# Advanced WSN Based Green House Monitoring and Controlling with GSM Terminal

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## ABSTRACT

*This paper represents the modeling and optimizations on advanced GSM (800-900MHz)-WSN (IEEE 802.15.4) based greenhouse monitoring and controlling with SMS terminal. The proposed system includes sensor station and base station terminals performing various conditioning functions. PIC18F4520 controller is used for better conditioning of climate parameters in the greenhouse. The sensor station is equipped with several sensor elements including temperature, humidity, light and soil moisture. The communication between the sensor station and base station is achieved via ZigBee wireless modules and base station to user is achieved via GSM network. By employing GSM Terminal access to proposed system, field parameter has been accessed by using conventional SMS facility. Solar panel is employed to energize the whole assembly in greenhouse. The wireless sensor stations in the greenhouse measures temperature, humidity, light, soil moisture etcetera with their relative standards. By relating the variation in set points of sensors, proposed parameters in greenhouse has been conditioned.*

**Keyword: -** *Base station, GSM (800-900MHz)-WSN (IEEE 802.15.4), greenhouse conditioning, sensor station, solar panel.*

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## 1. INTRODUCTION

In the previous decade a poly house concept was implemented by which real time controlling against the field environment like temperature, light intensity, humidity, soil moisture etcetera were done manually. The control action had done in a way that the sensor from sensing station or a sensing system generates the output related to the estimated parameter but it seems lack of general purpose automation system [1]. Furthermore, the implementation of the green house had done by using conventional embedded electronic system, they implemented general purpose microcontroller such as ARM family for monitoring the field parameters achieving the expected accuracy within them. The ARM board with relay circuitry has employed to drive the output circuitries such as fans, water pumps, etcetera which was semi-automated [2]. For remote sensing and manipulation of the input output terminals within the system was implemented by using wireless technology named as ZigBee and wireless sensor technology (WSN). It supports multiple sensing topologies which collect the more number of parameters from different sensor nodes within field by using ZigBee and conventional ARM based embedded systems. But the system limits the fully automated environment [3].The ARM based automated wireless greenhouse monitoring system by using ZigBee technology has implemented for communication between sensor station and base station with in the desired greenhouse field which allows sensor embedded system to be interface with general purpose ZigBee network for remote sensing as well as monitoring the field up to 100 meter of area. But it lags for connectivity with advanced communication network such as modems, cellular phones and satellite communication systems [4]-[5]. The acquired parameters from field were collected with ZigBee system can be further processed by using commercial hand held dedicated terminals which uses the ZigBee based trans-receiver system which allows to coordinator for initiating the manipulating commands [6]. By implementing controlling strategies via fully WSN with accommodation of computer system which allows the mobility function over a land based computer system to fieldsmen so that he would be able to monitor as well as control the field parameters from any serving location [7].

In order to accommodate an advance telecommunication system for an agriculture use a cellular network has been adopted. The mobile terminal fulfills the long distance interactions between fieldsmen and sensor station by using GSM network so that the parameters within the field were control using AT controlling based commands. The GSM module has implemented in the field environment in order to access the real time variations with in the states of sensors. If the sensor parameter varies above the thresholds then these database can be retrieved by using SMS service as soon it could be. Here user has full accessibility over controlling these parameters by using AT commands so that they can be semi-automated type of systems [9]-[12].While implementing an efficient greenhouse the power consumption is always need to consider for proper operating of the field devices. The optimum use of power should necessary if the system employees with battery backup power supplies [13]. This power consumption against battery backup system can be further more investigated. With the help of solar energy system by which sensor station and base station devices can be served efficiently without any external power sources [14].

In this proposed work, a fully real time advanced monitoring and controlling of field parameter in automated operation has been presented. Proposed system uses GSM based base station for initiating the status of current field parameters for transmitting towards the user Sensor station is used to sense the parameters from green house. Unexpected variations in the parameters of sensor station are continuously monitored against the predefined thresholds and control the output status according to them. The user receives the status of field environment parameters along with total controlling time required by particular sensor. The proposed system reports the change in the sensor station along with elapsed time for controlling the output parameters by means of GSM based SMS terminal for user access persistence.

## 2. SYSTEM ASPECTS AND DESIGN DETAILS

The proposed system comprises of two modules; a sensor station and a base station. The sensor station performs the sensing function that is collecting data from different location in greenhouse such as light intensity, soil moisture, humidity and temperature by using different sensors and then compared with the predefined data of parameters so that the proper action could be taken to maintain the environment in green house. Finally collected data is transmitted to the base station for investigation through the ZigBee. The base station receives data from sensor station and updates the same received data to the user through SMS using GSM network for worldwide interface between user and system.

### 2.1 Sensor Station

Sensor station block diagram is shown in Fig. 1. It consist of PIC18F4520 controller as a hart of sensor station which provides all the controlling platform for proposed system by using inputs sensors of temperature, humidity, light intensity and soil moisture sensor. It sends outs sensed parameters on LCD display for examination purpose of parameters to be monitor. A ZigBee module has implemented to communicate and transmit the parameters between base station and sensor station. Here the relay banks along with output devices has employed to maintain the required climatic conditions in Greenhouse if input parameter crosses the thresholds assigned to controller. Entire system has energized with solar panel power conditioning circuitry which makes overall system reliable in terms of continues power requirements from the external power sources.

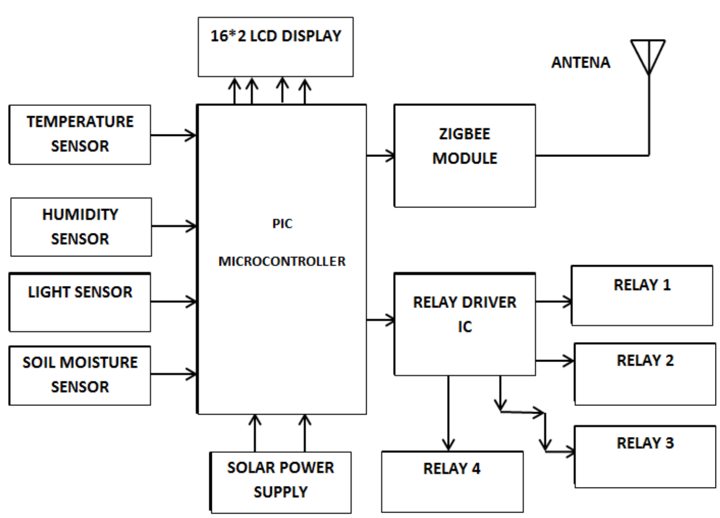



**Fig -1:** Block diagram of sensor station.

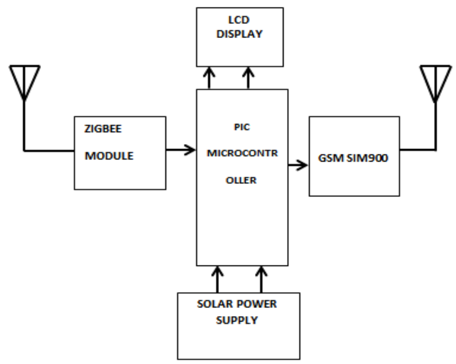



**Fig -2:** Block diagram of Base station.

### 2.2 Base Station Design

The block diagram of base station is shown in Fig. 2. It consists of PIC 18F4520 Microcontroller, ZigBee module, LCD display, and GSM modem. The transmitted field parameters from greenhouse via transmitting ZigBee module are received. by base station by using ZigBee receiving section. Microcontroller links received data towards the LCD display unit and again it is carry forward to the webpage or users mobile phone via GSM network that has been implemented by GSM Module. User can initiates the controlled commands for greenhouse parameters against the detected thresholds.

## 3. SYSTEM OPERATION

### 3.1 Operation for Sensor Station

The sensor station needs to be able to

- Collect data of different parameters from the Greenhouse environment:
  Various parameters such as temperature, light intensity, humidity and soil moisture can be continuously monitored and depending upon variations, the data should be collected.
- Perform analog to digital conversion on the collected data:
  Depending upon collected data, for proper signal conditioning, received data must be converted into the analog to digital format.

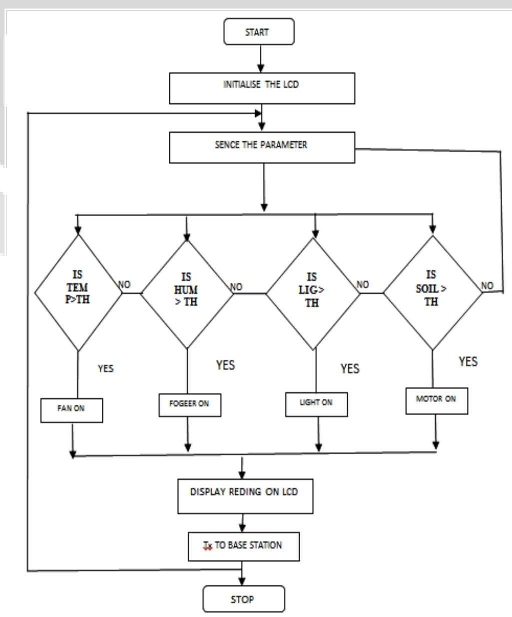



**Fig -3**: Flow charts for Sensor Station.

- Compare the collected data with threshold data:
  Depending upon predefined sensor condition the variations from the collected sense data can be compare for serving the next operation.
- If any parameter varies take a required action to control a climate condition:
  The variations with in the field parameters can be served by using control actions.
- Visually display real-time data in terms of total time taken by controlling output:
  To display the collected data by means of quantified representation of parameters.
- Send current status data to the base station:
  Here we have to send the collected data by sensor station to base station by using transmitting technology (ZigBee).
- Fig. 3. Shows the flow chat for sensor station.

### 3.2 Operation for Base Station

The base station needs to be able to:

- Receive data from the sensor station:
  To receive the transmitted data by sensor station by using transmitting technology (ZigBee) the base station receives all variations in field data.
- Send the received data packets to display unit:
  It represents the sensed parameter along with their timing specifications on the LCD display unit.
- Send the displayed data to user by using GSM Network in the form of SMS:
  Transmit the received field parameters to user by using GSM network.
- Fig. 4. Shows the flow chat for base station.

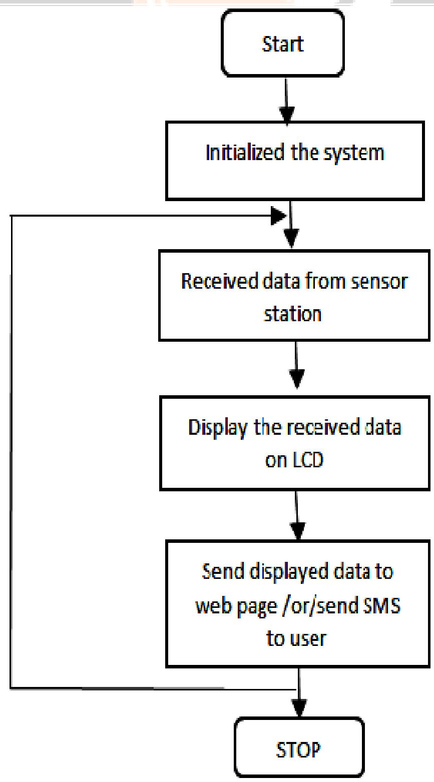



**Fig -4:** Flow charts for Base Station.

## 4. RESULTS AND DISCUSSIONS

The proposed system is simulated by using protus software and experimentally evaluated for various conditions of sensors. In this section, practical readings form temperature sensor, light sensor, humidity sensor, soil moisture sensor etc. are exposed. Each sensor on base station has observed for its optimum performance against defined levels. In regards with this, Proposed system has tested over a greenhouse having of area 1×1×1 feet's. The input-output variation within the assigned threshold levels are examined for various input devices.

**4.1 Temperature Sensor**

Input sensor considered for temperature is LM35 with temperature set point of $40^0$ C and examined with respect to output device. Status of fan has been examined for increment and decrement of thresholds of $40^0$ C temperatures.

- Condition 1: Temperature bellows to $40^0$C, fan should be OFF state which is shown in fig. 5.
- Condition 2: Temperature above $40^0$C, fan should be in ON state which is shown in fig. 6.
- Condition 3: Turn off the fan and display the message for time requires by cooling fan to maintain condition 1 as shown in fig. 7.

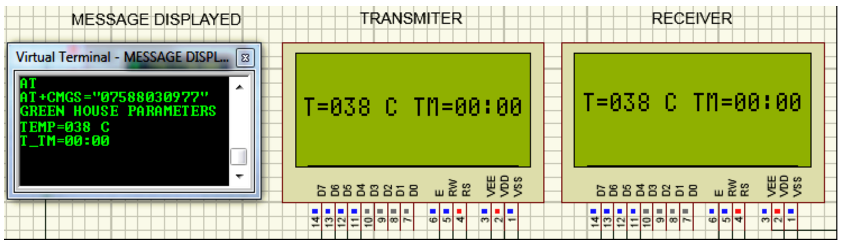



**Fig -5**: Simulated results for temperature < $40^0$C.

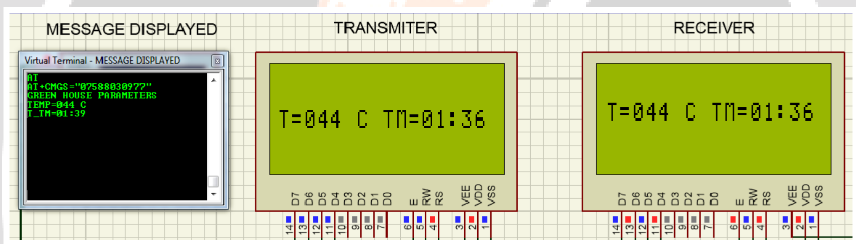



**Fig -6**: Simulated results for temperature > $40^0$C.

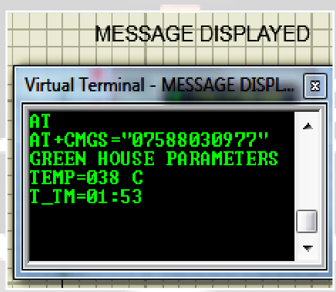



**Fig -7**: Time required for achieving condition 1.

**4.2 Light Intensity Sensor**

Input sensor considered for light is LDR with light intensity set point of 40% and examined with respect to CFL (16W, 500 lumens) as an output device. Status of CFL has been examined for incremental and decrements in thresholds of 40% light intensity.

- Condition 1: Light intensity is more than 40% lumens; CFL should be OFF state as shown in fig. 8.
- Condition 2: Light intensity is less 40% lumens, CFL should be ON state as shown in fig. 9.
- Condition 3: Turn OFF the CFL and display the message for time requires to maintain condition 1 as shown in fig. 10.

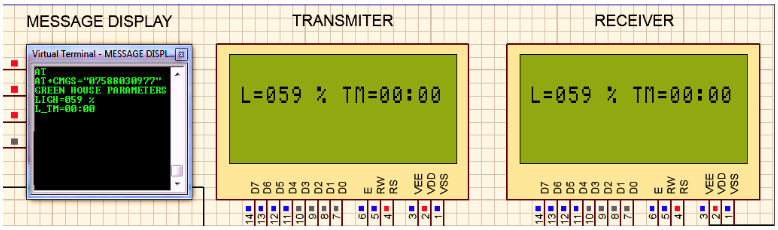



**Fig -8**: Simulated Results for Light Intensity > 40% lumens

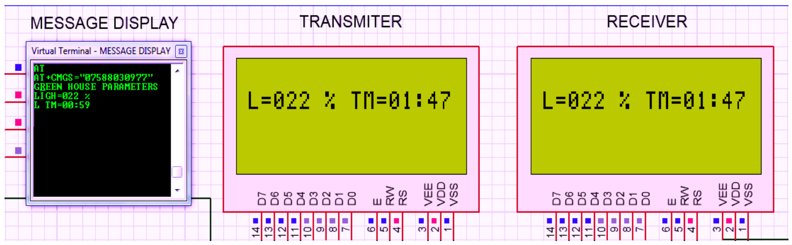



**Fig -9**: Simulated results for light intensity < 40% lumens

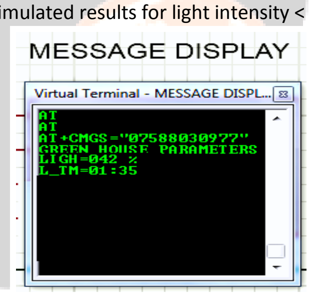



**Fig -10**: Times Required for Achieving Condition

### 4.3 Humidity Sensor

Input sensor considered for humidity is HS200 with humidity set point of 40% and examined with respect to heater as an output device. Status of heater has been examined for incremental and decrements in **thresholds** of 40% humidity

- Condition 1: Humidity is less than 40%, heater should be OFF state as shown in fig. 11.
- Condition 2: Humidity is more than 40%, heater should be ON state as shown in fig. 12.
- Condition 3: Turn OFF the heater and display the message for time requires to maintain condition 1 as shown in fig. 13.

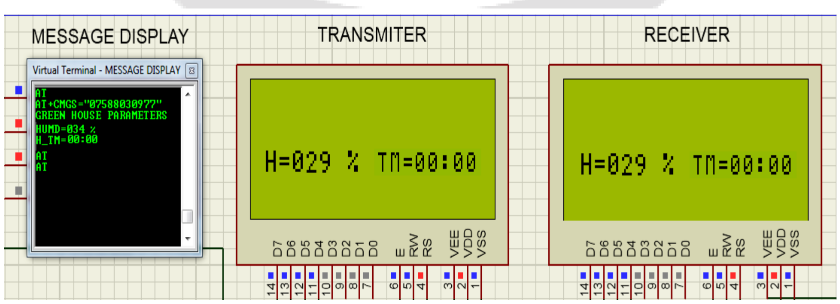



**Fig -11**: Simulated result for humidity < 40%.

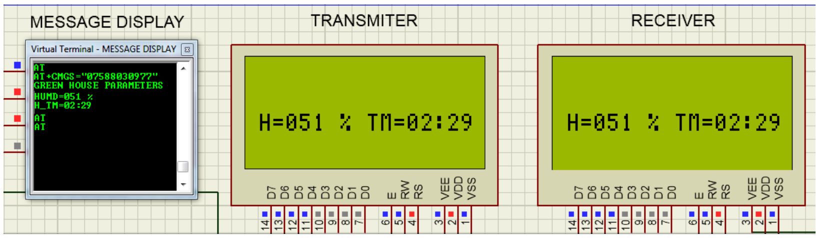



**Fig -12**: Simulated Results for Humidity > 40%.

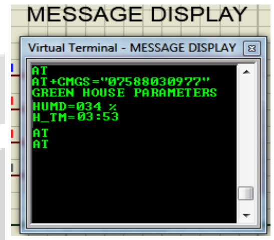



**Fig -13**: Times required for achieving condition 1

### 4.4 Soil Moisture Sensor

Input sensor considered for soil moisture is VH400 with soil moisture set point of 40% and examined with respect to water pump as an output device. Status of water pump has been examined for incremental and decrements in thresholds of 40% soil moisture.

Condition 1: Soil moisture is more than 40%, water pump should be OFF state as shown in fig. 14.

Condition 2: Soil moisture is less than 40%, water pump should be ON state as shown in fig. 15.

Condition 3: Turn OFF the motor and display the message for time requires to maintain condition as shown in fig. 16.

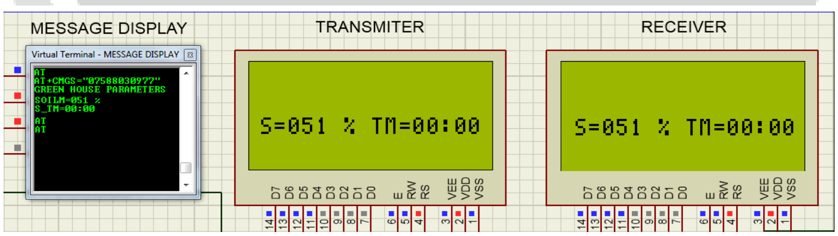



**Fig -14**: Simulated results for soil moisture > 40%.

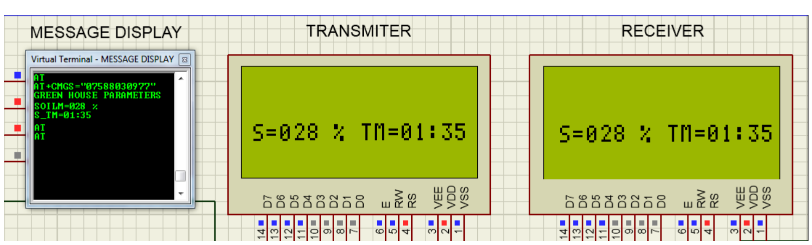



**Fig -15**: Simulated results for soil moisture < 40%.

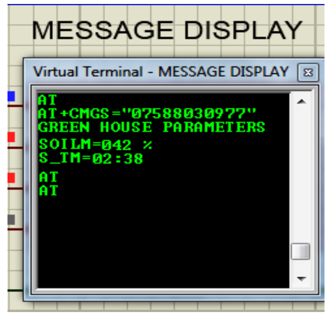


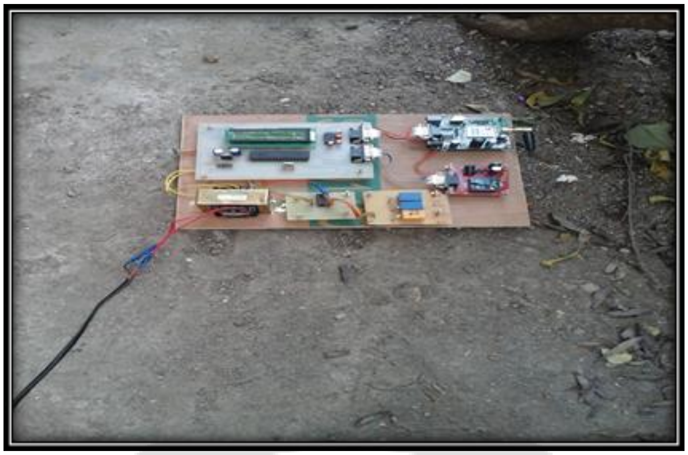

**Fig -16**: Time required achieving condition 1.

## 5. CONCLUSION

In these proposed work "Real Time Monitoring and Control System for Greenhouse Using Wireless Sensor Network and Solar Energy" has been implemented by using Microcontroller 18F4520 along with ZigBee and GSM 900 for initiated area of greenhouse (1.5×1.5×1.5).The proposed system manipulated fully automated operation for different field parameters with their critical values and by providing a solar based energy conditioning circuit for operation of sensor station and base station. The Proposed system has simulated against temperature 400C, humidity 40%, light intensity 40% and soil moisture 40%. The variation within these parameters is remotely manipulated with GSM modem. The user interaction function with proposed system has been carried out by using SMS service. The system co-operates variation with all mentioned four parameters and a real time required for operation of various output devices is been calculated and displayed it along with threshold levels. The Proposed system shows the novel tradeoff between the greenhouse monitoring and control systems, which suggest that, the proposed system has to be good candidate for modern agricultural applications for helping to improve quality and to increase crop yield.

Photographs of proposed system are displayed as follows.


(a) Project setup of greenhouse automated system for sensor station



(b) Project setup of greenhouse automated system for base station

**Fig -17**: The Complete project setup of greenhouse automated system using wireless sensor network.

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