Cognitive IoT incorporating intelligence in building smart environment

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Cognitive IoT incorporating intelligence in building smart environment

Dishari Sarker, Sumathy S*
School of Information Technology and Engineering, VIT University, Vellore-632014, India
*Email-ID : ssumathy@vit.ac.in

Abstract. The Internet of Things (IoT) is an invention of this century which also can be called as Internet which makes life more logical and electronic. According to research in the industrial field about which aspect in IoT contributes more for GDP is the concept which can be applied in various aspects of our life to make life logical and easier. We are very much aware of the increasing population and the pollution that is caused by the vehicles and many other sources such as harmful gas producers. So, this work focuses in determining the level of pollution in a specific area and predict how much more greenery has to be increased in that area. With its widespread application, this paper proposes an idea with a social cause in order to exhibit the concern towards the environment and mankind. This proposal will benefit farmers and others in polluted cities. The language to be used is Embedded C programming and Arduino IDE open source platform with both hardware and software interaction. The display will involve an android app called Blynk App.

Keywords—Internet-of-Things, Cognitive IoT, Connectivity, D2D Connection

1. Introduction

The Internet of Things is now a days the most important technology that is taken up by the industries to earn their profit and this is new IT according to industry. How does IoT bring in the profit? Who shows the interest? The answers to this question will lead to substantiate the reason for learning this technology and bring out a new concept to serve mankind.Human beings always prefer to make their job easier. They always want their work to be done with less effort and also think less about anything that has to be quantified. As a result of this IoT came into picture where engineers thought of making hardware which can be easily programmed with open source IDEs and libraries. The interesting fact is not only that the device can be programmed; it can connect more than one device and program them all. The sensors and actuators in IoT are made in such a way that it can help us to quantify anything going on around.A machine-to-machine or device to device architecture is discussed.

1.1 Market Analytics on IoT Applications

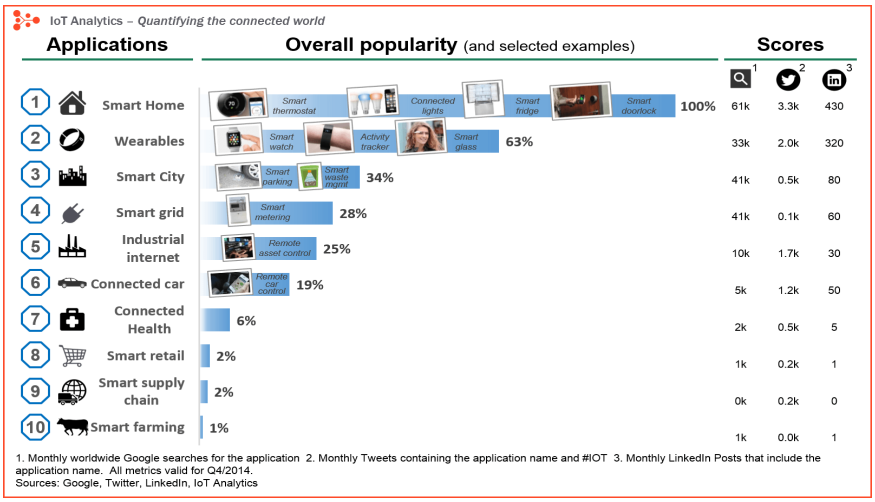


Fig 1:The aspects of IoT and their popularity

Figure 1 provides an analysis on how many people are interested in IoT to be associated in their lives so as to live a better life with all happening electronically quantified and in time. The fact is that it is already seen the most popular IoT applications in different fields in which smart home appliances contributes much profit in the IoT but it has keen interest in this project to serve mankind by cleaning up the environment where people have to stay. As mentioned in Figure 1, smart farming has earned only 1% importance in the human world but here it is chosen to help environment as the concept that is picked is a future work thought by many IoT specialized companies.

1.2 Components of IoT

IoT is driven by three things:-

- Sensors
- Actuators
- Connectivity
- People and Process

*Sensors:-*A sensor is an electronic equipment that detects and responds to some type of input from the surrounding nature. The specific input could be light, heat, motion, moisture, pressure, or any one of a great number of other environmental phenomena. The output is generally a digital or analog signal that is converted to understandability of human through various electronic display at the sensor location or transmitted electronically over a network for reading or further processing.

Actuators :- An actuator is a part or element of machines that can make the machine responsible for moving or controlling a mechanism or system.

Connectivity:- Figure 2 demonstrates various ways of connectivity between client and server machines or in case of loading data into the cloud. One way of communication between sender and receiver is the protocol or rules on which both sender and receiver has to agree upon. List of protocols and its component are specified for making a smart environment.

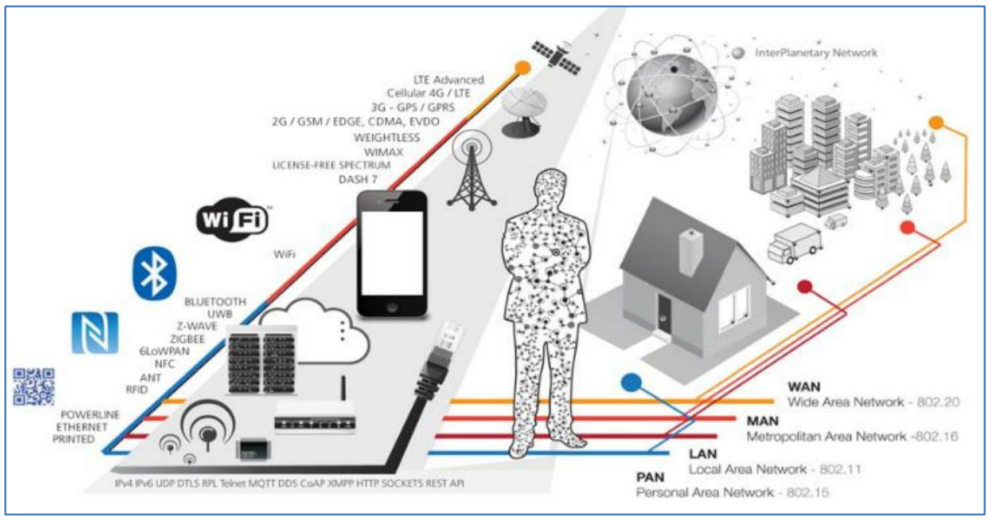


Fig 2: List of protocols and how it connects from M2M

List of protocols that make data to access online:

ETHERNET	Z-WAVE
POWERLINE	UWB
ANT	LICENSE-FREE SPECTRUM
2G/GSM /EDGE	CDMA
EVDO	3G-GPS/GPRS
NFC	DASH 7
6LOWPAN	WIMAX
ZIGBEE	WEIGHLESS
PRINTED	BLUTOOTH
RFID	WIFI
CELLULAR 4G/LTE	LTE-A

People and Process: -

This is the main target of preparing any application as they are the real consumers and it completely depends on how people want to process their data and build their business strategy and make their life easier and happier.

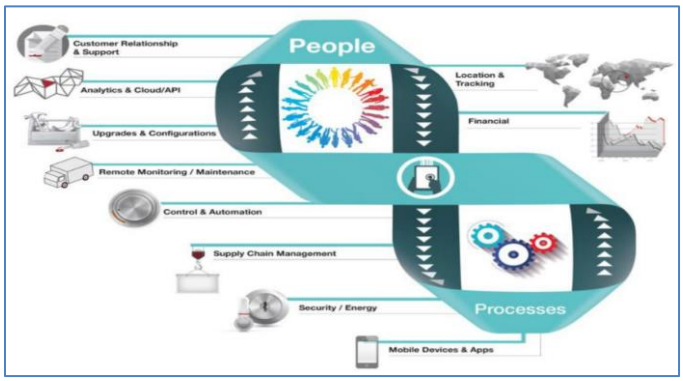


Fig 3: IoT industry with people

The most important context is the analytics part in order to collect thousands of data from the sensors and how to analyze them. Analysisof such large data needs processing of data through decision algorithms and various prediction algorithms.

1.3 IOT Architecture

IoT architectureis very much important in order to plan the architecture of the project required. Elaboration will be done for each module in this diagram as it involves each part in the project.User Interface Device is the top layer in architecture which a user can interact with. It can be of display type.Cloud is the top layer can also consist of another cutting edge technology that is cloud where all data can be stored and processed and the application also can be deployed in Cloud Service Models like PaaS-Platform as a Service application.

IoT Gateway is a way of connecting device to many other devices in different locations and perform critical functions and uses protocol translation and does data filtering on the accumulated data and security of the application and its updating. The machine learning or intelligence part can be done in this layer for the device enabled system.

Figure 4 represents the protocols used like Wi-Fi, Ethernet for connectivity with Internet so that we can connect the devices wherever it is located. In this work, these connectivity shields are used. Almost all protocols have been implemented in shields which have to be programmed only.RFID Module uses Radio Frequency Identification which authenticates the hardware to the application to send the data from sensor for processing data.Sensors are devices which can feel the senses that a human being can sense but are made into electrical chips. For Example, smoke, proximity, humidity, temperature etc. which can be programmed through Arduino IDE.

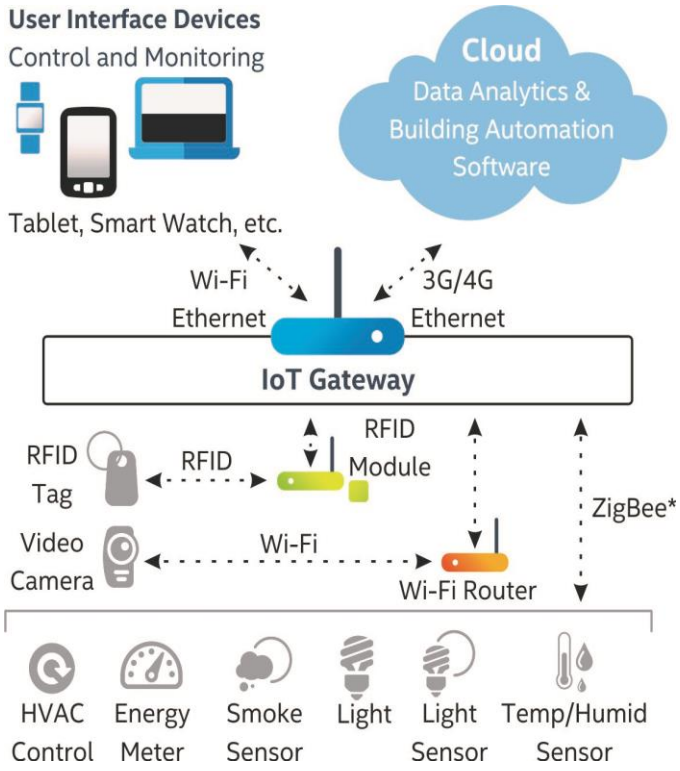


Fig 4:-Description of each module in the architecture

Fig 5: Arduino compatible sensors

The focus is on IoT on which the project is built. “Smart environment” can be a subdivision under Smart city or Smart farming. So, how it can be done is focusing should beon the pollution and the greenery. After a research done on most polluted cities in world we can rate them from analytics graph below (figure 6):

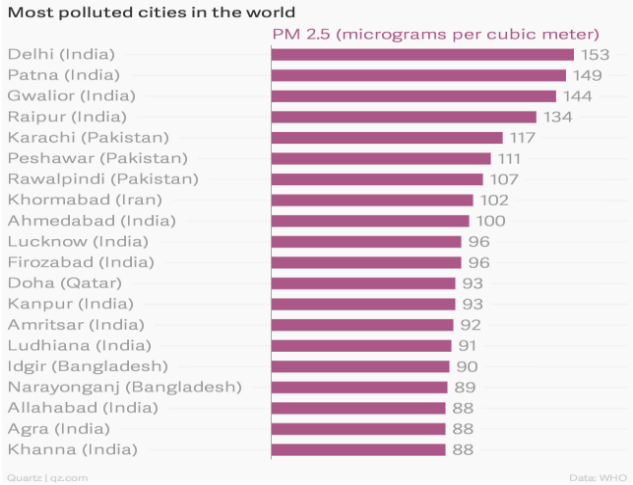


Fig 6: Highest polluted cities

The reason behind this is the harmful gases dissipated from the vehicles. As a gift from IoT there are various applications or setups done for detecting vehicular pollution. But none have been done for quantifying the amount of harmful gases and how to nullify them. Figure 7 provides the National Ambient Quality Standards holding up the value for which gas is the most responsible.

National Ambient Air Quality Standards

Pollutant	Time-Weighted Average	Concentration in Ambient Air		
(micrograms per m3)		Industrial	Residential	Sensitive
Sulphur Dioxide (SO2)	Annual Average	80	60	15
	24 Hours	120	80	30
Oxides of Nitrogen as NO2	Annual Average	80	60	15
	24 Hours	120	80	30
Suspended Particulate Matter (SPM)	Annual Average	360	140	70
	4 Hours	500	200	100
Respirable Particulate Matter (Size less than 10æm)	Annual Average	120	60	50
	24 Hours	150	100	75
Lead	Annual Average	1.0	0.75	0.50
	24 hours.	1.5	1.00	0.75
Carbon Monoxide (mg/M3)	8 hours	5.0	2.00	1.00
	1 hour	10	4.00	2.00

Fig 7:National Ambient Air Quality Standards

The standards specify the maximum limit to which major air pollutants, such as Sulphur dioxide, oxides of nitrogen, suspended particulate matter, etc. are permitted in various zones which could be industrial, residential and sensitive zones. The monitoring of air quality is undertaken under the National Ambient Air Quality Monitoring Program.

1.4 CognitiveIoT

Cognitive IoT is the utilization of cognitive computing advances in blend with information created by associated devices and the activities those devices can perform. What really matters to the Internet of Things and is about sensors and actuators? In concentrating on the cognitive computing perspective, what does it mean for the Internet of Things? Insight obviously implies considering, and keeping in mind that computers are not yet equipped for general human-like thought, they can now play out a portion of the same hidden capacities that people see as considering. Discernment includes three key components: Understanding, Reasoning and Learning. In a computer, system understanding means being able to take in large volumes of both structured and unstructured data and derive meaning from it—that is, establish a model of concepts, entities and relationships. Reasoning means using that model to be able to derive answers or solve related problems without having the answers and solutions specifically programmed. Also, learning means having the capacity to consequently gather new information from information, which is a key segment in comprehension at scale. The IoT is likewise altering the retail business by encouraging better correspondence amongst clients and sellers.Studies show that weather can have a huge impact on a person's shopping habits—it can dictate whether a person goes shopping as well as the products they chose to purchase. If retailers could have a better idea of the weather conditions at each store location, they could better prepare their stock and do so in a more personalized fashion. So, depending on this we can prepare web intelligence reports and crystal reports, so that it is easy for a company to analyze unstructured data without any hard work.

2. Literature Survey

In this paper it has been depicted that "Internet-of-Things" is used as a parasol keyword for making a capsule for various faces related to the widened area of the Internet into the physical domain, by means of the widespread installation of spatially distributed devices with embedded recognition, sensing and/or actuation proficiencies. Internet-of-Things anticipates a future in which digital and physical articles can be linked, by means of apt information and communication technologies, to empower a whole brand-new class of applications [1].

This section presents us with leading features and the driver technologies of IoT. Ubiquitous or pervasive computing, InternetProtocol, technologies opened to sensors, communication technologies, and embedded devices are brought together to make the digital and real world to interact symbiotically. They have picked up the issues which brings objection for IoT [2].This article presented five technologies on IoT that achieved success in deploying in industries and they also mentioned three categories of application for enterprise which they proved to have increased market value and enhance the customer satisfaction which increases value. They have also found out real approaches which can be worth investing in IoT industry [3]. This paper provides an overview of the technology for using intelligent sensors which can bring a revolution in M2M and D2D architectures, concepts, technologies, protocols, and application issues. They have mentioned that due to the improvement in the embedded architecture as in RFID,smart sensors, communicating technologies years. They have also concluded that IoT will be bringing new light in technological world by building intelligent decision making devices which can be introducing machine learning in IoT [4].

They portrayed a smart city which dealt withdatasets collected from devices through interconnecting technologies. The project improved the quality, efficiency of urban life and serving common people and ruling authority by saving power and resource intake. So, they made a concept of brilliant energy management in the high rise buildings which are increasing exponentially to support the population growth aiming to contribute to the smart city application [5].A remote organized LED road lighting framework with unified and remote control innovation has risen as an innovative city application with awesome potential to decrease resource cost and improve security. They have taken a

college campus as their simulation ground [6].

The expanding measure of information needs new strategies and systems for powerful data administration and examination to create data that can help with dealing with the usage of resources cleverly and dynamically. Through this exploration, Hierarchical Smart City engineering is proposed in light of semantic web innovations and Dempster-Shafer uncertainty theory. The proposed engineering is depicted and clarified regarding its usefulness and some real time contextual situations [7]. Attempting to make a city brilliant and computerized is the fundamental point of this paper [8].

Smart Home is the real building hinder for Smart Cities and have for some time been a fantasy for a considerable length of time, specialists in the late 1970s made Home Automation (HA) conceivable when PCs began attacking home spaces. While SH can share the vast majority of the IoT advances, there are one of kind qualities that make Smart Home extraordinary. From the consequence of a current research overview on Smart Home and IoT innovations, this paper characterizes the significant necessities for building Smart Home [9].A framework for Smart Home Automation system with Raspberry Pi utilizing IoT is proposed and it is made by incorporating cameras and movement sensors into a web application. To plan this framework, we are utilizing a Raspberry Pi module with Computer Vision strategies. Utilizing this, we can control home articles associated through a screen based web. Raspberry Pi works and controls movement sensors and video camera for detecting and inspection. For example, it catches invader's personality and distinguishes its nearness utilizing basic Computer Vision Technique (CVT). At whatever point movement is distinguished, the cameras will begin recording and Raspberry Pi gadget cautions the proprietor through a SMS and alert call [10].

Here they presented two innovative smart city IoT applications: the first one refers to heat and energy management, and aims at utilizing different resources (such as heat and electricity meters) in order to optimize use of energy in commercial and residential areas. The second application refers to cruise control for public transportation, and aims at utilizing different resources (such as environmental and traffic sensors) in order to provide driving recommendations that aim at eco efficiency [11].

They have described the wireless sensor network (WSN) which is one of the hugestadvancements in the 21st century. As an open and worldwide standard for WSN, ZigBee indicates advantageous, low power utilization and self-shaping. They have picked up recent researches of ZigBee wireless sensor network to organize a modern robotizing to build a smart agriculture. They have also shown that were it is more advantageous than wired connections and it has been utilized in smart medicinal care. The power consumption is also less in ZigBee technology which is important. [12].Authors [13] have portrayed how this rising innovation can be utilized to manufacture a smart hospital. In reality, utilized as a part of blend with cell phones in eHealth applications, RFID helps streamlining business forms in human services and enhance persistent security.

3. Proposed Work

According to research, India has cities like Delhi which is highly polluted. We investigate the diverse utilizations of smart sensor networks in the area of brilliant power lattice. This work attempts to bring out an innovation beneficial to the environment.

3.1 Trees Improve Our Air Quality

Urban woods help to enhance our air quality. Warm from the earth is caught in the climate because of elevated amounts of carbon dioxide (CO2) and other warmth catching gasses that forbid it from discharging the warmth into space. This makes a marvel referred to today as the "nursery impact." Therefore, trees help by evacuating (sequestering) CO2 from the air amid photosynthesis to produce carbohydrate that are utilized as a part of plant structure/capacity and return oxygen once more into the environment as a result. Generally, 50% of the greenhouse effect is created by CO2. Hence, trees act as carbon sinks, reducing the greenhouse effect.Overall, one section of land of new timberland can sequester around 2.5 tons of carbon every year. Youthful trees retain CO2 at a rate of 13 pounds for each tree every year. Trees achieve their most gainful phase of carbon storage at around 10 years and soon thereafter they are assessed to assimilate 48 pounds of CO2 for every year. At that rate, they discharge enough oxygen back into the climate to support two people. Planting 100 million trees could decrease an expected 18 million tons of carbon for every year and subsequently spare American purchasers $4 billion every year on service bills.

Trees additionally diminish the greenhouse effect by shading houses and office compounds. This lessens the requirement for air conditioning by up to 30 percent which also decreases the measure of non-renewable energy sources consumed to deliver electricity. The mix of CO_2 expulsion from the climate, carbon storage in wood and the cooling impact makes trees to a great degree proficient apparatuses in battling the nursery impact. Planting trees stays a standout amongst the cheapest methods for drawing abundance CO_2 from the air. If each American family planted one tree, the measure of CO_2 in the air would be lessened by one billion pounds every year. This likens to very nearly 5 percent of the sum that human movement pumps into the air every year.It is assessed by the U.S. Forest Service that all sequestered around 309 million tons of carbon every year from 1952 - 1992, balancing roughly 25 percent of human-brought about outflows of carbon amid that period. Over a 50-year life expectancy, a tree creates nearly $32,000 worth of oxygen, giving $62,000 worth of air contamination control. This tree would likewise be in charge of reusing $37,500 worth of water and controlling $31,000 worth of soil disintegration.

Work modules which will quantify the components of air and analyze the levels and predict the number trees to be planted in that area is defined. In this project third usage of Cognitive IoT that is connected appliances. This is a model which is simulated in Qualnet to show how devices can communicate across each other. Figure 8 shows communication with less number of devices and the second figure shows many numbers of devices that can be sensors and actuators. Data will be accumulated from all the devices and one device will mine the data intelligently to infer.

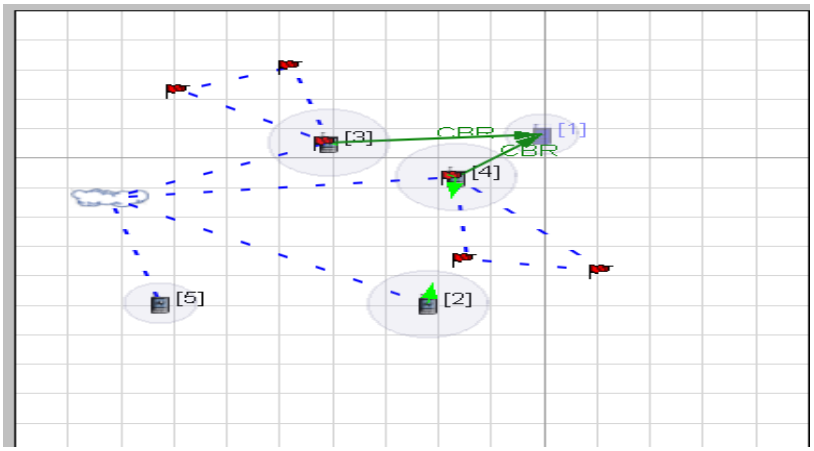


Fig 8:Less number of nodes

Figure 9 shows simulation when there are more number of devices connected then how the data can be transmitted.

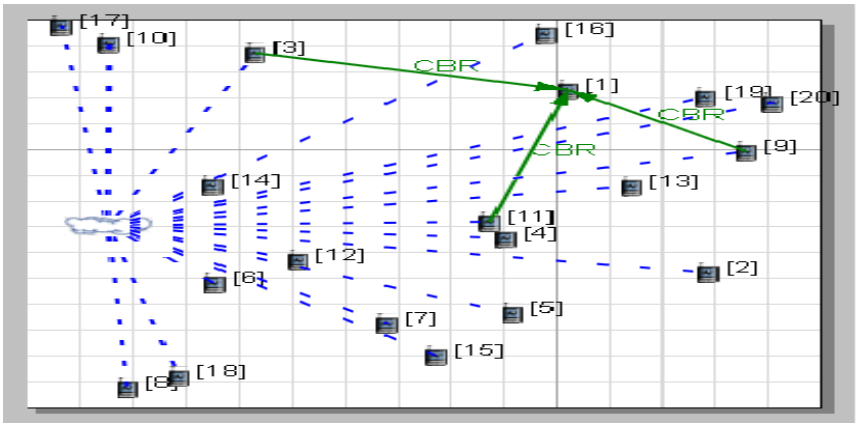


Fig 9: Multiple node scenario simulated in Qualnet

3.2 Methodology:

NodeMcu will be there in every node because it is the Wi-Fi module which will help to code for the client server parts so that data on sensors is directly send to the server. Here, as output Data Repository we have Blynk App storage were we can directly push the data to cloud if we publish our application.

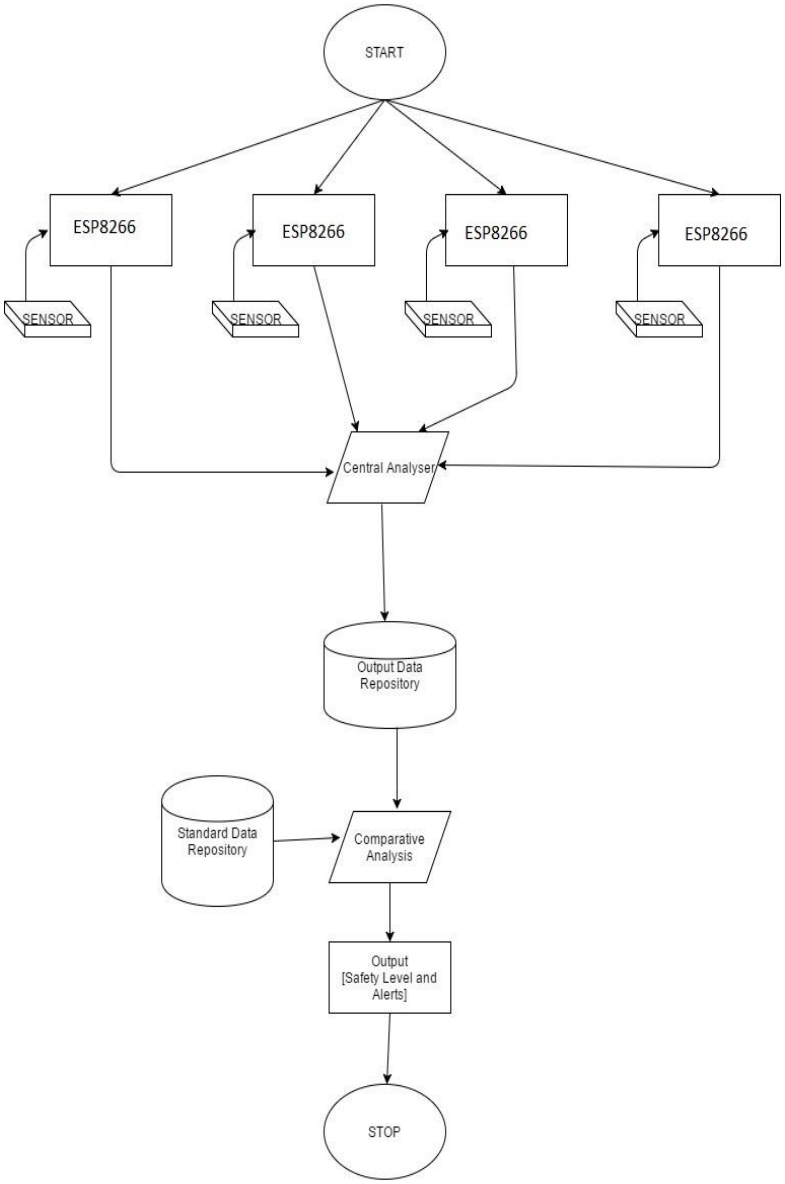
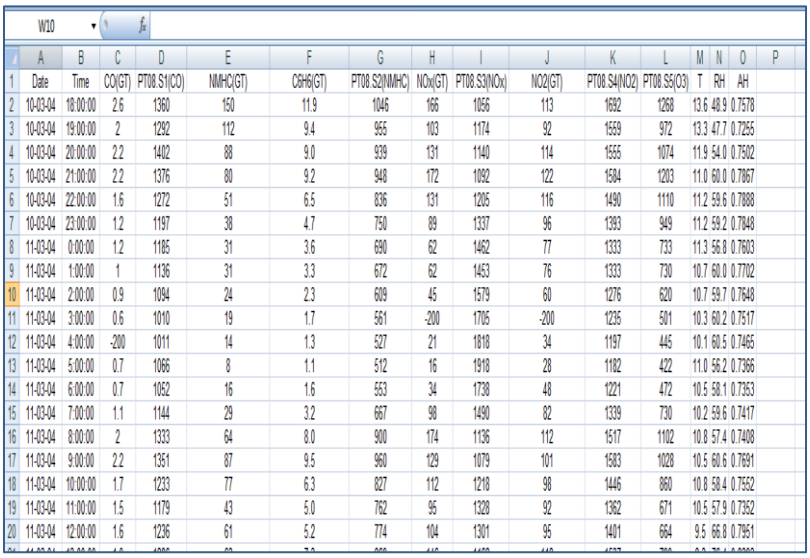


Fig 10:Modulewise flowchart of the project

Comparative analysis comes only when we have our many nodes connected. Here we can use decision making algorithm to predict the value.Depending on the level ppm, humidity and temperature we will be deciding whether we can improve the air quality and the amount of trees to be planted or percentage of greenery to be increased in the area which is proposed as my future work. In this paper I am specifying for some sensors only but we can use CO, NO_2, SO2 etc. sensors all together with Arduino board as it has more input, output pins than Node MCU and the data that will be calculated will be like in the figure 11 below.



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	Date	Time	CO(GT)	PT08.S1(CO)	NMHC(GT)	C6H6(GT)	PT08.S2(NMHC)	NOx(GT)	PT08.S3(NOx)	NO2(GT)	PT08.S4(NO2)	PT08.S5(O3)	T	RH	AH	
2	10-03-04	18:00:00	2.6	1360	150	11.9	1046	166	1056	113	1692	1268	13.6	48.9	0.7578	
3	10-03-04	19:00:00	2	1292	112	9.4	955	103	1174	92	1559	972	13.3	47.7	0.7255	
4	10-03-04	20:00:00	2.2	1402	88	9.0	939	131	1140	114	1555	1074	11.9	54.0	0.7502	
5	10-03-04	21:00:00	2.2	1376	80	9.2	948	172	1092	122	1584	1203	11.0	60.0	0.7867	
6	10-03-04	22:00:00	1.6	1272	51	6.5	836	131	1205	116	1490	1110	11.2	59.6	0.7888	
7	10-03-04	23:00:00	1.2	1197	38	4.7	750	89	1337	96	1393	949	11.2	59.2	0.7848	
8	11-03-04	0:00:00	1.2	1185	31	3.6	690	62	1462	77	1333	733	11.3	56.8	0.7603	
9	11-03-04	1:00:00	1	1136	31	3.3	672	62	1453	76	1333	730	10.7	60.0	0.7702	
10	11-03-04	2:00:00	0.9	1094	24	2.3	609	45	1579	60	1276	620	10.7	59.7	0.7648	
11	11-03-04	3:00:00	0.6	1010	19	1.7	561	-200	1705	-200	1235	501	10.3	60.2	0.7517	
12	11-03-04	4:00:00	-200	1011	14	1.3	527	21	1818	34	1197	445	10.1	60.5	0.7465	
13	11-03-04	5:00:00	0.7	1066	8	1.1	512	16	1918	28	1182	422	11.0	56.2	0.7366	
14	11-03-04	6:00:00	0.7	1052	16	1.6	553	34	1738	48	1221	472	10.5	58.1	0.7353	
15	11-03-04	7:00:00	1.1	1144	29	3.2	667	98	1490	82	1339	730	10.2	59.6	0.7417	
16	11-03-04	8:00:00	2	1333	64	8.0	900	174	1136	112	1517	1102	10.8	57.4	0.7408	
17	11-03-04	9:00:00	2.2	1351	87	9.5	960	129	1079	101	1583	1028	10.5	60.6	0.7691	
18	11-03-04	10:00:00	1.7	1233	77	6.3	827	112	1218	98	1446	860	10.8	58.4	0.7552	
19	11-03-04	11:00:00	1.5	1179	43	5.0	762	95	1328	92	1362	671	10.5	57.9	0.7352	
20	11-03-04	12:00:00	1.6	1236	61	5.2	774	104	1301	95	1401	664	9.5	66.8	0.7951	

Fig 11:If given sensors are different components of air causing air pollution then data to be collected.

As mentioned before to predict the final values which are accumulated from all the nodes we can use the Fuzzy logic for decision making and this logic has to be written in server side code. But different app has to be built for accepting those particular sensor data. But here in our single node architecture we will receive the output we can see in Blynk Application, Android platform for displaying the data.

4. Circuit Diagram

NODEMCU (ESP8266) - NodeMCU is an open source IoT platform which actually has a micro-controller so it can be operated independently and can be programmed from Arduino IDE and here I have used Arduino IDE 1.8.0 It includes firmware which runs on the ESP8266 Wi-Fi SoC. While operating Node MCU we have to give the SSID and password of the Wi-Fi we are using. We are using this board because we can save power as it needs only3.3VFig 12: The circuit in implementation

DHT 11-These sensors are exceptionally essential and moderate, however are incredible for specialists who need to do some fundamental information logging. The DHT sensors consist of a capacitive humidity sensor and a thermistor. There is a simple chip inside that does some analog to digital conversion and separates out a digital signal with the temperature and humidity. Microcontroller can easily read the digital signals.

MQ135- The MQ series of gas sensors utilizes a small heater inside with an electro chemical sensor these sensors are sensitive to a range of gasses are used at room temperature. MQ135 alcohol sensor is a Sno2 with a lower conductivity of clean air. When the target explosive gas exists, then the sensor's conductivity increases more increasing more along with the gas concentration rising levels. By using simple electronic circuits, it converts the charge of conductivity to correspond output signal of gas concentration. The MQ135 gas sensor has high sensitivity in ammonia, sulfide, benzene steam, smoke and in other harm full gas. It is low cost and suitable for different applications. There are different types of alcohol sensors like MQ-2, MQ-3, MQ-4, MQ-5, MQ-6 etc.

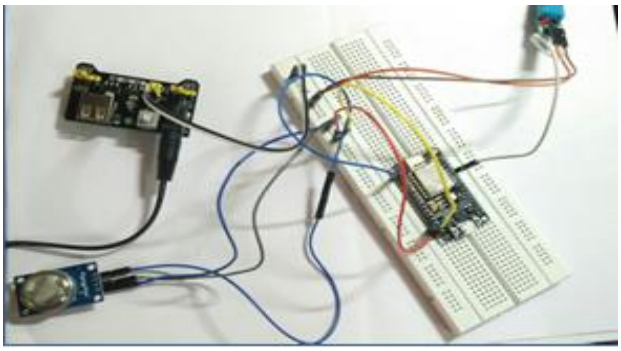


Fig 12: The Circuit Diagram

4.1 Blynk App-A Firmware

Blynk is not only "another IoT cloud". It's a conclusion to-end arrangement which spares you time and assets when building applications for associated devices and services. IoT is a buzz word nowadays. Deployment expenses are high; results are not generally clear. Return for money invested is unknown. Blynk help organizations to construct effective associated products. Our concept or platform empowers organizations to move easily from model to creation in short cycles, gathering feedback, and refining the product or full system at each advancement stage. With Blynk, a designer can get any electronic article on the web, connect it to the Internet, and fabricate a versatile application in minutes to remotely screen and control it.

Project can be published in cloud using this app by creating an account and doing the project there. We have to download the Blynk libraries and use it.The data collected in Blynk Library using the virtual pins to which the respective sensors are connected to as shown in the Figure 13. This also depicts how it collects data according to module.

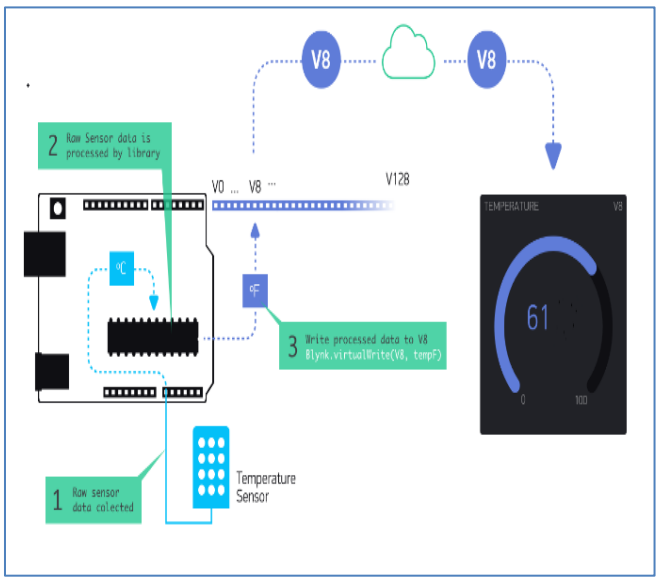


Fig 13:The way data gets collected through virtual pins

The project will also achieve one disadvantage of the IoT concept is that it can secure the data in the

server of Blynk App by creating own servers according to users by a step of authentication through email.So, here steps have been followed for creating a new project and authenticating the data in the server and display all the data collected in the sensor. Further output what we can show is analyze the data through if else condition and predict the amount of trees to be planted or greener zone to be increased. Data collected in different places is depicted in Table 1.

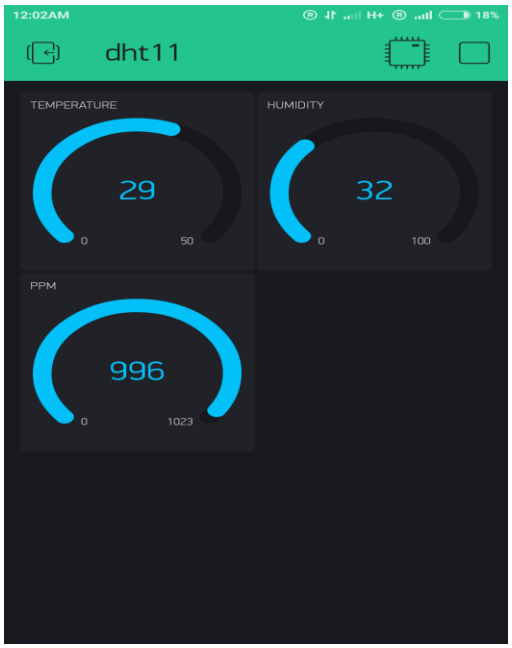


Fig 14: Simulation in Vellore on 28th March, 2017

Table 1: Readings recorded in different places

LOCATION	TEMPERATURE	HUMIDITY	PPM
BEML Layout	26	34	150
Vellore	29	67	996
Kormangala	33	60	100
Kuppam	39	50	170

5. Conclusion

This concept can help the environment and ecosystem to become clean because it will be a help to the mankind and also the new ones who are born which has every right to breathe the pure air. Here in the implementation and results one node is shown but if multiple sensors communicating to one node is required, the circuit can be replicated in every node and client part can be uploaded in it. So, the servers will accumulate various data at a time. In order to predict at that moment, a decision algorithm to help implementing deep learninghas to incorporated at the server end.

6. Future Work

Further, the focus is to get location details of that area and find out the percentage of greenery in that area and how much is needed to decrease the pollution or any other measure that can be taken. In the

Fig 15 presents that the fluorescent line clearly sectors the greenery of that area from the satellite footage.

Fig 15: The image collected from satellite map and florescent area selected as the amount of green zone

Map APIs used by the Android Applications and from there we can analyze the green color in that area and further find out the percentage.

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