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Feeder Automation Based on Medium-voltage High-speed Analog Communication Technology in Distribution Network

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Abstract As the current concept of sustainable energy continues to take root in the hearts of the people, more requirements are also put forward for the application and development of electric energy. In the field of distribution network, due to the development of smart grid, higher requirements are also put forward for the automatic control of distribution network. Distribution network feeder automation is an important part of distribution network automation system. Its operation status has a direct impact on the implementation effect of distribution network automation system. In order to better promote the operation level of distribution network feeder automation, based on the analysis of distribution network automation theory, combined with the currently popular medium-voltage high-speed analog communication technology, this paper indicated that it can be used in distribution network feeder automation, and emphatically analyzed the application of medium-voltage high-speed analog communication technology in distribution network feeder automation. Through research, it was found that this technology had good application value in distribution network feeder automation. It can improve the anti-attack of Circuit 4 and Circuit 1 communication data by 12% and 17.2% compared with traditional methods. In addition, this technology can effectively reduce its fault location isolation detection and power recovery time, and improve power quality and power safety. In addition, the research on distribution network feeder automation in this paper can also enrich the content of energy research and promote the sustainable development of energy.

Index Terms Feeder Automation, Medium-voltage High-speed Analog Communication Technology, Distribution Network, Fault Detection

I. Introduction

As the current energy sustainability issue is gradually being paid attention to, the development of electric energy has also caused many discussions. The power system mainly includes four aspects, namely power generation, transmission, distribution and consumption. The distribution network is the last link of power production and supply, and its importance is becoming increasingly significant. At the same time, with the continuous improvement of people’s living standards and the continuous development of economy, people’s demand for electricity is also increasing, which has resulted in the continuous growth of the number of distribution networks and distribution equipment. At the same time, the distribution network system also presents the trend of complex network structure and diversified power supply operation mode, which makes the difficulties in control operation and fault handling continuously increase. Therefore, how to improve the power quality and realize the sustainable and healthy development of power has become an urgent problem. As the most basic and critical component of distribution network automation system, feeder automation is of great significance. Therefore, in the application of distribution network automation, the first thing to consider is feeder automation. In view of the problems existing in the feeder automation of the distribution network at present, this paper focuses on the in-depth study of the medium-voltage high-speed analog communication technology, hoping that this way can effectively solve the communication difficulties and fault location and isolation problems in the distribution network, realize the rapid transmission of communication data, and provide higher reliability and security for residential power consumption.

For the feeder automation of distribution network, many scholars have discussed it from different angles and proposed methods to promote the optimal development of feeder automation. Dai Qiangsheng pointed out that feeder automation in the advanced distribution system has the self-healing ability of quick response, discussed the physical response of the distribution system to malicious network attacks of feeder automation, and proposed corresponding solutions, which promoted the better development of feeder automation in the distribution system [1]. In order to solve the problem of difficult selection of equipment and location in the feeder automation transformation of distribution network and promote the better development of feeder automation of distribution network, Chen Ruizhi proposed an optimized layout model of feeder automation equipment of distribution network for fault detection and local action type [2]. Gu Jyh-Cherng said that in the feeder automation of distribution network, the detection of high impedance fault events has become a difficult task. In order to better promote the development of feeder automation of distribution network, he proposed to enhance the feeder terminal unit to realize the feeder automation detection of distribution network [3]. Dai Qiangsheng said that feeder automation improved the reliability of distribution network, but also made the operation of distribution network more dependent on network physical components. To this end, he proposed an attack strategy to realize feeder automation operation and cut off important power users, and ultimately promote the efficient development of feeder automation in distribution network [4]. These scholars' research on feeder automation can enrich its theoretical content, but there are also certain deficiencies.

However, some scholars have discussed this issue from the perspective of communication technology and said that the development of communication technology provides more possibilities for the development of distribution network feeder automation. Lu Haiquan proposed a new communication transmission technology, which realized the low-complexity unbalanced single-carrier communication, was not affected by inter-symbol interference, and improved the efficiency of feeder automation [5]. Zhang Ruoqi proposed a carrier communication technology for Direct Current (DC) microgrid applications. This method can achieve better distribution of power and more precise scheduling of energy in the distribution network, with low cost and simple implementation, and improved the communication rate of distribution network feeder automation [6]. The research of scholars can provide some theoretical support for this paper, but because its research is only to analyze the application effect of communication technology in distribution network feeder automation, in order to further study its application in distribution network, this makes the research results can not be well applied. It can be seen that the application of medium-voltage high-speed analog communication technology in feeder automation of distribution network is currently a relatively blank field, which needs more research and enrichment.

In order to better promote the feeder automation of distribution network, based on the theoretical analysis of medium-voltage high-speed analog communication technology, this paper proposes a new way to promote the development of feeder automation of distribution network in combination with previous scholars' discussion on feeder automation of distribution network. Through empirical research, it is found that the method proposed in this paper can promote the development of current distribution network feeder automation. It can better achieve fault detection and improve the security of communication data. Compared with the traditional feeder automation technology of distribution network, the innovation of this technology is to pay attention to the unique advantages of medium-voltage high-speed analog communication technology for communication and fault detection and use it in feeder automation, which helps to improve power quality, shorten power recovery time and improve power supply reliability.

II. Evaluation on Feeder Automation Theory of Distribution Network

II. A. Overview of Distribution Network

II. A. 1) Meaning

In the current power system, large-capacity power stations are usually far away from the load center. The power generated by the power stations is usually transmitted to the load center through the high-voltage or ultra-high-voltage transmission network, and then the power is transmitted to users with different voltage requirements by relying on the low voltage network in the load center. Such a network that plays the function of distributing electric energy in the power grid is called distribution network [7].

According to the voltage level, the distribution network can be divided into 35 to 110 kV (high voltage), 6 to 10 kV (medium voltage) and 220 to 380 V (low voltage). According to its power supply area, it is divided into urban distribution network and rural distribution network. The distribution network is also known as the local power grid because it mainly supplies the power of a single area [8]. Compared with the regional power grid, the voltage level and power supply scale of the distribution network are relatively small.

II. A. 2) Distribution Network Automation System and Feeder Automation

Distribution Automation System (DAS) is a kind of computer technology that integrates the real-time operation, equipment composition, facilities, management data and geographic graphics of distribution network, and finally forms a complete intelligent system [9], [10]. The components of the distribution automation system are shown in Figure 1:

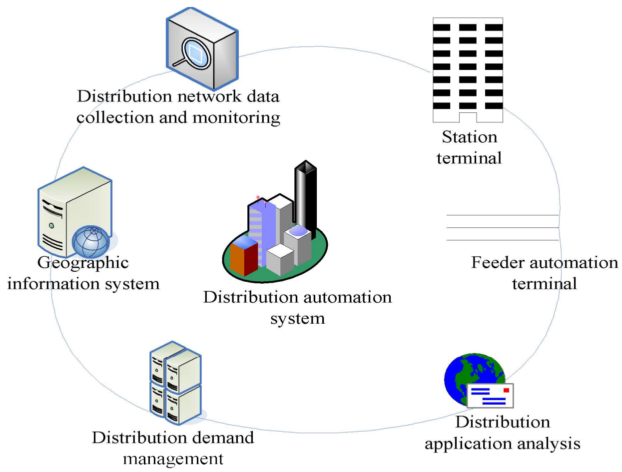

Figure 1: Components of distribution automation system

Feeder Automation (FA) refers to the automatic control of the feeder line from the substation outlet to the user's power supply equipment, which includes two parts. In general, the automation of feeder mainly refers to the automatic control of feeder lines such as overhead transmission lines, cables and overhead cable hybrid lines. The main hierarchy of feeder automation is shown in Figure 2:

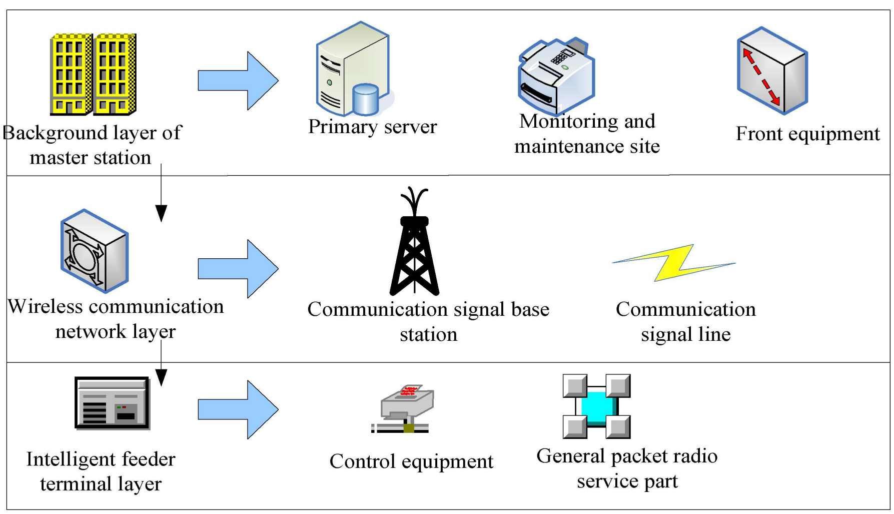

Figure 2: Main hierarchical structure of feeder automation

II. A. 3) Distribution Network Feeder Automation Status

Feeder automation of distribution network was first proposed by western developed countries in the 1970s. Because western countries are limited by region and power supply mode, in the process of developing and constructing distribution networks, in order to reduce asset investment and occupation of agricultural farmland, and improve power supply reliability and power quality, they rely on automatic switching equipment such as multiple reclosers and sectionalizers to realize the automation of distribution network feeders. With the subsequent development, the research of distribution network feeder automation in the world has mostly changed towards the direction of protection and control system. At the same time, during the normal operation of the distribution network, the collected feeder parameters can be transmitted to the distribution network control center to achieve real-time monitoring of the distribution network. By using the surface protection principle, the fault identification, isolation and power supply restoration of non-fault areas can be completed at one time, which shortens the fault processing time of the system, reduces the increase of power failure range caused by over-level tripping, and also reduces the loss of electrical equipment caused by multiple reclosures, thus extending the service life of electrical equipment. Compared with other methods, this method has simple fault criteria.

II. A. 4) Problems in Feeder Automation of Distribution Network

With the development of distribution network and feeder automation, feeder automation plays an important role in realizing the automation of distribution network. At present, the main station system and intelligent distribution terminal technology in the distribution network are quite mature, but there are still several problems in feeder automation:

The first is the communication problem, which is also the most important problem in the realization of smart grid and distribution network feeder automation [11]. There is no clear specification for the application of feeder automation in distribution network. Both distributed and centralized control modes are related to communication technology. The centralized control mode requires that the data of the feeder terminal equipment of the distribution network should be monitored and judged comprehensively by the sub-station or master station after communication, which undoubtedly increases the workload of the main station or sub-station of the power grid [12]. With the progress of science and technology, the cost of optical fiber equipment has been greatly reduced, and communication technology has become an important way to achieve sustainable energy development [13]. The biggest difficulty of feeder automation communication is laying. At present, when monitoring the operation of power supply lines and switch bodies, there is a large amount of real-time communication data, and most of these data rely on the communication system to transmit it to the master station background for storage. Once the communication system fails, it would cause a large number of valuable data loss, which would affect the status analysis and long-term planning of power supply lines and switch bodies. At present, most of the installed feeder terminals do not have the ability of communication encryption protection, especially the communication equipment. Most of them use the public network for data transmission, which makes it easy for criminals to use the public network to attack the feeder terminal or master station, and cause great losses.

Secondly, most of the existing feeder lines are radial. Once a fault occurs, the power supply downstream of the whole fault area would be cut off directly, and it would take a long time to fully recover the power supply. The power supply reliability is low, which affects the promotion and use of the feeder automation system. At the same time, due to the difficult coordination of multiple protection logics at the feeder terminal in the time sequence, it is easy to lead to switch misoperation, non-operation, over-level action and other misoperation phenomena, which eventually leads to the expansion of the fault and affects the reliable operation of the power grid.

Finally, the existing 10 kV feeder distribution switch monitoring terminal only has the functions of switch opening and closing, online monitoring and fault circuit protection, and cannot test the mechanical characteristics of the switch body. In the feeder line, the electrical fault caused by the switch body is also very common. At present, the inspection of the main body of the line switch is only limited to the factory test of the product or the disassembly inspection during the outage overhaul.

It can be seen from the above that there are certain problems in the feeder automation of the current distribution network, and how to solve these problems, realize the feeder automation, and improve the power safety and power quality is of great significance. Therefore, this paper proposes to use the medium-voltage high-speed analog communication technology in the feeder automation of the distribution network to improve the shortcomings of the feeder automation of the distribution network.

II. B. Medium-voltage High-speed Analog Communication Technology

II. B. 1) Meaning

Power Line Communication (PLC) is a communication mode that uses the current power transmission line as the communication signal channel to automatically transmit data information [14]. The special application technology of programmable controller has a large coverage area and can be used for two purposes, that is, automatic transmission of electric energy and data statistics, various electrical equipment, etc., which can be directly used as network terminal service facilities to access the network. In the power system, a new medium voltage high-speed analog communication technology with high speed, strong adaptability and large capacity is adopted. The medium-voltage high-speed analog communication technology is a technology that uses the power line as the data transmission channel of the distribution network automation system to transmit analog or digital signals at high speed by carrier wave. It is the only wired communication method that does not need to invest in the line at present. The principle of medium-voltage high-speed analog communication is shown in Figure 3:

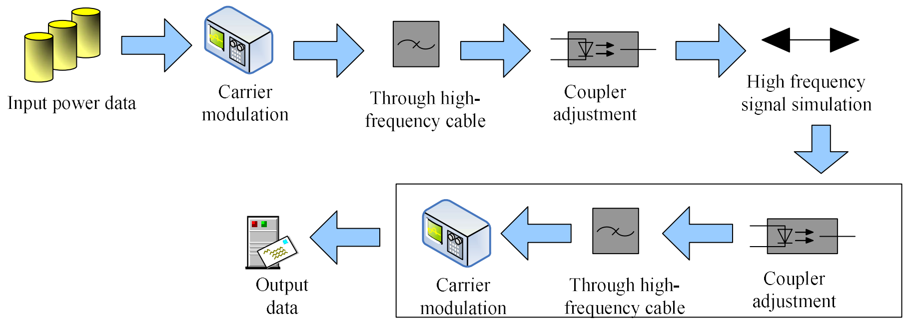

Figure 3: Schematic diagram of medium-voltage high-speed analog communication principle

In medium-voltage high-speed analog communication, its physical channel is usually divided into two categories. One is overhead transmission line, and the other is underground cable. Its transmission mechanism is also different. The basic working principle of overhead transmission line communication is to combine pulse signals with overhead transmission lines by using filters, high-voltage insulation capacitors, etc. [15]. This method has good coupling degree, but it also has the disadvantage of being easily affected by various factors such as environment, which causes the instability of signal transmission and thus causes the change of power supply. To solve this problem, a relay station is usually added to the system and a certain margin is reserved for the signal to noise ratio in the system. The underground cable channel is less affected by the line, and the shielding layer is independent of the power supply topology and does not change with the change of the power supply type. It is the best transmission channel for carrier signal. Its connecting devices are easy to install and independent of each other, and have no direct connection with the installation of high-voltage live equipment.

II. B. 2) Application of Medium-voltage High-speed Analog Communication Technology in Distribution Network

The medium-voltage high-speed analog communication technology is a communication mode that takes power line as digital signal and provides efficient transmission channel. It is a communication system that regards power line as automatic transmission medium, with unique performance and application advantages. Its application advantages in distribution network are mainly reflected in five aspects. The first is its controllability. The power grid is planned and established by power enterprises, which can fully control it and directly use different functions of distribution automation. The second is its low cost. The medium-voltage high-speed analog communication technology can be used efficiently, comprehensively and widely and can be used as an intermediary for automatic transmission of distribution network. The third is the large coverage. In today's era, the coverage of the power grid is very large. No matter in production, study or life, electricity is needed, especially in remote areas. The medium-voltage high-speed analog communication technology has natural advantages. The fourth is the convenience of maintenance. Unless it is an irresistible factor, the medium-voltage high-speed analog communication is rarely affected by external factors, so it basically does not need maintenance. Fifth, it has good functions. The medium-voltage high-speed analog communication technology can realize the access of all communication services of enterprises, schools and families, and can flexibly realize plug and play, and its functions can be expanded. The application process of medium-voltage high-speed analog communication technology in distribution network automation is shown in Figure 4:

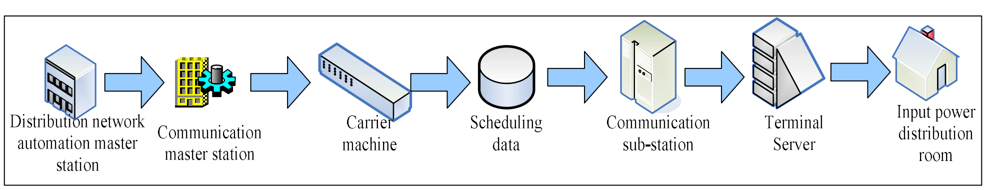

Figure 4: Application process of medium-voltage high-speed analog communication technology in distribution network automation

The traditional medium-voltage high-speed analog communication technology of distribution network is mainly used in two aspects: first, the communication between the control terminal and the distribution network is realized through overhead wiring, and the coupling effect of the carrier digital signal is realized by combining the filter controller and the high-voltage isolation capacitor. Its coupling efficiency is good, but it is vulnerable to the impact of the environment. The attenuation effect of the carrier digital signal on the wiring is uneven and not fixed. The second is to complete the communication between the terminal and the distribution network through buried cables, and complete the automatic transmission of carrier digital signals through transmission control, cable shielding and protection. This communication technology is less affected by the line, and is a good automatic transmission medium.

It can be seen that the application of medium-voltage high-speed analog communication technology in distribution network automation has certain theoretical basis, and as the focus of distribution network automation, the application of medium-voltage high-speed analog communication technology in distribution network feeder automation also has certain feasibility.

II. B. 3) Optimization of Medium-voltage High-speed Analog Communication Technology in Feeder Automation

Under the normal operation of the distribution network system, the feeder terminal machine shall transmit the collected voltage, current and other electrical parameters to the distribution network control master station through the communication system, so as to configure and adjust the operation structure of the distribution network. In the event of a fault in the distribution network, it is necessary to quickly complete the identification and isolation of the fault and restore the power supply in a timely manner in the non-fault area through the fast interactive command of the communication system between the adjacent feeder terminal units. After the structure of the distribution network is optimized or reconfigured, the adjusted values of various electrical parameters would be transmitted to the terminal units of each feeder through the communication system. Considering the real-time nature of fault monitoring and the reliability of power consumption in distribution network feeder automation, this paper selects medium-voltage high-speed analog communication technology as the communication system.

In this method, a periodic function is divided into infinite levels of fundamental component, DC component and harmonics. It can be expressed as follows:

$$\mathrm{m}(s) = \sum_{j=0}^{\infty}\left[x_j \cos(j\sigma_1 s) + y_j \sin(j\sigma_1 s)\right] \tag{1}$$

Among them: σ_1 is the fundamental angular frequency;

$\mathrm{y_j}$ and $\mathrm{x_j}$ are the amplitude of the sine and cosine terms of each harmonic.

From the Fourier series, the calculation formulas of y_j and x_j can be obtained:

$$y_j = \frac{2}{S}\int_0^S \mathrm{m}(s)\sin(j\sigma_1 s)\,dt \tag{2}$$

$$x_j = \frac{2}{S}\int_0^S \mathrm{m}(s)\cos(j\sigma_1 s)\,dt \tag{3}$$

The j-th harmonic current calculation formula can be expressed as:

$$m_j(s) = x_j \cos(j\sigma_1 s) + y_1 \sin(j\sigma_1 s) \tag{4}$$

Among them: y_1 is the amplitude of the cosine term of the fundamental component.

The calculation formula of its effective value can be expressed as:

$$M_j = \sqrt{\frac{y_j^2 + x_j^2}{2}} \tag{5}$$

The above y_j and x_j can be approximated by trapezoidal integration method as follows:

$$y_j = \frac{1}{J}\left[2\sum_{h=1}^{J-1}\mathrm{m}(h)\sin\frac{2h\pi}{J}\right] \tag{6}$$

$$x_j = \frac{1}{J}\left[\mathrm{m}(0) + 2\sum_{h=1}^{J-1}\mathrm{m}(h)\cos\frac{2h\pi}{J} + a(J)\right] \tag{7}$$

The current and voltage on the feeder terminal are provided by the control master station of the distribution network. The master station obtains the corresponding data by analyzing the structure and load of the distribution network, and then transmits it to the feeder terminal through the communication network. The calculation formulas of fixed value current and fixed value voltage can be expressed as:

$$M_{(z)} = H_1 M_J \tag{8}$$

$$V_{(z)} = H_2 V_J \tag{9}$$

Among them: M_J and V_J are the fixed current and voltage of the distribution network;

H_1 and H_2 are multiples set in advance by the main station of the distribution network according to the structure and operation of the distribution network.

The feeder terminal can quickly and accurately calculate the actual current and voltage. At the same time, the feeder terminal unit can compare the calculated current with the preset fixed value current. When its current value exceeds the fixed value current, it can be judged as the feeder fault overcurrent. Through the above medium-voltage high-speed analog communication technology, reliable and accurate communication between adjacent feeder terminals is realized, and a solution for fault detection and power recovery in distribution network is proposed, which has great application value.

III. Empirical Evaluation on Distribution Network Feeder Automation

Based on the theoretical analysis of medium-voltage high-speed analog communication technology, this paper believes that it has a good application prospect in distribution network feeder automation. Applying it to distribution network feeder automation can better solve the communication problems and improve the shortcomings of feeder automation. In order to better verify the practical utility of this communication technology in distribution network feeder automation, it is necessary to conduct empirical analysis.

III. A. Evaluation Methods of Distribution Network Feeder Automation

In order to verify the practical effect of medium-voltage high-speed analog communication technology in distribution network feeder automation, this paper compared it with traditional technology, and compared the different effects of the two methods from three aspects of bus fault detection and recovery, outgoing line fault detection and recovery, and communication of different circuits in distribution network feeder automation, so as to draw relevant conclusions.

III. B. Distribution Network Feeder Automation Test Results

III. B. 1) Bus Fault Detection and Recovery

In the feeder automation of distribution network, the bus plays the role of collecting, distributing and transmitting electric energy. In case of bus failure, the safety and reliability of all equipment connected on the line would be greatly reduced, leading to a large area of power failure. Finally, the quality of power consumption would be reduced. Therefore, it is very important to quickly locate and isolate the bus fault and restore the power supply in time. The time required for bus fault detection and recovery of different circuits in distribution network feeder automation under two methods is shown in Figure 5:

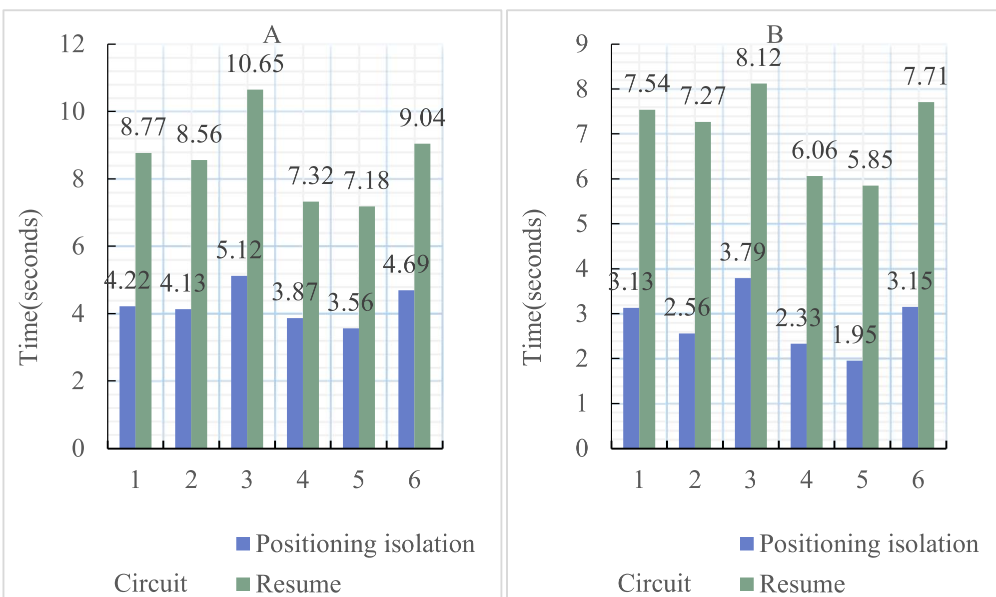

Figure 5 (A): Time required for bus fault detection and recovery of different circuits under traditional methods

Figure 5 (B): Time required for bus fault detection and recovery of different circuits in this method

Figure 5: Comparison of time required for fault detection and recovery of different circuit buses in distribution network under two methods

It can be seen from Figure 5 (A) and Figure 5 (B) that under the traditional method, the time required for fault location and isolation detection of different circuit buses in the distribution network was 4.22 seconds, 4.13 seconds, 5.12 seconds, 3.87 seconds, 3.56 seconds and 4.69 seconds respectively, and the time required for power supply recovery was 8.77 seconds, 8.56 seconds, 10.65 seconds, 7.32 seconds, 7.18 seconds and 9.04 seconds respectively. The time required for fault location and isolation detection of different circuit buses in the distribution network under this method was 3.13 seconds, 2.56 seconds, 3.79 seconds, 2.33 seconds, 1.95 seconds and 3.15 seconds respectively, and the time required for power supply recovery was 7.54 seconds, 7.27 seconds, 8.12 seconds, 6.06 seconds, 5.85 seconds and 7.71 seconds respectively. It can be seen that in Figure 5 (A), the time required for fault location isolation detection and power supply recovery of Circuit 4 and Circuit 5 was the shortest. In Figure 5 (B), the time required for fault location and isolation detection of Circuit 4 and Circuit 5 was 1.54 seconds and 1.61 seconds shorter than that of Figure 5 (A). The time required for power supply recovery was 1.26 seconds and 1.33 seconds shorter than that in Figure 5 (A). It can be seen that compared with the traditional methods, the method in this paper can effectively shorten the time required for bus fault location, isolation detection and power supply recovery in the distribution network. This was because the method in this paper accurately calculated the current and voltage of the feeder terminal bus through the medium-voltage high-speed analog communication technology, so that the distribution network can locate and handle the fault in time.

III. B. 2) Outgoing Line Fault Detection and Recovery

Outgoing line fault is also an important factor affecting distribution network feeder automation. In case of outgoing line fault of distribution network feeder, it may be inconvenient to use power, and cause distribution network fault and power safety. For this reason, it is still important to isolate and locate the outgoing line fault in the feeder automation of distribution network and recover the power consumption in time. The time required for fault detection and recovery of different circuit outgoing lines in distribution network feeder automation under two methods is shown in Figure 6:

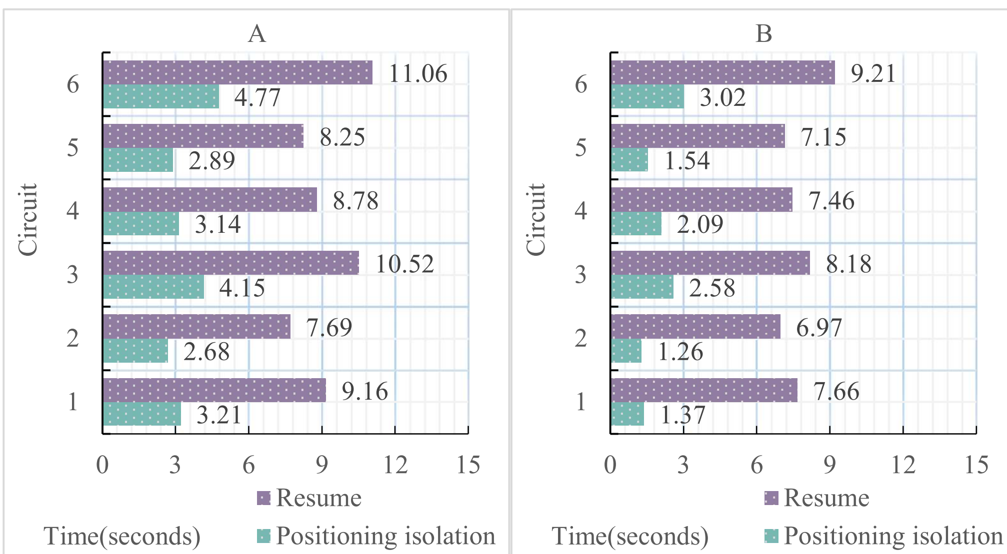

Figure 6 (A): Time required for fault detection and recovery of different circuit outgoing lines under traditional methods

Figure 6 (B): Time required for fault detection and recovery of different circuit outgoing lines in this method

Figure 6: Comparison of time required for fault detection and recovery of different circuit outgoing lines in distribution network under two methods

It can be seen from Figure 6 (A) and Figure 6 (B) that under the traditional method, the time required for the isolation, location and detection of outgoing line fault of Circuit 2 and Circuit 5 and the recovery time of power consumption were relatively small, wherein the time required for the isolation, location and detection of outgoing line fault of Circuit 2 and the recovery time of power consumption were 2.68 seconds and 7.69 seconds respectively. The time of outgoing line fault isolation and location detection and power recovery time of Circuit 5 were 2.89 seconds and 8.25 seconds respectively. However, the time of outgoing line fault isolation and location detection and power recovery time of Circuit 2 under this method were 1.26 seconds and 6.97 seconds respectively; the time of outgoing line fault isolation and location detection and power recovery time of Circuit 5 were 1.54 seconds and 7.15 seconds respectively. Compared with the traditional method, the detection time of outgoing line fault isolation and location and power recovery time of Circuit 2 in this method were reduced by 1.42 seconds and 0.72 seconds. The outgoing fault isolation, location and detection time and power recovery time of Circuit 5 were shortened by 1.35 seconds and 1.1 seconds. In addition, the outgoing line fault detection time and power recovery time of different circuits in distribution network feeder automation under this method were less than those of traditional methods, which meant that the medium-voltage high-speed analog communication technology was feasible for fault detection in distribution network feeder automation. It can effectively reduce the fault detection time and restore the power consumption in time.

III. B. 3) Communication Capability

At present, the biggest problem of distribution network feeder automation is the communication problem. How to reduce the burden of distribution network main station or sub-station and improve the anti-attack of distribution network real-time data is an urgent problem. This paper compared the anti-attack of different circuit communication data in distribution network feeder automation under two methods, and the specific results were shown in Figure 7:

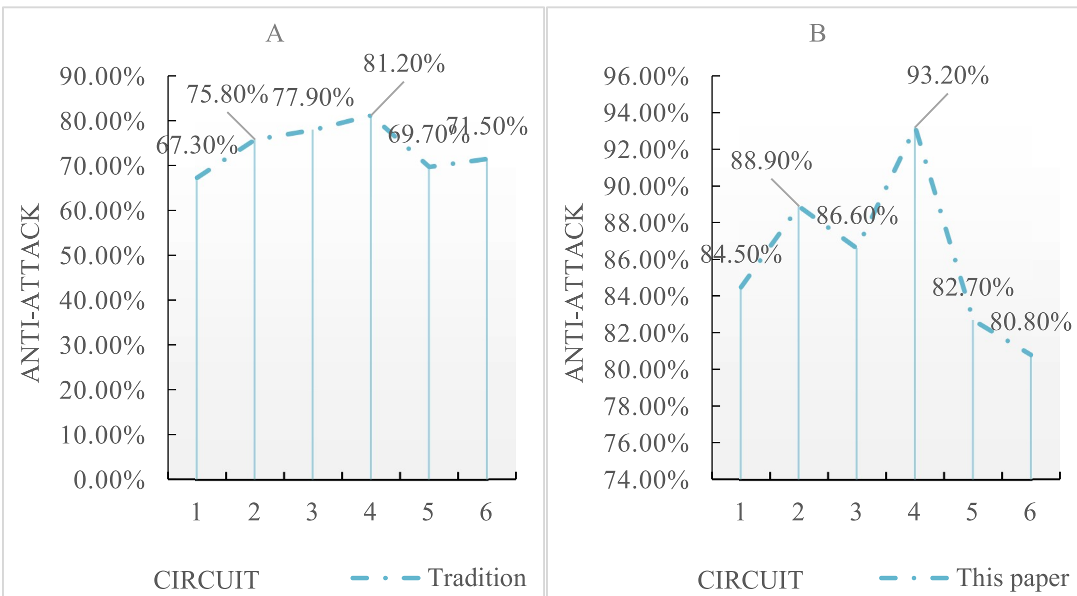

Figure 7 (A): Anti-attack of communication data of different circuits under traditional methods

Figure 7 (B): Anti-attack of communication data of different circuits in this method

Figure 7: Anti-attack comparison of different circuit communication data in distribution network feeder automation under two methods

It can be seen from Figure 7 (A) and Figure 7 (B) that the anti-attack degree of the communication data in the six different circuits under the traditional method was 67.3%, 75.8%, 77.9%, 81.2%, 69.7% and 71.5% respectively. Among them, Circuit 4 had the strongest attack resistance of 81.2%, and Circuit 1 had the worst attack resistance of 67.3%. The anti-attack degree of communication data in six different circuits in this method was 84.5%, 88.9%, 86.6%, 93.2%, 82.7% and 80.8%, respectively. The anti-attack degree of Circuit 4 was 93.2% and that of Circuit 1 was 84.5%. Compared with the traditional method, the anti-attack of Circuit 4 and Circuit 1 in this method was improved by 12% and 17.2% respectively. In addition, the anti-attack ability of the communication data in the circuit in this method was higher than that in the traditional method. It can be seen that the medium-voltage high-speed analog communication technology had better anti-attack performance because it improved the reliability and security of communication data through integrated intelligent control.

To sum up, through the empirical analysis of feeder automation based on medium-voltage high-speed analog communication technology in distribution network, this paper finds that it is completely feasible to use communication technology in feeder automation of distribution network, and this technology can better realize the detection and recovery of circuit faults. Compared with the traditional method, this technology reduces the bus fault location and isolation detection time of Circuit 4 and Circuit 5 by 1.54 seconds and 1.61 seconds, and the power supply recovery time by 1.26 seconds and 1.33 seconds. In addition, this technology can effectively improve the anti-attack of the communication data in the circuit. Compared with the traditional method, the anti-attack of the communication data in Circuit 4 and Circuit 1 under this technology has been improved by 12% and 17.2%. This shows that the medium-voltage high-speed analog communication technology proposed in this paper has good application effect and value in distribution network feeder automation, and can effectively solve the problem of distribution network feeder automation, and better meet the current demand.

IV. Conclusions

With the continuous development of the economy, the energy problem has become the focus of current people. How to improve the efficiency and quality of energy application and promote the better development of energy has caused many discussions. The subject of this paper is feeder automation based on medium-voltage high-speed analog communication technology in distribution network. This paper first gave a brief overview of the research background, then comprehensively analyzed the advantages and disadvantages of previous scholars' research, and proposed to apply medium-voltage high-speed analog communication technology to feeder automation in distribution network in combination with its research status. In order to verify the practical effectiveness of this technology, this paper also carried out practical verification. The experiment showed that the application of medium-voltage high-speed analog communication technology in distribution network feeder automation can help better achieve fault detection and power recovery, and it can also improve the anti-attack of communication data in distribution network feeder automation and realize real-time monitoring of communication data.

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