A Soil Quality Analysis and An Efficient Irrigation System using Agro-Sensors

Fenila Naomi J, Theepavishal RA, Madhuaravindh K S, Tharuneshwar V

Abstract*: *In today's busy world, people run out of time and technology is empowering them in all sectors. In this case, Agriculture is also developing in its technical aspect the primary sector which is India's backbone. Farmers are in the need of smart facilities to overcome their difficulties such as water scarcity, pesticide control, irrigation, soil. This paper is based on IOT device using sensors controlled by mobile application. The major nutrition required for growth of the plant in a soil is nitrogen, potassium and phosphorous using NPK sensors which can detect amount of fertilizers to be provided for the soil. Temperature and humidity sensor will monitor the weather and soil reports using past data. Therefore all these sensors are connected to the arduino board and the data collected from sensors are sent to the interface of the mobile application. This application will provide the user interface to monitor fertilizers, irrigation and humidity control. This also gives suggestion for best crop to be cultivated in the best time and the required pesticide for the crop using machine learning technique. If the crop has threat in a particular area are identified and provided with the sufficient need as it is connected to the every sprinkler and drip in the field. This application would be helpful for the farmers who are thinking for smart implementation in agricultural sector.

Index Terms*: *Sensors, Arduino, Machine learning, Mobile application, Agricultural sector

I. INTRODUCTION

Agriculture is Indian Economy's main significant sector. Indian agriculture accounts for 18% of India's GDP and provides income for 50% of the country's workforce. [1]. In this new era, the farmer can use technology to exert control over adapting crop management and water use dynamics. Farmers have obtained new technology and tools to increase their profits with both the birth of SaaS and cloud technologies, increasing the number of discerning consumers and unprecedented temperature values over the past few years. Unfortunately, many farmers are still using traditional farming methods, leading to low crop and fruit yields. But wherever there was automation and people were replaced by automatic machinery. Most papers imply using the sensors[2] that collect data from multiple sensor types and then use a wifi to send it to the cloud storage. The data gathered offer additional information on specific environmental conditions, which then in turn allows monitoring the system. Monitoring of environmental conditions is not adequate and comprehensive to enhance agricultural productivity. There are numerous other factors that have a major impact on productivity. These considerations include attacks on insects and pests which can be monitored by splattering the crop with necessary insecticide and pesticides [3]. Measurement of soil content N (nitrogen), P (phosphorus) and K (potassium)[4,5] is necessary to determine how much additional nutrient content is to be added to soil to increase crop fertility. The soil fertility is detected using NPK sensors. A major component of soil fertilizer is nitrogen, phosphorus, and potassium. Knowing their soil concentration can give rise to nutritional deficiency or abundance in soils used to endorse plant production. Moisture sensors are quite essential devices for environmental measurement of moisture. Technically, the device used to measure atmospheric humidity. A hygrometer detects observations and analyses the temperature of humidity and air. The ratio of humidity content in the air at a specific air temperature to the highest amount of humidity content is called relative humidity. When looking for safety, relative humidity becomes an important factor.Irrigation is the application at the required intervals of controlled quantities of watering plants. It helps grow agricultural crops, sustain landscapes, and revegetate deranged soils in dry areas and in less than average rainfall periods. It has certain needs in agricultural production, including frost protection, weed growth in grain fields, and soil acquisition avoidance. In agricultural production, temperature plays an important role. It has a profound impact on crop growth, development and yields, pest and disease incidence, water needs and fertilizer needs. Weather factors contribute to the optimum growth, growth and yield of crops.

II. LITERATURE SURVEY

This section describes the literature survey a soil quality analysis and an efficient irrigation system using agro-sensors. Ananthi[6] suggests in the system to cultivate the suitable crop that suits the soil. The soil is tested by varied sensors like hydrogen ion concentration device, temperature device, and humidity device. The values collected are sent through Wi-Fi router to the realm manager and the crop assertion is formed via the mobile application. Once the soil temperature goes up, auto irrigation system is delegated. Crop image is captured and it's sent to the sphere manager to legally tell about pesticides.Shubham bhardwaj et al[7] suggests that "Programmed Irrigation System with temperature checking" is expected to make a computerized water system instrument on identifying the dampness substance of the earth. It likewise screens the constant temperature of the homestead which is an exceptionally urgent factor for

Revised Manuscript Received on June 12, 2019

Fenila Naomi J, Department of Computer Science and Engineering, Sri Krishna College of Engineering and Technology, Coimbatore, India.

Theepavishal RA, Department of Computer Science and Engineering, Sri Krishna College of Engineering and Technology, Coimbatore, India.

Madhuaravindh K S, Department of Computer Science and Engineering, Sri Krishna College of Engineering and Technology, Coimbatore, India.

Tharuneshwar V, Department of Computer Science and Engineering, Sri Krishna College of Engineering and Technology, Coimbatore, India.

the generation as indicated by the yield. In the area of cultivating, usage of proper methods for water system is critical. It plays an AVR board ATmega16 smaller scale controller which is modified to gather the information flag of variable dampness conditions of the earth by means of dampness recognizing framework and turns on the water siphon at whatever point the homesteads requires water.Joaquín Gutiérrez et al[8] recommended a propagated remote soil particulates and temperature sensor system laid down in the plant's subsoil. In order to have access, a passage unit controls data from sensors, induces actuators, and directs data to a web app. A estimate was generated with threshold predictions of temperature and soil dampness amended to control the amount of water in a microcontroller-based passage.Gaikwad S.V et al[9] suggested a framework which will have a handheld gadget which gives pH esteem and appraise Nitrogen (N), Phosphorus (P) and Potassium (K) from the pH of that dirt. They utilized grouping calculation to anticipate reasonable harvests dependent on the quality and likewise it gives appropriate composts required to that arrive.

III. MATERIALS AND TECHNIQUES

The following sections discuss the paper's research materials and techniques briefly. The fig.1 shows proposed system flowdiagram.

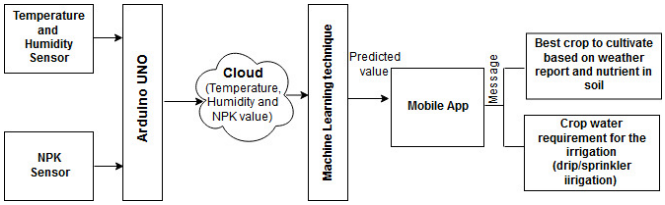

Fig.1 Proposed system flowdiagram

A. *NPK Sensor*

The presence of soil gas (N), phosphorus (P) and metallic element (K) is detected through the use of an optical electrical sensor. This sensor is required to make a decision on the proportion of additional insides to be added to the soil in order to extend crop yields for those nutrients area units. This can enhance the soil level and reduce the undesired use of pesticides to add value to the soil. The sample area unit NPK value determined by the absorption of each nutrient by sunlight. The electrical optical device is enacted as a monitoring device comprised of 3 LEDs as illumination source and a lightweight detector photodiode. The frequency of LEDs is chosen to fit each nutrient's optical occurrence. The nutrient penetrates the sunshine from the LED and therefore the photodiode transforms the remaining light that is mirrored to current by the reflector. The system includes associate Arduino to learn these things, so the inductive load output is raised-again into an alphanumeric display reading. The optical electrical device will examine the values of NPK soil content by testing on varied soil samples.

B. *Temperature and Humidity Sensor*

DHT11 is a digital output tag-generating humidity and temperature detector. DHT11 is an device that could produce instant results with Arduino. DHT11 can be a low-value detector for humidity and temperature, giving extremely reliable and future stability. The temperature and humidity sensor DHT11 takes the form of three main elements. A resistive sorting device connecting NTC (negative temperature coefficient) semiconductor unit (to live the temperature) aligns an 8-bit microcontroller, one that converts the analog signals for each of the sensors and sends out a single digital signal. The moisture detector DHT11 takes the form of four pins: VCC, Data Out, Unconnected (NC) and GND.

C. *Arduino*

Arduino Uno could support the ATmega328P (datasheet) as a microcontroller board. It does have 14 digital input / output pins, half a dozen analog inputs, a 16 megahertz quartz, a USB subsidiary, an ICSP header, and a reset button. It includes all that needed to endorse the microcontroller; simply plug it with a Usb port to a laptop or make it possible it to be commenced via an AC-to-DC adapter or battery. "Uno" means one in Italian and has been chosen to mark the Arduino code (IDE) discharge 1.0. Arduino's reference versions were the Uno board and version one.0 of Arduino code (IDE), currently evolving into newer releases. The Uno board is that the 1st is the reference model for the Arduino platform during a series of USB Arduino boards; for an intensive list of current, past or outdated boards see the Arduino board index.

D. *Cloud Storage*

InfluxDB Cloud is a efficient, time series database rich in features hosted on AWS. It is designed specifically in deployment monitoring, application analysis and authentic-time analytics for high availability storage and retrieval of time series data. Grafana dashboard is incorporated with InfluxDB cloud. It is most commonly used to visualize time-series data for infrastructure and application analytics in graphical representation.

E. *Machine learning technique*

Neural network method is a machine learning technique which has a firm ability to learn and can comprise the non linear relationship between the inputs and outputs of a system. Some of the neural network specific applications for irrigation and water resource management include soil moisture prediction, crop yield prediction, irrigation water demand prediction[10,11]. A NN method is used here to predict humidity and temperature aspects terms of their ability to produce reliable methods replicating complex processes. Feed Forward Neural Network is a NN method which cannot remember past values. This paper relies on a vibrant designing endeavor whereby the appropriate alternative is presented by the Recurrent Neural Network (RNN). An RNN has inner self-looped cells, enabling data to be upheld from previous steps in time. The Long Short-Term Memory Network (LSTM), a tier of RNNs, is chosen for its formal application in managing non linear dynamic systems. The LSTM requires considerable pre-processing of input data and is capable of maintaining useful data over multiple time stages. Time series data are adhered to the model as inputs on evaporation, precipitation and

temperature. Reliable water table depth prediction for LSTM models illustrates their potential to retain and learn from data from long-term time sequence. This ability is particularly lucrative in soil moisture irrigation whereby the present soil moisture content is contingent on past moisture, soil nutrient(NPK), precipitation and temperature data.

F. *Android Studio*

Android Studio is Google's authorized integrated development environment (IDE), built up on JetBrains ' IntelliJ IDEA software and built solely for Android development. It replaces the Android Development Tools (ADT) for Eclipse as the key IDE for native Android app development. Stable version provides Gradle-based build support for app building. This app is connected with database using database connectivity and frequently gives notifications to users. Mobile application provides user friendly interface to customers.

G. Irrigation Types

Sprinkler Irrigation It is a rainfall-like method of applying irrigation water. Water is usually pumped through a system of pipes. Sprinklers provide effective coverage for small to large areas and are suitable for use on all property types. They are also used for pasteurization and airborne dust control. It can also be adapted to almost all irrigable soils as there are sprinklers available in a wide range of discharge capacity. It is feasible to use irrigation sprinklers for residential, industrial and agricultural use.

Drip Irrigation It is a kind of micro-irrigation system which can save water and nutrients by allowing water to gently drip to plant roots, either from above the surface of the soil or entombed below the surface. The objective is to effectively position water in the root zone and reduce evaporation. Through a network of valves, pipes, tubing and emitters, drip irrigation systems circulate water. A drip irrigation system is more economical than other types of irrigation systems, like surface irrigation or sprinkler irrigation, depending on how well developed, mounted, maintained and operated it is.

IV. RESULTS AND DISCUSSIONS

The existing system helps in obtaining the information about nature of the soil to find right crop for their yield with the assistance of Raspberry pi board along with few sensors like pH sensor , humidity sensor and temperature sensor to collect the data from those sensor and sends to cloud storage to store the values of respective sensor. It provides android application facility for the end-user to get their sensor values. It can be accessed through entering the IP address of their device. But this system cannot predict the weather condition in prior and will not suggest the best crop to yield. It fails to notify regarding the irrigation at the required time. To analyze the soil quality, the proposed system uses humidity sensor, temperature sensor and NPK sensor to get details about the moisture content in the soil , temperature of the surrounding and Nitrogen , phosphorous , potassium contents in the soil. These sensors are connected to the Arduino UNO board. A dedicated wi-fi module is connected to the board that helps to send data to the cloud to process the data gathered by different sensors. The gathered data are Temperature, Humidity and NPK values. Those data from the sensors are stored in InfluxDB[12] cloud which is an high avaliability open source cloud storage. Data are updated to InfluxDB frequently. Grafana dashboard which is incorported with InfluxDB shows the graphical representation of the gathered data which are stored in InfluxDB. The Grafana Dashboard is shown in fig.2

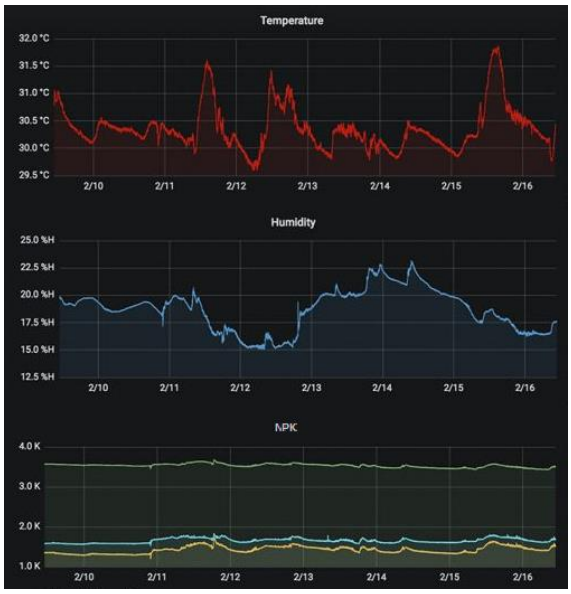

Fig.2 Grafana Dashboard

To anticipate the future values of the data, they are processed by machine learning technique. The technique used in this paper RNN-LSTM method which is utilized to anticipate the future value with long-term dependencies. Based on the predicted Temperature, Humidity and NPK values, the system can identify the suitable crop and what type of irrigation can be preferred for crop will be suggested to the user ie farmers. This is done with the help of mobile application. The application is created using android studio software. This application will display the temperature, humidity, nutrients of the soil. Also gives alert about the low moisture area to provide the irrigation. It use predicted temperature and nutrients to analyze the best crop. The farmer can login as shown in fig.3 to view the details and get suggestion for good yielding of crops as shown in fig.4.

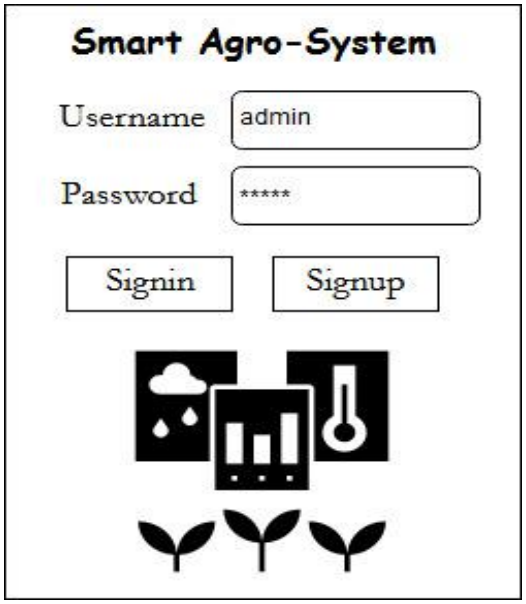

Fig.3 App Layout 1

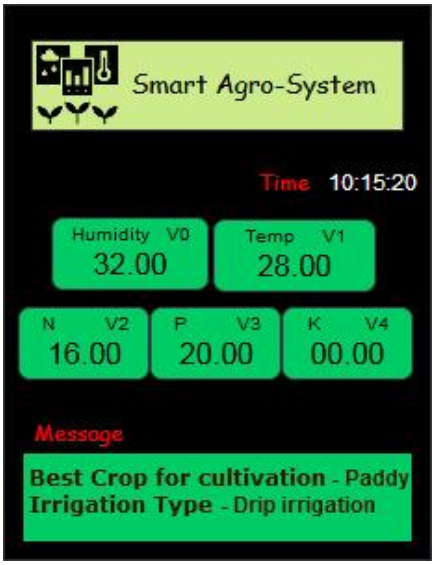

Fig.4 App Layout 2

V. CONCLUSION

In this paper, it gives the detail about nutrient contents, humidity and temperature of the soil with the help of different sensors connected to Arduino UNO board which is cost efficient. From NPK sensor, nutrient contents of the soil are obtained. RNN-LSTM technique gives the predicted values that helps farmer to know about irrigation required timing also it suggest the crop to sow for the particular period of time. So the farmer can get the good yield of cultivation.

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AUTHORS PROFILE

J. Fenila Naomi was born in Coimbatore, TamilNadu, India, in 1993. She received M.Tech degree from PSG College of Technology in the year 2018, Coimbatore. She has secured TANCET scholarship during her P.G. course. She received B.Tech degree from Hindusthan College of Engineering and Technology. Currently she is working as Assistant Professor at Sri Krishna College of Engineering and Technology, Coimbatore. Her research areas are Cloud computing, Data mining and IoT. She has published more than five research papers in International and National Journals and more than three papers in National and International Conferences.

Theepavishal RA, is currently pursuing B.E Computer Science and Engineering at Sri Krishna College of Engineering and Technology, Coimbatore, TamilNadu, India. His research areas are IoT and Machine learning. He has presented papers in International and National Conferences.

Madhuaravindh K S, is currently pursuing B.E Computer Science and Engineering at Sri Krishna College of Engineering and Technology, Coimbatore, TamilNadu, India. His research areas are web development, IoT and Machine learning. He is the member of IEEE. He has presented papers in International and National Conferences.

Tharuneshwar V is currently pursuing B.E Computer Science and Engineering at Sri Krishna College of Engineering and Technology, Coimbatore, TamilNadu, India. His research areas are IoT and Data Mining. He has presented papers in International and National Conferences.