An Automated Optimize Utilization of Water and Crop Monitoring in Agriculture Using IoT

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Abstract

Agriculture is the primary occupation in our country for ages. But now due to migration of people from rural to urban there is hindrance in agriculture. So, to overcome this problem we go for smart agriculture techniques using IoT. This paper includes various features like GPS based remote controlled monitoring, moisture & temperature sensing, intruders scaring, security, leaf wetness and proper irrigation facilities. It makes use of wireless sensor networks for noting the soil properties and environmental factors continuously. Various sensor nodes are deployed at different locations in the farm. Controlling these parameters are through any remote device or internet services and the operations are performed by interfacing sensors, Wi-Fi, camera with microcontroller. This concept is created as a product and given to the farmer's welfare. AI Solution for Farmers perform soil analysis, climate analysis, and productivity analysis using linear regression. It helps farmers to understand about the crop to be sown as well as the factors affecting their productivity with the help of different types of graphs and tables. Farmers need not to do anything on the application as it is highly interactive as by using speech API.

Keywords: IoT, Sensors, Raspberry-PI, Microcontroller, Wi-Fi.

1. Introduction

Agriculture is backbone of Indian economy, and it is primary sector of country. Growers (Farmers) require advance or expert's knowledge to take decision during soil preparation, seed selection, fertilizer management, pesticide management, water scheduling, weed management [1,2,3] etc, so that to get high yield. To help farmers in deciding the crop to be sown and to encourage people to adopt farming as a career by teaching and helping them to understand about the pros and cons of the crop to be sown. Scope of the proposed system is wide. Any person or organization who want to compare the crops or want to find best crop[4] for his farm can use it. Web Application is user friendly, very interactive as it uses image processing and speech API to interact with users and has dynamic support as well.

Internet of Things (IoT) is widely used in connecting devices and collecting data information. Internet of Things is used with IoT frameworks to handle and interact with data and information. In the system users can register their sensors, create streams of data and process information. IoT is applicable in various methodologies of agriculture. Applications of IoT are Smart Cities, Smart Environment, Smart Water, Smart Metering, Security and Emergency, Industrial Control, Smart Agriculture, Home Automation, e-Health etc. 'Internet of Things[5]' is based on device which is capable of analyzing the sensed information and then transmitting it to the user.

Measuring soil moisture is important in agriculture to help farmers manage their irrigation systems[6] more efficiently. Not only farmers are able to generally use less water to grow a crop but also they are able to increase yields and the quality of the crop by better management of soil moisture during critical plant growth stages. Embedded system for automatic irrigation of an agriculture field offers a potential solution to support site- specific irrigation management that allows producers to maximize their productivity while saving the water.

Typically, the farmers are still using traditional methods for monitoring their crop and agriculture field. To meet the end of the growing world needs, the farmers have to use new techniques of monitoring and tracking their crops which in turn help them by improvement in yield, reduction in farming cost, reduction in destruction to the environment and increase in the quality of the produce. Existing systems and methods of monitoring crops use wireless sensor network to collect data from the different sensors deployed at various nodes and send it through the wireless protocol. The collected data provide the information about the various environmental factors[7] . However, monitoring the environmental factors is not the complete solution to increase the yield of crops.

Therefore there is a need for an integrated and intelligent system to consider a plurality of parameters to increase the productivity in every stage of the agriculture. Further, there is a need for an efficient system that enables a farmer to remotely manage the crops and the agriculture field in real-time.

Artificial intelligence (AI) is a branch of computer science that includes study and development of intelligent machines and software. Major AI researchers and textbooks define this field as "the study and design of intelligent agents", where an intelligent agent is a system that perceives its environment and takes actions that maximize its chances of success. Clustering is a data mining technique which includes the task of grouping a set of objects such that the objects in the same group (called cluster) are more similar to each other than to those in other groups (clusters)[9]. It is a main task of exploratory data mining, and a common technique for statistical data analysis used in many fields, including machine learning, pattern recognition, image analysis, information retrieval, and bioinformatics. The Statistical data include farmers who were asked whether or not they have incurred unusual high rainfall events, such as a storm or heaving downpour. Technically, in machine learning the likelihood of reporting a storm is correlated with treatment in the (Instrumental Variable) IV and heterogeneous effect regressions which gives up farmers a more likely report of incurring a storm. Farmers who had received regular weather information became more aware of unusual rainfall events, which became more likely to report them to enumerators.

This review tends to understand the impact, limitations and potential of E-Agriculture in delivering agricultural and rural development (ARD) in developing or low income countries. This will be achieved through evaluating evidences from various literature concerning the need, adoption, usage, diffusion, extension and impact of e-agriculture solutions, technologies & innovations through a critical and systematic review of various literatures including both practitioner and academic sources.

2. Literature Review

A few researchers and organizations are working towards this topic for last few years. In this context, agro-industrial and environmental fields are ideal candidates for the deployment of IoT solutions because they occur in wide areas that need to be continuously monitored and controlled. At the same time, IoT opens new opportunities beyond ground floor automation when the collected data are used to feed machine learning algorithms to provide predictions (Xu, L.D., et al, 2014) [1], easing decision planning and decision making for owners, managers, and policy makers. IoT can be used at different levels in the agro-industrial production chain (Pujari, J.D., et al., 2013)[2] . It can help to evaluate field variables such as soil state, atmospheric conditions and biomass of animals. It can also be used to assess and control variables such as temperature, humidity, vibration, and shock during the product transport (Ngu, A.H et al., 2017). It can be used to monitor and predict the product state and its demand on shelves or inside refrigerators. In addition, it can provide information to the final user/consumer about the origin and properties of the product. The IoT applied to the agro-industry can contribute to create an informed, connected, developed and adaptable rural community. Under the IoT paradigm, low-cost electronic devices can improve human interaction with the physical world, and the computing power and software available on the Internet can provide valuable analytics. In summary, IoT can be an important tool in the years to come for people interacting within an agro-industrial system: sup- pliers, farmers, technicians, distributors, business men, consumers, and government representatives.

Once the data reach the cloud, governments can feed predictive models to forecast environmental variables, and identify and track pollution sources over time and space, ultimately leading to faster and better decisions to ensure a safe and healthy environment for all citizens. Based on the potential of IoT applications in agro-industrial and environmental fields described in the previous paragraphs, this project aims to identify the current state of solutions in these fields, as well as the trends, architectures, technologies and open challenges. This paper uses a Systematic Literature Review (SLR) based on a methodology proposed by Atzori, L (2010), in order to make it unbiased in terms of information selection, processing, and presentation of results.

3. Proposed Methodology

In Smart Agriculture system it shows the real time data by sensing the agriculture field data using Wi-Fi as allows user to control the system and monitor their agriculture from anywhere of world as the application is connected to the cloud where the data from sensor is stored and allow application to connect to hardware. There uses various sensors like ,DHT (Temperature and humidity) sensor[10] for sensing the local atmosphere data, Ultrasonic sensor for sensing the distance or obstacle in the field as it provide security to the agriculture field as well as for water level indicator in the tank, Soil moisture and humidity sensor for sensing the current soil condition, water motor for supplying the water to the soil automatically by sensing through sensor, Fencing of field for security to protect the field from animals or theft as it will send notification to the farmers mobile and buzzer will start buzzing ,CCTV camera and Drone technology for continuously monitoring of farm through application, Pesticides control system[11] which provide the perfect solution from insects for their valuable crops. Proper ratio of pesticides is given to the farmer so that they can take action quickly and accurately. The application is used to control and monitor data sensed from sensor and send it to server then to user application which is connected to hardware through internet system. The android application keep the data for weeks and even for months.

We know that Indian economy is mostly depends on agriculture but the farmer who produce crops are living a poverty life and are not able to feed their family as they are considered as the god but they itself are living a beggar life. Due to which sometimes they do suicide by getting frustrated from their life. This is due to the fact that they are not able to grow quality crops and their values in the market is low because they do not provide required material to crop at the time due to which it get destroyed because of not able to get correct prediction[13]. The prediction include such as watering or pouring water to plant or soil which get wrong mostly and because of this the problem arises.

- Irrigate is still moderated by the traditional knowledge for the farmers. Knowing how much water is required for a given crop for a soil type depends majorly on soil's capacity to hold moisture. We need an IoT, AI based solution which can auto irrigate the fields for a given crop based on the soil moisture content[14,15].
- Irrigating fields play a vital role in crop yield. However, how much and when to irrigate is still moderated by

the traditional knowledge for the farmers. Knowing how much water is actually required for a given crop for a particular soil type depends majorly on soil's capacity to hold moisture. We need an IoT, AI based solution which can auto irrigate the fields for a given crop based on the soil moisture content.

- Farming accounts for 70 percent of the water consumed and most of its wasteful use. Farmers are central to the whole picture and they are where most of the world's poverty is concentrated[16,17].
- Agriculture cannot be ignored in the water equation, it is the most important part of the developing world.
- A country like India with a tropical climate spread in disparity among its diverse land types, today experiences an ambiguous rainfall pattern which is a major source of irrigation the farmers have to rely on.
- The state's estimated irrigation potential is 5.1 million hectares of which 3.1 million hectares is already achieved. The gap of 2 million hectares cannot be fully addressed by ground water which is fully exploited[18,19].

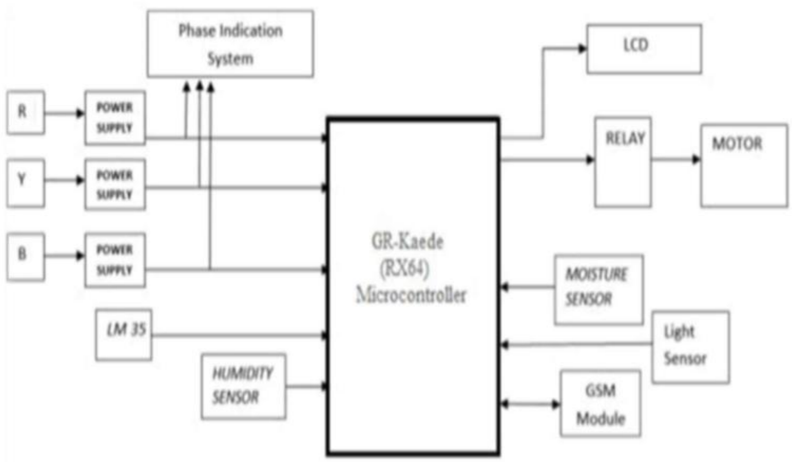

Figure 1: Block Diagram of Smart Agriculture

4. Experiments and Results

As agriculture sector runs in low margin, getting investments is quiet difficult. Although IoT related technology is growing, still there are some challenges in implementing IoT especially, in rural areas. Some barriers like wireless, broadband coverage are well known .Moreover there is something called "image problem". People still believe agriculture belong to grandfather generation so many people don't want to come in that sector[20]. Another challenge can be the question "who will be the owner of those sensor controller data?" Data on soil or water could be used by biotech giants. Access to real time info about harvesting helps corporation predict property value of farmers to get idea about market. However IoT should be brought closer to primary sector by integrating with complementary tools to generate more efficient product. Electronic media can help in this regard by advertising commercials[21,22] and on air campaigns about new technologies. The information from one farm can be shared with other farm in order to get aggregated output.

Proposed Algorithm

The following steps were followed to prepare the data for processing after incorporating all the datasets of this study in to CSV file:

Step 1: Acquiring each parameter (precipitation, minimum, average, maximum Crop Production and reference crop evapotranspiration) monthly mean records of each district from 2002 to 2015 from the Indian Government records.

Step 2: Calculating the total precipitation, average Production for the minimum, average, maximum and average reference crop evapotranspiration for each year for each district during the all season of Rajasthan state.

Step 3: The raw data set was then collated in single sheet which consisted of the following columns in CSV file: sr. no, name of the district, year, precipitation, minimum, average, maximum reference crop evapotranspiration, area, production and yield.

Step 4: For some of the districts particular year's parameters or production data was not available hence those year's data was not used for the current research. Record number was added for each record.

Step 5: For preparing the data set for applying classification techniques, unrequired columns were omitted. They were sr. no, name of the district and year.

Step 6: The data set was then sorted on the basis of area. Area less than 100 hectares were not considered for the present research. So those records were omitted.

Step 7: The dataset was then sorted on the basis of yield to classify the records in to low, moderate and high.

Step 8: The yield has been calculated on the basis of area and production hence these two columns were omitted.

Step 9: This data set was then saved in .csv format for further applying machine learning techniques.

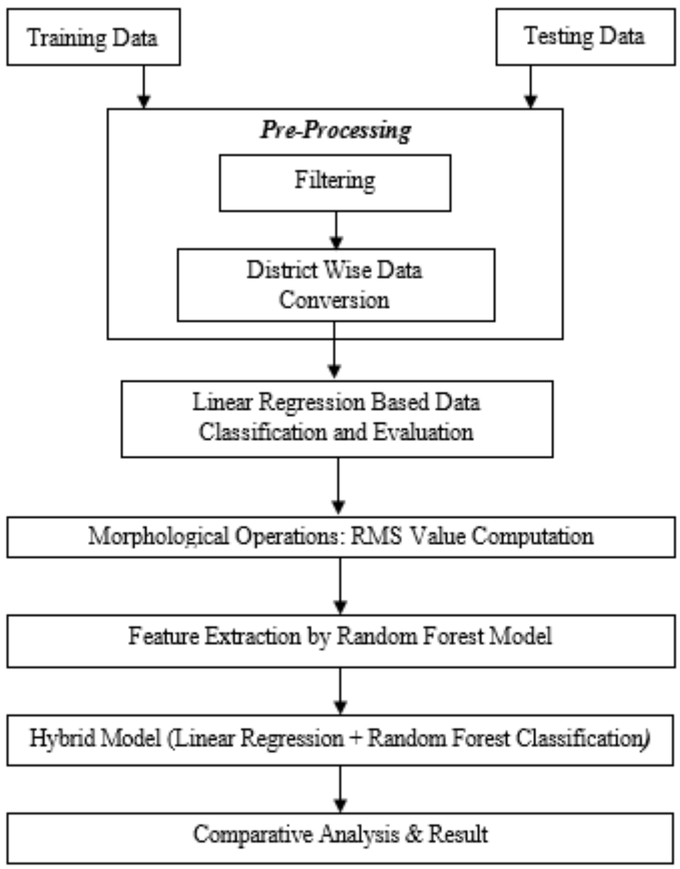

Figure 2: Hybrid Model

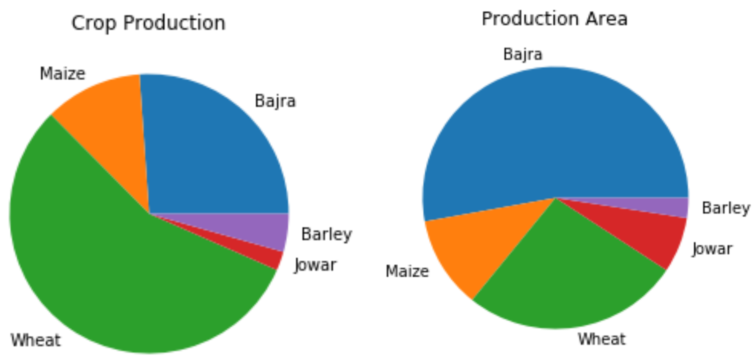

Figure 3: Pie Chart of Crop Production v/s Production Area

Description: Above Pie chart simply visualize that Wheat, Bajra and Maize crops[23] have the larger production area as well as larger crop production than other crops thus analysis of existing dataset shows that these crops have the most suitable environment in Rajasthan. This production may vary at the various places in Rajasthan, which we can analyze in this research work and can predict the crop yield in the specific district on the basis of previous years data and the farmer can be informed about the same predicted crop production in his/her district so that the total production of various crops can be kept balanced in order to fulfill the need of people.

```
In [2]: import pickle as pkl
        import numpy as np

In [3]: district = input('Enter District : ')
        crop = input('Enter Crop : ')
        year = input('Enter Year : ')
        area = input('Enter Area : ')

        Enter District : ajmer
        Enter Crop : bajra
        Enter Year : 2019
        Enter Area : 20983

In [5]: filename = 'models/'+district.lower()+'-'+crop.lower()+'.pkl'

In [6]: model = pkl.load(open(filename, 'rb'))

In [18]: ip = np.array([year,area],dtype = 'float64')

In [19]: model.predict(ip.reshape(1,-1))
Out[19]: array([58522.5101866])

In [ ]:
```

Description: Proposed System would ask to farmer for the following information as shown in above screenshot.

Name of District: To identify their location.

Name of Crop: The crop which the famer wants to cultivate.

Year: Year for which the prediction of crop production to be done.

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Area: Area of crop production

On the basis of above information, proposed system will predict the amount of production for the required crop and desired location.

```
In [31]: lr = LinearRegression()
         rf = RandomForestRegressor()
         ridge = Ridge(random_state=1)

In [32]: stregr = StackingRegressor(regressors=[rf,lr],
                                    meta_regressor=ridge)
         stregr.fit(X_train, y_train)

/usr/local/lib/python3.6/dist-packages/sklearn/ensemble/forest.py:246: FutureWarning: The default value of n_estimators will ch
ange from 10 in version 0.20 to 100 in 0.22.
  "10 in version 0.20 to 100 in 0.22.", FutureWarning)
```

Description: We have used linear regression, Random Forest regression [16,17], Ridge Regression and our proposed hybrid approach for predicting the crop yield as shown in above screenshot. In the next section we will see the accuracy achieved by each model with the common dataset.

```
In [34]: fr = RandomForestRegressor()
         fr.fit(X_train,y_train)
         fr.score(X_train,y_train)

/usr/local/lib/python3.6/dist-packages/sklearn/ensemble/forest.py:246: FutureWarning: The default value of n_estimators will ch
ange from 10 in version 0.20 to 100 in 0.22.
  "10 in version 0.20 to 100 in 0.22.", FutureWarning)

Out[34]: 0.8708855045722896

In [35]: rl = LinearRegression()
         rl.fit(X_train,y_train)
         rl.score(X_train,y_train)

Out[35]: 0.6373943953621659

In [36]: rd = Ridge()
         rd.fit(X_train,y_train)
         rd.score(X_train,y_train)

Out[36]: 0.6373935734861627

In [37]: stregr.score(X_train,y_train)

Out[37]: 0.9372416190009722
```

5. Conclusion and Future Scope

IoT is not just a technology but an ecosystem of technologies or amalgamation of different sets of technology that can have a profound impact on our lives– personal, professional and social. With respect to agriculture, IoT devices provide precise information on a wide range of parameters that are required for enhancing farming methods and cultivation of fresh produce. These include environmental factors, growth conditions, soil, farming equipment, greenhouse production environment, water irrigation, pest and fertilizers. Although IoT in agriculture is in nascent stage in India still the way we are embracing technologies we can be hopeful. If farmers are provided with proper training about technologies, with a smart mobile in hand they can perform many of their agricultural tasks without even reaching there. Basically it helps farmers to stay connected with their farms from anywhere anytime. It also

DOI: https://doi.org/10.54216/JCHCI.010105

helps in reducing human effort with increased productivity and at the same time it boosts economy of farmers. ‘Financial Inclusion’ and ‘IoT for Agriculture’ can be the two pillars to kick-start the journey of rural India towards socio-economic equality. It is now upon the private sector and start-up communities to bring innovations that can help realize these dreams. There are many companies like Onfarm, Farmobile, CropX, Farmx and Farmlogs are working towards smart farming.

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