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# Development Of PSO Based Hand Held Device To Monitor The Environmental Parameters For Coal Mines And Rigs

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**Abstract**

In this Paper a data acquisition system has been proposed for coal mines and rigs which will measure the certain parameters like temperature, humidity, the level of gases present in atmosphere and transmit these parameters to the control room wirelessly as well as to the concerned person of the area by the latest smart handheld device. Since these sensors will be deployed randomly, the coverage of these sensors on the field needs to be investigated. The sensors position need to be placed in such away that the network covers the full field area also ensures high quality of service. This can be achieved by placing optimal number of sensors covering maximum area in the network without any communication failure or dark zone. In order to achieve the same, in this paper, network optimization algorithm was used for efficient routing. There are various optimization algorithms available and studied. However, particle swarm optimization algorithm was selected and used to find the optimal positions of the sensors because of better scalability. This paper also includes the implantation of hardware for the proposed system.The handheld device will be connected to the centralized computer which is connected to optimized network by means of zigbee. Data from various field sensors will be collected by central data logger. The RF modem is used to transmit the values to the control room node using star and mesh network topologies. The ZigBee network is working at 9600 baud rate and 2.4GHz frequency in ISM band. The ZigBee nodes are capable to transmit the information upto 100meteres and for long distance communication, multi-hopping is used. The central data logger is having the facility of GSM network for communicating data to outstation.

**Keywords-** Coal mines, GSM, Handheld device, PSO, Rigs, RF modem.

## 1. Introduction

Literature survey was carried out on the wireless sensor networks and its applications. Paper[1] speaks about a methodology to develop a biosensor for the analysis of glucose concentration is proposed using a simple microcontroller based data acquisition system. The current generated by the biosensor for different glucose concentrations was signal conditioned, then acquired and computed by a simple AT89C51-microcontroller and operating parameters are optimized for better performance. Paper [2] elaborates an integrated wireless SCADA system for monitoring & accessing remotely situated device parameter such as temperature, pressure, humidity on real time basis, is proposed. It consist of GPRS based mobile network and SCADA system to create an low cost device which can be used in many different SCADA applications. Paper [3] discuses a wireless sensor network for early detection of forest fires is suggested, by analyzing the Fire Weather Index (FWI) System. Its different components can be used in designing efficient fire detection systems with wireless sensor networks. Paper [4] describes the importance of wireless sensor networks for collecting and monitoring environmental variables such as meteorological parameters or pollutants. The system can efficiently monitor and detect anomalies, a context for the monitoring and near-real-time assessment of environmental data is proposed that offers reduced data representation utilizing fuzzy clustering for the shrinkage of spatial data combined with an LZW scheme for the compression of temporal data. In paper [5] a system is suggested for weather monitoring by measurements of temperature, atmospheric pressure and relative humidity remotely by using the sensors. The analogue outputs of the sensors are connected to a microcontroller through an ADC for digital signal conversion and data logging. An LCD display is used to display the measurements. For analysis the data can be transferred to a PC with a graphical user interface program through a USB link. The interface program allows sampling parameters such as the date and time of the data-logging operation to be configured. Paper[6] presents a low power ZigBee sensor network with bidirectional communication and control of inter-node data pack reception designed for use in agricultural fields. The network consists of sensors, routers that propagate the network over larger distances, and a computer, which in turns illustrates the data and controls the entire system. The end devices provide data from the sensors to the personal computer, at variable time points determined by the central node, which control the water flow to the plants in a greenhouse. The ACO algorithm [7] is originated from ant behavior in the food searching. When an ant travels through path, from nest to food location , it drops pheromone. According to pheromone concentration the other ants choose appropriate path. The paths with the greatest pheromone concentration are the shortest ways to food. The first ACO algorithm was implementation of the algorithm have been developed. Particle swarm optimization [8] is initialized with a group of random particles (solutions) and then searches for optima by updating generations. Particles profit from the discoveries and previous experience of other particles during the exploration and searches for higher objective function values. Each particle in PSO flies in d-dimensions problem space with a velocity which is dynamically adjusted according to the flying experiences of its own and its colleagues. Paper [9] proposed a dynamic locating system in jacket using handheld computing system for the automobile warehouse management application. It is worn by employees during warehousing of automobiles, to calculate the locationof parking spaces dynamically. In this paper[10] a handheld assistive device for the blinds is suggested to improve the quality of life. Paper [11] explores the possibility of harnessing the energy during the user's everyday actions to generate power for his or her computer. Power generation by leg motion is analyzed.

Above literature survey suggest that although environment monitoring has been performed using WSN, but monitoring of parameters by handheld device was not done before for the coalmines and rigs. This paper addresses this issue.

## 2. Hardware Development


**Fig.1 Proposed System**

Fig.1 shows the system is configured with three units, sensor nodes, handheld devices and data collecting unit. Different sensor nodes are placed in coalmines and rigs which collect the data from the environment like temperature, humidity, gas, water level and soil moisture, sensors will continuous monitor the environmental changes and send the whole data to data collecting unit by RF module, then data will be collected to data logger and will be optimized by using optimizing algorithm and this optimized value will be sent to small handheld devices with authorized person and the whole information will be displayed on display unit provided on the device.

### *2.1 Sensor*

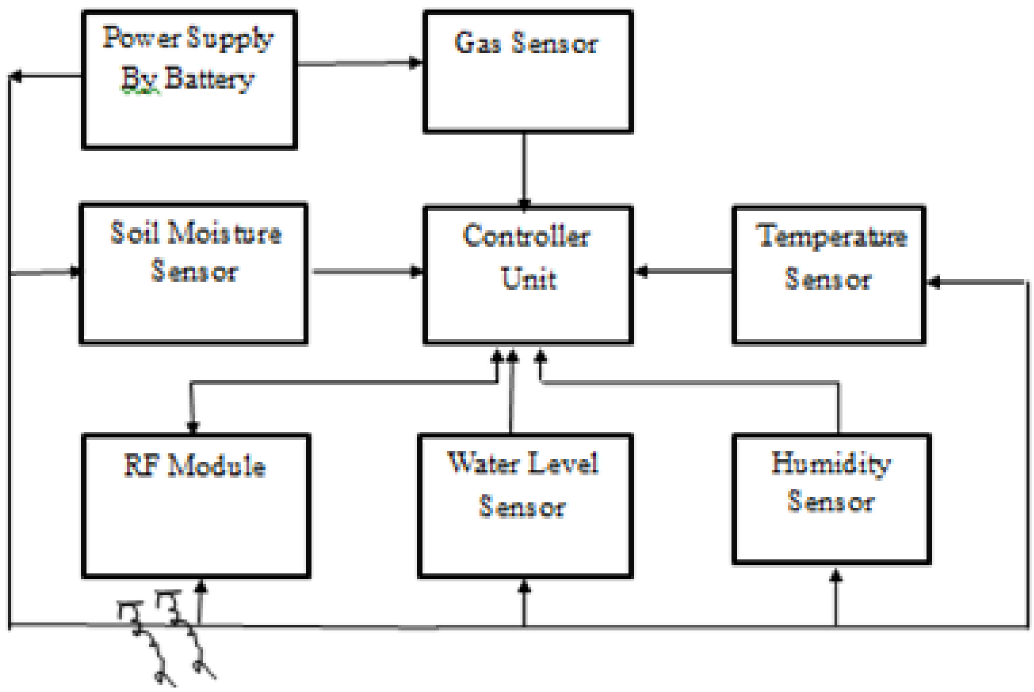


**Fig.2 Block diagram of Sensor nodes**

Fig.2 shows block diagram of sensor node, its processing unit is microcontroller and power supply mode is battery. The node location is defined by using particle swarm optimization algorithm.

The node comprising of different sensors like soil moisture sensor, gas sensor, temperature/humidity sensor, water level sensor and a RF module to communicate with handheld device and data logger.

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### *2.2 Handheld Device node*

Fig.3 shows block diagram of handheld device. It comprises of controller unit i.e. a microcontroller. Switch array to provide switch on/off as it is battery driven device user can use device as per requirement also and previous data can also be monitored. RTC provide real time at which data has been received and EEPROM to give facility of data storage to the device for further use. RF module is to communicate with sensor nodes.

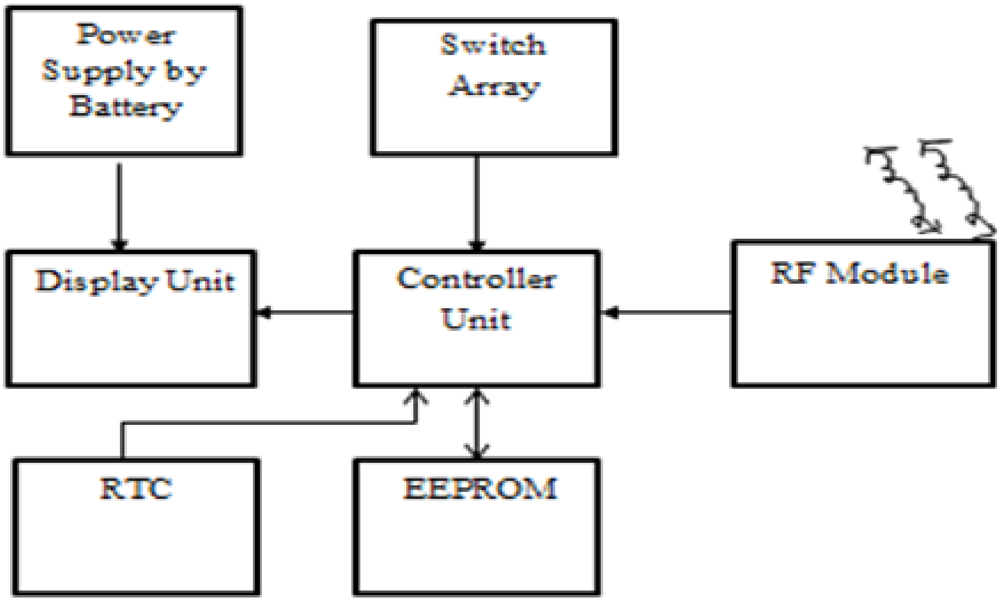


**Fig.-3 Block diagram of Handheld device**

### *2.3 Data logger*

Data logger is designed with GUI in MATLAB. It will show all sensor data in a proper format and optimized data will be sent to the handheld device after a predefined duration.

## 3. Software Development

This work is about development of handheld device for displaying optimized field data with network optimized wireless sensor network placed on the rigs. An embedded system has been developed for this purpose. The system is developed using AVR Atmega8L. Therefore, AVR studio is employed as the IDE and firmware is developed in embedded C environment. Along with the main programme the firmware comprises various modules developed for specific tasks. Following are the modules developed and used in the programme with proper sequence.

a) ReadADC() is used to read of the Analog signal
b) ADCcalibration( ) is used to calibrate the Humidity sensor
c) InitLCD is used to Initialize the LCD
d) LCDWChar is used to write characcter on LCD
e) USARTReadChar() and USARTWriteChar() for serial communication
f) Serial communication [ser_trans_zigbee()]
g) dealy() is used for Delay Function

### *3.1 PSO Algorithm*

There are number of cluster nodes in a particular section which is controlled by a cluster head. The cluster nodes need to communicate among themselves and also need to communicate to cluster head and main control room. Since the numbers of nodes are large the communication need to be done using optimized routing algorithm. There are several methods available for network optimization. The traditional methods like kruskal's algorithm, minimum spanning tree, Prim's algorithm have the drawback of limited exploration of search space and insensitivity to scaling. Hence in this paper PSO has been used for network routing. PSO also has the advantage of less memory usage and better results.

The PSO algorithm is as follows-

1. For parameters initialization the every particle is given a random position and velocity.
2. Initialize the number of the sensor_node particles, maximum number of iterations
3. set the position of the initial sensor_node
4. allocating the dynamic value for calculating gbest
5. Define objective function
   // objfcn = @(x)(x(:,1)- 20).^2 + (x(:,2) -25).^2;

6. set the position of the particles
7. set initial velocity for particles
8. evaluate the function using the position of the particle
9. compare the function values to find the best ones
10. update best position with the velocity
11. get the updated position
12. update the best value so far for network as global best value
13. update the velocity of the particles

Here
For The optimization of parameters the following equation has been used .

```
n = 60;          % Size of the swarm " no of birds "
B_setp=60;   % Maximum number of "birds steps"
dimension= 2;          % Dimension of the problem
inertia=1.0
correction factor=2
fitness=0*ones(n, bird_setp);
velocity=inertia*velocity+c1*(R1.*(L_b_position-c_position))
+c2*(R2.*(g_b_position-c_position)); and
c_position = c_position + velocity; [12]
```

## 4. Circuit and Simulation

Fig.4 shows circuit diagram of system comprising sensor node and handheld device node.

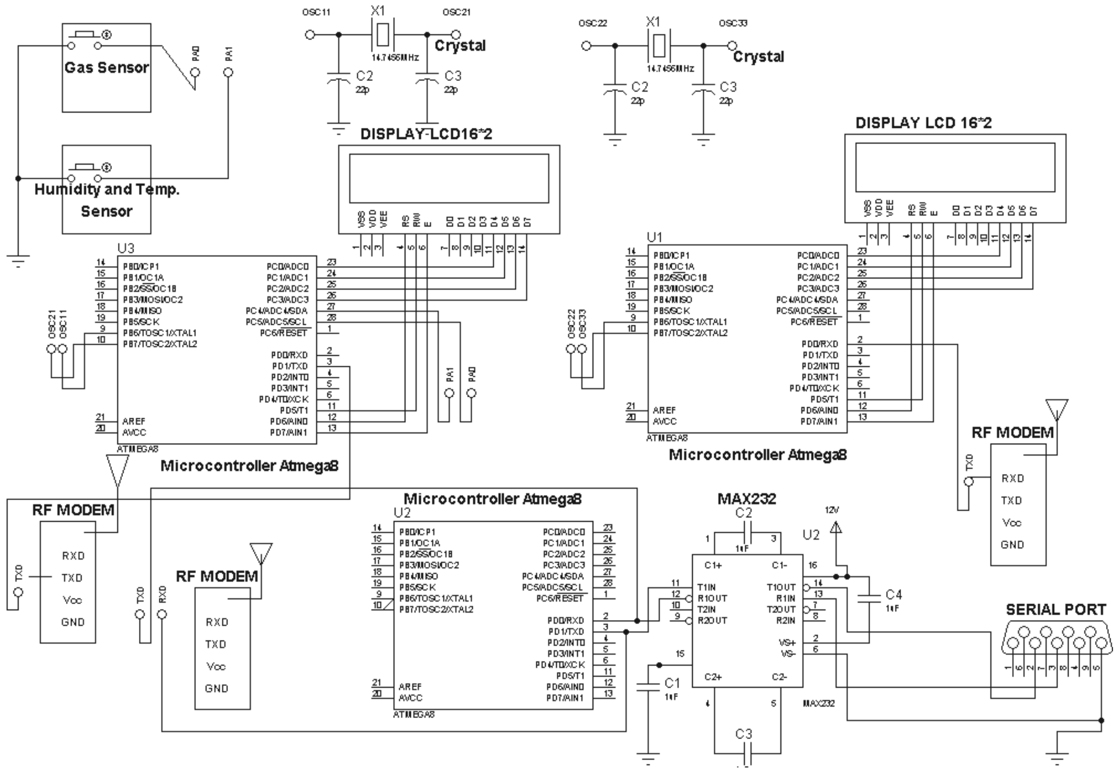


**Fig.4 Circuit Diagram**

The circuit diagram of sensor node has number of sensors which is attached in PORTA of microcontroller atmega16. The crystal oscillator of 14.7456MHz is connected with atmega16 microcontroller to generate 9600 baud rate. The RF modem has 4 pins Rx, Tx, Vcc and ground which are connected to Tx(15),Rx(14), 5V and ground of microcontroller atmega16 respectively. The control pins RS, RW,E of 16*2 LCD are connected with PD6(20),PD5(19) and PD7(21) pins of Atmega16 and upper data pins of LCD D4,D5,D6,D7 are connected to PC0(22),PC1(23),PC2(24) and PC3(25) of atmega16 microcontroller. The circuit diagram of handheld device node has RF modem, Crystal oscillator, LCD are connected with atmega16 microcontroller in the same way as that of sensor node.

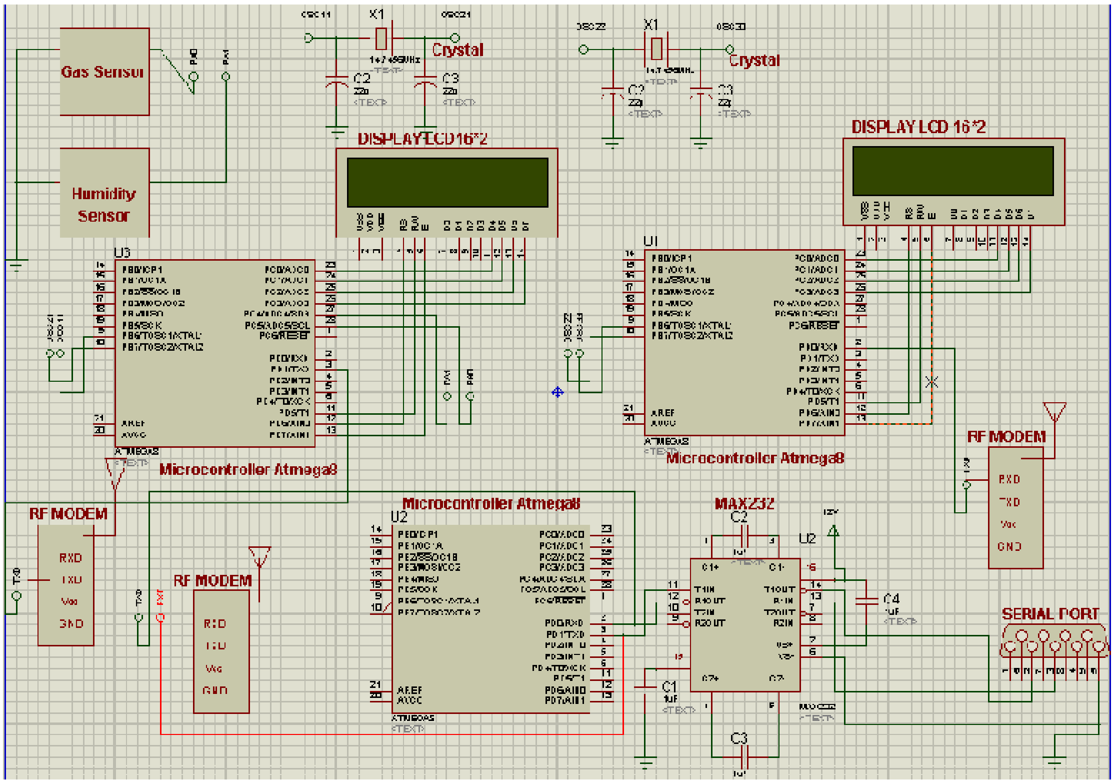


**Fig.5 Proteus Simulation of system**

Fig.5 shows Proteus simulation model for the system. The simulation is done before hardware implementation to check accuracy and feasibility. The above circuit diagram is realized using proteus software and tested by writing the code in AVR studio 4. The C code is written for cluster node and cluster head separately.

## 5. Results and Discussion

Using proposed model, the Wireless Sensor Node is designed and implemented for development of handheld device.

The PSO algorithm has achieved the optimal solution for the field being covered by the sensors in the WSN as shown in fig.6, 7 and 8. The deployment of nodes is derived by the PSO algorithm which adequately covers the given area without any dark zone.

Fig.6 shows the elapsed time is 6.5233 seconds for 50 iterations.

Fig.7 shows Centroid node position for model

Fig.8 Deployment of sensor nodes in the defined area

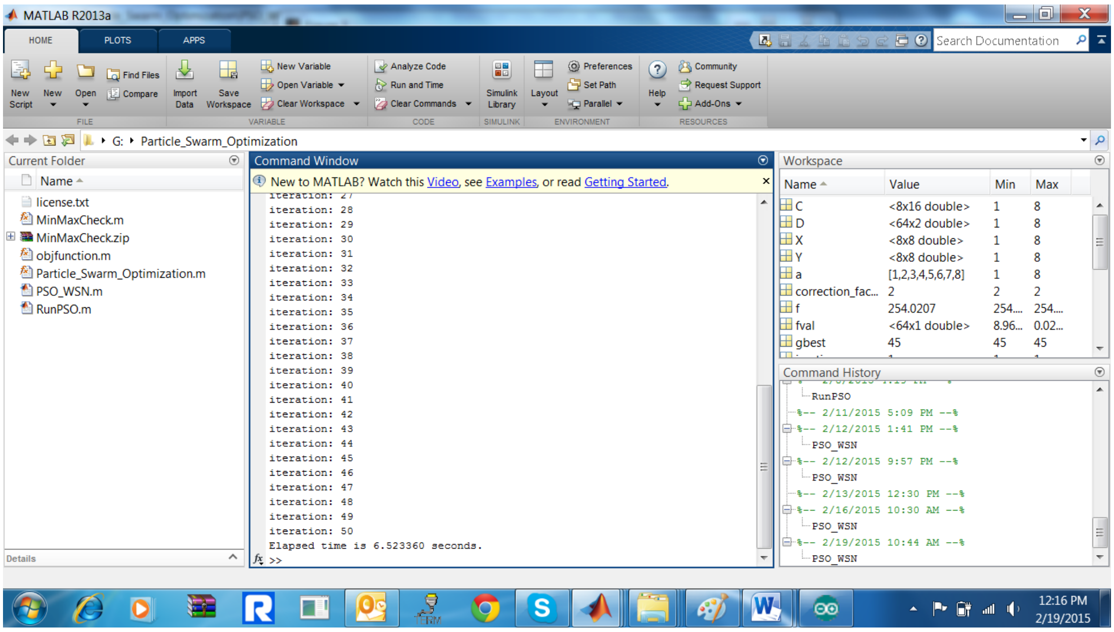


**Fig.-6 Elapsed time for 50 iterations**

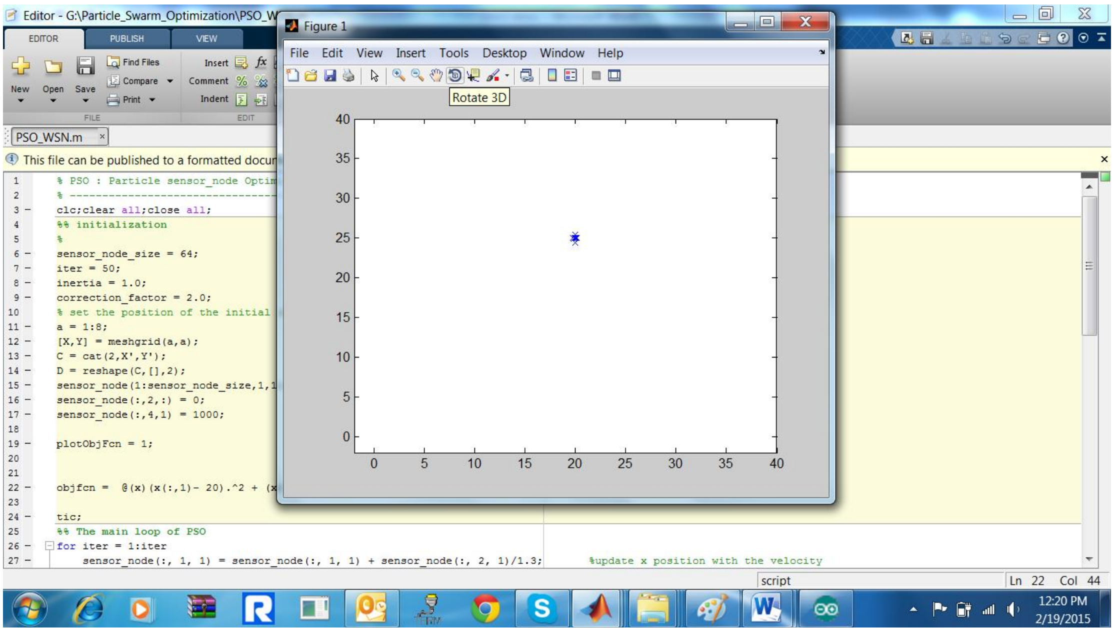


**Fig.-7 Centroid node position for model**

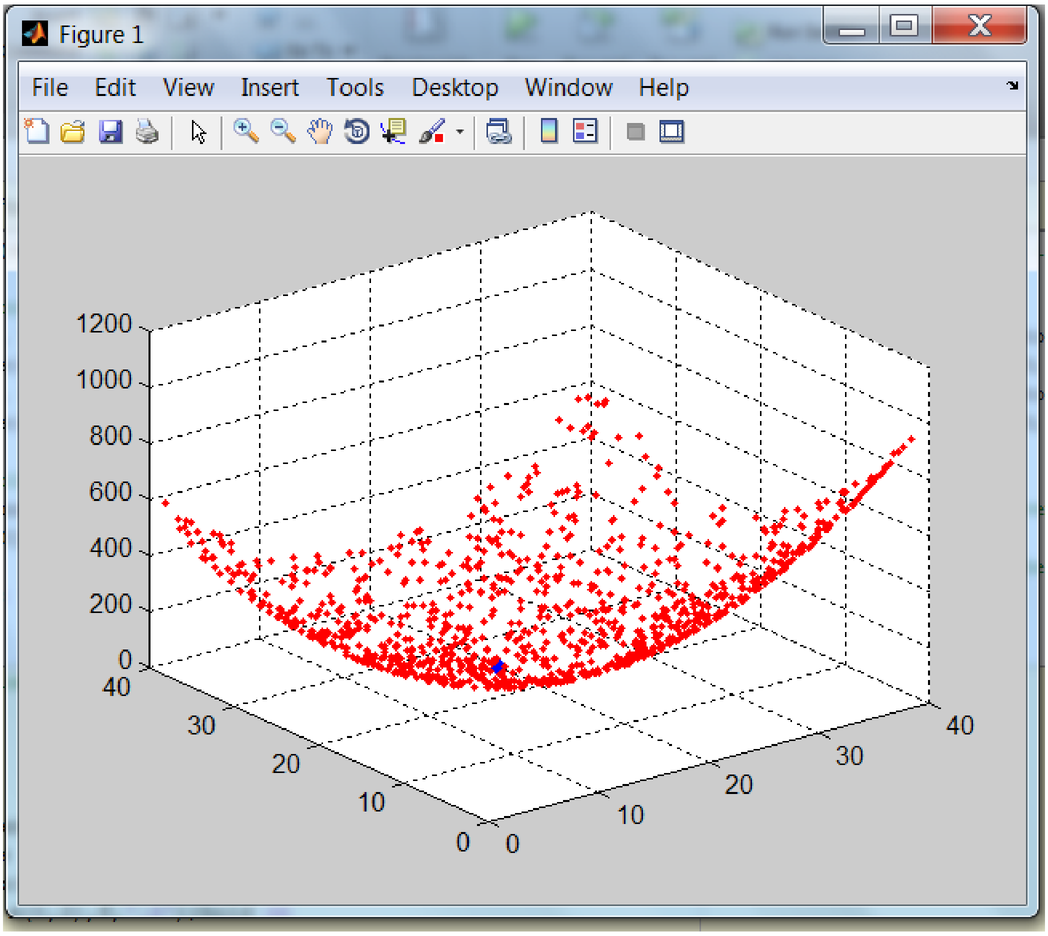


**Fig.-8 Deployment of sensor nodes in the defined area**

The accuracy and reliability of the system has been enhanced by using optimization in data collection as well as network routing.

The figure-9 shows the snapshot of developed system having the sensor node, handheld device node and central data logger.In future, more number of sensor nodes can be deployed for gathering more information.

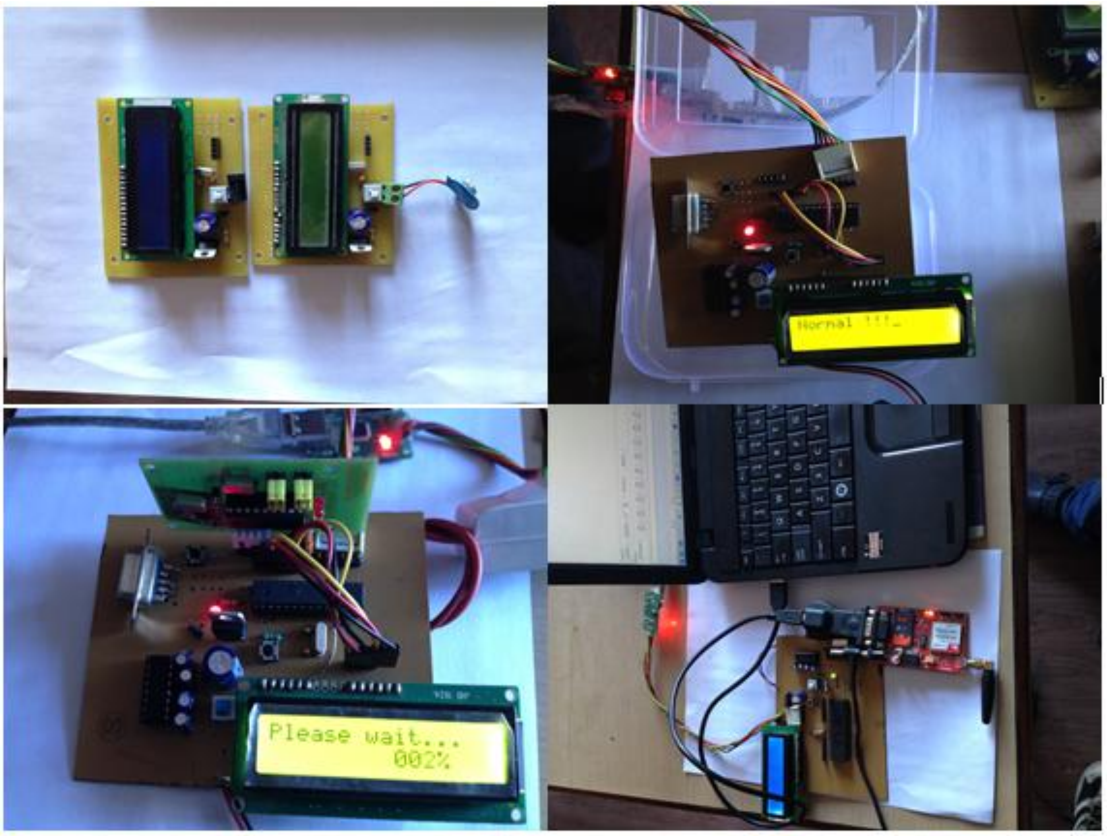


**Fig.9 Developed prototype for the system**

From the developed system, it is found that the temperature and humidity data collected from nodes deployed in the area is accurate. The above model does not take consideration of the obstacles caused by the several instruments and coal blocks in the mines for the deployment of the sensor nodes, in order to achieve the same suitable modification in objective function and sensor range can be done.

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