A Survey on Plant Health Monitoring using IoT

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Abstract: Plants are one of the important kind of organisms available over the world. There are so many ways in which plants help the environment and human's life on the earth by providing food for humans and wildlife. So it is necessary to keep the plants in a healthy manner. Healthy plants leads to a country's profitable agricultural production. Internet of Things (IOT) has played a vital role in monitoring plants health. It helps farmers by monitoring the plant as well as leads to a greater production. The proposed system is based upon sensors for monitoring. The factors such as soil moisture, pH, temperature, air quality can be determined by using specific sensors with the help of a microcontroller. The values are collected from the sensors. By comparing the already stored value with the collected value we can determine the result. The paper represents the system and considered the detailed information related to the processing of the results.

Keywords: Plants health, agriculture, Internet of Things, Sensors, microcontroller.

1. INTRODUCTION

Agriculture is one of the most important sector in our country, in which plants plays an important role. Plants are one of the main sources for our food and also gives us oxygen. Some plants are used for the purpose of medicine. So humans life are mainly depends upon plants. A healthy plant is the one which needed water, sunlight, air and essential nutrients. Fertilizers are also provides various nutrients to the plants which leads to the healthy growth of the plant. India has around 40000 plant species and contributes about 12% of the global plant prosperity. Proper land and water resources are needed for the good growth of a plant. The project is plant health monitoring using IOT (Internet of Things).IOT is used for day-to-day applications and plays a vital role in human life. To determine soil moisture level, temperature, pH level, air quality level of the plant to make it as a good quality which leads to efficient production. Sensors are used to collect information from surroundings. And it is used to reserve the data.

2. Internet of Things

Internet of things are often any device with any quite built-in-sensors with the flexibility to gather and transfer information over a network while no Manual intervention. The embedded technology within the object helps them to act with internal states and therefore the external setting, that successively helps in selections creating method. IOT may be a thought that connects all the devices to the net and allow them to communicate with one another over the net.IOT may be a large network of connected devices that every one of that gather and share information regarding however they're used and therefore the environments during which they're operated. By doing this every of your devices are learning from the expertise of alternative devices, as humans do. IOT is attempting to expand the reciprocity in human- i.e interact, contribute and collaborate to things. Most of IOT devices will turn out in truth an excellent type of statistic information that square measure of giant interest in computing. In step with a study administered by world information, the IOT market is projected to achieve $318bn new value by 2023.

3. LOGISTIC REGRESSION

Logistic regression may be a classification algorithmic program won't to realize the likelihood of event success and event failure. It's used once the variable is binary (0/1, True/False, Yes/No) in nature. It supports categorizing information into distinct categories by learning the connection from a given set of labelled information. It learns a linear relationship from the given dataset and so introduces a non-linearity within the kind of the Sigmoid operate. Logistic regression is simpler to implement, interpret, and extremely economical to coach. It makes no assumptions concerning distributions of categories in feature area. It will simply be multiple

classes (multinomial regression) and a natural probabilistic read of sophistication predictions. It not solely provides a live off however applicable a predictor (coefficient size)is, however conjointly its direction of association (positive or negative).It is in no time at classifying unknown records.

4. RELATED WORKS

4.1 Plant soil monitoring using WSN:

Wireless device Network (WSN) is that the technology, at intervals that the data collected from the sphere of interest is transmitted through wireless link. WSN is used in varied fields like observance, wireless measurements, dominant, etc. at intervals the sphere of accuracy agriculture and organic farming, it's a necessity to endlessly monitor the fields as they are computer specific. Observance of plant health is very important that enriches the productivity of food grains. Soil condition is one in each of the primitive issue for plant health. The water that continues to be in soil as a thin film aid in provision nutrients to the plant growth. The foremost objective of this paper, is to determine a plant soil condition observance system that permits the user to observe the plant health remotely. For wireless communication, Zigbee technology is used to assemble data that's then transferred to the server. Thus on extend the time period of WSN, Event Detection formula (EDA) is adopted.IOT enabled soil condition observance system victimization WSN are implemented in real time. The data received from the sensors is then transmitted through zigbee transceiver to the Raspberry Pi, from that the data area unit uploaded to the cloud. Once a soil condition device is immersed in dry soil, it provides 1/3 reading. As a result of the water is poured to soil can increase, the reading is found to be exaggerated.
Major disadvantage of WSN is energy depletion thanks to the communication among device nodes. EDA is adopted to beat the upper than issue. EWMA is one in each of the sting based EDA that's used throughout this analysis, thus on line the management limits of soil condition.

4.2 Using AI and IOT:

Artificial Intelligence (AI) and net of things (IOT) based mostly observance systems are in nice demand and offers a certain extraction and analysis of information. During this paper, the analysis is performed on a flower plant to notice the foremost appropriate conditions for plant growth. The philosophy behinds this work is to scale back the risks in agriculture and to market sensible farming practices. The result of physical conditions like humidness, temperature, soil temperature and wetness and lightweight intensity on the plant growth, is monitored victimization IOT based mostly observance system. The info liable for the plant growth is obtained victimization totally different sensors units like DHT11, LDR, DS18B20, Soil wetness sensors, Noir camera, single board microcontrollers and Application Programming Interfaces (APIs). The variation of plant rate of growth w.r.t. the intensity of daylight was determined among thevary of a thousand lx1200 lx, category-2 (best). The more analysis of the extracted parameters is completed victimization totally different Machine Learning (ML) algorithms. Provision Regression, Gradient Boosting Classifier and Linear Support Vector Classifier (SVC) algorithms are found best for analysis of physical parameters liable for the flower plant growth.All the sensors are deployed within the field and written victimization C++ in Arduino IDE. Jason script is employed to take care of the serial communication between Arduino Uno and Esp8266 WiFi module before long as this Wi-Fi module obtained information from primary microcontroller,it sends the info , victimizations the communication protocol to the cloud for storing and observance.

4.3 Using XBEE:

Plant observation system is employed to observe the status in round the plants to possess correct growth and maintenance. Within the planned system, a sensing element node is intended that runs with battery for extended length and measure parameters like temperature, sun intensity level, wetness level and carbon-dioxide. Particularly electrical phenomenon kind wetness level sensing element is intended so as to live the wetness level of the soil. A wireless sensing element network (WSN) is formed to sense parameter associated with individual plants. Here a MCU having integral sixteen bit ADC is employed and programmed to transmit the info victimization XBee S2C as router. The XBee S2C is organized in low power mode victimization hardware management. The info transmitted by sensing node are received by organizer XBee S2C connected to Raspberry Pi victimization UART acting as Brain unit. This Raspberry Pi is additionally connected with greenhouse gas sensing element victimization UART as communication protocol through a 2:1 MUX as Raspberry Pi has only 1 UART. The info is processed and pushed to the server through Wi-Fi. Currently now a days web of Things (IOT) is enjoying anoutstanding role so as to possess communication between things and

folks and between things. IOT technology permits to enhance the access to worry, most significantly it reduces the price of care, it reduces human interruption and conjointly will increase the standard of care. Hence IOT is employed during this work. So, the ultimate processed data is hold on within the cloud and at the recipient facet a mobile application (app) is developed so as to intimate the knowledge to the owner of the plant concerning the health of the individual plant. An occasional power sensing element node coming up with associate degreed implementation for an IOT based mostly plant observation system is studied during this project. With the assistance of temperature sensing element, intensity level sensing element and electrical phenomenon kind wetness level sensing element, individual plants area unit monitored and therefore the perceived data is processed with the assistance of MCU and transmitted with the assistance of XBee S2C in low power mode. With the assistance of organizer XBee S2C the transmitted data is received and therefore the received. Data alongside greenhouse gas sensing element information is processed with the assistance of Raspberry Pi . With the assistance of integral Wi-Fi the info is pushed to the server, from the server the info is retrieved anyplace and at any time by the owner of the plant. This data may also be hold on within the cloud for IOT application. This project tends to associate degree evolved good means of plant health observation system victimization low power wireless communication. To realize the good means of plant observation system wireless sensing element network (WSN) is integrated with web of Things (IOT).

4.4 An ARM Based Wireless Sensors Network:

In this paper a new approach is devised for effectively monitoring the health of plants in the intended crop field. The idea is to employ a smart combination of the emerging IOT and wireless sensors network technologies. A system prototype is successfully realized. It is based on the STM32F407 board based wireless sensing nodes and STM32F429 based base station. The STM32F407 board employs the ARM CORTEX-M4 processor as brain. The CPU is realized with a Windows operating system based PC. The monitoring platform is realized with a specific MATLAB based implementation. The processing units on base station and sensing nodes are configured with the specifically developed C based embedded applications. The liaison between the cloud and the Wireless Sensors Network is realized via the CPU. It is implemented in MATLAB by employing the "Thing Speak" read and write functions. The interface between the CPU and the base station is realized via a USB port. The interface between the base station and the sensing nodes is realized via the Zig Bee protocol. The functionality of this wireless interface is successfully tested for a maximum distance of 50m between base station and sensing nodes. An experimentation setup is realized in order to test the devised system functionality. Results have assured a proper functionality of the devised system. Storage of the intended crop field parameters on cloud allows the remote users to access this data on smart phones via the Thing View application. It allows a timely interaction and cure of the concerned crop fields which promises a better crop yield. As a result, it will bring a positive impact on the socio economic system of farming. The employment of event driven data acquisition in the sensing nodes and send on delta based wireless interface realization between the sensing nodes and the base station will improve the system efficiency in terms of resources utilization and power consumption [13, 14, 15]. The study and integration of these features in the proposed system is a future work.

4.5 Prediction Analysis:

Precision agriculture uses the IOT options to assist in managing crops production, by optimizing the standard of the crops through applying needed nutrients and scale back the harmful impacts on the atmosphere thanks to the appliance of excess pesticides. during this paper, we tend to deployed a sensing network to assemble the sphere knowledge of some crops (Potatoes, Tomatoes, etc.), then fed these knowledge to a machine learning algorithmic rule to urge a warning message finally displaying each the info and also the warning message through a Graphical computer program (GUI).
An image of the planned design for IOT exactness agriculture applications has been enforced. Sensing element nodes mentioned within the perception layer area unit deployed and tested. The nodes send knowledge to one entree victimization the MQTT protocol. Nodes act as a publisher MQTT shopper and initiate the association by causing CONNECT message to the MQTT broker. The broker then responds with CONNECT to the shopper. Once the association is established, the shopper keeps causing the sensing element readings within the given topics to the broker. The broker keeps the association open as long because the shopper doesn't send a disconnect command or lose the association. The Subscriber MQTT shopper that is that the entree subscribe the info that sent from identical topics. Then knowledge area unit analyzed and hold on the entree device to use the machine learning algorithmic rule code and predict the appropriate action. the info and also the warning action message area unit visualized and displayed on the web site as a user interface that facilitate the user interfacing to stay the farmer observation the sphere.

4.6 Using Hypaponics monitoring system:

Hypaponics may be a watching system that takes care of integrated vertical farming. It's monitored exploitation varied sensors and also the predictions are taken supported the information exploitation Machine Learning Algorithms. The careful data regarding it'll be noted beneath the hardware topic and also the information from the IT are going to be keep on the cloud (AWS, Microsoft Azure, Google cloud, IBM Cloud, etc) for machine learning. The organic store are going to be hosted wherever the organic product are uploaded with their value. The patron will check whether or not its organic or not by the QR code that the patron found on their pack, wherever every field, product can have distinctive QR code in it. The farmers also will get all quite supports from the assistance table they notice on the portal. The full system is monitored 24/7 and also the input to farmers are given at an everyday intervals of your time. The newest technologies like web of Things and Machine Learning are employed in this project to predict the plants growth and also the maintenance charges are less. The ten of the water is just consumed by this technique whereas comparison with the traditional irrigation methodologies. This additionally saves the atmosphere from pollution, illness, diseases. Hypaponics system monitors all the fields and offers the information image on a webpage wherever it contains water temperature, part temperature and humidness, hydrogen ion concentration of the water that are major factors moving this technique and takes a call thereon. The organic store additionally helps farmer to own a right away contact with patrons to induce an improved profit rate. The crops cultivated during this technique are made in nutrients and flavour. This helps the individuals to make their manage vegetation by themself. In future we would like an effective mode of exploitation fresh over agriculture to avoid fresh inadequacy and additionally ought to increase the food production rate five hundredth additional than currently. This technique additionally helps the individuals to avoid diseases that ar caused by food exploitation chemical fertilizers whereas cultivating. It additionally prevents the soil. The Temperature and humidness sensing element is employed to live the region temperature and humidness. Hydrogen ion concentration sensing element is employed to require the hydrogen ion concentration price from the cultivation to control the pump supported soil wet sensing element, hydrogen ion concentration sensing element and water temperature reading. The info is transmitted to cloud via wired or wireless association. This technique uses the Transmission management protocol [TCP] for wireless and User Datagram Protocol [UDP] for wired within the transport level and HyperText Transfer Protocol Secure [HTTPS] in application level.

For wireless communication like local area network this technique encompasses an Intrusion Detection System (IDS) that detects any intrusion happened during this system to require action thereto. If any intrusion detected those details are sent to the admin of this technique. This will be improved by victimization king protea to catch the knowledge concerning the hacker or interloper.Designed a separate web site for hypaponics wherever all the info gets unreal and also the organic market is found that the users are differentiated victimization their login details. Every type have totally different links that are given within the QR Code for the merchandise   whereas   purchase.

RESEARCH DIRECTION

Name	Contribution	Limitation

Plant soil monitoring using WSN[1]	The foremost objective of this paper, is to determine a plant soil condition observance system that permits the user to observe the plant health remotely. For wireless communication, Zigbee technology is used to assemble data that's then transferred to the server. Thus on end the time period of WSN, Event Detection formula (EDA) is adopted. IOT enabled soil condition observance system victimization WSN are implemented in real time. The data received from the sensors is then transmitted through zigbee transceiver to the Raspberry Pi, from that the data area unit uploaded to the cloud. EWMA is one in each of the sting based EDA that's used throughout this analysis, thus on line the management limits of soil condition.	Zigbee disadvantages: It operates on short vary i.e. 10-100 meters line of sight. Low transmission rate. It has bound limitations within the space of memory size, process speed of information. Less secure compared to Wi-Fi based mostly security systems. Event detection disadvantages: Event detection issues square measure very situationally-dependent. Event detection issues square measure typically based mostly upon the wants of an essential application. Examples of essential applications embrace observation essential assets, detecting breaches at intervals security perimeters. Event detection issues will still be exceptionally giant.
Using AI and IOT [2][5][9]	The philosophy behinds this work is to scale back the risks in agriculture and to market sensible farming practices. The result of physical conditions like humidness, temperature, soil temperature and wetness and lightweight intensity on the plant growth, is monitored victimization IOT based mostly observance system. The info liable for the plant growth is obtained victimization totally different sensors units like DHT11, LDR, DS18B20, Soil wetness sensors, Noir camera, single board microcontrollers and Application Programming Interfaces (APIs). Provision Regression, Gradient Boosting Classifier and Linear Support Vector Classifier (SVC) algorithms are found best for analysis of physical parameters liable for the flower plant growth.	Disadvantage of svc: SVM formula isn't appropriate for big information sets. SVM doesn't perform okay once the information set has a lot of noise i.e. target categories are overlapping. In cases wherever the quantity of options for every datum exceeds the quantity of coaching information samples, the SVM can underperform. Gradient boost classifier: Gradient Boosting Models can continue up to attenuate all errors. This could hyperbolize outliers and cause overfitting. Computationally overpriced - usually need several trees (>1000) which may be time and memory complete.

Using XBee[3]	A wireless sensing element network (WSN) is formed to sense parameter associated with individual plants. Here a MCU having integral sixteen bit ADC is employed and programmed to transmit the info victimization XBee S2C as router. The XBee S2C is organized in low power mode victimization hardware management. The info transmitted by sensing node are received by organizer XBee S2C connected to Raspberry Pi victimization UART acting as Brain unit. This Raspberry Pi is additionally connected with greenhouse gas sensing element victimization UART as communication protocol through a 2:1 MUX as Raspberry Pi has only 1 UART. The info is processed and pushed to the server through Wi-Fi.	Raspberry pi Disadvantages: Raspberry pi does not have any internal storage it needs a small American state card to figure as an interior storage. Raspberry Pi mini computers can be exposed to security problems thanks to a vulnerability within the software. Xbee Disadvantages: Not victimization the most recent microcode Forgetting to produce power or ground Deciding Associate in Nursing XBee is burned out once it's simply sleeping.
An arm based wireless sensors network[4]	A system prototype is successfully realized. It is based on the STM32F407 board based wireless sensing nodes and STM32F429 based base station. The STM32F407 board employs the ARM CORTEX-M4 processor as brain. The CPU is realized with a Windows operating system based PC. The monitoring platform is realized with a specific MATLAB based implementation .It is implemented in MATLAB by employing the "ThingSpeak" read and write functions. The interface between the CPU and the base station is realized via a USB port. The interface between the base station and the sensing nodes is realized via the ZigBee protocol. Results have assured a proper functionality of the devised system. Storage of the intended crop field parameters on cloud allows the remote users to access this data on smart phones.	MATLAB: The first disadvantage is that it's Associate in Nursing understood language and, therefore, could execute a lot of slowly than compiled language. This downside may be check by properly structuring the MATLAB program. A full copy of MATLAB is 5 to 10 times a lot of pricey than a traditional C Disadvantages of ARM processors: • It isn't binary compatible with x86, which suggests you can't run windows thereon terribly before long. • Some ARM processors clock frequencies that is why speeds and memory bandwidths are restricted in such cases. •The programming of directions makes debugging tough.
Predictive analysis[7]	Sensing element nodes mentioned within the perception layer area unit deployed and tested. The nodes send knowledge to one entree victimization the MQTT protocol. Nodes act as a publisher MQTT shopper and initiate the association by causing CONNECT message to the MQTT broker. The broker then responds with CONNECT to the shopper. Once the association is established, the shopper keeps causing the sensing element readings	MQTT uses transmission control protocol which needs additional process power and additional memory. Transmission control protocol uses acknowledgement protocol which needs frequent come to life and communication time intervals. This affects battery consumption. What is more transmission control protocol connected devices tend to stay sockets open for every different that adds memory/power needs. Centralized broker limits the quantifiability as every consumer devices take up some overhead. So as to avail quantifiability, native

	within the given topics to the broker.	broker hub is employed.
		Centralized broker will limit scale
	The Subscriber MQTT shopper that is that the entree subscribe the info that sent from identical topics. Then knowledge area unit analysed and hold on the entree device to use the machine learning algorithmic rule code and predict the appropriate action. the info and also the warning action message area unit visualized and displayed on the web site as a user interface that facilitate the user interfacing to stay the farmer observation the sphere.	
Hypaponics monitoring System [8]	This Hypaponics may be a watching system that takes care of integrated vertical farming. It's monitored exploitation varied sensors and also the predictions are taken supported the information exploitation Machine Learning Algorithms. This helps the individuals to make their manage vegetation by themself. In future we would like an effective mode of exploitation fresh over agriculture to avoid fresh inadequacy and additionally ought to increase the food production rate five hundredth additional than currently. This technique additionally helps the individuals to avoid diseases that are caused by food exploitation chemical fertilizers whereas cultivating.	Vertical farming is performed in a very controlled, indoor surroundings High costly Vertical farming is technology-dependent It is keen about a spread of technologies for lighting, regulation temperature, managing humidness, and more.

CONCLUSION

Our system combines all parameters for the purpose of monitoring the plant's health. It includes parameters like finding moisture content, temperature, pH, air quality. Provides high transmission rate. Using Wi-Fi provides higher security. Linear Logistic regression gives the exact value. Simple to use. Gives high accurate result. This algorithm allows models to be updated easily to reflect new data. Logistic Regression proves to be very efficient. Collecting past and present data to predict the future data.The main downside in agriculture is that the usage of water and our approach offers a far better result. We've got used the sensing element for locating the wet level and consistent with that more operation is performed. The opposite issue that's addressed is that the temperature and pH, whether or not correct quantity of temperature and pH is obtainable for higher growth of the crop. The farmers will take more action depends on the knowledge gathered. Thus, the IOT based mostly farming are terribly useful for the farmers for obtaining the updated info. Meanwhile, Farmers and landowners should grasp the potential of IOT within the market presently. The demand conjointly speedily will increase if we tend to use IOT technology during a correct manner. We can cut back the wastage of water and power consumption by pump so they are preserved for future use. This technique provides complete observance action of sensors in fields that's terribly simple to manage the sector. IOT is that the promising revolution that conveys ability and machine to extraordinary dimensions. Farmers must know the value of IOT in the market currently. Because IOT based monitoring are very helpful for the farmers for getting the updated data. The demand also rapidly increases if we use IOT technology in a correct and efficient manner.

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