IoT based Smart Farming using TVWS

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Abstract*: This project uses IOT as its domain which plays the key part in smart agriculture. Checking environmental factors is one of the key points to enhance the yield of the harvest. The idea behind this project is smart farming which uses IoT sensors that are capable of giving information or data about the farming fields. Since the information is utilized and processed by computerization, the whole process is efficient. In this system we'll be having an Arduino based programmed IOT system which enhances the efficiency of the yield and also incorporates different sensors like observing proximity sensor, nitrogen sensor, soil moisture, infrared radiation, water level and smoke sensor in the farming field and for the purpose of storing cultivated products temperature control sensor is used. In this system, with the help of VPS hosting, we host a dedicated server which reflects the computerized data collected from the sensors and creates a way to track down the collected data lively. IoT without internet is an absolute waste so in order to provide the best internet connectivity we are using TV White space technology which is basically revolutionizing traditional broadband connectivity. This technology refers to the unused TV channels between the dynamic ones in the UHF range and these unused range can be used to provide internet access which has the greatest coverage and will also eliminate internet connectivity issues. The objective of this work is mainly the crop advancement at low source utilization and also to use the available water at the required time efficiently and the objective is only possible if there is internet access for which TV white space technology is also a primary consideration. The proposed system is completely built on the information sent from the sensors and hence the system will calculate the optimal condition for achieving maximum yield and can predict the effective utilization of sources at different conditions.

Index Terms*: Internet of Things, Ultra high frequency, Virtual Private Server.

I. INTRODUCTION

For a long time, agriculture has been related to the generation of basic food crops. Agribusiness plays a crucial role in the whole existence of a given economy. It is the foundation of the economic arrangement of a given nation. Notwithstanding giving food and crude material, agribusiness likewise gives business chances to a huge level of the populace. Indian soils have been utilized for developing yields more than a huge number of years without thinking about replenishing. This has provoked consumption and depletion of soils resulting in low profitability. The normal yields of practically every one of the harvests are among the least on the planet. Regardless of the expansive scale motorization of agriculture in certain parts of the nation, a large portion of the farming activities in bigger parts is completed by human hand utilizing straightforward and ordinary instruments. Next to zero utilization of machines is made in furrowing, sowing, watering, diminishing and pruning, weeding, gathering sifting and transporting the harvests. This is particularly the situation with little and negligible farmers. It results in tremendous wastage of human work and low yields. Generally, it is noticed that farmers squander more time watching their fields to make sense of when to water their yields. This may be a tedious procedure since different elements like moisture content, water levels and so forth must be thought about, which makes it a troublesome errand for the farmers. Additionally, when there is just less water accessible for the water system, farmers ought to most likely utilize the accessible asset effectively coming up short which will result in serious issues sooner rather than later. Our undertaking tends to these issues and brings along numerous approaches to tackle the equivalent with the utilization of IoT. IOT plays a key part in smart agriculture. Checking environmental factors is one of the key focuses to enhance the yield of harvest. IoT sensors are proficient of giving information/data about the farming fields. Since the information is utilized and processed by computerization, the whole process is efficient. Arduino based programmed IOT system is put into use which enhances the efficiency of the yield and also incorporates different sensors like observing proximity sensor, nitrogen sensor, soil moisture, infrared radiation, water level and smoke sensor in the farming field, and for the purpose of storing cultivated products, temperature control sensor is used. In IoT as the name itself suggest internet connectivity is a must but since we can't guarantee internet access within rural areas it becomes an issue. This is where TV white space technology comes into play. TV white space technology alludes to the unused TV channels between the dynamic ones in the VHF and UHF spectrums. But since the VHF spectrum has certain disadvantages like a reflection can occur when going between objects isolated by separations littler than its wavelength. So as to stay away from that we here use UHF spectrums which because of its higher throughput and unrivalled coverage in wooded and forest like areas make it an perfect choice for rural broadband.

Revised Manuscript Received on 30 March 2019.
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With traditional Wi-Fi routers, the connectivity range is relatively limited, around 100 meters that too under optimal conditions, and the connectivity can be blocked by walls or other barriers. To overcome this as internet connectivity is a must in the case of IoT and we adapt TV whitespace technology because of its superior range and ability to penetrate into obstacles such as trees, building, walls and rough terrain and also it can cover an expanse of about 10 kilometers in diameter.

In this system, with the assistance of VPS hosting, we host a dedicated server which reflects the computerized data collected from the sensors and creates a way to track down the collected data lively. And to connect to the dedicated virtual server internet connectivity is provided with the help of TV white space technology which can basically fix all the existing internet connectivity barriers. With all these, the system will calculate the optimal condition for achieving maximum yield and can predict the effective utilization of sources at different possible conditions.

II. RELATED WORKS

A. A Model for Smart Agriculture Using IOT

Patil K. An et al. (2016) proposes a savvy farming model in reconciliation with ICT. ICT have dependably made a difference in Agriculture space. Over time, climate examples and soil conditions and pandemics of irritations and ailments changed got refreshed data enables the agriculturists to adapt to and even advantage from these progressions. It is to give such learning as a result of profoundly confined nature of agricultural data, particularly unmistakable conditions. The entire continuous and verifiable condition data accomplishes productive administration and use of assets. The issue is that the procedure can accomplish advantageous remote association inside a short-remove[1].

B. Automated Irrigation System Using Wireless Sensor Network & GPRS Module

Joaquín Gutiérrez et al. (2014), The paper goes for streamlining water use for agricultural products. An algorithm was created with edge estimations of temperature and soil dampness that was modified into a portal to control the amount of water. The structure was constrained by photovoltaic sheets and had a duplex correspondence associate reliant on a cell Internet interface that thought about data examination and water system planning to be customized through a page. The issue is that the interest in electric power supply would be costly[2].

C. An Effectual Method for Crop Monitoring Using Wireless Sensor Network

Shakthipriya N et al. (2014) As specified it surveys the state of wireless technology in agriculture. In light of the estimation of the soil dampness sensor, the water sprinkler works in the season of water lack. Once the field is sprinkled with sufficient water, the water sprinkler is cut off. Thusly water can be rationed. Additionally, the estimation of soil pH is transferred to the agriculturist by means of SMS utilizing GSM modem . The issue is that it gives just exactness esteems that isn't precise and isn't cost effective[3].

D. Automation of Water Pumps

Hussain A. Attia et al. (2015) It explores the outline and re-enactment of an electronic structure for customized controlling of pumps that are utilized for farming fields and plant watering depends on the dimension of soil moisture. The speed of the engine is differed by the dimension of the dirt dampness content; the engine is OFF amid greatest wet and is running with HIGH speed amid dry soil conditions separately. The term water pumping is controlled by a clock circuit. The framework is tried utilizing NI MULTISM re-enactment programming. DIAC and TRIAC systems are utilized. The issue is that it doesn't support a few water levels and uses old strategies[4].

E. Real - Time Automated system for Agriculture

G.Meena Kumari et al. (2014) The approach proposes precisely it is possible to use in check and control of nursery parameter in precision cultivation. In the Field transport idea, the information exchange is primarily controlled by crossbreed system(wired and remote) to robotize the framework execution and throughput. ZigBee protocols dependent on IEEE standards for the wireless framework is utilized[5].

Disadvantages Of Existing System

- Convenient wireless connection only within a short-distance.
- The investment in the electric power supply is expensive.
- Provides only precision values that are not accurate and does not cost efficient.
- Does not support various water levels and uses old techniques.
- Not energy sparing and data fusion, bearings are left for future research.

III. PROPOSED SYSTEM

ESP8266 is the main block of the proposed system consists of a low-cost Wi-Fi microchip with full TCP/IP stack control and also full microcontroller capability where everything is bound on the same die. Basically, it is portable, consumes low power it can be even powered with a power bank and at the same time, it provides fast and secure connections. Environmental factors are one of the key points to enhance the yield of the harvest. Even a single variation might affect the crop production so the monitoring of environmental conditions is pretty much important so sensors are used. The soil moisture sensor is used which measures the volumetric water content in the soil and temperature infrared sensor is used which senses the relative temperature. Also, here we use TV White Space communication to provide internet access.

Tv White Space refers to the low-power unlicensed operation of communication services in an unused portion of the RF spectrum that falls within frequencies allocated by the respective organizations.

So, on the whole, we could combine this whole system where internet access is given by Tv White Space Technology to get an inexpensive but reliable IoT based smart farming system.

IV. SYSTEM DESIGN

The whole system is divided into two modules. First is the smart farming system and the other one is Tv Whitespace technology which provides the internet required to transfer collected data from the sensors to the virtual private server through the internet.

Module 1

Description of ESP8266

NodeMCU is an open source advancement board and firmware situated in the broadly utilized ESP8266 - 12E WiFi module. It enables you to program the ESP8266 WiFi module with the basic and robust LUA programming language or Arduino IDE. With only a couple of lines of code, you can set up a WiFi association and characterize input/yield pins as indicated by your necessities precisely like Arduino, transforming your ESP8266 into a web server and much more. It is what could be compared to ethernet module. Presently you have the Internet of things (IoT) genuine instrument.

Important Features of ESP8266

1)It is a programmable Wi-Fi module.

2)Arduino-like (programming characterized) equipment IO.

3)It can be modified with the straightforward Lua programming language or Arduino IDE.

4) USB-TTL included plug and play.

5)10 GPIOs D0-D10, PWM usefulness, IIC and SPI correspondence, 1-Wire, and ADC A0 and so on across the board.

6)Wi-Fi organizing (can be utilized as an access point as well as the station, have a web server), associated with the web to get or transfer information.

7)It also acts as an Event-driven API for system applications.

8)It has inbuilt PCB antenna.

Description of Temperature sensor

In this work, TMP007 temperature infrared thermopile sensor is utilized which has worked in math motor. This sensor ingests energy from an object and wavelengths between 4 um to 16 um inside the characterized field. It comprises math engine, detects the comparable change in voltage over the thermopile with the inside cold- intersection reference (±1°C (max) from 0°C to +60°C and ±1.5°C (max) from – 40°C to +125°C) computerized control on temperature sensor to locate the ideal field temperature. It also has non-volatile memory for recording coefficients. The TMP007 is planned with versatility and low power supply (2.5V to 5.5V)

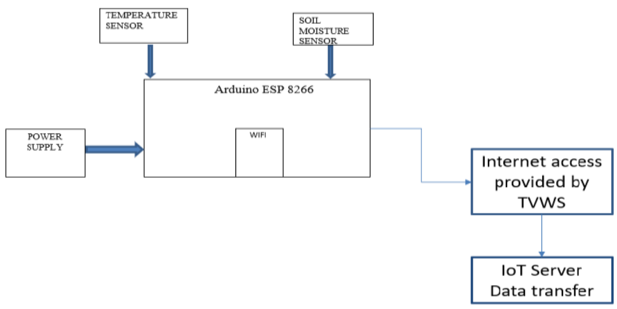
Description of the Soil Moisture sensor

This sensor comprises two probes which are utilized to quantify the volumetric content of water. The two probes enable the current to go through the soil and afterward it gets the opposition incentive to quantify the moisture esteem.

At the point when there is more water, the soil will lead to greater electricity which implies that there will be less resistance. In this manner, the moisture level will be higher. Dry soil conducts electricity inadequately, so when there will be less water, at that point the soil will direct less electricity which implies that there will be more resistance. Hence, the moisture level will be lower.

This sensor can be associated in two modes; Analog mode and digital mode. In the first place, we will interface it in Analog mode and afterward, we will utilize it in Digital mode.

Fig.1

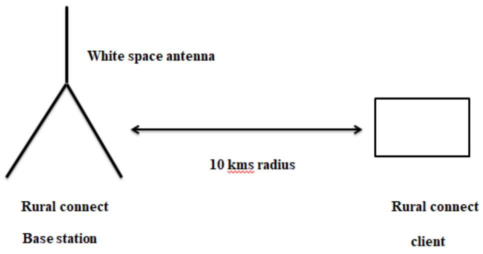


System Architecture

Module 2

Tv White Space Technology

Fig.2



TV Whitespace Architecture

Internet access is an essential element In IoT and also a critical enabling agent for the information-age economy. As a consequence, assuring affordable and ubiquitous access to internet service is important.

Tv White space spectrum has the potential to be the world's first globally available, broadband-capable band in the optimal sub-1Ghz spectrum. The main objective is to provide internet access to the unconnected urban and rural areas so that there is efficient data transfer through the internet. This remains as a primary consideration because without internet the designed IoT system won't work efficiently since there won't be any data transfer between the sensors and the virtual private web server.So with all these considerations, we deploy Tv White Space Technology which acts as a communication medium between the virtual server and the smart farming system.

Architecture requirements

A typical architecture for an internet access system using TVWS frequencies consists of three main components:

I. A base station that is already connected to a high-speed backbone internet connection on one side and a transmitting antenna up to 108 feet from the ground on the other side which is aware of its location and the location of devices to which it is connected.

II. A customer premise equipment(CPE) device which is connected to an antenna at a user's location

III. A database service that makes known to the TVWS equipment what TV channels are unused in the locations where the equipment is deployed.

Using the general architecture as depicted in Fig., we can have internet access services even to an area that falls outside the reach of traditional broadband access networks. So as long as a network user is located within roughly a 10-km radius of the centrally located antenna with high-speed internet.

In Table I, it depicts the comparison coverage range between TVWS and other Wireless(Wi-Max/Wi-Fi) in rural areas

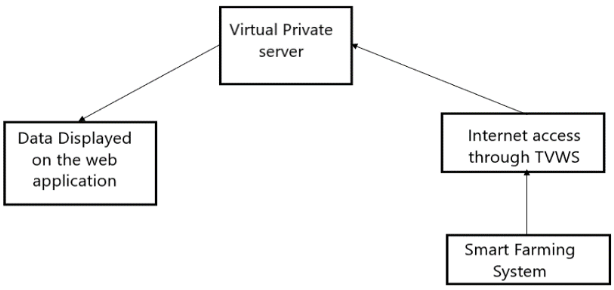
Table I.

Modulation Technique	DownlinkCoverage Area in rural Area		Uplink Coverage Area in rural Area	
	TVWS	Other Wireless (WiMAX/Wi-Fi)	TVWS	Other Wireless (WiMAX/Wi-Fi)
QPSK 1/2	59 km	7 km	61 km	9 km
QPSK 3/4	46 km	6 km	49 km	8 km
QPSK 7/8	42 km	5.5 km	45 km	7.5 km
16 QAM 1/2	40 km	5 km	41 km	7 km
16 QAM 3/4	29 km	4 km	31 km	6 km
16 QAM 7/8	23 km	3.5 km	27 km	5 km
64 QAM 3/4	21 km	3 km	19 km	3 km
64 QAM 7/8	18 km	2 km	17 km	2 km

TVWS and Wi-Fi comparison

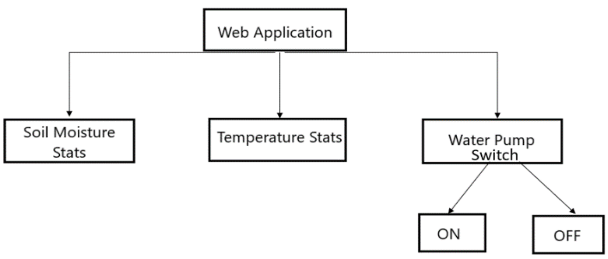
V. METHODOLOGY

Fig.3



Dataflow in the system

Fig 4



Web Application Functions

As depicted in the Fig.3, the data flow is from the smart farming system which comprises of sensors that collect data and gets transferred to the virtual private server that is hosted on the web. The internet access is obtained through TVWS which makes reliable data transfer possible and through the web application the farmer can view the recorded data and will be having control over the water pump with the help of pump ON and OFF button provided on the web application which can be seen in the above provided Fig.4, to water the field accordingly as per the needs.

VI. OBJECTIVE

To improve resource management by installing this smart system in farm fields. This smart system comprises of sensors which not only improves the cultivation but also help in to prevent human made errors. This project is mainly developed for the agriculture purpose it will check the water content in the soil by using the soil moisture sensor it will measure the water content and update regularly through the IOT. If the moisture content is low in the soil the plants will die in order to avoid this it will turn on the relay which will turn on the water pump and will pump the water to the soil. The relay is controlled by the microcontroller. We can control the water pump through the IoT by just clicking the ON and OFF button provided in the web application.

VII. RESULT

The designed system works in such a way that the data obtained from sensors are transferred to the cloud and with the help of internet provided by TVWS technology it can be monitored by the farmer through his/her mobile/ PC. The system provides accurate values which actually occur from the system are observed by the farmer, with his intervention at his crop fields the irrigation can take place automatically. Microcontroller processed and correlated huge data obtained from the sensors is checked at every time to the threshold values. Here calibration of the sensors system is so important. The system displays condition of soil moisture and temperature, based on the two sensors and the condition of the motor. The status of the system can be even checked at remote places and the complexity of the system is less so we can do troubleshooting the firmware is of ease. And it is also made sure that the whole system is economical even though setting up TVWS needs higher funds initially, in the long run, it will be cheap as it requires less maintenance and at the same time, it provides reliable and fastest possible internet connection because of its characteristic features.

VIII. CONCLUSION

The proposed system in this paper is a smart IoT based smart farming using TVWS. The crop management can be done by providing the required amount of water, fertilizers and all updates about crop growth can be received from anywhere to any place. Machine-to-Machine can be connected and all meteorological information is accessed and the solution can be applied and implemented.

In order to solve the connectivity and power problem of the old system, which is a limitation of the existing smart farm, we implemented a communication method using a Wi-Fi module as a low power module. In addition, by applying a simple solution to the connection loss that can occur in wireless communication, the TVWS technology is implemented and by applying a standardized message exchange method, the possibility of expanding the technology application in the IoT field can be confirmed.

FUTURE WORK

Internet of things is far and wide castoff in relating gadgets and social occasion insights. This farming observing framework fills in as a solid and effective framework. Remote observing of field lessens human power and it additionally enables the client to see precise changes in harvest yield. It is less expensive in expense and expends less power. The brilliant agribusiness framework has been outlined and combined. The created framework is more productive and valuable for agriculturists. It gives the data about the temperature, soil moisture through the designed web application to the agriculturist, on the off chance that it is far away from the ideal range. The framework can be utilized in greenhouse and temperature dependent plants. The utilization of such a framework in the field can propel the reap of the harvests and worldwide generation. In the future, this framework can be enhanced by including a few more features like updating the real-time data through SMS/MMS, Solar-based power source utilization and few more upgrades that would increase the efficiency of the system.

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