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Analyzing the Effects of Propagation Impairments Using ITU-R Model

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ABSTRACT
The primary goal of this work is to record the effects of atmospheric signal deterioration on the wireless communication signals that are often used in daily life. Numerous research has been carried out to support and address the attenuation influence of temperature, humidity, acetone, rain, CO, CO2 and Ammonia various wavelength channels. Transmission Impurities cause phenomena such as scattering and diffraction at lower frequencies. The impacts of the atmosphere are calculated using properties that are comparable to those created. In this project a NODE MCU (Microcontroller Unit) system to measure atmospheric impedances in propagation impairments. Experimental results showed that the attenuation effect caused by rain began at specific frequencies. The NODE MCU was the apparatus we employed to test atmospheric impedances in propagation impairments.

KEYWORDS
Atmosphere, Propagation Impairments, NODE MCU, Temperature, Humidity, Acetone, Rain, CO, CO_2 and Ammonia
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1. INTRODUCTION

Variations in ground elevation have less of an impact on propagation across paths shorter than one kilometer, as buildings and trees do. Buildings have a major impact since most short-path radio links are in urban and suburban areas. The transport terminal is perhaps in a car or being carried by a person. This recommendation offers techniques for assessing path loss and delay spread for short propagation paths, as well as classifications for such paths. A radio propagation model that calculates the route loss inside a room or a closed space inside a building that is enclosed by walls of any kind is called the ITU indoor propagation model, sometimes referred to as the ITU model for indoor attenuation. Most appropriate for indoor appliances.

The environments covered by this recommendation are only classified according to their radio propagation characteristics. The surroundings, such as building heights and structures, the way a mobile terminal is used (pedestrian or vehicle), and the antenna locations, all affect how radio waves propagate.

The growth of civilization and the increase of polluting emissions from industry and cars cause the state of the atmosphere to deteriorate annually. Even though air is a vital resource for life, a significant portion of the population either doesn't realize how important air pollution is or only recently became aware of it. Among other pollutants including water, soil, heat, and noise, air pollution is the most dangerous and severe type.

It also plays a role in major illnesses and climate change. According to the World Health Organization (WHO), 90% of the population currently breathes contaminated air, and air pollution kills 7 million people annually. Heart disease, lung cancer, and stroke are just a few of the grave health consequences that pollution brings about. Furthermore, air pollution has a negative impact. The Environmental Protection Agency (EPA) of the United States claims that interior air pollution is 100 times higher than outdoor air pollution. Since many people in today's world spend 80–90% of their time indoors, the quality of the indoor air directly affects human health more than outside air quality. Furthermore, indoor pollutants have a 1000-fold higher risk of entering the lungs than atmospheric pollutants, which can result in illnesses such multiple chemical sensitivity, dizziness, and sick building syndrome. Management of indoor air quality is critical because it can reduce exposure by taking proactive preventative actions. Thus, to effectively regulate air quality, efficient and effective indoor air monitoring is required. The spectrum of oscillation of electromagnetic radio waves, or radio frequency (RF), spans from 3 KHz to 300. A signal's fast and slow oscillations cause an atmospheric event. Previously known as scintillation, it causes abrupt changes in the signal output that push the medium toward uncontrolled refractive index in homogeneity. In the meantime, modest fluctuations are typically brought on by particles, particularly water droplets in the satellite-earth station link, absorbing and distributing the signal energy. Both tropospheric and ionospheric scintillation are caused by asymmetry in radio refractivity when the wave moves across the troposphere at various medium densities. and anomalies in the electron density within the atmosphere. The broadcast signal parameters, frequency (f) and angle of elevation (θ), have been modified due to the significant impact on the number of alterations in the atmosphere. A transmitted signal that is less than 3GHz is greatly affected by ionospheric scintillation. But as the frequency rises, this effect diminishes. The other events, including as clouds and rain, were discovered to possess a significant effect of frequency on signal attenuation higher than 10 GHz. On the other hand, space-based particles of water vapor, oxygen, and rain can all intensify the medium signal conductions' effective rain, cloud cover, and oxygen content, respectively, during low-angle rain transmission. This will reduce the quantity of signal that can be received. Thus, oxygen and vaporized water have a large effect on signal bands with high frequencies. Condensed clouds, elevation angle and earth station have a significant relationship that lessens the impact of atmospheric elements. To gauge the degree of atmospheric fade and choose the best fade mitigation method (FMT), a reliable prediction model must be created for improving the quality of earth sky wireless communication.

2. LITERATURE REVIEW

We suggest using the Internet of Things to effectively monitor instantaneous data. We suggest using cloud computing to analyze indoor real-time air quality. To provide the suggested IoT system with functionality for anytime, anywhere, we first created a mobile application. The platform has been put into use in a building to verify its viability, and the device's data reliability has been examined.

3. METHODOLOGY

A basic wireless satellite communication system model consists of the three necessary parts—the satellite, the ground station, and the link that connects them. The channel and receiver model is constructed using MATLAB and has been demonstrated to be particularly suitable for satellite communication, based on the signals approved by the International Telecommunication Union (ITU). In the end, this study will show how atmospheric perturbations impact the satellite's connectivity. Thus, this work presents an Internet of Things (IoT) platform that combines cloud computing and IoT for indoor air quality monitoring.
Additionally, a gadget known as "Smart-Air" was created to effectively transfer data in real time to a cloud-powered web host via an The Internet of Things sensor network and precisely monitor indoor air quality. This platform's cloud-based web server incorporates graphic components and does real-time data analysis to display the interior air quality conditions. Additionally, the web server was made to notify facility administrators or users of mobile applications of moderate or poor air quality, allowing the appropriate parties to take prompt corrective action. Real-time monitoring combined with a prompt alert system creates an effective platform for enhancing indoor air quality.

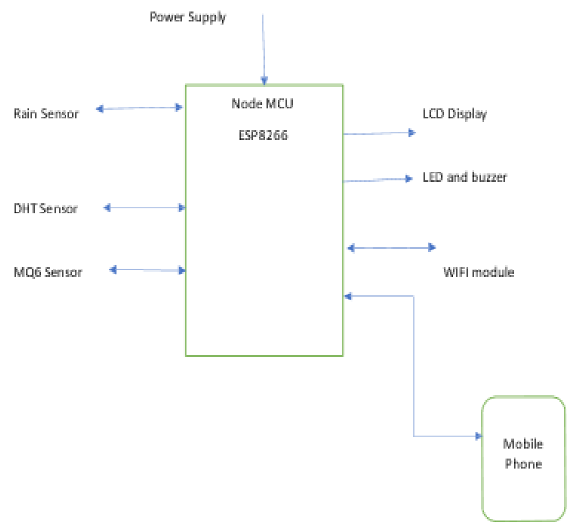

Fig 1 Block Diagram

This is designed to program an ESP8266 microcontroller, which is a popular choice for Internet of things (IOT) projects. The microcontroller is accustomed to connecting to the Blynk platform, which is a cloud-based service that allows you to control and monitor your devices remotely through a smartphone app. The first part of the code sets up the necessary libraries and credentials to establish a connection between the ESP8266 and the Blynk platform. This includes providing your Wi-Fi network credentials and the authentication token provided by Blynk. Next, the code initializes the DHT (humidity and temperature) sensor. This detects commonly used to measure the ambient temperature and humidity in the surrounding environment. The sensor is connected to the microcontroller, and the code configures it to read data from the sensor periodically. Similarly, the code initializes a smoke sensor. This sensor is used to detect the presence of smoke or other harmful gases in the air. It is also connected to the microcontroller, and the code sets it up to read data from the sensor at regular intervals. The code also includes the setup for an LCD display. The LCD display is used to show weather information, which is retrieved from an online weather API. The code fetches the weather data, such as temperature and humidity, and displays it on the LCD screen. To continuously monitor the sensor data and update the Blynk app, the code includes a loop that runs indefinitely. Within this loop, the code reads transmits the sensor data to the Blynk platform., and updates the LCD display with the latest weather information. Overall, this code enables you to remotely monitor the temperature, humidity, and smoke levels in your environment, as well as display real-time weather information on the LCD screen. It combines the capabilities of the ESP8266 microcontroller, the Blynk platform, and various sensors to create a connected IoT device.

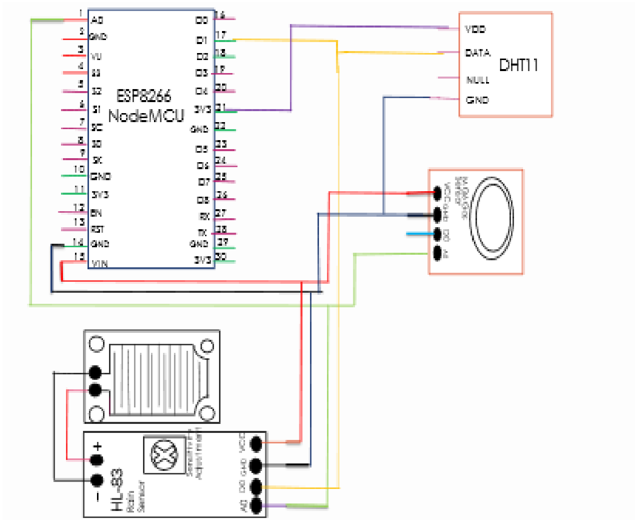

Fig 2: Circuit Diagram

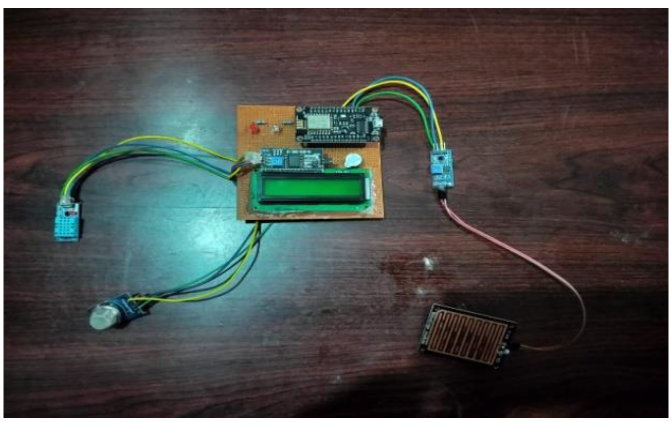

Fig 3: Proposed Prototype

Light Emitting Diode (LED):

An LED is a type of light source composed of semiconductors. LEDs are widely employed as indicator lamps in gadgets, and their applications in other forms of lighting are growing.

Liquid Crystal Display (LCD):

This LCD screen is an electronic display module, often known as a liquid crystal display. with multiple applications. The A 16x2 LCD screen is a simple module that is commonly used in a wide variety of gadgets and circuits. There are two lines and sixteen characters per line of text on a 16x2 LCD. Every character is shown on this LCD as a 5x7 pixel matrix. On this LCD, there are command, and data are the two registers.

MQ2 Gas Sensor:

The MQ2 gas sensor is a metal oxide semiconductor type. A voltage divider network included within the sensor is used to monitor the concentration of gas in the gas. The voltage needed for this sensor is 5V DC. It can identify gases at concentrations between 200 and 10,000 parts per million.

Characteristics:

- broad range of detection
- long-lasting and steady
- Quick reaction time and elevated sensitivity

Rain Sensor:

The Raindrops detecting sensor module is used to sense rain. It's also employed to determine how heavy the rain is. Rain sensors can be used in a range of weather monitoring applications by converting them into output signals and AO.

Characteristics:

- Utilizing the wide voltage comparator with the LM393
- Offer output in both digital and analog formats.
- LED indication for output
- Suitable for Arduino

Details:

- VDC (operational voltage): 3.3 to 5.5
- Comparator of Voltage: LM393

Humidity & Temperature Sensor DHT 11:

This sensor offers superior quality, quick reaction time, ability to prevent interference, and affordability. It is connected to a high-performance 8-bit ARM processor and features resistive-type humidity and NTC temperature measurement components. Relative humidity sensor: - Frequency output type, readily connected with user application system; - Very low power consumption; - Excellent performance, two-point calibration using capacitor type sensor; - No additional components required.

Buzzer:

Often called a buzzer or beeper, an auditory signaling device can be electromechanical, mechanical, or piezoelectric (piezo for short). Timer systems and alarm systems, and devices that verify user input—such as mouse clicks and keystrokes—often employ buzzers and beepers.

ITU-R MODEL

The International Telecommunication Union Radio Communication Sector is known by its acronym, ITU-R. The ITU-R standards are updated nationally every four years. Since 1869, India has been a participating member of ITU. P.530-7 is the ITU-R framework's particular suggestion or guideline. A useful tool for examining how atmospheric conditions affect signal transmission is the ITU-R P.530-7 model. It offers principles and suggestions for comprehending how atmospheric gases, precipitation, and fog affect signal quality. The model aids in forecasting signal attenuation, fading, and delay by considering variables like frequency, distance, and meteorological information. It's a useful tool for communication system optimization under different air conditions.

The ITU-R model, also known as the ITU-R P.530-7 model, includes a formula for rain attenuation that estimates the attenuation of microwave signals caused by precipitation. Raindrops absorbing and dispersing radio signals along the propagation path is what causes the attenuation. The ITU-R P.530-7 model's particular rain attenuation formula is given as

$$A_R = K.R^p.L^q.f^r.\gamma \quad (1)$$

Where, A_R is the precise decibel attenuation caused by rain (dB). K is a constant depending on the specific model and units of measurementR is the rain rate in millimetres per hour (mm/hr). The path's length, expressed in kilometres (km), is L. f is the signal's frequency expressed in gigahertz (GHz). γ is a random variable that depicts the path's statistical variations in rain intensity. $p,\ q,\ and\ r$ are the empirical coefficients determined based on extensive measurements and observations.This formula captures how rain attenuation varies with path length, statistical variances in rain intensity, and rai rate, among other parameters. It is noteworthy that the coefficients p, q, and r may differ based on the frequency range and climate circumstances considered. The ITU-R P.530-7 model helps with the design and development of microwave communication systems operating in rain-affected areas by offering a thorough framework for calculating rain attenuation in various scenarios.

EMISSION OF CO_2:

CO2 is produced by humans when they consume fossil fuels including coal, oil, gas, and gasoline. Consequently, the amount of CO2 added to the atmosphere each year increases by 9.1 billion tons. The oceans take up 2.2 billion tons of this extra carbon, and plants and soil take up 2.8 billion tons.

EMISSION OF CO:

A multitude of combustion sources, such as cars, power plants, and other incinerators, and wildfires. It is also a byproduct of incomplete combustion of fuels containing carbon, such as natural gas, wood, and gasoline.

EMISSION OF ACETONE:

It is believed that the main sources of acetone emissions are solid fuels used in incinerators, barbecues, and home heating. Aerosols and solvents used around the house also contain it.

EMISSION OF NH_4:

A variety of non-agricultural sources, including combustion, industry, landfills, sewage treatment plants, police cars' catalytic converters, organic material composting, and wild animals and birds, also release ammonium into the atmosphere.

EMISSION OF HUMIDITY:

Humidity can be emitted from breathing, sweating, cooking, and bathing all release moisture into the air indoors. And manufacturing processes, such as those in textile, paper, and food industries. And bodies of water such as oceans, rivers, and lakes; vegetation through transpiration; and soil through evaporation.

EMISSION OF TEMPERATURE:

This emission can be in the form of thermal radiation. Which follows Planck's law and depends on the temperature of the source. Examples include stars, heated objects.

4. RESULTS

Fig 4: Temperature, Humidity, CO_2, CO values

Fig 5: NH_4, Acetone values

As shown in Fig 4 and 5 the shows the real time monitoring data of temperature is 31^0Cit is moderate. Humidity is 68% it is high. CO is 43 ppm it is high. $CO_2$is 16 ppm it is normal. NH_4 is 15ppm it is weak acid and Acetone is 2 ppm it is low.On Oct 12, the values were taken out. It is displayed on the 16*2 LCD Display.

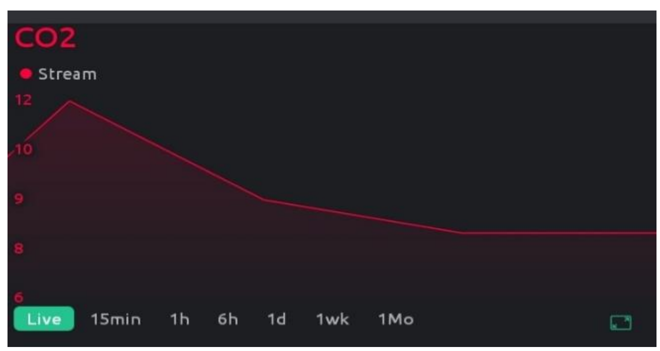

Fig 6: CO_2

As shown in the above Fig: 6 the graph shows the real time monitoring data of CO_2 is 12 ppm it is considered to be low level.

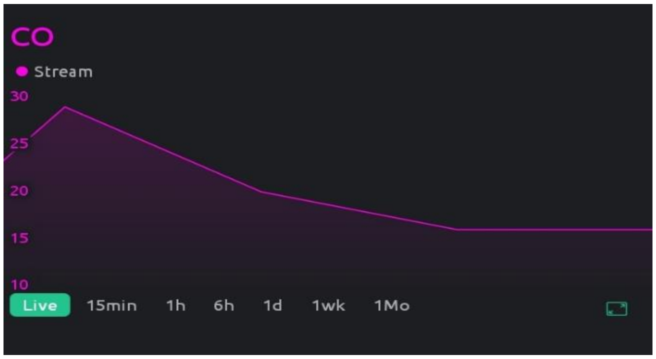

Fig 7: CO

As shown in Fig: 7 above, the graph displays the carbon mono oxide real time monitoring data reported of CO is 29 ppm it is high level.

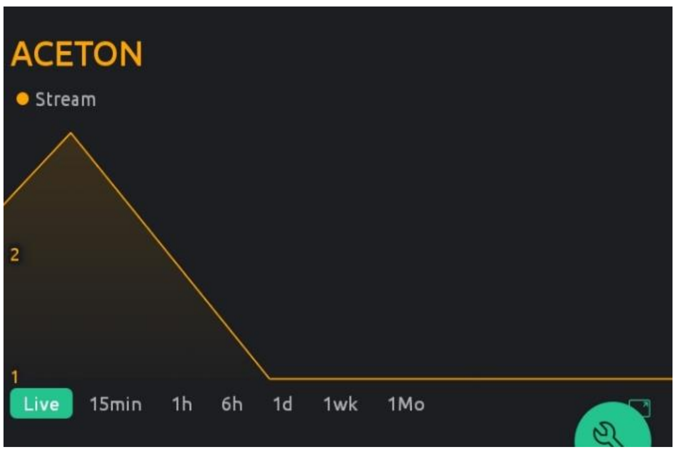

Fig 8: ACETONE

As shown in the above Fig: 8 the graph shows the real time monitoring data of Acetoneis 4 ppm it is it considered to be low level.

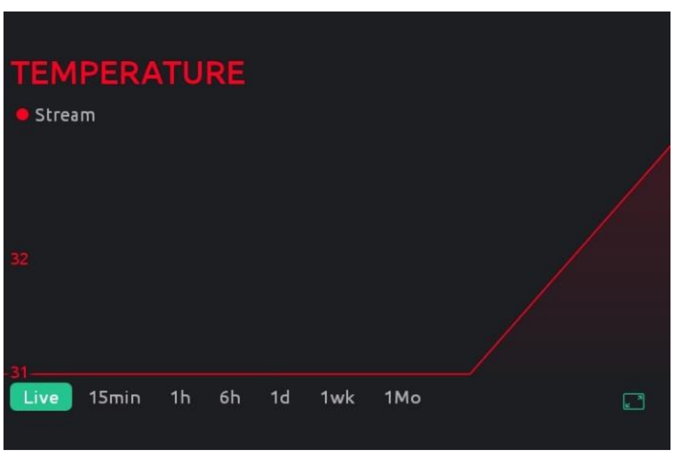

Fig 9: TEMPERATURE

As shown in the above Fig: 9 the graph shows the real time monitoring data of temperature is 33^{0}C it is moderate level.
As shown in the above Fig: 10 the graph shows the real time monitoring data of NH_4 is 12.8 ppm it is moderate level.
As shown in the above Fig: 11 the graph shows the real time monitoring data of humidity is 67.5% it is high level.

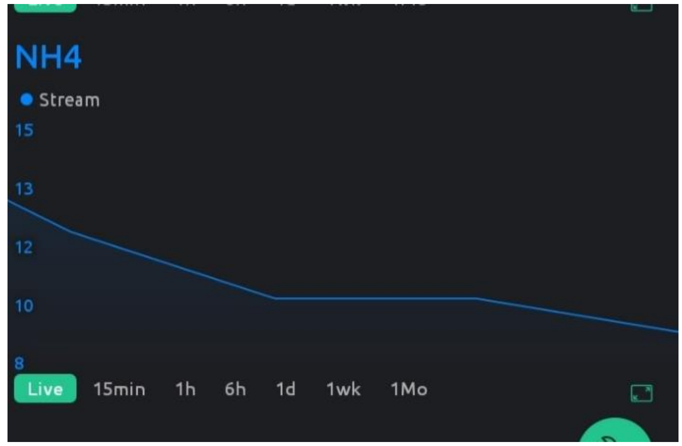

Fig 10: NH_4

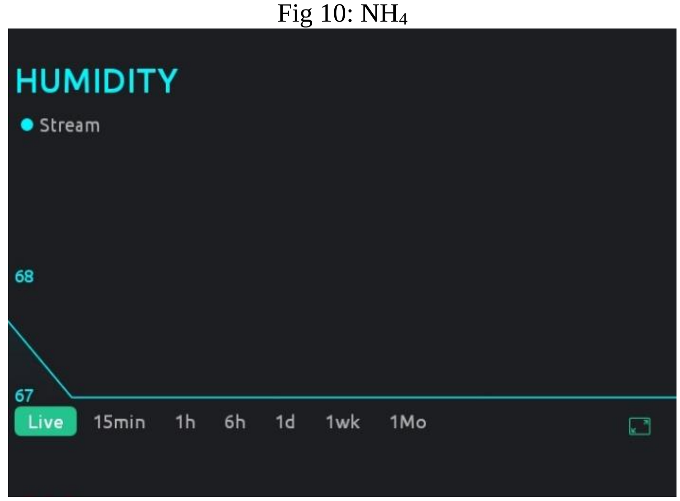

Fig 11: HUMIDITY

5. CONCLUSION

Real-time Systems for monitoring the atmospheric environment are vital for gathering and analysing meteorological data, which is needed for a variety of purposes such as transportation, agriculture, and disaster relief. This study describes a weather monitoring system that collects and transmits data in real time over the internet using the Node MCU platform. The system has several sensors that detect air pressure, temperature, humidity, wind direction, and speed subsequently, the data is sent to a cloud-based platform for storage and analysis. Because of the Node MCU's Wi-Fi connectivity, the system can be remotely monitored and controlled, and real-time weather data may be accessed from any location in the globe. The precision and dependability of the system are demonstrated by studies carried out in real-world weather situations. The system's affordability and dependability as a weather monitoring solution are demonstrated by the evaluation of its scalability and cost-effectiveness. Recommendations for further system applications and enhancements are made at the end of the paper. The impact of atmospheric impairments on various wireless communication frequencies are discussed in this work. It has been demonstrated that rain, clouds, gasses, and water vapor all because different forms of attenuation, also referred to as transmission impairments. The true measured values in the real world were used to derive the atmospheric impairment results. The performance was examined using a variety of wireless satellite radar communication propagation modules and transmission parameter variations. In addition to other atmospheric events that were preceded by the attenuation of the less efficient gases and the cloud, the acquired data show that the attenuation effect induced by rain began at a frequency range above 10 GHz. In this paper, the atmospheric propagation model is presented Even if the angle of elevation is inversely proportional to the degradation of signal quality, the simulation's findings show that the frequency to be broadcast, the rate of rainfall, the liquid water contents, and the relative humidity are all strongly correlated with it.

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