Available Online at www.ijcsmc.com

International Journal of Computer Science and Mobile Computing

A Monthly Journal of Computer Science and Information Technology

ISSN 2320–088X

IJCSMC, Vol. 4, Issue. 6, June 2015, pg.1158 – 1165

RESEARCH ARTICLE

A Novel Approach for Precision Agriculture Using Wireless Sensor Network

Pratibha Gangurde[1], Manisha Bhende[2]

[1]Department of Computer Engg, Pad. Dr. D.Y. Patil Institute of Engineering and Technology, Pimpri, Pune, India
[2]Department of Computer Engg, Pad. Dr. D.Y. Patil Institute of Engineering and Technology, Pimpri, Pune, India
[1] pratibhagangurde15@gmail.com; [2] manishabhende@gmail.com

Abstract — ***Wireless Sensor networks (WSN) make use of sharing, storing and collecting the sensed data. Cheap sensors availability is capable of measuring a number of ecological parameters permit nonstop monitoring of the surroundings and real-time applications. Today, environmental monitoring have develop its concept from on-line sensors network to real-time sensor networks. WSN system contains a set of sensor nodes and a communication system which permit automatically data collection process and sharing process. WSN monitoring hazardous, remote, dangerous and unwired areas. It is helpful in the major environmental disasters to monitoring and warning systems for precision agriculture. Precision agriculture is the skill and knowledge of using advanced tools to enhance crop production. Wireless sensor network can make the improvement of precision agriculture. This paper attempts to determine effectiveness of WSN in the precision agriculture also search for the solutions to the commonly arising questions in the duration of the execution like energy consumption issue and cost reduction issue. Using the proposed method finding the optimal sensor topology for reduce the implementation cost and energy consumption as well as make WSN system is new effective solution for all kinds of fields and cultivations.***

Keywords— ***Wireless Sensor Networks, Precision Agriculture, Environmental monitoring, Real time sensors, Agri-parameters, Topology Network Control.***

I. INTRODUCTION

Wireless Sensor Networks (WSNs) have involved much attention in recent years. The many applications of WSNs are vast. They are very useful in collecting, storing and sharing sensed data. WSNs are used in various applications including habitat monitoring, agriculture, nuclear reactor control, security and tactical surveillance. The WSN system developed here for use in precision agriculture applications, where real time data of climatologically and other environmental properties are sensed and control decisions are taken based on it to modify them. The architecture of a WSN system comprises of a set of sensor nodes and a base station that communicate with each other and collect local information to make inclusive decisions about the physical environment. The engineering questions related with precision agriculture using WSN give attention to on increasing the efficiency of the overall system for improvement.

A. Precision Agriculture

In Precision-Agriculture field agri-parameters are monitoring, storing for manage and improve production of crop. Precision Agriculture take care and deals with the three branches of science.

1. Crop Science: Understanding requirements of crops according to climate and monitoring agriparameters like temperature, humidity, water and fertilizers.
2. Environmental Protection: Precision agriculture help to decrease Carbon, Nitrogen and Methane emissions.
3. In agriculture using WSN can reduce wastage, preserve resources, and utilize them successfully resulting in enhanced efficiency, reduced efforts and increase economy.

WSN Technology is effectively handled and achieve it. WSN having the capability to deploy the sensors which gives real time information of agriculture field helpful to complete real time monitoring and control at agriculture fields from remote location or base station. Production of crop and farming efficiency can be enhanced by precision agriculture if the WSN technology can be reach at the farms. Wireless Sensor Networks having the potential to achieve this. Wireless Sensor networks is used for monitoring spatiotemporal changes in weather, pressure, temperature, soil moisture, plant eco-physiology and reporting most excellent options to the agriculturist or farmer. If such type of information is getting regularly can be a big advantage for him. In command to zone of the difficult conditions which challenge the agriculturists, farmer, automatic actuated devices can be used to control irrigation, fertigation and pest control. Conventional precision agriculture have following parts:

a) Sensing agricultural parameters.
b) Identification of sensing location.
c) Transferring data from crop field to control station for decision making.
d) Actuation and Control Decision based on sensed data.

B. *Wireless Sensor Networks (WSNs)*

Wireless Sensor Networks (WSNs) is promising technology with a broad variety of potential applications such as patient health monitoring systems, environment monitoring, earthquake detection, military applications (such as surveillance, navigation, security and target tracking management).A wireless sensor networks is a collection of sensor nodes structured into a supportive network. Sensor networks spatially distributed independent sensors to monitor physical and environmental conditions at different locations like temperature, water level, pressure, motion sound, humidity, vibration etc. Many protocols for WSNs have been specially designed should be efficient, quick, resource responsive where energy responsiveness is necessary design matter. In wireless sensor networks, there are exclusive challenges with regards to unit power utilization, overall size and heat transfer. Recognized authentication is the process used to enable trust and security questions to be confirmed in relative to security protocol design for the information communications zone as shown in Fig. 1. WSNs typically consist of small, inexpensive, resource-constrained devices that communicate between each other using a multi-hop wireless network.

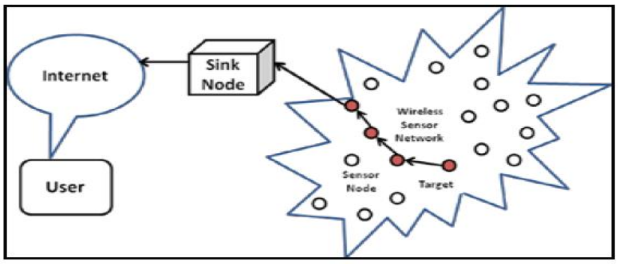

Fig. 1: Architecture of Wireless Sensor Network

Each node, called a sensor node which consist sensor, limited memory, embedded processors, low power radio and is generally battery operated. Each sensor node of the network is dependable for sensing an occurrence nearby which is required and at end user occurrence is reported which is for relaying a remote event sensed by other sensor nodes. Sensor has restricted energy resources as battery- powered, and their functionality continues until their energy is completed and energy conversation is always a study focus in WSN. A node should not be switched to sleeping state when it is collecting data. To ensure this, the time of the node in working state should be longer than the time spent in collecting data. Therefore, applications and protocols for WSNs should be carefully designed in terms of energy-efficient manner so that the lifetime of sensor can be longer. The sensing component of a sensor search the surrounding environment. The components of sensor node are sensing unit, processing unit, transmission unit, power unit which are shown in the fig. 2.

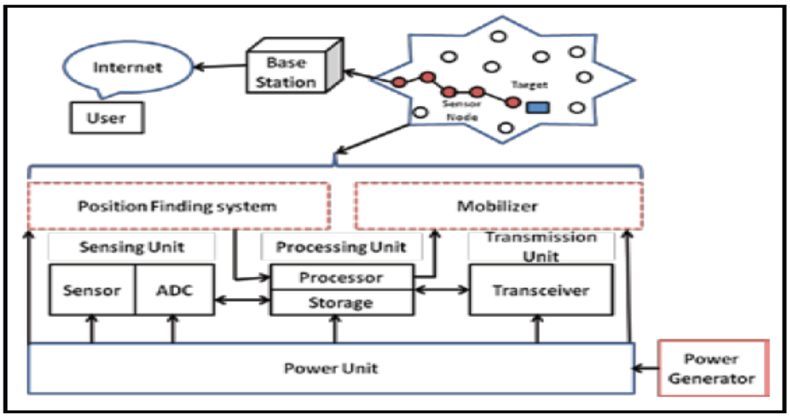

Fig. 2: Components of Sensor Node

The power saving modes of process are sensor nodes communicate using shortest paths, the shorter the packets, the more control of startup energy, operation in a power saving mode is energy well-organized in that container when the time depleted in that form is more than a certain threshold. Wireless sensor networks consist following actions can be engaged to save energy reason by communication are scheduling the state of the nodes. (i.e. transmitting, receiving, idle or sleep), change the transmission range between the sensing nodes, using data gatharing systems and capable routing as in the case of eavesdroping ignore the unwanted data handling. If an exciting occurrence is noticed after performing signal procedureing of the experiential data, sensors communicate this data to the sink or base station using a radio based link. This communication happens in a single or multihop fashion depending on the location of the sensing data node and this node have to contact the intermediate and then send the data.

This paper is structured in sections as follows. Section II contains literature surveys studies on Precision Agriculture Using WSNs. Section III presents proposed method WSN related to performance such as topology network control and energy consumption, Section IV presents mathematical model with technical setting and result. Finally, section V present Conclusion.

II. Literature Survey

After the investigate in the agricultural field researchers found that the yield of agriculture goes on falling day by day. In the field of agriculture use of technology plays important role in rising the production as well as in reducing the extra human power efforts. Some of the researches develop the system for farmers and provides the systems that use technologies which are helpful for increasing the agricultural yield. Some of such researches passed out in field of agriculture are summarised here.

System proves advanced development in wireless sensor networks which is used in monitoring many parameters in agriculture. With the growth of miniaturized sensor strategy attached with wireless technologies and it was capable of remotely observing parameters such as humidity, water level, light density, soil moisture and temperature. System organize to develop, plan and execute a wireless sensor network related to a middle node using Zigbee, which in turn was related to a Central Monitoring Station (CMS) from end to end General Packet Radio Service (GPRS) or Global System for Mobile (GSM) technologies. The system also got Global Positioning System (GPS) parameters associated to the field and sent them to a central monitoring station. This system was usual to make easy farmers in evaluating soil situation and be lively accordingly [1].

The objectives of the system were to develop a low cost wireless controlled irrigation system, to observe water satisfied of soil in real time, to remove the need for workmanship for monitoring irrigation. The intended system have three unit specifically base station unit, regulator unit and sensing unit which were applied for controlling drip irrigation of 1000 dwarf cherry trees. The investigation of the system produced the approximately linear graph between volumetric water content and time for which system was analysed. This system provide the facilities like low cost and reliable system, preventing moisture strain of trees, minimising extreme use of water and ensuring of rapid rising weeds. System may be more helpful by allowing for other environmental factors. [2]

FPGA based real time monitoring system researchers suggested for agricultural field by considering temperature, humidity and light intensity as their key parameters. This system was an surrounded based which monitors as well as control environmental parameters on expected basis so as to make best use of the production of crop with reducing human intervention. This was low cost and automated system also it can be ready successful by considering other environmental parameters and real time fault detection. [3]

Some researchers developed a monitoring system to measure the water level in agriculture using sensor network which offers precision agriculture. They investigate a routing algorithm which provides information connected to water level as well as useful in computing threshold values based on transmit range. The algorithm described the system which is based on distances of wireless data from source towards sink node as well as on minimum angle between source and destination. The use of algorithms based on genetics and neural network proposed system be able to be optimized. [4]

Chen Cunxian discussed grid-based energy efficient routing protocol in Wireless Sensor Networks. Due to limited energy of Wireless Sensor Networks (WSNs) routing plays a critical role in improving energy effectiveness. The low-energy adaptive clustering hierarchy (LEACH) protocol is a classical solution to reduce energy cost but it ignore remaining energy of sensor nodes and long-range communication which causes low network coverage and high energy utilization. In this paper WSNs are separated into two levels: one is called secondary level grid (SG), which is formed by one cluster head (CH) and several cluster members (CMs); the other one is premier level grid (PG), which consists of nine adjacent SGs. In each round, CH is selected based on residual energy level of sensor nodes in a cluster. Then fused data of CH will be transmitted to sink node through multi-hop routing which is determined by minimum weight. It is significant to develop routing algorithms which adapts energy-saving and coverage-preserving scheme to balance energy consumption and keep high network coverage in WSNs. [5]

Jao Jonathan described a Prototype Wireless Sensor Network for Precision Agriculture .Most existing work in wireless sensor networks addresses their fundamental challenges, including power supply, limited memory, processing power & communication bandwidth & focuses entirely on their operating system. In this paper, author presents a proof of concept WSN to collect soil moisture content, which is one of the most fundamental data required for precision agriculture. Architecture is general, so it is easy to integrate the driver of other sensor probes, thus collecting more types of data. We have built a prototype WSN to collect soil moisture. This paper utilize MicaZ motes from memisic to carry out single node experiment & multiple node experiment. Outdoor WSN have been applied to monitor active volcanoes, pipeline infrastructure, redwood trees, precision agriculture, sea monitoring, and groundwater transport models. MDA300CA is a versatile data acquisition board with multifunction direct user interface. [6]

Brandolese Carlo described Power Management Support to Optimal Duty Cycling In Statefull Multitasking WSN. WSN is the group of embedded, persistent, tiny and low-cost computing strategy with a built in microcontroller, a transceiver and sensor nodes for monitoring environmental phenomenon. The main concern is to minimize the energy consumption of the battery operated nodes on the working Network. The objective is to find the optimal energy cycle which defines a neutral relation between consumed and harvested energy. This paper focuses on the power management infrastructure with support for heterogeneous applications to save their status in idle time. Integrated and general power management system which is transparent to end user with support for heterogeneous concurrent applications. [7]

L.M.Kamarudin described Modeling and Simulation of WSNs for Agriculture Applications using Dynamic Transmit Power Control Algorithm. Modeling of wireless sensor network architecture on simulation platforms is often over simplified with numerous using straightforward radio force representations that do not regard as the complication of the radio spread environment or assuming infinite transmit power levels. This system described the energy utilization presentation of the system using two broadcast path models & pass on power control algorithm. The arriving indication force pointer (RSSI) is employed to decide the power level required to transmit between two nodes. To estimate the RSSI, radio spread models are used. Performance examination by the CC2420 power copy with pass on power control algorithm based on different radio channel propagation models. In system described radio energy representation and convey power organize algorithm and the effect on network performances based on different spread models. The study have exposed that the application of transmit power control can extend the lifetime of networks by more than 8.5% with greater efficiencies achieved in high signal attenuation environments. [8]

III. THE PROPOSED METHODOLOGY

Motivation for designing a method for agricultural monitoring is to make a working structure designed to point the well-ordered advance and protection of applications for Agriculture based on WSNs. After studying the current agricultural monitoring identified a set of actions that used frequently in the development, deployment, and maintenance processes of agricultural applications. Based on these, Proposing a set of common tasks that must be carried out as part of the process of developing and deploying efficient sensor networks for agricultural monitoring. Instead of the particular requirements of each application and the characteristics of each type of crop, our methodology identifies a set of common tasks that need to be performed and which have the possible of saving time and effort, and therefore, increase the productivity of developing applications.

In this paper, we propose different topologies for precision agriculture. The development and deployment of WSNs have taken traditional network topologies in new directions. Different Wireless sensor network topologies are Bus, Star, Ring, and Grid.

A. Bus Topology

In this topology, there is a node send message to another node arranged the network sends a transmission message against the network that entirely further nodes realize, but only the intended recipient actually accepts and processes the message. Bus topology is relaxed to fix but bottleneck of traffic then single path communication. Nevertheless bus networks work supreme with a restricted number of nodes.

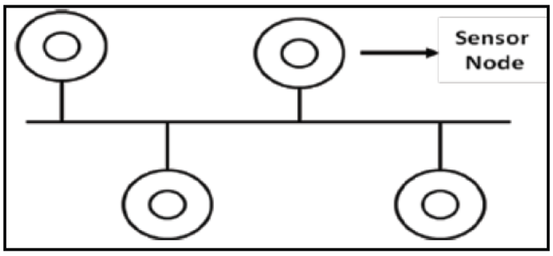

Fig. 3: Bus Topology

B. Star Topology

Star networks are associated to a central communication sink and the nodes cannot communicate directly with each other. The complete communication needed be directed through the central hub. Each node is called a "client" whereas the central hub is the "server or sink" as shown in Fig. 4. But there is disadvantage of single path communication.

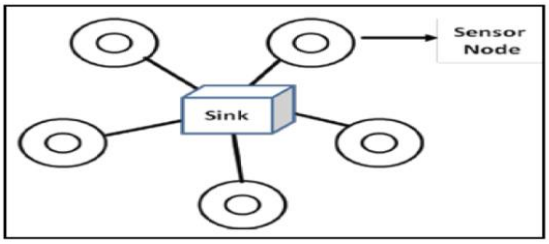

Fig. 4: Star Topology

C. Grid Topology

The sensor network field dividing into grids as shown in Fig 5. The network area is subdivided into non-overlapping quadrangular grid with similar size. There should be at least one and only one node in working state in each grid at any time. In order to extend the network life time, the nodes in a grid should work in turn. Inside each grid, one node is selected as a grid head which is responsible for forwarding routing information and transmitting data packets. Direction-finding is done in a grid- by- grid manner. Grid founded multi-path routing protocol proposed to route packets fast, utilize and spread sensor nodes energy in addition to avoiding and handling network congestion when happens in the network.

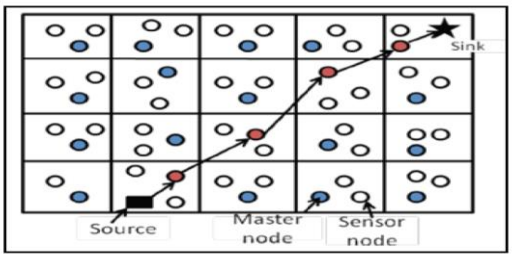

Fig. 5: Grid Topology

D. Ring Topology

In a ring network, every node has exactly two neighbours for communication purposes. Totally messages transmit through a ring in the similar direction (either “clockwise” or “counter clockwise”). A disappointment in node breakdowns the ring and can revenue down the whole network. But bottelneck of traffic and double path communication.

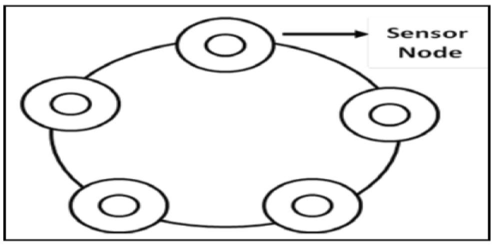

Fig. 6: Ring Topology

IV. MATHEMATICAL MODEL AND RESULT

TABLE I. SENSOR PROPERTIES

Sensor Specifications	Model	Protocol	Freq.	Tx Power	Sensitivity	Range
	WI-FI	IEEE 802.11b	2.4GHZ	100mw	-20db	500m

TABLE II. ANTENNA PROPERTIES

Antenna Specifications	Type	Gain	Dimensions
	WI-FI	IEEE 802.11b	2.4GHZ

Here, for all topologies, we consider the same technical setting for sensors which are shown in table I, II. Number of access point is an important factor in this project; therefore it is given by equation 1. We use this number of access points to cover the whole area. *f* is frequency in MHz and *d* is distance in Km in equation 1. Therefore, FSPL3 is:

$$FSPL(db)=20\log10(20)+20\log10(f)+32.45 \quad \text{..... (1)}$$

We consider a set of performance metrics for comparing different topologies using *delay*. The execution time is 100 mili seconds. Delay definitions of the metrics:

• **Delay**: Time to send a message from source to destination. For any destination, if n packets have arrived, delay for that destination is given by equation 2.

Where di is the delay of the ith packet.

Network delay is averaged by the number of destinations.

$$Delay = \sum_{i=1}^{n} \frac{di}{n} \quad \text{...... (2)}$$

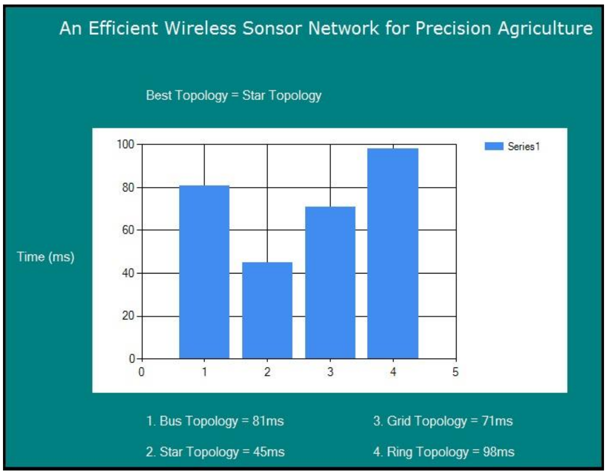

Fig. 7: Delay for All networks

Figures 7 show the result using delay. Delay in star case is much less than delay in bus, grid and ring topology as shown in Fig. 7. We have calculated the average network delay using the execution for the four cases. It is 45ms for the star, 71ms for the grid, 81ms for the bus and 98ms for the ring topology. In star, delay is decreased by approximately 50%.

V. CONCLUSION

In present day Precision Agriculture more number of the parameters is required to be monitored and controlled because of the large varieties of the crop at the same time. Use of WSN will be increasing day by day because of the development in WSN technology and its adaption by agriculture technology. In this situation, the wireless sensor network with additional hardware and software is an efficient solution for Precision Agriculture. In future, when more number of agri-parameters is to be controlled, then for WSN technology with present available bandwidth, may not suffice. Then probably WSN with topology control network technology may be the futuristic solution. This advancement in precision agriculture through Wireless Sensor Network is extremely useful. This has scope in developing countries like India, where agriculture is the bone of economy.

ACKNOWLEDGEMENT

I Pratibha P. Gangurde would like to thank everyone, including : parents, teachers, family, friends, and in essence, all sentient beings for their help and support this paper would not have been possible. Especially, I dedicate my acknowledgment of gratitude toward my guide and Co-author Manisha Bhende for her valuable guidance and support.

REFERENCES

[1] G. V. Satyanarayanads, S.D. Mazaruddin, "Wireless Sensor Based Remote Monitoring System For Agriculture Using Zigbee and Gps", Conference On Advances In Communication and Control Systems 2013 (Cac2s 2013).

[2] M. Dursun and S. Ozden, "A Wireless Application of Drip Irrigation Automation Supported by Soil Moisture Sensors", Scientific Research and Essays, pp. 1573–1582, April 2011.

[3] M. Dinesh and P. Saravanam, "FPGA Based Real Time Monitoring System for Agricultural Field", International Journal of Electronics and Computer Science Engineering, pp. 1514–1519, June 2011.

[4] I. Singh and M. Bansal, "Monitoring Water Level in Agriculture using Sensor Networks", International Journal of Soft Computing and Engineering, pp. 202–204, November 2011.

[5] Chen Cunxiang, He Zunwen, Sun Hongmei, "A grid-based energy efficient routing protocol in Wireless Sensor Networks", Wireless and Pervasive Computing (ISWPC), 2013 International Symposium on 20-22 Nov. 2013 , pp: 1 – 6

[6] Jao Jonathan, Sun Bo, Kui Wu "A Prototype Wireless Sensor Network for Precision Agriculture", Distributed Computing Systems Workshops (ICDCSW), 2013 IEEE 33rd International Conference on 8-11 July 2013 , pp: 280 – 285

[7] Brandolese Carlo, Fornaciari William, Rucco Luigi, "Power Management Support to Optimal Duty Cycling In Stateful Multitasking WSN ",Trust, Security and Privacy in Computing and Communications (TrustCom), 2013 12th IEEE International Conference on 16-18 July 2013 , pp: 1123 – 1132

[8] L.M.Kamarudin, A. Harun, "Modeling and Simulation of WSNs for Agriculture Applications using Dynamic Transmit Power Control Algorithm", Intelligent Systems, Modelling and Simulation (ISMS), 2012 Third International Conference on 8-10 Feb. 2012 , pp: 616- 621

[9] K. Yunseop, R. G. Evans, and W. M, Iversen, "Remote Sensing and Control of an Irrigation System Using a Distributed Wireless Sensor Network," Proc. Of IEEE Transaction On Instrumentation AND Measurement, USA , vol. 57, no. 7, pp. 1379 - 1387 , July 2008.

[10] G.H. E. L. de Lima, L. C. e Silva, P.F. R. Neto, " WSN as a Tool for Supporting Agriculture in the Precision Irrigation," sixth International conference of Networking and Services (ICNS), 2010, pp. 137 – 142

[11] Y. Xijun, L. Limei, X. Lizhong , " The Application of Wireless Sensor Network In the Irrigation Area Automatic System, :International Conference on Network Security, Wireless Communications and Trusted Computing (NSWCTC), vol.1, pp.21- 24, Dec.2009

[12] M.A.M. Vieira, C.N. Coelho, Jr, D.C. da Silva, Jr., J.M. da Mata, "Survey on wireless sensor network devices," IEEE Conference on Emerging Technologies and Factory Automation Proceedings. vol.1, pp.537 - 544, Sept. 2003.

[13] H. Karl and A. Willig, "Protocols and Architectures for Wireless Sensor Networks," ISBN: 0-470-09510-5, 2005.

[14] S. Yi, "The Short-distance Wireless Communication and Network Technology, " Washington D.C, UAS, Academic , vol. 2, 2009.

[15] R. W. Wall and B. A. King, "Incorporating plug and play technology into measurement and control systems for irrigation management," presented at the ASAE/CSAE Annu. Int. Meeting,Ottawa, Canada, pp. 042189 ,Aug. 2004.

[16] T. Wark, P.Corke, P.Sikka, L.Klingbeil,"Transforming Agriculture through Pervasive Wireless Sensor Networks,"Pervasive Computing IEEE, vol. 6, no.2, pp. 50-57, 2007

[17] B. Han,"The Principle and Network optimizing of GPRS,"Vehicular Technology Conference Proceedings.Tokyo Japan, vol.1, pp. 440 – 444 , 2004.

[18] K. Konstantinos , X .Apostolos, K. Panagiotis , S. George," Topology Optimization in Wireless Sensor Networks for Precision Agriculture Applications, " SENSORCOMM, March.2007 , pp.526 - 530,doi: 10.1109/SENSORCOMM.2007.101.

[19] A.Baggio," Wireless sensor networks in precision agriculture," CA: Delft University of Technology, 2009.

[20] W. Cao, G.Xu, E. Yaprak, R. Lockhart, T. Yang and Y. Gao, "Using Wireless Sensor Networking (WSN) to Manage Micro-Climate in Greenhouse", MESA , Oct. 2008, pp. 636 – 641.

[21] W. Zhang, G. Kantor, and S. Singh."Integrated wireless sensor/actuator networks in agricultural applications". In Second ACM International Conference on Embedded Networked Sensor Systems (SenSys), pp. 317, 2004

