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Fault Classification in Radial Distribution Feeder

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Abstract: ***Distribution feeders those used for the power distribution is affected with various faults as they are exposed to the environment .so these feeders must be protected from the faults for continuous power flow without any disturbance .For the protection and better fault correction the type of fault must be known. In this paper, a new fault detection technique is proposed for transmission line protection using Euclidean distance between successive current samples. The proposed technique is extended to identify faulty phase. However the normal relays are not reliable in situations like sudden load changes, switching operations etc., and it is very important to discriminate the faults. The proposed technique effectively works under these situations. Finally it is observed that the proposed algorithm is more effective to detect faults in transmission and distribution line system. The proposed algorithm was tested on the IEEE 13-bus test feeders using MATLAB/SIMULINK.***

I. INTRODUCTION

In recent years many digital computer programs have been developed for the analysis of three-phase radial distribution feeders. The programs use a wide variety of iterative techniques and range from very simple with many simplifying assumptions made for line and load models to very sophisticated with little if any simplifying assumptions. With so many different programs available there is a need for benchmark test feeders so that the results of various programs can be compared. This paper presents the data of a 13-bus radial distribution feeder. The deterioration of voltage distribution feeder equipment develops over time until a major outage takes place. Therefore, to improve reliability and longevity of equipment, the growing failing equipment must be detected and maintained. These failures may result in an unsafe operation or hazards. This paper considers a 13-bus distribution test feeder circuit and the technique used for fault detection and classification is the Euclidean distance technique. In this modern age of technological development demand of the electricity is increasing where generation and transmission capacity is not increasing at same rate. This gives constraints on the power system. The erection of a new transmission line is not an easy task especially in the developing countries like India. So a power system engineer must try to use existing transmission and distribution lines up to their stability limits. There is no fault-free system and it is neither practical nor economically feasible to build a fault-free system. The various abnormal circumstances such as natural events, physical accidents, breakdowns, and incorrect operation create disturbances in the power supply. The consequences of the disorders are strengthening the current flow, increasing heat in the conductors, which are among the most important causes of damage produced. The actual level of interference will depend on the resistance to flow and varied impedance between the fault and the source of the power supply. Impedance consists of the fault resistance, resistance and reactance of the Conductor, the impedance of the transformer reactance of the circuit, and an impedance of power plant.

Faults in overhead transmission system can be classified into two types, i.e. series (open conductor) faults, and shunt (short circuit) faults. Serial faults can easily be identified by observing the single-phase voltage. If the voltage values are increased, this means that open conductor fault has occurred. Short-circuit faults can easily be identified by observing the individual phases current. If the current values increases, it indicates short circuit has occurred. Short circuit faults are divided into two types, i.e. asymmetrical faults, and symmetrical faults. here, in this paper we use a shunted three-phase fault in order to test the results. Asymmetrical faults line to ground (LG), line to line (LL), and double line to ground (LLG), and symmetrical faults are triple line (LLL) and triple line to ground (LLLG) faults. The most commonly occurring fault is LG fault and this fault is less severe when compared to the other faults. The next fault in severity wise and occurrence wise is LL fault, LLL and LLLG faults are much severe than all the faults. From this what we can take is that if 3-phase fault has occurred, the entire system collapses. So protection needs, in order to determine the fault and the fault type and location of the fault within less time classify to avoid damage. For this until now, so many methods have to be invented, each method has its own disadvantages and disadvantages. The classification is a common procedure with categorization, the procedure in which thoughts and objects are perceived and separated. Classification enables us to see, connections between things that may not be clear. The classification of things makes it less challenging for us to make judgments about the value of the different things. The accuracy of the fault detection and classification are the most important elements for the protection of line. This has a different enthusiasm for protection technology. By so many techniques developed for a classification that the user may get confused to choose the appropriate technology. Easy to understand, this review of the widespread fault classification procedures in 3 types divided up as follows: (A) Prominent Faults (B) Hybrid Faults (C) Modern techniques.

The technique implemented in this paper would be a modern technique that includes the Euclidean distance technique.

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II. PROPOSED TECHNIQUE

The technique used in this paper is the Euclidean distance technique. This technique is used to determine the fault location and type of fault in the considered 13 bus distribution feeder system. In mathematics, the Euclidean distance or Euclidean metric is the "ordinary" distance between two points that is given by the Pythagorean formula. The associated particular is called as Euclidean norm. Consider two points in a space; this corresponds to the length of the line between the two points drawn between them. This distance is considered as the Euclidean distance and is calculated using the Pythagorean Theorem.

Consider a Cartesian plane ,in which the Cartesian coordinates are considered as p=(p_1,p_2,….,p_n) and q=(q_1,q_2,….,q_n) .These are the are two points in Euclidean n-space, then the distance(d) between the points p and q is given by Pythagorean formula.

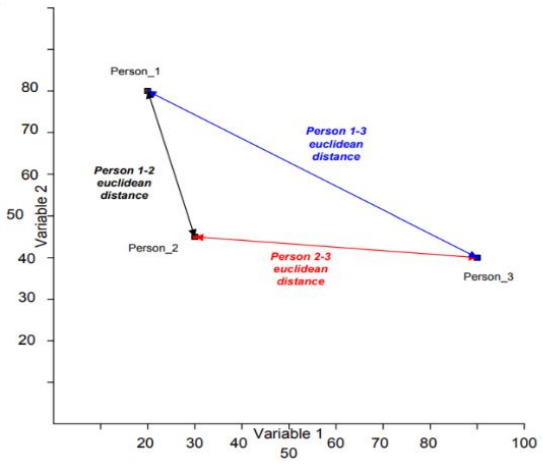


Fig 1: Representation of Pythagoras theorem

$$d=\sqrt{((q_1-p_1)^2+(q_2-p_2)^2+\cdots+(q_n-p_n)^2)}$$

from the above equation we have ; $$d=\sqrt{\sum_{i=0}^{n}(q_n-p_n)^2}$$

In this paper we consider the two dimensional Euclidean distance between two successive current samples. Now we consider two current samples I1, I2 at time interval t_1 ,t_2 respectively. The Euclidean distance technique is used to find the Euclidean distance between the successive current samples that is I_1 and I_2 .The Euclidean distance between these current samples is calculated using the Pythagorean formula as shown below

$$E_i=\sqrt{((t_2-t_1)^2+(I_2-I_1)^2)}$$

where E_i is the Euclidean distance between I_1 and I_2 .The following figure gives the representation of the parameters and the sketch of the line whose distance is calculated.

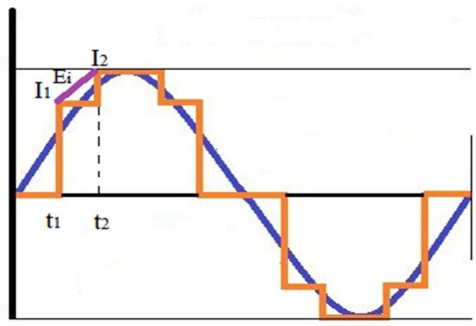


Fig 2: Representation of distance calculation

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As there are three phases, let us consider phase A, phase B and phaseC. let us consider the euclidean distance of a particular current sample of phase A calculated as E_A, similarily E_B and E_C for the corresponding B,C phases.

$$E_A = \sqrt{((t_2 - t_1)^2 + (Ia_2 - Ia_1)^2)}$$

where t2 , Ia2 are time and current samples at which Euclidean distance has to calculated.t1,Ia1 are the successive previous time and current samples .Similarly E_B , E_C are also calculated at time sample t2.
This technique makes to detect all the types of faults in the transmission and distribution line. By this technique we can detect the faults even under different conditions like transients, switching of capacitance and loads ,different sensitivity load centers ,different locations of the faults and at different inception angles.

III. SIMULATION

The system includes a 13 bus system of source voltage of 115kv, 50HZ frequency in this the Bus1 is the source bus and the remaining buses are the load buses. The positive sequence parameters such as resistance, inductance and capacitance of the transmission line are 0.1156 Ω, 9.835e-4 H and 1.57199e-9 F respectively. The negative sequence parameters are same as the positive sequence parameters. The zero sequence parameters are 0.4060 Ω, 0.0031 H and 1.3398e-9 F.
Each buses are placed at different distances from each other and connected by transmission line of different length the length of the transmissions line are represented in the below table.

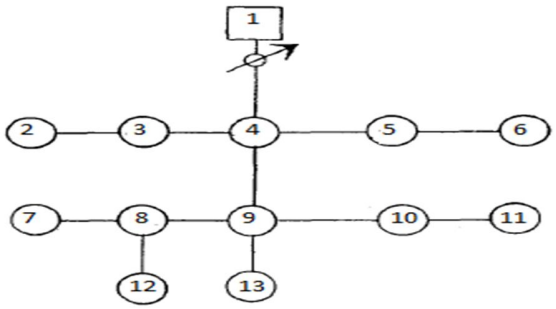


Fig 3: Block diagram of 13 bus radial distribution system

BUS A	BUS B	LENGTH(ft)
4	3	500.0
5	4	500.0
5	6	0.0
3	2	300.0
1	4	2000.0
12	8	800.0
9	4	2000.0
9	8	300.0
9	13	1000.0
11	10	500.0
8	7	300.0
10	9	0.0

Table 1: 13 bus radial distribution system line section data

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Different loads are used for different connected buses, therefore the loads used in this paper are represented in the below table. The corresponding KW and KVAR values are given below.

BUS NO.	LOAD MDL	PH KW	PH KVAR
34	1	42.63	20.18
45	1	170.53	125.09
46	6	230.22	131.97
52	3	127.90	85.79
71	4	383.70	219.95
75	1	281.38	154.09
92	5	170.53	151.38
911	2	170.53	80.74

Table 2: 13 bus radial distribution system bus loads as kW and kVar

IV. RESULTS

While considering all the above conditions and parameters the technique was carried out to obtain the results. The results shown below were obtained when fault was introduced in the system at different bus locations. All the 10 types of faults were tested and the results are shown as follows. Hereunder the Line to ground (LG), Line to line (LL), Double line to ground (LLG), Triple line (LLL) are represented.

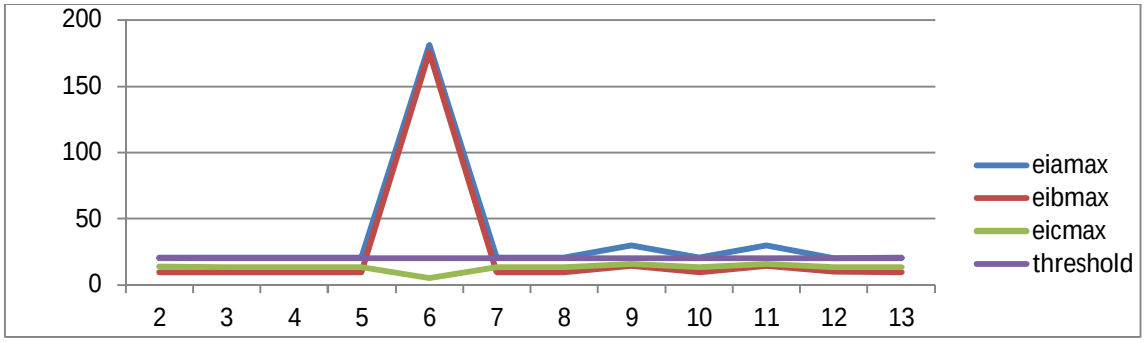


Fig 4: Representation of AG or LG fault with threshold

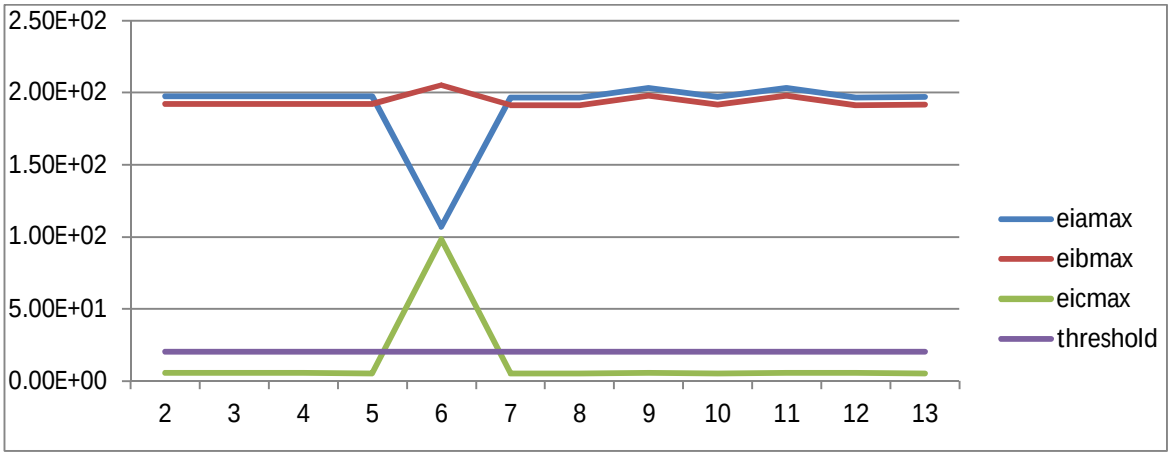


Fig 5: Representation of AB or LL fault with threshold

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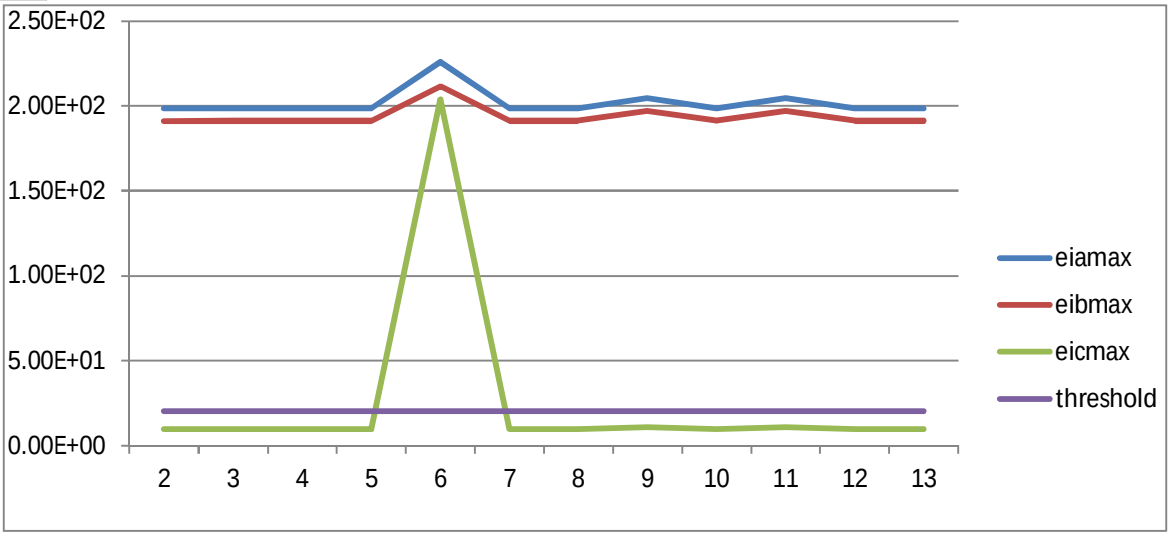


Fig 6: Representation of ABG or LLG fault with threshold

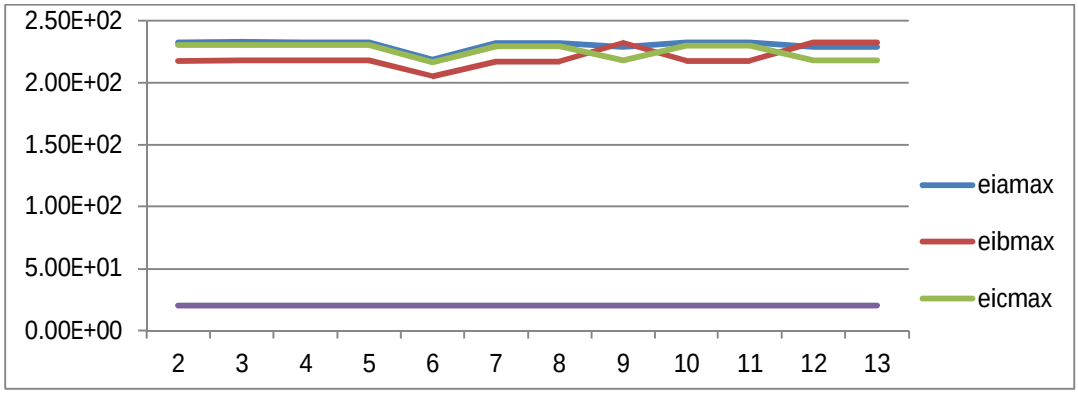


Fig 7: Representation of ABC or LLL fault with threshold

A. Effectiveness Of Proposed Algorithm In Failure Of Fault Detection

During the process of application of the Euclidean distance technique to identify the fault in the system, there occurred conditions in which the fault detection was not correctly read. The below table represents the operating conditions at different buses and different faults with a threshold limit as 15 for precise operation. In the following table Y denotes that the following fault is detected correctly and N denotes that the fault was not detected correctly.

BUS NO.	AG	BG	CG	AB	BC	AC	ABG	BCG	ACG	ABC
2	Y	Y	Y	Y	Y	Y	Y	N	Y	Y
3	Y	Y	Y	Y	Y	Y	Y	N	Y	Y
4	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
5	Y	y	y	y	y	y	y	y	y	y
6	N	N	N	N	N	N	N	N	N	Y
7	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
8	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
9	Y	N	Y	Y	Y	Y	Y	Y	Y	Y
10	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
11	Y	N	Y	N	Y	N	Y	Y	Y	Y
12	Y	Y	Y	Y	Y	Y	Y	N	Y	Y
13	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

Table 3 effectiveness of proposed algorithm in failure of fault detection

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V. CONCLUSION

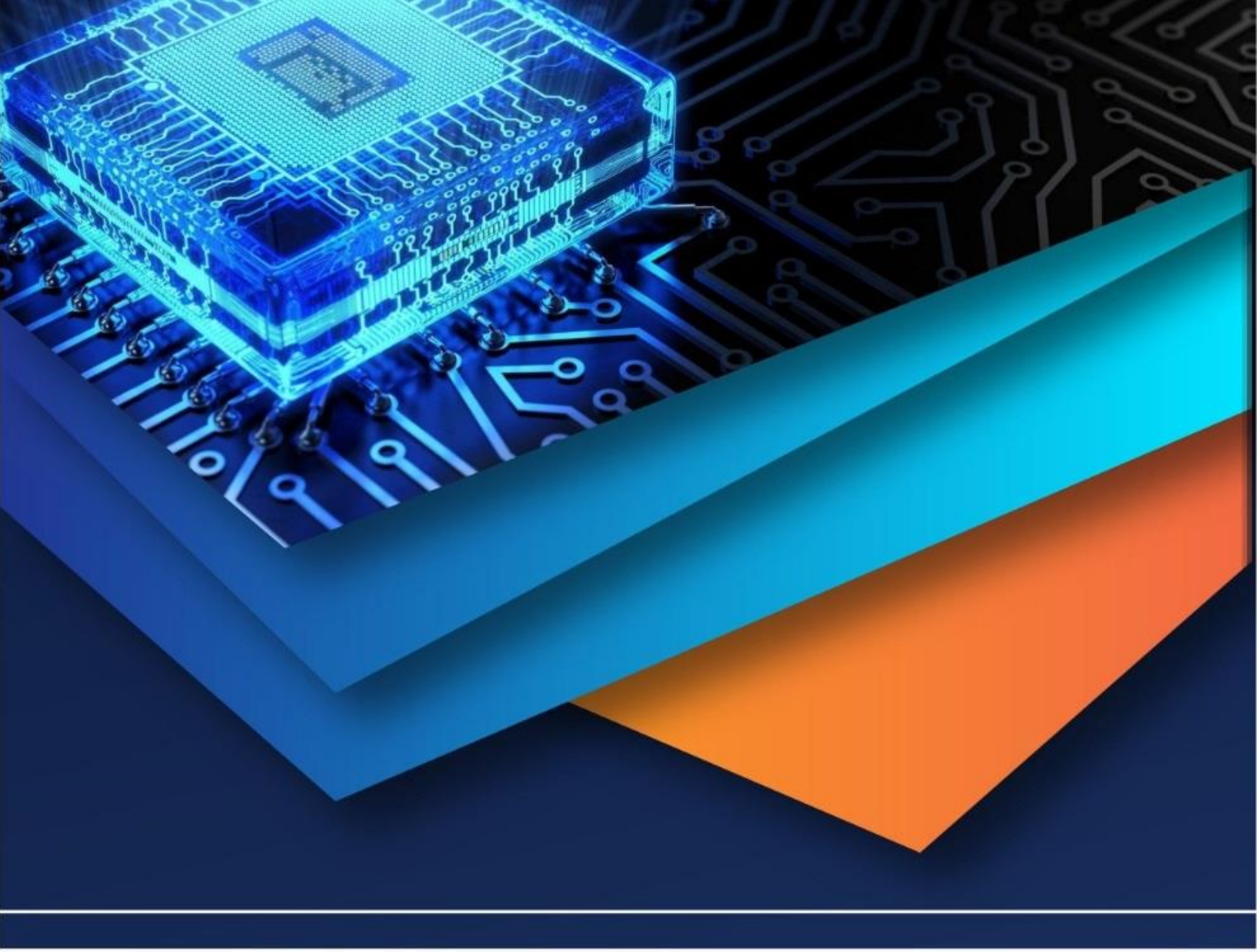
The proposed Euclidian distance approach for fault detection and classification is effective in 13 bus distribution system. This approach has also tested efficiently in all abnormal conditions like switching of capacitance, load variations. The current and voltage signals are used in this approach for fault detection. This approach considers the maximum current Euclidean distances between two successive currents samples during no fault as reference. Based on the value of fault index (F_i) the present approach has differed between ground fault and phase fault. The following major conclusions can be drawn from the work:

A. This approach has worked for different load centers and also detects faults at any location on the line.
B. The performances of this approach during all fault conditions are tested and are effective.

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