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AN ELECTRIC ARC DETECTION SYSTEM USING IMAGE PROCESSING METHODS FOR PROTECTION OF POWER SYSTEMS

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Arc protection is a vital subject in power systems ,due to the potentially drastic damages caused by arc short-circuits. This paper describes a new method for detection of electric arcs in power systems, based on the digital image processing techniques. Such a system may be implemented as an embedded systems for power devices , e.g. line protection relayes with integral arc protection.

I.INTROUCTION

An electric arc is formed when current flows from one electrode to another via an ionized gas. Arc phenomena has industrial applications , e.g. in arc furnaces and arc welding, and happens regularly in normal switching operations. However, an electric arc can cause short circuit in a power distribution system and can be dangerous and harmful, when it happens unintentionally and irregularly. Electric arcs can cause high temperatures (as high as 20 000 K), and release a vast amount of energy that can cause harm to personnel ,damage to equipment, fires, as well as potential financial losses.

In this situations, if arc detected and the current in the circuit breaked in a short time (35 ms is a typical value), damage can be limited.

Arc can be detected by analyzing visible light, acoustic waves, infrared or radio frequency radiation [1] or even the pressure wave it causes. The most usual method of arc detection is visible light. The presence of short-circuit current together with one of the above indications is usually required before making an arc short-circuit trip[2]. However, the coverage of this type of systems is limited, because the number of arc sensors is limited.

II. THE VISUAL SYSTEM

The main idea behind the suggested system is that a visual system can inspect a wide area in a power system for arc detection. Based on this idea, a digital image processing system has been designed for this purpose.

Figure 1 shows the block diagram of system. The imaging system produces successive image frames of inspection area in digital form. This system acts as a large array of arc detection sensors. A single camera or an array of cameras can cover all the inspection area. Reduced cost and size of CCD cameras makes them a good choice as imaging device. A preprocessing phase is required for reduction of imaging system errors such as lens flare effect and light reflection from surround environment [3,4]. This unit also combines sub pictures captured by each camera in camera array to produce a single large image.

The basic processing unit implements the "logic" of system. In this unit, successive frames of captured image compared and any drastic change in illumination of an area in image detected as an arc. For improvement of accuracy, if needed, detection made by this unit may be verified by other protection systems, including temperature and current sensors.

The basic processing unit forwards information about detected arc to a post processing unit. In this unit, information about detected arc location compares with a predefined map of power system. This map includes all the needed data about buses, wires and other electrical devices in power system and their physical locations. This unit generates proper warning signal to show the occurrence of arc and its location in power system. If information about arc detection in a specific place of power system is wired to the incoming feeder's over current relay, the incoming feeder can be tripped when an arc is detected anywhere in the power system. In addition, this information can be logged as a file in a digital media, or transmitted to service personnel by means of WAP services, Internet, or any other communication system.

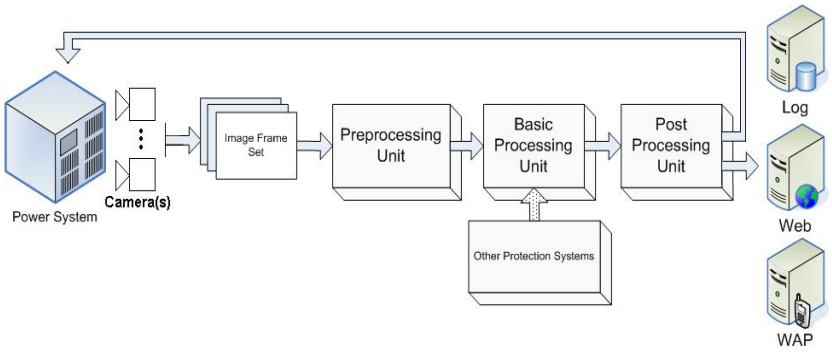

Figure 1

Such a system may replace an array of usual arc sensors that sense temperature or light rise only in a small region. Processing in the system can be done by microcontrollers and whole of the system may be implemented as an embedded systems for power devices , e.g. line protection relayes with integral arc protection..

III.RESULTS

The system implemented as a software package. Figure 2 shows a screen shot of the system at work. For testing system, an "arc phenomena simulation system" implemented. This system can produce a simulated arc in any area of an image. Figure 3 shows twelve successive frames of an electric arc produced by this system.

Generated image frame set fed to analysis system and the system detected arc in all tests successfully.

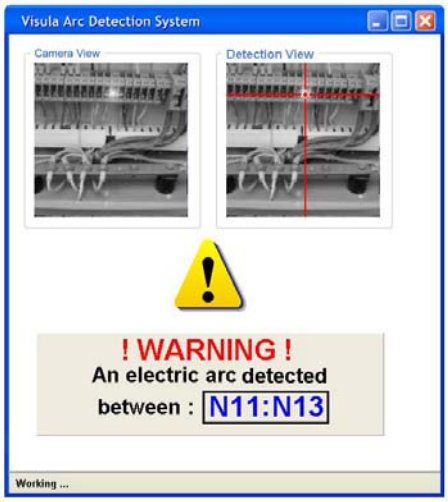

Figure 2

IV.CONCLUSIONS

Arc protection is a vital subject in power systems ,due to the potentially drastic damages caused by arc short-circuits. Usual methods of arc detection (e.g. light and temperature sensors) require a vast amount of sensors to cover a large protection area in a power system. The large inspection area and flexibility of visual inspection systems makes them a proper candidate for this purpose. Based on this idea, a digital image processing system has been designed and implemented. Experiments in laboratory show the system effectiveness.

For further work, its operation must be tested in industrial "real" environments. The system implementation as an embedded systems for power devices , e.g. line protection relayes with integral arc protection, is another area for future work.

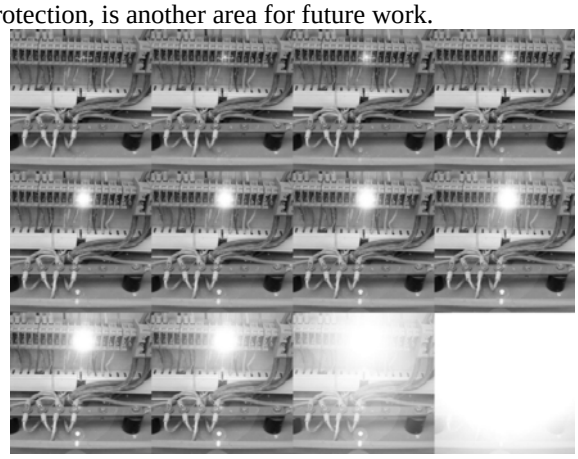

Figure 3

[1]. Sidhu T.S, Gurdeep S, Sachdew M.S, "Microprocessor Based Instrument for Detecting and Locating Electric Arcs", IEEE Transactions on Power Delivery, Vol. 13,No. 4, October 1998.

[2]. Juha ARVOLA, Olavi VÄHÄMAKI, "Integrated Arc Protection Concept", Western Protective Relay Conference Spokane, WA, October 19-21, 2004.

[3]. Scott E. Umbaugh, Computer Vision and Image processing, a practical approach using CVIPtools, Prentice-Hall Inc., USA, 1998.

[4]. Jain, A. K., Fundamentals if Digital Image Processing, Prentice-Hall Inc., USA, 1989.

[5]. [5] Gary Scott, Lori Dorrell, "Digital Arc Aetection used to Mitigate Arcing in Aircraft", Conference on Aging Aircraft, USA, 1999.

[6]. Lionel R. Orama -Exclusa, Bienvenido Rodríguez-Medina, "Numerical Arc Model Parameter Extraction for SF6 Circuit Breaker Simulations", International Conference on Power Systems Transients – IPST 2003 in New Orleans, USA.

[7]. IEEE Std 1584 – Guide for Performing Arc -Flash Hazard Calculations. 23rd September 2002.