Energy Modeling in Carbon Nano Tube based Wireless Sensor Networks

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***Abstract*- We have analyzed the effect of innovations in Nanotechnology on Wireless Sensor Networks (WSN) and have modeled Carbon Nanotube (CNT) based system. We have shown the integration of CNT in WSN and formulated a Nano routing system. A proposition is put forward by us on the changes needed in the existing sensor node structure to improve its efficiency and to facilitate and enhance the assimilation of CNT based devices in a WSN. We have shown the functioning of CNT based Nano devices in WSN technology. Finally we have commented on the challenges that exist in this technology and described the important factors that need to be kept under consideration for the calculation of the energy of CNT based WSN.**

I. INTRODUCTION

The combination of recent technological advances in electronics, nanotechnology, wireless communications, computing, and networking has hastened the development of Wireless Sensor Networks (WSNs) technology. Wireless Sensor and Actor Networks (WSANs) constitute an emerging and pervasive technology that is attracting increased interest for a wide range of applications. WSN see application in various areas like space research, biomedical engineering, military applications such as battlefield surveillance and the quest for making low power, reliable and cheap sensor nodes has been a prime focus in recent years. We know that Nanotechnology has enabled realization of low power devices such as MEMS devices and CNT based FETs [3, 4]. CNT based sensors have shown many benefits over their past counterparts and are suitable candidates in this Nanotechnology driven age [14].

Nanotechnology uses the smallest unit of matter to engineer new materials and devices atom by atom, aiming at achieving superior properties and performance through atomic scale architecture. An improvement in techniques of Nano-characterization and Nano-fabrication has helped us to pave the way to develop many novel materials that can be applied to various spheres of technology. For example the impact of Nanotechnology on Wireless Communications has been shown by Er. Ping Li [5]. An Architecture of Quantum-Based Nano-sensor Node for Future Wireless Sensor Networks has been proposed [2]. WSN in space application has been shown in [1] which uses adaptive MEMS antennas. Wireless Sensor Networks with Biomedical Applications has been shown by Zachary Walker describing the importance of Middleware [6]. Miniature Acoustic Communication Subsystem Architecture for Underwater Wireless Sensor Networks has been proposed by Saunvit Pandya [11]. WSN architecture for the Wireless Health Mobile Bio-diagnostic System for physiological studies has been proposed [12]. Also recent developments in RFID based on MEMS and CNT and their new modeling techniques are making it easier to move toward CNT and MEMS based technology [17, 18]. Thus, we have expanded and proposed designing and modeling of MEMS based array of sensors in our paper that can lead to its practical applications in these areas.

II. CNT SENSORS AND NANO PROCESSORS

Research on carbon nanotubes is ever intensifying in diverse fields of science and engineering in spite of the more than a decade that have passed since and many applications being proposed over the years. Realization of CNT based sensors devices can make them a suitable candidate for WSN sensor nodes. Functionalization of CNT can lead to novel device application giving advantages of their unique properties [7].

Hence we can model a sensor dependent on the above parameters as follows:

1. Define *m, n* and calculate the radius required for the particular sensor as electronic structure (energy band gap structure) depends on the integers, m and n.
2. Take note of impact of working temperature and environmental factors on the reactivity of CNT like hydrogenation, oxygenation, NO_2, NH_3, CO, O_3.
3. Effect of elasticity, mechanical motions and effect of other adsorbent on CNT surface.
4. Predicting the reliability of the sensor.

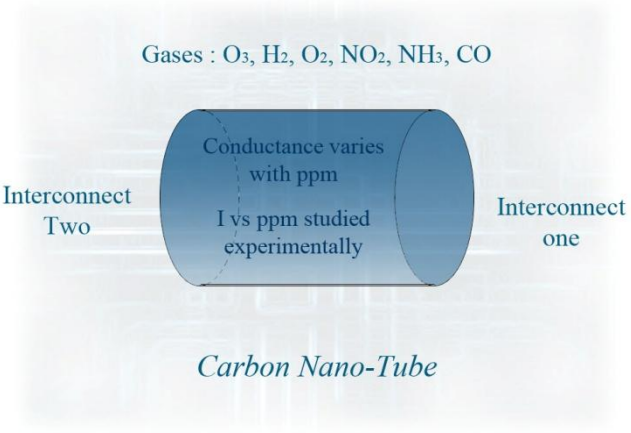

Fig. 1. Interaction of CNT and other molecules.

We know that variations in current conductance properties of CNT make it a useful for detecting gas and chemicals as shown in Fig. 3. The special semiconducting properties of CNTs have been exposited that makes them a suitable

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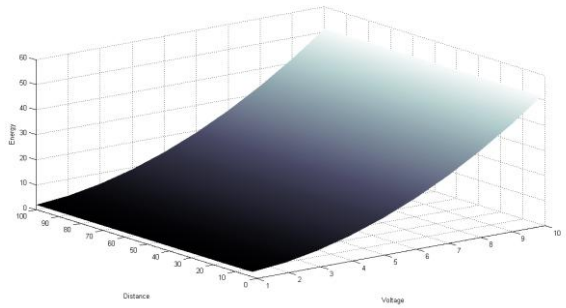

Fig. 6. Energy consumption in Nano routing of a CNT based WSN.

Now we need to find the a path in which the the distance, the load at node (which is defined in terms of n which is also the number of connection is made) and the energy conservationas to makes least energy dissipation for routine in a CNT based sensor network. As we can see that this energy loss will be calculated by each node and then it will decide the path of propogation. Thus the analysis leads to Energy optimized Adhoc analysis which can be seen in fig.6.

IV. CONCLUSION

Thus we have shown how Nanotechnology enabled devices can be used in a WSN environment and the challenges that needs to be confronted. We have substantiated the integration of CNT based devices in WSN. We corroborated the challenges that exist on modeling of CNT based devices for a WSN sensor node. We have demonstrated the functioning of CNT devices and the possible reliability issues effecting WSNs. We have also proposed the changes that are needed in the analysis of the current setup of a sensor node system to enable and improve the integration of CNT based devices in WSN. Change in the properties of CNT devices that is needed to be incorporate in their analysis has been proposed. We have constructed a energy efficient model and using the same we have performed the testing of a CNT based WSN sensor node for an ad hoc system.

REFERENCES

[1] Gaura E., Newman R.M., "Wireless Sensor Networks: The Quest for Planetary Field Sensing," *Proc. 31st IEEE Conference on Local Computer Networks*, pp. 596 –603, Nov. 2006.

[2] Lee L., Xin X., Kuo G.S., "A Novel Architecture of Quantum-Based nanosensor Node for Future Wireless Sensor Networks," *Proc. 5th IEEE Conference on Nanotechnology,* Vol. 1, pp. 207-210, 11-15 Jul. 2005.

[3] She J.P.M., Yeow J.T.W., "Nanotechnology-Enabled Wireless Sensor Networks: Overcoming the Limitations from a Device Perspective," *Proc. IEEE International Conference on Mechatronics and Automation,* Vol. 3, pp. 1610-1617, 2005.

[4] She J.P.M., Yeow J.T.W., "Nanotechnology-Enabled Wireless Sensor Networks: From a Device Perspective," *IEEE Sensors Journal,* Vol. 6, Issue 5, pp. 1331-1339, Oct. 2006.

[5] Li E.P., "Impact of Nanotechnology on Wireless Communications," *Proc. International Symposium on Microwave, Antenna, Propagation and EMC Technologies for Wireless Communications,* pp. K3- 1-K3- 2, 16-17 Aug. 2007.

[6] Zachary W., Melody M., Teng-Sheng M., "A Development Platform for Wireless Sensor Networks with Biomedical Applications," *Proc. 4th IEEE Consumer Communications and Networking Conference, CCNC 2007*, pp. 768-772, Jan. 2007.

[7] Ciraci S., Dag S., Yildirim T., Gulseren O., Senger R.T., "Functionalized Carbon nanotubes and Device Applications," *J. Phys.: Condens. Matter IOP Publishing*, Vol. 16, pp. R901–R960, 2004.

[8] McEuen P.L., Fuhrer M.S., Park H., "Single-Walled Carbon nanotube Electronics," *Transaction of IEEE on Nanotechnology*, Vol. 1, Issue 1, pp. 78-85, Mar. 2002.

[9] Lee W.Y., Lai C.Y., Weng C.H., Juang Z.Y., Leou K.C., Chang-Liao K.S., Tsai C.H., "Electrical Characteristics of CNT-FETs with Symmetric Field-Effect-Free-on Source and Drain," *Proc. IEEE Conference on Emerging Technologies - Nanoelectronics*, pp. 392-395, 10-13 Jan. 2006.

[10] Zhang S., Choi M., Park N., "FET-based nanoarray Architecture with h-hot Addressing Scheme," *Proc. 19th IEEE International Symposium*, pp. 356- 364, 10-13 Oct. 2004.

[11] Pandya S., Engel J., Chen J., Fan Z., Liu C., "CORAL: Miniature Acoustic Communication Subsystem Architecture for Underwater Wireless Sensor Networks," *Proc. of Sensors 2005 IEEE*, pp. 4, 30 Oct. - 3 Nov. 2005.

[12] Jin M. H., Lee R. G., Kao C. Y., Wu Y. R., Hsu F., Tse-Ping D.D., Huang K. T., "Sensor Network Design and Implementation for Health tele-care and Diagnosis Assistance Applications," *Proc. 11th International Conference on Parallel and Distributed Systems*, Vol. 2, pp. 407- 411, 20-22 Jul. 2005.

[13] Atashbar M.Z., Baratto C., Faglia G., Sberveglieri G., "Functionalized Single Wall Carbon Nanotubes Based Gas Sensor," *Proc. IEEE Sensors, EXCO,* Oct. 22-25, 2006.

[14] Atashbar M. Z., Baratto C., Faglia G., Sberveglieri G., "Functionalized Single Wall Carbon Nanotubes Based Gas Sensor," *Proc. IEEE Sensors, EXCO,* Oct. 22-25, 2006.

[15] Shrestha A., Xing L., Liu H., "Modeling and Evaluating the Reliability of Wireless Sensor Networks," *Annual Reliability and Maintainability Symposium, RAMS '07*, pp. 186-191, 22-25 Jan. 2007.

[16] Rohit P., Satyadhar J., Salman Ahmed, "Wireless Sensor Network: Simulink Modeling and Reliability of Nano-Nodes," *Proc. 2nd International Workshop on Electron Devices and Semiconductor Technology, IEDST 2009*, 1-2 Jun. 2009, DOI=10.1109/EDST.2009.5166129.

[17] Rohit P., Satyadhar J., "Multi-Scale Modeling and Analysis of Nano-RFID systems on HPC setup," *Contemporary Computing, Communications in Computer and Information Science, Springer Berlin Heidelberg*, Vol. 40, DOI=10.1007/978-3-642-03547-0_61

[18] Rohit P., Satyadhar J., "Multi Scale Modeling and Intricate Study of MEMS Based Elements in RFID systems" *Conference on Innovative Technologies in Intelligent Systems & Industrial Applications, (CITISIA2009)*, Jul. 2009, DOI=10.1109/CITISIA.2009.5224196