ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

IJARCCE

International Journal of Advanced Research in Computer and Communication Engineering

ICRITCSA

M S Ramaiah Institute of Technology, Bangalore

Vol. 5, Special Issue 2, October 2016

Applications of Mobile Cloud Computing and Big Data Analytics in Agriculture Sector- A Survey

Athmaja S[1], Hanumanthappa M[2]

Research Scholar, Department of Computer Science and Applications, Bangalore University, Bangalore, India [1]

Professor and Chairman, Department of Computer Science and Applications, Bangalore University, Bangalore, India[2]

Abstract: The objective of this literature survey was to identify the applications of Mobile Cloud Computing and Big Data Analytics techniques in the agriculture sector. Related literature from IEEE journals and other International journals were collected and reviewed. A conclusion is made by proposing a new model that uses mobile cloud computing and big data analytics techniques together to meet several challenges that the farmers are facing today in the agriculture sector. The proposed model helps farmers in making optimal decisions on their agricultural production and thereby reducing the post-harvest wastage of their products.

Keywords: big data, analytics, mobile, cloud, computing, agriculture, farmer, machine learning.

I. INTRODUCTION

Agriculture plays a vital role in the overall economic and social well-being of any nation. Agricultural development had helped to a greater extent in the process of industrialization in developed countries such as USA, Japan and England. With the advents in Information and Communication Technology, it became easier to collect, store, process and analyse a huge volume of agricultural data (Big Data) and to derive useful knowledge from them to help farmers and farming communities. The major ICT tools for agricultural sector like mobile phones are very much helpful to farmers in taking quality decisions which will have positive impact on the way agriculture and allied activities are conducted.

It is found that even though mobile phones play a significant role in improving farm productivity and rural incomes, the following aspects-the quality of information, timeliness of information and trustworthiness of information- have great potential to meet the needs and expectations [1]. That is access to right information at right time at right place is essential in reducing several agricultural challenges. This is possible by bringing the possibilities of data analytics techniques, cloud computing and mobile technology under one umbrella in the agricultural sector. Application of big data analytics in the agricultural sector to reduce the challenges that the farmers are facing today due to the improper planning of agricultural production is a promising area of research. This survey paper reviews various papers written on big data analytics techniques in collaboration with mobile technology and cloud computing to help farmers and farming communities to improve agricultural productivity and sustainability.

II. THE SCOPE OF MOBILE CLOUD COMPUTING IN AGRICULTURE SECTOR

Mobile and cloud computing techniques have been used in vast and varied application areas such as banking, healthcare, entertainment, agriculture, etc. all around the world nowadays. Mobile computing technology allows transmission of data (text, image, voice and video) through wireless enabled devices such as mobile phones, laptops, PDA, etc. without having to be connected to a fixed physical link [2]. Mobile devices play a vital role in the farmer's daily business by letting them use mobile application and services. Cloud Computing technology makes use of the Internet and central remote servers to store and process data and thereby allows for much more efficient computing process. Mobile Cloud Computing (MCC) is a combination of the above mentioned technologies in which a mobile client uses cloud computing techniques to store and process data over cloud-based resources. The MCC architecture is as follows.

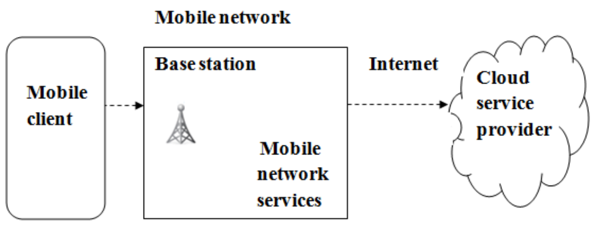

Fig. 1 Mobile Cloud Computing Architecture

Mobile Cloud Computing (MCC) is an infrastructure where data storage and processing is done on a powerful

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

IJARCCE

International Journal of Advanced Research in Computer and Communication Engineering

ICRITCSA

M S Ramaiah Institute of Technology, Bangalore

Vol. 5, Special Issue 2, October 2016

and centralized computing platforms located in the cloud. Radio links such as Wi-Fi, GPRS or 3G can be used to connect mobile devices to a base station. The centralized cloud applications can be accessed over the wireless connection by a browser on the mobile devices. Even though the client is a mobile device; the main concept is still cloud computing. By integrating cloud computing into the mobile environment, the MCC technology overcomes many obstacles such as battery life, storage and bandwidth, heterogeneity, scalability and availability and security[5].

MCC offers several advantages to agriculture sector and many positive impacts to farmers. Without worrying about the hardware & software investment and the technical knowledge, farmers can send their requests for a specific cloud service using their mobile phones with an Internet connection. The cloud service provider will process the request dynamically, and finally will send back the results to the client. Nowadays the MCC technology is widely used in the agriculture sector. Some of the related works are discussed below.

Manav Singhal et al. [3] developed a mobile application called "Krishi Ville" to help farmers. This android app was built to share many updates like different agricultural commodity updates, weather forecast updates, agricultural news updates and also various loan schemes offered by different banks in India to farmers. Krishi Ville app follows client-server paradigm. HTTP Connection is used to send requests and responses. The client receives data from the server data bases in XML formats. The weather data collected from Google Weather Application Programming Interface (API) Web Services is also in XML form. Therefore, the XML data are parsed before presenting to the user on the mobile screen. Various updated loan schemes for many nationalized and agricultural banks are hard coded in the application. Similarly, Krishi Vigyan Kendra contact addresses are also hard coded in the application.

Shitala Prasad et al. [4] proposed an MCC model called AgroMobile on a handheld device which helps farmers for relatively better cultivation and marketing. It's a client-server paradigm wherein the AgroMobile server contains Application Service Providers (ASP) providing on-demand software, called software as a service (SaaS), over the network architecture to the clients (farmers). Farmers can submit their queries/requests and receive answers from the experts on the spot using their handsets. This model helps farmers to collect information related to farming, weather forecasting, crop analysis, etc. This tool provides some useful advice for young farmers such as information related to crop selection, crop rotation and mixed cropping. This model can also be used by the researchers to identify various species and their diseases. A high-level image processing component is included for crop analysis. Crop images are sent from the client side. Low-level image processing operations such as colour transformation, gamma correction, linear and non-linear filtering, simple noise reduction, image enhancement, etc can be performed on the client mobile devices. These operations are simple and require less memory for execution and can run on mobile devices with a low bit processor.

The intermediate-level as well as high-level image processing operations like segmentation, extraction edge, object recognition, etc. are executed using parallel and distributed computing servers. By using the image analysis techniques for disease detection and identification, farmers become aware of the status of their crops. This improves the production rate and also helps farmers to supervise their land in a convenient way. This mobile application was developed using the Android OS version 2.3.5.

For simulation, various tools are used; MATLAB 2008a is used for Image Processing, OpenNebula 2.0 toolkits are used on the server machine to manage heterogeneous distributed data. For experiment purpose, the connectivity between mobile client and the cloud is implemented using Wi-Fi. Entire data analysis process is classified into two steps: the pre-processing and machine learning. In the pre-processing part noise removal, normalization, image equalization, and few morphological operations are performed. In order to perform machine learning task, support vector machine (SVM) is used with Radial base function (RBF) kernel. The accuracy of this method is more than 90 % on test data.

Mayank Agarwal et al. [6] proposed a mobile application named "Agro-App". This app provides several useful insights to farmers like information related to crops, pesticides, insecticides, and financial sector details, etc. Expert planting tips like which crop to plant in summer, which crop to plant in spring, and which crop is suitable for a particular region, etc. are offered. Also information about current agricultural bank loan rates and schemes are provided. In this mobile app, a facility is provided to select a particular crop sowed by the user and once it is done, this app automatically briefs out all the diseases which are susceptible to that crop. An active Internet connection is required for fetching the information. The huge volumes of data are maintained in cloud storage. This application was developed using the latest Android SDK available at Google. Java and Eclipse Juno integrated with ADT plug-in are also used. This app includes many screens like splash screen, state selection screen, menu item screen, etc.

Previous studies show that mobile phones play a key role in promoting the farmer's business by providing improved customer relation, enhanced communication with suppliers, extension officers and customers.

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940
IJARCCE
International Journal of Advanced Research in Computer and Communication Engineering
ICRITCSA
M S Ramaiah Institute of Technology, Bangalore
Vol. 5, Special Issue 2, October 2016

III.THE SCOPE OF BIG DATA ANALYTICS IN AGRICULTURE SECTOR

The term big data which describes extremely large data sets- both structured and unstructured data- is widely being used among different researchers such as computer scientists, economists, mathematicians, agricultural scientist, political scientists and many others all over the world. It is very difficult to process big data using traditional data management tools or processing applications. It can be better analysed using soft computing techniques to reveal patterns, trends, and associations. Big data analytics is an emerging area that deals with the process of collecting, organizing and analysing large sets of data to discover patterns and other useful information. Big data analytics helps us to identify the data that are most important to the business and future business decisions and also helps to derive knowledge from the large data sets.

To understand the big data phenomenon clearly it is better to explain the different V's associated with them such as Volume, Velocity, Variety, Veracity and Value.

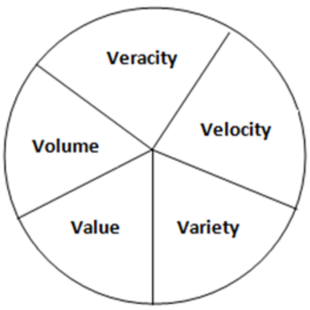

Figure 2. Five V's in Big Data

- Volume: It represents the huge volume of data generated every second ranging from a few dozen terabytes to many zettabytes or brontobytes of data. We can use the distributed systems to store and use these big data sets.
- Velocity: This term refers to the speed at which data is generated and processed to meet the demands.
- Variety: it refers to the different types of data that we can use such as structured data (example. financial data) and unstructured data (example. images).
- Veracity: This is another term that represents the quality of the data. That is, it refers the biases, noise, abnormality etc. in the data. This is an important factor in big data analysis.
- Value: This term refers to the valuable insights uncovered from the big data.

The inclusion of big data analytics techniques in the agriculture sector has several positive outcomes as they analyse the historical data and uncovers hidden knowledge from them. Usually agriculture is practiced against a predetermined schedule. But by gathering various real-time data such as weather data, soil and air quality data, crop maturity data and equipment and labour costs data, etc., predictive analytics techniques can be used to make smarter decisions [7]. Big data farming, also known as 'precision farming', plays a wide variety of significant roles such as weather forecasting, cloud-hosted information resources for farmers, automated irrigation recommendations, monitoring of grain prices, and many more using mobile-based technologies [8]. Those types of forecasts and field data facilities on a mobile platform help farmers to take decisions on the go. Precision farming plays a vital role in reducing several agricultural challenges due to the improper planning of production and thereby enabling farmers to generate better agricultural produce. Companies like Monsanto, John Deere and DuPont Pioneer, etc. are working on precision farming techniques and helping farmers do more with their exploding volumes of data. Monsanto's Climate Corp., for example, offers a suite of decision support tools known as Climate Pro to help farmers to increase yields, decrease costs and save time [9]. Big data analytics techniques are widely being used all over the world in the agriculture sector. Some of the related literatures are reviewed in the following session.

M.R. Bendre et al. [10] presented a paper discussing the use of big data in precision agriculture. In this paper they mentioned that the big data can support a wide range of precision agriculture functions for discovering intelligence and insights from the data to address many new and important farming decisions. They pointed out that a greater part of agricultural data is collected by on-site farming, remote farming or satellite farming. As the world population is increasing day-by-day, it is crucial to have necessary advancements in agricultural production and disaster management to produce agricultural products to meet the demand. Studies showed that the prediction of weather on area wise is vital for future farming in precision agriculture. They categorize the precision agricultural data into the following groups: -

- Historical data such as soil testing, field monitoring, climate conditions, crop patterns, GIS data etc.
- Agricultural equipments and sensor data such as the data collected from remote sensing devices, soil moistures, GPS based receivers, etc.
- Social and web based data such as farmers and the customer's feedback, agricultural websites and blogs, social media groups etc.
- Publication data such as data from the agriculture research and the agricultural reference materials.
- Streamed data such as data from crop monitoring, mapping, aircraft, smart phones, etc.
- Business, industries and external data such as data from agricultural departments, equipment manufacturing companies, etc.

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

IJARCCE

International Journal of Advanced Research in Computer and Communication Engineering

ICRITCSA

M S Ramaiah Institute of Technology, Bangalore

Vol. 5, Special Issue 2, October 2016

They discussed about a three layered approach for precision agriculture through ICT – at first the application layer, then the store & processing layer and finally the infrastructure layer. The application layer models data acquisition tools, web based solutions and development platforms. The next store and processing layer presents solutions like cloud computing solutions for data storage and management and parallel and distributed systems for data processing and management. The infrastructure layer represents a clustered network of sensors and systems that are used to create and manage huge chunks of data. Hadoop is a good choice for big data processing. The various components of Hadoop such as Mahout machine learning applications, MapReduce, Hbase, etc. help for data acquisition, management and visualization of applications in the ICT. It is found that 64-bit computing is the best choice for big data applications. Amazons Elastic Computing Cloud (EC2) is a solution for cloud computing in parallel and distributed processing of the big data over many machines. The data used in this research work are the weather data for the last 10 years such as daily minimum and maximum temperature, humidity and rainfall data collected from the Krishi Vidyapeeth Vidyapeeth Rahuri (KVR) and the various parameters used in this work are rainfall in Cm, temperature in degree Celsius and humidity in percentage. The MapReduce programming techniques can be used to analyze large chunks of data that do not fit in the memory. Several machine learning algorithms like decision trees, Kmeans, clustering, K-nearest neighbor search, the expectation maximization algorithm, hidden Markov models, and neural networks can be used to develop big data prediction models.

They proposed a model using the MapReduce for big data processing and the linear regression technique for data prediction. The MapReduce programming model is used to solve the big data problem by distributing it over the distributed file system -Google File System (GFS). Since the current ensemble weather forecasting systems provide accurate statements about the uncertainty in daily and seasonal forecasting, the researchers tried to develop a model to improve modeling, statistical analysis, and visualization technologies for disseminating the ensemble results. Linear regression is used for predicting future patterns from the historical data items. The data collected from the KVR station are stored in the database by using data storage functions. Where the vector x consisting of n numerical values (x_1; x_2; x_3:::; x_{n-1}, x_n), and n is the number of feature values of each data item in the dataset, the equation 1 shows a general model used for data processing.

$$\hat{y} = f(x) + \xi \qquad (1)$$

and Equation 2 shows the algorithm used to model y as a function of x:

$$\hat{y_i} = a_0 + a_1 x_i + \xi \qquad (2)$$

By using the following equations, the regression coefficients are calculated

$$\bar{xy} - \bar{x}\bar{y} = \frac{1}{N}\sum_{i=1}^{N}(x_i - \bar{x})(y_i - \bar{y}) \qquad (3)$$

$$a_1 = \frac{\bar{xy} - \bar{x}\bar{y}}{y^2 - \bar{y}^2} \qquad (4)$$

$$a_0 = \bar{y} - a_1\bar{x} \qquad (5)$$

The size of the x and α1 data vectors are equal to the number of dimensions in the feature space and error term is the difference between the actual and predicted value of target variable. The y symbol is used to indicate the predicted value of target variable by the model where

$y = \alpha_0 + \alpha_1 x$.

The objective is to minimize the difference of actual and the predicted values for all data items,

$$f(q) = \frac{1}{N}\sum_{i=1}^{N}\xi_i^2 \qquad (6)$$

The main objective of the MapReduce algorithm is to split huge chunks of heterogeneous data for faster processing. Here the MapReduce technique is used to calculate mean values and they are used in the regression model for fitting and calculating the trends of data, which are the predicted values. The results were calculated using this model by applying different rainfall values, when the historical data values increase, it minimizes the execution time as per normal execution. The model predicted rainfall and temperature values for the year 2013 and also compared actual and predicted values to minimize the error. The results forecasted using this regression model and big data handled by Mapreduce in this study provide a great potential to data fusion in the field of crop and water management for applications such as precision agriculture.

Ritaban Dutta et al. [11] implemented big data based knowledge recommendation framework architecture for sustainable precision agricultural decision support system using Computational Intelligence (Machine Learning Analytics) and Semantic Web Technology (Ontological Knowledge Representation). The feature extraction process was done using data mining and text mining techniques and a unique feature base from the individual data source was created. Neural networks algorithm were used to extract targeted feature base from the observation based on the actual application as well as the domain expert knowledge (undocumented farmer's knowledge).

Copyright to IJARCCE

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

IJARCCE

International Journal of Advanced Research in Computer and Communication Engineering

ICRITCSA

M S Ramaiah Institute of Technology, Bangalore

Vol. 5, Special Issue 2, October 2016

Semantic extraction (domain guided extraction using machine learning) generated semantic feature base. Meta feature base and semantic feature base were integrated together to form the enriched feature space. A standard protocol was developed to gather necessary domain knowledge. Essential environmental attributes and a pre-defined threshold of those attributes are present in most of the agricultural decision support system. Data driven autonomous hybrid unsupervised clustering techniques (combining PCA, Self Organizing Map and Fuzzy C means) were applied to create and match class labels for possible decisions which are defined and stored in the farmer's mind, that is a semantic class identifier was implemented. Four different rule constructors were used to formulate these relationship, namely, fuzzy rule constructor (using a fuzzy rule base creation), conditional probabilistic rule constructor (using a conditional probability rule generation), order logic constructor (using an order logic to formulate rules) and threshold based significant event rule constructor (where the threshold of a few environmental variables, directly defined by the farmers in conjunction with an event which led to make an unusual decision).Various machine learning approaches such as unsupervised learning, ensemble learning, deep learning and state based learning were used for autonomous knowledge discovery and online inference of knowledge over the cloud based computing infrastructure. The proposed model was tested against various environmental analytics based decision support case studies and got more than 90% accuracy in all cases.

IV. CONCLUSION AND FUTURE WORK

This paper presents the scope of bringing mobile cloud computing and big data analytics under one umbrella to meet several challenges in the agriculture sector. The mobile and cloud computing techniques help us to collect, store and process a large volume of heterogeneous data in an efficient way. It is also found that the emerging big data analytics has a great positive impact on precision agriculture.

India is the second largest producer of many agricultural products like tomato, potato, cauliflower, onion, sugar cane, rice, wheat, etc. across the globe. A major portion of the workforce is engaged in farming or allied activities as their principal means of livelihood. But many times they are not getting remunerative prices for their products due to various reasons. According to a recent study Rs. 44,000 crores worth agricultural produce is wasted annually in India and fruits & vegetables contribute to 30% of this, which comes to Rs.13, 300 crores. For example, consider the case of tomato. Sometimes due to excess supply, the prices of this vegetable had crashed so much that many farmers in the country preferred to dump their produce on the roadside rather than sell the vegetable at low prices. Hence post-harvest wastage is a big societal challenge in India nowadays. In addition to this, the seeds, the labor, the fertilizers and all other resources that the farmer utilized are also wasted. All of these happen because the farmer didn't know how much to produce so that his harvest is proportionately matching to the aggregate demand (given storage, climatic conditions, etc which has an impact on the harvest). By taking all these challenges into consideration, we will be implementing a model by using the scope of mobile cloud computing and big data analytics together to meet several challenges that the farmers are facing today in the agriculture sector. The proposed work aims at the implementation and use of a mobile application and big data analytics techniques to help farmers in making optimal decisions on their agricultural production and thereby reducing the post-harvest wastage of their products.

REFERENCES

[1] Surabhi Mittal and Gaurav Tripathi, "Role of Mobile Phone Technology in Improving Small Farm Productivity", Agricultural Economics Research Review, Vol. 22, pp. 451-459, 2009.
[2] https://www.tutorialspoint.com/mobile_computing/mobile_computing_quick_guide.htm.
[3] Manav Singhal, Kshitij Verma and Anupam Shukla, "Krishi Ville – Android based Solution for Indian Agriculture", Advanced Networks and Telecommunication systems (ANTS), IEEE 5th International Conference, 2011.
[4] Shitala Prasad, Sateesh K. Peddoju and Debashis Ghosh, "AgroMobile: A Cloud-Based Framework for Agriculturists on Mobile Platform", International Journal of Advanced Science and Technology, Vol.59, pp.41-52, 2013.
[5] Ruay-Shiung Chang et al.,"Mobile Cloud Computing Research - Issues,Challenges and Needs", IEEE Seventh International Symposium on Service-Oriented System Engineering, 2013.
[6] Mayank Aggarwal et al., "Agro App: An Application for Healthy Living", Information Systems and Computer Networks (ISCON), IEEE International Conference, 2014.
[7] http://www.research.ibm.com/articles/precision_agriculture.shtml.
[8] http://www.wipro.com/blogs/big-data-revolutionizing-agriculture/.
[9] http://fortune.com/2014/05/30/cropping-up-on-every-farm-big-data-technology/.
[10] M. R. Bendre, R. C. Thool and V. R. Thool, "Big data in precision agriculture: Weather forecasting for future farming", Next Generation Computing Technologies (NGCT), IEEE International conference, 2015.
[11] Ritaban Dutta et al., "Big Data Architecture for Environmental Analytics", Environmental Software Systems. Infrastructures, Services and Applications ,Volume 448 of the series IFIP Advances in Information and Communication Technology, pp 578-588, Springer 2015.

BIOGRAPHIES

Dr. M. Hanumanthappa is currently working as Professor and Chairman in the department of Computer Science and Applications, Bangalore University, Bangalore, India. He has over 18 years of teaching (Post Graduate) as well as Industry experience. He is the member of Board of Studies /Board of Examiners for various Universities in India. He is actively involved in

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

IJARCCE

International Journal of Advanced Research in Computer and Communication Engineering

ICRITCSA

M S Ramaiah Institute of Technology, Bangalore

Vol. 5, Special Issue 2, October 2016

funded research projects and guiding research scholars in the field of Data Mining, Information Retrieval, Natural Language Processing and Network Security. He has several research publications in International & Indian Journals and he was the recipient of Dr. Radhakrishan Gold Medal Award by Global Economics Progress and Research Association (GEPRA, Tamil Nadu) in 2012. He is also an active member of various professional societies.

Mrs. Athmaja S. is currently pursuing her PhD in the department of Computer Science and Applications, Bangalore University, Bangalore. After completing her MCA from Mother Teresa Women's University Kodaikanal, she did M.Phil in Computer Science with specialization in data mining and machine learning. She has over 5 years of experience in technical training (Post Graduate & Corporate). Her research areas of interest are data mining, pattern recognition, machine learning, big data analytics and mobile cloud computing.