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Research paper

Design and development of C3 protocol for performance measurement of wireless sensor network

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Abstract

In twenty-first century, technology changes tremendously. A wireless sensor network is bunch of sundry sensor nodes where, nodes are distributed arbitrarily. Sensor consumes most of its energy in data transmission and reception. System ascertained different amended protocols for performance quantification of WSN. Sensing node sense environment but doesn't transmit or receive the data. Slumber nodes neither sense environment nor transmit or receive data. Proposed system validate the analytical models utilizing extensive simulations incorporating experimental results on the substratum of different parameter here performance is checked. A protocol for communication and connectivity in Wireless Sensor Network is proposed. This ascertains coverage, connectivity and energy-efficient communication. It contains steps such as: Declaration of deployment area, cull of nodes, connectivity of nodes, and communication between all nodes.

Keywords: *Wireless Sensor Network, C3: Connectivity, Coverage, Communication, Routing*

1. Introduction

Wireless sensors devour most of their energy in transmission and reception of data, it has inhibited battery power. In WSN many applications required precise time synchronization, data co-ordination and data consistency. Wireless sensing network consists of various devices such as node, router etc. These are capable of collecting information as per their specification. This is generally utilized in security an environment monitoring and industrial tracking application. Here consideration of nodes complete, in order to energy and perpetuate network lifetime, at any time instance in WSN. Three types are nodes active node, sensor node and sleep node. Active node senses an environment, send and receive data. Similarly, sensing node sense environment but doesn't send or receive the data. Slumber nodes neither sense environment nor transmit or receive data. Proposed system develops coverage, connectivity and communication protocol for WSN. Currently, Communication and coverage protocol is developed and hardware is implemented. On the basis of different parameters, range of wireless sensor network is checked.

Bin li et al.[1] have presented analysis, performance and optimization for energy-efficient co-operative transmission in wireless sensor network. Nodes are scattered randomly; it forms clusters which helps in packet transmission. System performance can be evaluated with help of Energy consumption and packet error rate. Author had completed analysis of wireless sensor network and developed performance of WSN. Domenico Ciuonzo et al. [2] have analyzed performance analysis of energy detection for MIMO Decision Fusion in Wireless Sensor Networks over Arbitrary Fading Channels. Sensor node simultaneously reporting their decision to fusion center with many antennas and Gaussian model is used to obtain Fading characterization of channels between sensors and fusion. Theoretical readings are taken and checked with help of simulation. Deborah Estrin et al. [3] have designed adaptive self-configuring sensor network topologies they have created nodes in the network. Nodes in this network will perform the sensing data transferring task. Large number of nodes is deployed in this region. Here, nodes were self-configured and established a topology, it provide good communication as well as good sensing range. Gurbinder Singh Brar et al. [4] proposed a protocol energy efficient direction based PDORP routing protocol for WSN. Researcher studied analysis of Energy consumption packet loss, network lifetime, network scalability. Karthi J.S et al. [5] performance analysis of wireless sensor networks with IEEE 802.15.4 MAC based on variation in packet size. Wireless sensor networks (WSNs) are sensing data from the surrounding environment, and forwarding data collected from other sensor nodes to the sink. The IEEE 802.15.4 MAC has been designed to suit the requirement of low power sensor nodes. Author analyzed WSN employing 802.15.4 MAC protocol using packet size as the optimization criterion. Klye Jamienson et al. [6] has published paper span: an energy efficient co-ordination algorithm for topology maintenance in ad-hoc wireless network. They have presented a system which having power saving technique for multi-hop and hoc wireless network. It decreases energy consumption span algorithm identifies the all node (Active node, Sleep nodes). B. Ndibanje Bruce et al. [7] developed a protocol i.e. a communication security protocol for ubiquitous sensor networks. In WSN data accessibility simply done anywhere-anytime. At end user application, security and privacy are two major terms. Author designed protocol which ensure about data privacy through gateway. MiloshI vanovich et al. [8] have completed a survey on topology control techniques for extending durability of battery powered WSN. On the basis of previous research results were studied and done analysis. Hence, network lifetime concept widely used for assessing algorithms performance. Efficiency of energy and topology study control techniques used. M Akhlaq et al. [9] have designed the recursive time synchronization protocol for WSN, they have designed such a system which provides global clock synchronization. Recursive means repetition; also provides high accuracy and low energy. Due to time synchronization accuracy occurs but for time synchronization high energy required. Hence, recursive time

synchronization protocol used which provides global clock synchronization with high accuracy. Multiple access control achieves good performance. Here, adaptive resynchronization interval used, it analyze the sources of error and efficiency. Muhammad Akhlaq et al. [10] described communication, coverage and connectivity protocol in WSN. Design energy-efficient protocol and in WSN, nodes generally transmit and receive the data. Network consists as virtual rings, clusters are defined, structure divided into following steps. Create ring with received signal strength indicator, find redundant nodes, and develop connection between neighbor's nodes. Building connection between two neighboring nodes results deployment area, energy efficient communication.. Efficient use of battery power is needed. Author developed the system which ensures that coverage is 90% of total decided area. Myounggyu Won et al. [11] paper proposes robust, energy-efficient algorithms to enhance the detection of disrupted network connectivity in insensitive. With help of adoption technique reduce energy required for detect cut of wireless, following parameters considered such as node density, cluster size and threshold. Phuntsog Toldan et al. [12] researcher presented design Issues and Various Routing Protocols related to wireless sensor network. A system designed which is used for data collecting, processing and transmitting purpose. In this paper author study about the design issues and the various routing protocols for wireless sensor networks WSN divided into two parts Static sensor network and Mobile sensor network. In static sensor network sensor node concentrate only in particular time and mobile sensor network are energy efficient, provides more data fidelity. Trong-Minh Hoang et al. [13] presented analyzing the performance of unslotted sensor networks based on the IEEE 802.15.4 employed EIED algorithm. This paper explains WSNs based on the IEEE 802.15.4, beside some interesting advantages, a WSN has to face with several challenges which affected to network performance such as throughput or energy consumption. Author analyzed the performance on the basis of Exponential Increase Exponential Decrease (EIED) back-off algorithm. Tejpreet Singh et al. [14] have designed energy efficient secured routing protocol for MANETs. Author designed energy-efficient secured routing protocol; every node selects multiple relay nodes in a set of one-hop neighbors, it reaches at another node. Routing protocol delivers security to protocol with selecting a secure link. By node identification, access control entity authorizes nodes. Communication privacy can be maintained using secures our anonymous message authentication. Communication privacy for both messages end and message recipient using secure source anonymous message authentication. Yang et al. [15] have presented energy-efficient border intrusion detection using wireless sensors network" Energy efficient method for border security, to diminish human involvement. System monitors prohibited movement at the national border, Wireless Sensor Network (WSN) is useful to find coverage protocol, connectivity protocol and expanding network's lifetime effectively. M. Etthus et al. [16] have proposed a new system in their paper latency power consumption and system capacity in Multi-hop routed SS-CDMA wireless networks. Researcher has designed a system using CDMA, SS (spread spectrum) many stations are able to transmit data at same time. No need to co-ordination across the network.

In this proposed work, communication, connectivity and coverage protocol is developed with the help of software simulation and hardware implementation. NS2 is used for simulation, fifty nodes considered for checking simulation result. In case of hardware five nodes are developed and checked its performance. Section two gives detail information about proposed work, section third explains detail experimental results for both software and hardware and section fourth gives conclusion of the system.

2. Proposed work

Software implementation

The proposed system contains design and implementation of communication and connectivity protocol. In software implementation, NS2 is used for protocol development. Coding based on scripting language and C++.

NS2 software details: Wireless communications is pervasive now-a-days. Wireless internet and Mobile phones users tremendously increased in this decade. First generation wireless networks mainly targeted at voice and data communications at low data rates. A second and-third generation wireless system incorporates the features, in addition to supporting mobility, broadband support multimedia traffic. The third generation provides high speed packet switching data. Fourth generation is used to include several types of wireless access communication systems. WSN is composed of low cost, small device which can communicate wirelessly. It has capacity of processing and sensing. System can extract relevant information from available data. After this, mobility given to nodes. Another tcl file contains twenty nodes which having mobility. Data can be transmitted at one end and received at another end.Bit rate keptfirstly 512and 1024 respectively. When nodes are less communicaion successfully done. As nodes increase and deployment area packet loss is started. Fig.1 shows flow chart step by step procedure. Decidation of deployment area, formation of node, mobility of wireless node and dta transfering from one node to other etc.

Protocol is developed shown in Fig.1. Flowchart of protocol, calculation of performance on the basis of parameters such as packet loss, throughput, delay etc. With help of simulation, assessment of scenario is possible. Following parameters used to generate simulation scenario. Antenna Type: for simulation Omni-directional antenna is used because its ability to transmit equal power in all direction. Simulation Time: Simulation time is operating time of network it ranges from 60 sec, 200sec or 300sec etc. following parameters used for performance measurement of WSN.

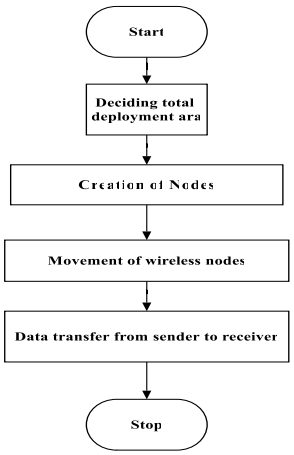

Fig. 1: Flow chart of system

Hardware implementation

Below Fig.2 and Fig. 3 shows flow chart of protocol and internal structure of node. It contains power supply, sensor, communication device i.e. Zigbee, controller block diagram of system.

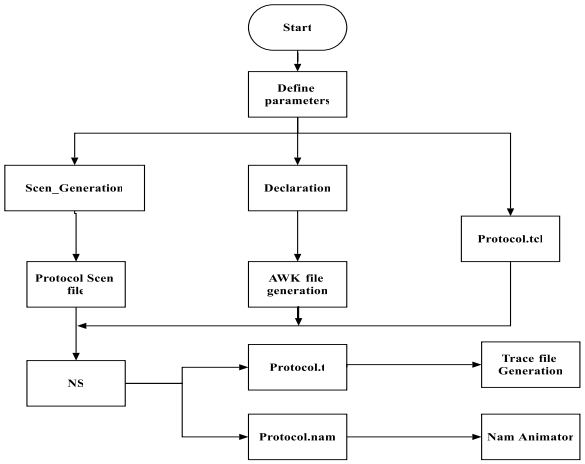

Fig. 2: Flow chart of protocol

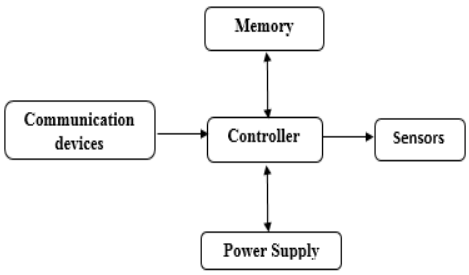

Fig .3: Internal block diagram of sensor node

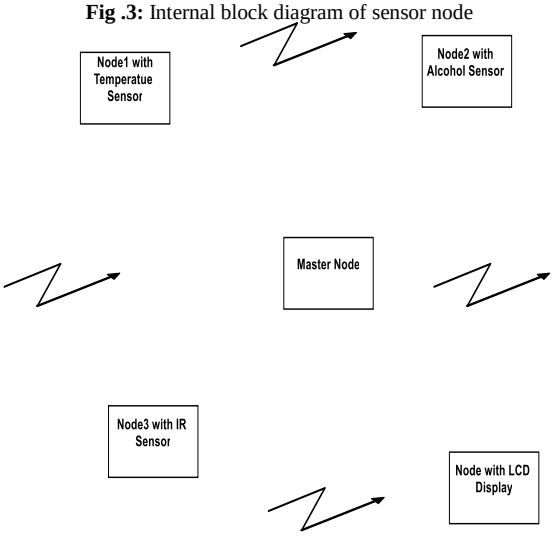

Fig. 4: Position of nodes in deployment area

Fig. 4 indicates positioning of nodes in total deployment area. Hardware implementation consists of total five nodes, three nodes act as transmitter and remaining act as receiver.

1. Arduino board

Fig 5. shows the pin-out diagram of Arduino. Some of the features of Arduino are as follows:

- Microcontroller Atmel ATmega328 or ATmega8L.
- Operating Voltage - 5 V.
- Input Voltage -7-12 V.
- Input Voltage (limits) 6-20 V.
- Digital I/O Pins 14 (of which 6 provide PWM output)
- Analog Input Pins 8.

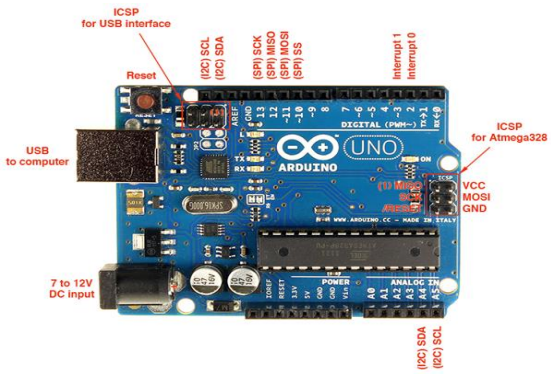

Fig. 5: Pin-out diagram

2. Temperature sensor

Above Fig. 6 shows temperature sensor consist of three terminals V+, V out and GND respectively. At output of LM35 scale factor is 10mV/°C. Increase in every 1 °C temperature will increase 10mV. Arduino has analog input A0. This will show us results at output side it senses temperature and display it on LCD using controller. Analog data is transmitted through controller and Zigbee module.

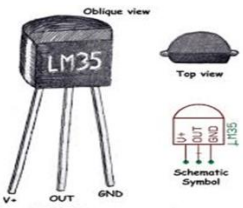

Fig. 6: LM35 Temperature sensor

3. Zigbee

Zigbee is a wireless communication module in which IEEE 802.15.4 standard is used. This is generally used for low power application of Trans receiver. It consists of serial port to send and receive data. Zigbee can also be used to form a LAN. Zigbee used in many applications such as wirelessly controlled robot, wireless communication, remote monitoring system, wireless home automation system etc. They have approximately range 50m to 200m. Zigbee configuration is required then only communicate completed. In proposed system communication and coverage protocol implemented with the help of Arduino. In hardware five zigbee and three sensors are used for wireless communication. Temperature sensor, alcohol sensor and obstacle detection sensor used respectively.

3. Results and discussion

This includes the experimental results of proposed system. Software and hardware part of proposed system is shown here. In NS2, TCL scripting required. Deployment area is decided in programming, Nam file is created. Firstly, seven nodes are crated then, using protocol communication is completed. Again Tcl script is developed for mobility of nodes with data transmission.
Simulation parameters:
The various simulation parameters used in the research are given below.
1. Width of the network: 1000 m
2. Height of the network: 1000 m
3. Aggregation Energy of the nodes
4. Energy consumption at transfer of packet;
5. ER = Energy consumption at receiving packets.
6. Network Type: GPS
7. Nodes: 20 to 100
8. Network allocation: Random
9. Network Coverage: $\sqrt{(x2 - x1)2 + (y2 - y1)2}$

Simulation Time: Simulation time is operating time of network it ranges from 60 sec, 200sec or 300sec etc. following parameters used for performance measurement of WSN
Calculation of distance between two nodes**:**

$$d = \sqrt[2]{\left((x(i) - x(j))2 + y(i) - y(j)\right)2} \quad (1)$$

For developing protocol, distance between two nodes must be calculate. Above formula is useful to calculate Distance between two nodes. Pythagoras theorem is used to calculated distance between two nodes. Where, x and y are two different nodes. Fig.7 and Fig.8 shows fixed nodes and mobile nodes respectively. In Fig.8 shows nodes with different color such as red, yellow, blue and green etc. Each color set of different group of nodes.

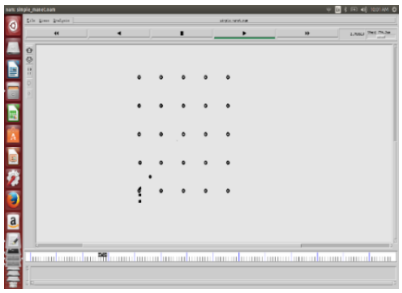

Fig. 7: Distance between fixed nodes

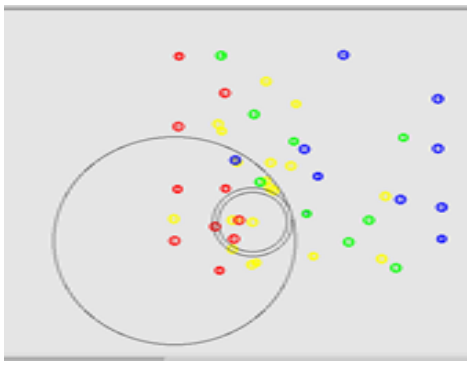

Fig. 8: Distance between mobile nodes

End to end delay

End to end delay defined as time required to reach a signal from transmitter to receiver.
Count =Total packet count
Delay[i] = receiving time[i] – sending time[i]
Total Delay = Total Delay + delay[i]
Average Delay= Total Delay/ Count
Data transmission occurs between one region to another, mobile nodes are moving in declared deployment area. Group of nodes shown in figure. Fig.9 shows end to end delay graph , x-axis shows time simulation and y- axis shows time required to reach at receiver end. For calculating end to end delay AWK files are required, at the back end trace file is generated.
Total Delay =41.3852sec
Average Delay = 0.0557841s

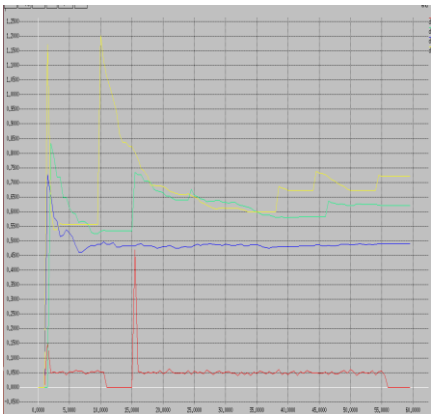

Fig. 9: End to end delay

Packet loss

Packet loss means during data transformation how many packets reach at receiver end shown in Fig.10. Suppose initially packets at transmitter is 512 and 500 packets are reached at receiver end it means there is 12 packets are lost, Fig.11 shows packet loss in the nodes.

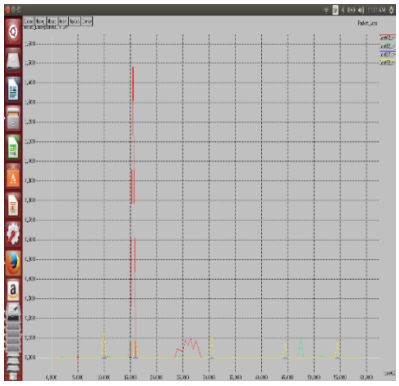

Fig. 10: Packet loss for packet size 512 bytes

Packet Loss= Number of packets delivered–Number of packets delivered
Ratio= No. Of Packet Received/ No. Of Packets Send

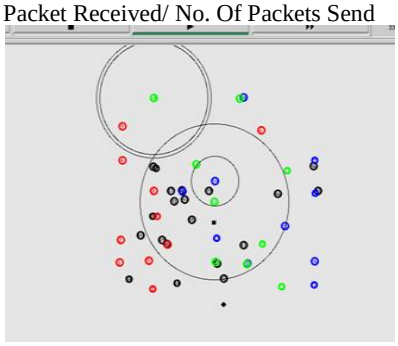

Fig. 11: Packet loss in nodes

Throughput

During communication, Amount of data transfer from one node to another node within given time is called as 'Throughput'.

$$\text{Throughput} = \frac{\text{Recieved Data} * 8}{\text{Data Transmission Period}} \quad (2)$$

Energy

During a communication, energy of every node should be recognized. When simulation finishes in proper time, it generates a trace file; this trace file is convenient to treasure out energy of each node. Following figure shows results Tcl scripts. Results are achieved with help of terminal window. In terminal window path is specified, result is displayed in Nam window. Fig.12 shows data

communication between two nodes of different coverage area, Performance measurement completed with aid of parameters such as packet loss, distance, throughput, jitter etc.

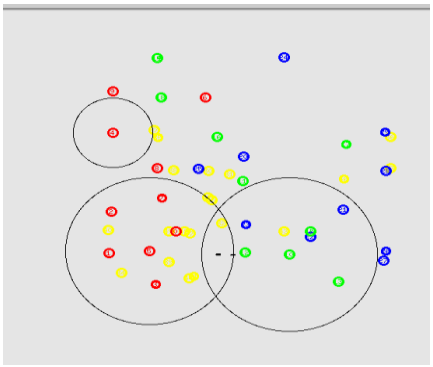

Fig. 12: Data Transmission

Hardware implementation

Wireless sensor network is composed of low cost, small device which can communicate wirelessly. It has capacity of processing and sensing. System can extract relevant information from available data. Fig.13 shows flow chart of system Above Fig.14 shows temperature sensor LM35 interfacing with AVR controller and with the help of Zigbee transmitting the data. This transmitter act sensor node, it consists of Zigbee module,
AVR controller, temperature sensor, transformer etc. This node turns as a transmitter. As temperature augmented, sensor senses it and with the support of Zigbee data transmitted wirelessly to another sensor node shown in Fig.15. Below. Hardware implementation consists of five nodes.

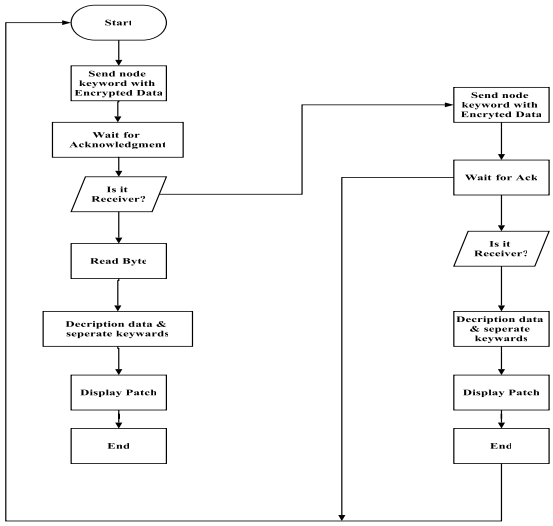

Fig. 13: System flowchart for hardware implementation

Total deployment area is 150m. Fig 16 and Fig.17 shows alcohol sensors node and IR sensor node respectively. Fig.18 shows master node which indicates IR sensors values on LCD display at another end. Zigbee configuration always required stored IP addresses. Initially all nodes are placed at different places.

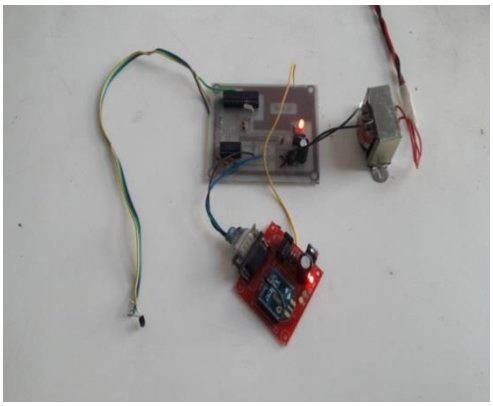

Fig. 14: Sensor node-1 (Temperature Sensor)

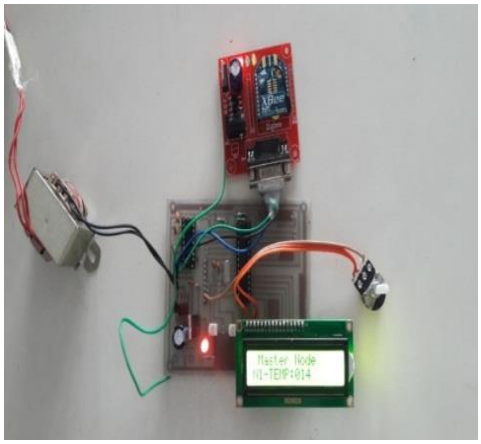

Fig.15: Receiver End

Nodes accessing the data from other node. It identifies from which node data is peregrinated, nodes sends keywords for encryption of data. Then it waits for ACK, if it got cognizance then send it to receiver. If not then again same procedure is carried out. Zigbee is utilized as communication contrivance. In master node address of all nodes are stored. Two links are engendered in this system first is in temperature sensor and alcohol detection sensor, second is alcohol sensor and IR sensor. In wireless network when system commences working then it can senses any links. Suppose, temperature sensor senses temperature, it send ACK to master node. It waits for another sensor availabity, if yes then exhibit on LCD exhibit with both nodes received potency. If any node is absent then it sends data to master node, master node exhibit power and its presence in wireless network. Similarly, it checks for another link and exhibits data. As number of nodes incremented in wireless network coverage area become vigorous.

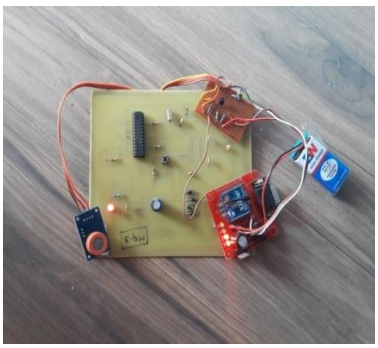

Fig. 16: Sensor node-2(Alchohol sensor)

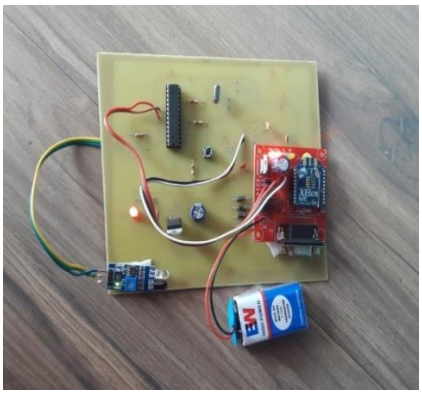

Fig.17: Sensor node-3(IR sensor)

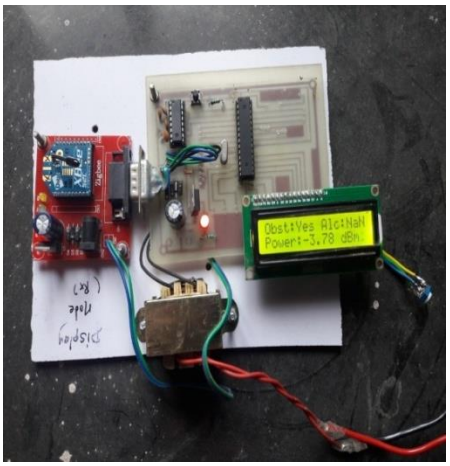

Fig. 18: Master Node shows IR sensors value on LCD display

4. Conclusion

As comparing previous system results its efficiency is increased from 80% to 92% in current scenario. When packet size changes from 2^0 to 2^16.Drawback of system is at extreme low and extreme high packet size results cannot be check correctly. With the help of thirty iterations results generated. Throughput results gives approximately above 95% values. Coverage, connectivity and communication protocol implemented in NS2 and checked out its performance on basis of throughput, packet loss, end to end delay and energy of each node is calculated. In hardware five nodes are placed in network at distance 30m to 100m. Two links are created in this system first is in temperature sensor and alcohol detection sensor, second is alcohol sensor and IR sensor. In wireless network when system starts working then it can senses any links. As number of nodes increased in wireless network coverage area become strong. , energy of each node in software implementation and in hardware implementation is same.

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