

Study of Wireless Sensor Network using a Matlab based Simulator

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Abstract - Recently, there has been a noticeable interest in Wireless Sensor Network (WSN) which is a group of devices called sensor nodes utilised for monitoring physical events such as moisture, temperature and else. In the future, there will be an increment in the usage of WSN for nowadays technologies, and therefore study of this kind of network will have crucial importance. There is also a need for a model that simulates the work of WSN to improve the performance of the network which the main objective of this study. In this paper, a very brief list of main challenges in WSN filed pointed out and a presentation of the future model has been investigated through simple examples.

Key Words: (Wireless Sensor Networks, Routing, Simulation).

1. INTRODUCTION

Wireless Sensor Network (WSN) can be defined as a distribution of different equipment that has sensors. These sensors are used to achieve a monitoring process of a physical phenomenon such as temperature, humidity, motion .etc. This is very useful for several purposes including safety, security and enhancements of services. The basic elements of any wireless sensor network comprising sensing points, processing unit and communication parts which are used to move the data to the user using specific protocols. The simple structure of the wireless sensor network is shown in figure1.

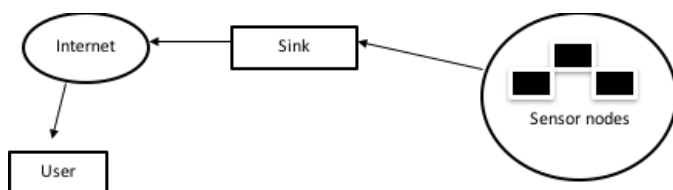


Figure-1: Wireless Sensor Network structure

The sensor node is a low cost and minimised power tool that has small size but it also has low processing units, a small amount of memory and limited power [1]. However, there are different modern filed that Wireless Sensor Network has been utilised like the Internet of Things (IoT) and smart cities.

WSN differs from traditional networks, as it has different design and resource constraints, such the limitation of the processing and the storage for each node, the amount of energy is also limited, the ranges of short communication are short and with low bandwidth [2]. Wireless sensor networks have a large number of the nodes when it

compared with the traditional Ad-hoc networks. As well as, the sensor nodes have a limited lifetime and the topology of the network may be changing continuously [2].

There are many topologies. The most used topologies are presented in [3]. Namely; star, mesh and hybrid which can be used in different scenarios depending on the application.

There are also standards for WSN which are developed by several researchers. The IEEE 802.15.4 is the most important one and many other ones which were developed depending on the layer of work.

A list of various Wireless Sensor nodes can be found in (http://en.wikipedia.org/wiki/List_of_wireless_sensor_nodes).

In this paper, a general study of WSN and an attempt to present the nowadays challenges of Wireless Sensor network. The main aim of this paper is to introduce a simulation software for Wireless Sensor Network can be used for several purposes.

2. General challenges in WSN

As mentioned WSN employed for collecting information about the specific event without the need to human. A general survey of Wireless Sensor Network can be found in [4]. Wireless Sensor Network has several differences from the traditional networks. First and foremost is the deployment of WSN can be random or planned, and there is a cooperation between nodes in WSN to process each other information which makes them also different in network topology [4].

Routing protocols for WSN are also important to be studied for several reasons, mostly to get the protocol(s) that makes saver energy of nodes. The researchers in [5] point out that IP address is not applicable in WSN since it does not have IP addresses. There are several routing protocols for WSN such as Optimized Link State Routing (OLSR), Ad Hoc On-Demand Distance Vector (AODV) ...etc. , and most of the techniques for these can be found in [6].

There are also networking protocols such as Wireless HART [7] and ZigBee [8] and many others. There are similarities and differences among theses protocols and the use of any of them depends mostly on the application itself.

The following are well-known challenges in the field of Wireless Sensor Network:

- a- Minimization of power in Wireless Sensor Networks for specific applications.
- b- Memory or buffer management.
- c- Optimisation path routing.

However, these are only elected specific challenges to study, as a point of view the authors. There could be more hot topic to investigate which have been left as a future work of current project.

3. Model and Tests

Simulating a Wireless Sensor Network using Matlab is not a new idea (see [9]), but it is useful to improve the performance of such simulation systems. Our model is on the process of assessment and more details will be published after tests. Generally, the model is given in Figure 2. The model is basically consisting of three main functions as shown in the figure. There are also six subordinate functions which are attached to each of the main ones. Sens1.m is basically working as the entity of sensing field (i.e. nodes and its attachment). It is important to mention here that real-time data from sensor nodes may be used in order to derive the model or obtain the simulated data which have been already harvested from archive. Sinky.m substitute the sink, and it delivered a mat file from Sens1 a make the necessary process in order to deliver it to Drivy.m. The sink has been defined here as a normal base station which contains a memory for expected data that to be collected from sensor nodes. The initial state of the matrix (memory) has zeroes which is then filled by the necessary information coming from nodes. The latter one represents the final destination point for wireless sensor network. This is the easiest part to deal with since it will just has the final readings of the procedure. In the current version of the model there are few caution that are necessary in simulation to make a conversions between units and get the final simulated results.

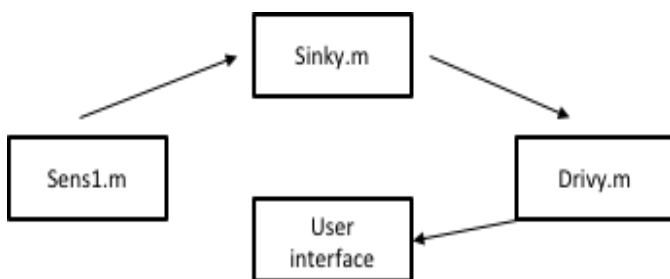


Figure -2: The main Matlab functions for WSN model.

Figure 3 shows measured and modelled received signal strength indicator (RSSI) over different distance in an indoor measurement. The communication model XBee Pro S2c that is compatible to work as a communication model and Wasmotes from Libelium company. It has been used an attenuator with about 2.5 dBi for both transmitter and receiver. The modelling was used in the Matlab simulation program that has been mentioned.

The signal strength at both last figures were given in dBm the mostly commonly used units in this filed and the distance in meter (since it is supposed for the network to work only within short distances for the specific applications).

It can be seen that there is a good agreement between the observation and the modelling. However, the simulated results have a smoothed shape rather than the measured ones. The power levels vary over the distance, in other words, goes from higher when both transmitter and receiver closed to each other.

In Figure 4, it has been utilised the same network characteristics but within the outdoor field (e.g. within a crowded street). It is evident that there is a lower power level recorded as compared with the indoor measurements. This can be as a result of the effects of various obstacles such as reflection, refraction, ducting ..etc.

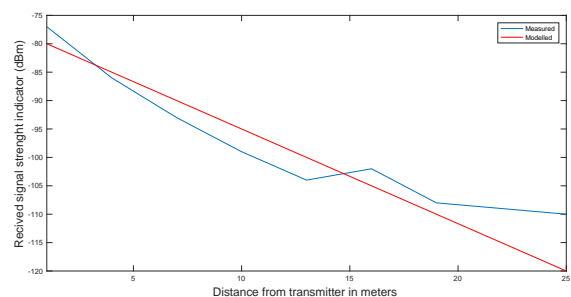


Figure -3: Signal strength over different distances. The blue line is from the measurements and the red line is the simulation.

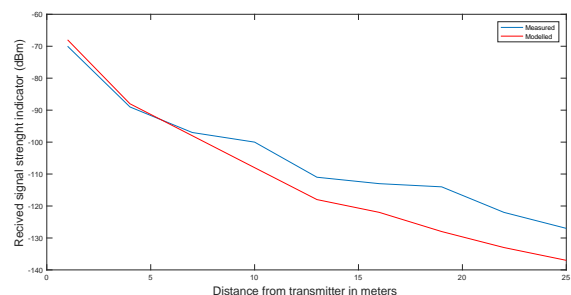


Figure -4: As in Figure 3 but within outdoor.

In point of view of this paper, the model gives some generally accepted results which encourage the researchers to do more tests. It is important to mention that two rays propagation model and free space model has been both adopted to make more realistic outcomes.

Currently, it was not possible to obtain outcomes of different topics e.g. routing, buffering ..etc. Ongoing developments in the model aims to work in increasing the outcomes from the model and enhancing its performance.

3. CONCLUSIONS

It is generally accepted that studying Wireless Sensor Network is an important issue since several fields are dealing with this topic. There is no doubt that smart cities are going to employ sensors for health issues, agricultural and forecast of other topics. Therefore, more experimental work will be required rather than depending on simulators.

A prototype of measurement and simulation has been provided in this paper. The simulator shows good agreement with the observation. More work and tests will be required to model routing protocols using also network simulators e.g., NS3, OMNET, OPNET..etc. The importance of modelling of Wireless Sensor Network is to provide planning for big projects since modern technologies employ WSN i.e.IoT.

Overall the paper represents a simple piece of work and a good starting point for researchers in this field. There are some trends which the reader is probably already aware of, however, these trends can save time for several amateurs and readers who are interested in studying in such fields.

The next step of this project is to improve the simulation by increasing the data sources in addition to implement an interface system to be worked with hardware.

It is also important to do more comparisons with measurements which could enhance the reliability of our model.

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