2023 International Journal of Scientific & Engineering Research,Volume 9, Issue 5, May-2018 ISSN 2229-5518

Precision Agriculture using LoRa

Sushmita Tapashetti, Dr. Shobha K.R. **Abstract**—Agriculture is the broadest economic sector and plays a key role in the overall economic development of nation. There are many issues related to farmers which always hampers the course of our evolution. One of the best solution to tackle these problems is to encourage farmers to use modern techniques as they help in increasing agricultural productivity and cut down the input cost. This paper proposes, solution to measure minerals present in agricultural land such as nitrogen, phosphorous, and potassium as well as humidity, soil moisture and temperature using sensors, LoRa and Cloud technology. The data obtained from the sensors will be collected into the cloud database which will be used to give information to end user. The approach uses the combination of LoRa and cloud computing that promotes the fast development of agricultural modernization and helps to realize smart solution for agriculture and efficiently solve the issues related to farmers from a remote location.

**Index Terms**—Precision Agriculture, LoRa, Cloud Computing, NPK values.

——————————◆——————————

**1 INTRODUCTION** A

griculture Indian nomic Agriculture is the most important sector of economy which plays a decisive role in socioeco- development of the country. Indian agriculture sector accounts for 18% of India’s gross domestic produc- tion (GDP) and provides employment to 50% of countries workforce. India is second largest producer of vegetables and fruits in the world [9]. In India 43% of geographical area is occupied FAO, needed this rise. mand crease the changes tural demands number Not fields one for in to in population. only by in the maintain climatic [8]. is nine agricultural of food that, expected The population people is a changes some age-old healthy It going will to around land researches increase IJSER to and be methods because and [10]. be more the shrinking active doubled According as world have challenging of of population lifestyle receding growing shown lack number by to 2050 adequate and prediction task continues crops water that of due says agricul- to the won’t to level, meet food that

de- in- of

to

help in increasing the agrarian output with all the above- mentioned issues. These facts demands for more research de- velopment in agricultural sector. According to recent reports, about 70-80% of agricultural greenhouse gas emissions, such as nitrous oxide come from use of nitrogen fertilizer. So, one must apply the required amount of nitrogen fertilizers after knowing the requirement of the crops. Even supplying water to agriculture field should be in controlled manner so that it won’t wash away the miner- als added to soil as well as cause soil erosion. All these re- quires real time monitoring of the agricultural field as well as crop growth. Hence it requires use of modern techniques in agricultural fields which helps in improvement of crop productivity with sufficient use of resources.

————————————————

• *Sushmita Tapashetti is currently pursuing masters degree program in digital communication engineering inRamaiah Institute of Technoloy,India. E-mail: sush.tapashetti@gmail.com*

• *Dr.Shobha K.R. is a associate professor in telecommunication engineering in Ramaiah Institute of Technlogy, India. E-mail: shob- ha\_shankar@msrit.edu*

IJSER © 2018 http://www.ijser.org

To use technology more efficiently one has to know the re- quirements of crop growth. There are number of elements which are essential to plant life and they must be provided in certain proportion to obtain a healthy crop. Knowing the nu- trients required to grow plants is only one aspect of successful crop production. Optimum yield also requires knowing the rate to apply, the method and time of application, the source of nutrients to use, and how the elements are influenced by soil and climatic conditions. Essential nutrients are C, H, O2 provided by atmospheric CO2 and H2O. Among all the nutri- ents that are required by crops the most important are nitro- gen, phosphorous and potassium. These are used in maximum quantity by most of the crops. Hence use of sens- ing and cloud technology has become important as they help in providing real time requirements in the field. The agriculture in India requires more attention to be paid to the farming activity and farmers. More research must be car- ried out regarding latest agriculture tools and testing the qual- ity of various innovative ideas. So, here we study the applica- tion of Precision agriculture (PA) that aims to improve the revenue by utilizing more precise information recorded using technologies available for sensing and communicating.

**1.1 Precision Agriculture(PA)** Precision agriculture is a farming management concept based on observing, measuring, and responding to inter and intra- field variability in crops. Precision agriculture uses detailed, site-specific information to manage production inputs like water, fertilizers and pesticides. The main goal of any precision agriculture remote sensing is to detect something in time to make a correction. Examples of things that could need correction include irrigation, plant dis- ease, drainage, soil nutrient and crop damage. Precision agri- culture includes data collection from various sensor nodes placed in agricultural fields and provide solutions based on the data collected to farmers. This helps farmers to use only the required quantity of water, fertilizers and pesticides. In fact, field trials have shown that use of sensors measurement to vary water input across the farm for irrigation can increase the agricultural output by 46% while reducing water intake by 34%. Similarly, other techniques like seeds, soil nutrients have proven to be beneficiary [8]. Hence usage of modern technolo- gies not only increases the agricultural productivity but they

2024 International Journal of Scientific & Engineering Research,Volume 9, Issue 5, May-2018 ISSN 2229-5518

also help in saving the resources as well as keeping the envi-

forward on vegetable crop using smartphone and wireless ronment clean and safe.

sensor networks for smart farming. The environmental data can be collected, and the irrigation system can be controlled **1.2 LoRa Technology**

using smartphone was demonstrated in this work. This paper Long range, low power wireless platform is the prevailing

mainly concentrated on automation of irrigation by control- technology choice for building IoT networks worldwide. LoRa

ling the flow of water by knowing temperature, humidity and is the emerging technology which is making our world a

soil moisture. Thus, helping proper growth of vegetable crops. smart planet. LoRa Technology offers a very compelling com-

This implementation used zigbee communication to perform bination of long range, low power consumption and secure

above functions and communication was between sensor data transmission. LoRa makes use of spread spectrum modu- lation technique which is insusceptible for interfering signals

nodes and smart phones for information collection or control- ling water flow in field. and noise. Thus, LoRa overcomes the drawbacks of traditional direct spread spectrum modulation technique. The key fea- tures of LoRa technology which makes it efficient transceiver

In [3], use of agricultural drone for spraying fertilizer and pes- ticides in agricultural lands depending on their requirement in are scalable bandwidth, consistent envelop, high robustness,

fields was discussed. The decision about spraying of chemi- multipath/blurring resistant, Doppler resistant, Long range

cals on crops was taken depending on climatic conditions, capability, upgraded network capacity and rang-

such as the intensity and direction of the wind while spraying ing/localization.

and controlling path of UAVs to reduce the wastage of chemi- Public and private networks using this technology can provide

cals. Thus, it explains optimum use of fertilizer and pesticides coverage that is greater in range compared to that of existing

in agricultural field depending on the requirement thus aiding cellular networks. It is easy to plug into the existing infrastruc-

reduction of soil pollution . ture and offers a solution to serve battery-operated IoT appli- cations. power and use lands analysis. **1.3** Cloud enables **Cloud** of gateways with LoRa computing it ubiquitous Since gives the **Computiong**

to LoRa best help placed collect is solution access of provides an data at gateway information long to from IJSER

for shared large distances. and connecting sensors distance store technology pools placed Hence, it of devices in coverage configurable cloud paradigm in we agricultural like for can with sensors further make

that sys- low

tem resources and higher-level services that can be rapidly

In [4], cloud computing is used to collect data related to esti- mation of the fields requirements, its production and quality of crops. Data collected is used effectively to increase produc- tion and reduce wastage. Thus, this paper mainly concentrates on data collection regarding growth of qualitative growth of plants. It uses zigbee technology for data collection and plac- ing it in cloud database. They have used sensors with small memory to monitor peer nodes. App is designed for end user to get the data required for them to take further measures based on unique ID generated for each user as well as GPS location given by the user.

provisioned with minimal management efforts, often over the internet. Cloud computing relies on sharing of resources to achieve coherence and economy of scale, like utility. In this paper we are using this cloud platform to collect data obtained by end nodes through LoRa transceiver and display the ob- tained data to get the required solution; the obtained infor- mation is only data which is of no help to farmers hence, it

In [5], the idea of sensing the nutrients in soil and provide so- lution to farmers from the analysis done on the data collected in data collection centre was introduced. The proposed idea was implemented with WiFi or zigbee. In this paper data col- lection was done using zigbee or WiFi which covers smaller distance compared to LoRa.

must be converted into useful information. Therefore, this da- ta must be collected in effective storage space which can be accessed anywhere in world. The cloud database is the best

**3 PROPOSED METHODOLOGY** place to store the data, analyse and compute the required out-

As discussed earlier, there are many issues which hinders the put which can be provided to farmer or user.

increase in productivity of crops as well as reduction envi- ronmental pollution. **2 LITERATURE REVIEW**

Let us consider a scenario of application of fertilizer to the agricultural land. To do above procedure one has to have the In [1], a novel approach for Digital Agriculture was proposed

knowledge of nutrient requirement by the crop as well as the describing Relationships between Precision Agriculture, Digi-

know the amount of nutrient already present in the soil, so tal Earth, Information Agriculture, Virtual Agriculture, and

that he can have an idea of fertilizer requirement by that crop. Digital Agriculture. The requirement to put forward the con-

To do this task one has to take the soil to soil testing centre, get cept of Digital Agriculture was discussed. They explained use

the result and then apply the fertilizers to the field which will of satellite and other on/underground instruments for infor-

be tedious task and sometimes the person may just assume mation collection. And also automation and remote monitor-

some amount of fertilizer and apply it in field which may be ing of agriculture is discussed.

more or less. If applied nutrient is less crop production will be low and if more it may lead to leaching, soil pollution and In [2], sensor data collection and irrigation control were put

IJSER © 2018 http://www.ijser.org

International Journal of Scientific & Engineering Research,Volume 9, Issue 5, May-2018 ISSN 2229-5518

account for some greenhouse gases. It’s not only nutrient ap- plication, but we also need to know the amount of water re- quired by crops so that proper quantity of water will be given to the fields during crop growth. The field temperature and humidity also play a very im- portant role in deciding the crops suitable for the given region.

**3.1 Methodology** Smart Agricultural solutions are the evolving trend in day to day lives. Recent field trials done using advanced technology have shown increase in crop production with reduction in water consumption. It also reduces soil erosion, leaching and f greenhouse gases produced from application of nitrogen ferti- lizer to fields. So, in this work an attempt is made to use tech- nology effectively to grow healthy crops by providing proper quantity of nutrients like nitrogen, phosphorous, and potassi- um, and water to the fields. LoRa technology, which provide long range coverage for data transmission with low power consumption and more efficient when compared to existing technologies is used in the current implementation. Sensors placed in agricultural fields are used to sense the required da- ta from the fields and the sensed data will be collected by Lo- Ra gateway. The collected information was uploaded to cloud for further analysis. Depending on the analysed data further measures were taken to increase the crop yield. The analysed data was converted to useful information and was given to end user using email or SMS. This information can be used in agricultural field for quantitative as well as qualitative growth of crops. Here we have got the nutrient requirements of tomato and potato plant and we are providing requirement related to the- se crops through LoRa and cloud technologies by alerting end user through email notification.

Fig. 1. Block Diagram

**3.2 Implementation** The flow charts below explain the flow of implemented algo- rithm. Fig.2, elaborates the flow of algorithm at the client side. First initial settings like pin assignments must be done. Then, Baud rate and frequency must be set according to require- ment. Since algorithm uses serial communication one must check for serial communication. If serial pin is available for communication one must go for next step if not, then continu-

IJSER © 2018 http://www.ijser.org

ously check for the availability of serial pin. If serial pin is available, collect the data from sensor and broadcast the data and then check for the gateway. If available, check for acknowledgement from gateway if acknowledgement is re- ceived successfully, then it indicates communication success- ful between the LoRa node and the gateway.

Fig. 2. Flowchart for client node

Fig.3 elaborates in detail about flow of algorithm at the server side i.e., from receiving the broadcasted message of the LoRa node and sending out the acknowledgement to same LoRa node. Initially the baud rate and frequency have to be set with the API key obtained from the cloud account for a particular channel. Continuously check for the data at the set frequency. If available, get the data and display it on serial monitor as well as cloud.

2025

IJSER

International Journal of Scientific & Engineering Research,Volume 9, Issue 5, May-2018 ISSN 2229-5518

**4 SYSTEM DESIGN** The comple system is divided into three modules as shown in following diagram

Fig.5 System Design

**4.1 Client Module**

Fig.3 Flowchart of gateway

Client module consists of LoRa node along with atmega128 controller and is connected with sensors which are used to Fig.4 explains the algorithm flow for multiple nodes at the server side i.e., data transmission from multiple nodes and collecting the broadcasted data by single gateway which up- loads the data collected into different channels of cloud. First, nodes must be differentiated at client side by assigning differ- ent node ID’s. Once nodes are differentiated and data is transmitted from the client nodes with their ID’s. The data received at gateway will be verified for their node ID. Once

collect condition of soil such as its moisture and also nutrients present in soil like nitrogen(N), phosphorous(P) and potassi- um(K). Humidity and temperature of the field is collected at regular interval to provide information regarding water re- quirement in the field. NPK sensor is used to collect the in- formation regarding amount of N,P,K present in the soil and suggest the crop that can be grown in such soil and also sug- gest if extra quantity of fertilizers is required in soil for the node ID is confirmed data will be sent to the channel assigned

suggested crop. Soil moisture sensor is used to calculate the to it.

moisture of soil. DHT11 sensor is used to collect humidity and temperature of field. This data collected, was analyzed to pro- vide information regarding water requirement in the field. The same setup as explained above is done with another LoRa node and experimented to get data from multiple nodes to gateway.

**4.2 Gateway Module** Gateway module acts as a link between the LoRa nodes and cloud. Gateway collects the data from the LoRa nodes and gives it to cloud to analyze the data. LoRa gateway can com- municate with the LoRa nodes placed at almost 1-3kms dis- tance in open field as their range is higher than the any pre- sent technologies. Basically, gateway uses two technologies to communicate one is Lora technology to collect information from LoRa nodes placed in fields and second one is WiFi, which is used to up- load the data collected into the cloud. It uses HTTP protocol to communicate between gateway and cloud. Thus gateway has to be placed as per the requirements. re- ceive data from LoRa nodes through LoRa communication and upload data to cloud through HTTP protocol.

**4.3 Cloud Module**

Fig.4. Flowchart of the gateway for multiple nodes

To store the data collected in gateway to cloud, one has to cre- ate an account in cloud with specific user name and password. Once account is created one must give the API keys of specific channel of the account to make the HTTP communication

IJSER © 2018 http://www.ijser.org

2026

IJSER

International Journal of Scientific & Engineering Research,Volume 9, Issue 5, May-2018 ISSN 2229-5518

from gateway to cloud. Once the connection is established between cloud and gateway, the data from gateway will be stored in the cloud. Data collected in the cloud is analyzed in MATLAB to notify user through email (shown in Fig.12) about water and fertilizer requirement in field. Even the data collected in cloud can be displayed in mobile through mobile widget as shown in fig.8 and 11.

**5 RESULTS AND DISCUSSIONS** The figures below show the graph of information collected by gateway in cloud at real time

Fig.6 shows the results obtained from node 1 It shows humidi- ty, temperature, soil moisture and nitrogen, phosphorous and potassium content in soil of node ID 111 and Fig.8 shows the data collected in cloud through mobile widget.

Fig.6 Data obtained from sensors connected to node ID:111

Fig.7 Data obtained on mobile widget for node ID: 111

Fig.8 shows the results obtained from node 2. It shows humid- ity, temperature, soil moisture and nitrogen, phosphorous and potassium content in soil by node ID 112 and Fig.9 shows the

data collected in cloud through mobile widget.

**6 CONCLUSION** Agriculture plays a very important role in growth of Indian

IJSER © 2018 http://www.ijser.org

Fig.8 Data obtained from sensors connected to node ID:112

Fig.9 Data obtained on mobile widget for node ID: 112

Fig.10 Email notification sent to end user

Fig.10 shows the email notification got by the end user which tells end user about water and fertilizer requirement.

2027

IJSER

2028 International Journal of Scientific & Engineering Research,Volume 9, Issue 5, May-2018 ISSN 2229-5518

economy, hence methods for improving crop yield plays a significant role. The above work helps one to monitor the amount of NPK present in the soil and its moisture content. Thus, above work provides a solution to increase the yield of crops using current technology of sensors and LoRa. The in- formation obtained from sensors is analysed and information

[13] T.K. Hartz,‖ Soil Testing for Nutrient Availability Procedures and Interpretation for California Vegetable Crop Production‖, *Vegetable Research and Information Centre, University of California*. [14] LoRa Gateway user manual by Dragino wiki: http://www.dragino.com [15] Haider Mahmood Jawed, Rosdiadee Nordin, Sadik Kamel Gharghan, Aqeel Mahmood Jawad, Mahamod Ismail, ―Energy Efficient Wireless Sensor Networks for Precision Agriculture: A Review‖, *Sensors,* 2017. regarding amount of nutrients and water required by crops is given to end user using email and mobile. The use of LoRa Techonolgy helps to cover large geographical land with low power consumption. Thus, increasing the efficiency of opera- tion. This work aids remote monitoring of fields to farmers as well as assists increase in yield. As part of future work drones can be used to cover larger geo- graphical area and collect data from substantial number of nodes and upload it to cloud for remote monitoring

**7 ACKNOWLEDGMENT** We would like to thank Vision Group of Science and Technol- ogy for supporting the project through KFIST funding

**REFERENCES**

[1] [2] [3] [4] Shihao Conception Remote Kaewmard, control for 106 Prof. Narve, Pesticides‖ M.K.Gayatri, smart – Swati 112, Tang, Purva on Sensing farm‖, 2014.

vegetable *IJARCSSE* Nattapol, of D Qijiang V J.Jayasakthi, Digital Kale, Symposium, Gangal, IEEE crop Swati Saiyod, Zhu, Volume Agriculture‖ Conference ‖ using Xiaodong Agriculture V 2002.

Dr.G.S.Anandha IJSER Saiyan 5, Khandagale, smart Issue on *IEEE* ―Sensor Zhou, phone December Wireless Drone *International* Shaomin Shweta and data for Mala, sensors 2015.

wireless collection Spraying S Liu, Gaikwad, ―Providing *Geoscience* (ICWiSE), Menxin sensor and Fertilizer irrigation networks Sayali Wu, Pg.no.

Smart *and*

and ―A

S

Agricultural Solutions to Farmers for better yielding using IoT‖ *IEEE International Conference on Technological Innovations in ICT for Agriculture and Rural Development*, 2015. [5] T. Sujithra, S. Durai and M. Thanjaivadivel ,‖ Measuring macronutrients of the soil for smart agriculture in coconut cultivation ‖, *International Journal of Civil Engineering and Technology* , 2017,Pg.no.768-778. [6] Rupanagudi, SudhirRao, Ranjani B.S., Nagaraj, Prathik Bhat, Varsha G, Thippeswamy G.A, ―Novel cloud computing based smart farming system for early detection of borer insects in tomatoes‖ *International Conference on Communication, Information & Computing Technology (ICCICT),* 2015 2015 , Pg.No., 1 – 6. [7] Angel, G.Brindha, ―Real-time monitoring of GPS-tracking multifunctional vehicle path control and data acquisition based on ZigBee multi-hop mesh network‖ *International Conference on Recent Advancements in Electrical, Electronics and Control Engineering (ICONRAEeCE)*, 2011. [8] Gerard Rudolph Mendez, Mohd Amri Md Yunus and Subhas Chandra Mukhopadhyay, ― A WiFi based Smart Wireless Sensor Network for Monitoring an Agricultural Environment‖,*IEEE conference on Communication, Information & Computing Technology* 2012. [9] Chetan Dwarkani M., Ganesh Ram R., Jagannathan S., R. Priyatharshini, ―Smart Farming System Using Sensors for Agricultural Task Automation‖ *IEEE International Conference on Technological Innovations in ICT for Agriculture and Rural Development,* 2015. [10] India in Business Investment and Technology Promotion Division, Ministry

of External Affairs, Govt. of India, 2015. [11] Arjun K.M., ―Indian Agriculture- Status, Importance and Role in Indian Economy‖, *International Journal of Agriculture and Food Science Technology,* Page No.343- 346., 2015 [12] Rita Bajpai,‖ Monitoring Of Macronutrients Uptake by Soil and Potato Plants – A Comparative Study‖, *IOSR Journal of applied chemistry,* Volume 6, Issue 6 PP 57-59, Jan. 2014.

IJSER © 2018 http://www.ijser.org