastic model. The autoregressive model parameters and the independent random number can be seen in Table 1 as follows,

TABLE 2
PARAMETERS OF 4TH ORDER AUTOREGRESSIVE MODEL

parameters	values
ε	0,4791
b_1	1,0252
b_2	0,0375
b_3	−1,0176
b_4	0,9555

Based on the parameters of autoregressive model and the independent random number in the Table 1, can be simulate stochastic monthly rainfall as presented in the Fig. 7 and Fig. 8 as follow,

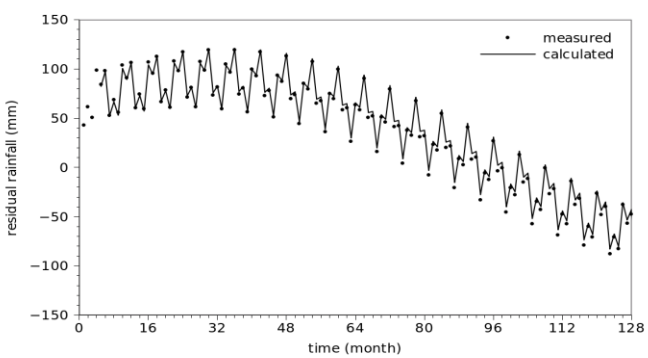

Fig. 7. Variation of measured and calculated stochastic monthly rainfalls from station Purajaya (1-128).

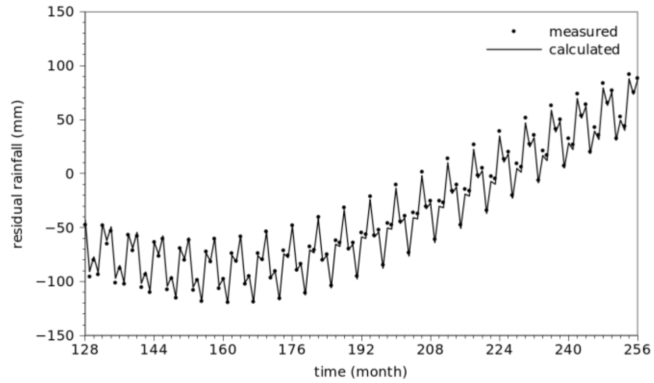

Fig. 8. Variation of measured and calculated stochastic monthly rainfalls from station Purajaya (128 – 256).

By using the periodic and stochastic model, measured and calculated cumulative monthly rainfall series from station Purajaya can be presented in the following Figures,

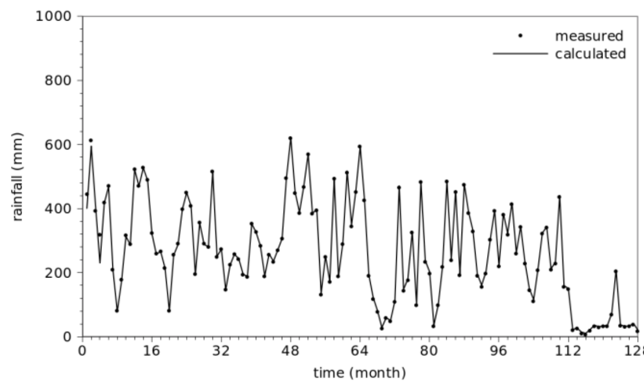

Fig. 9. Variation of measured and calculated periodic + stochastic monthly rainfalls from station Purajaya (1-128).

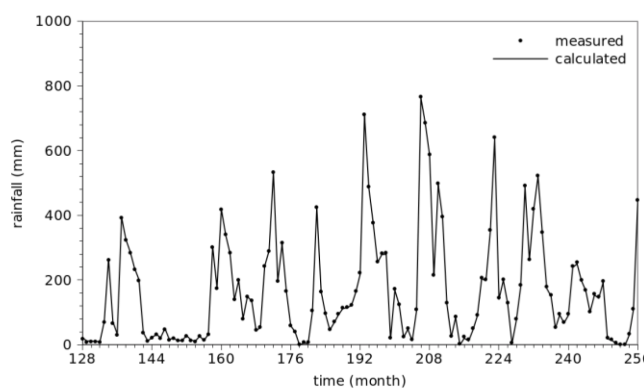

Fig. 10. Variation of measured and calculated periodic + stochastic monthly rainfall from station Purajaya (128-256).

A comparison between the measured monthly cumulative rainfall and the calculated monthly cumulative rainfall of the periodic and stochastic modeling as shown in Fig. 9 and Fig. 10 indicates that, the calculated monthly cumulative rainfall of the periodic and stochastic model gives highly accurate result.

For modeling of the periodic rainfall provides the value of correlation coefficient R is 0.9200. For modeling of the stochastic rainfall is using 4th orders autoregressive model gives the value of correlation coefficient R is 0.9945. For modeling of stochastic and periodic monthly cumulative rainfall giving the value of correlation coefficient, between the data and the model is 0.9992. Value of the coefficient correlation is almost close to 1. This shows that the model of periodic and stochastic cumulative monthly rainfall is almost close to the pattern of rainfall monthly cumulative rainfall data that are measurable. The variation of the orders for the correlation coefficient of stochastic model R(S), the correlation coefficient of periodic and stochastic model R (P+S) and the error of monthly cumulative rainfall can be seen in the Fig. 11.

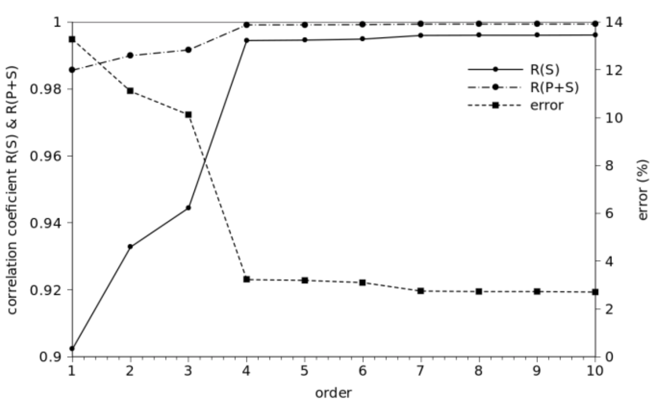

Fig. 11. Variation of the orders for correlation coefficients R(S), R(P + S), and error (%) of the stochastic and periodic models.

Based on the results presented in Fig. 11 shown that, using the 4th order autoregressive model can give better accuracy results than the 3rd order accuracy result. For the accuracy of the 5th order up to the accuracy of the 10th order, did not provide more significant results, if it is compared with the accuracy of 4th order. So in this research, stochastic model is using the 4th accuracy. The correlation coefficient (R) and error (%) for periodic model delivers each of 0.92 and 28%. For the periodic and stochastic models can provide the value of the coefficient of correlation and error each of 0.9992 and 3.23%.

Monthly cumulative rainfall modeling in this research can provide more complete result when it is compared to monthly rainfall modeling such as that done by [4] and [6], where in modeling of monthly rainfalls [4] only use a few periodic and stochastic parameters. In his work [4], he is using 6 harmonic components with the stochastic components for accuracy of 3rd order. Where for [6], in their research, they use only 3 harmonic components with the stochastic component for accuracy of 1st order. In my research, more complex solution is conducted than the previous research. In my research 125 periodic components are used but the harmonic modeling of monthly rainfall in this research still can be done quickly. It is because of by applying the method of Fast Fourier Transform (FFT), prediction of the frequency components of harmonic monthly cumulative rainfall can be generated quickly.

The characteristic of stochastic monthly cumulative rainfalls in my research can be seen as presented in Fig. 7 and Fig. 8. The stochastic component series are the difference between the monthly cumulative rainfall data with the periodic model series. From the figures are presented that the stochastic component fluctuates from - 119.5 mm up to 119.3 mm. In this research, the correlation coefficient of stochastic models with the accuracy of the 4th order is equal to 0.9945, while for the accuracy of the 1st order is equal to 0.9023. The result is better when compared with the other results presented by [6] which uses stochastic model for the accuracy of the 1st order and give the coefficient correlation for stochastic model of 0.9001.

In my results, by using the 125 periodic components and 4th order accuracy stochastic components yield the simulation model of monthly cumulative rainfall accurately, with a correlation coefficient is equal to 0.9992. The correlation coefficient presented in Fig. 11 is evidence that periodic and stochastic models (P + S) of monthly cumulative rainfall has a very good correlation and accurate results when compared with only using periodic model (P) that generates correlation coefficient of 0.9200. This result also presents much better when it is compared to the research is done by [6], where the model only using the 3 periodic components with the 1st order accuracy of stochastic component with the correlation coefficient is 0.9961.

IV. CONCLUSION

The spectrum of the monthly cumulative rainfall time series generated by using the FFT method is used to simulate the synthetic monthly cumulative rainfall. By using the least squares method, the monthly cumulative rainfall time series can be produced synthetic rainfall quickly. By using 125 periodic components and 4th order stochastic components, the monthly cumulative rainfall model or Purajaya station can be produced accurately with the correlation coefficient of 0.9992. In the future work, using the same method, other cumulative rainfall series can be used to study periodic and stochastic rainfall components, and other spectrum methods can be used to generate more accurate rainfall spectrums.

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