Review of Wireless Monitoring of Multi parameter in Oil and Gas Refinery

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Abstract---The increasing demand of oil and gas supplies frequently requires the design and execution of plants over remote locations with harsh environmental conditions and challenging logistics. The adoption of cabling to fully interconnect machines and monitor/control large number of processes is becoming unfeasible. The system consists of monitoring unit and detecting unit. Monitoring unit consists of Zigbee interfaced with pc and detecting unit consists of controller, liquid level sensor, Flow Sensor and gas sensor In the system liquid level sensor and gas sensors are interfaced with microcontroller .The liquid level sensor measures the level of the oil in the tank and sends the information to the controller. The flow sensor sends information of flow of liquid and gas sensor is used to detect if any leakage is there in the tank and if any leakage is there it will send the information to the controller and the controller sends the collected information to the personal computer through Zigbee network.

Keywords: Oil and Gas Industry, Wireless monitoring, Liquid level sensor, and oil level sensor, zigbee.

I. INTRODUCTION

The Oil and Gas Industry is a major industry that has tremendous impact on the global economy. It includes processes for exploration, extraction, refining, transportation, and marketing petroleum products (Akhondi, Talevski, Carlsen, & Petersen, 2010). In the course of the above processes, thereexists a need for extensive monitoring of various parameters through the aid of large number of sensors. These sensors are placed at different locations to measure different data about plant performance and the operational environment. Over the years, deployed sensors haveworked effectively together via wired cable links. These wired sensors are costly to deploy, operate and maintain, are not best suited for temporary installations and are difficult to set up in hostile and remote environments. (Petersen et al., 2007, Talevski, Carlsen, & Petersen, 2009)

Wireless Sensor Network (WSN) technology provides a faster, less costly, more flexible and more convenient option to the wired sensor systems. The field of WSN has evolved considerably due to engineering advances in Micro- Electro-Mechanical Systems (MEMS) technology which facilitated the development of smart sensorswith reducesize, weight and cost. Advances in the field of internet, communications and information technologies have also contributed to development of WSNs. (Sohraby, Minoli, & Znati, 2007,Yick, Mukherjee, &Ghosal, 2008).

WSNs have tremendous application in Industrial automation for manufacturing and process control automation through monitoring of parameters like temperature, pressure and flow. The future prospects for WSN impact are very promising. Reports from (Hatler, Gurganious, & Chi, 2012) show that the industrial WSN market has doubled over from 2010 - 2012. They project that there will be nearly 24 million wireless-enabled sensors and actuators deployed worldwide by 2016 and WSN technology would have a greater influence on applications.

With a more restricted consideration of the Oil and Gas industry, the impact of WSN is also very promising as reported in literature. A market Dynamics Report (Hatler et al., 2012) released by ONWorld's Research in 2012 show that Oil and gas expolaration, production and pipelines made up 27% of the global industrial WSN market in 2011. Two-thirds of the oil and gas end users in the survey are planning a standards based approach for future deployments of WSNs.

This paper seeks to present a critical look at the involvement of WSN in the Oil and Gas Industry, present the performance results from case studies available and identify the future prospects and research challenges.

II. OVERVIEW OF WSN

A Wireless Sensor Network is an infrastructure comprised of sensing (measuring), computing, and wireless -based communication elements that gives an administrator the ability to instrument, observe, and react to events and phenomena in a specified environment. The environment being monitored can be the physical world, a biological system, or an information technology (IT) framework while the administrator is usually a civil, governmental, commercial, or industrial entity. (Sohraby et al., 2007)

The four basic components in a sensor network are: an assembly of distributed or localized sensors, an interconnecting wireless network,

a central point of information clustering; anda set of computing resources at the central point (or beyond) to handle data correlation, event trending, status querying, and data mining.

Nodes in the sensor network typically have one or more sensors, a radio transceiver or other wireless communication device, a small microcontroller and an energy source, usually a battery. (Kay & Mattern, 2004)

III. WSN APPLICATION IN OIL INDUSTRY

A. *Typical uses of sensors*

In the Oil and Gas Industry, the type of data sensed includes pipeline pressure, flow, temperature, vibration, humidity, gas leaks, fire outbreaks, equipment conditions etc. (Talevski et al., 2009) This is usually performed in typical application scenarios as described below:

B. Pipelines & Corrosion Monitoring:

Pipelines are extensively used in the oil and gas industry including sub-sea, above ground, buried and gas pipelines. (Jawhar, Mohamed, Mohamed, & Aziz, 2008) Pipeline corrosion, especially for aging pipeline infrastructure leads to leaks, emissions and deadly explosions in production facilities and refineries. It is therefore crucial to perform real-time monitoring of flow, pressure build-ups, temperature changes, valve position to ensure safety, efficiency and streamline pipeline operation. WSN provide cheaper alternatives for this kind of monitoring. (Jawhar et al., 2008,Hatler et al., 2012)

C. Condition monitoring of plants:

Organized sensor systems are able to perform preventive and predictive maintenance and improve post-fault diagnosis. Decisions are made after sensor measurements are obtained from real- time monitoring to determine the condition of components.(Akhondi et al., 2010) WSN can also be used to monitor Oil and Gas installations embedded in the ocean. In order to optimize production and to ensure safety, equipments and parameters have to be monitored. WSN can be used to monitor production processes, prevent or detect oil and gas leakage, enhance production flow and yield of wells, improve working conditions and better protect the environment. (Dalbro et al., 2008)

D. Wellhead Automation:

WSN technology is usedin optimizing the process of well drilling. New health monitoring systems are also being deployed in harsh and remote locations like offshore rigs. (Hatler et al., 2012)

E. Oil exploration and Seismic Surveys:

The growing demand for energy worldwide is driving oil exploration and efficient and less expensive alternatives like WSN will be at the forefront. WSN provides a means for real-time production monitoring with efficient acquisition and transmission of data. The technology fits well in harsh environments, has cost benefits and supports temporary deployments and sensor expansions. In the long run, if fully implemented, the derived benefits include remote equipment diagnosis, reduced equipment failures and shutdowns. (Cramer, 2012)WSN is also at the forefront of improved seismic surveys. The process of conducting surveys in deep and remote regions has been simplified and expanded, providing a possibility for millions of seismic sensors deployment around the world. (Cramer, 2012, Hatler et al., 2012)

IV. CASE STUDY APLLICATION

In this section, development of WSN in Oil & Gas scenarios are presented.

A. Typical Oil Site Laboratory testing:

WSN solutions (SmartMesh network and SensiNet network) were deployed in laboratorieshaving typical Oil and Gas equipments made of reinforced steel and concrete.The network performance tests proved that both SmartMesh and SensiNet are able to provide reliable communication in an Oil & Gas environment, and SmartMeshachieved this with relatively high stability and low latency. For interference with IEEE 802.11b networks, results show slight reduction in stability and increase in latency. The authors conclude that techniques to improve battery life have to be employed to make WSN suitable for Oil and Gas.(Petersen et al., 2007)

B. Routing Protocol for WSN Pipeline monitoring:

In (Jawhar et al., 2008), the authors considered the special linear structure wheresensors are deployed on pipelines to monitor data. They presented an architectural model of the sensor networkandbased on this unique model for Oil and Gas pipelines, they demonstrated a multilayer addressing scheme with address assignments and communication schemes that ensure effective routing of data packets. The network also can utilize cellular GSM, GPRS networks, satellite cellular technology or WiMax to relay collected data to the Network control center.

C. WSN for Sub-sea (underwater) Oil installation:

Authors(Dalbro et al., 2008)presented a heterogeneous multi-hop network solution for underwater deployment with a combination of ultrasonic, optical and RF networks as supplements to wires. This system ensures redundancy for robust and uninterrupted communication for critical industrial application like subsea oil and gas installations providing real-time information exchange and integration.Equipment position, movements and orientation can be monitored via sensor nodes placed on them.This is useful for manipulation and monitoring of sub-sea oil installations.Experimental results show a good match between the estimated distance between the motes based on voltage level (calculated data graph) and the actual measured distance.

D. Wireless Geophone Network:

In (Savazzi& Spagnolin, 2009), authors presented an architecture for a Wireless Geophone network exploits appropriate radio transmission technology to support short and long range transmissions in order to harness the advantages of both and provide efficiency as well as coverage. The system provides large- scale, real time, synchronous and spatially dense monitoring. There are three network entities: The Wireless Geophones ((WG) - sensors forming independent mesh sub networks), Wireless Geophone Gateways ((WGG) - GPS equipped sub network coordinators) and Storage unit (overall network coordinator). Ultra-wide band technology was proposed for short range WG to WG transmission within sub networks to conform to the data rat e and power consumption requirement, guarantee network scalability and eas of use of other radio technologies. Specifications for the Medium access control (MAC) and network layer were also presented.

E. WSN remote monitoring of Oil Well:

(Yi, Lizhi, & Yuanzhong, 2010), A WSN based remote monitoring system for optimizing Oil reservoir production was presented. The system performs real time monitoring and surveillance of the oil well characteristics (temperature and pressure),), gathers sensed data, processes it and forwards it to a database server on the internet for further processing. The system consists of a data acquisition terminal and a surveillance system (which has visualization and statistical capabilities).

F. *WSN for seismic exploration of oil and gas reservoirs:*

In (Papoula, 2011), the author presented a WSN system effective for seismic exploration of Oil and gas reservoirs on land. Controlled seismic vibrations were generated at some points in the exploration area. Vibration Sensor nodes spread across the area were then used to capture the vibration signals reflected from the geologic structure and then seismic images of the geologic subsurface were constructed from the distributed measurements at the backend. The design employed Digital Signal Processing (DSP) techniques to obtain high resolution image.

V. RESEARCH CHALLENGES

WSN is a relatively new technology in the Oil and Gas Industry compared to the wired cables. The technology will continue to improve and provide performance that effectively meet the industry requirements. The sensing requirements have to be determined, the type of sensors that can withstand the conditions and the type of antennae required are areas for research. (Tookey, 2012) Power management is a challenge because the sensors are battery- powered devices. The lifespan of the battery determines the life of the sensor, so research will continue to develop efficient power management techniques to meet Oil and Gas requirements like energy harvesting, efficient scheduling etc. The effects of interference on wireless signals from the hostile environments where the sensors are deployed also have to be investigated to ensure that WSN can operate unhindered. Extreme temperature, wind, humidity, noise, dust rain etc could likely have interference effects. (Talevski et al., 2009) RF penetration, noise immunity and dynamic network topology adaptation are critical for reliable data transmission. (Minetti, 2012)When deploying new WSN systems in existing plants, the required changes in factory and plant work processes must be considered. Developing efficient data processing, simple but powerful software interfaces, middleware and security(authentication, authorization, encryption)considerations are also research issues highlighted in (Talevski et al., 2009) Other issues include full development of standards, data rate/bandwidth, ease of use of system, scalability, seamless integration and range. (Hatler et al., 2012)

VI. CONCLUSION

In this paper, an overview of WSN application in Oil and Gas Industry has been presented. WSN technology introduces significant benefits in cost, ease of deployment, flexibility and convenience in relation to the wired alternative that is well established in the industry. Significant research points to projection of widespread deployment of WSN in industrial automation. Case studies were presented showing WSN deployment in Condition monitoring, pipeline monitoring, seismic exploration and sub-sea installation. The technology is however not without its unique challenges which have been highlighted here as areas of research.

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