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An Investigation on Wireless Sensor Nodes for Health Monitoring

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ABSTRACT: In the last several years, wireless sensing technologies have piqued interest in structural health monitoring. In comparison to cable-based systems, the appealing characteristics of wireless sensor nodes in terms of both cost and manpower are ascribed to this trend. When wireless sensing technologies were first introduced to the area of structural health monitoring, the emphasis was on power economy and wireless communication dependability. Various kinds of embedded software are suggested to perform fundamental tasks inside the nodes in order to minimize resource usage and improve their functionality. The majority of software in wireless sensor nodes is utilized to conduct some basic data processing and analysis activities locally. Previous review articles detailed the engineering community's collective experience using wireless sensor nodes in structural health monitoring, with an emphasis on hardware and technical requirements. This article, on the other hand, aims to provide a comparative evaluation of current-generation wireless sensor nodes, with a focus on embedded computing capabilities and the capacity of nodes to handle difficult monitoring issues autonomously and decentralized.

KEYWORDS: Health Monitoring, Software, Wireless Sensor Networks, Wireless Nodes.

1. INTRODUCTION

Wireless networks have become an appealing alternative to conventional cable systems due to the appealing characteristics of wireless sensor nodes. The substantial cost savings resulting from the removal of lengthy coaxial cables as well as the shorter installation time have lately prompted a number of research initiatives aimed at resolving the flaws and limits of wireless sensor networks. The majority of issues in wireless sensor networks stem from the sensor nodes' fundamentally restricted resources in terms of power consumption and transmission reliability. Sensor nodes [1] are self-contained systems with some computing capability and autonomy. However, in early efforts to integrate wireless sensor networks in structural health monitoring, these characteristics were not exploited to a sufficient degree (SHM). Traditional transfer of lengthy raw time series to a central repository, in particular, has quickly proved to be an inefficient and time-consuming procedure. The sensor nodes are tasked with transferring hundreds of bytes of data in this process, but the correctness of the findings is not always guaranteed owing to the system's susceptibility to data loss and transmission delay. The aforementioned problems highlight the necessity for dependable sensor nodes with increased local computing capacity and sophisticated on-board data processing carried out by embedded software.

Several methods to embedding software in wireless sensor nodes [2] have been suggested, including a wide variety of algorithms. Most suggested software is intended for local data interrogation and data processing in an effort to minimize the quantity of data that must be wirelessly transmitted by sensor nodes. The main benefit of local data processing is that (possibly) relevant information from processed data is much smaller than raw data, and the lower size of processed data relative to raw data has been shown to decrease power usage significantly during transmission. Other methods, aided by recent advancements in SHMrelated artificial intelligence research seek to improve the system's performance even more (Figure 1).

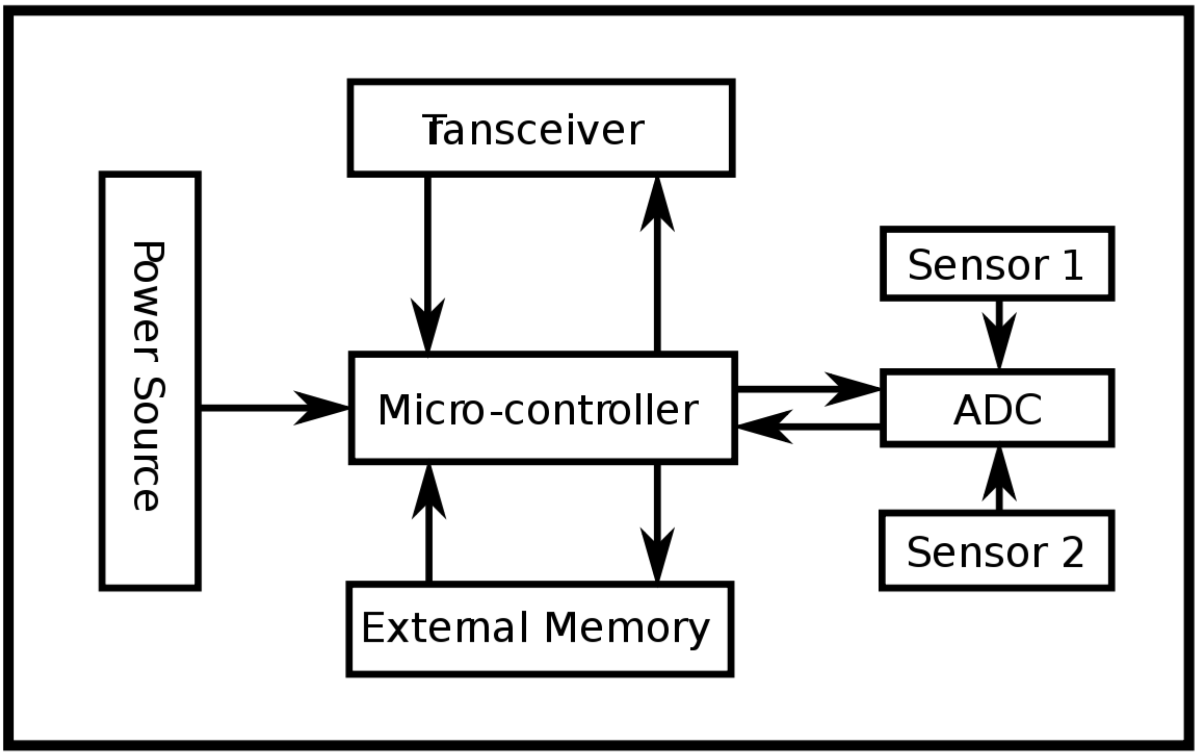

Figure 1: Illustrates the connection between the sensors and transrecievers

With the architecture of decentralized wireless SHM networks, the degree of intelligence of "smart" sensor nodes. Several methods have been suggested to enhance network programmability and autonomy, as well as structural control in active or semi-active systems, to this aim. Sensing technologies are combined with local computing power and wireless transmission capabilities in wireless sensor nodes. A typical wireless sensor node platform consists of three fundamental parts: a sensing unit, a processing unit, and a wireless transmitter, with some “smart” sensor nodes additionally include actuation modules for structural control applications. A wireless sensor node's fundamental functions are data collection through an analog-to-digital converter in the sensing unit, storage and local processing of the acquired data in the processing unit, and wireless transmission of the processed data via the transceiver.

2. DISCUSSION

Straser and Kiremidjian [3] created a wireless modular monitoring system (WiMMS), which was further enhanced in terms of computing power.The sensor node's computational core consists of an 8-bit Atmel AVR Microcontroller, 128 kB of reprogrammable flash memory that supports the C programming language, and 4 kB of SRAM. An external 128 kB memory chip is provided to offer additional capacity for data storage. Wang et al. [4] presented a prototype wireless sensor based on the WiMMS node, providing multi-threaded software that allows the sensor node's microcontroller to do several tasks at once.

First, a software module is included to allow synchronized data sampling by the sensor node, which is guaranteed by a central server transmitting a beacon signal and all sensor nodes confirming reception. A state machine-based communication protocol is also added to improve

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the system's communication dependability. The capacity to gather and transmit data in real time is another essential feature of embedded multi-threaded software. The memory bank corresponding to each sensing channel is divided into two stacks for this purpose, one of which is utilized for data collecting and the other for data transmission to the central server. Finally, local data processing is facilitated by the use of a Cooley-Tukey FFT method, which may improve the wireless sensor network's scalability and performance if the raw time series is not needed. All components of the proposed program passed laboratory and field validation testing, indicating that it performs well.

Lei et al. [5] investigated the performance of system identification algorithms in both laboratory and outdoor trials. Lei et al. evaluated the accuracy and power efficiency of sensor nodes with integrated FFT and PP modules using the prototype provided by Wang et al. [4]. Experiments on a 3-story shear frame in the lab and on the Wuyuan steel arch bridge in China were compared to findings from offline analysis of the raw time series. In addition, an extra module for calculating steel cable forces based on modal properties is included. Overall, the findings from all experimental settings match extremely well with the results from offline analysis, indicating that using embedded data processing algorithms may be a cost-effective option in terms of power usage.

To solve problems such as communication dependability, synchronization, and data aggregation, Nagayama et al. [6] proposed three "middleware services." The extraction of model parameters may be inaccurate due to data packet loss, synchronization problems, or sluggish transmission speed, resulting in poor performance of the structural health monitoring system. The middleware services are designed to address these issues by establishing dependable unicast and multicast communication protocols for data packets and transfer instructions. Resampling and generating time-domain correlation functions between cross spectral density functions using the FFT and inverse FFT techniques are also used to produce synchronized sensing.

Finally, Zhu et al. [7] proposed a transportable wireless sensor node as a cost-effective and practical alternative to dense sensor arrays, marking a further enhancement to the WiMMS prototype described earlier. A mobility module is provided with the enhanced WiMMS node, in addition to the multi-threaded embedded software that controls the sensor node's movements. The motion control instructions are transmitted via the wireless transceiver, and the orders are carried out by the microcontroller's embedded software. The state machine communication protocol is modified to accommodate the mobility modules for this purpose. The suggested mobile sensors may travel to different measurement sites as well as detect boundary conditions such beam-to-column connections. Zhu et al. used four mobile sensor nodes to perform validation tests in a steel frame. Smooth mode forms were recovered despite the limited number of nodes, correlating to a denser discretization of the steel frame.

Authors of [8] proposed the "wireless structural data extraction network," a wireless network design with integrated sensing capabilities (WISDEN). The sensor nodes include modules that guarantee dependable connectivity, data compression, precise time stamping, and damage detection algorithms. Each sensor node is given the task of collecting response data and keeping a local list of all detected frequencies. Following the transmission of local findings to a selected node, a joint evaluation of the monitored structure's global status is carried out to identify mode changes. They utilized the Mica2 sensor node, which had been modified to allow high frequency sampling, in a prototype laboratory version of the proposed network.

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Rice et al. [9] introduced the "Illinois structural health monitoring project" (ISHMP) tool suite, a complete service-oriented software architecture that implements different components that enable data collecting, data processing, and reliable communication. The ISHMP offers "foundation services" that ensure the accuracy of collected data in terms of synchronization and reliable communication, as well as "application services" that cover a wide range of sophisticated data processing algorithms such as correlation function estimation (CFE), FDD, eigensystem realization algorithm (ERA), stochastic subspace identification (SSI), and more.

Rice et al. [6] also include three supplementary software modules to enable full-scale autonomous monitoring: the first software module wakes sensor nodes in power-saving sleep mode, the second module establishes a response value collected by part of the network as a threshold to activate the rest of the network, and the third software module is used for autonomous cooing. Using a network of Imote2 nodes, the suggested software was fully deployed at Jindo Bridge in South Korea. The tests showed that Imote2 is a good fit for the suggested program, both in terms of autonomous operation and system identification.

Smarsly and Law [10] suggested developing software to be integrated in a resource-efficient wireless sensor network, which resulted in a "migration-based" method. The network's computing capacity is split between two kinds of embedded software programs, namely "on-board agents" and "migrating agents." The word "agent" refers to a software program's capacity to function independently, communicate with other software, understand its (computational) surroundings, and take proactive steps toward accomplishing its objectives. In this way, the on-board agents are intended to run basic data gathering algorithms. In contrast, migrating software agents are more sophisticated software programs that are built in real time and utilized to migrate to sensor nodes and evaluate possible abnormalities on demand.

The migration-based method improves the dependability of the monitoring system by reducing energy consumption and increasing on-board memory use; wireless code migration is utilized to offer a holistic evaluation of the system, overcoming the restricted localized perspectives of individual sensor nodes. A wireless network of Java programmable Oracle SunSPOT sensor nodes equipped with temperature sensors and accelerometers was used to perform laboratory validation testing of the proposed method on an aluminum beam and an aluminum plate. The SunSPOT sensor nodes are equipped with an ARM 920T microcontroller with a 32-bit bus size and a 180 MHz clock speed, as well as 1 MB flash memory and 512 kB RAM. The results of the tests show that moving FFT algorithms called on demand in the case of anomalous temperature monitoring by the on-board agents, rather than locally performing FFT, results in a substantial decrease in memory and power usage of up to 96%.

3. CONCLUSION

Over the last several years, the use of wireless sensor nodes in structural health monitoring has grown in popularity. One of the most appealing aspects of wireless sensor nodes is the ability to combine sensing modules with computing power, allowing for the creation of decentralized monitoring networks. Various embedded computer methods for wireless sensor nodes have been suggested to this aim, mostly for data interrogation and local data processing tasks. The complexity of the algorithms to be embedded, the kind of monitoring job, and therefore the overall monitoring goal all influence the selection of appropriate sensor node specifications. When concentrating on distributed networking, the significance of the bus size and the speed of the microcontroller – in other words, the "computational power" – must be considered, although memory capacity is an essential component in instances of intense local data processing (e.g., SSI, FDD). Most sensor nodes allow the usage of high-level languages, some

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of which take use of the advantages of object-oriented programming in terms of software structure, modularity, and extensibility. In conclusion, the creation of a good trade-off between computing capacity and power consumption, which is a major limitation in wireless sensor networks, should be given particular consideration.

REFERENCES:

[1] H. Z. Abidin, N. M. Din, N. A. M. Radzi, and Z. I. Rizman, "A review on sensor node placement techniques in wireless sensor networks," *Int. J. Adv. Sci. Eng. Inf. Technol.*, 2017, doi: 10.18517/ijaseit.7.1.1514.

[2] S. Bisoi, S. S. Bhunia, S. Roy, and N. Mukherjee, "iSENSE: Intelligent Sensor Monitoring Services with Integrated WSN Testbed," *Procedia Technol.*, 2013, doi: 10.1016/j.protcy.2013.12.396.

[3] E. G. Straser, A. S. Kiremidjian, T. H. Meng, and L. Redlefsen, "Modular, wireless network platform for monitoring structures," 1998. doi: 10.1016/s0920-5489(99)91996-7.

[4] Q. Zhang, X. L. Yang, Y. M. Zhou, L. R. Wang, and X. S. Guo, "A wireless solution for greenhouse monitoring and control system based on ZigBee technology," *J. Zhejiang Univ. Sci. A*, 2007, doi: 10.1631/jzus.2007.A1584.

[5] L. Lei, Z. Zhong, K. Zheng, J. Chen, and H. Meng, "Challenges on wireless heterogeneous networks for mobile cloud computing," *IEEE Wirel. Commun.*, 2013, doi: 10.1109/MWC.2013.6549281.

[6] T. Nagayama, B. F. Spencer, and J. A. Rice, "Autonomous decentralized structural health monitoring using smart sensors," *Struct. Control Heal. Monit.*, 2009, doi: 10.1002/stc.352.

[7] T. Zhu, Z. Zhong, Y. Gu, T. He, and Z. L. Zhang, "Leakage-aware energy synchronization for wireless sensor networks," 2009. doi: 10.1145/1555816.1555849.

[8] K. Chintalapudi *et al.*, "Monitoring civil structures with a wireless sensor network," *IEEE Internet Comput.*, 2006, doi: 10.1109/MIC.2006.38.

[9] F. J. Harris, C. Dick, and M. Rice, "Digital receivers and transmitters using polyphase filter banks for wireless communications," *IEEE Transactions on Microwave Theory and Techniques*. 2003. doi: 10.1109/TMTT.2003.809176.

[10] K. Dragos and K. Smarsly, "A comparative review of wireless sensor nodes for structural health monitoring," 2015.