ISSN 2348 – 8034
Impact Factor- 3.155

GLOBAL JOURNAL OF ENGINEERING SCIENCE AND RESEARCHES

INTELLIGENT SYSTEM PROTOCOL FOR WIRELESS SENSOR NETWORKS

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ABSTRACT

The aim of this study is to analyze the effect of applying wireless sensor network technology in industrial platforms and the corresponding technical difficulties and design goals. A wireless sensor network distributed autonomous sensors to monitor physical or environmental conditions, such as temperature, sound, vibration, pressure, motion or pollutants and to cooperatively pass their data through the network to a main location. The WSN is built of "nodes" – from a few to several hundreds or even thousands, where each node is connected to one (or sometimes several) sensors. Each such sensor network node has typically several parts: a radio transceiver with an internal antenna or connection to an external antenna, a microcontroller, an electronic circuit for interfacing with the sensors and an energy source, usually a battery or an embedded form of energy harvesting.

Keywords- *Intelligent System, Sensor Networks application, sensor sensor's scalability, sensor type, resource of wireless sensor.*

I. INTELLIGENT SYSTEM FOR WIRELESS SENSOR CLASSIFICATION

- Readiness for field deployment: measures maturity for field deployment in terms of economic and engineering efficiency.
- Scalability: a sensor's scalability to distributed environmental monitoring tasks requires that the sensors be small and inexpensive enough to scale up to many distributed systems.
- Cost: Sensors are deployed in thousands. It is expected that cost will drop but current generation sensors are still expensive to allow wide deployment. Sensors Usage
- A Study involving a total of interested users in terms of sensors preferences. The users include researchers and developers [1].

The results are classified in the next 5 main fields:

- environmental,
- gas,
- physical,
- optical and
- Biometric.

1.2. USE OF ENVIRONMENTAL SENSORS

- **sensors:** Temperature, Humidity (soil,leaf,ambient), Soil moisture, Wind (speed and direction), Pressure, Leaf, Ph, Redox [2].
- Precision agricultural applications are one of the most required in the terms of temperature, humidity (soil, leaf, ambient) and wind (speed and direction).
- Phand Redox sensors being demanded for water quality

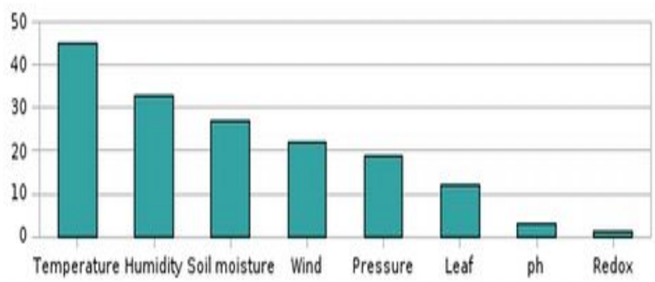

Fig 1. Use of Environmental Sensors

ISSN 2348 – 8034
Impact Factor- 3.155

1.3. USE OF PHYSICAL SENSORS

- Sensors: accelerometer, presence, vibration, power, hall, ultrasound, water, sound, bend, flex, strain, stress[3].
- Motion of any kind using accelerometers, vibration, and presence sensors.
- Security applications are waiting to be deployed.
- World of objects: bend, flex, strain and stress sensors let know how each object is interacting with the world and miniaturize its state.

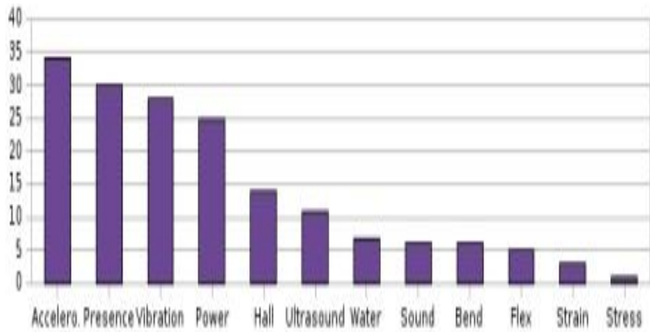

Fig 2. Use of Physical Sensors

1.4. USE OF GAS SENSORS

- Sensors: Co2, Co, CH4, O2, NH3, SH2, NO2, Pollution.
- Organic gases (carbone) derived from the "live systems" such as respiration in humans (CO2), animals (CH4) and combustion (CO) of vegetable elements (fire forest) are the most required sensors [4].
- Other toxic gases which can be found in animal farms (NH3, SH2) and the fabric and cars pollution gases (NO2) complete the list [5].

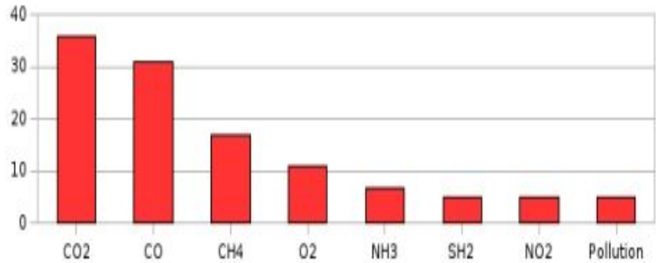

Fig 3. Use of GAS Sensors

1.5 USE OF OPTICAL SENSORS

- Sensors: Infrared, Sunlight, Radiation, Ultraviolet, color**.**
- Optical sensors to detect human presence through the IR spectrum are the most voted sensors in this area [6].
- Agriculture applications where the sun light, radiation and ultraviolet sensors are required in order to measure the total amount of energy and light which is absorbed by the plants [7].

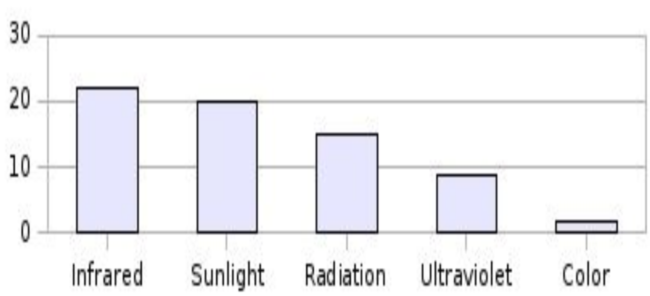

Fig 4. Use of Optical Sensors

1.6 USE OF BIOMETRIC SENSORS

- Sensor types: Electrocardiogram ECG, Oximetry, Pulse, Fall, Sweat
- Prevent a possible attack or the fall of a elderly person (using an accelerometer) by monitoring his heart pulse, rate and other heart activities. Used in combination of SMS alarm susing the GSM/GPRS module [8].
- *Requirements*: a real time and redundant alarm system so that communication can always be established [9].

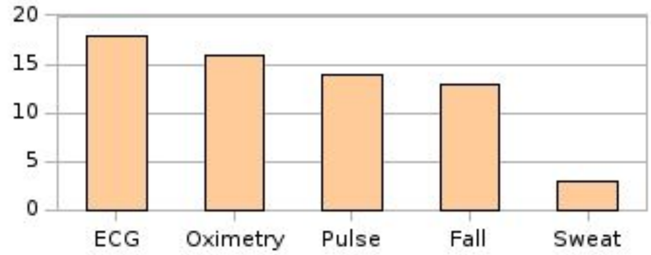

Fig 5. Use of Biometric Sensors

II. WIRELESS SENSOR CLASSIFICATION

In area of WSN, applications vary and depend on a wide range of technologies, characteristics, design objectives and challenges of WSN. Therefore application requirements on WSNs differ from one application to another [10]. A few explorations that should be taken in consideration is mentioned and discussed below.

2.1. Characteristics

- As wireless sensor network (WSN) is recently considered as one of the most important telecommunication technologies that proves its compatibility and reliability in many applications disciplines. Based on references [3, 4] WSNs uniquely have the following distinctive characteristics [11].
- Dense self-deployment: WSN is a huge distributed computational system. Large number of sensors are scattered and densely randomly deployed in the network environment. Sensors are configured autonomously as each sensor independently manages its self communication in the network.
- Limited processing and storage: Sensor nodes are small battery powered autonomous physical devices that highly limited in, computational capabilities and storage capacity [12].
- Limited energy resources: Due to the tough nature of WSN applications environment and the fact that sensor nodes are battery powered devices, it is usually hard to change or recharge theses batteries.
- Sensor heterogeneity: Since sensor nodes existence is not guaranteed in the WSN life time, unreliable and inconsistent sensor nodes will prone due to physical damages or failures while harsh deployment.
- Data redundancy: Data can be sent differently by more than one node to central node due to the need of collaboration and communication of sensor nodes as well as the physical nature of the sensor nodes.
- Application centric: As it is always hard to change or modify in the wireless sensor network, the network is usually designed and deployed for a specific application. This mainly affects the design requirements, network size, energy consumption and routing constrains of network [13].
- Broadcast communication: Sensors in WSN usually depend on exchanging sensed data between multiple sensor nodes and particular sink node using different flooding routing techniques. · Topological inconstancy: Due to power scarcity in sensor nodes as well as the harsh environment, Network topology will usually suffer frequent changes such as connection failures, node death, adding new node, energy consumption or channel fading [14].
- Limited transmission range: The limited physical characteristic of sensor nodes are usually limited strictly the network capabilities and affect the coverage range and communication quality.

2.2. Design objectives

The design of WSN generally depends on the applied area of application as each application has its different requirements, however some general design objectives should be taken in consideration while deploying WSN [15]. The following are the most common design objectives:

ISSN 2348 – 8034
Impact Factor- 3.155

- Network size, cost, resources: WSN size mainly depends on the size and coverage of geographical area of the deployed network for a specific application. The number of sensor nodes varies to thousands and even more. Size of WSN mainly affects the required nodes number, cost, routing techniques and connection technology. This also will directly affect the network scalability and feasibility.
- Network topology: One of the main aspects in the WSN design that affects network capacity, complexity, delay and routing. The size of the network and the area of interest determine the network topology. WSN topology is a dynamic topology that may be simple with single or few numbers in direct communication hops between the nodes or complex with multi-hop complex topological architecture.
- Power consumption: The physical nature of the sensor nodes constrained it with very limited energy resources. Sensors mainly depend on batteries as power suppliers. According to the harsh environment for WSN, it's almost hard or even impossible to change or replace these batteries. The overall network life time is a cumulative of its sensors life. Therefore, preserving network life urges researches to focus on the development of an efficient power management approaches and routing protocols that manage and control the consumption of sensors` energy [12].
- Coverage range: In order to preserve the network consumed energy and to increase its productivity and reliability, network coverage range should be selectively determined. Small transmission range between nodes will decrease the amount of needed power for transmission between directly connected nodes. The huge coverage areas usually cased an eavesdropping.
- Quality of service: The area of WSN application restrains the provided quality of service in WSN. For real time applications, sensed data should be delivered as soon as it is
- sensed. The frequent changes in the sensed data are highly effected with the time factor. Reliability and usability usually depend on QoS [7].
- Simplicity: The heterogeneous and autonomous nature of sensors in WSN as well as the complex topological nature requires simple and convenient communication, processing and power consumption models in order to ease and increase the efficient utilization of the network.
- Mobility: The mobility nature in WSN after deployment usually results due to the automotive capabilities of sensor nodes. Each sensor has the flexibility to change its location based on some environmental factors that strongly affect nodes movements are varies based on the application area. Mobility may apply to all nodes within a network or only to subsets of nodes. Therefore based on the mobility taxonomy, sensors in WSN expand to different status. They may act as an active or passive nodes, this is addressed by each sensor`s automotive capabilities, so the sensor may depend in motion device or move by itself. The motion as well may be occasional movement with time intervals of immobility in between, to constant as in static nodes. Although the high degree of mobility in WSN, some sensors may remain static. The extent of dynamic in WSN as well as the speed of mobility frequently influences the size, design and protocols of the network [12].
- Fault tolerance: The ability to preserve the network performance and functionality even after individual node failure or congestion in some of parts of the network. The adaptability of WSN can be achieved by using efficient routing protocols, power management approaches and communication establishments.

2.3. Challenges

Deployment of WSN face a number of great challenges that urge researches to focus on it in order to reach an optimal performance of WSN, below are some general challenges that have been faced in different WSNs applications.

- Hardware constraint: Since WSNs depend on battery based power devices; power supplier is the most important part in the sensor nodes. The less energy consumption devices in WSN are the most efficient and lasting WSN. The characteristic of sensor nodes; such as the computational capabilities and storage capacity; will also affect the performance and life time of WSN as they may increase the energy consumption and data redundancy. The size, processing, cost and the amount of the sensors in the applied environment should be taken in consideration while we develop WSNs.
- Power consumption: The limitation of power resources in WSNs vice versa the high energy consumption direct the researchers attentions to power conservation and power management approaches that will effectively prolong the WSN lifetime [6].
- Deployment: A WSN is an infrastructure less randomly deployed network consist of small autonomously distributed sensors. The network deployment can be densely by a huge number of sensors in applied area of application or sparse network with a few and limited number of sensors. Communication in WSNs is

achieved by single or multi number of hops between sensors. The importance of application as well as the cost of deployment controls the class of WSN deployment.

- Scalability: WSNs should be able to support variety of routing protocols, huge nodes number and wide area of application as well as the frequent increases of network expansion. The scale of performance and workload of WSN should not be anticipated during the initial network design stage.
- Flexibility: Due to the wide diverse of WSN application, as well as the network constraints and scarcity of resources, some sort of flexibility are needed such as different network deployment schemes and topologies, routing protocols, power management methods and so on.
- Reliability: A WSN should be able to adapt and manage the corruption of the network in case of node failure. The functionality and performance to WSNs should not be affected negatively. Some fault tolerance techniques ensure reliability in WSNs.
- Connectivity: Maintain connectivity among all sensor nodes through the network life time is a very challenging issue. The importance of each sensor node as well as the importance of sensed data and routing route that each sensor may take urges the network to preserve the life of each node. Some sleep modes can be practiced by some nodes in order to reduce the rate of harvested energy [8].
- Lifetime: The longevity and coverage of the WSN should be guaranteed. The main emphasis is to prolong the network lifetime. Sensor nodes are finite life time devices as they are battery powered. Some adapting mechanisms such as power management techniques and adaptive routing protocols are used to overcome the limited resources efficiently and to ensure the maximum network lifetime.

III. APPLICATIONS OF WIRELESS SENSOR NETWORK

- Disaster relief operations
- Drop sensor nodes from an aircraft over a wildfire
- Each node measures temperature
- Derive a "temperature map"
- Biodiversity mapping
- Use sensor nodes to observe wildlife
- Intelligent buildings (or bridges)
- Reduce energy wastage by proper humidity, ventilation, air conditioning (HVAC) control
- Needs measurements about room occupancy, temperature, air flow, …
- Monitor mechanical stress after earthquakes
- Machine surveillance and preventive maintenance
- Embed sensing/control functions into places no cable has gone before
- E.g., tire pressure monitoring
- Precision agriculture
- Bring out fertilizer/pesticides/irrigation only when and where needed
- Medicine and health care
- Post-operative or intensive care
- Long-term surveillance of chronically ill patients or the elderly
- Challenges Encountered
- Event detection: when to start collecting data?
- High data rate sampling
- Spatial separation between nodes
- Data transfer performance: reliable transfer required
- Time synchronization: data has to be time-aligned for analysis by seismologists
- Bridge Monitoring
- Structural health monitoring (SHM) is a sensor-based preemptive approach

IV. CONCLUSION

Work done on WSNs, both simulation and Test bed has revealed that It's an interesting, complex, new technology. However, we have been witnessing poor deployment resulting from many causes: slow adoption ? Lack of standardization ? Need for more applications ? cost devices, do not require additional infrastructure, and are self-healing. These properties are prerequisites when planning for monitoring of large scale critical infrastructures such as energy distribution networks. Reliability is a key requirement for WSNs used in critical infrastructure protection;

however, the level of reliability also depends on system properties such as security, energy consumption, and radio connectivity. we try to take all these issues into account, with a special emphasis on security issues.

V. FUTURE WORK

The concept of characteristically pairing among sensor nodes energy utilization is optimized. Simulation results show that our proposed proto colnificantly improved the network parameters
and can be a useful approach for WSNs.

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