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MONITORING GREEN HOUSE ATMOSPHERIC CONDITIONS USING DISTRIBUTED SENSORS

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Abstract – *Wireless sensor networks are considered an important dimension of the modern information and communication technology-based solutions for greenhouse monitoring.They carry out cooperative activities due to limited resources and nowadays, the applications of these networks are abundant, varied and the applications in agriculture are still budding. One interesting purpose is in environmental monitoring and greenhouse control, where the crop conditions such as weather and soil do not depend on natural agents. To control and notice the environmental factors, sensors and actuators are essential. Under these conditions, these devices must be used to make a distributed measure, dispersed amount of sensors all over the greenhouse using distributed clustering mechanism. In modern greenhouses, several measurement points are required to trace down the local climate parameters in different parts of the big greenhouse to make the greenhouse automation system work properly. Cabling would make the measurement system expensive, unsafe and unprotected. Moreover, the cabled measurement points are difficult to relocate once they are installed. Thus, a Wireless Sensor Network (WSN) consisting of small-size wireless sensor nodes equipped with radio and one or several sensors is an attractive and cost efficient option to build the required measurement system. This paper reveals an initiative of environmental monitoring and greenhouse control using a sensor network.*

Key Words: Wireless sensor, monitoring, environmental, actuators, clustering mechanism, greenhouse gases

1. INTRODUCTION

In order to improve the farming practices in greenhouses, Eco-friendly high-quality agriculture has been investigated. Recent developments in the field of wireless sensor networks as well as make on a smaller of the sensor nodes has allowed accurate agriculture to grow. Accurate agriculture concentrates on providing the means for harvest, managing the work and growth information.In modern greenhouses, several measurement points at plant level are required to create an objective and detailed view of the climatic conditions at various areas in the entire greenhouse region. All greenhouse cultivation systems, regardless of geographic location, comprise climate control components. Air temperature, solar radiation and air relative humidity are important variables of the greenhouse climate that can be controlled, since they affect crop growth and production but also energy expenditure, which can account for up to 40% of the total production cost. The main purpose of greenhouse climate control is to obtain healthy, well-developed crops with high yield and quality production, while using fewer resources.

Sensors are devices that translate aspects of physical reality into a representation understandable and processable by computers. A multi sensor node is intelligent to sense several magnitudes in the same device. In a multi sensor, the input variables may be temperature, fire, infrared radiation, humidity, smoke and CO2. The most imperative factors for the quality and yield of plant growth are temperature, humidity, light and the level of the carbon dioxide. Constant noticing these variables of these gives information to the person to better understand, how each aspect affects growth and how to administer maximal crop productiveness.

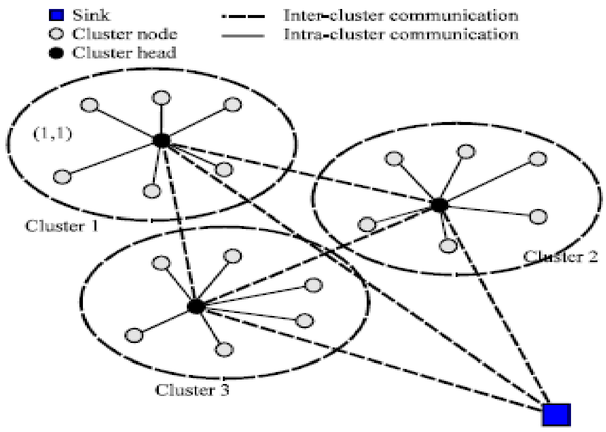

Fig-1: Clustering in a sensor network

Wireless sensor network can form a helpful part in contemporary greenhouses constructively. Compared to the cabled systems, the setting up of WSN is fast and easier to relocate the measurement points when needed by immediately moving sensor nodes from one location to another within a communication range of the organizer gadget. If the greenhouse vegetation is high and dense, the small and light weight nodes can be hanged up to the branches. WSN maintenance is also relatively inexpensive and problem-free. The only other expense occurs when the sensor nodes run out of batteries (figure 2) and the batteries need to be recharged or replaced. In this work, the very first steps towards the wireless greenhouse automation system by building a wireless measuring arrangement for that purpose is taken and by testing its convenience and trustworthy with a straightforward experimental setup. Clustering may be centralized or distributed, based on the array of Cluster Head. In centralized clustering (figure 1), the CH is preset but in distributed clustering CH has no permanent architecture. Distributed clustering mechanism is used for some classified reasons like sensor nodes prone to failure, better collection of data and minimizing redundant information. Hence these distributed clustering mechanisms cover considerably self-organizing capability.

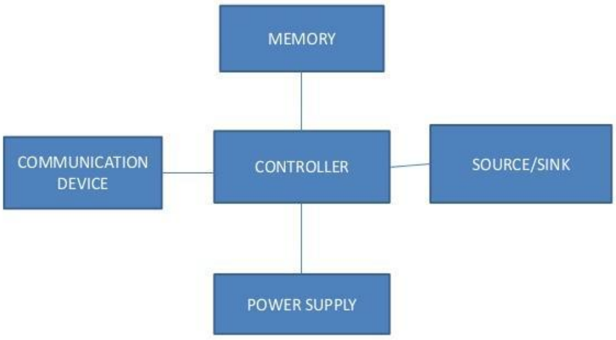

Fig-2: Components of wireless sensor node

2. MEASURABLE FACTORS IN A GREEN HOUSE

2.1. THE GREENHOUSE ENVIRONMENT

A greenhouse is a structure with walls and roof made chiefly of transparent material, such as glass, in which plants requiring regulated weather conditions are grown. These structures range in size from small sheds to industrial-sized buildings As a result, quantities of measurement points are also needed. This group of area is demanding both for the sensor node electronics and for the short-range IEEE 802.15.4 wireless network, in which communication choice is greatly longer in open environments.

2.2. GREEN HOUSE

A greenhouse is a pattern covering the ground frequently used for growth and progress of plants that will revisit the owner's risk, time and capital. This exhibit is mounted with the purpose of caring and keep safe of the crop and allowing a better environment to its advancement. This cover is enough to guarantee a higher quality in production in some cases. However, when the main idea is to achieve a superior control on the garden cultivation and development process, it is necessary to monitor and control the factors that influence the progress of a culture. The foremost role of a greenhouse is to offer a more compassionate environment than outside. Unlike what happens in traditional agriculture, where crop conditions and yield depend on natural resources such as climate, soil and others, a greenhouse ought to promise production independent of climatic factors. It is noteworthy to view that even though a greenhouse protects crop from outermost factors such as winds, water excess and warmth it may root so many problems such as fungus and extreme humidity. Therefore, mechanisms to inspect and manage a greenhouse environment are unbelievably important to get better productivity. To get superior productivity and quality, better control system is necessary and as a result the production costs also get reduced. The chief elements involved in a greenhouse control system are: temperature, humidity, CO_2 concentration, radiation, water and nutrients.

2.3. SENSOR NODES DESIGN

Sensor nodes designed in this system receive measured data from heat in the greenhouse area, atmospheric moisture, leaf temperature and rain sensors, process the data with a microprocessor (MSP430 MCU) and transmit the data to a PC and relay nodes using a transceiver (CC2420 RF chip). Nodes and sensors are designed to be separate from each other to minimize the effect of heat emitted from nodes on sensors. The MSP430 microprocessor has a 16 bit RISC structure and has 48 KB of program memory and 10 KB RAM, which can handle multiple sensor data simultaneously with high speed. The CC2420 transceiver is a RF chip supporting Zigbee that works in the 2,400~2,483.5 MHz frequency band. Communication is made by DDDS method, supporting O-QPSK modulation and 250 Kbps data rate, which makes low-power real-time wireless communication possible

Speedy response time, low power consumption and tolerance beside moisture climate, relative humidity and temperature sensor forms a perfect preference and explanation for the greenhouse environment.

Communication between SHT75 sensor and node is similar to IIC interface Communication among sensor nodes can be carried out by IIC interface. Luminosity can be measured by light sensor, which converts light intensity to equivalent voltage. Luminosity was measured by TAOS TSL262R, which converts light intensity to voltage. Unstable output signal is handled by low-pass filter to get correct luminosity values. Unstable output signal is handled by low-pass filter to acquire exact luminosity values. CO_2 measuring takes longer time than other measurements and CO_2 sensor voltage supply must be within ±0.1V from the 5 Volts.The carbon dioxide assessments can be read from the ensuing output voltage. Operational amplifier raises the voltage level of weak signal from the sensor.

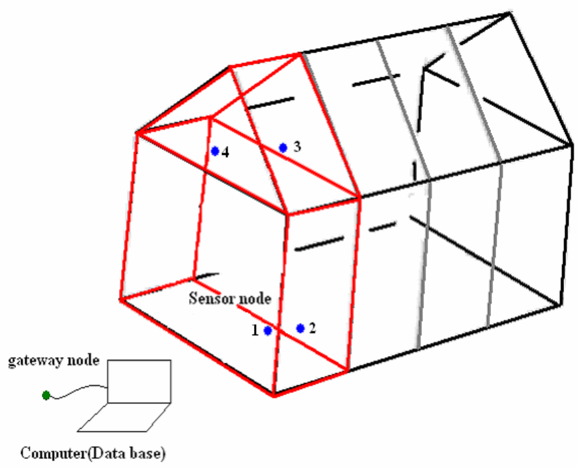

Fig-3: Sample experimental setup in green house

2.4. TEMPERATURE AND HUMIDITY

The ambient temperature and humidity as well as leaf temperature values collected with environmental sensor nodes are used to calculate the dew point. The collected data are substituted for the dew point formula of Barenbrug. This equation has an error value of ±0.4 °C [1] and it is valid for:

$$0\,°C < T < 60\,°C \quad 1\,\% < RH < 100\,\% \quad 0\,°C < T_d < 50\,°C \quad \text{......(1)}$$

where

- T: Temperature in degrees Celsius
- RH: Relative humidity (4)
- Td: Dew point temperature

The equation is:

$$T_d = \frac{b \cdot \alpha(T, RH)}{a - \alpha(T, RH)} \quad \text{.........(2)}$$

where:

$$\alpha(T, RH) = \frac{a \cdot T}{b + T} + \ln(RH / 100) \quad \text{........(3)}$$

and a = 17.27, b = 237.3 °C (a, b is constant)

Temperature is one of the main key factors to be monitored since it is unswervingly related to the development and progress of the plants. For all plant varieties, there is a temperature variety considered as a best range and to most plants this range is comparatively varying between 10ºC and 30ºC. Among these parameters of temperature: intense temperatures, maximum temperature, minimum temperature, day and night temperatures, difference between day and night temperatures are to be cautiously considered.

2.5. WATER

An additional significant factor in greenhouses is water. The absorption of water by plants is associated with the radiation. The deficient in or low level of water affects growth and photosynthesis of these plants. Besides air, the ground humidity also regulates the development of plants. The air humidity is interconnected with the transpiration, while the ground humidity is linked to water absorption and the photosynthesis. An atmosphere with tremendous humidity decreases plants transpiration, thereby reducing growth and may endorse the proliferation of fungus. On the other hand, crouch humidity level environments might cause dehydration.

2.6. RADIATION

Radiation is an elementary element in greenhouse production and sunlight is the key starting place of radiation. It is an imperative component for photosynthesis and carbon fixing. Momentous radiation features are intensity and duration. The radiation intensity is linked to plant development and the duration is explicitly associated with its metabolism.

2.7. CO2 CONCENTRATION

CO_2 is an indispensable nutrient for the plant development, allowing the adaptation of carbon. The carbon retaining process occurs through the photosynthesis when plants take away CO_2 from the atmosphere. During photosynthesis, the plant use carbon and radiation to produce carbohydrate, whose purpose is to permit the plant development. Therefore, an enriched air environment should add to plant growth, but it is also vital to note that an intense carbon level may turn the environment poisonous.

3. GREENHOUSE CLIMATE HETEROGENEITY ASSESSMENT EXPERIMENTS

The WSN consisted of wireless sensor nodes placed at specific points that covered the entire area of the greenhouse. The measured variables were air temperature, relative humidity and leaf temperature. The wireless nodes were equipped with the air temperature, humidity sensors and infrared thermocouple sensors.

Fig-4: Topology of the experimental WSN

4. PROPOSED MODEL

The proposed model is implemented in hardware, tested and the results show an excellent improvement in the sensing parameters when compared to the existing set of environmental monitoring and greenhouse control models. Sensor arrays like temperature sensor, light sensor, humidity sensor and CO2 sensors are incorporated in the board. The sensed data is processed by the micro controller and displayed in the LCD display. Wireless transmission of the parameters is accomplished by a zigbee module that sends information to the remote monitoring station periodically.

To control and monitor the environmental variables planned in an earlier section, sensors and actuators capable of measuring and controlling the values inside the greenhouse are essential. Generally, a greenhouse control is implemented just by approximating a calculated cost to a reference or ideal cost. Figure 5 shows the basic block diagram of the proposed model. Due to cost considerations, the proposed model uses sensor network instead of wireless sensor network. The sensed data is forwarded to the gateway. The gateway then forwards the data to the remote monitoring base station. The base station is a remotely located software configured computer, where the monitored details are periodically visualized to carry out further control actions.

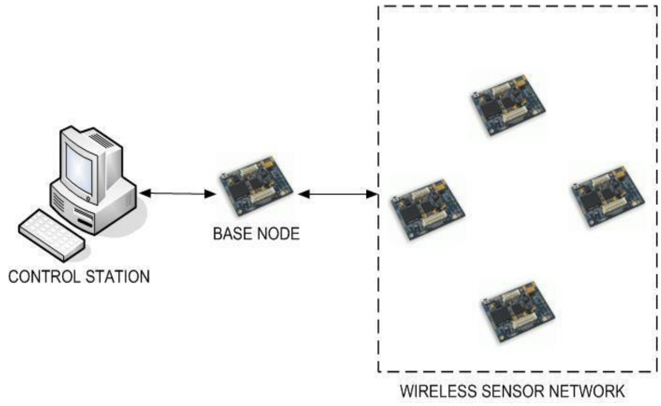

Fig-5: Block diagram of the proposed model

In the proposed model, the ideal assessment depends on the climate and type of plant. Control systems can be separated into either centralized or distributed systems. A centralised system is a database that is located, stored, and maintained in a single location. So, every components of the system are connected to this private element. In a distributed control system, connections between nodes and the information processing is distributed amid the system components.

Advantages of distributed system include Give more performance than single system. If one pc in distributed system malfunction or corrupts then other node or pc will take care of. More resources can be added easily. Resources like printers can be shared on multiple pc. The major difficulty of these technologies is that they are not developed for WSN and they do not present mechanisms to perk up energy efficiency.

Fig-6: Sample Experimental setup for environmental monitoring

5. SENSORS USED IN THE MODEL

Fast response time, low power consumption and tolerance against moisture climate made SHT75 relative humidity and temperature sensor [10] a perfect solution for the greenhouse environment. Temperature accuracy of the sensor is ±0.3 °C and the accuracy of the relative humidity under ±2 %. Communication between SHT75 sensor and node is similar to IIC interface developed. Data and clock line are the same in both cases, but SHT75 has only one pull-up resistor between data and power supply line.

Luminosity was measured by TAOS TSL262R [11], which convert light intensity to voltage. Unstable output signal is handled by low-pass filter to get correct luminosity values. Mounted irradiance, temperature and humidity sensors into nodes, but Carbon dioxide sensor was tricky because it sets special requirements for the input voltage and the response time. Figaro's TGS4161 [12] carbon dioxide sensor (see Figure 7 on the right) was the alternative, which was the most compatible with low voltage sensor node. CO2 measuring takes longer time than other measurements and CO2 sensor voltage supply must be within ±0.1V from the 5 Volts. The carbon dioxide value can be read from the output voltage. Operation amplifier raises the voltage level of otherwise weak signal from the sensor.

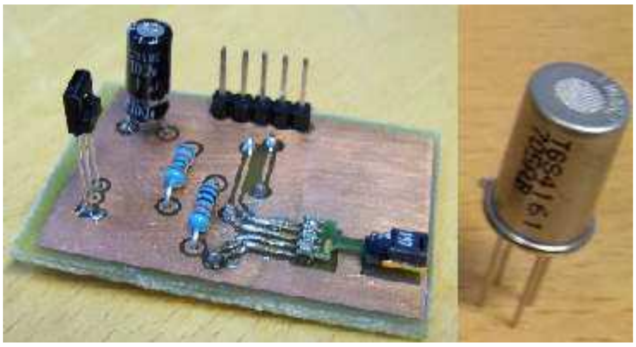

Fig- 7: Sensor board (equipped with luminosity and temperature/humidity sensors) and carbon dioxide sensor

The sensors used in a greenhouse environment assures a real-time monitoring and an improved measurement through distributed environment. The collected data in the system proposed is sent to a base station situated apart from the greenhouse. The base station is linked by a gateway. With the execution of this architecture, each node is communicating through its sensors for data collecting and sending it to its neighbour node until all collected data emerge at the base station. The gateway normally uses wireless and Ethernet communication. In this application, node protection is necessary to avoid the damage by water and inputs. It is imperative to highlight that the use of wireless sensors and actuators is beneficial to make the system installation trouble-free and to obtain suppleness and mobility in the nodes prototype. The difficulties in applying WSN in agricultural applications include higher costs and short of standardization on WSN communication protocols.

RESULTS

A low expense sensor deployment strategies with guaranteed performance which addresses the sensor deployment problems in the on-hand models has been proposed. Hardware implementation of this model has been done and the parameters are periodically keeping record to monitor with few varieties of sensors.

6. CONCLUSION

A model of agricultural application using sensor networks for greenhouses monitoring and control has been presented. The WSN technology, although under development, seems to be gifted mainly because it allows real time data acquisition. A greenhouse is a controlled environment and does not need a lot of climatic parameters to be controlled. The use of this sensor technology in large level seems to be something for the near future. In this application, climatic parameters like temperature, water, humidity can be monitored using the sensors. As a greenhouse is fairly small and controlled environment, and energy is a partial resource, the likelihood of replacing batteries or even resorting to a strongly and solidly build energy source adaptation is a helpful feature. This paper reveals a plan of environmental monitoring and greenhouse control by means of a sensor network. The hardware implementation shows periodic monitoring and control of greenhouse gases in an improved manner.

REFERENCES

[1] Teemu Ahonen, Reino Virrankoski and Mohammed Elmusrati "Greenhouse Monitoring with Wireless Sensor Network"

[2] Gonda, L., & Cugnasca, C. E. (2006). A proposal of greenhouse control using wireless sensor networks. Computer in Agriculture and Natural Resources, 4th World Congress Conference, 229e233, Orlando, FL, USA.

[3] Sensinode (2007). OEM Product catalog. [Online]. Catalog-20071101.pdf.
Available: http://www.sensinode.com/pdfs/sensinode

[4] G. J. Timmerman and P. G. H Kamp, "Computerised Environmental Control in Greenhouses " PTC, The Netherlands, Page(s): 15–124, 2003.

[5] Greenhouse guide. (Referred 20.04.2008). [Online]. Available: http://www.littlegreenhouse.com/guide.shtm

[6] M. Mancuso and F. Bustaffa, "A Wireless Sensors Network for Monitoring Environmental Variables in a Tomato Greenhouse," presented at 6th IEEE International Workshop on Factory Communication Systems in Torino, Italy, June 28-30, 2006.

[7] H. Liu, Z. Meng and S. Cui, " A Wireless Sensor Network Prototype for Environmental Monitoring in Greenhouses," presented at Wireless Communications, Networking and Mobile Computing 2007 (WiCom 2007), International Conference on 21-25 Sept. 2007 Page(s):2344 – 2347.

[8] Dr. S.R.Boselin Prabhu, Dr. E.Gajendran, N.Balakumar "MONITORING ATMOSPHERIC CONDITIONS USING DISTRIBUTED SENSORS" , International Journal of Inventions in Engineering & Science Technology http://www.irapub.com (IJIEST) 2016, Vol. No. 2, Jan-Dec e-ISSN: 2454-9584; p-ISSN: 2454-8111

[9] S.R.Boselin Prabhu, C.V.Dhasharathi, R.Prabhakaran, M.Raj Kumar, S.Wasim Feroze "Environmental Monitoring and Greenhouse Control by Distributed Sensor Network" Int. J. Advanced Networking and Applications Volume: 5 Issue: 5 Pages: 2060-2065 (2014) ISSN : 0975-0290

[9]S.R.Boselin Prabhu, S.Sophia, (2011), Real-World Applications of Distributed Clustering Mechanism in Dense Wireless Sensor Networks, International Journal of Computer Science and Engineering Survey, Volume 2, Number 4, Pages 165-176.

[10] S.R.Boselin Prabhu, S.Sophia, (2011), A survey of adaptive distributed clustering algorithms for wireless sensor networks, International Journal of Computer Science andEngineering Survey, Volume 2, Number 4, Pages 165-176.

[11] Boselin Prabhu S.R. and Sophia S., 'Hierarchical distributed clustering algorithm for energy efficient wireless sensor networks', International Journal of Research in Information Technology, 1(12), 2013.

[12] T. Boulard; S. Wang, Experimental and numerical studies on the heterogeneity of crop transpiration in a plastic tunnel. Computers and Electronics in Agriculture 2002, *34*, 173–190.

[13] Konstantinos P. Ferentinos , Nikolaos Katsoulas , Antonis Tzounis ,Thomas Bartzanas , Constantinos Kittas "Wireless sensor networks for greenhouse climate and plant condition assessment" journal homepage: www.elsevier.com/ locate/issn/15375110

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