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ORIGINAL CONTRIBUTION

DESIGN AND DEVELOPMENT OF SMART IOT-BASED AIR QUALITY DETECTION AND MONITORING DEVICES FOR INDUSTRY 4.0

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ABSTRACT

Smart Air Quality Monitoring System in the context of IoT advances empower cultivators and ranchers to decrease waste and improve efficiency going from the amount of compost used to the number of excursions the homestead vehicles have made and empowering effective usage of assets like water, power, and so forth. IoT brilliant cultivating arrangements is a framework that is worked for observing the harvest field with the assistance of sensors (light, mugginess, temperature, soil dampness, crop wellbeing, and so on) and computerizing the water system framework. The ranchers can screen the field conditions from any place. They can likewise choose between manual and computerized choices for making important moves considering this information. For instance, if the dirt dampness level reduces, the rancher can convey sensors to begin the water system. Shrewd cultivating is profoundly productive when contrasted and the customary methodology.

KEYWORDS: *ATMega 328P, DHT11, MQ 6, MQ 131, MQ135, MQ136, Dust*

1. INTRODUCTION

Actual objects (or collections of such objects) with sensors, handling capabilities, programming, and other innovations that interface and exchange data with other devices and frameworks via the Internet or other correspondence organizations are depicted by the Internet of Things (IoT). The term "Internet of Things" has been considered a misnomer because devices just need to be connected to a company and be exclusively addressable, rather than having to be connected to the public web.[7]In the case of a site collapse or other extraordinary failure occurrences, [8]data consistency [4,5].

Numerous developments, including as omnipresent registration, product sensors, increasingly powerful installed frameworks, and artificial intelligence, have come together to advance the sector [8]. The Web of things is autonomously and collectively empowered by the conventional domains of installation frameworks, remote sensor organizations, control frameworks, and robotization (including building and residential mechanization). IoT innovation is typically inextricably linked to products that support the concept of the "shrewd home" in the consumer market. These products include devices and equipment (such as lighting devices, indoor controls, home security systems, cameras, and other household appliances) that support one or more typical biological systems and can be operated by devices associated with that environment, such as cell phones and smart speakers. Medical care systems also make use of IoT [9].

There are a number of concerns regarding the risks associated with the development of IoT innovations and products, especially in the areas of security and safety. As a result, industry and government actions have begun to address these concerns, such as strengthening international and local laws, regulations, and administrative frameworks.

IoT framework engineering, in its oversimplified view, comprises three levels: Level 1: Gadgets,

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Level 2: the Edge Entryway, and Level 3: the Cloud[10]. Gadgets incorporate arranged things, for example, the sensors and actuators found in IoT gear, especially those that utilize conventions like Modbus, Bluetooth, Zigbee, or restrictive conventions, to associate with an Edge Passage. The Edge Door layer comprises sensor information accumulation frameworks called Edge Passages that give usefulness, for example, pre-handling of the information, tying down availability to the cloud, utilizing frameworks like Web Socket, the occasion center, and, even now and again, edge examination or mist processing. The edge Entryway layer is likewise expected to give a typical perspective on the gadgets to the upper layers to work with in simpler administration. The last level incorporates the cloud application worked for IoT utilizing the micro services engineering, which is typically bilingual and innately secure utilizing HTTPS/OAuth. It incorporates different data set frameworks that store sensor information, for example, time series data sets or resource stores utilizing backend information capacity frameworks (for example Cassandra, and Postgre SQL) [11]. The cloud level in most cloud-based IoT frameworks highlights occasion lining and informing framework that handles correspondence that unfolds at all levels. A few specialists characterized the three levels in the IoT framework as edge, stage, and undertaking, and these are associated with nearness organization, access organization, and administration organization, separately [12].

2. Related Work:

A collection of interconnected processing devices, mechanical and sophisticated machines, objects, animals, or people that have been assigned unique identifiers (UIDs) and the ability to transfer data throughout an organization without requiring human-to-human or human-to-PC collaboration is known as the Internet of Things, or IoT [1]. The introduction to the world of IoT is described in paper 1.The Internet of Things is permitting agribusiness, here explicitly arable cultivating, to become information-driven, prompting all the more opportune and financially effective creation and the executives of homesteads, and simultaneously decreasing their ecological effect. This audit is tending to a logical overview of the current and expected use of the Internet of Things in arable cultivating, where spatial information, exceptionally differing conditions, task variety, and cell phones present remarkable difficulties to be defeated contrasted with other horticultural frameworks [24]. The use and implementation of IoT in agribusiness are described in paper 24.

Despite the discernment, individuals might have concerning the agrarian cycle. The horticulture sector today is more precise, information-focused, and intelligent than ever before. Almost every industry was improved by the rapid development of the Internet of Things (IoT), including "brilliant agribusiness," which switched from factual to quantitative approaches. Such radical shifts are upending the farming methods of today and opening up new avenues along a range of challenges. This article highlights the potential of IoT and remote sensors in agribusiness, along with the challenges that will likely arise when integrating this innovation with traditional farming practices. A detailed breakdown of IoT devices and communication tactics pertaining to remote sensors used in agriculture applications is provided [35].

Zhao [36] suggested integrating Internet of Things (IoT) technology into real-time agricultural production using wireless internet communication and remote monitoring. A system of information management is also built to handle crop data for study. In order to gather real-time data and offer services to customers for research purposes, BingF. [37] has covered the devices used in the Internet of Things as well as its architecture, services, and protocols.

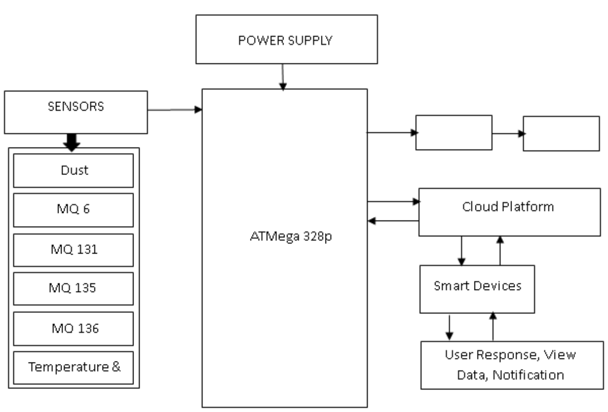
By diversifying into an advanced system that deals with complexity and robust nature, Wang C. [38] demonstrated the impact of cloud computing and IoT on the conventional system. They also described the methods in which innovations have been made to accomplish the objective of IoT with automation. The improvements of open IoT platforms in agriculture have been covered by Alam K. M. [39] in order to validate, process, and analyze crop growth data from sensors and its surroundings in order to make effective judgments.

3. PROPOSED RESEARCH METHODOLOGY

In this project, we are using various devices and sensors and with the help of the Internet of Things (IoT), we are connecting with the internet to partially automate the Air Quality Monitoring methodologies. With the help of a central node and various sensors, we are trying to monitor and measure air parameters like temperature and humidity, hydrogen disulphide(H_2S), ozone(O_3), methane(CH_4), atmospheric carbon dioxide (CO_2) content, and dust for the output response we are using a relay to control the water content in the soil.

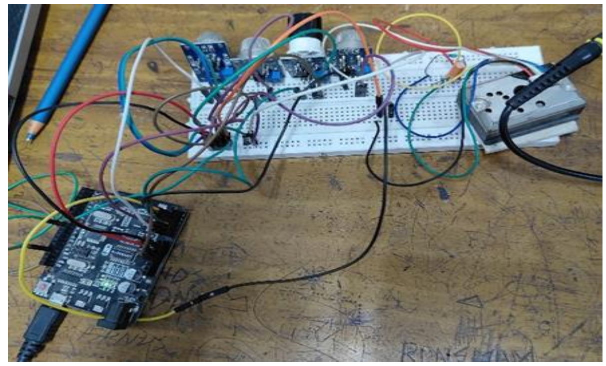
In this prototype model, various sensors measure the intended parameters and send them to the central node. From this central node, the sensed data is transferred to the Blynk Cloud website and Blynk Mobile App. The user can monitor the parameters and accordingly give the desired response through the cloud service with the help of smart devices like smartphones or other handheld devices. The user can remotely give the desired response from faraway places.

4. CIRCUIT DIAGRAM



=proposed mode;

Console.



5.WORKING PROCESS

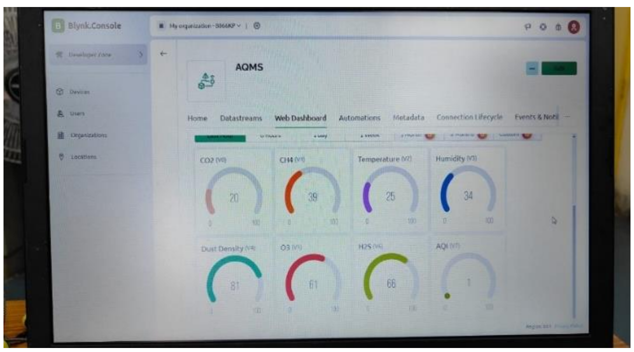
1. Import libraries.
2. Define Blynk Parameters (Template ID, Device Name, Auth Code).
3. Setup the Blynk Console and sensors calibration.
4. Measure the CO_2 sensor voltage and map it within the defined range.
5. Measure the CH_4 sensor voltage and map it within the defined range.
6. Measure the O_3 and map it within the defined range.
7. Measure the H_2S sensor map it within the defined range
8. Measure the temperature and humidity values.
9. Measure PM 2.5 sensor value.
10. Write all the measured values to Blynk Console
11. Stop.

6. RESULTS AND DISCUSSION

For the central node, we are using a ATMega 328P Model B microcomputer which receives the signals from the sensors and processes them accordingly and with the help of an inbuilt Wi-Fi module, we are sending the data to the cloud for further monitoring, measurement, and desired responses from the user.

For monitoring, we are using digital sensors like DHT11) which can be directly connected to the input, and analog sensors like dust sensor, MQ-135 (CO2 sensor), MQ-6 (CH4 sensor), MQ-131 (O3 sensor) and MQ-136 (H2S sensor) to detect the analog input. To connect analog sensors to the ADC Model ,we are using an Analog-To-Digital Converter.

All the above-mentioned sensors are used for data collection purposes and send the data to the ADC module



Below are the various data gathered with the help of

the sensors in normal greenhouse conditions

Serial No.	Models	Precision	Recall	Accuracy	F1 - score
1	DT	0.93	0.93	0.923	0.92
2	RF	0.95	0.95	0.947	0.95
3	KNN	0.74	0.74	0.74	0.74
4	SVM	0.8	0.82	0.82	0.8

7. CONCLUSION

The development and implementation of an air quality monitoring system represent a critical step towards safeguarding public health and environmental sustainability. Through this project, we have underscored the importance of real-time data collection and analysis in assessing air quality parameters such as particulate matter, ozone levels, and harmful gas concentrations.

In this experiment we have also used various mchine learning models like Decision Tree (DT), Random Forest(RF), Support Vector Machine(SVM) and K-Nearest Neighbors (KNN) to find the Air Quality Index(AQI).

Decision tree predicted with an accuracy of 92.33%Random Forest predicted with an accuracy of 94.67%SVM predicted with an accuracy of 82%kNN predicted with an accuracy of 74%So from all the calculations we analyse and conclude that Random Forest is the best Machine Learning model among the four models to predict the Air Quality Index(AQI) for our research project with an accuracy of 94.67%.

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