Transforming Agriculture using the Internet of Things (IoT)

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***Abstract*: Agriculture is the major source for the largest population in India to earn income and carry out their livelihood. Meticulousness agriculture is now adopted in other countries, but India still need to implicate IoT and cloud computing technologies for better production of crops. The Internet of Things (IoT) will be beneficial to connect the devices, collect and distribute the information. Cloud adoption is expected to increase expressively in near future due to better cloud hosting services and quicker internet speeds. Together they will be able to give essential information along with the deliberation of saving in cost which will be advantageous to farmers.**

Internet of Things Precision Agriculture utilizes the herbal resources more effectively by using accumulating actual-time data on crop development, soil, weather, and air satisfactory, to help agriculture employees and farmers to make intelligent decisions almost about planting, fertilizing, and harvesting crops. Using this generation, farmers can successfully use records to reap greater yields and therefore earn higher income.

***Keywords*: Internet of Things (IOT), Cloud Computing, Agriculture, Sensor network.**

I. Introduction

With the combination of both advanced technologies in hardware and software, the Internet of Things is able to track and count everything which can greatly reduce the waste, lost and cost. The information of parameters of interest can simply obtained at fingertips using electronic devices which ease the user to take further action. The IOT transforms the agriculture industry and enables the farmers to contend with their challenges, Innovated applications can address these issues and therefore increase the quality, quantity, sustainability and cost effectiveness of crop production. The Organisations makes use of Internet of Things (IOT) by applying the waspmote plug & sense in its greenhouse. Sensor probes are installed at various points to measure the parameters of interest. The system is programmed and connected with star topology. Two of the sensor nodes send the extracted data to the two of the sensor nodes send the extracted data to the central node at every interval of 15 minutes. The data is sent via 3G to a server and stored in an internal memory. The information is then visualised through its web interface. Users can take actions by controlling the irrigation system through the web interface. [24]

The Food and Agricultural Organization of the United Nation (FAO) predicts that the global population will reach 8 billion human beings by means of 2025 and nine.6 billion human beings by means of 2050. In order to preserve tempo, meals production must boom with the aid of 70 percent through 2050 globally. India is a massive agricultural Country, and agricultural production has an essential effect on country wide meals safety also. Compared with evolved countries within the world, the location of farmland in step with capita is a ways decrease than the common degree inside the international and the manufacturing value consistent with capita and land yield in step with unit are also on a decrease stage in case of India. Thus, to stand challenges of meals production, we want to develop methods to produce greater output with the restricted to be had natural assets.

IOT and cloud computing is an era which has a tendency to attach diverse items in the international to the Internet [4][5]. It entails using RFID, wireless and other sensors with Internet stack inbuilt into the device. Applications are advanced primarily based on IOT enabled devices to display and manipulate diverse domain names based totally on programs [3].

IOT and cloud computing technology can be efficaciously used to increase the crop production to meet the developing wishes of increasing population in India [1][12][21]. M2M being the imperative a part of IOT is beneficial to experience the geographical necessities through tracking the land where we want to enforce IOT [2][16]. Cloud computing alongside IOT is beneficial to price pay in line with usage and as a result decreasing the price in agriculture [4][5][13]. New innovative IOT applications may be developed to growth the great, quantity, sustainability and fee effectiveness of agricultural manufacturing [15].

Indian farmers have already began taking help of the cutting-edge and superior agriculture tools and machines. But as a ways as usage of IOT is worried, Indian farmers are simply at an introductory degree in the usage of the IOT generation for agriculture as compared to the opposite nations that have reached to the advance stage in making use of the generation for farming [22].

II. IoT and Cloud Computing for Agriculture

With the global increase in populace, the need for increase in food production is raised. The Food and Agricultural Organization of the UN (FAO) survey anticipated that growth in global populace will in addition create bad circumstances in destiny with the simultaneous boom in charge of meals products if right measures will no longer be taken. This will bring about starvation to the people who fall underneath the poverty line.

Use of generation is constantly growing to improve food manufacturing and business activities. IOT can be used to connect the world's objects in both a sensory and clever manner through combining technological traits in object identity ("tagging things"), sensors and wi-fi sensor networks ("feeling things"), embedded systems ("thinking things") and nanotechnology ("shrinking things")[17].

Farmers need type of records and services to enhance crop manufacturing based on land, crop, climate situations, finance availability, irrigation facilities etc. Cloud computing is required in agriculture because it is not possible for farmers to cope with service companies on an person basis. They want comprehensive and cost powerful service providers with more than one services. In this example cloud computing can also provide information as a service (DaaS), it costs much less as compared to the constant services that are charging on a fixed foundation no matter utilization of provider. Cloud computing affords sharing of resources with cheap cost. Cloud computing service provider may provide services like Infrastructure as a Service (IaaS), Platform as a Service (PaaS) and Software as a Service (SaaS) with less costly cost. Cloud computing has been used for storage of agriculture statistics by Government and personal businesses. Use of IOT along with Cloud Computing can help loads to Indian farmers to growth the manufacturing with the aid of imparting the precise verbal exchange between objects and charging consistent with the use of service [18].

III. Problem Statement:

1. Limited amount of workers to cover a large area of farm
2. Limited by time. Farmers are hard or even unable to monitor and provide the required conditions for plants at certain time such as during the night or emergency. [24]

IV. Objectives

- To overcome the limitations of the irrigation system in conventional farming
- To provide and maintain the crops in their optimum environment for growth in terms of soil moisture and temperature. [24]

V. Existence of IoTand Cloud Computing in other Countries

Considering the Asian nations for reference is right in our case, as India is part of Asia continent. Here, lifestyles of IOT and Cloud Computing for agriculture is explored in of the Asian international locations, China and Japan. Both of those countries are already within the enhance degree in terms of using IOT and Cloud Computing for agriculture.

A. IOT in agriculture at China

Internet of factors draws an awful lot greater attention in China than that in the United States, the European Union and different countries inclusive of India. The first Chinese agriculture IOT utility carrier platform has been constructed through scale, which connects the first organization of the sixty four IOT bases worried in the production, processing and distribution in China [6]. They could make evaluation and selections with records remarks from the sensing and incorporated with the rural know-how [2][13]. They at the moment are used in agricultural manufacturing (inside the cities of Beijing, Shouguan and Shanghai), on the fruit (orange) farms (within the town of Chongqing), in the proper husbandry farms (inside the metropolis of Beijing) and as well as inside the technique of the storage, transportation and tracing of agricultural merchandise, and so on. [20].

B. Cloud Computing in Agriculture at Japan

Cloud computing is enormously suited to in addition optimize human expertise to later generations. Fujitsu in Japan has developed a version for the use of Cloud Computing in agriculture which also can be utilized in other sectors inclusive of environment, medication and preservation sectors[7][14]. The version includes the following series: Inputs-Data garage-Visualization-Analysis-Instruction. The version become field examined for verification in vegetable and paddy cultivation in Miyazaki and Shiba prefectures, respectively. [25]

VI. Challenges to Utilize Internet of Things in India

Although IOT is beneficial for the Indian agriculture area, this era has numerous demanding situations [19] as a ways as India is concerned. Internet availability and connectivity in India is one in all the largest venture. Consumer IOT adoption: this will continue to be another foremost undertaking. As global companies, frequently mistakenly, expect that Indian clients are "no longer prepared" for superior products [8][9]. This may be very much glaring in the IOT space, with infrequently any type of vendor interest these days. This, in turn has led to low cognizance ranges of IOT devices and systems amongst clients. Apart from internet the helping infrastructure consisting of clever grids, site visitors systems, and many others, are some distance from being geared up for IOT.

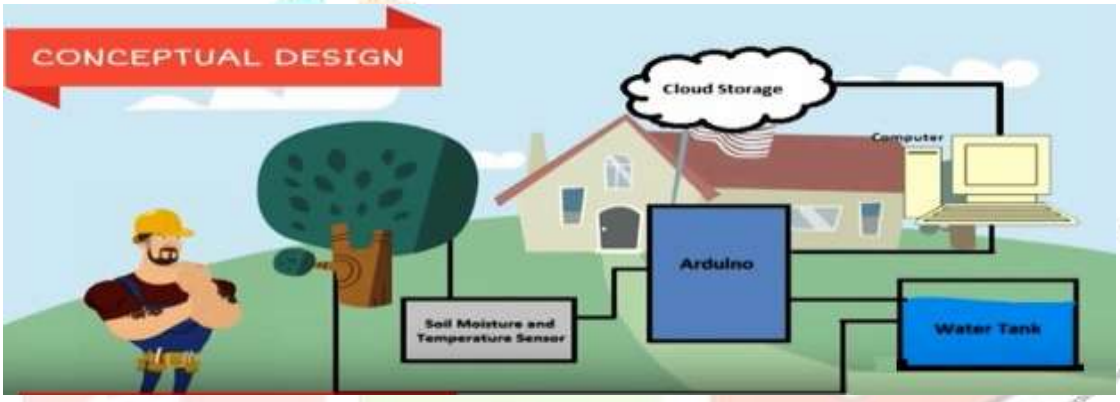
The IOT offers fantastic ability to innovate in agricultural field. With its wealth of revel in in IP design and venture control, India is in a unique role to give you innovative merchandise. Recent authorities incentives and help have given marketers the boost they want to forge beforehand. If they do, India can virtually recognize the dream of "Make in India" for the arena.

VII. Proposed Model

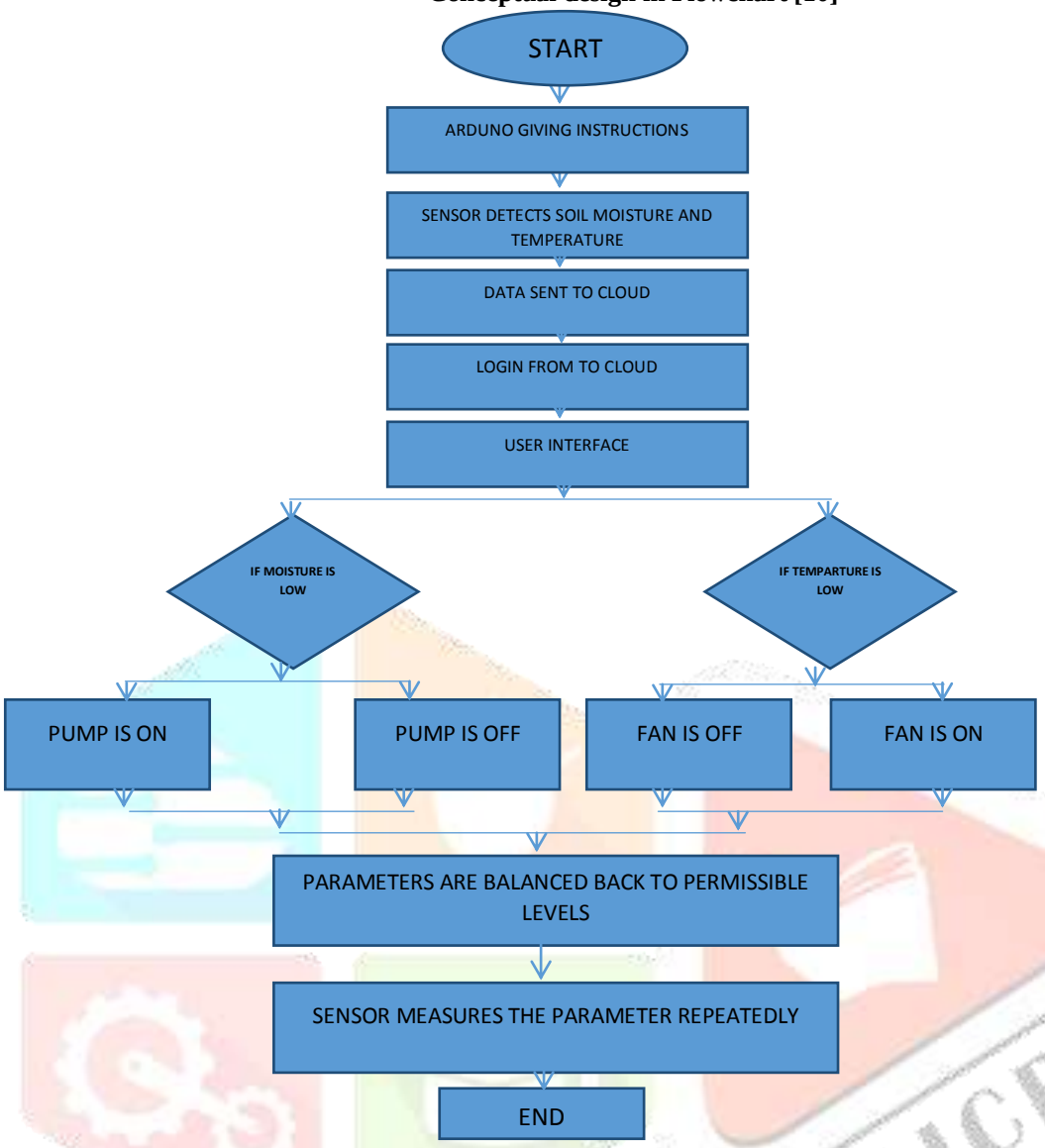
As proven within the underneath discern, the proposed version uses IOT to gather required facts of various gadgets positioned in exclusive elements which isn't viable without the use of sensor network. Here, use of cloud computing garage server is proposed to lessen the price of records service, and thereby overcoming any other drawback of excessive cost of facts. [25]

Cloud computing and IOT based agricultural proposed model [10]

VIII. Conceptual design[10]



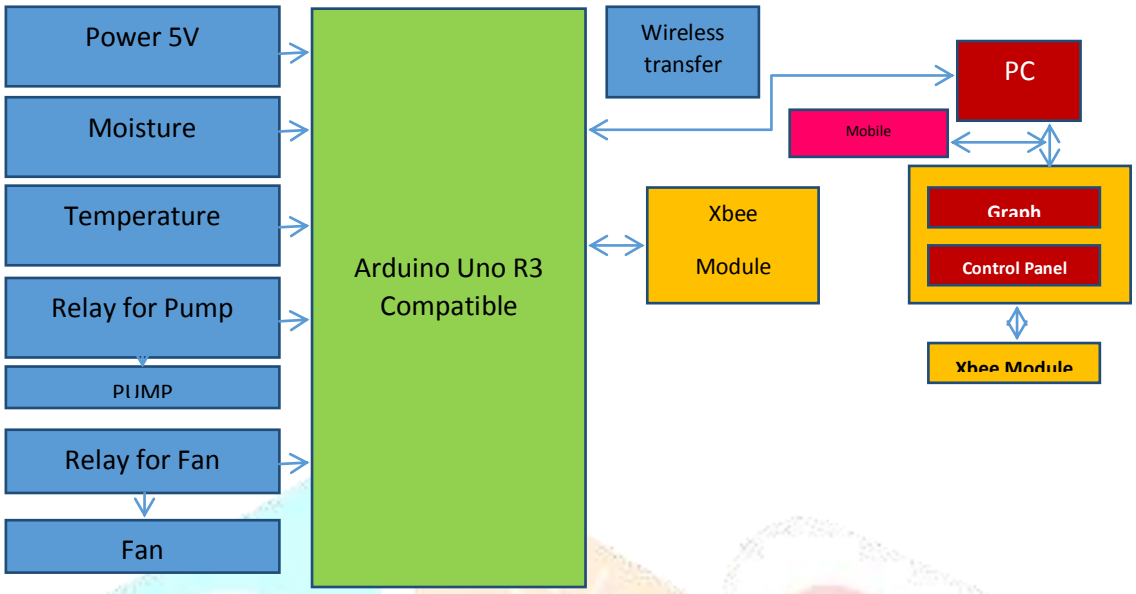
Conceptual design in Flowchart [10]



IX. System Design

The proposed model of smart irrigation system aims to provide and maintain the optimum conditions for the crops.By growing in an environment with sufficient water supply and ideal temperature, we believe that the growth of plants can be improved and thus the productivity of the agriculture field will thus increase as well. [24]

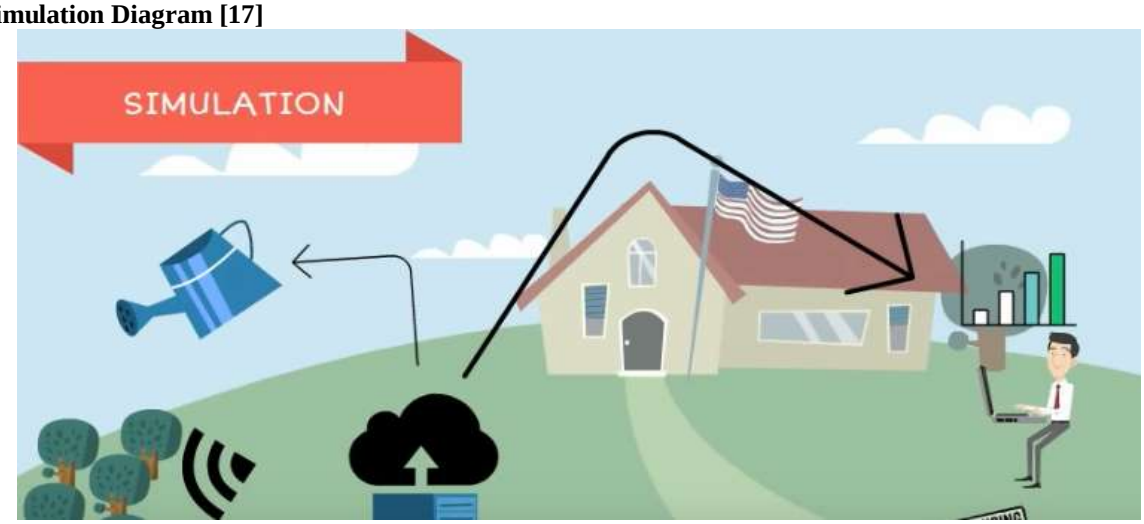
Block diagram [18]



X. Materials required

S. No.	Name of the Item	Image
1.	Soil Moisture and Temperature Sensor	
2.	Two Channel Relay Module and	
3.	Arduino Uno R3 compatible	

XI. Simulation Diagram [17]



As in step with the discern of proposed version, the data is sent to server by means of numerous gateways. The information at gateways are collected from exceptional sensor nodes which can be embedded at extraordinary places of agricultural fields [10]. The wireless sensor community is gathering the facts of geographical location by means of tracking the fields with Radio-frequency identity and other sensing gadgets [11]. RFID is the wi-fi use of electromagnetic fields to transfer records, for the functions of automatically figuring out and tracking tags connected to objects. The server acts because the notion layer which senses and offers region facts. Now the second one layer gets the records from notion layer and uses extraordinary technology like Wi-Fi, CDMA, 3G, and so forth. For the delivery reason. Then, the cloud computing technology is used for the virtual storage cause.

The benefit of the usage of the cloud computing storage server is that the fee of data as a service is reduced, as now the user is supplied with the extra facility to request only the specified service for the required time from the server. The user no longer requires to pay for the complete carrier bundle for a hard and fast length that's a highly-priced solution. Thus, if the customer is an person (farmer) then that individual might not be able to find the money for the complete service package and if the client is any agency (kingdom authorities) then they're capable of buy the complete bundle.
Basically there are three styles of offerings presented with the aid of cloud garage:

1) Infrastructure As A Service (IaaS)
2) Platform As A Service (PaaS)
3) Software As A Service (SaaS)

According to Pay Per Utility concept of cloud computing, the client can request any of the above services. [25]

XII. Benefits of IoT and Cloud Computing in Agriculture

Various beneficiary packages can be evolved primarily based at the proposed model for India. Some of the advantages of IOT and cloud computing packages in agriculture are as stated beneath:

- Forestry
- Storage monitoring – water tanks, fuel tanks
- Allocation of sources on demand without restriction
- Maintenance and enhancements performed within the returned-end
- Easy rapid improvement together with collaboration with other systems in the Cloud
- Improvement in the green usage of inputs like soil, water, fertilizers, insecticides, and so forth.
- Reduced fee
- Livestock tracking
- Indoor farming – greenhouses and stables
- Fish farming

XIII. Conclusion

With the IOT, single farmer might be capable to deliver the crops immediately to the purchasers no longer simplest in a small vicinity or stores but in a wider vicinity. This will amendment the whole deliver chain which is in the main inside the hand of massive agencies and agents at present. A more immediately, shorter chain among producers and customers can be hooked up to offer gain to farmers. Cloud Computing might permit business sector to supply all the important offerings at less costly value to farmers in rural regions. IOT will rework the way rural India live, play, and work. It may be considered as an interesting vicinity for revolution. It gives common challenges and opportunities, from scaling applications and offerings from billions to trillions of linked gadgets, and from Tera to Zeta bytes of statistics for a socially expanded country. [25]

The main purpose of the irrigation system is to provide and maintain the ideal environment in terms of soil moisture and temperature for the optimum growth of crops.

Using electronic devices such as smartphones and remote computers, user can log in to the cloud storage to extract the sensor data. User can monitor the crops and control the water pumps and fans in the control panel of the user interface.

There are some advantages that can be highlighted in this system. Firstly, it can save time and water as you do not have to personally go to the farm to do the watering.

The irrigation system supplies the right amount for the plants as excessive watering may affect the growth of the plants and sometimes the water from the rainfall is not sufficient for the plants.
So, this system makes used of the sensor to detect the soil moisture level and do watering by using the water pump. Then since the water is supply directly to the roots of the plants, it can actually prevent weeds from growing around the plants. This may also save you from spending money and energy to do the weeding process.
Soil temperature also has big effect on the plant growth. If the temperature is too high, the soil will become dry and loss its nutrients. Hence, by knowing the soil temperature from the sensor, electric fans are switched on remotely when the soil temperature is above the ideal level.
Other than that, the irrigation system will in fact reduce human effort as the sensor will be the one who collects all the data directly from the farm to the user's electronic devices. User does not have to go on site to monitor the environment of the plantation which is impractical if the area is too wide. All this work can be done at the end of fingertips with the introduction of Internet of Things in Agriculture field.

By providing and maintaining the ideal environment for the growth of crops using innovation application of Internet of Things(IoT), we believe that the productivity of the crops can be increased and is sufficient to feed the estimated human population of 9billion people in year 2050. [24]

References:

[1] AnupriyaTuli, NitashaHasteer, Megha Sharma and Abhay Bansal ," Framework to leverage cloud for the modernization of the Indian agriculture system," Electro/Information Technology (EIT),IEEE International Conference ,pp. 109 - 115,5-7 June 2014.

[2] CharithPerera, ArkadyZaslavsky, Peter Christen and DimitriosGeorgakopoulos, "Sensing as a Service Model for Smart Cities Supported by Internet of Things," Transactions on Emerging Telecommunications Technologies, Australia,2014.

[3] Duan Yan-e, "Design of Intelligent Agriculture Management Information System Based on IOT," Intelligent Computation Technology and Automation (ICICTA), International Conference on Volume:1 28-29 March 2011 pp : 1045 - 1049,2011

[4] Fan TongKe,"Smart Agriculture Based on Cloud Computing and IOT",Journal of Convergence Information Technology(JCIT) Volume 8, Number 2, Jan 2013

[5] HemlataChanne, Sukhesh Kothari , Dipali Kadam,Assistant Professors, Department of CE, PICT, Pune, India"Multidisciplinary Model for Smart Agriculture using Internet-of-Things (IOT), Sensors, Cloud-Computing, Mobile-Computing & Big-Data Analysis "IJCTA | May-June 2015

[6] Ji-chun Zhao, Jun-feng Zhang, Yu Feng, Jian-xinGuo, "The Study and Application of the lOT Technology in Agriculture ",2010 IEEE

[7] Kiran R. Biduaa, Dr.Chhaya N. Patel, Internet of Things and Cloud Computing for Agriculture in India International Journal of Innovative and Emerging Research in Engineering Volume 2, Issue 12, 2015, e-ISSN: 2394 – 3343 p-ISSN: 2394 – 5494

[8] K.Venkataramana, Dr.M.Padmavathamma "A Design of Framework for Agri-Cloud" IOSR Journal of Computer Engineering (IOSRJCE) ISSN: 2278-0661 Volume 4, Issue 5 (Sep.-Oct. 2012), PP 01-06 Department of Computer Science, S.V.University, Tirupati.

[9] Muhammad Azrul, IoT Project National University of Malaysia (UKM) https://www.youtube.com/watch?v=j4HBlOf5ZDA

[10] Lin Li "Application of the Internet of Thing In Green Agricultural Products Supply Chain Management"Intelligent Computation Technology and Automation (ICICTA), 2011 International Conference on (Volume:1) Page(s): 1022 - 1025 Sch. of Comput. & Inf. Eng., Harbin Univ. of Commerce, Harbin, China

[11] MeonghunLee ; Dept. of Inf. &Commun. Eng., Sunchon Nat. Univ., Sunchon, South Korea ; Jeonghwan Hwang ; Hyun Yoe "Agricultural Production System Based on IOT" Computational Science and Engineering (CSE), 2013 IEEE 16th International Conference on 3-5 Dec. 2013 Page(s): 833 – 837

[12] Mitsuyoshi Hori, Eiji Kawashima , Tomihiro Yamazaki "Application of Cloud Computing to Agriculture and Prospects in Other Fields"FUJITSU Sci. Tech. J., Vol. 46, No. 4 (October 2010)

[13] Mr. Mahesh D. S, Ms. Savitha S, Dr. Dinesh K. Anvekar "A Cloud Computing Architecture with Wireless Sensor Networks for Agricultural Applications" International Journal of Computer Networks and Communications Security VOL.2, NO.1, January 2014, 34–38

[14] Prashant Satpute,OmprakashTembhurne, "A Review of Cloud Centric IOT based Framework for Supply Chain Management in Precision Agriculture ",International Journal of Advance Research in Computer Science and Management Studies, Volume 2, Issue 11, November 2014

[15] Rao, B.B.P, Saluia, P. ; Sharma, N. ; Mittal, A. "Cloud computing for Internet of Things & sensing based applications " Sensing Technology (ICST), 2012 Sixth International Conference on 18-21 Dec. 2012 ,Kolkata, Pages: 374 – 380

[16] Rupanagudi, S.R, Ranjani, B.S, Nagaraj, P, Bhat, V.G. " A novel cloud computing based smart farming system for early detection of borer insects in tomatoes " Communication, Information & Computing Technology (ICCICT), 2015 International Conference on 15-17 Jan. 2015 Page(s): 1-6

[17] Sivabalan, M. A. Rajan and P. Balamuralidhar,"Towards a Light Weight Internet of Things Platform Architecture",july 2013; Accepted August 2013,Journal of ICT Standardization, Vol. 1, 241–252.
[18] Suciu. G, Vulpe, A , Fratu, O,Suciu, V. "M2M remote telemetry and cloud IOT big data processing in viticulture" Wireless Communications and Mobile Computing Conference (IWCMC), 2015 International 24-28 Aug. 2015 page(s): 1117 – 1121
[19] Swathi B S, Dr. H S Guruprasad,"Integration of Wireless Sensor Networks and Cloud Computing ",Volume 2, Issue 5, May 2014 PG Scholar, Dept. of ISE, BMSCE, Bangalore Professor and Head, Dept. of CSE, BMSCE, Bangalore,IPASJ International Journal of Computer Science (IIJCS)
[20] V.C.Patil, K.A.Al-Gaadi, D.P.Biradar, M.Rangaswamy, "Internet of Things (IoT) And Cloud Computing For Agriculture: An Overview", Proceedings of AIPA 2012, INDIA.
[21] Yen-Kuang Chen,Intel Corporation Santa Clara, CA, USA,"Challenges and Opportunities of Internet of Things", Design Automation Conference (ASP-DAC), 2012 17th Asia and South Pacific,IEEE, Jan. 30 2012-Feb. 2 ,2012,Page(s): 383 – 388
[22] Yichuan Zhang, Kai Zhou and Xinzheng Li,School of Horticulture and Landscape Architecture, Henan Institute of Science and Technology, Xinxiang 453003, China"Study on the Construction of Smart Agricultural Demonstration Park "International Journal of Smart Home Vol.8, No.5 (2014), pp.261-268
[23] Yifan Bo, Haiyan Wang,"The Application of Cloud Computing and The Internet of Things in Agriculture and Forestry" 2011 International Joint Conference on Service Sciences School of Information Science and Technology Beijing Forestry University Beijing, China
[24] Yi Liu; Fudan Univ., Shanghai, China ; He Wang ; Junyu Wang ; Kan Qian " Enterprise-Oriented IOT Name Service for Agriculture Product Supply Chain Management" Identification, Information and Knowledge in the Internet of Things (IIKI), 2014 International Conference on 17-18 Oct. 2014 Page(s): 237 - 241