Journal of Iraqi Al-Khwarizmi (JIKh) Volume:8 Issue:2 Year: 2024 pages: 29-34

Evaluation the Entropy and the Reliability of 400KV Iraqi Super Grid

Authors Names	**ABSTRACT**
Sara Abdul Kadhem Ghanem[a] *Abeer A. Abdul-Razaq*[b] ***Article History*** Publication data: 30/ 8 / 2024 ***Keywords: Reliability; Entrop***	This paper deals with the calculation of the entropy and the reliability of the Iraqi 400kv super grid based on the reduction method as. a reliability calculation method. As well as computer programming has been used to a create.an algorithm which calculates the.reliability and entropy

1. INTRODUCTION

Network reliability analysis receives nice attention for the design, effectiveness, and protection of the many real word system. [1]

The Iraqi electrical national grid consists of 400kv super grid and 123 kv ultra high voltage electrical power transmission networks and it consist of 33kv and 11 kv system distribution networks [2].

Entropy network is a concept rooted within the field of statistics principle and network technological know-how. It refers to a community or device characterised by way of the measure of entropy, which quantifies the uncertainty or randomness within the gadget. The concept of entropy is borrowed from thermodynamics, wherein it represents the degree of ailment in a bodily gadget. In the context of networks, entropy offers insights into the complexity and records content material of the community shape.[3]after two meaning reliability and entropy network in this paper will comput the reliability and the entropy of Iraqi electrical national grid.

Iraqi electrical power system is divided in to six subsystems R1 is Iraqi North Zone reliability index, R2 is Dyala- Anbar Zone reliability index, R3 is Baghdad North Zone reliability index, R4 is Iraqi Middle Zone reliability index and R6 is Iraqi South Zone reliability index .So in this paper the reliability and the entropy of 400kv Iraqi will calculate after dividing national network to six zone.

1.1 BASIC CONCEPT

a. Entropy, is a disorder measure derived from information theory to describe the level of randomness and the amount of information encoded in a graph.

b. Reliability of series system, The reliability of a series system is the probability that component succeeds and and all of the other components in the system succeed so the reliability given by

$$Rsys = pr(x_1 x_2 \ldots x_n) = \prod_{i=1}^{n} pr(x_i) = \prod_{i=1}^{n} R_i \qquad (1)$$

c. Reliability of parallel system,

If at least one of components must succeed for the system to succeed, then the system called parallel system so to find the reliability

$$Rsys = 1 - \prod_{i=1}^{n} (1 - Ri) \qquad (2)$$ [4],[5],[6].

[a]Mathematics department College of Education for Pure sciences Thi-Qar University, Iraq, Sarahabdalkadhem.math@utq.edu.iq
[b]Mathematics department College of Education for Pure sciences Thi-Qar University, Iraq, abeeraladub80@gmail.com

1.2 REDUCTION METHOD

In the realm of reliability networks the reduction method is a technique employed to simplify network structures while preserving the crucial reliability aspects of the system. Reliability networks are utilized for modeling and assessing the dependability or accessibility of systems like power grids, communication networks or manufacturing systems .

The main objective of the reduction method is to streamline the representation of the network by diminishing the number of components or nodes without impacting how we evaluate overall reliability. This simplification aids in making analysis more manageable computationally while still providing insights into how reliable the system behaves.

Various approaches exist for reducing networks in reliability analysis and which specific method to employ hinges, on both system characteristics and analysis objectives. Here are a few used techniques;

In this paper depend on Series and Parallel Reduction; This approach comes into play when a system can be broken down into series and parallel configurations of components. By identifying sub networks they can be substituted with equivalent components resulting in a simplified network structure [7].

1.3 EVALUATION THE RELIABILITY OF 400 KV IRAQI SUPER GRID.

After applied the reduction method and start to reduction from south to north get,

R1 = R10 (1-R46) (1-R19) R49
R2= R9 R18
R3= R2 R1
R4= (1-R47) (1-R3)
R5= R9 R4
R6= R8 (1-R49) (1-R21) (1-R20) R53
R7= R8R22R50
R8= R23 R24
R9= (1-R51) (1-R52)
R11=R9R8
R12= R5R6
R13=(1-R51) (1-R12)
R14= (1-R30) (1-R61) (1-R29)
R15=R13 R14
R16= R25 R39
R17= R25 R54
R18= R37 (1-R57) (1-R36) R56 (1-R38)
R19= (1-R54) (1-R18)
R20= R27 R55
R21= (1-R16) (1-R26) R34
R22= R15 R16 R43
R23= (1-R22) (1-R44)
R24= R23 R28
R25= R3 R13
R26= R4 R42

R27= R26 R14
R28= (1-R41) (1-R12)
R29=R28 (1-R40)
R30= (1-R12) (1-R29)
R31= R1 R11
R32=R31 R40
R33= (1-R32) (1-R42)

SO the reliability of Iraqi 400 KV super grid is
Rsys = 1-[(1-R5) (1-R15) (1-R19) (1-R24) (1-R33)]
So after substitute every pier of Ri get 72 terms, as the following
Rsys= R18*R32*R42 - R18*R42 - R32*R54 R42*R54 - R18*R32 + R18*R32*R54 +R18*R42*R54 + R32*R42*R54 + R4*R9*R18*R32+…+R4*R9*R13*R14*R18*R23*R28*R32*R42*R54. (3)

1.4 IISHANNON ENTROPY

Shannon entropy, referred to as information entropy or Shannon information serves as a metric, for determining the level of information, uncertainty or randomness in a discrete random variable or an information source. This concept was introduced by Claude Shannon within the realm of information theory.

Shannon entropy is introduced by

$$H = -E(\log(p(x)) \qquad (4)$$

where p(x) is a probability of a system being in cell x of its phase space [8].

1.5 THE PROBABILITY DENSITY FUNCTION OF 400KV IRAQI SUPER GRID

From the information of Iraq's electricity supply and demand, 2010- 2017

	Domestic	Commer-cial	Governm-ental	Agricult-ural	Industrial
2010	12622187	1537225	7027800	689264	5567285
2011	11072685	1446026	6079683	636299	6321307
2012	13885716	1910332	8916237	1166778	7484381
2013	17571511	2717505	12279354	1509536	9042037
2014	17070854	2791115	12915706	929274	8724183
2015	20276941	3087472	11549188	671955	6449184
2016	17952433	1936788	12093705	645284	4123331
2017	24993174	2483965	7553790	709790	5029902

TABLE 1: Iraqi's electricity supply and demand

And according to Kolmogorov-Simonov test, electricity consumption is increasing and approaching an exponential distribution

By the probability theory the reliability system is defined

$R(x) = p(X > x) = 1 - P(X \leq x) = 1 - F(X)$ (5)

Since the distribution of 400kv Iraqi super grid is exponential then the cumulative density probability (cdf) is

$F(x) = 1 - e^{-\lambda x}$ (6) where λ grater than zero

By substitute equation (6) in equation (3) gets $Rsys = 4e^{-3\lambda x} - 4e^{-2\lambda x} + 13e^{-4\lambda x} - 12e^{-5\lambda x} - 11e^{-6\lambda x} + 13e^{-7\lambda x} + e^{-8\lambda x} - 2e^{-9\lambda x} + e^{-\lambda 10x}$.(7)

In probability theory ther is a relationship between the reliability and a pdf
Pdf=f(x)=-d Rsys (8) after derivative equation (7) obtain the probability density function(pdf) of 400kv Iraqi super grid,

$$f(x) = -[-12\lambda e^{-2\lambda x} + 8\lambda e^{-\lambda x} - \lambda 52e^{-3\lambda x} + 60\lambda e^{-4\lambda x} + 66\lambda e^{-5\lambda x} - 91\lambda e^{-6\lambda x} - 8\lambda e^{-7\lambda x} + 18\lambda e^{-8\lambda x} - 10\lambda e^{-9\lambda x}]$$
(9).

1.6 EVALUATION SHANNON ENTROPY OF 400 KV IRAQI SUPER GRID

After obtaining the probability density function of 400kv Iraqi super grid we can compute Shannon entropy and after sub lay equation (4) get,

$$H=-E(\log(-[-12\lambda e^{-2\lambda x} + 8\lambda e^{-\lambda x} - \lambda 52e^{-3\lambda x} + 60\lambda e^{-4\lambda x} + 66\lambda e^{-5\lambda x} - 91\lambda e^{-6\lambda x} - 8\lambda e^{-7\lambda x} + 18\lambda e^{-8\lambda x} - 10\lambda e^{-9\lambda x}])$$

$$= \int_0^\infty \lambda e^{-\lambda x} (\log[12\lambda e^{-2\lambda x} + 8\lambda e^{-\lambda x} - \lambda 52e^{-3\lambda x} + 60\lambda e^{-4\lambda x} + 66\lambda e^{-5\lambda x} - 91\lambda e^{-6\lambda x} - 8\lambda e^{-7\lambda x} + 18\lambda e^{-8\lambda x} - 10\lambda e^{-9\lambda x}]) \, dx.$$

$$H = -E\left(\log\left(-\left[12\lambda e^{-2\lambda x} + 8\lambda e^{-\lambda x} - 52\lambda e^{-3\lambda x} + 60\lambda e^{-4\lambda x} + 66\lambda e^{-5\lambda x} - 90\lambda 6^{-6\lambda x} - 8\lambda e^{-7\lambda x} + 18\lambda e^{-8\lambda x} - 10\lambda e^{-9\lambda x}\right]\right)\right.$$
$$= \int_0^\infty \lambda e^{-\lambda x}\left(\left[12\lambda e^{-2\lambda x} + 8\lambda e^{-\lambda x} - 52\lambda e^{-3\lambda x} + 60\lambda e^{-4\lambda x} + 66\lambda e^{-5\lambda x} - 90\lambda 6^{-6\lambda x} - 8\lambda e^{-7\lambda x} + 18\lambda e^{-8\lambda x} - 10\lambda e^{-9\lambda x}\right]\right) dx$$

The integration details in the last of paper
After integration, we obtained a high percentage of confusion with the information
$H = 12.6458$

1.7 CONCULUTION

In this paper the reliability of Iraqi super grid was calculated and the probability density function also compute the entropy of Iraqi super grid.

This is a code to evaluate the Shannon entropy

```
clc;clear;close all
syms x
 v=0.981;
 t=-12*v*exp(-2*v*x;(
r=8*v^2*exp(-v*x;(
d=52*v*exp(-3*v*x;(
u=60*v*exp(-4*v*x;(
w=(66*v*exp(-5*v*x)) - (91*v*exp(-6*v*x;((
z=(8*v*exp(-7*v*x))+(18*v*exp(-8*v*x))-(10*v*exp(-9*v*x;((
% f=((108*v^2*exp(-3*v*x) - 32*v^2*exp(-2*v*x) + 832*v^2*exp(-4*v*x) - (3*v^2*exp(-5*v*x))/2 - (12*v^2*exp(-6*v*x))/5 + (9*v^2*exp(-7*v*x))/2 + 512*v^2*exp(-8*v*x) - (3*v^2*exp(-9*v*x))/2 + v^2*exp(-10*v*x))^(3/2((
f=simplify(t-r+d-u-w+z(
%g= log[108*v^2*exp(-3*v*x) - 32*v^2*exp(-2*v*x) + 832*v^2*exp(-4*v*x) - (3*v^2*exp(-5*v*x))/2 - (12*v^2*exp(-6*v*x))/5 + (9*v^2*exp(-7*v*x))/2 + 512*v^2*exp(-8*v*x) - (3*v^2*exp(-9*v*x))/2 + v^2*exp(-10*v*x))^(3/2)]^q
g=simplify(log(f((
n=10;h=0.5;
x=1:h:n;
p= -(f*g(
p =inline(' log(3888*exp(-18*x) - 1152*exp(-12*x) + 29952*exp(-24*x) - 54*exp(-30*x) - (432*exp(-36*x))/5 - 162*exp(-42*x) + 216*exp(-60*x)^(3/2))^(1/2)*(1152*exp(-12*x) - 3888*exp(-18*x) - 29952*exp(-24*x) + 54*exp(-30*x) + (432*exp(-36*x))/5 + 162*exp(-42*x) - 216*exp(-60*x)^(3/2;('((
s1=0;
for i=2:n-1
    s1=s1+p(i;(
end
int=h/2*(p(1)+2*s1+p(n))
```

REFERENCES

[1] Abeer A. Abdul-Razaq, A laa. K.Jihel and Ahmed A. Ouda, (Amodified technique to evaluate the reliability of Atomium Bridge), 2019.

[2] Mohammed S.Raheem,(Evaluation of the reliability indices 400 kv Iraqi super Grid), 2013.

[3] Claused. A .Moore, C. Newman M..E, (Hierarchical structure and the prediction of missing links in network), journal :Nature, 453, 2008.

[4] Anard and eal ., (Entropy distribution and condensation in random networks with a given degree distribution), 2014.

[5] R. Billinton and R.N. Allan, Reliability evaluation of engineering systems: concepts and techniques, Springer Science and Business Media, 2013.

[6]S.M. Alghamdi and D.F .Percy , "Reliability equivalence factors for a series–parallel system of components with exponentiated Weibull lifetimes", IMA Journal of Management Mathematics, vol. 28.3 (2015), pp. 339–358.

[7] Gertsbakh, I. B., & Krymsky, V. G. (2017). Reliability of large and complex systems (Vol. 1). Springer.

[8] C .Wang, Shannon information entropy in heavy-ion collisions, 2018.