Big Data and Computing Visions

www.bidacv.com

Big. Data. Comp. Vis. Vol. 3, No. 1 (2023) 21–25.

Paper Type: Original Article

Greenhouse Monitoring with Wireless Sensor Network

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Citation:

Torabi, S., & Fan, L. (2023). Greenhouse monitoring with wireless sensor network. *Big data and computing visions, 3*(1), 21-25.

Received: 23/11/2022 Reviewed: 23/12/2022 Revised: 09/01/2023 Accept: 15/02/2023

Abstract

Greenhouse works with exact observing and controlling of different boundaries, to develop quality conscience crops without killing assets. The cabling laid for the sensors, conveyed inside the greenhouse isn't possible. Thus the need for a computerized framework utilizing remote correspondence, what's more, remote detecting is basic. This paper proposes a Wireless Sensor Network (WSN) based implanted framework and manages the execution of ZigBee organization (over IEEE 802.15.4) for remote controlling of the greenhouse boundaries. The nitty gritty data in regards to the foundation of the ZigBee network in star geography as well as in Mesh Topology, inside the greenhouse is shown. It likewise shows the continuous observation of boundaries like temperature, and dampness, as well as the aggregate power utilization of the framework, with the assistance of a PC-based GUI application, created on the Java stage.

Keywords: Greenhouse, Real-time monitoring, WSN, Embedded system, ZigBee (IEEE 802.15.4), Topology, GUI.

1 | Introduction

Because of the examination and progression in the field of automation, it has worked with advancement in remote correspondence. Robotization alongside the utilization of Wireless Sensor Networks (WSNs) has supplanted the customary manual control systems consequently acquiring notoriety in modern, homegrown too as in agrarian areas [1]. This has prompted a coordinated way prompting new arrangements, better execution, and a flat-out framework. In the field of computerization, WSNs have altered the plan of arising implanted frameworks as far as different factors viz. versatility, portability, power utilization, and so forth [2]. A remote sensor organization (WSN) comprises of spatially conveyed independent sensors to helpfully screen the physical or ecological circumstances, like temperature, vibration, pressure, movement, and so forth [3]. As depicted in and expressed in the novel attributes of WSNs are [4]:

I. Can store and collect restricted power.
II. Capacity to endure unfeeling natural circumstances.
III. Capacity to adapt to hub disappointments.
IV. Portability of hubs is conceivable.
V. Dynamic organization geography.

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https://doi.org/10.22105/bdcv.2022.371385.1087

VI. Heterogeneity of hubs.
VII. Enormous scope sending.
VIII. Unattended activity and self-administering capacity.

2 | ZigBee Protocol

2.1 | Features of ZigBee Protocol

First, it is a low information rate. WPAN (LR-WPAN) standard which gives information rate up to 250 Kbps in the worldwide 2.4-GHz Industrial, Scientific and Medical (ISM) band [5]. ZigBee is a self-designing, self-recuperating arrangement of repetitive what's more, low-power hubs [6] has different exceptional highlights some of which are:

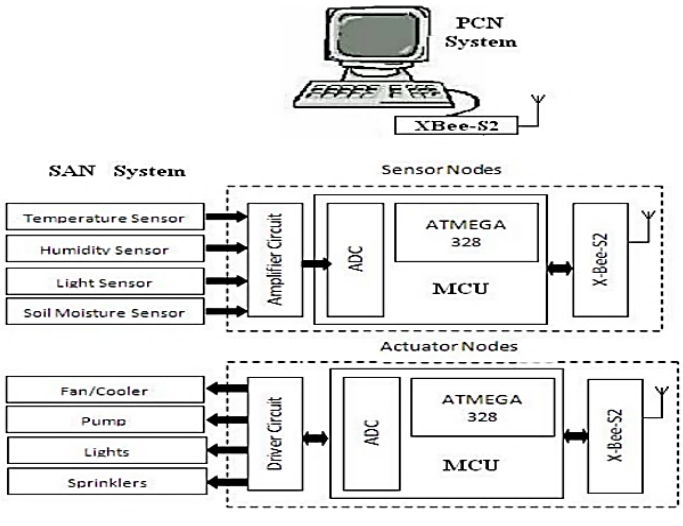
I. Ultra-low power utilization and versatility [7].
II. Uphold's star, mesh, and bunch tree geographies [8].
III. Self-coordinated, multi-jump, and dependable lattice organizing [9].
IV. Give long battery duration.

2.2 | ZigBee Protocol Stack

The ZigBee has layered engineering displayed in *Fig. 1*. It utilizes MAC layers to give dependable wireless information move. The ZigBee alliance determines the logical organization, security, and application software to finish the correspondence suite. PHY layer performs tweaks (Offset Quadrature Phase Shift Keying (OQPSK)) and communicates the packets. Similarly, on the collector side, it gets the parcel and performs demodulation [10]. Macintosh layer utilizes Carrier Sense Multiple Access-Collision Avoidance (CSMA-CA) strategy for getting to the network. The network layer gives organization configuration, and message steering [11] and oversees gadgets in the network. Further, the interoperability and buried similarity between comparable items from various makers are given by ZigBee profiles characterized in the application layer [12].

3 | System Design

Before our planned framework is carried out with the ZigBee convention. It primarily comprises two frameworks viz. Versatile controller hub framework and the Sensor and Actuator Node (SAN) framework. The block diagram is shown in *Fig. 1* below [13].



Block diagram of proposed system

Fig. 1. Block diagram of t proposed model.

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3.1 | Portable Controller Node System

Portable Controller Node (PCN) framework mostly comprises of client PC/PC and ZigBee handset module communicated with PC by means of Universal Asynchronous Receiver-Transmitter (UART) port [14]. It is utilized which is designed as PAN facilitator API. It communicates client control orders serving as the Controller hub [15]. A Java put-together GUI application is created with respect to PC which works with the constant observing of different greenhouse boundaries involving sensor hubs as well as controller of machines utilizing actuator hubs [16].

3.2 | Sensor and Actuator Node System

Both PCN and SAN frameworks are remotely connected by ZigBee with star geography [17]. If the greenhouse region and apparatuses to be controlled are far away then the sensor and actuator hub can be executed independently, while they can be incorporated as one hub in the event that distance is less in the SAN framework [18].

3.3 | Sensor Node

Various sensors, for example, temperature, stickiness, light, and soil dampness, since the individual boundaries inside the greenhouse and send to the PCN system [19]. These sensors are coordinated with the AT mega 32 and XBee modules to frame the sensor node. It's an 8-cycle Micro Controller Unit (MCU) [20] with 32 Kbytes of 'in framework glimmer' and 1 Kbyte of Eeprom memory. It has an in-constructed 10-bit Analog to Digital Converter (ADC) which converts input simple detected worth to relating advanced esteem. It gives these readings to the MCU for additional handling [21].

3.4 | Actuator Node

Another piece of the SAN framework is the Actuator hub. It is coordinated with AT mega 328 MCU, XBee handset, and transfer driving hardware for controlling the appliances. The sensor hub sends the detected qualities in the type of parcel to the PCN framework for plotting continuous diagrams furthermore, to the actuator hub for control activity [22].

I. Contingent upon these qualities, the actuator hub goes to the corrective lengths or the client can physically convey the control messages [23].
II. With the assistance of GUI worked at PCN framework to settle the greenhouse boundaries.

4 | Establishment of ZigBee Network

After in our framework correspondence among PCN and SAN systems is laid out by ZigBee organization. PCN side Transceiver is associated with the client PC through the BAFO link and is designed as the organization PAN Coordinator. Each ZigBee organization ought to have no less than one PAN Coordinator which is interested in the network. It performs different tasks, for example, organizing the network, laying out a tending to conspire, and keeping the addressing tables. To lay out the network alongside the PAN facilitator no less than one ZigBee Router (in the instance of highlight point setup) or at least two, ZigBee switches and ZigBee Gadgets (if there should arise an occurrence of highlight multi-point setup) are required. We have designed PCN side transceiver as a PAN facilitator which trades the orders with SAN side switches.

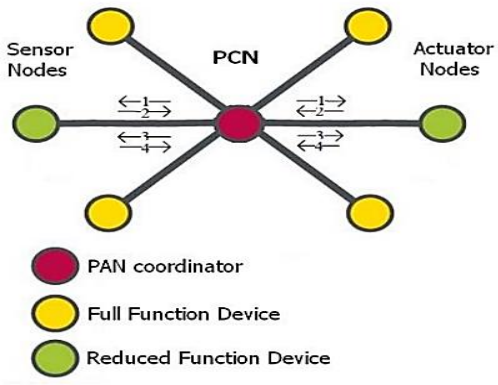

Fig. 2. Establishment of ZigBee network.

Table 1. Comparison of Xbee radios.

Paeameter	XBee-S2	XBee-PRO
RF data rate	250 kbps	250 kbps
Indoor range	40 m	90 m
Outdoor range**	120 m	3200 m
Transmit current	35 mA/45 mA*	205 mA
Receive current	38 mA/40 mA*	47 mA
Transmit power	1.25 mW	63 mW
Receiver sensitivity	-96 dBm*	-102 dBm

5 | Result in Analysis

The point of the planned WSN-based framework is the genuine time checking of different greenhouse boundaries, for example, temperature, humidity, soil dampness level, and light power. These boundaries had been shown on the LCD at the SAN system. Along with that utilizing solid remote correspondence over 802.15.4, these were effectively sent to the PCN framework to satisfy the point of ongoing checking of these boundaries at a remote spot. The framework additionally gives the controller of different machines utilizing GUI-based applications and actuator hubs. Communicating the detected boundaries of SAN framework towards PCN and plotting a constant chart was the essential point. Thue as opposed to utilizing extremely exact and complex sensors, we have carried out promptly accessible sensors. The outcomes gotten are talked about further.

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