Use of Helmet Camera of Field Engineer Integrated to SCADA for Remote Supervision and Fault Rectification in Distribution Management System (DMS) – Smart Grids

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Abstract— With the growing need for electricity, the utilities are now towards the transformation of their existing delivery assets to a smart grids and distribution management system has become the key enabler towards this transformation. Distribution Management System includes the two main themes that forms the focus areas of utilities – interoperability and reliability, enabling a decreased customer outage duration. The Fault Location, Isolation & Supply Restoration (FLISR) is the major module of the distribution management system. Any technological advancements in the FLISR module ensures improved effectiveness in the distribution management system. Thus, this paper provides the inclusion in FLISR component where in the helmet camera of the field personnel is integrated with the Distribution Management System that helps in operator in faster fault location and isolation. The solution is broadly around having a wireless camera in built /attached to the safety gear that the field staff /engineer uses while working in the field. The camera connects to the router and transmits that particular data to the network destination. This data can then be viewed through DMS_SCADA by a control room operator. Also, based on requirement mobile supervision access is possible and thus enabling the reliability in distribution service.

Key words: Distribution Management System, FLISR, Wireless, Helmet Camera, SCADA

I. INTRODUCTION

The grid network communication is the sustainable solution to the present Indian power sector that is pillared by generation, transmission, distribution. To meet challenges of growing need of electricity, there is always a need for improvisation in the existing technologies of power sector in meeting power needs of rapidly growing population.

Today's SCADA system, in response to changing power sector needs, have added new functionalities enabling strategic advancements thereby providing interactive as well as self-healing grids. A reliable SCADA system enables utilities deliver economical, reliable power and also helps to lower costs and achieve reliability in terms of customer satisfaction and retention. Modern SCADA systems are already contributing & playing major role in utilities towards achieving:

- Higher levels in electric grid reliability
- Proactive problem detection and resolution
- Meeting the mandated power quality requirements which leads to increased customer satisfaction
- Real time strategic decision making which leads to costs reduction and better planning

A modern SCADA system is also a dynamic investment which is essential component for utilities of all sizes facing the challenges of the present and future market competition and reliability in terms of data exchange which is real time that comes with it. This need for a sustainable development envisages the need for improvisation in Automation & Control mainly in distribution sector. The document here signifies the use of automation & control for the supervision, control & data acquisition of field personnel working in site location with camera attached to his helmet.

II. SOLUTION

The solution is broadly around having a wireless camera in built /attached to the safety gear that the field staff /engineer uses while working in the field. The camera connects to the router and transmits that particular data to the network destination. This data can then be viewed through SCADA by a control room operator. Also, based on requirement mobile supervision access is possible.

An IP-based system is recommended, taking advantage of technology advances in IP cameras, recording, and networking. IP video (as opposed to analog video) offers the advantages of greater options for video transmission modes, enables more flexible storage and retrieval of video, and can be more easily compressed into smaller file sizes resulting in lower bandwidth.

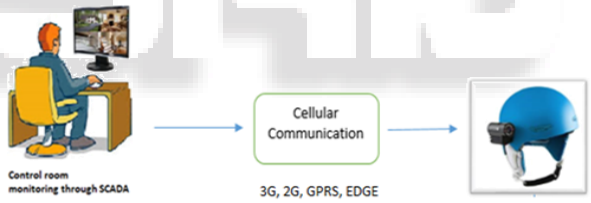

Fig. 1: Helmet camera and operator view with cellular communication

The Image below provides supervision access to two or more helmet cameras and also a CCTV camera that is fixed in that particular site. The SCADA enables the supervision aspects to control room operator.

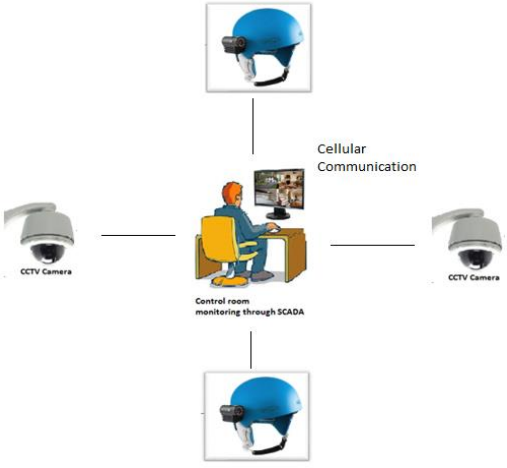

Fig. 2: Possible Integrations of camera to SCADA

III. CAMERA CONTROL PROPERTIES

- Zoom – near/far
- Focus – at necessary point
- Iris options – brightness/darkness properties
- Tilts if necessary (depends on camera model)
- Auto connect - Auto connect property causes a configured camera to be automatically connected when the page is loaded in runtime. Set to "1" to enable auto connection.

Data Type: Digital
Allowable Values:

- 0 - Auto Connect property is Off
- 1 - Auto Connect property is On

Default Value: 0

- Up to 3 Megapixel (MPx) Resolution
- Up to 30 Images per Second (IPS)
- Lens Mounts
- Auto Back Focus (ABF)
- Power over Ethernet
- Motion Detection
- Camera Sabotage Analytics
- Storage -Micro SD
- ONVIF® Profile S and Profile G Conformant

IV. TAGS ASSOCIATION IN SCADA

To be able to connect to a camera from the Viewer Control at runtime, you will need to pass the camera connection information to an object in the Viewer Control. These camera properties are stored in tags defined within SCADA. For example, for each RTP camera the following basic Camera properties must be defined:
Camera IP address – String type
Camera port number – Long type
Camera number – Long type
Unicast stream – Digital type
Unicast stream IP address – String type
Unicast port number – Long type

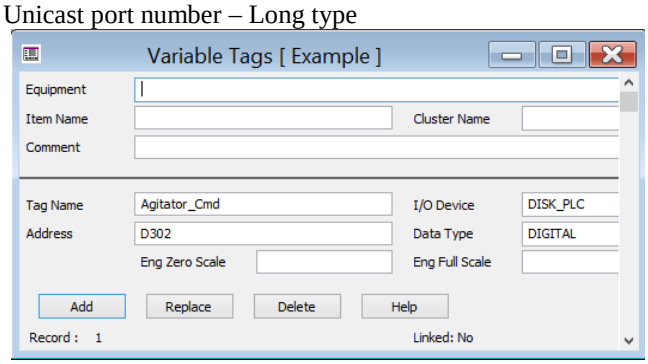

Fig. 3: Tags association in SCADA
Image Source: Vijeo Citect SCADA

From the start of HMI and supervisory products, the development of data access, scripting, alarming has been on the concept of tags. The approach through the concept of tags enables a simple and portable aspect from one work location to another using a flat namespace, which is a shortcoming because individual elements linking or organizing into more unique structures has been difficult with built-in relationships and interdependencies.

- Incremental tag addition feature
- Tags can easily be enabled\disabled from a Graphics page (or Test page)
- Unlimited Tag descriptions can be added to any tag
- Tag List page can be sorted by several tag selectors
- Tag List displays several tag selectors including current value (updated in real-time)

V. SOLUTION FEATURES

A. Low Light Day/Night Operations:

Wherever possible, day/night cameras can be selected so that the cameras can operate under ambient lighting conditions. Low-light, day/night technology enables the camera images to appear as color during conditions with good ambient lighting, and black and white images under low light conditions, permitting better nighttime visibility.

B. Integration with the Existing System:

The SCADA (Supervisory control & data acquisition) is integrated with the field engineer helmet camera through Ethernet communication. Here the fixed IP of camera is registered in the SCADA tags list and the supervision & control aspect takes place.

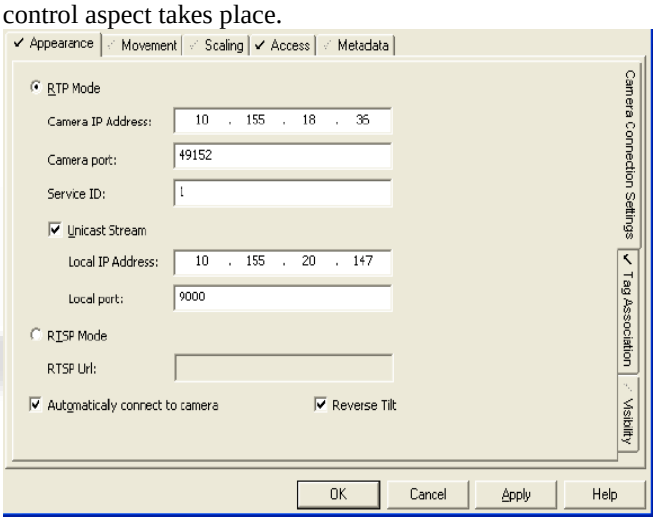

Fig. 4: Integration of Camera Properties
Image Source: Schneider electric Vijeo Citect

The figure above illustrates the configuration of viewer (SCADA screen) properties.

The following are the included aspects of integration process,

- Camera IP Address (may be fixed)
- Port Number
- Service ID determines the camera Number
- Local IP Address
- Local port number
- Auto connect

C. Event Based Alarms:

Alarm link provides a convenient way of integrating the alarm system and camera. The key to implementing camera alarm link is to use code to run the "Preset" method provided by the Viewer Control programming interface.

This alarm link helps in the aspects of,

- changes in temperature at field side
- changes in pressure
- Others

The costing of the camera starts hundred dollars (price ranges based on the applications that we require) which is less compared to the long run advantages that a utility is acquainted with.

VI. APPLICATIONS

A. Utility can have an immediate observation in case of any fatal accidents that take place at field

There are some instances where there is need for immediate action to take place. Such include the fatal accidents that take place due some equipment explosions. Under these, the field personnel equipped with helmet camera working at that location can provide the immediate vision to the accident and necessary steps can be taken from the control Center.

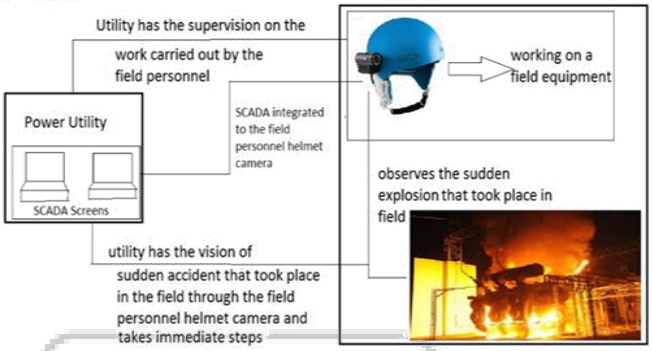

Fig. 5: observations through helmet camera

B. Ability to Evaluate the Performance and Efficiency (P&E) Of Field Personnel

SCADA systems integrated to helmet camera help the utility to evaluate the performance of the field personnel, as it is able to monitor the entire work carried out by the personnel. This technology helps in finding out the errors caused at the field personnel side.

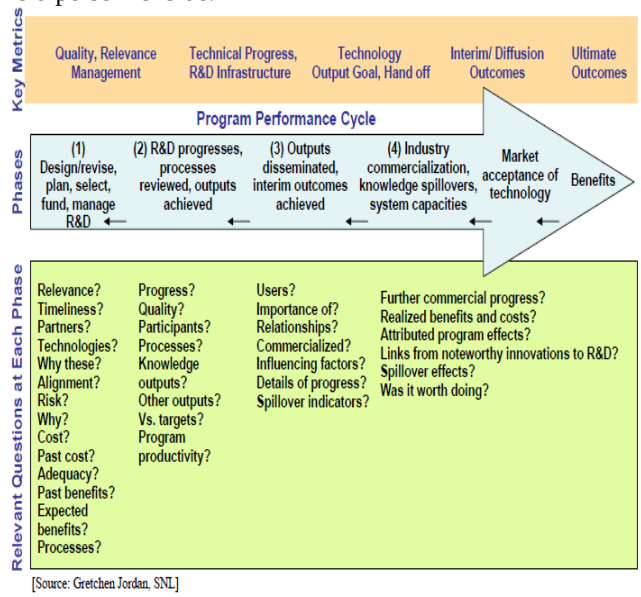

Fig. 6: Performance Evaluation

This technology helps in evaluating performance of field personnel and efficiency. It describes the following aspects:

- Efficiency is an impact of the training given to field personnel on work conducted at field.
- Efficiency is achieved if personnel being trained are able to perform their duties errorless.
- Efficiency determines if the personnel-field engineer knowledge and skills are increasing over years which can judged from the performance graph.
- Effective training signifies the training that is done in the best and most economical way. The same result obtained at a lower cost, or a better result obtained at the same cost could not be a possibility.

It also enables for the conclusions in efficiency of field personnel i.e. this technology provides the conclusions for following aspects:

- Activities of Training
- Activities of Evaluation
- Effectiveness indicators of training

C. Monitoring of the Servers

The real time monitoring on the personnel working in the server room will be a crucial aspect as the servers are the backbone of entire networks. This technology helps in reliable surveillance to the control room operator through the supervision of the troubleshooting aspects carried out by the personnel.

D. Meeting the Power Quality Requirements

The power quality requirements are met with the proper equipment handling under failure conditions and thereby ensuring continuity in supply. This helps in quality of power to be maintained hence ensuring customer satisfaction.

E. Proper Engagement with Field Personnel

This technology enables for a proactive engagement between the field personnel and the control center as both are involved in the process carried out.

F. Alarm Management

Alarm management provides the notification of the field events that record for variations in temperature, pressure and others

G. Reduced Disputes during Meter Change

There exists no dispute about readings in old meters and replaced new smart meters as the helmet camera provides the entire video display of the old meter reading before replacing it with a smart meter.

H. Asset mapping and Technology Assessment

- Real time asset monitoring for Distribution Company
- Easily be integrated with network security and enable centralized security configuration
- Interoperable for various devices for communication

I. Financial Reliability

The technology provides following aspects:

- A reduction of costs in terms of specific maintenance activities
- Improvement in equipment production activities and process.
- Maintenance responsibilities
- Maintenance procedures
- Reliability in training of maintenance employees

J. Safety to the field personnel

This technology helps in providing the safety to personnel. For instance, consider a situation where a line man is working on transmission line. If any sudden accident occurs, then control center receives the notification about it by its supervision and formulates immediate steps.

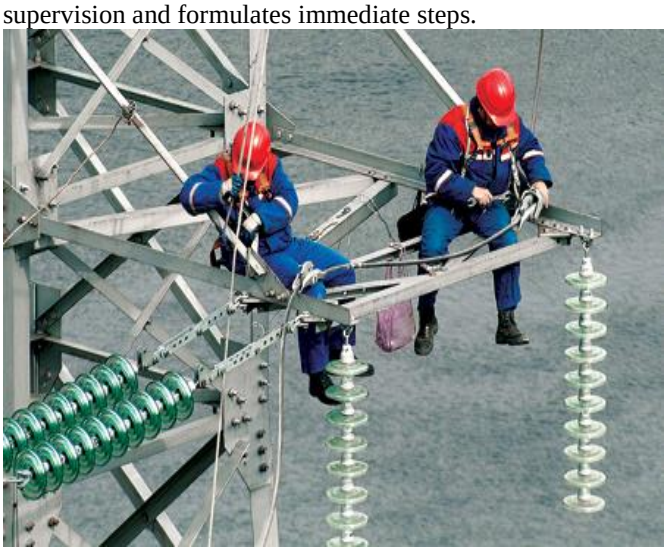

Fig. 7: Safety To Personnel

K. Efficiency in Data Collection

The technology also helps in data collection (hard data and soft data) with greater efficiency as the entire data collection process is under supervision. Data (Hard data & soft data) is supervised from the utility side which enables for greater efficiency.

L. Increased Trending Options

This technology provides the trends for different aspects like,

- Time taken for fault repairing
- Preventive maintenance duration
- Extent of area coverage by the field personnel
- Number of faults occurred
- Equipments efficiency Others

VII. Cost of Implementation

Cost for implementation includes:

- Helmet – ranging from Rs. 200 to 1000
- Camera cost – ranging from Rs. 20000
- Network switches & routers – ranging from Rs. 3000 to 9000

VIII. Conclusion

This technology identifies the importance for supervision and control aspects of distribution network under real-time. It points out that the fact that in addition to having communication systems, intelligent supervisory control and data acquisition (SCADA) integrations improves the overall reliability of the network and solutions to obtain to obtain an accurate **estimation**. It enables the solutions from protective relays and distribution feeder controllers to smart meters at homes—to have monitoring aspects in real-time, how voltage is being affected by distributed assets.

This technology enables for following benefits

- Real Time Monitoring
- Reduced Technical errors from the field side
- Reduced Plant-down times
- Reliable maintenance activities
- Safety to the line man
- Reliable plant surveillance
- Monitoring the plant conditions
- Reliable Plant Security

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