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A Comparative Analysis of Methods of Polynomial Coefficients Determination for Reliability Indices of Ilorin Distribution Systems

Ganiyu A. Ajenikoko, Anthony A. Olaomi
Department of Electronic & Electrical Engineering, LadokeAkintola University of Technology, P.M.B. 4000, Ogbomoso, Nigeria
Corresponding Email: ajeedollar@gmail.com

Abstract :Distribution system delivers the transmitted energy to the end users which are customers. This paper develops a generalized polynomial model and compares the coefficients for the assessment of reliability indices of Ilorin distribution system feeders. The results of the coefficients obtained were validated by subjecting the polynomial model to three methods namely: Lagrange Polynomial, Newton and Chebychev Polynomial function methods. The results of the work showed that average values of -7x10^{-4}, 0.00212, -0.0256, 0.1549, -0.4865 and 0.7049 were obtained as the coefficient values from the Lagrange, Newton and Chebychev polynomial function methods which compare favourably well with the coefficient values of -7x10^{-4}, 0.0021, -0.0257, 0.1549, -0.4865 and 0.7048 obtained from the simulation results. The knowledge of these coefficients will form a basis for adequate planning and management of power distribution systems.

Keywords: **Polynomial, coefficients, Lagrange, Newton, Chebychev, reliability indices, distribution systems.**

I. Introduction

Power distribution systems are directly linked to consumers (Billinton and Allan 2006, Allan and Da-Silva,1995). The distribution system plays an important role in the overall power system reliability and the perceived reliability to customers(Buzacott 2004,Chery et al,2003). By improving distribution protection systems such that sustained outage times can be reduced, power system reliability can be enhanced(Elena et al,2010, Eissa et al,2010).

Electric power system has a primary role of providing reliable and continuous supply of electric energy to satisfy system load (Chowdhurry et al 2003, Danny 1989).

In a broad sense, electric power system reliability, can be defined as the ability of the system to provide an adequate supply of electric power with a satisfactory quality(Cheok et al 1998,Chun,2010). Reliability indices are logical parameters of judging the performance of an electrical power system (Andreotti 2009, Anderson and Bose 2003).Power systems have three main components: generation, transmission and distribution systems. The generation system produces electricity, transmission system delivers the generated electricity to distribution systems for supplying load demands. The generation and transmission systems are called the composite system or the bulk power system (Billinton and Wang 1998, Danny 2009).

Accurate reliability analysis of power systems helps to predict future failure behaviour and make appropriate maintenance plans (Billinton and Wenyuan 2004, Dan 2003).Reliability performance of distribution utilities has received considerable attention in recent years (Allan and Da-Silva,1995).

The reliability of power distribution systems is greatly affected by outages caused by different environmental factors on overhead lines. Since animals cause significant number of outages on overhead distribution systems, it is important to investigate these outages (Chun, 2010).

II. Materials and Methodology

Ten years of outage information from Ilorin distribution systems were used as input parameters with the following procedural steps.

(i) Computation of the mean values of the system reliability indices.

(ii} Computation of the values of the Relative Customer Average Interruption Duration Index(CAIDI}

(iii) Obtaining a generalized polynomial model and the corresponding coefficients.

(iv) Subjecting the polynomial model to three different methods to determine their coefficients.

The three methods are:

(a) Lagrange polynomial function method.

(b} Newton polynomial function method.

(c) Chebyshev polynomial function method.

(v) Compare the coefficients in the three methods with the coefficients in the original polynomial model.

III. Discussion of results

The result of Relative CAIDI for Ilorin distribution systems is shown in Figure 1. The model equation represented the relationship between the relative CAIDIs and the number of feeders. The Relative CAIDI model developed for Ilorin distribution system is a polynomial of order 6 with coefficients of -7e-5, 0.00221, -0.00257, 0.1549, -0.4856 and 0.7048 with a constant value of -0.1765 and coefficient of determination R^2 of 0.9729..

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The values of the coefficient of determination R^2 show the extent of the reliability of the model to predict the relationship between the relative CAIDI and the number of feeders. Model equation with values of coefficient of determination $R^2 > 0.5$ was used to represent the relationship between the relative CAIDI and the names of feeders. Equations with low values of R^2 (i.e. $R^2 < 0.5$) cannot be used to really show the relationship between the relative CAIDI and the number of feeders. This implies that for low values of R^2, other non-empirical relationship can be adopted. Kwara-Poly feeders appeared to be a critical feeder at a Relative CAIDI of 0.1743 , hence the most reliable of all the feeders. This is because customers' interruptions on this feeder were greatly reduced and clearing of the faults were done properly. Water-works feeders with a Relative CAIDI of 0.0717 appeared to be the least reliable feeder. A Comparative analysis of the coefficients and constants using different methods for Ilorin distribution systems are shown in Figures 2 to 6 while Table 1 shows a comparative analysis of the coefficients and constants for Ilorin distribution systems using different methods. It is observed that the coefficients obtained are the same when the polynomial model is subjected to Simulation, Lagrange method, Newton method and Chebychev methods.

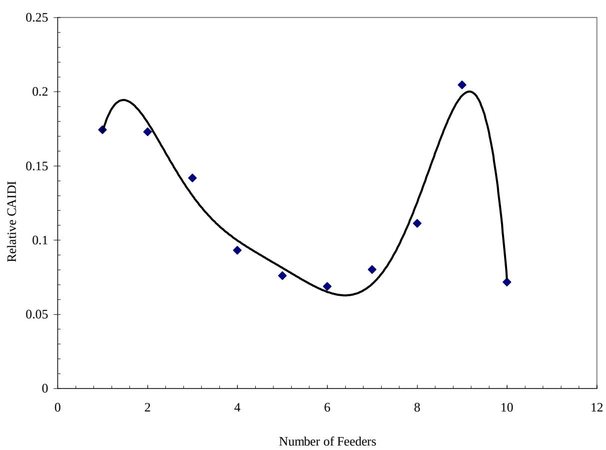

Figure 1: Relative CAIDI results for Ilorin distribution systems.

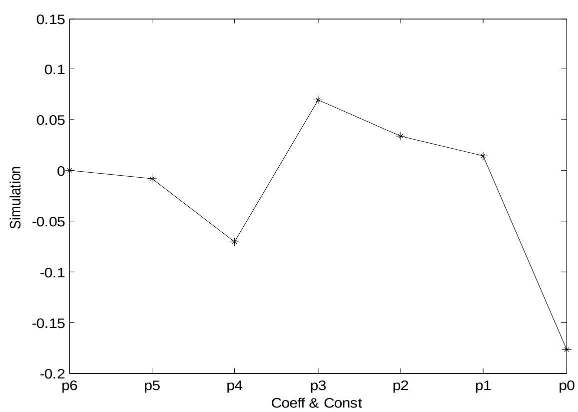

Figure 2: Coefficients of Simulation results for Ilorin distribution systems.

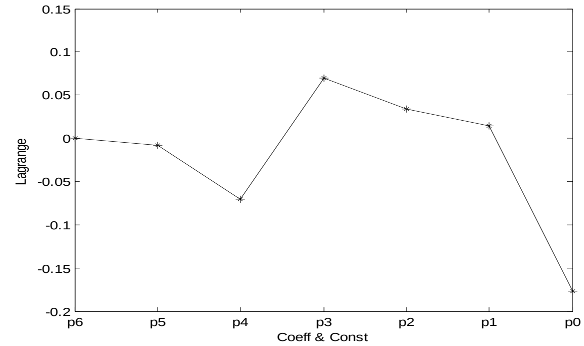

Figure 3: Coefficients of Lagrange results for Ilorin distribution systems.

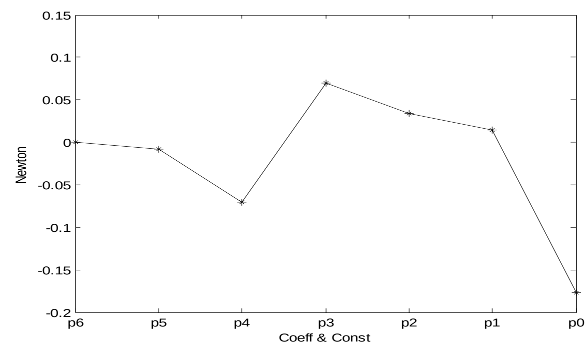

Figure 4: Coefficients of Newton results for Ilorin distribution systems.

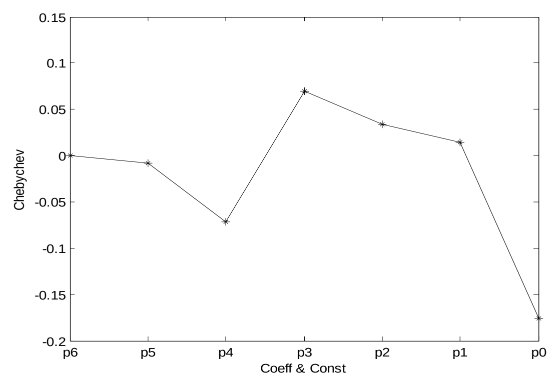

Figure 5: Coefficients of Chebychevresults for Ilorin distribution systems.

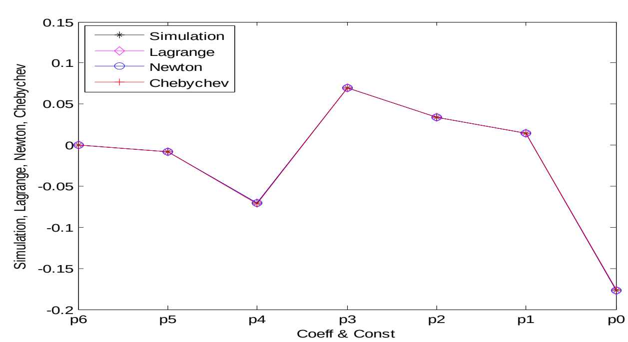

Figure 6: Coefficients of Combined methods results for Ilorin distribution systems.

IV. Conclusion

A comparative analysis of methods of polynomial coefficients determination for Ilorin distribution systems have been discussed. The discussion started with the identification and computation of Ilorin distribution system reliability indices and the failure rate. The Relative CAIDI was computed to establishthe relationship between the mean values of SAIDI and SAIFI in order to obtain the polynomial model. The developed polynomial model is then subjected to three different methods- Lagrange, Newton and Chebychev polynomial methods in order to compare the coefficients in each method. It is observed that the coefficients obtained in the three methods were in arrangement with the coefficients in the simulation results.

Table 1: Compari	Simulation Results	Lagarange polynomial	Newton polynomial	Chebyshev polynomial
P6	$-7x10^{-6}$	$-7x10^{-6}$	$-7x10^{-6}$	$-7x10^{-6}$
P5	0.0021	0.0022	0.00213	0.00211
P4	-0.0257	-0.0256	-0.0257	-0.0256
P3	0.1549	0.1549	0.1550	0.1548
P2	-0.4865	-0.4864	-0.4865	-0.4867
P1	0.7048	0.7049	0.7050	0.7049
P0	-0.1765	-0.1766	-0.1767	-0.1762

REFERENCES

i. *Allan R. N. and Da-Silva M. G. (1995): "Evaluation of reliability indices and outage costs in distribution systems" IEEE Transactions on power systems Vol. 10, No. 5, pp 345-365.*

ii. *Anderson P. and Bose A, (2003): "A probabilistic approach to power system stability analysis", IEEE Transactions on Power Apparatus and Systems, Vol. PAS – 102, Pp. 2430-2439.*

iii. *Andreotti A., Assante D, Mottola F and Verolino L. (2009): "An exact closed-form solution for lightning induced over voltage calculations", IEEE transactions on power system, Vol. 24, No. 3, Pp 1328-1343.*

iv. *Billinton R and Allan R (2006): "Reliability evaluation of Power Systems". Plenum Press, New York. Second Edition, Pp 36-51*

v. *Billinton R and Wang P (1998): "Distribution system reliability cost/Worth Analysis using analytical and sequential simulation techniques, IEEE Transactions on power systems, Vol. 13, No. 4, Pp. 1245-1250.*

vi. *Billinton R and Wenyuan L., (2004): Power System Modeling, Analysis and Control. EPRI Power System Engineering Series, McGraw Hill, Second Edition, Pp 69-92*

vii. *Buzacott, J.A. (2004): "Network Approaches to finding the reliability of repairable systems". IEEE Transactions on Reliability, Vol. 18, No.6, Pp 169 –174.*

viii. *Cheok M.C, Parry G.W and Sherry R.R (1998): "Use of important measures in risk-informed regulatory applications", IEEE Transactions of Reliability and System safety. Vol. 60, Pp. 314-322.*

ix. *Chery, A. W, Dan J. P, Michael T. J. (2003): "A Nationwide survey of recorded information used for calculating distributions reliability indices". IEEE Transactions on power delivery Vol. 18, No. 2. pp 449-453.*

x. *Chowdhurry A. A, Sudhir K. A and Don O. K (2003): "Reliability modeling of distributed generation in conventional distribution systems planning and analysis", IEEE Transactions on industry applications, Vol. 19, No. 5, Pp 1493-1498.*

xi. *Chun, R-Y (2010): "Composite power systems reliability evaluation, IEEE Transactions on power system, Vol. 13, No. 2, Pp. 655-660.*

xii. *Dan Z. (2003): "Power system reliability analysis with distributed generators". IEEE Transactions on Power Systems. Vol. 6, No. 12, Pp 93-107.*

xiii. *Danny D.K (1989): "Unification of reliability/Availability/reparability models for Markov systems". IEEE Transaction on reliability. Vol. 38, No. 2, Pp 113-126.*

xiv. *Danny S.Y. (2009):"A Review of/reparability models for Repairable systems". IEEE Transaction on power systems, Vol. 8, No. 7, Pp 146-153.*

xv. *Eissa M. M, Masoud M. E. and Elanwar M. M. (2010): "A Novel back up wide area protect technique for power grids using phasor measurement unit", IEEE transactions on power delivery, Vol. 25, No. 1, Pp 270-278.*

xvi. *Elena F, Luca L.S, Anna M.P and Piercesare S (2010): "Statistical analysis of exceptional events; The Italian regulatory experience", IEEE transactions on power system, Vol. 24, No. 3, Pp 1319-13*