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# Advance Greenhouse using Wireless Sensor Network based on Optimised Routing

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***Abstract*-Due to increasing demand for crop production, quality and utilization of high quality greenhouses, modern greenhouses are having great sizes and they are equipped with sophisticated monitoring and control systems. Increase in the greenhouse size has increased the demand in order to provide real time measurement of some parameters. This has led to complexity in managing and maintaining them. The aim of this paper is to present a wireless sensor network based technology for greenhouse monitoring and controlling. Since tiny nodes are used in WSN, these are spatially distributed and are battery operated and energy limited; due to this the nodes might die leading to failure of communication. Thus to overcome this drawback we implement a routing protocol to balance the resource consumption among all sensor nodes to elongate the lifetime of the sensor node.Hence leading to a promising greenhouse measuring various parameters.**

***Keywords:- Greenhouse, routing protocol, wireless sensor network.***

## I. INTRODUCTION

With the rapid increase of crop growth and measuring the parameters of the environment is becoming difficult resulting in a number of conflicts such as time and environmental factors e.g. temperature, humidity, soil moisture, etc.

A WSN consists of a large number of smart sensors which form a multihop network by radio communication in sensor fields. They measure and process information gathered from sensing area and transmit it to the data base station. WSN can be used in many fields such as environmental monitoring, smart homes, commercial, military applications and many more.The greenhouse agriculture is developing very fast with the increasing demand of fresh vegetables in the large and medium cities. It is a kind of place in which it can change the plant growth environment, create optimum condition for plant growth, and keep out of the environment changes and the influence of the weather. On the basis of making full use of natural resources, greenhouse monitoring system obtain the optimum condition of plant growth by changing the factors of greenhouse environment such as temperature, humidity, intensity of illumination, soil moisture, and the purpose is to increase crop yield, improve its quality, regulate growth cycle, improve economic benefit. Greenhouse monitoring system is a complex system, the different kinds of parameter in the greenhouse needs automatic monitoring, information processing, real-time control and on-line optimizing.

In our system, we monitor a group of sensors each one detecting periodically if there is any change in the greenhouse parameters. This information is forwarded to the sink node. The sink node itself is connected to the managing centre. The managing centre can help the users monitor as well as control the greenhouse parameters.

Fig 1- Sensor nodes deployment

The sensor nodes are based on popular Arduino platform. Arduino is an open source electronics prototyping platform with flexible and easy to use hardware and software. We are developing a network protocol on nRF24L01 radio modules. We have taken features of network protocols, in particular with clustering protocol such as low energy adaptive clustering hierarchy (Leach) and optimized leach protocol.

The remainder of this paper is as follows. In section II, we describe the system design the node hardware architecture. In section III, we explain the design of layer 2 and 3 of WSN protocol operation. The research questions and experiments are in section IV. Finally, we describe the work in section V.

## II. SYSTEM DESIGN

For this experimental study we developed a network of smart objects based on Arduino platform.

### *A. Cluster Network*

The proposed single hop topology is shown in the figure 2 given below.

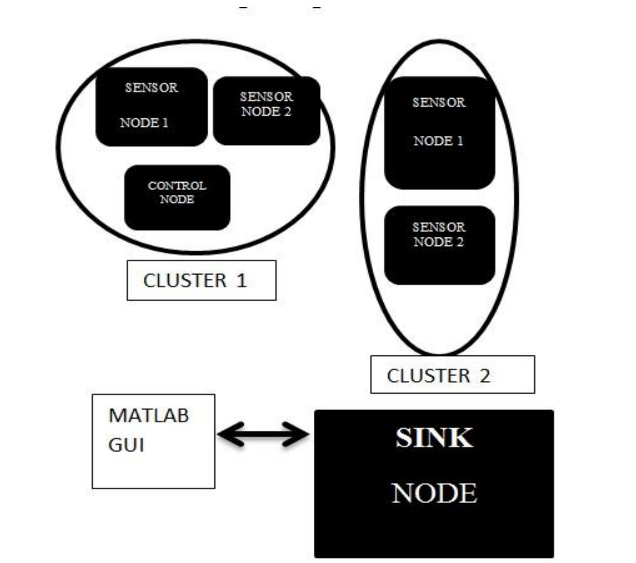


Fig 2- cluster network of the greenhouse

The sensor network is divided into 3 groups, one for each cluster and one for the sink node. Each group uses a specific RF channel. The sensors detect if there is a change in any of the greenhouse parameters. The sensor will be located in a strategically fixed position on the floor and will sense periodically to detect the parameters.

1. Sensor node- A sensor node periodically measures the distance with the sensor and compares with the last measurement. If the result has changed it sends and advertisement message (ADV) to cluster head (CH).
2. Cluster Head (CH)- The cluster head monitors the greenhouse but at the same time waits for ADV message from other sensor nodes. It aggregates the information and forwards it to the sink node.
3. Sink node- This fixed node is continuously listening on designated channels to forward packets coming from cluster head to management station.

*B.* Node Architecture

We use the Arduino platform, with many improvements on hardware side e.g. energy efficient surface mount device (SMD) components and extra analog and digital I/O pins. The Atmel ATmega328P microcontroller has 32Kb integrated flash memory with read-while-write capabilities, 1kb EEPROM and 2kb SRAM. We use a dedicated nRF24L01 low power radio module working in 24.5 Ghz ISM band. The radio uses FSK modulation type and operate within 125RF channels with 250kb/s, 1 or 2 Mb/s of data rate. We use DHT11 sensor which is a basic, ultra low-cost digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air, and spits out a digital signal on the data pin (no analog input pins needed). It is fairly simple to use, but requires careful timing to grab data. A soil moisture sensor is used to measure the volumetric water content of soil. An LDR sensor is a light-controlled variable resistor. The resistance of a photoresistor decreases with increasing incident light intensity; in other words, it exhibits photoconductivity. We use external batteries and a USB powered sink node. A motor to drive the fan in case when the temperature of the greenhouse goes high. As the energy levels of the batteries decrease the battery voltage goes down.

## III. WSN Protocol Design

We havedeveloped and tested a wireless communication protocol based on some features of clustering hierarchical protocols such as LEACH and optimized LEACH protocols.LEACH (Low Energy Adaptive Clustering Hierarchy) is given in fig 3 which is energy based approach for WSNs. In LEACH, initially the randomly selected Cluster Head (CH), which collects the data of the cluster member and add own data, then sent the data to the sink directly, which consumes lot of energy of sensor node.

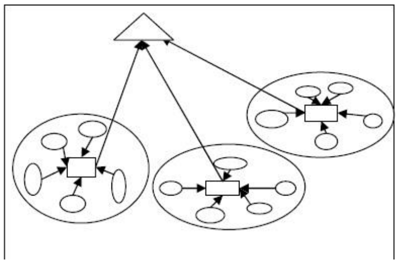

Fig 3- LEACH protocol

Optimized LEACH approach is discussed in whichis reduce the death rate of the node, and may be increase the lifetime of network due to reduction of death rate. In this approach, there are many rounds to transmit the data to the sink. After transmitting the data to the sink in each round, check the residual energy of cluster head. If energy of cluster head is less than maximum energy or threshold energy then more energetic node in cluster become cluster head.

Our implementation is based on LEACH clustering where the clusters are formed, each cluster having a cluster head and member nodes, after each round it checks the residual energy and the node having the maximum than threshold becomes the cluster head , and once the data has been transmitted to the cluster head, that node goes to the sleep mode. Therefore this protocol reduces the number of transmissions to the necessary, thereby saving energy and not letting the node die. A sensor transmits the information to the sink node when it detects the changes in parameters. The sensor will not have new information to report very often, thereby lowering the number of transmissions to minimum and increasing the systems lifetime.

*A. Layer 2 Operation*

In the collision avoidance mechanism we implemented, every node that wants to transmit must first listen to the channel. If it is free, the node transmits the packet and waits for an acknowledgement. If it is occupied, the node waits for a back-off time and listens to the channel again. After a number of unsuccessful tries, the packet is dropped.

*B. System Operation*

The system operation, shown in Figure 3, is divided in three phases: CH selection, sensing, communication.

1) Cluster Head Selection Phase:

- The CH broadcasts an Energy Request message.
- The SNs measure their energy level and send it to the CH with an Energy Reply message.
- The CH collects all replies and compares the energylevels. The node with the highest energy level isselected as the new CH.
- CH broadcasts the new CH ID to all the SNs.
- The SNs update the CH ID at the same time.

2) Sensing Phase: The node detects if there is a changein the parameter value. If there is one, it goes in to theCommunication Phase, otherwise the node goes to sleep mode. Because the SNs are synchronised during the CH selection, they would wake up at the same time.

3) Communication Phase: The node report the updated parking lot status to the CH by sending an ADV message. Meanwhile, the CH collects the ADV packets of all SNs. The CH sends an aggregated data packet (DATA), which contains all the collected status updates, to the sink.

## IV. EXPERIMENTAL STUDY

Our goal is to develop an energy-efficient implementation of a smart parking application. Some of the research questions in this project are:

1) Is theArduino platform a good choice for this specific WSN application?

2) How can we minimise energy consumption per node to maximise network lifetime?

3) How do we optimise the CH selection algorithm?

4) How reliable is this system?

To evaluate the performance of the protocol, we propose two different variations of the same practical scenario. The sink is positioned with the monitoring center around 2 clusters which consists of 5 nodes and a control node.

1) The whole network has been divided in 2 clusters, with 5 SNs per cluster.

2) The network is formed by 10 SNs which are part of the same cluster.

## V. RESULTS

The fig4 below shows the GUI of the monitoring centre. The figure 5 shows the GUI showing the various readings of the parameters of the greenhouse as well as the node type after each round. The results show that clustering scheme is adapted using optimised routing which saves the energy of the node and increasing the lifetime of the node.


Fig 4- GUI showing monitoring center

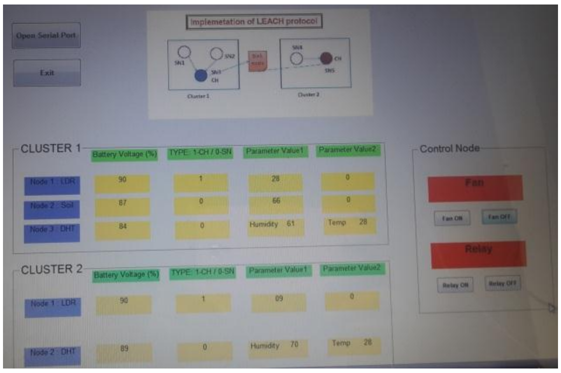

Fig 5- GUI of monitoring center showing the battery voltage and type of node as CH

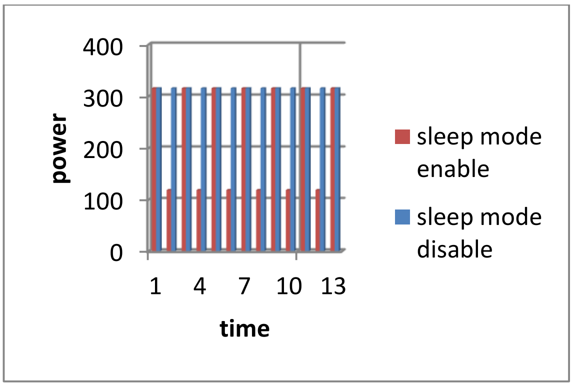


Fig 6- Bar graph showing power

## VI. CONCLUSION

We proposed a practical implementation of an WSN clustering protocol. Our protocol is hierarchical, all nodes are divided in clusters with one CH. We implemented an energy-aware CH selection algorithm similar to the LEACH protocol. The system was implemented using arduinodevelopment boards, nRF24L01+ low-power RF modules. And by implementing routing protocol we are able to save the energy of the node thereby increasing the lifetime of the node.

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