

# A Wireless Sensor Network Simulation Framework for Structural Health Monitoring in Smart Cities

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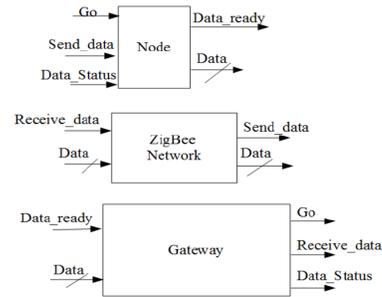
## Introduction

- ❖ Smart cities have one or more smart components such as smart healthcare, smart grids, smart communication and smart buildings.
- ❖ The three key features of smart cities such as intelligence, interconnection, and instrumentation, are provided by IoT.
- ❖ Deployment of wireless sensor networks (WSN) is a possible solution in smart cities.
- ❖ WSN are networks that monitor various parameters such as temperature, pressure, vibration, stress and humidity.
- ❖ The behavior of a system can be analyzed analytically, and experimentally with a simulation mode.
- ❖ Simulation models help in developing a faster prototype and analyzing the behavior of the system with low cost.
- ❖ Since the objective is focused on integrating the software model and hardware prototype, MATLAB® plays an important role in the design.

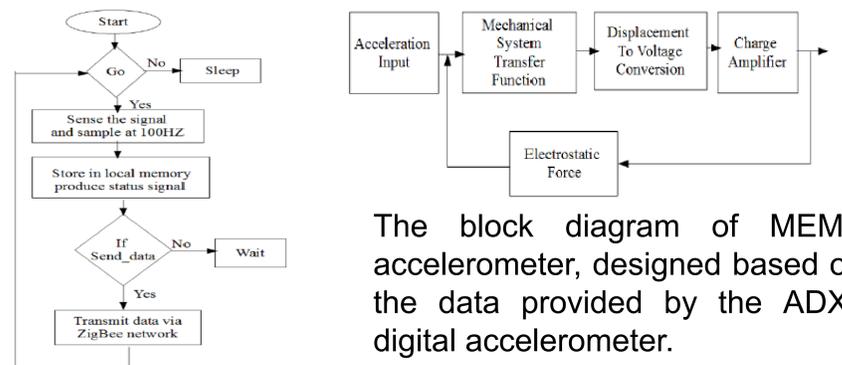
## Major Contributions

- ❖ A WSN simulation framework is developed so that it could be integrated with a hardware prototype to monitor the structural health of bridges, monuments, and skyscrapers.
- ❖ The simulation framework is developed in MATLAB/Simulink which can be used to simulate WSN.
- ❖ The data integrity of the simulation framework is analyzed using cyclic redundancy check (CRC) and transmission error rate calculator.
- ❖ We used 10 nodes to demonstrate the framework operation and the proposed framework has negligible transmission error rate with low power dissipation.

## Simulation Framework Design

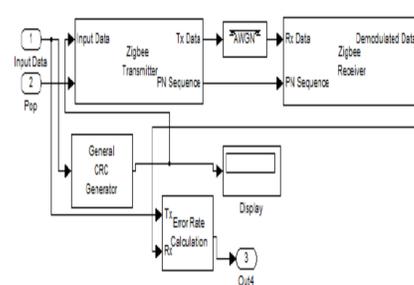


General block diagram for the simulation framework

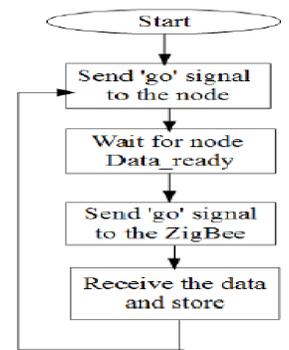


The block diagram of MEMS accelerometer, designed based on the data provided by the ADXL digital accelerometer.

Algorithm for sensor node design



ZigBee transceiver model

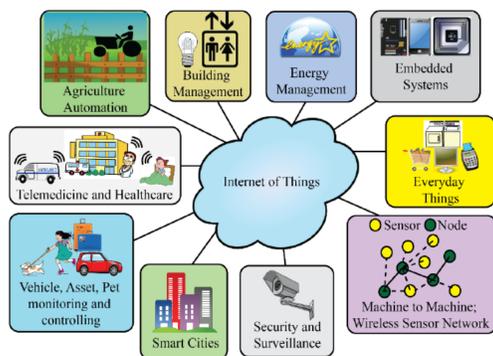


Algorithm for gateway design

## WSN in smart cities

The core of smart city implementation is the Internet of Things. Four main components for the IoT are:

- ❖ The Thing
- ❖ The local area network (LAN)
- ❖ The Internet
- ❖ The cloud



A broad concept of a smart city

This figure shows a specific example of usage of WSN.

The collected data provides better understanding of the structural materials and generates an alarm when required.

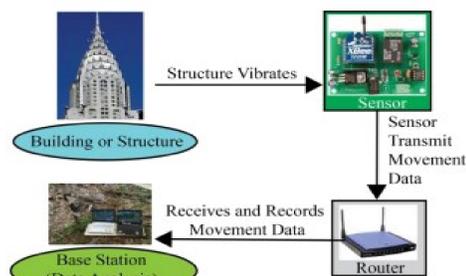
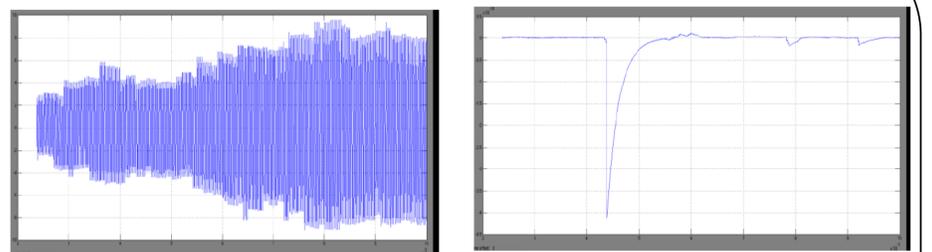


Illustration of a WSN for structural health monitoring

## Results



Displacement in the MEMS mass Output voltage generated in the sensor

Simulation Time	: 4 seconds
Outputs from each node	: 5
Total number of nodes	: 10
Error rate	: 0.1 BER for a total of 100 bits

## Conclusions

- ❖ A WSN simulation framework in MATLAB/Simulink which can be used to simulate WSN for structural health monitoring is presented.
- ❖ In the future, the high speed WSN simulation framework can be integrated with hardware prototypes to study various characteristics of structural health monitoring.