

# Literature Survey on Structural Health Monitoring

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**Abstract**— Structures are playing very important role in our day-to-day life such as dams ,bridges, rail tracks, aircrafts, industrial machineries ,high-rise building and so on. However, the long-term decay of these structures can be caused by unnatural/disaster conditions such as earthquakes, tsunami, winds and hurricanes. In this unfavorable condition constant supply of electric current to the Wireless Sensor Network (WSN) are impossible. So, we are adopting Wireless Rechargeable Sensor Network (WRSN) in Structural Health Monitoring (SHM). Comparing with WSN, WRSN provides sensing and analyzing of structures even during the unfavorable moments. On the same side it overcomes the key challenges like computationally intensive, resource constraints and long-term monitoring. The main issues in our SHM includes network life-time, stability, damage detection, reliability and trade-offs in model which is overcome by multi-scale Wireless Rechargeable Sensor Network with restricted input network activation scheme and the integration of data network activation scheme and the data integration from a heterogeneous sensor array to improve damage detection for low-order models. It helps to improve power efficiency, minimize packet loss and latency and eliminate synchronization issues through the use of a decentralized analysis scheme (i.e.) Cyber Physical System (CPS) approach.  
**Key words:** Wireless Sensor Network, Wireless Rechargeable Sensor Network, Cyber Physical System, Structural Health Monitoring

## I. INTRODUCTION

Cyber Physical System is a combination of computation, networking and dynamical physical processes with feedback loops. Embedded computer and the network monitors and controls the physical process. It is co-engineered inter acting networks of physical and computational components. It provides infrastructure to form smart services to improve the quality of life. It links the real world with the virtual world of information processing .It has software system, communication technology, sensors which will interact with real world .It is employed to monitor and control physical and organizational or business processes .It requires integration of different technical disciplines and different application domain. The Wireless sensor network consisting of spatially distributed autonomous devices which are connected wirelessly. The sensors are deployed to monitor physical and environment condition. A gateway is used to fuse with wired network and distributed nodes .A sensor network has multiple detection stations called sensor nodes which are small and portable devices. Every sensor node has transducer, transceiver, microcomputer and power source. Electrical signals are generated based on sensed physical phenomena by transducer. The microcomputer processes and stores the sensor output. The transceiver receives commands from a central computer and transmits data to computer. The power of the sensor is provided by battery. Limited energy of battery in each node is the major design constraint of wireless sensor network. To overcome this limit, wireless Rechargeable

sensor network is used. The transmission of electrical energy from a charger to sensor node by using electromagnetic radiation or magnetic resonant coupling. This paper illustrates the integration of cyber physical system with wireless Rechargeable sensor Network in case of structural event monitoring.

## II. LITERATURE SURVEY

Yuanchao Shu and et al said that Wireless Rechargeable Sensor Network (WRSN) [1] batteries in sensor nodes can be replenished by a mobile charger that periodically travels along a certain trajectory in the sensing area.

Md Zakirul Alam Bhuiyan and et al told Cyber-physical system (CPS) for structural event monitoring [2] with WSNs and propose a novel model-based in-network decision making named MODEM.

Xuefeng Liu and et al stated that different from other applications of WSNs such as environmental monitoring [3], SHM applications are much more data intensive and it is not feasible to stream the raw data back to the server due to the severe bandwidth and energy limitations of low-power sensor networks.

Jose Antonino-Daviu and et al defined that the issue (fault diagnosis by developing portable device) remains unsolved [4] because most of the developed fault diagnosis techniques rely on the user expertise, since they are based on a qualitative interpretation of the results.

Apoorva Jindal and Mingyan Liu proposed that the distributed computation problem over a wireless sensor network tells that the heaviest computation is to determine the singular value decomposition (SVD) to extract mode shapes (eigenvectors) of a structure but where the centralized location of SVD and raw data results in high energy consumption and delay. The NP-Hard problem was implemented in order to reduce clustering problem and integer linear program (ILP) [5] and approximate algorithm with a proven approximation ratio helps to solve the constrained problem.

Songtao Guo and et al discussed the wireless rechargeable sensor networks [6], time variation of rechargeable rates networks imposes a great challenge in obtaining an optimal data gathering strategy. A framework of joint wireless energy replenishment and anchor-point based mobile data gathering (WerMDG) in WSNs was implemented by considering various sources of energy consumption and time-varying nature of energy Replenishment. The WerMDG problem into a network utility maximization problem which is constrained by flow, energy balance, link and battery capacity and the bounded time of the mobile collector.

Sheng Zhang and et al defined that the wireless energy transfer and the rechargeable lithium batteries overcome the energy constraints of wireless sensor network [7] .The periodic scheduling of multiple mobile chargers helps to optimize the energy in WSN.

Liguang Xie and et al stated that the wireless energy

transfer can be imposed with the help of mobile stations [8]. The mobility of station leads to a critical problem named collocating of mobile station in the network. The problems includes “each sensor node is charged in time so that it will never run out of energy, and all data collected from the sensor nodes are relayed to the mobile base station”.

Yi Shi and et al proposed that Wireless charging vehicle (WVC) is employed to charge scalable sensor node in wireless sensor network [9]. In order to charge scalable wireless sensor network, the network is partition into cellular structure which partitions the two-dimensional plane into adjacent hexagonal cells.

Yuanchao Shu, Yu (Jason) Gu and Jiming Chen discussed that access control is a mechanism that enables an authority to control access to restricted areas and resources at a given physical facility or computer-based information system[10].

### III. DISCUSSION

From the paper which we took into account, the following result was concluded as “The structural event monitoring is mostly deployed with the help of wireless rechargeable sensor network. The objective is to monitor the complex events in our structure (high-rise building, industrial machinery).The cyber physical system was implemented in order to avoid the constraints of WRSN and to increase the quality of monitoring. The model based in network decision in CPS was named as MODEM, where group wise local decisions were named in the structure. The large physical structure is divided into number of substructures, and the rechargeable sensors are deployed in group, in such a way that group-wise final decision can be provided for each substructure independently. The fully distributed MODEM promises to give the quality of monitoring similar to the wired-based schemes and consumes the energy. Its recharge ability criteria overcome the power constraints in WSN; due to this WRSN have gained its popularity and quality of monitoring become more effective and economical”.

### IV. CONCLUSION

This survey discusses and presents a detailed view of various papers on WRSN, Cyber Physical System and wireless mobile recharger. It also presents a wide knowledge on principles and algorithm used by them. It will be very helpful for doing various research activities on this domain.

### REFERENCES

- [1] “Near-Optimal Velocity Control for Mobile Charging in Wireless Rechargeable Sensor Networks” by Yuanchao Shu, Hamed Yousefi, Peng Cheng, Jiming Chen, Yu (Jason) Gu, Tian He on IEEE TRANSACTIONS ON MOBILE COMPUTING, VOL. 15, NO. 7, JULY 2016.
- [2] “Sensing and Decision Making in Cyber-Physical Systems: The Case of Structural Event Monitoring “ by Md Zakirul Alam Bhuiyan, JieWu, Guojun Wang, Jiannong Cao on IEEE TRANSACTIONS ON INDUSTRIAL INFORMATICS, VOL. 12, NO. 6, DECEMBER 2016 .
- [3] “Distributed Sensing for High-Quality Structural Health Monitoring Using WSNs” by Xuefeng Liu, Jiannong Cao, Wen-Zhan Song, Peng Guo, and Zongjian He on

IEEE TRANSACTIONS ON PARALLEL AND DISTRIBUTED SYSTEMS, VOL. 26, NO. 3, MARCH 2015.

- [4] “Diagnosis of Rotor Asymmetries in Induction Motors” by Jose Antonino-Daviu, Selin Aviyente, Elias G. Strangas, Martin Riera-Guasp on IEEE TRANSACTIONS ON INDUSTRIAL INFORMATICS, VOL. 9, NO. 1, FEBRUARY 2013.
- [5] “Networked Computing in Wireless Sensor Networks for Structural Health Monitoring” by Apoorva Jindal, Mingyan Liu on IEEE/ACM TRANSACTIONS ON NETWORKING, VOL. 20, NO. 4, AUGUST 2012.
- [6] “Joint Mobile Data Gathering and Energy Provisioning in Wireless Rechargeable Sensor Networks” by Songtao Guo, Cong Wang, Yuanyuan Yang on IEEE TRANSACTIONS ON MOBILE COMPUTING, VOL. 13, NO. 12, DECEMBER 2014.
- [7] “Collaborative Mobile Charging” by Sheng Zhang, Jie Wu, Sanglu Lu on IEEE TRANSACTIONS ON COMPUTERS, VOL. 64, NO. 3, MARCH 2015.
- [8] “A Mobile Platform for Wireless Charging and Data Collection in Sensor Networks” by Liguang Xie, Yi Shi, Y. Thomas Hou, Wenjing Lou, Hanif D. Sherali, Huaibei Zhou, Scott F. Midkiff on IEEE JOURNAL ON SELECTED AREAS IN COMMUNICATIONS, VOL. 33, NO. 8, AUGUST 2015.
- [9] “Multi-Node Wireless Energy Charging in Sensor Networks” by Liguang Xie, Yi Shi, Y. Thomas Hou, wenjing Lou, Hanif D. Sherali, Scott F. Midkiff on IEEE/ACM TRANSACTIONS ON NETWORKING, VOL. 23, NO. 2, APRIL 2015.
- [10] “Dynamic Authentication with Sensory Information For The Access Control Systems” by Yuanchao Shu, Yu (Jason) Gu, and Jiming Chen on IEEE TRANSACTIONS ON PARALLEL AND DISTRIBUTED SYSTEMS, VOL. 25, NO. 2, FEBRUARY 2014.