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
IMPACT FACTOR: 7.056

IJCSMC, Vol. 10, Issue. 11, November 2021, pg.47 – 53

Using IOT to Improve Indian Agriculture

Ajay Kumar[1]; Anmol Swaroop[2]
[1]Maharaja Surajmal Institute of Technology, Delhi, India
[2]KIET, Ghaziabad, Delhi, India
ajaykatha@msit.in; getch1997@gmail.com

DOI: 10.47760/ijcsmc.2021.v10i11.006

Abstract: The use of Internet of Things (IoT) may provide the boost which is required to improve the productivity of Indian agriculture system which is well below the world average and may help in improving the income and conditions of Indian farmer. The present paper presents the efforts done by the researchers in this direction to promote the use of Information technology in general and IoT in particular in Indian agriculture sector. The areas in which IoT helps are, robotics, decision support systems, smart irrigation, precision farming, use of social media for the benefit of Indian farmers. The use of agent based systems in Indian Agriculture scenario has also been discussed in this paper.

Keywords: IoT, Productivity, agent based system, smart irrigation

I. INTRODUCTION

The Indian farm and agriculture sector is lagging behind the farming sector of other countries because the farmers here follow traditional practices. The productivity of all the crops in India is significantly below the world average. That's why we are not able to come in competition in food and other crops production with countries such as USA which is despite having highest agricultural land in the world. Another reason may be the diversified weather pattern, diversified cultures, different land profile and varying socio-economic condition in various areas of the country. Another challenge is the small land holdings with the Indian farmer making it difficult to adopt modern practices or global standards in agriculture. Hence, the global information technology solutions applied in farming in developed countries cannot be directly applied in Indian scenario and we need to develop indigenous solutions for our specific problems taking cue from the global standards.

With the increased penetration of mobile, internet and computers among the farmers, it is now feasible to develop information technology solutions for the Indian farmers, to disseminate it quickly among the farmers and to educate them about the benefits of these solutions. The government of India has also been focusing on this area since a while and the government thinks that this will help in achieving its ambitious target of doubling the farmer's income by 2022 [1]. For that purpose Indian government has taken several initiatives such as soil health card eNam and Kisan Call centre. The use of IoT in agriculture may be also seen in the perspective of 3 farm bills.

There are various problems in Indian agriculture sector such as lack of irrigated land, small land holdings, age old farming practices, late detection of plant disease, lack of accessibility of

farmers to various lucrative markets, lack of good quality seed bank and so on. In developed world, several countries have taken immense advantage of Information Technology in solving problems of agriculture sector and reaped the benefits in terms of increased production and quality. The environment and sustainability is another area where Information Technology can help. In India, use of Information Technology in agriculture sector is rarely visible because of poor IT infrastructure and lack of awareness in the farmers.

The Information Technology infrastructure has also reached to the village through fiber optical cable via government of India. The digital India push has also worked in the direction of digital literacy including farmers. Therefore, in recent years, several researchers have focused on use of Information Technology in farming in Indian context and tried to tackle all of the problems mentioned in above paragraph in one way or other. The student community has also been involved through smart India hacathlon in which the UG students [2] try to provide solutions of the problems provided to them by agriculture ministry using Information Technology. In this research paper, the information technology solutions indigenously developed only for Indian agriculture sector have been summarized. E-yantra lab has also announced the theme of the year as Internet of Things (IoT).

The rest of the paper is organized as per the description ahead. Section 2 contains the use of IoT in irrigation, section 3 presents the use of image processing & IoT in plant disease detection, section 4 exhibits the use of social media and eNAM for the benefit of *Indian* farmers, section 5 exhibits the effective use of robotics along with IoT in India which is an extension, section 6 discusses the use of IoT and ICT in precision farming whereas section 7 discusses miscellaneous issues. Finally, section 8 concludes the paper.

II. IOT IN IRRIGATION

It is being said that IIIrd world war will be fought over the scarcity of water. In India, there is plenty of agriculture land in comparison of other countries; however, most of it is non-irrigated. The per capita yield in an irrigated land is significantly higher than the per capita yield of a non-irrigated land. Moreover, due to global warming, the Himalayan glaciers are melting at a very fast speed, thus reducing the availability of fresh water to a great extent. It has been estimated that these glaciers will be eliminated by 2050 and our perennial rivers like Ganga, Yamuna, Satluj, Vyas will become seasonal rivers. Therefore, it is of extreme importance for India to save water during farming practices as much as possible. The government of India has initiated "More crop per drop" initiative which motivated several researchers to work in this direction. The efforts in this direction have been summarized below:

Rathod-Khedkar-Chaudhry [3] mentioned in their work that over irrigation and under irrigation is major problem of Indian agriculture sector. The major problem with manual irrigation system is that it is time based irrespective of whether plants require water or not. Depending upon, soil type, weather condition, the variety of seed and the crop duration between successive irrigation must vary which is very difficult to be judged by the farmer manually. Moreover, if the water resource is limited, the irrigation between different crops of the same farmer must be prioritized in order to maximize the profit. Hence, the authors proposed and intelligent irrigation system based upon the above mentioned parameters. The proposed system uses humidity and temperature sensor to sense the water content in the soil and its temperature along with crop pattern and water requirement of each crop. The proposed system provides an efficient schedule for the irrigation of different plots with in the same farm. The system contain a LCD display to provide the pertinent information to the farmer.

Precise control of irrigation water for improving water use is critical for sustainability of irrigated farming systems under present water crisis scenario. Border-check irrigation is the predominant method of irrigating dairy pastures, which is one of the largest water user. Dasanayke et al. [4], proposed a system which consists of a wireless sensor and actuation network, a central host/user interface, which collects stores and displays real time information, and central control system software. The proposed system helps in saving water significantly and presently installed for evaluation purpose.

Prabhu-Spohia [5] presented a review of use of wireless sensor network (WSN) in drip irrigation. The wireless sensor network can be installed in the farm to collect different physical as well as chemical parameters such as ambient temperature, ambient humidity, soil temperature, drip water temperature, soil moisture, soil pH, water pressure, flow rate, amount of water, energy calculation,

chemical concentration and water level. These parameters are related to plant health and need for irrigation. The data is collected by sensor nodes and forwarded to the central server through gateway. Upon receiving this data, the server initiates various necessary control signals. The control buses are used to route these signals to the respective controllers which helps in implementation and automation of the drip irrigation system.

Kulkarni [6] discusses the decision support system for controlled irrigation adapted in various countries such as Australia, South Africa and China. South Africa has developed an innovative decision support system called Mycanesim' by deploying the sophisticated information and communication technology. The system consists of a sugarcane simulation model, an on-line weather database and a communication network which automatically provides farmers with near real-time field-specific irrigation advice and yield estimates using cell phone text messages (SMS). In Australia, a simple mechanical device called a 'Wetting Front Detector (WFD)', which shows the irrigator as how deep the water has penetrated into the soil was introduced to help better irrigation scheduling. To help irrigators, an interactive visualization tool 'The Fullstop Game' is provided on a specially developed website< www.fullstop.com.au>. In China a new irrigation approach called Controlled Alternate Partial Root-zone Irrigation (CAPRI) also called partial root-zone drying (PRD) was applied to improve crop water use efficiency without significant yield reduction.

III. PLANT DISEASE DETECTION USING IMAGE PROCESSING & IOT

The plant diseases in crops cause a significant reduction in yield of almost every crop in India. Due to this Indian farm sector and farmers are under stress. Moreover, due to indiscriminate and illogical use of pesticides and herbicides is making the ground water polluted and Indian agriculture unsustainable. Plant Disease detection at an early stage may prove to be a major mile stone in the Indian agriculture. The information technology in general and image processing in particular may help in achieving this goal. Hence, in this section, the use of image processing in plant disease detection has been summarized.

Wable-Khapre-Mujalkar [7] proposed the prototype of a system which can detect plant disease using image processing in any kind of polyhouse crop. In the proposed system a farming robot to detect the plant health automatically has been used. The robot has a camera for capturing images of plants and sensors to sense the environmental parameter in real time condition. The sensors used are temperature, humidity, soil humidity and light sensor. Zig-Bee is used for communication purpose. Arm-7 is used as controller and RG-CAM-1 as camera.

Jhuria-Kumar-Borse [8] used image processing as a tool to monitor three diseases of grapes and two of apple. The Authors purposed a system using artificial neural network. Two separate image databases for training and implementation of query images have been used in the proposed system. The author claims that the proposed algorithm is effective for controlling the spread of disease The practical implementation of the proposed system has been performed using MATLAB.

Dandwate-Kokare[9] proposed an approach based on image processing for the detection of diseases in soybean plants. The images are captured using mobile camera and provided as input to the Decision Support System (DSS). The decisions support system works using Support Vector Machine (SVM). The proposed algorithm may detect unhealthy leaves with an average accuracy of 93.79%.

Rupagandhi et al. [10] presented a Cloud Computing based System for Early Detection of Borer Insects in Tomatoes. In this solution the crop is continuously monitored with the help of image processing, cloud computing and robotics. The paper also discusses the possible use of IoT in detecting borer insect. The wireless web camera continuously captures the images from the field and sends these to the server for further processing and early detection of insects. The authors claimed that the proposed solution prevents unnecessary spraying.

IV. IOT, SCOIAL MEDIA FOR INDIAN AGRICULTURE

The impact of social media in every field including agriculture cannot be ruled out. In [11], Agarwal-Atrey-Sundari presented Krishi Ekta as an integrated knowledge distribution system for Indian Agriculture. The proposed system addresses the issue of access of important information to various stakeholders in Indian agriculture such as farmers, government agencies, planning commission, ministry officials. The proposed system gathers information from multiple sources and organizes it in to various categories. The categorized information is distributed using SMS, tweet,

Facebook post and digests e-mail. The information summarized properly having relevant links are distributed to the subscribers.

Rai-Sahila [12] tried to establish the relationship between the rural development particularly farmers in India and the social media. The author extended the definition of social media networks from the social networking sites and micro blogging to other media such as AIR, news channels and NGOs. The paper discusses various areas in which social media has affected or may affect the lives of rural people. The social media networks must speed up in order to properly disseminate information to remote villages and poor farmers.

Syiem-Raj [13] conducted a study to determine the level of usage of information technology between farmers of Meghalya. The results of the survey demonstrate that the majority of the farmers owned mobile phones, TV and radio. The farmers used mobile phones for social communication and information transferring among themselves. The mobile phone is used to get the price of their crop from the middle men and getting advice from the agriculture experts on real time basis. However, in the survey it was revealed that the major problems in using Information technology by them is the lack of confidence in operating it.

V. IoT, WSN & Robotics in Farm Sector

The IoT, WSN and Robotics are costly affair and in country like India it is difficult to implement. It is widely assumed that due to small land holding and over populated Indian farm sector does not have much space for use of robotics in farm practices. However, there are certain areas in which the use of robotics in Indian agriculture may be beneficial for the farmers for example, in case the height of a fruit tree is too high, it is difficult for a farmer to judge the outbreak of a disease, in case of a spray of a harmful pesticide the farmer's life may be in danger. In such circumstances, the use of robotics may be beneficial in the context of Indian Agriculture. In recent years, several researchers from India tried their hands in this emerging area, the details of some of these ventures have been summarized below:

Agarwal-Thakur [14] designed a robot specifically helpful for farm practices in Indian context and named it as "Agro Robot. The agro robot has ultrasonic sensor, orientation sensor soil moisture sensor besides solid dispensing mechanism and liquid dispensing mechanism. Agro robot can be used for selection and rate for spray of solid/liquid fertilizer/insecticides/pesticides/weedicide. The robot may be used for planting seeds and controlling irrigation depending upon the soil moisture level. The agro robot may prove to be very useful for the farmers.

Potdar et al. [15] proposed an IoT based solution for farming using arduino technology. In proposed system the sensor nodes have various external sensors for, soil moisture, soil pH ,leaf wetness and atmospheric pressure sensors. The system uses two cloud database from agriculture department and provides help to the farmer in deciding when to irrigate field or when to apply fertilizer/manure/insecticide/pesticide etc. The authors also compared the cost of various farm practices in case of use of agro robot with manual farming and mechanized farming using tractor and claimed that the cost is least in case of agro robot.

Ojha-Misra-Raghuvanshi [16] provided a comprehensive survey on use of WSN in agriculture. The authors used the Indian as well as global context. The authors discussed under ground WSN's and terrestrial WSN's and their use in agriculture. In their paper, they discussed various case studies discussing various scenarios. In Indian scenario, use of Wireless Sensor Networks in the water management, precision farming and crop disease have been widely discussed. The authors elaborated previously executed projects, ongoing projects and upcoming projects.

Srivastva et al. [17] presented a robot to facilitate the Indian farmers in agriculture tasks. The robot uses DTMF (Dual Tone Multi- Frequency) and can be controlled by a mobile phone. The robot will help the farmers to monitor and control his agricultural task without going to the field. The robot can sense soil moisture and may initiate irrigation process. It may help in sowing the seeds, remove the weeds from the field and control the pests by spraying as per the commands of the farmer. The presented machine may be used for terrines where farmers need to do harder efforts for e.g. hill areas, mountains etc.

VI. IOT AND PRECISION FARMING

The precision farming is aligned with PM Modi's "More Crop Per drop" and reducing the use of chemical fertilizers. The precision farming according to Wikipedia can be defined as follows: **"Precision farming** or **site specific crop management** is a farming management concept based on observing, measuring and responding to inter and intra-field variability in crops. The goal of precision agriculture research is to define a decision support system(DSS) for whole farm management with the goal of optimizing returns on inputs while preserving resources." [Wikipedia]. As the definition suggests, the precision farming is not possible without the effective involvement of information technology. Moreover, the precision farming helps in increased production, reduced wastage and efficient utilization of resources. Considering its potential in India, several researchers are working in this direction. Some of the most relevant and recent works have been summarized below.

Mondal-Tewari [18] presented a survey paper indicating the status of precision farming. The main topics included in the paper are yield mapping, positioning system, variable rate technology, remote sensing and information transmission standard. The authors concluded that the present era is the era of bio technology in information technology revolution and when these two mixed together can do wonders in the field of agriculture. The genetically modified plants can automatically send signal to the system about the change in environment.

Patil-Maru-Shanwad [19] use of remote sensing and Geographical Information system in precision farming particularly in Indian Context. They discussed the opportunities and challenges in this area. They concluded that the reliable and detailed information on soils type, land use, agricultural crops, water resources, natural and agro meteorology is required together with the season-wise information on crops acreage and production to enable the country to select suitable procurement policies and measures to meet shortages.

In [20], Chaudhry-Nayse-Waghmare presented a Wireless Sensor Network based solution for parameter control in green house used for precision agriculture. In green house, because of the large number of crops in a small enclosed areas more parameters need to be controlled for precision agriculture. It is very difficult and expensive to manually control these parameters in a efficient and balanced way. Therefore, in this case, the wireless sensor network using miniature sensing devices may prove to be an efficient solution for climate control in green house being used for precision farming. Sapkota et al. [21] conducted a study to evaluate precision nutrient management options for nutrient use efficiency, wheat yield, profitability, and green house gas emission in intensive wheat systems of north west India. The authors also studied the effect on environment when precision nutrient management is followed instead of normal use of nutrients.

VII. VARIOUS OTHER ISSUES

In the above sections we discussed the pertinent issues. Besides these above discussed area there are several areas and issues in which the Indian researchers have started working in the direction to increase the use of information technology and Internet of things for the benefit of farmers. However, due to the space constraint it is not possible for us to cover all of these issues in detail. Nevertheless, in this section, some important issues in the Indian context have been briefly summarized in order to give the readers a detailed insight about the current trends.

Gutta-Sajja [22] developed a web application using multi agent system and applying fuzzy logic. The authors used an open source library called jfuzzylogic which is entirely written in java and follows the standard for FCL (Fuzzy Control Language) described by the International Electro technical Commission (IEC 61131-7). They considered farm size and speed of internet connection as the most important parameters for their system. The authors claimed that with the use of fuzzy logic uncertainty and vagueness of Indian Agriculture sector can be handled to a certain extent.

Khan- Khan [23] proposed a mega portal named as FMP (Farming Mega Portal) using agents for helping the farmer to get the desired information in a quick and easy way. The authors claimed that the portal may help in increasing the food production and minimizing the food waste. Further, the proposed solution uses Voice Internet Intelligent Agent based FMP . The solution uses a simple phone using voice and natural language for interaction. The solution mainly Focuses on "informal education" "Automated Method" and on Innovation and Entrepreneurship. The content type, delivery, usage and learning are simple, natural & easy. The wireless sensor network [24], linear wireless

sensor network [25] and under water sensor networks [26] can be effectively used to improve the productivity of Indian agriculture system.

VIII. CONCLUSION & FUTURE WORK

In this era of Information Technology, no area can remain untouched by the effect of information technology. The use of information technology is increasing at an exponential rate in Indian agriculture scenario. The increased internet speed, mobile penetration, cheap hardware and advancement of India in space technology have also contributed in this growth. The major areas where information technology can significantly contribute are smart irrigation, disease control, use of robotics, precision farming, and prediction of crop yield, weather prediction, propagation of information and decision support system. The use of information technology in Indian agriculture is bound to increase, However, considering the peculiar nature of India and Indian farmers the readymade solutions for developed countries may not be directly used in Indian context. Therefore, we need to develop indigenous solutions for the problems of Indian agriculture thus reducing our dependability on other countries in terms of technology and technological solutions for the problem of Indian farmers. Developing innovative solutions for Indian farmers particularly small and marginal farmers using Internet of Things may be an interesting area because for that we need to develop cost effective solutions.

REFERENCES

[1]. Niti Policy paper No.1/2017: http://niti.gov.in/writereaddata/files/document_publication/DOUBLING%20FARMERS%20INCOME.pdf

[2]. https://innovate.mygov.in/sih2017/

[3]. S.R. Rathod, S.S. Khedkar, S.S. Choudhry," Design and development of an intelligent irrigation system for farming", IJREAS, Vol. 02, Issue 02, pp. 90-93, July 2014.

[4]. D. Dassanayake, K. Dassanayake, H. Malano, G.M. Dunn, P. Douglsan, J. Langford, "Water saving through smarter irrigation in Australian dairy farming: Use of intelligent irrigation controller and wireless sensor network", In proc. Of 18th World IMACS / MODSIM Congress, Cairns, Australia 13-17 July 2009

[5]. S.R.B. Prabhu, S. Sophia, "A Review of Efficient Information Delivery and Clustering for Drip Irrigation Management using WSN", International Journal of Computer Science and Business Informatics Vol. 14, No. 3., pp. 1-13 October/November 2014

[6]. Suresh Kulkarni, "Innovative Technologies for Water Saving in Irrigated Agriculture", International Journal of Water Resources and Arid Environments, vol. 1, No. 3,pp. 226-231, 2011

[7]. A.A. Wable, G.P. Khapre , R.M. Mulajkar , "Intelligent Farming Robot for Plant Health Detection using Image Processing and Sensing Device ", IJESC, vol. 6, No. 7, pp. 8320-8321, 2016.

[8]. M. Jhuria, A. Kumar, R.Borse,"Image processing for smart farming: Detection of disease and fruit gradin" In proc. 2013 IEEE Second International Confenrence on Image Information Processing (ICIIP), 2013

[9]. Y. Dandwate, R. Khokare, "An Automated Approach for Classification of Plant Diseases Towards Development of Futuristic Decision Support System in Indian Perspective", In proc. 2015 International Conference on Advances in Computing, Communications and Informatics (ICACCI), 2015

[10]. S.R. Rupanagudi, R. B. S. Prathik Nagaraj, Varsha G Bhat G. Thippeswamy, "A Novel Cloud Computing based Smart Farming System for Early Detection of Borer Insects in Tomatoes", In proc. 2015 International Conference on Communication, Information & Computing Technology (ICCICT), Jan. 16-17, Mumbai, India

[11]. R.Agrawal, M. Atray, S.K. Sundari,"KrishiEkta, integrated knowledge and information distribution system for Indian agriculture." In proc. 4th Annual Symposium on Computing for Development, 19, 2013.

[12]. Anmol Rai Gupta, Zafar Shahila, " Rural India : The Next Frontier for Social Media Networks", International Journal of Engineering Research & Technology (IJERT) Vol. 2, No. 1, pp. 1-6, 2013

[13]. R. Syiem, S. Raj , " Access and Usage of ICTs for Agriculture and Rural Development by the tribal farmers in Meghalaya State of North-East India", Journal of Agricultural Informatics (ISSN 2061-862X) Vol. 6, No. 3, pp.24-41, 2015

[14]. N. Agarwal, R. Thakur, "Agricultural Robot: Intelligent Robot for Farming", International Advanced Research Journal in Science, Engineering and Technology Vol. 3, No. 8, pp. 177-181, 2016.

[15]. A. R. Potdar, I. Vidya, S. Mankar, S. Shelar, P. Sonawane, "An IOT Based Farming By Using Arduino Technology ",International Journal for Research in Engineering Application & Management (IJREAM) *ISSN : 2454-9150* Vol. 3, No. 7, pp. 14-17, 2017

[16]. T. Ojha, S. Mishra, N.S. Raghuvanshi, "Wireless sensor networks for agriculture: The state-of-the-art in practice and future challenges", Computer and electronics in agriculture, vol. 118, pp. 66-84, 2015

[17]. A. Srivastava, S. Vijay, A. Negi, P. Shrivastava, A. Singh, "DTMF Based Intelligent Farming Robotic Vehicle An Ease to Farmers In proc. International Conference on Embedded Systems - (ICES 2014), pp. 206-210, 214

[18]. P. Mondal, V.K. Tewari, "Present status of precision farming in India", International Journal of Agriculture Resaerch, Vol 2. No. 1, pp. 1-10, 2007.

[19]. V.C.Patil, A. Maru, G.B.Shashidhara and U.K.Shanwad, "Remote Sensing,Geographical Information Systemand Precision Farming in India: Opportunities and challenges" https://www.researchgate.net/publication/259713797

[20]. D.D.Chaudhary, S.P.Nayse, L.M.Waghmare, "Application of wireless sensor networks For greenhouse parameter control in Precision agriculture", International Journal of Wireless & Mobile Networks (IJWMN) Vol. 3, No. 1, pp. 140-149, 2011

[21]. B. Sapkotaa, K. Majumdab, M.L. Jata, A. Kumara, D.K. Bishnoia ,A.J. McDonald, M. Pampolinoea," Precision nutrient management in conservation agriculture basedwheat production of Northwest India: Profitability, nutrient useefficiency and environmental", Field Crops Research Vol.155, pp. 233–244, 2014

[22]. A. Gutta, Dr. P.S. Sajja, "Fuzzy Logic based Intelligent Farming Multi Agent System Int.J.Computer Technology & Applications,Vol. 4, No. 1, pp. 28-32, 2013

[23]. E. Khan, E.Khan, "Intelligent Agent based Farming Mega Portal: A Necessity for Farmers" In Proc. Latest trends in applied computer science, 2013, pp. 187-194, 2013.

[24]. S. Varshney, C. Kumar, A swaroop, "A comparative study of hierarchical routing protocols in wireless sensor network", In Proc. IndiaCom 2015.

[25]. S. Varshney, C. Kumar, A Swaroop, "Linear Sensor Networks: Applicatin, issues and major research trends" In Proc. ICCCA 2015.

[26]. H. Bhambhri, A. Swaroop, "Under water sensor networks, architecture, challenges & applications", In Proc., IndiaCom 2014.

