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SMART FARMING WITH IOT: ENHANCING AGRICULTURAL EFFICIENCY AND SUSTAINABILITY THROUGH REAL-TIME DATA AND MOBILE TECHNOLOGY

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ABSTRACT

The Internet of Things (IoT) is a force for good in all fields, changing people's lives by bringing intelligence to everything. It is a collection of various devices that function as a self-adjusting network. The application of IoT to Smart Farming is revolutionizing traditional agricultural practices by decreasing crop waste and increasing efficiency while also saving farmers money. The technology that will be proposed can send out notifications to farmers via various platforms by generating messages. In addition to helping farmers practise smart farming by raising crop yields and conservingresources (fertilisers and water), the device will also help farmers by providing real-time data (temperature, humidity, soil moisture, UV index, and IR) from the farms.

The device described in this paper makes use of an ESP32 Node MCU, a breadboard, a DHT11 temperature and humidity sensor, a soil moisture sensor, an SI1145 digital UV index, infrared, visible light sensor, jumper wires, LEDs, and a live data feed that can be seen on a serial monitor and a Blynk mobile platform. This will enable farmers to manage their crops in line with modern farming practices.

A smartphone is one of the devices that might be helpful in agriculture due to its economical, portable, and practical features. It facilitates location-finding, information access, and audio and picture capturing for users. It is possible to create adaptable mobile agriculture applications by combining smartphone functions. They aid in disseminating information on crops and the demands of management.

This study creates the "Krishidristi" Android app, which aims to improve the cultivation of crops through smart farming.

KEYWORDS: SMART (S-Specific, M-Measurable, A- Attainable, R-Realistic T-Time Bound) Internet of Things (IoT), Precision Agriculture, Soil Moisture Sensor, Blynk Platform, Resource Management, Environmental Monitoring, Agricultural Efficiency

1. INTRODUCTION

Agriculture provides the majority of the world's food. Throughout history, it has been critical to civilizational progress. According to the United Nations (UN), the world's population will grow by 2 billion people by 2050, up from 7.8 billion today, requiring the planet to feed approximately 11 billion people by the end of the century [1]. Agriculture is the world's greatest user of water, accounting for more than 70% of total annual water use. It supports a variety of operations such as irrigation, watering, and cleaning of livestock and aquaculture. High concentrations of pesticides, fertilisers, and other contaminants contaminate the water from these applications. It seems that in order to feed the growing global population, food production must rise.Food grains grown sustainably and with minimal environmental impact are measured by sustainable agriculture [2]. Farmers and resources can be supported by encouraging the use of sustainable farming techniques and approaches. It preserves soil quality, reduces soil degradation, conserves water, increases land biodiversity, and ensures a safe and natural environment while also being economically feasible [3]. Sustainable agriculture helps to preserve natural resources, prevent biodiversity loss, and reduce greenhouse gas emissions [4].
Resilient farming In addition to increasing farming's efficiency, farming allows us to preserve the environment without sacrificing future generations' essential necessities. The fundamental achievements of smart farming in impact agriculture are crop rotation, crop nutrition

deficits, pest and disease management, recycling, and water harvesting, all of which contribute to a safer environment overall. A healthy habitat for living things is essential, as greenhouse gas emissions affect humans, animals, plants, and the ecosystem. [5]. According to the 2018 Economic Survey, by 2050, agriculture would account for only 25.7% of the total employment. The next generation of farmers in rural areas is increasingly disappearing from farming families as a result of issues such as rising cultivation expenses, low yield per capita, poor soil management, and migration to non-farming jobs. The world is set to experience a digital revolution; therefore, now is the best time to integrate.

With the application of technology, smart farming provides a route towards sustainability. In the cyber-physical cycle of farm management, it involves the application of information and communication technologies (ICTs), including robotics, artificial intelligence (AI), cloud computing, andthe Internet of Things [5]-[8]. By providing each plant or animal with exactly what it needs to thrive in the best possible way, precision agriculture is a clever farming method that increases operational accuracy and optimises overall performance while lowering waste, inputs, and pollution. Even though precision agriculture uses highly advanced technology, it only considers factors specific to the field. However, smart farming takes a step further by basing management responsibilities on data as well as location, which is enforced by situational awareness and context and is fueled by real-time occurrences

[9]. With an 18% GDP contribution and 57% of the population living in rural areas, agriculture is India's largest industry. India's overall agronomic output has grown throughout time, but the proportion of growers has decreased—from 71.9% in 1951 to 45.1% in 2011 [10]. The development of new technologies including the Internet of Things, more affordable and sophisticated sensors, actuators, and microprocessors, high-bandwidth wireless technologies, cloud-based ICT systems, big data analysis, artificial intelligence, and robots helped progress smart farming in these early years. Data is no longer solely obtained from farm equipment; new services are available that transform data into information that is useful. The goal of IoT use in agriculture is to give farmers the right tools to help them with automation and decision-making by offering goods, information, and services that will increase profit, quality, and production. IoT is regarded as a component of the internet of the future, which will be made up of billions of "things" capable of intelligent communication. Even though the meaning of "things" has evolved as technology has progressed, the essential goal of deciphering computer data without the help of humans has not altered.

2. LITERATURESURVEY

With the extensive compilation of strategies, such as accuracy and conservative cultivation to meet field obstacles, the Internet of Things (IoT) is revolutionizing the agribusiness that engages the farmers. Different approaches have been suggested by researchers for the agricultural sector, utilizing one or more of the technologies mentioned. For example, an irrigation system that determines the irrigation volume of water based on soil water measurement is detailed in [11]. This employs the Bluetooth communication model, which has drawbacks of its own, such as restricted device accommodation and range. An author proposed timing the power supply to the sensors in 2016 to increase energy efficiency [12]. An author in a publication [13] mentions the use of IoT in agriculture. Unfortunately, it demonstrates a lack of interoperability—a crucial component when discussing vast agricultural areas. In a 2017 publication [14], Jinsoohan offered a method for comparing the energy usage of two appliances. In their research, N.K. Suryadevara and S.C. Mukhopadhyay employed ideas from pervasive computing, data aggregation, etc. to use Zigbee to monitor environmental variables [15]. But, when more nodes are installed, it could show concerns about increased power usage and agricultural automation [16]. The approach for giving farmers access to real-time information about their land and crops is outlined in the paper 1[17], which offers the required data butis a stand-alone system. In 2015, Prem Prakash Jayaraman, Doug Palmer, and Arkady Zaslavsky introduced the concept of phononet, which is a network of intelligent wireless sensor nodes that share information with a central system. This paper [18] discusses the application of IoT, cloud computing, and mobile computing to smart agriculture.

3. WORK METHODOLOGY

Our project is divided into two parts:

3.1 HARDWARE

"Smart agriculture technologies and innovations" refers to the wide range of devices and programs that are revolutionising the agriculture industry. These developments are essential to the sustainable growth of agriculture and are bringing in a new era in farming.

Internet of Things (IoT) gadgets and sensors are becoming more and more crucial in modern agriculture since they facilitate real-time data collection and improve resource management. Specifically, sensors for IoT agriculture are essential for monitoring variables such as soil moisture, temperature, and indications of crop health. These sensors gather incredibly useful data that aids in the development of informed decisions regarding critical agricultural processes such as crop harvesting, reproductive cycles, and production predictions.

A few key points about how hardware technology operates are as follows: The hardware work methodology is divided into 4 parts:

a. Soil moisture sensing

Soil moisture sensors measure soil's volumetric water content. Soil moisture sensors indirectly assess volumetric water content by employing a soil parameter, such as electrical resistance, dielectric constant, or neutron interaction, as a surrogate for moisture content. This is because direct gravimetric measurement of free soil moisture requires the removal, drying, and weighting of a sample.

b. Temperature and Humidity monitoring

It basically monitors several meteorological data, such as temperature and humidity. Node MCU (ESP8266) serves as the device's heart. In this research, a temperature and humidity sensor (DHT11) is employed and coupled to a Node MCU. When the code is uploaded to the Arduino IDE, the board is connected and the sensors begin working. All observed data is stored on the BLYNK platform.

c. Automatic irrigation

This consists of a water pump, relay module, power supply, soil moisture sensor, Node MCU microcontroller, and water pump. The relay module is connected to the Node MCU digital output, which operates the water pump, and the soil moisture sensor is connected to the Node MCU analog input [11]. Configuring the software components comes next when the hardware setup is finished. Installing the Arduino IDE and any required libraries is part of this process. The Node MCU is configured to monitor the values from the soil moisture sensor and manage the water pump via the relay module.

d. Remote monitoring

To gather and process data on various atmospheric conditions, weather monitoring systems are essential tools. Weather monitoring systems based on the Internet of Things (IoT) are becoming more and more popular due to their ability to provide real-time data on weather conditions.

The system consists of a temperature, humidity, and air pressure sensor, a Wi-Fi module for connecting to the Blynk platform, and a Nodemcu microcontroller. Clients can access and manage their Internet of Things devices from any location in the world with the assistance of the mobile app platform Blynk.

The system functions include collecting meteorological data, sending it to the Blynk platform, and providing real-time weather updates through a mobile app. The Nodemcu microcontroller facilitates easy system setup by connecting to the sensors via a breadboard and facilitating communication with the Blynk platform using the Wi-Fi module. Users may create alerts based on different weather conditions using the Blynk app, which also displays real-time sensor data[12].

3.2 SOFTWARE

With improved farming techniques and appropriate crop management, the advantages of information technology present a viable way to raise crop yields. As technology develops, crucial information on farming—from planting to harvesting—can be found on an internet platform[13]. Using a Smartphone, users may access a mobile application that has all the crop's information. The majority of the functionalities of the program are free, and users will utilise it by downloading it to their Smartphone[14].

3.2.1 Mobile technology

The world was first exposed to mobile technology as new generations (G) of smartphones, such as 2G and 3G. A mobile device could only make calls, send texts, and record voice messages prior to smartphones. More than just fundamental operations can be performed on a smartphone thanks to its innovative technology. With the inclusion of a hardware sensor, smartphones can record and take high-resolution pictures and videos [15]. When using mobile data plans via 2G, 3G, and 4G networks, wireless data access is the standout feature of any smartphone (4G). Our lives have changed and gotten easier since smartphones have become a part of our way of life. Due to the increasing demand for smartphones, mobile applications are utilised extensively in daily life.

3.2.2 Mobile application

Mobile applications are created to operate on mobile devices' machine firmware and operating systems. "Krishidristi" is one example of a mobile application on farming that has been created. Apps assist users, particularly farmers, in making better decisions and enhancing their present methods. The majority of smartphone users, according to [16], spend 86% more time on mobile applications than on websites (14%). The reason for this is because the application is easier to use and instantly available on their smartphone. The majority of mobile apps don't require the Internet.

3.2.3 Advantages and disadvantages of mobile application

One benefit of mobile applications is their ability to fix problems. For instance, people may plan a vacation to a new location and reach their destination securely by using Google Maps. The application offers a better user experience and performance than a website since mobile applications load pages more quickly than websites [17]. Mobile applications include a notification feature that provides users with news or information on the status of their apps or the most recent updates. Human health risks include depression and vision issues [17], as well as time wastage from using apps like games

.

4. METHODOLOGY

The development of mobile applications uses Android Studio[18].The presentation layer, application layer, and database layer are the three layers that make up a mobile application. Users access the presentation layer using mobile devices like tablets and smartphones. The User Interface (UI) and associated process components comprise this layer. Application management is the main emphasisof the application layer, often known as the business layer. The application's process is part of the management. All of the data entered into the program is stored in the database layer, which also serves to safeguard it. The core of the mobile application is this layer.

4.1 FUNCTIONALITIES

1 Registration–Register with the Krishidristi app.

2 Login-Pre-existing user logins with name and password.

3 QuestionsandAnswers-Ourfarming-relatedapplication's"QuestionandAnswers"featurelets users peruse a carefully curate list of frequently asked questions and their thorough responses.

4 About crops crops-Our application's "About Crops" function provides users with a wealth of information about different crops that are frequently cultivated in agriculture.

5 Training videos-Our application's "Training Videos" function gives users access to instructional videos about farming, agricultural techniques, and crop development.

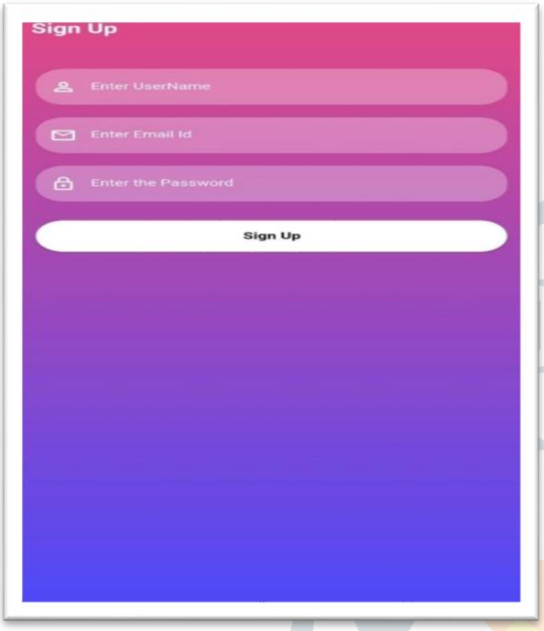

Fig.1 Sign up Page

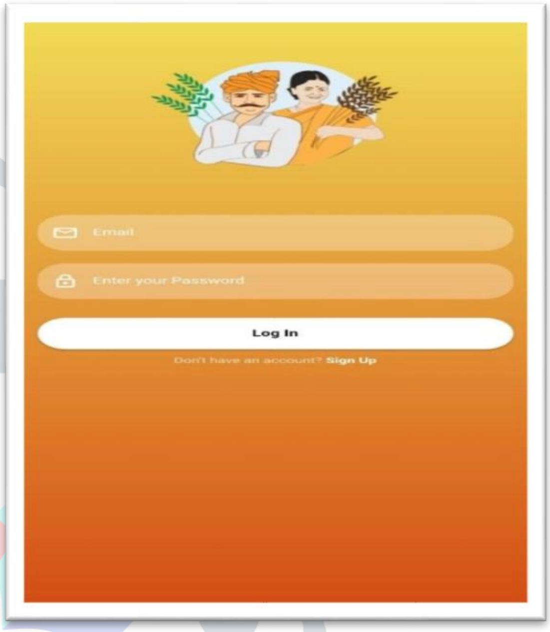

Fig.2 Login Page

Fig.3 Question and Answer Page

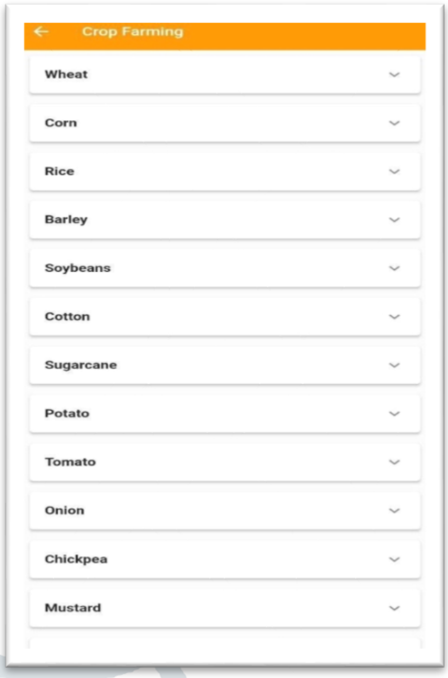

Fig.4 About Crops Page

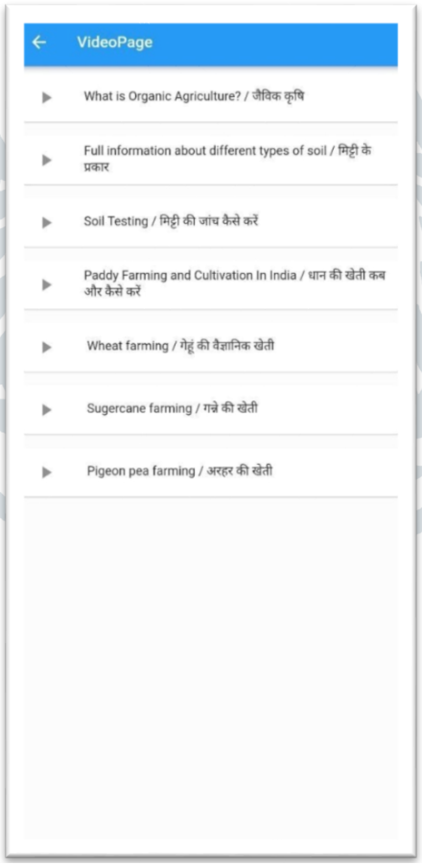

Fig.5Training Videos Page

4.2 TOOLSANDTECHNOLOGIES

4.2.1 ANDROID STUDIO

Android Studio is the official integrated development environment (IDE) for developing on the Android platform. Android Studio is based on Jet Brains' IntelliJ IDEA software, which was designed specifically for Android development. It is the official Google IDE for developing native Android applications and is available for download on Windows, Mac OS X, and Linux. This programme has supplanted Eclipse Android Development Tools (ADT).

4.2.2 FLUTTER

A cross-platform framework called Flutter is designed to help developers create mobile apps with great performance. Flutter apps operate Android and iOS devices. Flutter is unique in that it doesn't use web views; instead, it depends on the OEM widgets on the device. Every view component in Flutter is rendered using a powerful rendering engine of its own. This offers an opportunity to create apps with the same level of performance as native programs.

4.2.3 DART

is not possible to program in Flutter by oneself. Instead, it's an SDK containing ready-to-use, editable widget code that has already been prewritten. Dart, the programming language in use, was also created by Google. Flutter reduces performance problems and speeds up app startup times by not requiring the use of a bridge to interact with native platforms like iOS or Android.

4.2.4 FIREBASE

Firebase is a real-time database and also acts as a Backend-as-a-Service(BaaS). It makes it possible to save an object list. Developers may create applications for Android, iOS, and Webplatforms using Google Firebase, an application development platform powered by Google. The data is saved in JavaScript Object Notation (JSON) format, which eliminates the need for queries when adding, updating, removing, or modifying information. It is a component of a system's backend that functions as a database for data storage [19].

5. RESULT AND ANALYSIS

During our analysis we have considered two flowering seasons. One is for the roses and the other is for the sunflower. During our analysis we have measured the humidity and soil moisture percentages at different temperatures. Table 1 represents the observations obtained through the developed system:

Table1: Data Obtained through Analysis

Months	Temperature(Degree Celsius)	Humidity(grams per cubic metre)	Soil Moisture(%)
ROSES			
February	16	57	39
	20	37	57
March	24	46	55
	18	43	45
	26	45	41
SUNFLOWERS			
April	32	25	9
	35	48	20
	34	31	53
May	39	41	55
	35	54	45
	45	48	41
	46	55	20

The soil moisture threshold is observed to be 55 percent.
The data draws the following conclusion for the respective plants:

ROSES:

- The optimal range of temperature is 15℃ to 25℃.
- The optimal range of humidity is 40% to 60%.
- Soil moisture should be around 40% to 60%.

SUNFLOWERS:

- The optimal range of temperature is 20°C to 25°C.
- The optimal range of humidity is 40% to 60%.
- Soil moisture should be around 40% to 60%.

In summary, the successful completion of the Krishi Drishti application represents a major step forward in the creation of smart farming systems. Farmers are able to tackle irrigation issues, temperature issues, humidity issues, and other issues with these devices, which also allow for the inspection of the soil's quality and cultivator growth. The Internet of Things and wireless sensor networks communication can help reduce the challenges faced by farmers and improve the communication path for the transfer of useful data between various nodes. Both sensors and microcontrollers that is readily available for agricultural parameters can easily interface with one another. The successful completion of the hardware components has also built a solid foundation for the integration of physical sensors and devices in the next stage of development. We were able to verify the system's functionality and compatibility during the simulation stage, ensuring that everything went according to plan when we moved to the experimental hardware configuration.

6 Conclusion

The Internet of Things (IoT) is revolutionising many industries by incorporating intelligence into common gadgets. In agriculture, IoT is transforming traditional farming practices by reducing crop waste, increasing efficiency, and lowering expenses. The suggested solution will notify farmers across numerous platforms, promoting smart agricultural practices, boosting crop yields, and preserving resources like fertiliser and water. It monitors temperature, humidity, soil moisture, UV index, and infrared radiation in real time. The suggested device incorporates an ESP32 Node MCU, temperature, humidity, soil moisture, UV index, and visible light sensors, as well as a connection to the Blynk mobile platform for real-time data monitoring. The Krishidristi Android app was created to promote smart farming by delivering critical information and capabilities such as real-time data, automated irrigation, and weather monitoring.

To summarise, the successful completion of the Krishi Drishti application marks a significant advancement in the development of smart farming systems. The software component uses mobile technology to provide farmers with accessible and useful tools, such as crop information, training videos, and a Q&A area. It provides a powerful and user-friendly interface for managing agricultural activities, having been developed with Android Studio, Flutter, Dart, and Firebase.

The program's user-friendly and easy architecture allows farmers to quickly engage with the rich real-time data provided by IoT-enabled infrastructure. The successful completion of the hardware components has also laid the groundwork for the next stage of development, which will involve the integration of physical sensors and devices. During the simulation step, we could evaluate the system's functioning and compatibility.

REFERENCES

1. **World** population prospects 2019: Highlights," [Online]. Available: https://population.un.org/wpp/Publications/Files/WPP2019_Highlights.pdf. Accessed on: Mar. 24, 2020.
2. Srisruthi, S.; Swarna, N.; Ros, G.M.S.; Elizabeth, E. Sustainable agriculture using eco-friendly and energy efficient sensor technology. In Proceedings of the 2016 IEEE International Conference on Recent Trends in Electronics, Information & Communication Technology (RTEICT), Bangalore, India, 20–21 May 2016; IEEE: Bangalore, India, 2016; pp. 1442–1446. [**Google Scholar**] [**CrossRef**]
3. Brodt, S.; Six, J.; Feenstra, G.; Ingels, C.; Campbell, D. Sustainable Agriculture. *Nat. Educ. Knowl*. **2011**, *3*, 1.
4. Obaisi, A.I.; Adegbeye, M.J.; Elghandour, M.M.M.Y.; Barbabosa-Pliego, A.; Salem, A.Z.M. Natural Resource Management and Sustainable Agriculture. In *Handbook of Climate Change Mitigation and Adaptation*; Lackner, M., Sajjadi, B., Chen, W.Y., Eds.; Springer: Cham, Switzerland, 2022.
5. G. Fortino, W. Russo, C. Savaglio, W. M. Shen, and M. C. Zhou, "Agent-oriented cooperative smart objects: From IoT system design to implementation," *IEEE Trans. Syst. Man Cybernet.:Syst.*, vol. 48, no. 11, pp. 1939–1956, Nov. 2018. doi:10.1109/TSMC.2017.2780618
6. **J.** M. Garibaldi, "The need for fuzzy AI," IEEE/CAA J. Autom. Sinica, vol. 6, no. 3, pp. 610–622, May 2019. doi: 10.1109/JAS.2019.1911465
7. M. Ghahramani, Y. Qiao, M. C. Zhou, A. O'Hagan, and J. Sweeney, "AI-based modeling and data-driven evaluation for smart manufacturing processes," IEEE/CAA J. Autom. Sinica, vol. 7, no. 4, pp. 1026–1037, Jul. 2020. doi: 10.1109/JAS.2020.1003114
8. X. Yang, L. Shu, J. N. Chen, M. A. Ferrag, J. Wu, E. Nurellari, and K. Huang, "A survey on smart agriculture: Development modes, technologies, and security and privacy challenges," IEEE/CAA J. Autom. Sinica, vol. 8, no. 2, pp. 273–302, Feb. 2021. doi: 10.1109/JAS.2020.1003536
9. Latake, P.T.; Pawar, P.; Ranveer, A.C. The Greenhouse Effect and Its Impacts on Environment. *Int. J. Innov. Res. Creat. Technol.* **2015**, *1*, 333–337. [**Google Scholar**]
10. S. Wolfert, L. Ge, C. Verdouw, and M. J. Bogaardt, "Big data in smart farming–a review," *Agr. Syst.*, vol. 153, pp. 69–80, May 2017. doi: 10.1016/j.agsy.2017.01.023
11. M.K.Gayatri, J.Jayasakthi, Dr. G.S. Anandha Mala, (2015). Providing Smart Agricultural Solutions to Farmers for better yielding using IoT. IEEE International Conference on Technological Innovations in ICT for Agriculture and Rural Development (TIAR 2015)
12. NikeshGondchawar,Dr.R.Complexion.Kawitkar,"IoTbasedagriculture",all-embracing almanack consisting of contemporary analysis smart minicomputer additionally conversationplanning (ijarcce), vol.5,affair 6, June 2016. Overall Journal on Recent and Innovation Trendsin Computing and CommunicationISSN: 2321- 8169 Volume: 5 Issue: 2 177–181
13. SoumilHeble, Ajay Kumar, K.V.V Durga Prasad, Soumya Samirana, P.Rajalakshmi, U. B.Desai. A LowPower IoT Network for Smart Agriculture [15] Rajesh M, Salmon S, Dr. Veena
14. Dr. N. Suma, Sandra Rhea Samson, S. Saranya, G. Shanmugapriya, R..Subhashri, (2017). IOT Based Smart Agriculture Monitoring System. International journal on recent and innovation trends in computing , energy efficiency and communication-IJRITCC volume: 5 issue:
15. Paparao Nalajala D.Hemanth Kumar, P.Rameshan Bhavana Godavarthi,2017Design And Implementation of Modern Automated Real Time Monitoring System for Agriculture using Internet of Things (IoT). Journal of Engineering and Applied Sciences, 12: 9389- 9393.
16. R. Nageswara Rao, B. Sridhar, (2018). IoT based smart crop field monitoring and automation irrigation system. Proceeding of the second international conference on inventive system and control (icisc2018). [22] Sahitya. Roy, Dr Rajarshi. Ray, Aishwarya Roy, Subhajit
17. PaparaoNalajala, P Sambasiva Rao, Y Sangeetha, Ootla Balaji,K Navya,"Design of a Smart Mobile Case Framework Based on the Internet of Things, Advances in Intelligent Systems and Computing,
18. "Smart irrigation system using soil moisture sensor and solar-powered pump" by S. R.Tawade and R. S. Hukkeri (2021)
19. Kumar, Gigyashu and kumar, Ankit and Khan, Jamal Akhtar, Iot Based Weather Monitoring System Using Nodemcu and Blynk (May 5, 2023). Kilby 100: 7th International joint conference on computing sciences, Available at SSRN: https://ssrn.com/abstract=4486940 or http://dx.doi.org/10.2139/ssrn.4486940
20. Orillo JW, Bansil Jr G, Bernardo JJ, Dizon C, Imperial H, Macabenta AM, Palima Jr R.Determination of Green Leaves Density Using Normalized Difference Vegetation Index via Image Processing of In-Field Drone-Captured Image. Journal of Telecommunication, Electronic and Computer Engineering (JTEC). 2017 Jun 1;9(2-6)
21. Norasma CY, Fadzilah MA, Roslin NA, Zanariah ZW, Tarmidi Z, Candra FS. Unmanned AerialVehicle Applications In Agriculture. InIOP Conference Series: Materials Science and Engineering 2019 Apr (Vol. 506, No. 1, p. 012063). IOP Publishing.
22. Jiménez AR, Seco F, Torres-Sospedra J. Tools for smartphone multi-sensor data registration andGT mapping for positioning applications. In2019 International Conference on Indoor Positioning and Indoor Navigation (IPIN) 2019 (pp. 1-8). IEEE.Atsushi I, Hiroyuki H,Kazuki M. A