

PAPER • OPEN ACCESS

Structuring Rich Agriculture using Pervasive Computing

To cite this article: Anurag Bhatnagar *et al* 2021 *IOP Conf. Ser.: Mater. Sci. Eng.* **1099** 012078

View the [article online](#) for updates and enhancements.



ECS **240th ECS Meeting**
Digital Meeting, Oct 10-14, 2021
We are going fully digital!
Attendees register for free!
REGISTER NOW

Structuring Rich Agriculture using Pervasive Computing

Anurag Bhatnagar¹, Nikhar Bhatnagar² and Pradeep Kumar³

¹Department of Information Technology, Manipal University Jaipur, Jaipur-Ajmer Express Highway, Dehmi Kalan, Near GVK Toll Plaza, Jaipur, Rajasthan 303007 India

²Department of Information Technology, SKIT Jaipur, Jagatpura, Jaipur, Rajasthan 302017 India

³Department of Computer Application, Manipal University Jaipur, Jaipur-Ajmer Express Highway, Dehmi Kalan, Near GVK Toll Plaza, Jaipur, Rajasthan 303007 India

E-mail: anurag.bhatnagar@jaipur.manipal.edu

Abstract. Now a day almost all humans carry gadgets which are smaller in size but has maximum utilization in term of functionality i.e., mobile or smart watches. Cloud Computing is proven one of the best hope for farmers for better cultivation of crops by using digital compilation. In almost every year, more than 40% downfall in the cultivation has observed due to unfavourable conditions for instance changes in the climate, the storage of water and shortage of labour due to increased urbanized population. The solution of this problem turn onto the form of a new technology named 'eplant'. With the minimized input the best possible crops production for the best health is the focus of this technique. Thus the term "Pervasive Computing" came into existence. "Pervasive Computing" is also known as "Ubiquitous Computing". This paper is about introducing this new technique in farming. Data sensors are used to provide all necessary resources for better crop development through and different compatible actuators are also used as per the environmental conditions. The role of sensors is the collection of the data about soil, the climate and for specific plants conditions. In order to minimize the hard work and to maximize the profit of the farmer this technique provided desired parameters by different calculations.

1. Introduction

Pervasive Computing [1], synonymously known as Ubiquitous Computing, is the most viral and emerging trend in today's era. Embedded microprocessors are used for day to day information communication by using different objects. The term pervasive symbolizes "existing anywhere and anytime." It is a combined approach of man, nature, hardware and software. It deals with the idea that any device handling [2] clothing to food, tools to applications, cars to unmovable object, health to wholeness can be embedded with microchips to connect a device to infinite networks. Pervasive computing systems are internally connected and perpetually available. Human life is getting highly dependent and improvised toward pervasive computing [3].

In the current scenario of getting everything in just a touch away, this sympathetic of expertise provides an implausible solution for processors environment. For acquisition of this argument, computer systems must be modest in accounting devices, form and placed them in walls, wearables, buildings and furniture's. This operates all the computers power in physical users' region making it



indistinguishable from end user's point of view. UbiComp also unfurled the way of handling day to day life situations with just a hold of a button, unbounding us from desk application interactions.

The main characteristics of ubiquitous computing devices are that they are very tiny and even invisible. Inexpensive in nature, robust networked processing devices either movable or embedded in almost every type of objects like clothing, cars, tools, applications-all broadcasting through increasingly interconnected mesh. Mobile devices prove to be of great help and provide high value and usability [4]. The basic principles on which ubiquitous works are decentralization, diversification, connectivity and simplicity. Refer figure 1.

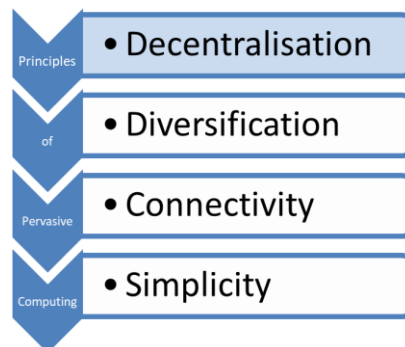


Figure 1. Principles of Pervasive Computing [4]

In decentralization, all computing is done by basic, small devices that are doltish, yet communicate in an open community where the structure of connections changes dynamically. In diversification, devices are Small and special purpose, supplying a few, or even just one type of information.

In connectivity, poor devices can produce powerful and intelligent environment, if multiple devices act in parallel linked by an underlying infrastructure e.g., the Internet [5]. This versatile system is used in many places such as information access, text retrieval, automatic indexing, user sensitive devices, device discovery, and security, speech and gesture recognition.

Focusing the process of how digital interface of the nature is created? is the aim of this paper. Particularly to selected species of plants. A tree way connection is developed between plant, people and their objects. This methodology shows a growth process of hybrid system which consist of interactive plants with their objects in situations ranging from domestic plant care. Control is done with the help of sensors and actuators, for example the fertilization deliberation in soil is itself based on the information grounded on soil, temperature and other factors. Precise information is very important for a high level crop which is sensitive like wine grapes and citrus fruits. Calm Computing, through algorithms, calculate by taking all the data and shows the accurate results. Refer figure 2.

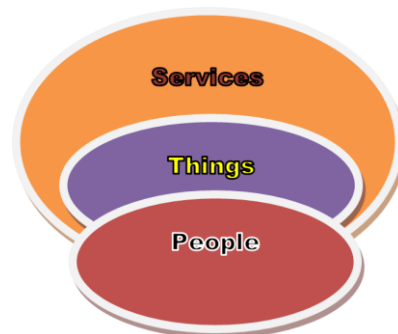


Figure 2. A Tree Connection [5]

Single person which was termed as 'ubiquitous computing. The survey in this paper shows a brief presentation of the research efforts to create digital interfaces to nature particularly to selected species of plants. For the purpose of environmental monitoring pervasive computing is far beyond the use of sensor networks. It put emphasis on the progress of a system architecture that comprises of the plants and associated computation as an integral part of the system. Interaction of plants is also allowed in this and artifacts in the form of synergistic and scalable mixed societies. Actuator will be a group of tools which are able to grant information the user wants on the environment.

2. Research Background

Dr. Mark Weiser in 1988 was the first person to define "UbiComp" in the Electronics and Imaging Laboratory (EIL) of the Xerox Palo Alto Research Center (PARC) [6][7]. In 1991 Dr. Weiser wrote an article in Scientific American, quoting that "The most profound technologies are those that disappears. They interlace themselves into the fabric of everyday life until they are indistinguishable from it." As far as research suggests there have been three major waves in computing so far. The first concept of pervasive computing was implemented in the year of 1960's in which the transistorized mainframe computers were in use with a single computer and they were shared by many people. Second was implemented in 1980's when an era of personal computers and notepad came into existence where single computer was used by an individual one. Consequently, third wave in computing began in 1988 which increased the power of computation and resulted in the usage of multiple figure. 3 i.e., Architecture of Pervasive Computing.

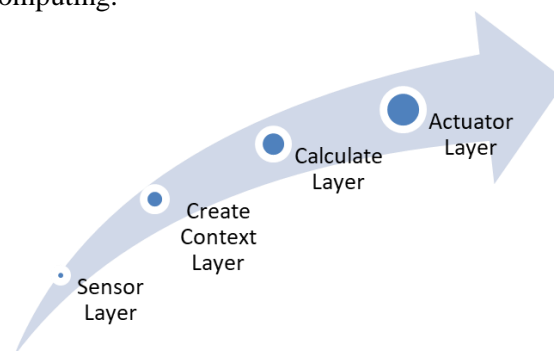


Figure 3. Layered Architecture of Pervasive System

A survey had been done in this paper about a system which helps in increasing the production of crop by fabricating optimum growing condition for the crop with best possible health and least inputs. Thus crop management becomes more economic, minimum environmental damage and ecological because of the use of a reduced amount of inputs. Transmitters are one of the main elements in this system and another important unit is sensors, but eplantOS is the core of the whole system as it's the management software [8] which uses an infrared camera to scan the entire crop canopy. Sensors are, one of the part of pervasive computing system which collect data to perform various types of computations. Another unit of the system is actuators which are organized in the layer form and they are connected to external environment. In this layer a hardware actuator is used for the environment-based calculation.

When a technical aspect is introduced a plant is said to be an eplant. A middleware operating system is used in peer-to-peer interaction model. In this system plants are monitored and devices of the system are unanimously modeled. Consumption is minimized by using a wireless transceiver capability with embedded protocol software. Specially developed wireless transmitters are used so that sensors may communicate their data. A sort of microchip (FPGA) field programmable gate array [9] that is used to carry different function. The working of the chips is based on wireless technology and these chips contain their own batteries in order to communicate in large distances which is approximately to 10 m. Plants communicate with their other components by converting the botanical signal into digital signal.

These digital signals provide the user with the set of graphical tools which provides useful operation like creating, composing and inspecting knowledge symbolized by plant ontology [10] monitoring the plant and environment parameters and as a final point managing dynamically the rules taking part in decision - making process. Sensors are used in plant project in order to detect plant signal and microelectronic module to collect and transmit information. Researchers use ontologies for betterment of this technology [11]. Refer figure 4.



Figure 4. Sensors used in Pervasive Computing [11]

Sensors data is interpreted by computers than the desired adjustments to plant's environment are done. Plants characteristics are captured in a software abstraction called a "Plug". For each and every single part of a crop there is its own digital plug of characteristics. "Synapse" - a virtual channel for data exchange between the two plugs are used for plug to plug communication [12]. Plant signal are characterized and threshold level for action to combat plant stress is determined. This system is used in the determination of temperature rise, chlorophyll fluoresces, bug storming on the crop and gases released by the leaf.

3. Temperature Signal

A process in which plan draws the water through that eventually evaporates from the leaf surface in order to cool the plant is known as "Plants transpire". Increment in the temperature within a leaf means leaf pores, avoiding transpiration because there is little water available to the plant. By using thermistors on plants leaves or by IR (Infrared) images plant canopy temperature can be measured. Refer figure 5 [13][14].

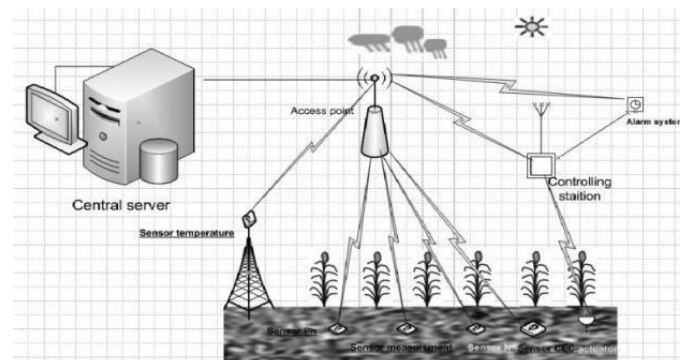


Figure 5. Views of Pervasive Computing Context Aware in Agriculture Environments

4. Chlorophyll

Chlorophyll molecules absorb light and this raises electrons to excited state. After some time, the electron loose some energy and moves to the ground state, and the energy is known as red fluorescence. Photosynthetic efficiency and the stress condition of a plant are measured by measuring Chlorophyll [1] This process is reliant on proximal sensing of fluorescence emission following modulated light pulses.

5. Leaf Gaseous Signal

Volatile organic chemicals are released by plants with cocktail of these gases relating to stress response. The composition of gases released is realized by the stress produced by the plants. Refer figure 6.

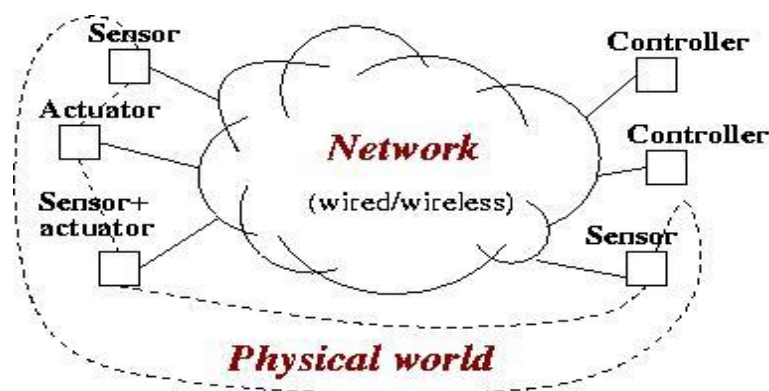


Figure 6. Sensors-Actuators Connections

6. Future Efforts

The researchers are trying to increase the range of the chips so that they can communicate to larger distance. Many researches are also working on "power harvesting" [15] for the chips so that its own energy can be produced through solar energy or ground vibrations, making chips completely independent and eco-friendly. Efforts are also being made to grow plants in space or soil less system which may prove extremely useful [16].

7. Future Scope Ideas

The new approach which we propose in this paper is to use pervasive computing in such a way that it can be proved efficient during floods [17]. In such a condition we can develop such a sensor which can signal the rise of water in fields so that we can raise the walls of the field so that the water does not rise above the required level. Another system which can be developed is when the attack of a particular insect increases which can be proved harmful a signal can be given so that we can use pesticides to decrease the level of insects. Sensors can also be used in such a way so that they can study the soil condition and can indicate the shortage of water and other components which are essential for the particular crop so that we can irrigate the fields and provide the soil with required nutrients [18].

8. Conclusion

A crop monitoring system established with the help of wireless sensor network has been emphasized [19]. Sensors, actuator and the used software is discussed in the paper. Basic designing and the design objectives are essentially recognized, and the design constraints are convened. This field has a good

scope to work upon which to improve the firmness and the system reliability. In addition, complex environmental modifications and to enhance the functioning of low-power use have been adopted. Plants are truly ubiquitous entities motivates us to work in this domain, since they survive in daily environment. Subsequently, plants may be utilized either as "biosensors" or as a "natural" and exquisite interface to facilities [20]. Plants have the extra sensing mechanism to be applied by humans known to be environmental quality indicators; in the concluding issue, artifacts may treat plants as a front end for providing facilities (alarms, narration, greetings, etc). Consequently, plants, if called e-plants, may turn out to be component of Ubicomp that has a wider scope since farming to household usage. Thus, the involvement with the characteristic of agriculture precision, focuses on crop management that derived from plants. Then in real time, fertilizer usage, irrigation methods and pesticide utilization for specific sections of a field; in advance can be controlled by monitoring nature of soil, type of crop and the climate. Thus, decision support system becomes able to learn, the best possible treatments for the better productivity of crops.

9. References

- [1] Chi, Ed.H., Borriello, G., Hunt,G., Davies,N., "Pervasive Computing in Sports Technologies", *IEEE PERVASIVE computing*, JULY-SEPTEMBER 2005
- [2] D. Tennenhouse, "Proactive Computing," *Comm. ACM*, vol. 43, no. 5, May 2000, pp 43–50.
- [3] Saha, D., Mukherjee, A., "Pervasive Computing: A paradigm for 21st Century".
- [4] M. Baldauf, S. Dustdar, and F. Rosenberg, "A survey on contextaware systems," *International Journal of Ad Hoc and Ubiquitous Computing*, vol. 2, no. 4, pp. 263–277, 2007.
- [5] J. C. Augusto, V. Callaghan, A. Kameas, and I. Satoh, "Intelligent environments: a manifesto," *Human-Centric Computing and Information Sciences*, vol. 3, p. 12, 2013.
- [6] Weiser Gold and Brown," The Origins of Ubiquitous computing research at PARC in the late 1980s", *IBM system journal*, vol 38 no 4, 1999.
- [7] Transforming agriculture thru pervasive wireless sensor network published by *IEEE computer society* 1536-1268/07 copyright 2007 IEEE pg no. 51.
- [8] Y. Cho, K. Cho, C. Shin, J. Park, and E. Lee, "An agricultural expert cloud for a smart farm," *Future Information Technology, Application, and Service*, vol. 164, pp. 657–662, 2012.
- [9] Balasaheb S. Darade and Tarun A. Parmar, 2002. Paper Presentation on Programming FPGA's Using Handel-C" *Jawaharlal Nehru Engineering College Aurangabad*.
- [10] T. Kim, N. Bae, M. Lee, C. Shin, J. Park, and Y. Cho, "A study of an agricultural ontology model for an intelligent service in a vertical farm," *International Journal of Smart Homes*, vol. 7, no. 4, 2013.
- [11] T. R. Gruber, "A translation approach to portable ontology specifications," *Knowledge Acquisition*, vol. 5, no. 2, pp. 199–220, 1993.
- [12] J. G. Pohl, "The evolution of intelligent computer software and the semantic web," in *Proceedings of the 16th International Conference on System Research, Informatics and Cybernetics*, 2004.
- [13] T. Salvador, G. Bell, and K. Anderson, "Design Ethnography," *Design Management J.*, vol. 10, no. 4, Fall 1999, pp. 35–41.
- [14] S. Lewis et al., "Ethnographic Data for Product Development: A Collaborative Process," *Interactions*, vol. 3, no. 6, Nov./Dec. 1996, pp 52–69.
- [15] J. Lifton, "Pushpin Computing System Overview: A Platform for Distributed, Embedded, Ubiquitous Sensor Networks," *Proc. Ist Int'l Pervasive Computing Conf. 2002, Lecture Notes in Computer Science*, no. 2414, Springer-Verlag, 2002, pp. 139–151.
- [16] D. Estrin et al., "Instrumenting the World with Wireless Sensor Networks," *Proc. Int'l Conf. Acoustics, Speech, and Signal Processing (ICASSP 2001)*, vol. 4, IEEE Press, 2001, pp. 2033–2036.
- [17] Judd, G., Steenkiste, "providing contextual Information to Pervasive Computing Applications", *Proc, IEEE International Conference on Pervasive Computing*, March 2003.

- [18] Walker, K., kabashi, A., Abdelnour, J., Ngugi, K., Underwood, J., Elmirghani, J., and Prodanovic, M., "Interaction design for rural agricultural sensor networks", *Internal Environmental Modeling and Software society (iEMSs)*, 2008.
- [19] D. Estrin, "Next Century Challenges: Scalable Coordination on Sensor Networks," *Proc. 5th Ann. Int'l Conf. Mobile Computing and Networking (MobiCom 99)*, ACM Press, 1999, pp. 263–270.
- [20] Baggio, A., "Wireless sensor networks in precision agriculture", *In Proc. ACM Workshop Real-Word Wireless Sensor Network*, 2005

Acknowledgments

Authors deeply acknowledge all the reviewers and contributors for their sincere contribution towards the publication of the research paper.