An Intelligent System for Monitoring and Managing Agricultural Fields

Pramod Mathew Jacob, Juna Maria John, Parvathy Nath H, Parvathy Nandakumar, Sravan Suresh

Abstract:***Agriculture is a primary concern of every developing nation to maintain their GDP. But most of the processes involved in agricultural sector are still orthodox and inefficient. Though the technology is improving day by day, it is high time to incorporate technology innovations into the field of agriculture for better productivity and resource utilization. We propose an intelligent farming technology with the aid of Internet of Things (IoT) to make various farming techniques smarter and efficient. Various sensors were deployed in the fields to remotely monitor the parameters of soil, water and air. The sensed information is fed to an Android app and it will process the data and alert the farmer if any unusual events occur. Experimental results prove that our model can be used for efficient utilization of agricultural resources like water and fertilizers and thereby improve the productivity and profit.***

Keywords : ***Smart farming, Internet of Things (IoT), IoT in agriculture, Sensors***

I. INTRODUCTION

Agriculture is one of the primary concerns of any developing nations to improve their GDP. Indian soil has been used for growing crops over thousands of years without caring much for replenishing. This has led to depletion and exhaustion of soils resulting in their low productivity. Since the production of food all over the world is reducing day by day, it is high time to focus on implementing new farming techniques. Internet of Things (IoT) can play a vital role in this scenario.

Internet of Things is a networked collection of sensors and devices managed by a centralized or decentralized architecture. IoT system uses light weight architecture. The sensors are usually deployed in the target environments and it will collect required data. This gathered data is fed to a central coordinator which will process the data and initiate suitable actions with the help of actuators. The typical IoT system architecture is shown in Figure1.

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The application fields of IoT are drastically increasing day by day from personal applications to industrial applications.

Presently IoT is applied in various sectors such as transport, health, home automation, smart cities, agriculture, education etc. Our project is focusing on in-cooperating various IoT techniques in agriculture sector and thereby making the farming process smarter.

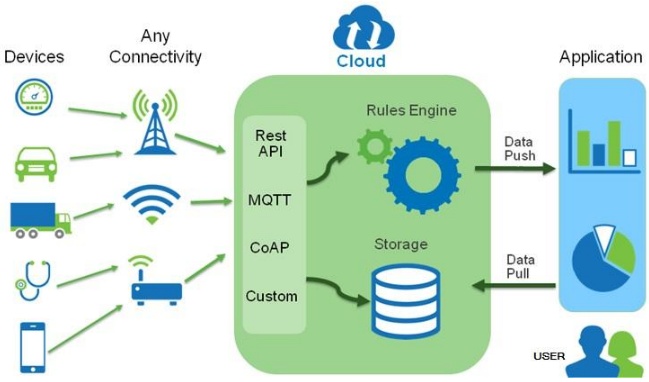

Fig 1: Architecture of Internet of Things (IoT)

The traditional farming system performs various actions like ploughing, sowing, watering, fertilizing and monitoring of plants manually. This requires huge human effort and time. The various challenges faced by the farmer in this scenario is listed below:

- The mineral content in the soil cannot be directly measured
- Sending the soil sample to a lab and getting the results is a time-consuming process.
- Constant automated watering of plants may lead to decaying of plants during the rainy season.
- Due to the presence of pollutants in the air the growth of the plants is affected.
- Crops maybe be destroyed due to unexpected fires.
- Wastage of enormous amount of water due to improper watering cycles.

We propose a model to address these challenges with the help of Internet of Things and mobile application. Our aim is to not only automate the farming process but also the efficient utilisation of resources.

Various objectives of our proposed model are:

- To develop a module to remotely sense the presence of fire in the field.
- To develop a module to monitor the quality of air by analyzing the content

of Carbon Monoxide (CO).

- To model a smart watering system based on weather reports.
- To design a module to monitor the moisture content in the soil and thereby initializing the watering process.
- To develop a model to monitor the pH value in the agriculture field.
- To develop a system to monitor the fertilizer content in the soil.
- To develop an Android app for the farmer to remotely monitor and actuate the farming process.

The scope of this project has a global perspective as agriculture is a major source of income in every nation. But due to implementation difficulties and scalability issues, our model is restricted to confined agriculture fields in village areas. The agricultural field area is restricted to 1 acre for the purpose of easier implementation and experimental evaluation.

II. LITERATURE REVIEW

We have analyzed various existing works in the area of smart farming. Most of the systems focus on limited aspects like detecting soil nutrition levels, detecting soil moisture contents, detecting the presence of smoke or other toxic gases etc. They have used various microcontrollers or microprocessors to integrate the various modules. We hereby provide the summary of most relevant 20 works in the area of smart farming.

Masrie et al [1] proposed a system for detecting the presence of Nitrogen, Phosphorous and Potassium of the soil using optical transducer. It contains of three LEDs that acts as a light source and uses a photodiode as a light detector. The light from LED is absorbed by the nutrients and the remaining light is transformed to current with the help of a reflector. In this model an Arduino microcontroller was used to operate the LEDs. Their experimental evaluation proves that water content in the soil can be determined with the help of optical transducer.

Sowmiya et al [2] proposed a system which can be used to improve the cultivation of crops in farming. The pH rate, Temperature, water level can be monitored using a 8 bit PIC 16F877A micro controller. LM35 is used for monitoring the temperature. Alerts can be sent through SMS.

Andac et al[3] proposed a system that aims to deliver a method by which any agriculture enthusiast whether it be a farmer or a gardener can monitor the conditions of the soil easily. The system checks for the pH, humidity and temperature of the soil. The microcontroller used it the Photon which has an in-built Wi-Fi function. The battery pack is 2000mAh. The solar panel used is weather sealed. The soil temperature sensor is SHT10 (it also measures the moisture), SEN0161 is the pH probe. The app is created with node.js with the database being PostgreSQL of heroku. The advantage of the system is that it can measure the soil condition periodically and send the data to the cloud.

Abdullah et al [4] proposed a model which uses STM32L152RE MCU to take samples from sensors and transfers that to mobile. DS18b20 temperature sensor is used to sense temperature and it works on Dalla's wire protocol. The pH senor hastwo electrode one for pH and another electrode for soil moisture. For soil moisture estimation it uses an inverse relation between soil resistance and soil moisture. The system is powered using 1.5v battery. Its limitation is that it is needed to be recharged for every 30 days. The advantage is that MCU used has low power consumption and it can be cost effective.

Ravi et al [5] proposed a model that contains a esp8266 microcontroller and a moisture sensor that utilizes Losant platform. Moisture Sensor Kit is perceived using Node MCU development board. It has a soil moisture sensor module and an ESP8266 Wi-Fi module wrapped on the development board. This sensor module is connected to comparator called LM393. When the soil becomes dry, it provides an active-high (H) level output and an active-low output is given when the soil is wet. This output is fed to one of the I/O terminals of the micro-controller. Power supply is provided using a micro USB cable. It is a low-cost system which monitors the soil moisture continuously.

Adil et al [6] proposed a model in which the elements in the soil like phosphorous, potassium and nitrogen are detected and are collected. This model uses a software application to engage the data and help the clients to identify which crop is to be planted in that soil. It alerts the user when a match is found between soil data and crop data. To use the developed software easily, this model incorporates a mobile app. The advantage of this model is that it will immediately notify the farmer. It alerts which crop to be grown in a particular soil. But it needs manual calculation and data collection.

Sharma et al[7] proposed a system that contains digital sensors which are used for soil testing at real time with minimum efforts and with almost précised results. Portable remote data acquisition system coupled together with sensor for collecting results from wide locations. A portable handheld device for soil testing is implemented and result is uploaded over IoT. System will be a microcontroller-based device connected to EC sensor, pH sensor and color sensor. It reads reading from sensors and transmits it to mobile application over Bluetooth serial communication. Finally, the mobile app will upload the data over server for further analysis and comparison. Main idea behind system is to make it portable to identify the color texture, Electrical Conductivity and hydrogen-ion concentration (or pH) of soil.

Lily et al [8] proposed an Android application to assist monitoring of soil moisture. This application obtains data from the sensor which is connected to Raspberry Pi. This data will be sent to the server and displayed on Android application. LED indicator is provided to notify the water supply for the plants. The final result of this research is a system application development where a sensor with analog data can be converted into percentages and displayed in the Android application. From this percentage, users can set the indicator for the sensor to turn on the LED. Users can also view graphs from percentage data, manage plant data for the database, and set the application configuration.

Xiaojun et al [9] proposed a real time air pollution monitoring and forecasting system for large scale monitoring of air pollution. The system contains of 3 layers called perception layer, network layer and application layer. Perception layer includes monitoring sites selection sensor, environment sensor deployment and meteorological sensor deployment. The data from these sensors are received and are sent to a central server. The function of the application layer is to perform air quality evaluation and air pollution prediction. This system provides high accuracy because of the use of large number of sensors and one of its advantage is that its implementation cost is less when compared to the conventional system.

Kumar et al [10] proposes a system for air quality monitoring. In this model various sensors are used for detecting and monitoring the presence of Carbon Monoxide (CO), Carbon Dioxide (CO_2), Temperature, Pressure and Humidity. There is an Arduino Board and Raspberry pi which is linked with Arduino Uno and the sensors are connected to it using USB cable. The Sensors senses the data and send this data to the cloud through Raspberry pi over the internet. The particulate elements like smoke and dust is measured using a PM sensor DSM501A. The temperature, humidity and pressure is sensed using DHT22 and BMP180. The Carbon monoxide and carbon dioxide are measured using analog sensors like MQ9 (Gas sensor) and MQ135 (air quality sensor).

Muthukumar et al [11] is implements a system for the air pollution that are caused by the automobiles. In highly polluted areas like cities, the system can reduce the traffic by considering some control measures. The various sensors in the proposed system monitors the quality of air and are provided to control. The algorithm in the control unit predicts the traffic based on this information. The traffic is controlled based on the output of this algorithm. Various sensors like MQ-7, MQ135, MQ4, G37 are connected to PIC16F877A microcontroller.

Lampe et al12] proposes a model that measures the presence of particulate matter in the air using the reflected IR light. It uses to communicate the pollution levels it is provided with a Bluetooth Low Energy (BLE) in the user's phone. It helps the users to check the quality of air based on the data in the user's phone. The accumulated data can be viewed on a crowd-sourced pollution map which is obtained from multiple devices. The advantage is that the model is cost effective and can be charged by solar energy.

Pappu et al[13] proposes a model to be used in the residential area's storage tanks. A pH sensor and TDS sensor are connected to the Arduino. The data from the sensors, which includes pH and total dissolved solvents are sent to a Raspberry pi3 from the Arduino with help of serial communication. The water quality is predicted using K-Means Clustering Machine learning algorithm. The advantage is that compare to traditional, approach it is faster and more easily available.

Anuradha et al [14] proposed a system that aims to achieve real time monitoring of water quality. The system aims to achieve real time monitoring of water quality. Turbidity, pH, temperature, TDS and of the water is measured the measured values from the sensors send to the core controller for processing. Then the sensor data can be viewed using ThingSpeak API. Temperature (DS18B20), pH(SKU:SEN0161, TDS(SEN0244) and Turbidity(SEN0189) are the sensors used. The advantages are that this is cheaper compared some other implementations and low maintenance.

Subramanian et al [15] proposed a system that can be used to measure the water moisture and pump water as needed. LM393 soil moisture sensor, LM35 and PH sensors are used along with Atmega 328. A DC motor is used to pump water as moisture is reduced in soil. Advantages of the proposed system are that the system uses a solar panel for power which makes it more portable and self-sufficient.

Chaloemcha et al [16] proposed a model to measure the water quality by implementing a prototype. Various hybrid sensors are used which is the combination of e-tongue and e-nose for the data collection about water. The obtained dataset is saved on the micro SD card in the main device in offline and the same is saved online on cloud system. There is a ESP8266 Wi-Fi module which is connected to the device using a wireless internet network. Thing speak and NetPie are the cloud servers in this model. Then 10-fold cross validation technique is used here. The advantage is that using data mining technique water quality patterns can be monitored from the data in the sensors. The training and testing with 10-fold cross validation has disadvantages like the training set must be large that cause testing set to be small

Nageswara et al [17] proposed a modelthat uses Arduino board to find pH value of water. This model is mostly implemented at municipal water tanks and water reservoir. It uses a GSM module for message technique. Water parameters are simultaneously monitored uses aLED display. The pH value of water is sent to the client through a message.It can measure pH of water in less cost. Turbidity of the water that shows how much water is clean is not measured in this model.

Rashmi et al [18] proposed an irrigation and crop security operational model which monitors automatically based on pre-calculated threshold value. Thus, water can be effectively applying in the right place, at right time and in proper amount. The system consists of soil moisture sensor, Float sensor, temperature sensor, and humidity sensor Humidity sensor record humidity of environment, which helps to checks damage of pipes. PIR sensor detects movement of objects (birds, animals) and activate buzzer to scare crows.

Gabriela et al [19] implements an embedded system that uses Internet of Things and a set of sensors to allow the monitoring of climatic variables and irrigation of an urban. Sensors measure parameters such as environmental humidity and temperature, soil moisture and temperature, CO2 levels, luminosity and crop presence; processed within an ATMEL microcontroller which takes decisions for irrigation based on crop requirements. This information is received by the remote server through the Wi-Fi protocol, which stores it in the cloud within a database and sends it to the client computer or mobile device, who will be able to access this data in real time from any location where it has access to the Internet.

Rahul et al [20] proposed a system that contains IoT sensors like air, temperature sensor, soil pH sensor, soil moisture sensor, humidity sensor, water volume sensor etc. The model [21] is a simple architecture of IoT sensors that collect information and send it over the Wi-Fi network to the server, there server can take actions depending on the information.

From the review, it is clear that there is no standard model which will address all these challenges in agriculture. So, we aim to propose a smart farming system to manage and monitor various farming processes in an efficient and effective manner.

III. METHODOLOGY

The proposed smart farming system consists of the following 3 modules: Android app module, sensors module and a central coordinator module. The sensors are placed in the agricultural field to sense the required parameters. The sensors sent the data to the central coordinator which is managed by an Android application. This data is sent to a cloud database. The mobile app analyses the cloud data and alerts the farmer if any parameter exceeds its threshold limit. The Arduino Uno and Raspberry PI acts as the central coordinator. The user can view all the data acquired from the sensors on the app and necessary actions can be taken [22]. The block diagram of proposed system is shown in Figure 2.

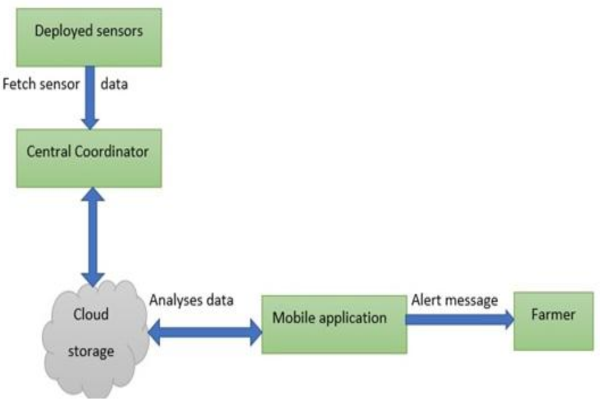

Figure 2: Block diagram of proposed model

A. *Android App*

When the app is started, the user is first presented with the login page. The user is directed to the main page once login is successful. The main page shows abreviloquent version of the sensor data. Also, if any unusual spikes in the data are detected an alert is shown in this page. Along with this the latest weather information is displayed. There is a hamburger menu which can direct the user to different pages including notifications, help, reference values, history, actuators and settings. The App will analyze the sensor information and alerts the farmers when any parameter exceeds its threshold.

B. *Sensor module*

The proposed model aims to collect various parameters like water pH content, moisture content of soil, presence of carbon monoxide in air, water content in soil etc. These parameters should be remotely sensed and the gathered information should be fed to a central data processor for further processing. In this scenario we go for standard sensors available in the market. The sensors used include LM393-Soil moisture sensor, pH sensor, Optical transducer, MQ2 Smoke sensor and MQ9 Gas sensor

C. *Central coordinator module*

The central coordinator is an Arduino microcontroller[23] system which has powerful processing capability. The central coordinator controls and coordinates all the activities of the system. Raspberry PI installed with Raspbian OS is used as the central coordinator. Arduino Uno board is used as the MCU. The sensor information will be collected through MCU and is fed to the central coordinator. This sensed information is further processes to identify the various soil, air, water quality parameters. If any of these parameters exceeds the preset value and alert message or mail is sent to the farmer.

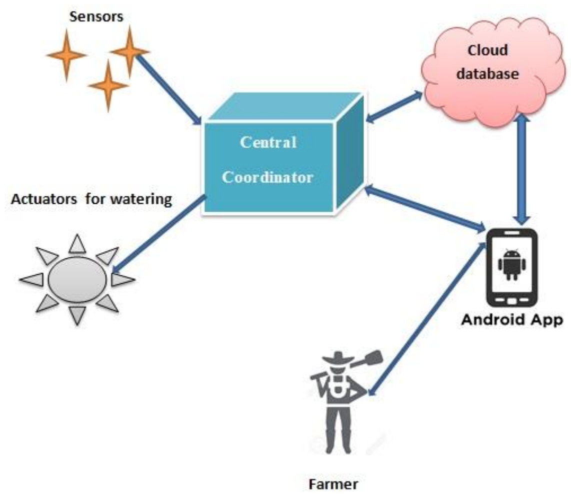

Figure 3: Proposed System Architecture

Figure 3 shows the working of the proposed system. Sensors for gathering the information are deployed in the field. Actuators (Water sprinklers) for watering the crops are also deployed. The sensors continuously collect field parameters and are fed to the central coordinator. The central coordinator[24] backs up this data for further analysis. If any of these parameters exceeds the threshold limit, an alert message or email will be sent to the farmer. In case of fire, an alert will be also sent to the nearest fire station.

IV. SYSTEM IMPLEMENTATION& RESULTS

We have implemented the system using Arduino microcontroller[25]. The various sensors like temperature sensor, soil moisture sensor, Water level sensor etc. are connected as shown in Figure 4.

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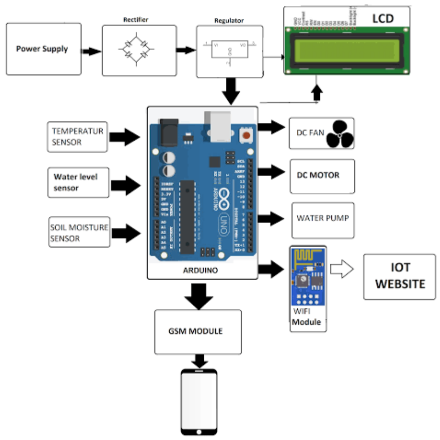

Figure 4: Connection diagram

The sensor senses the various data and is fed to the central microcontroller. The analog data is converted to the required digital data. The system constantly monitors whether any sensor data reaches its threshold. If it reaches the limit, an alert message is sent to the farmer's Android application.

The Android application to assist the farmers is developed using Android Studio [26]. The login page of the smart farming system is shown in Figure 5. The farmer should login to the system. The various options for sensing various sensor data is shown in home page[27]. When any of the sensed data reaches threshold, alert message is initiated.

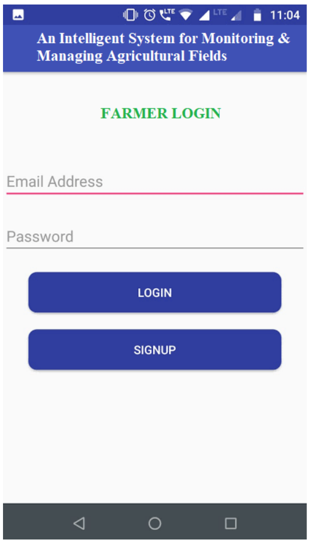

Figure 5: Login page of Android App for farmer

The decision table [28] generated for performing various actuations are shown in Table 1.

Table 1: Decision table for sensor module

		RULES			
CONDITIONS	Soil moisture sensor is LOW'	T	T	F	F
	Presence of CO is 'HIGH'	T	F	T	F
ACTIONS	Initiate water pump	X	X		
	Send alert to fire station	X		X	
	Send alert to farmer's mobile/email	X			
	Restart monitoring	X	X	X	

V. CONCLUSION& FUTURE WORK

Remote monitoring of agricultural fields was a herculean task for every farmer. Our proposed intelligent farming system can remotely sense the water content in the field, soil moisture content, presence of fire in the field etc. using various sensors. The sensed information is continuously monitored to detect any unusual events. In case of any unusual occurrence, an alert message is given to the farmer through the mobile application. The farmer can even remotely take remedial actions for the same with the help of various actuators. Experimental results show that our model is cost efficient and effective to monitor and manage the agricultural fields. Our future work may include the process of automating the detection of pests in the agricultural fields.

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REFERENCES

1. M Masrie, M. S. A. Rosman, and R. Sam and Z. Janin, "Detection of Nitrogen, Phosphorus, and Potassium (NPK) nutrients of soil using Optical Transducer," in Proceedings of the International Conference on Inventive Research in Computing Applications (ICIRCA 2018) , Putrajaya, Malaysia, 28-30 November 2017, pp. on Smart Instrumentation, Measurement and Applications (ICSIMA).
2. S.Sivaranjani E.Sowmiya, "SMART SYSTEM MONITORING ON SOIL USING INTERNET OF THINGS (IOT) ," International Research Journal of Engineering and Technology (IRJET) , vol. iv, no. 02, pp. 1070-1072, 2017.
3. Quality with the Internet of Things, "Remote Monitoring of the Soil Quality with the Internet of Things ," 2017.
4. W. Isaac, S. Varshney ,E. Khan A. Na, "An IoT based system for remote monitoring of soil characteristics," in A. Na, W. Isaac, S. Varshney and E. Khan, "An IoT based system for remo 2016 International Conference on Information Technology (InCITe) - The Next Generation IT Summit on the Theme - Internet of Things:Connect your Worlds, Noida, 2016.
5. A. Sahu R. K. Kodali, "An IoT based soil moisture monitoring on Losant platform," in 2016 2nd International Conference on Contemporary Computing and Informatics (IC3I), Noida, 2016.
6. Nishant Kumar Verma Adil Usman, "Internet of Things (IoT): A Relief for Indian Farmers (Stage II)," San Jose, 2018.
7. D. V. Padole P. Sharma, "Design and implementation soil analyser using IoT," in 2017,International Conference on Innovations in Information, Embedded and Communication Systems (ICIIECS), Coimbatore, 2017.
8. J. Andjarwirawan,R. P. Wardojo L. P. Dewi, "Android Application for Monitoring Soil Moisture Using Raspberry Pi," in 2017 International Conference on Soft Computing, Intelligent System and Information Technology (ICSIIT), Denpasar, 2017.
9. L Xianpeng, X Peng C Xiaojun, "IOT- Based Air Pollution Monitoring and Forecasting System," 2015 International Conference on Computer and Computational Sciences (ICCCS), pp. 257-260., 2015.
10. A Jasuja S Kumar, "Air Quality Monitoring System Based on IoT using Raspberry Pi," in International Conference on Computing, Communication and Automation (ICCCA2017, Greater Noida, 2017.
11. W.S Mary, Kiruthiga.R, Mahalakshmi.M, Jayanthi M S.Muthukumar, "IoT based air pollution monitoring and control system," in Proceedings of the International Conference on Inventive Research in Computing Applications

(ICIRCA 2018), Coimbatore, 2018.
12. T. Mau, S. Morehead, N. Turner-Bandele, S. Krishnan and B. Dezfouli B. Lampe, "Halo: A Personal IoT Air Monitor ," in IEEE Global Humanitarian Technology Conference (GHTC), San Jose, 2018.
13. Pr Vudata and Niharika.A.V S Pappu, "Intelligent IoT Based Water Quality Monitoring System," International Journal of Applied Engineering Research ISSN , vol. 12, pp. 5447-5454 , 2017.
14. Bhakti, Chaitra R, Pooja D Anuradha T, "IoT Based Low Cost System for Monitoring of Water Quality in Real Time," International Research Journal of Engineering and Technology , vol. v, no. 05, pp. 1658-1663, 2018.
15. P. Mohana A.Subramanian, "Smart Agriculture based on IOT Control," Internatinal Journal of Scientific Research and Reviews, pp. 167-176, 2018.
16. P. Lorwongtrakool C. Lowongtrakool, "IoT Based Water Quality Measurement Using Hybrid Sensors and Data Mining," in 2018 International Conference on Information Technology (InCIT), Khon Kaen, 2018.
17. C. Mukesh P. Vidya Sagar N. R. Moparthi, "Water Quality Monitoring System Using IOT," in 2018 Fourth International Conference on Advances in Electrical, Electronics, Information, Communication and Bio-Informatics (AEEICB), Chennai, 2018.
18. D. P. Gaikwad R. R. Agale, "Automated Irrigation and Crop Security System in Agriculture Using Internet of Thing," in 2017 International Conference on Computing, Communication, Control and Automation (ICCUBEA), Pune, 2017.
19. M. Huerta ,B. Barzallo G. Carrión, "Monitoring and irrigation of an urban garden using IoT," in 2018 IEEE Colombian Conference on Communications and Computing (COLCOM), Medellin, 2018.
20. S. Som,S. K. Khatri R. Dagar, "Smatr Farming – IoT in Agriculture," in 2018 International Conference on Inventive Research in Computing Applications (ICIRCA), Coimbatore, 2018.
21. P. Sharma and D. V. Padole, "Design and implementation soil analyser using IoT," in International Conference on Innovations in Information, Embedded and Communication Systems (ICIIECS), Coimbatore, 2017.
22. P. M. Jacob and P. Mani, "A Reference Model for Testing Internet of Things based Applications", *Journal of Engineering, Science and Technology (JESTEC),* Vol. 13, No. 8 (2018) ,pp. 2504-2519.
23. P. M. Jacob and P. Mani, "Software architecture pattern selection model for Internet of Things based systems," in *IET Software*, vol. 12, no. 5, pp. 390-396, 10 2018. doi: 10.1049/iet-sen.2017.0206.
24. Pramod Mathew Jacob and M. Prasanna, "A Comparative analysis on black box testing strategies," International Conference on Information Science – ICIS –'16, Kochi, India, 2016
25. V. Bose, R. Roy, M. Nadirsha, B. Raj, Ajesh M and P. M. Jacob, "Gesture based painting system," *2016 International Conference on Information Science (ICIS)*, Kochi, 2016, pp. 23-27.
26. P. M. Jacob, Muhammed Ilyas H, J. Jose and J. Jose, "An Analytical approach on DFD to UML model transformation techniques," *2016 International Conference on Information Science (ICIS)*, Kochi, 2016, pp. 12-17.
27. Pramod Mathew Jacob and Prasanna Mani, "A Performance Estimation Model for Software Testing tools", ," International Journal of Engineering and Advanced Technology (IJEAT), vol. 8. no. 4, pp. 248-253, 2019
28. Jisha Mariyam John and Hariharan R.L, "An Intelligent Rider Assistant System using Machine Learning for two wheel vehicles," International Journal of Engineering and Advanced Technology (IJEAT), vol. 8, no. 6, pp. 1361-1366, 2019

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