Development of Intelligent Detector for Handheld Multifunctional Power Equipment Based on Internet

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Abstract: it is an important means to discover the hidden troubles of internal device by detecting infrared thermal imaging and partial discharge testing in the running state of power equipment. However, it is difficult for power enterprise to find out potential trouble of the equipment on the high-place (pole tower) in operation condition at present. In order to make up for this trouble, this paper aims to develop a set of portable integrated detector integrating image recognition, infrared thermal imaging partial discharge testing to achieve multi-function integration and integration of charged high precise patrol as well as comprehensive hidden trouble identification in deep level and charging device information excerption to avoid insufficient hidden danger identification with strong concealment, which can not only enhance quality of line inspection but also efficiency of operation and maintenance effectively. In addition, it reduces pole mounting work falling risk for operator and maintainer and electric shock risk for live working so as to eliminate risk of electric shock by employees in its tracks and realize essential safety.

1 INTRODUCTIONS

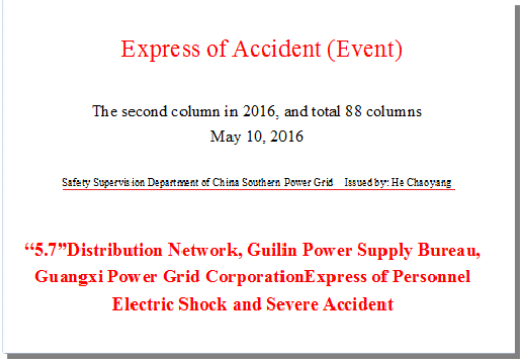
At present, for hidden danger identification methods of power equipment on the high-place (pole tower), most of power enterprises adopt telescope observation method and power failure pole mounting inspection method, and these two conventional inspection methods mainly have following limitations and hidden dangers:

1. Telescope observation methods are limited by height and line sight, which is difficult to observe and discover defects of high-place equipment in all directions

Figure 1: Diagram of power system high-place power equipment

2. Pole mounting inspection methods have characteristics of working aloft, high risk and long time-consuming, prone to falling, electric shock or casualties in high altitude, which is difficult to find equipment defects under operating conditions and ensure reliability of power supply.

3. For charging transcription of power equipment nameplate, there is a big security risk, and more likely to occur accident of falling into river in high altitude and electric shock casualties.


Express of Accident (Event)

The second column in 2016, and total 88 columns
May 10, 2016

Safety Supervision Department of China Southern Power Grid Issued by: He Chaoyang

"5.7"Distribution Network, Guilin Power Supply Bureau, Guangxi Power Grid CorporationExpress of Personnel Electric Shock and Severe Accident

Figure 2: Notification for power system accidents and events

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4 Infrared thermal imager and partial discharge tester are expensive, and inconvenient to carry, leading to the application of great limitation in the inspection and examination of distribution network line equipment.

In order to make up for this trouble that is difficult to find out potential trouble of the equipment on the pole tower in operation condition, this paper aims to develop a set of portable integrated detector integrating image recognition, infrared thermal imaging and partial discharge testing to solve problem of equipment hidden danger in the charging operation of distribution network line, which reduces the risk of pole mounting work in group and the risk of electric shock in live working, improves the reliability of power supplying network, and extends the function of equipment data acquisition and conversion.

2 TECHNICAL SCHEME

In this paper, an intelligent detection instrument for handheld multi-function power equipment based on Internet is developed. This instrument combines main high-definition smart camera, infrared thermal imager, partial discharge tester and smart phone (or tablet PC) to achieve comprehensive test integrating image recognition, infrared thermal imaging and partial discharge test in combination with wireless data transmission and intelligent hardware and software.

2.1 Main components

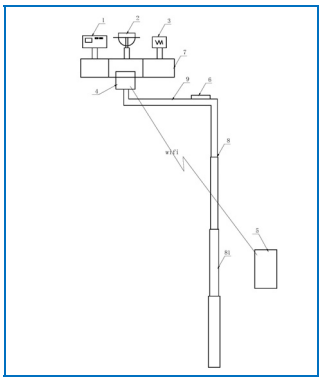

Figure 3: Structure diagram of power equipment intelligent detector

Among them: 1.Partial discharge detector 2.Camera 3.Infrared thermal imager 4. Master controller 5. Mobile terminal 6. Battery 7. Bracket 8. Extendable rod 81. Insulating tube 9. Support rod.

2.1.1 Partial discharge detector, camera and infrared thermal imager are installed in the bracket at the same time, and connected with main controller electrically;

2.1.2 Bracket is fixed at one end of the support rod, and the other end of the support rod is expandable Rod;

2.1.3 The internal support bar is equipped with local discharge detector, camera and infrared thermal imager and battery electrically connected to main controller.

2.1.4 Signals collected by camera, partial discharge detector, infrared thermal imager are transmitted to mobile terminal by the wireless network through host controller, and reflected in a chart or video.

2.1.5 Mobile terminals are mainly mobile phones, laptops and other commonly used mobile devices with popularizing rate.

2.1.6 Expansion rod is composed of multi-section flexible tube, including 1 to 2 insulation tube.

2.2 Enforcement mode

In order to explain this device clearly, the following content is described further in combination of Figure 3 and specific implementation mode

The first enforcement mode: signals collected by partial discharge detector1, camera 2 and infrared thermal imager 3 are transmitted to mobile terminal 5 by the wireless network through host controller 4, reflecting in a chart or video.

The second enforcement mode: the difference from the first one is that users can separately check detection information transmitted by partial discharge detector 1, camera 2 or infrared thermal imager 3 according to the need:

Signals collected by partial discharge detector1, camera 2, infrared thermal imager 3 are transmitted to mobile terminal 5 by the wireless network through host controller 4.

Specific operation flow: in the actual power inspection application, firstly pull extendable rod 8 and move it to detection position according to detection position; then open mobile phones, computers and other mobile terminals 5 and open public wireless network, log in corresponding

display and control software, observe detection information transmitted by partial discharge detector 1, camera 2 or infrared thermal imager 3 through mobile terminal 5 according to the need at the same time, or observe it respectively.

3 PRINCIPLE DESCRIPTION

3.1 Preliminary conceptions

Aiming at limitations and potential risks in the telescope observation method and power failure pole mounting inspection method, operators of power enterprises have developed a set of distribution network equipment device - mine sweeper which is the prototype of power equipment detector (Figure 4) with safe and easy operation and maintenanceaccording to the initial ideas: install high definition smart camera in the insulating rod so as to achieve visual observation of charging equipment in close range and hidden danger of charged equipment in all directions in combination with tablet PCs, APP applications and wireless real-time transmission technology.

Figure 4: Prototype of power equipment intelligent detector

The use of “mine sweeper” has realized close-range hidden danger identification for 360-degree of all-weather, safe and charging power equipment in high-altitude without hidden corners, and discovered equipment hidden dangers that cannot be found by routine inspection, which reduced ascent work greatly, improved operation and maintenance quality and efficiency, relieved pressure on owner of equipment operation and maintenance, and won general consent of teams and groups.

3.2 Ultimate technical principles

In the popularization and application process of “mine sweeper”, it was found that some power equipment not only needed to inspect image recognition for discover of equipment hidden danger in high altitude, but also test infrared thermal imaging and partial discharge in high altitude so as to further determine online health state of running equipment, and other extension functions of “mine sweeper” shall be dug deeply.

What is more, due to slim and long insulation rod, it is difficult to for operators to operate and control, and insulation rod should be improved further. Therefore, a set of portable integrated detector integrating image recognition, infrared thermal imaging and partial discharge testing shall be developed in combination with wireless data transmission and intelligent hardware and software. Technical principles include the following aspects:

(1) Partial discharge detector, camera and infrared thermal imager are installed in the bracket at the same time, and connected with main controller electrically; bracket is fixed at one end of the support rod, the other end of the support rod is expandable rod; the internal support bar is equipped with local discharge detector, camera and infrared thermal imager and battery electrically connected to main controller.

(2) Signals collected by three instruments are transmitted to mobile terminal by the wireless network through host controller, and reflected in a chart or video.

(3) Expansion rod is composed of multi-section flexible tube, including 1 to 2 insulation tube.

(4) Mobile terminals are mainly mobile phones, laptops and other commonly used mobile devices with popularizing rate.

Steps: in the actual power inspection application, firstly pull extendable rod and move it

to detection position according to detection position; open mobile terminals and public wireless network, log in corresponding display and control software, observe detection information transmitted by three instruments through mobile terminal according to the need at the same time, or observe it respectively.

4 IMPLEMENTATION EFFECT

The instrument is applied in the field of smart grid detection equipment technology, using mutual interoperability of high definition smart camera, infrared thermal imager, PD tester and smart handheld devices to achieve 360-degree high definition video inspection in all directions in the operation condition of pole tower, and simultaneously realize running equipment temperature measurement, partial discharge and internal defect hidden dangers in accordance with the health status of running equipment, which improves the operation and maintenance quality and operation and efficiency greatly and has great economic and social benefits:

4.1 Economic benefits

It can be seen that intelligent detector of power equipment improves operation and maintenance efficiency obviously through power equipment intelligent detector and conventional methods to carry out hidden danger identification for power equipment.

Table 1: Comparison of hidden danger identification efficiency for power equipment intelligent detectors and conventional methods

Equipment checking	Conventional checking time	Checking time of intelligent detector	**Saving time**
Transformer body	Close observation power failure pole mounting (totaling power failure, electrical power and grounding time) takes more than 60 minutes.	Full angle observation takes 10 minutes.	More than 50 minutes
Drop-out fuse	Close observation power failure pole mounting (totaling power failure, electrical power and grounding time) takes more than 60 minutes.	Full angle observation takes 5 minutes	More than 55 minutes
Drop-out lightning arrester	Close observation power failure pole mounting (totaling power failure, electrical power and grounding time) takes more than 50 minutes.	Full angle observation takes 5 minutes	More than 55 minutes
Switch body	Close observation power failure pole mounting (totaling power failure, electrical power and grounding time) takes more than 50 minutes.	Full angle observation takes 10 minutes	More than 40 minutes
Switch PT	Close observation power failure pole mounting (totaling power failure, electrical power and grounding time) takes more than 50 minutes.	Full angle observation takes 8 minutes	More than 42 minutes

Through the calculation, it took an average of more than 60 minutes to check the equipment by pole mounting in the last. At present, by using portable integrated detector for checking hidden danger, it took about 10 minutes on average. In comparison with the past, about 50 minutes can be saved. There are about 89, 444 switchgear transformers and switch gears on pole in Foshan Power Supply Bureau. With a monthly inspection of 30 %, it can save 22,361 hours per month, with an average hour of 11 Yuan for one person per month, which can save 491, 900 million per month.

4.2 Social benefit

4.2.1 Based on Internet, through common mobile terminals, relying on relevant software, detection information is directly to mobile terminal; achieve function of image contrast and preliminary analysis to make it more adaptable to requirements for site.

4.2.2 With multi-functional integration, achieve partial discharge performance, images or video, thermal performance of corresponding detection

position, can be reflected in a picture or video centrally, and provide more intuitive data for scientific decision-making; achieve purpose of equipment data acquisition and conversion, portable temperature measurement and partial discharge.

4.2.3 Low price; adapt to requirements for smart grid application of a large number of intelligent testing
equipment; there are no separate external test outer parts and displayed long-distance detection settings due to electrical safety. In particular, there is no need to configure a dedicated monitor, which can display detection information directly by using mobile terminals such as personal mobile phones and computers with low cost.

4.2.4 The combination of intelligent power detector and insulation rod can shoot clear picture of equipment in high altitude and observe equipment health status in 360-degree and all directions, carry out temperature measurement and partial discharge work for necessary equipment, complete it without pole mounting, and reduce work risk effectively.

5 RANGE OF APPLICATION

Portable integrated detector can be promoted widely in power industry. It is mainly used in various equipment hidden danger identification, equipment rated plaet information collection, project constructional acceptance of common distribution transformer, 10kv outdoor switch body and feeder automation switch PT, drop-out fuse, dis-lodging arrester in the operating condition.

5.1 Achieve hidden danger identification for 360-degree of all-weather, safe and charging power equipment in high-altitude; implement 360-degree high definition video inspection in all directions in the operation condition of pole tower; realize running equipment temperature measurement, partial discharge and internal defect hidden dangers simultaneously; solve equipment hidden dangers that cannot be found by routine inspection basically

Figure 5: Practice effect of power equipment intelligent detector 1

Figure 6: Practice effect of power equipment intelligent detector 2

5.2 Achieve charging transcripts and data conversion of equipment information, do not contact with adjacent charging equipment, no risk of electric shock, and eliminate electric shock risk of copy information for staff. The organic combination of instrument and insulated expandable rod and realization of safe operation of operation and maintenance and charged equipment without using pole mounting can reduce risk of high-altitude falling and electric shock effectively, and solve personal safety problems of power operator and maintainer during inspection operation basically.

5.3 Accurate image video analysis; reducing the gap between staff experience; scientific and accurate equipment hidden danger analysis.

5.4 Enhance level of equipment operation and maintenance, improve quality and efficiency of operation and maintenance, reduce the user's power failure time indirectly, and improve reliability of power supply essentially.

5.5 Reduce pole mounting operation quantity of operator and maintainer in an all-round way, realize risk pre-control of pole mounting operations, solve risk of pole mounting effectively during equipment inspection, reduce pressure on operator and maintainer, and improve operation and maintenance efficiency.

6 CONCLUSION

The development and use of portable integrated detector can solve technical problems of equipment hidden danger in the charging operation of distribution network line, on one hand, it can implement data acquisition of distribution network equipment in all weather, high precision operation and maintenance, troubleshooting analysis, inspection of distribution network line equipment and other daily operations and maintenances, on the other hand, it can achieve safety isolation of operation and maintenance work and charging equipment in all weather, which reduces pole mounting work falling risk for operator and maintainer and electric shock risk for live working efficiently without using pole mounting and solves safety issue for power operator and maintainer in the inspection operation and work safety accident caused by insufficient potential safety hazard checking and controlling for power equipment in high altitude.

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