AN INTELLIGENT IOT BASED WIRELESS SENSOR NETWORK FOR MONITORING WATER QUALITY BY USING RNN IN REAL-TIME

A Dissertation

Submitted

In Partial Fulfillment of the Requirements for

The Degree of

MASTER OF TECHNOLOGY

In

Computer Science & Engineering

Submitted by:

Sana Afreen

Under the Supervision of:

Dr. Shashank Singh

(Astt. Professor)

Department of Computer Science & Engineering

Faculty of Engineering

INTEGRAL UNIVERSITY, LUCKNOW, INDIA

August, 2020

CERTIFICATE

This is to certify that **Ms. Sana Afreen** (Enroll. No. 1800101654) has carried out the research work presented in the dissertation titled **" An intelligent IoT based wireless sensor network for monitoring water quality by using RNN in Real-Time "** submitted for partial fulfillment for the award of the **Master Of Technology In Computer Science & Engineering** from **Integral University, Lucknow** under my supervision.

It is also certified that:

(i) This dissertation embodies the original work of the candidate and has not been earlier submitted elsewhere for the award of any degree/diploma/certificate.

(ii) The candidate has worked under my supervision for the prescribed period.

(iii) The dissertation fulfills the requirements of the norms and standards prescribed by the University Grants Commission and Integral University, Lucknow, India.

(iv) No published work (figure, data, table etc) has been reproduced in the dissertation without express permission of the copyright owner(s).

Therefore, I deem this work fit and recommend for submission for the award of the aforesaid degree.

Dr. Shashank Singh
Dissertation Guide
(Astt. Professor)
Department of CSE,
Integral University, Lucknow

Dr. Mohammadi Akheela Khanum
H.O.D
Department of CSE ,
Integral University, Lucknow

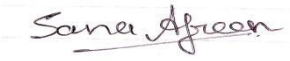
Date: 10-8-2020
Place: Lucknow

DECLARATION

I hereby declare that the dissertation titled **"An intelligent IoT based wireless sensor network for monitoring water quality by using RNN in Real-Time "** is an authentic record of the research work carried out by me under the supervision of Dr. Shashank Singh, Department of Computer Science & Engineering, for the period from August, 2019 to August, 2020 at Integral University, Lucknow. No part of this dissertation has been presented elsewhere for any other degree or diploma earlier.

I declare that I have faithfully acknowledged and referred to the works of other researchers wherever their published works have been cited in the dissertation. I further certify that I have not willfully taken others work, para, text, data, results, tables, figures etc. reported in the journals, books, magazines, reports, dissertations, theses, etc., or available at web-sites without their permission, and have not included those in this M.Tech dissertation citing as my own work.

Date: 10-8-2020



Signature

Sana Afreen

Enroll. No.1800101654

COPYRIGHT TRANSFER CERTIFICATE

Title of the Dissertation:**An intelligent IoT based wireless sensor network for monitoring water quality by using RNN in Real-Time**

Candidate Name: **Sana Afreen**

The undersigned hereby assigns to Integral University all rights under copyright that may exist in and for the above dissertation, authored by the undersigned and submitted to the University for the Award of the M.Tech degree.

The Candidate may reproduce or authorize others to reproduce material extracted verbatim from the dissertation or derivative of the dissertation for personal and/or publication purpose(s) provided that the source and the University's copyright notices are indicated.

SANA AFREEN

ACKNOWLEDGEMENT

I am highly grateful to the Head of Department of Computer Science and Engineering for giving me proper guidance and advice and facility for the successful completion of my dissertation.

It gives me a great pleasure to express my deep sense of gratitude and indebtedness to my guide **Dr. Shashank Singh , Astt. Professor, Department of Computer Science and Engineering,** for his valuable support and encouraging mentality throughout the project. I am highly obliged to him for providing me this opportunity to carry out the ideas and work during my project period and helping me to gain the successful completion of my Project.

I am also highly obliged to **Dr. Mohammadi Akheela Khanum (Associate Professor, Department Of Computer Science and Engineering)** and PG Program Coordinator **Mr. Faiyaz Ahmd, Assistant Professor, Department of Computer Science and Engineering,** for providing me all the facilities in all activities and for his support and valuable encouragement throughout my project.

My special thanks are going to all of the faculties for encouraging me constantly to work hard in this project. I pay my respect and love to my parents and all other family members and friends for their help and encouragement throughout this course of project work.

Date: 10-8-2020
Place: Lucknow

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS AND SYMBOLS

WQM System	Water Quality Monitoring System
CPCB	Central Pollution Control Board
UNESCO	United Nation Educational, Scientific and Cultural Organization
WHO	World Health Organization
WSN	Wireless Sensor Network
IoT	Internet of Things
CC	Cloud Computing
ML	Machine Learning
pH	Potential of Hydrogen
MPN	Most Probable Number
°C	Degree Celsius
IS	Indian Standard
RFID	Radio Frequency Identification
WiFi	Wireless Fidelity
LAN	Local Area Network
WAN	Wide Area Network
PAN	Personal Area Network
LTE	Long Term Evolution
NFC	Near Field Communication
OSI	Open System Interconnection
IaaS	Infrastructure-as-a-Service
PaaS	Platform-as-a-Service
SaaS	Software-as-a-Service
IT	Information Technology
QoS	Quality of Service
DoS	Denial of Service
DDoS	Distributed Denial of Service
UDP	User Datagram Protocol

ICMP	Internet Control Message Protocol
SYN	Synchronize
ACK	Acknowledgement
SCADA	Supervisory Control and Data Acquisition
LSTM	Long Short Term Memory

ABSTRACT

Water uses is increasing day by day. As development continues, the demand for water is increasing. Water is require for daily routine, for irrigation, for fish and wildlife and for industrial use, not only water but pure water is require. As industrial development is increasing and global warming is increasing, water purity is decreasing. The purity and the quality of water is depleting day by day due to dumping different types of wastage such as human waste, industrial waste and other polluted contamination in rivers, ponds, reservoirs and other water bodies.

In this paper a water quality monitoring system has been proposed which monitors the water quality in real-time. This is a helpful approach to make people or authorities aware and alert about water quality in real-time situation. In this paper, with the help of proposed technology the condition of water can be measured in real-time and appropriate action can be taken by the people or authority, if there is contamination in water.

In this paper, the proposed technology helps to monitor the water quality in real time situation or environment. The technology such as Internet of Things, Wireless Sensor Network and Cloud Computing are used in this approach for water quality parameters (pH, minerals and Temperature) measuring in real-time environment. For water quality prediction and analysis, a training data set has been prepared and these training data sets use for categorize utility of water in different field. The sensor sensed the water parameters and send these sensed data to the cloud for processing. These data compared with training data set. In this paper monitor data classify by using Naive Bayes and the utility of water can be predicted by the use of Recurrent Neural Network. The resultant of this proposed approach are : it gives high accuracy and the response time of this approach is very less comparatively.

CHAPTER: 1

INTRODUCTION

1.1 BACKGROUND :

Water is the main source of life. The good quality water in not only needed for drinking but also in various other activities like agriculture, industry and many more. Now the question is arise, the water we use for daily life activities like drinking, cleaning, agriculture and many other purpose is really usable? According to UNESCO and WHO most of diseases are caused due to the usage of impure and polluted water. For reducing these problem we need a 'Water Quality Monitoring System' [1]. Nowadays quality of water depleting day by day. By the using impure and polluted water many kind of problems are arising like health problems, land problem, loss of lives of many humans,plants, animals and birds etc. In order to reduce these kinds of problem we must have a centralized system that works in the area where the water quality is continuously degrading.

Around 71% of Earth's surface is occupied by water. However, approximately 3% of water is freshwater and 97% water is saline water. Most of 3% of water is in form of glaciers and ground-water and almost its 0.3% fresh water is in lakes,rivers and ponds.

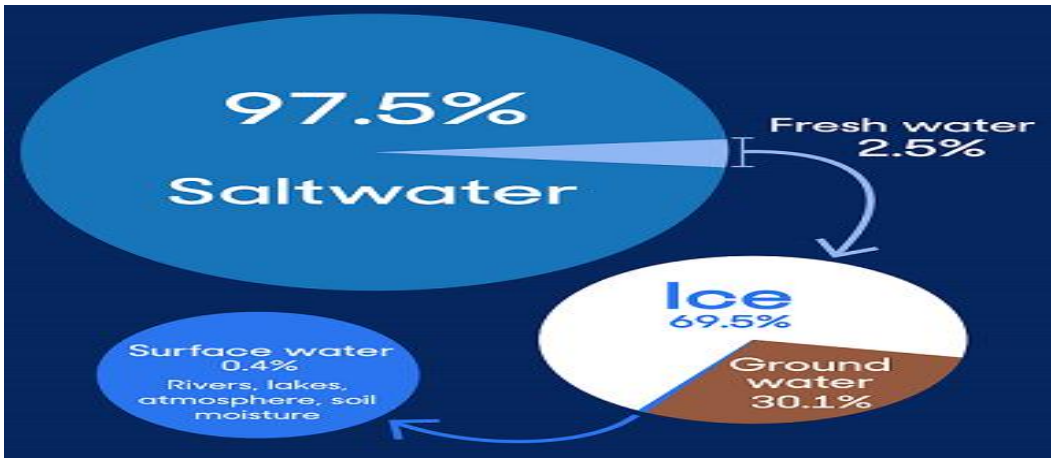


Figure 1.1 : Water on Earth

It has become mandatory to check the water quality nowadays. The surface water like rivers ,lakes, ponds can be easily contaminated by throwing human waste, industrial waste and waste pollution. Drinking such polluted water is the reason of illness and death of animals, it impact on humans health and causes to the diseases and deaths of humans, it can also impact the growth of vegetation where the water are polluted. Traditional methods of water quality involve the manual collection of water sample at different locations, followed by laboratory analytical techniques in order the character the water quality according [2] and [3].

Water quality has to be monitored regularly in real-time environment. Internet of Things (IoT) [5], Wireless Sensor Network (WSN) [7] and Cloud Computing (CC) are the easiest and cheapest way for water quality measuring in real time [4]. Cheap and inexpensive 'multi sensor system for water quality monitoring'[9] can be installed in particular area such as rivers, lakes, homes, ponds and next to industry. It can continuously monitor the water quality and keep sending data to a centralized system or cloud that would alert the people and authority to take action if problem arise. Intelligent IoT [31], and WSN makes an intelligent and smart monitoring system that are capable of monitoring water quality in real-time environment and make alert to the people or authority by sending the message like 'water is usable' or 'water is not usable' or storing data on cloud after monitoring the quality parameter of water. Water quality becomes one of the important quality factors for life [8]. By using IoT and WSN technologies, we can create a cheap and effective way to monitor water quality and other environmental conditions.

1.2 WATER QUALITY STANDARD FOR DIFFERENT USES :

For any source of water, to use it and function it optimally in satisfying criteria of use, it should have degree of purity. The purity of drinking water must be highest priority. Just as demand for water supply is high, water quality is also an important aspect. The water quality nowadays becoming an important concept.

A standard should be set for quality of water from any water body and it is required to identify the uses of water in that water body. Indian **Central Pollution Control Board** (CPCB) [4] and [13], has developed a concept of **designated best use** [35]. It is categorize in five class(Class A, B, C, D and E). These designated best uses have been identified in following table.

1.2.1 Designated Best Uses of Water (Classification and Standard) :

1.2.1.1 Classification

Table 1.1 : Classification of Water by CPCB

Classification	Type of use
Class A	The source of drinking water without conventional treatment but after disinfection
Class B	Outdoor bathing
Class C	Drinking water source with conventional treatment followed by disinfection.
Class D	Propagation of Fisheries and wildlife
Class E	Irrigation, industrial use and controlled waste disposal

1.2.1.2 Standard

Table 1.2 : Standards of water quality parameter by CPCB

Class	Standard
A	1. Total Coliforms Organism MPN/100ml will be 50 or less 2. The pH should be lies between 6.5 to 8.5 3. The Dissolved Oxygen should be 6mg/l or more 4. Biochemical-Oxygen Demand 5 days 20 °C and 2mg/l or less
B	1. Total Coliforms Organism MPN/100ml will be 500 or less 5. The pH should be lies between 6.5 to 8.5 2. The Dissolved Oxygen should be 5mg/l or more 3. Biochemical-Oxygen Demand 5 days 20 °C and 3mg/l or less
C	1. Total Coliforms Organism MPN/100ml will be 5000 or less 2. The pH should be lies between 6 and 9 3. The Dissolved Oxygen should be 4mg/l or more 4. Biochemical-Oxygen Demand 5 days 20 °C and 3mg/l or less
D	1. The pH should be lies between 6.5 and 8.5 2. The Dissolved Oxygen should be 4mg/l or more 3. Free Ammonia 4. Biochemical-Oxygen Demand 5 days 20 °C and 2mg/l or less
E	1. pH between 6.0 and 8.5 2. Electrical Conductivity at 25 °C micro mhos/cm, maximum 2250 3. Sodium absorption Ratio Max. 26 4. Boron Max. 2mg/l

1.2.2 Water Quality Standards in India (Source IS 2296:1992) :

Indian CPCB has identified basic water quality criteria in terms of some chemical characteristics. BIS (Bureau of Indian Standards) has also recommended quality parameters of water for different uses is shown in following tables.

Table 1.3 : Water Quality Standards in India (Source IS 2296:1992) [35]

Characteristics	Designated best use				
	A	B	C	D	E
Dissolved-Oxygen (DO) mg/l, min	6	5	4	4	-
Biochemical Oxygen demand (BOD)mg/l, max	2	3	3	-	-
Total coliform organisms MPN/100ml, max	50	500	5,000	-	-
pH value	6.5-8.5	6.5-8.5	6.0-9.0	6.5-8.5	6.0-8.5
Colour, Hazen units, max.	10	300	300	-	-
Odour	Un-objectionable			-	-
Taste	Tasteless	-	-	-	-
Total dissolved solids, mg/l, max.	500	-	1,500	-	2,100
Total hardness ($CaCO_3$), mg/l, max.	200	-	-	-	-
Calcium hardness ($CaCO_3$), mg/l, max.	200	-	-	-	-
Magnesium hardness ($CaCO_3$), mg/l, max.	200	-	-	-	-
Copper (Cu), mg/l, max.	1.5	-	1.5	-	-
Iron (Fe), mg/l, max.	0.3	-	0.5	-	-
Manganese (Mn), mg/l, max.	0.5	-	-	-	-
Cholorides (Cu), mg/l, max.	250	-	600	-	600
Sulphates (SO_4), mg/l, max.	400	-	400	-	1,000
Nitrates (NO_3), mg/l, max.	20	-	50	-	-
Fluorides(F), mg/l, max.	1.5	1.5	1.5	-	-
Phenolic compounds (C_2H_5OH), mg/l, max.	0.002	0.005	0.005	-	-
Mercury (Hg), mg/l, max.	0.001	-	-	-	-
Cadmium (Cd), mg/l, max.	0.01	-	0.01	-	-

Salenium (Se), mg/l, max.	0.01	-	0.05	-	-
Arsenic (As), mg/l, max.	0.05	0.2	0.2	-	-
Cyanide (Pb), mg/l, max.	0.05	0.05	0.05	-	-
Lead (Pb), mg/l, max.	0.1	-	0.1	-	-
Zinc (Zn), mg/l, max.	15	-	15	-	-
Chromium (Cr^{6+}), mg/l, max.	0.05	-	0.05	-	-
Anionic detergents (MBAS), mg/l, max.	0.2	1	1	-	-
Barium (Ba), mg/l, max.	1	-	-	-	-
Free Ammonia (N), mg/l, max	-	-	-	1.2	-
Electrical conductivity, micromhos/cm, max	-	-	-	-	2,250
Sodium absorption ratio, max	-	-	-	-	26
Boron, mg/l, max	-	-	-	-	2

1.3 DISTRIBUTION OF WATER ON EARTH :

It is known, that 71% Earth's surface is occupied by water and almost 97% of the water is saline is distributed as seas and oceans. These water are salty, harmful and not appropriate for direct use like drinking, house-work, industrial-work and irrigational purposes. Only 3% of the earth's water is the fresh water, however almost 66.7% of it's water is in the form of ice and glaciers and about 30.1% is exist as groundwater [36] and 0.3% water is in the lakes rivers and ponds. The rest 0.9% are available as water vapour and other forms.

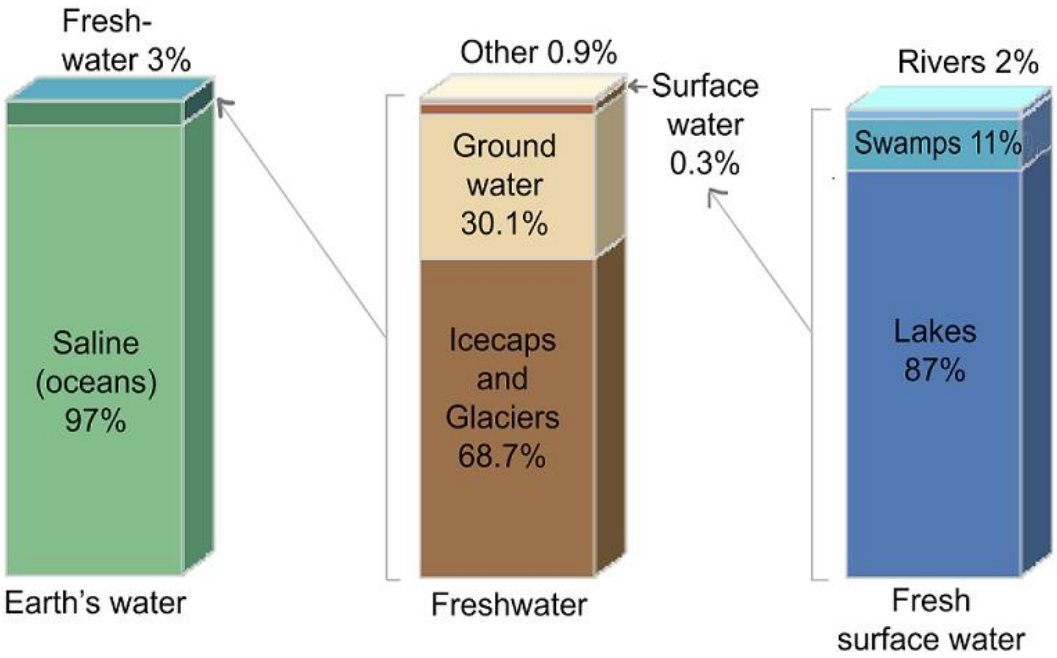


Figure 1.2 : Distribution of Water on Earth

1.4 IMPURITIES IN WATER :

Water is liquid in its natural form, so it cannot be completely pure. No matter how clean water is or isolated from source of contamination, it contaminate some chemical impurities [34].

There are basically two type of impurities in water, one is soluble and other is insoluble. The soluble impurities like salt, chemicals, bio-organisms and insoluble impurities like sand, soil, rocks or solid substances. Soluble impurities are hard to find without any testing process but insoluble impurities can be view easily because its change the colour and taste of water.

Groundwater dissolves much minerals, salt and other material, this is why it is harder than surface water, the groundwater also contain irons and manganese [34]. The

impurities are less in groundwater than surface water. The minerals and impurities are presents in water in very small amount, that's why it is measured in ppm or mg/l and some contaminants can also be measured in ppb or μg/l.

Impurities of water is classified as--

1.4.1 PHYSICAL IMPURITIES :

1.4.1.1 Turbidity

The turbidity in water know as insoluble matter in water like mud, sediment, sand, clay, silt etc. Insoluble matter and salts in water may be injurious to health and causes to the death.

1.4.1.2 Color

Water has colourless characteristic, water gets colour from impurities that is discharge from industries like chemical, textiles etc. An example: yellow color water indicates the existence of chromium and large amount of organic matter.

1.4.1.3 Taste

Water is tasteless, it is a characteristic of water. Due to dissolved minerals, water produces taste but not odor. Due to presence of manganese, sulphate, aluminum or excess amount of lime in water it is taste as bitter, the presence of huge amount of sodium bi carbonate in water it is taste as soap.

1.4.1.4 Odor

Industries discharge waste products that contaminate in water and it change the odor and taste, the smelling compounds are generally chlorine, hydrogen, sulphide etc.

1.4.1.5 Temperature

One of the important factor factor of water quality is temperature. The highest dense water at 4 °C and lowest density at either higher or in vapour [36]. Water temperature between 13 °C to 50 °C is suitable for daily purpose use. The boiling temperature of water is 100 °C.

1.4.2 CHEMICAL IMPURITIES :

1.4.2.1 Acids

The industries like battery factories, explosive factories are discharge waste product directly into water that is so harmful to life and destroy self purification of water. This kind of impurities also effect the marine life.

1.4.2.2 Organic Compound

Organic compound like fruits, vegetable, dead animals and dead humans are contaminate in water directly and it contain harmful elements which are dangerous for life. The water may contains organic compounds due to fat, protein and carbohydrate.

1.4.2.3 In-Organic Compound

The industries like fertilization industry, oven industries produce waste products that contain inorganic compound, these compounds mainly consist sulphide, ammonia etc which are harmful to health. .

1.4.2.4 pH

pH indicates that number of hydrogen ions in water and determine the value that substance is acid, base or neutral. pH stands for ‘Potential of Hydrogen’. The pH value

lies between 0 to 14, on which 7 means substance is neutral, if pH value is above than 7 that means substance is basic solution and if pH value is below than 7 that indicate substance is acidic solution [6] and [11]. The permissible range of pH value recommended by several health and pollution control organizations e.g. WHO, CPCB, BIS i.e. 6.5-8.5 [14].

1.4.3 BIOLOGICAL IMPURITIES :

Biological impurities of water impurity is causes by the living organisms such as bacteria, algae, pathogens, protozoa, Viruses, microbes, Parasites and their eggs etc [34]. These living organisms are collectively called microorganisms or germs. Dead bodies and unhygienic discharge of sewage though into the river, ponds or into the other water bodies without any treatment are the cause of pathogenic bacteria , fungus, viruses etc. This is the reason of water born disease. Drinking such contaminated water is effects on livings health. Cholera, thyroid fever, dysentery, diarrhea etc. are the disease due to taking of biological contaminated water.

1.5 TECHNOLOGY USED IN WATER QUALITY MONITORING APPROACH :

1.5.1 Internet of Thing (IoT) :

The IOT concept was introduce by a member of the Radio Frequency Identification development (RFID) community in 1999 [18]. Due growth of mobile devices, embedded and ubiquitous communication, cloud computing and date analysis IoT has becomes very popular in practical world.

The IoT stand for Internet of Things basically use for collecting and sensing the data from the physical and environmental conditions to across the world and share these data to across the internet where it can be utilize and processed for different purpose. In short IoT is a platform where many enclosed devices are connect to each other via internet for sharing data and information. There is various kinds of IoT applications like wearable technologies, smart phones, personal computers, home applications, environmental monitoring systems, health centric devices etc are very beneficial for humans life. IoT applications help users to acquire high automation, analysis and integration within a system.

IoT is a platform which provides the physical devices present in the network embedded with electronics, software, sensors, actuators, and connectivity to connect and exchange information to address specific needs [12]. The internet is not only use as network of computers systems but it can be use for other devices which available in each type and sizes like smart phones, home appliances, vehicles, medical instruments, cameras and industrial systems, buildings, all connected & sharing information based on specified protocols in order to achieve smart reorganizations, positioning, tracing, safety & control real time monitoring , online upgrade, process control & administration etc.

Water is an important resource for life and its existence [17]. For water quality monitoring system, IoT is becomes an cheapest object that include sensors, nodes, WiFi, Bluetooth, battery and memory. Sensors sense the water parameter like pH, temperature and mineral, the collected data transmitted from source node to destination node by internet, it can also stores data.

1.5.1.1 IoT Characteristics :

The fundamental characteristics of the IoT [23] -

- **Connectivity :**

Connectivity increase network compatibility and accessibility. Compatibility provides the ability to produce and consume data and accessibility allows reach on network .

- **Services :**

The IoT have capability to provide thing-related services like privacy protection, security, consistency, efficiency and authorization between physical things (devices) and virtual things (application or software).

- **Scalability :**

The Scalability can be increased by managing devices which are communicates to each other or connected withe each other via internet. The data generated capability can be increased and managed for specific purpose via IoT devices on cloud. It is also increase efficient data handling process.

- **Security :**

IoT provides us a lot of facilities, but do not forget about its security. The security of data and device both are important. A security paradigm needed that will secure the network, data, and communication travels from one point to another point via internet.

- **Inter-connectivity :**

In terms of IoT, physical objects can be interconnected globally and share global data and communication infrastructure.

1.5.1.2 IoT Architecture :

There are no such exact architecture of an IoT but a Layered Architecture defines basic architecture of IoT [18] and [23] -

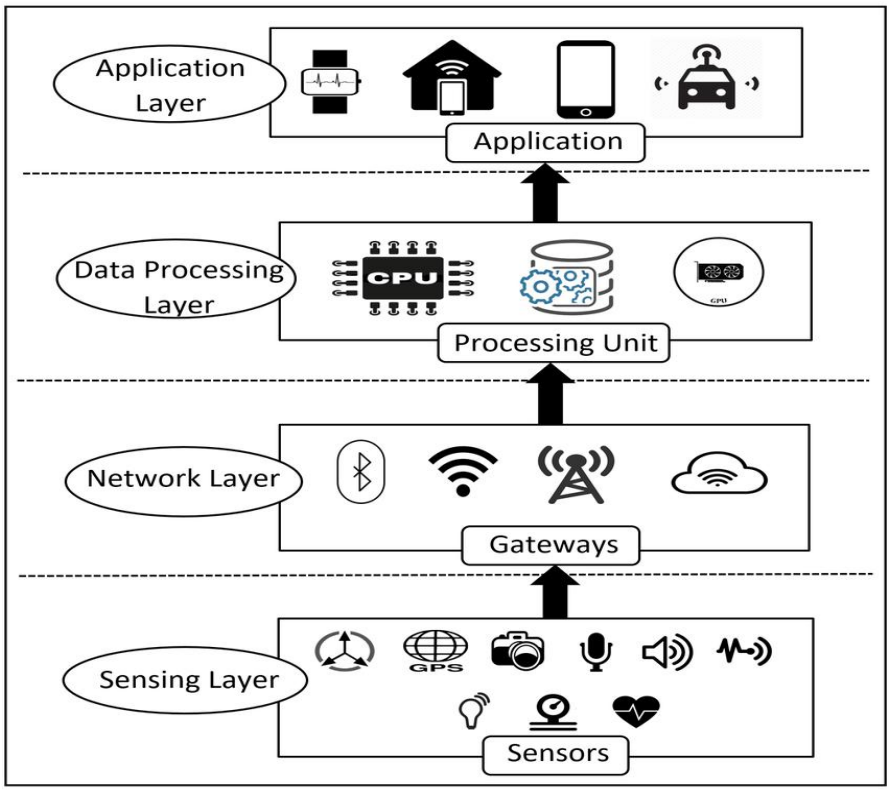


Figure 1.3 : Architecture of IoT

- **Sensor Layer :**

The last layer of IoT architecture is sensor layer. This layer integrated with multiple sensors and sensors provide interconnection of the physical device and virtual world that collect and process real-time data. Different sensors are used for different purpose like sensor can measure temperature, water quality, air quality, pressure, speed,

movement, noise, pollution etc. Some sensor can also store measurements for comparison or process or observant of data. A sensor can measure the physical situation or environmental condition and convert it into signal that can be processed by devices, sensors are grouped according to their specific purpose such as home appliance sensors, environmental sensors, body sensors and vehicle sensors, etc.

- **Network Layer and Gateways :**

The second last layer is network layer or gateway layer. Large amount of data can produce by the sensors that needed a efficient and secure transport medium for transmitting one point to another point via wired or wireless network. Wireless network like internet is the cheapest way to traveling from one point to another point. The network tied with different protocols, the protocols have been used to support network and applications to transmitting safe and secure data. The network can be private, public, community or hybrid.

Their are various type of gateways available like microprocessor, micro-controller etc. The sensor need connectivity to the sensor gateways can be LAN (Local Area Network) such as WiFi and Ethernet or WAN (Wide Area Network) such as GSM, GPRS and LTE or PAN (Personal Area Network) such as ZigBee and Bluetooth. The sensor that require low-power and low-data rate connectivity known as WSN (Wireless Sensor Network). WSN is more popular than Wired Sensor network because WSN have more sensor nodes and consuming low-power and it is also cheaper than Wired Sensor Network.

- **Management and processing Layer :**

Management and Processing layer provide services like analysis, security control, processing models and management of device and data both. The sensor collect data from physical situation which is processed in this layer that data is relevant or not whether it can be send or store etc.

- **Application Layer :**

This is the toppest layer of IoT and it is also an user interface layer. The IoT project such as Smart Transportation, Smart Building, Smart City, Smart Lifestyle, Smart Retail, Smart Agriculture, Smart Factory, Smart Supply chain, Emergency, Smart Health-care System, Smart User interaction, Smart Culture and tourism, Smart Environment Monitoring System and Smart Energy producing System.

1.5.1.3 IoT Technology and Protocol :

The IoT technologies and protocols are -

- **Radio-frequency identification (RFID) and Near-field communication (NFC) :**

RFID and NFC provide simple, low-energy, and versatile options for access token, connection bootstrapping, identity and payments.

- RFID technology engage two-way radio transmitter and receivers to identify and track label associated with objects.
- NFC includes communication protocols for electronic devices and other physical objects, typically a mobile device.

- **Low-Energy Bluetooth**

It supports the low-power consumption and needed long-use of IoT function.

- **Low-Energy Wireless**

Low-energy wireless reduces consumption of battery and also exceeds the life of the device by less use. This technology replace power consuming source of an IoT system and make it low power consuming device.

- **Radio Protocols :**

Radio protocols are Z-Wave, ZigBee and Thread that use for creating low-rate PAN. These technologies are consuming low-power and gives high throughput.

- **LTE-A**

LTE-A is also known as LTE Advanced. LTE-A delivers an essential upgrade to LTE by increasing its coverage area,reducing its latency and increasing its throughput. It provide IoT an enormous power by expanding its range.

- **WiFi-Direct**

WiFi-Direct eliminates the requirement for an access point. WiFi-Direct allows speed of WiFi with peer-to-peer (P2P) connections but with lower latency. WiFi-Direct does not allow any kind of sacrifice on speed and throughput.

1.5.1.4 Advantage and Disadvantage of IoT :

- **Advantages :**

➢ **Improved Customer Engagement**

IoT need to achieve higher and much effective engagement with audiences, that attract audience towards the IoT technologies.

- **Technology Optimization**

IoT opens a world of sensitive functional of device and field data, this technologies enhance the customer experience and also improves the use of device and it helps to improvement of technologies.

- **Reduced Waste**

IoT provides real-world information, that leading to more efficient management of resources and reduce the waste.

- **Enhanced Data Collection**

IoT enhanced the storage capacity of device but somehow it is limited. IoT needed a technology that enhance the storage capacity for collecting an accurate picture of everything, that can be analyse and processed .

- **Disadvantages :**

- **Security**

A constantly connected devices communicating over networks may not secure and this leads a various kind of attack.

- **Privacy**

Privacy is an important factor of IoT but some time it is compromised in constantly connected device over network.

- **Complexity**

IoT systems are complicated. In terms of deployment, design and maintenance, IoT systems are very complex but it is easy to use.

- **Compliance**

The IoT should comply with regulations like most of technologies. Some time the complexity of IoT devices makes issues of compliance.

1.5.1.5 IoT Applications :

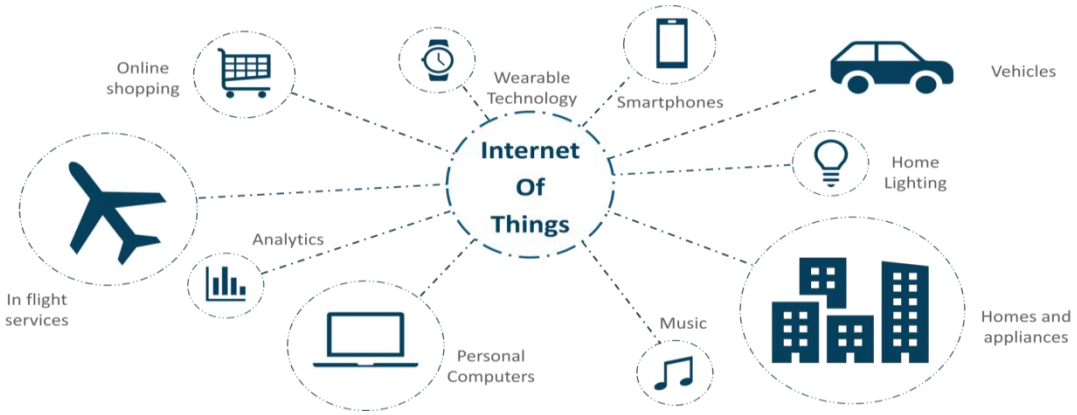


Figure 1.4 : Applications of IoT

- Environmental Monitoring
- Manufacturing Applications
- Energy Applications
- Water quality Applications
- Building/Housing Applications
- Educational and Health Care Applications etc.

1.5.2 Wireless Sensor Network :

WSN is type of wireless distributed networks that consisting with distributed autonomous devices. These sensors are basically use to monitoring the physical and environmental condition. These automation devices or nodes combine with routers or Wi-Fi and the gateway to create a WSN system. For collecting natural data such as quality of water, temperature, pressure, noise etc we use sensors and transmitted to the server for processing and utilization of these data. The applications like environmental applications, military applications, home applications, health applications etc are basic application of WSN.

Nowadays WSN is the most popular technology used in house, industrial and commercial, shipboard, building applications [25]. The WSN used because of its technical capability in processor, communication and it uses low-power embedded computing system, low-cos implementation and reliability [10] and [42]. For monitoring environmental and physical conditions, it uses sensor nodes such as sound sensor, temperature sensor, pressure sensor, humidity sensor, vibration sensor etc. In many real-time applications such as water quality monitoring system, surveillance system etc. The sensor node are use for different tasks such as neighbor node discovery, data storage and processing, smart sensing, data aggregation, node localization, control and monitoring the nodes, synchronization and efficient routing between nodes and base station.

WSN helps to transmit sensed data to its destination. In case of our approach that is the monitoring of water quality, the data transmit through wireless network that ensure the

security and integrity of data. Wireless network sends data to the centralize system or cloud server.

1.5.2.1 The components of WSN system :

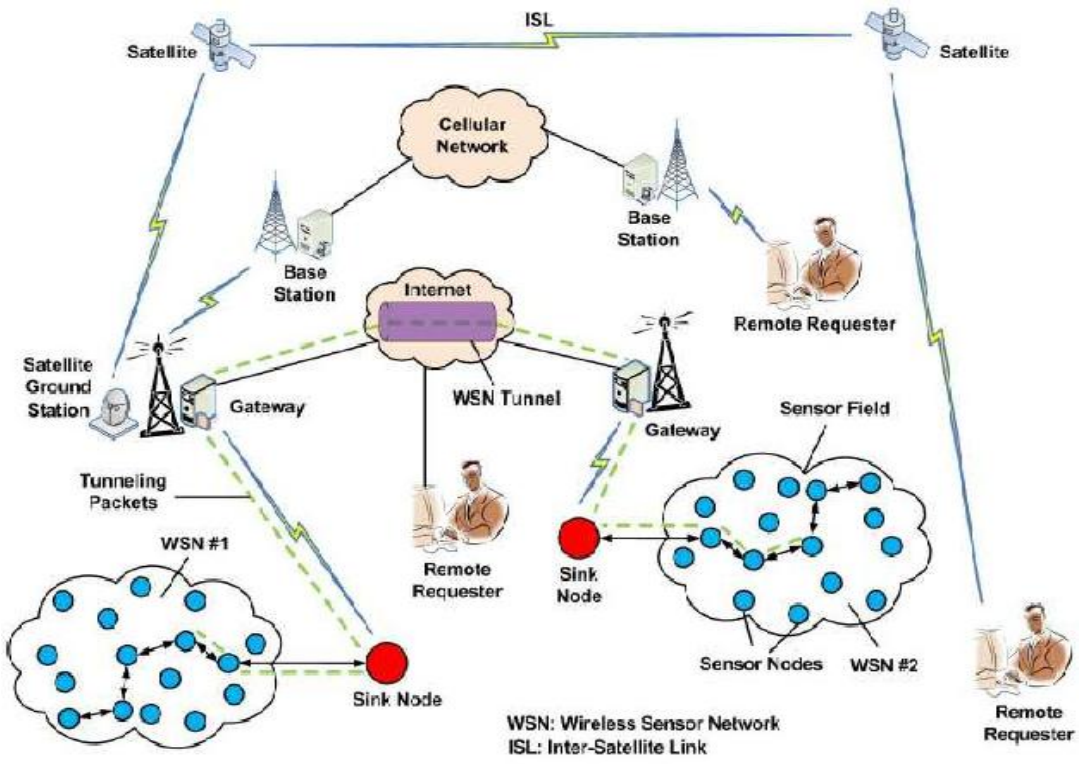


Figure 1.5 : Component of WSN

- **Sensor node ;**

A sensor node capable of communicating with other associated nodes, executing data processing and data collecting in the network through internet.

- **Relay node :**

Relay node is use to communicate with adjacent node. Relay node is also known as midway node. Relay node does not interface with process itself and it enhance the reliability of network.

- **Actor node** :

Actor node is an end node and it is used to process and make a decision which is depending upon the requirement of applications. These nodes are full with resource which have high quality processing abilities, greater transmission rate and greater battery life.

- **Cluster head :**

A cluster head is a high bandwidth sensing node, which used to perform data fusion and data aggregation functions in Wireless Sensor Network. Inside the cluster, it will be contains more than one cluster head which is based on the requirement of the system and system applications.

- **Gateway :**

The interface between sensor nodes and outside networks is known as gateway. Their are various type of gateways available like microprocessor, micro-controller etc. The sensor need connectivity to the sensor gateways can be LAN (Local Area Network) such as WiFi and Ethernet or WAN (Wide Area Network) such as GSM, GPRS and LTE or PAN (Personal Area Network) such as ZigBee and Bluetooth. The sensor that require low-power and low-data rate connectivity known as WSN (Wireless Sensor Network). WSN is more popular than Wired Sensor network because WSN have more sensor nodes and consuming low-power and it is also cheaper than Wired Sensor Network.

- **Base station** :

Base station is an extraordinary node with high computational power and processing capability.

1.5.2.2 WSN Characteristics :

The major characteristics of the sensor node used to evaluate the performance of Wireless Sensor Network.

- **Fault Tolerance :**

The fault tolerance, maintains the sensor network functionalities without any break in case of sensor node failures, fault tolerance is required.

- **Dynamic Network Topology :**

To travel from one sensor node to another senor node or network the network follows some standard topology. The WSN should have the ability to process in dynamic topology.

- **Communication Failures :**

If the node in the WSN stops or fails to transmit data to other nodes, it should be informed the base station or gateway node without delay.

- **Mobility of Nodes :**

To enhance the communication efficiency, the nodes can travel from one point to other point within the sensor field.

- **Security :**

In general, a secure WSN shall satisfy the following security concerns- Confidentiality, Authentication, integrity, availability [26].

- **Scalability :**

The amount of sensor nodes, may be hundreds of nodes, in a sensor network according to the physical situation. Wireless Senor Network designed is suppose to be highly scalable and robust.

1.5.2.3 WSN Architecture and Protocol :

Wireless Sensor Networks follows most common architecture of OSI model [19]. Mainly, there are five layers in sensor network, these are physical layer, data link layer, network layer, transport layer and application layer. There are also three cross layers namely power management plane, connection management plane, task management plane.

- **Physical Layer :**

The last layer of WSN architecture is physical layer, it provide an interface to transfer data over physical medium. it is responsible for generating channel frequencies, frequency selection, signals modulation, signal detection and data encryption [42].

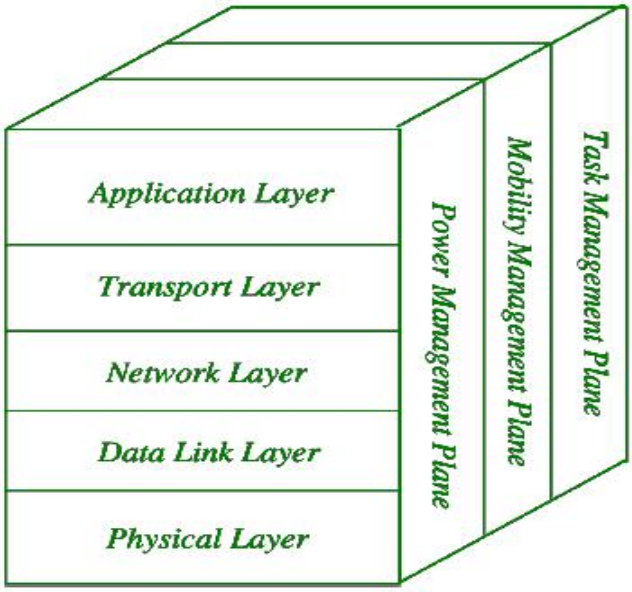


Figure 1.6 : Architecture of WSN

- **Data Link Layer :**

The second last layer of WSN architecture is data link layer and it is accountable to maintain the error detection and error correction mechanisms. DLL is also responsible for multiplexing of data frame detection, data streams, error control and medium access.

- **Network Layer :**

Network layer is the middle layer and main focus of network layer is routing. The routing protocols is ensure the reliability and redundancy of a route or path by which data is travels from one sensor node to other sensor node. There are various type of protocols available like PEAS, GAF, SPAN, MTE (Minimum Transmission Energy) CLD(Controlled Layer Protocol), LEACH (The Low-Energy Adaptive Clustering Hierarchy)[30].

- **Transport Layer :**

Transport layer is second higher layer, it provides intrusion and congestion avoidance and reliability. This layer is needed when a sensor data need to be sent between sensor nodes or network. It takes data from above layer and split it into stream or bytes and transfer to the NL and it also ensure the transmission of complete data. There are lot of protocols used in this layer like TCP, UDP,SCTP,SPX [19].

- **Application Layer :**

The upper layer is Application Layer. This is basically user interface layer and it provide services like traffic management and provide software for different applications, and convert stream or bit data into understandable form. This layer uses various protocols such as FTP, SMTP, TELNET, DNS, NTP, NFS [19]. Sensor networks utilized in different applications such as; medical, military, house, environment, agriculture fields etc.

- **The three cross layers are -**

The WSN paradigm leads to *cross-layer* solutions that tightly integrate the layered protocol stack [42].

- **Power management plane :**

It is first cross layer, it manages the level of power of the sensor nodes for sensing, processing and communication.

- **Connection management plane :**

It is second cross layer, used for configuration of sensor nodes, that in which order sensor nodes are establish and maintain network connectivity.

- **Task management plane :**

It is third cross layer, which is responsible for distribution of tasks between sensor nodes to increase network lifetime and improve energy efficiency.

1.5.2.4 WSN Limitation and Challenges :

- Very limited resources :
  - It has limited memory.
  - It has limited computation capability.
  - It has limited power.
- Security is also a big challenge because of it transmission nature and malicious environment and to prevent an authenticated application from being hacked or authenticate an application's access to the control plane [39].
- Maintenance of sensor network is very difficult and it has fewer infrastructure.
- Unreliable communication, unreliable data transfer, conflicts and latency.
- It is big challenge of Sensor networks to fit into any regular topology, because during deployment of the sensor nodes they get scattered[40].
- The hardware design of sensor node like unattended operations, exposure to physical attack, remotely managed, no central control point should be considered.

- Sensor node depends only on battery.
- Some challenging issue in sensor networks are addition of node, deletion of node, failure of node, changes in topology.

1.5.2.5 WSN Applications :

- Vehicle Parking
- Military applications
  - ✓ Surveillance of friendly forces
  - ✓ Battlefield monitoring
  - ✓ Targeting

Figure 1.7 : Applications of WSN

- Environmental applications

- ✓ Forest Fire Detection
- ✓ Definitude Agriculture

- Health Applications
  - ✓ Monitoring and tracking patient and doctors inside hospitals
  - ✓ Drug management in hospitals

- Biological Applications
  - ✓ Biological Task Mapping
  - ✓ Green House Surveillance

1.5.3 Cloud Computing (CC) :

CC is a computing model that provide services via internet. Cloud Computing is development of grid computing, parallel computing and distributed computing and it is the combination and evolution of Virtualization and Utility computing. As per the definition provided by the National Institute for Standards and Technology (NIST) "cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction" [20] [24]and [29].

Cloud computing provide services such as Software-as-a-Service (SaaS), Infrastructure-as-a-Service (IaaS) and Platform-as-a-Service (PaaS). Cloud shows, web server as a space where computing has been installed previously and it exist as a

services, data operating systems, storage, applications and processing power and these services always ready to be shared. Cloud Computing provides services to the users as Pay-per-Use or On-Demand mode by which user can easily access and share IT resources via Internet, where IT resources are network, server, storage, applications, services etc.

CC is a model that functioning everywhere on internet. It is convenient and it is on-demand network access in shared pool. It can be rapidly provisioned and released with minimum management effort.

In our approach CC gives services in distributed network to process and store data in virtual memory. Virtualization is simplifies or happen because of innovation of the cloud computing, that provide services like processing, storage, memory, computing, transmitting etc. Here the data can be process with help of previous stored data.

1.5.3.1 Characteristics of Cloud Computing :

- **On-demand self-service :**

A user can unilaterally regulate computing capabilities like server time and network storage, when it needed by the user. It automatically provide services without human interaction with each service provider or services.

- **Broad network access :**

The services of cloud computing can be access by any device like mobile, laptops, tablets and workstations which have broad network access from anywhere via internet.

- **Resource pooling.**

Consumer used multi-tenant model to use resources like memory, storage, processing and network bandwidth. These resources are provided by the resource provider to the consumers, when the consumer demand for it. These resources can be access by different medium which may be physical or virtual medium. The resources can be assigned and reassigned to consumers according to the demand of consumer.

- **Rapid elasticity**

Cloud resources can be ‘scaled up’ and ‘scaled out’ depends on the demand of the resources, there two types of scaling, horizontal scaling (scaling out) and vertical scaling (scaling up).

- **Measured service**

The cloud systems control and optimize resources automatically. The use of resources can be monitored and controlled, it can also reported and providing transparency for both the provider and consumer.

1.5.3.2 Service Models :

There are basically 3 type of service model in cloud

- Software-as-a-Service
- Platform-as-a-Service
- Infrastructure-as-a-Service

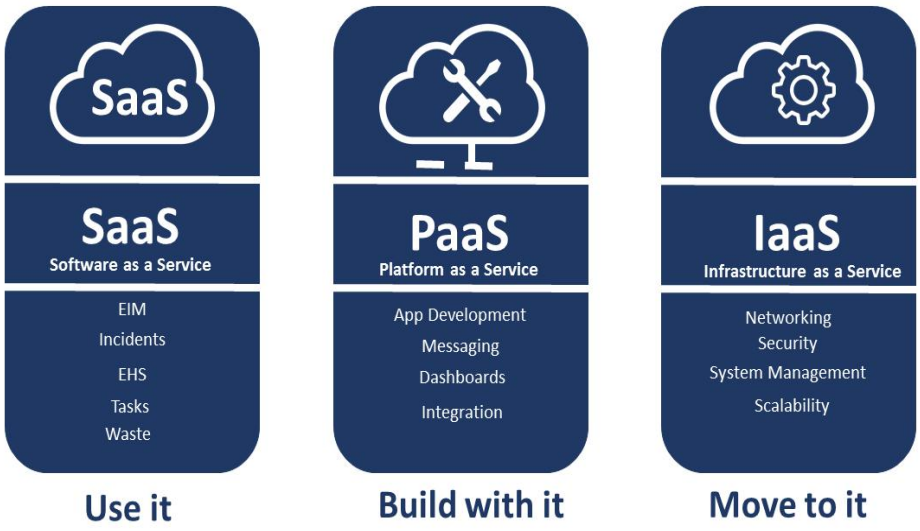


Figure 1.8 : Service Model of Cloud Computing

- **Software-as-a-Service (SaaS) :**

Software-as-a-service provides capability, to utilize the provider's applications which is running on a different cloud infrastructure, to the consumer. The applications can be access by the multiple clients through a thin client interface like web browser, or program interface like API. The cloud service provider can manages or controls the main cloud infrastructure which includes network, servers, OS, storage and also individuals application capabilities, while consumer privileged to use these services [33].

- **Platform-as-a-Service (PaaS) :**

Cloud provides the platform to the consumer in form software libraries, APIs and development tools etc. to appoint onto the cloud infrastructure or acquired the applications. The user has control over the appoint or deployed applications [33]. The user can also configured the settings for the application on cloud.

- **Infrastructure-as-a-Service (IaaS) :**

In this service cloud provides capability to the user is to implement their own operating system and applications and it also provide capability of storage, processing, networks, and other basic computing resources. The user has control over storage, OS and deployed applications and possibly user has limited control of selecting networking components [33].

1.5.3.3 Deployment Models :

There are four deployment model in cloud computing-

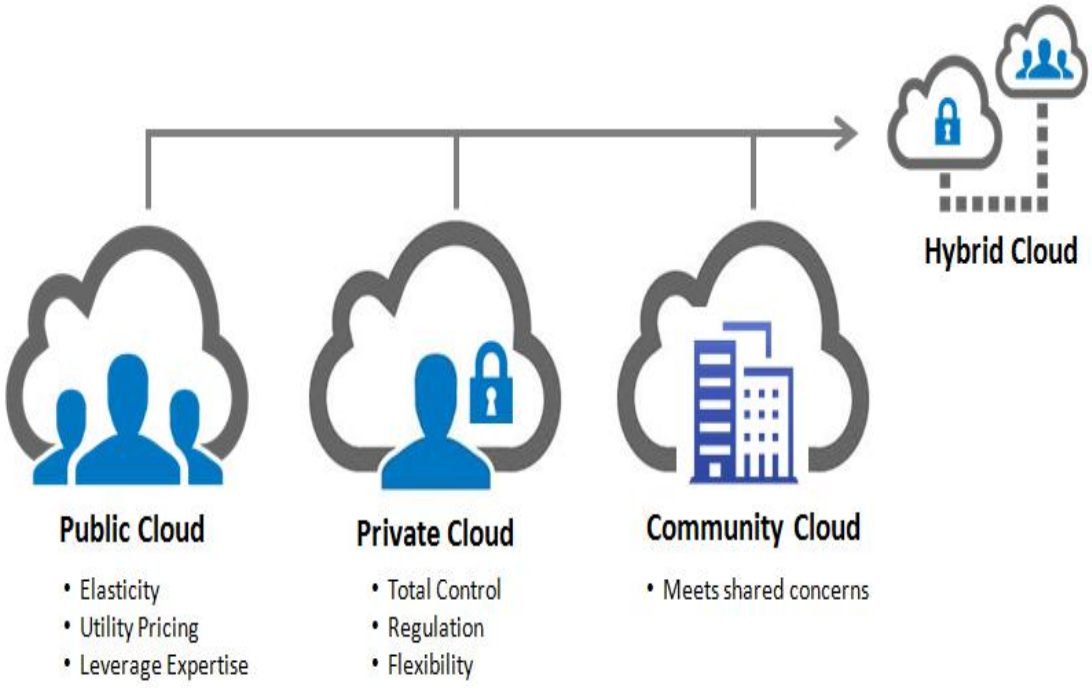


Figure 1.9 : Deployment Model of Cloud Computing

- **Private Cloud (PC) :**

The Private Cloud infrastructure is provided for a single organization [15] that can only access by their consumers and authority (like business unit). It provides Scalability, agility, efficiency and higher level of security. It can control and also it can managed and operate by single organization or third party or combination of them.

- **Community Cloud (CC) :**

The community cloud services are shared by several organization. The Community Cloud infrastructure is provided for a specific community of users from organizations that have shared concerns (like security requirements, policy, mission, and compliance considerations). It may be managed, owned and operated by one or more than one organizations in the community.

- **Public Cloud (PC) :**

The Public Cloud infrastructure is provided for open use by the public. It may be managed, and operated by a business or government organizations or combination of both.

- **Hybrid Cloud (HC) :**

The Hybrid Cloud infrastructure is mixture of two or more different cloud infrastructures like private cloud, community cloud, public cloud [15]. These clouds are bounded by standardized or proprietary technologies.

- **Cloud Storage (CS) :**

Clouds storage are virtual storage over a network. It provides QoS assured services. Cloud storage can store many resources and seems as a single system. CS has high fault tolerance. It can store many type of data like audio, video, documented files, programs,

APIs etc. We can use cloud storage for different purpose just backing up our home desktop data into cloud storage or as an archive to maintain data for regulatory.

1.5.3.4 Cloud Computing Application :

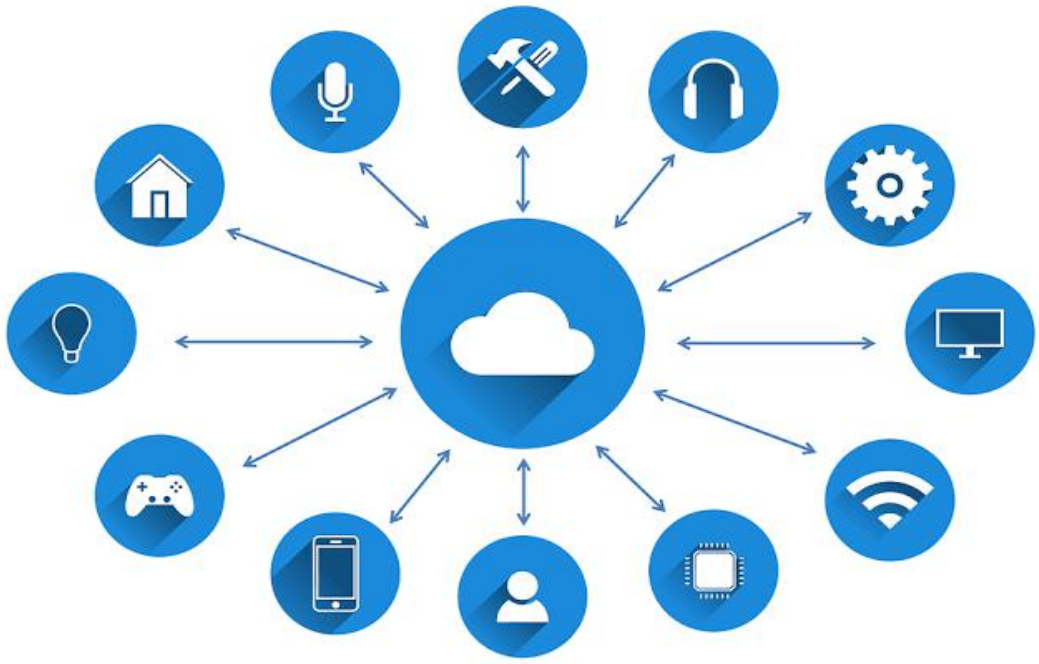


Figure 1.10 : Applications of Cloud Computing

- Hybrid Cloud Approach
- Audio streaming
- Video streaming
- Business Approach
- Testing, analysis and development
- Anti-Virus Application
- Big data analysis
- Storing File Online

- Recovery
- Backup

1.5.4 Machine Learning (ML) :

Machine Learning is a subset of artificial intelligence, the term machine learning refers to the ability of IT systems to find solutions to the problems by verifying patterns in databases. Machine Learning helps IT systems to recognize patterns by using existing algorithms and data sets and to develop sufficient solution. Therefore, Machine Learning generates solutions to the problems on the behalf of experience, data sets or knowledge.

ML is the learning of algorithms that reform automatically through experience and practice. It is a subset of artificial intelligence. Machine learning algorithms creates a computatinal models which is based on sample data. The sample data is also known as training data. ML algorithms are used in a wide range of applications such as email filtering and computer vision.

The era is moving on automation, it is possible because of Machine Learning. Machine Learning is a technology gains experience by learning again and again. Some time it use supervise learning and some time it uses unsupervised learning. Semi supervised learning has attracted increasing attention recently because it is defined between supervised and unsupervised learning [16]. Here ML perform the task by using previous stored data. With the help ML we can categories the use of water for different purpose.

1.5.4.1 Types of ML :

Machine Learning is categorized in different learning techniques :

- Supervised Learning
- Unsupervised Learning
- Reinforcement Learning
- Deep Learning
- Deep Reinforcement Learning

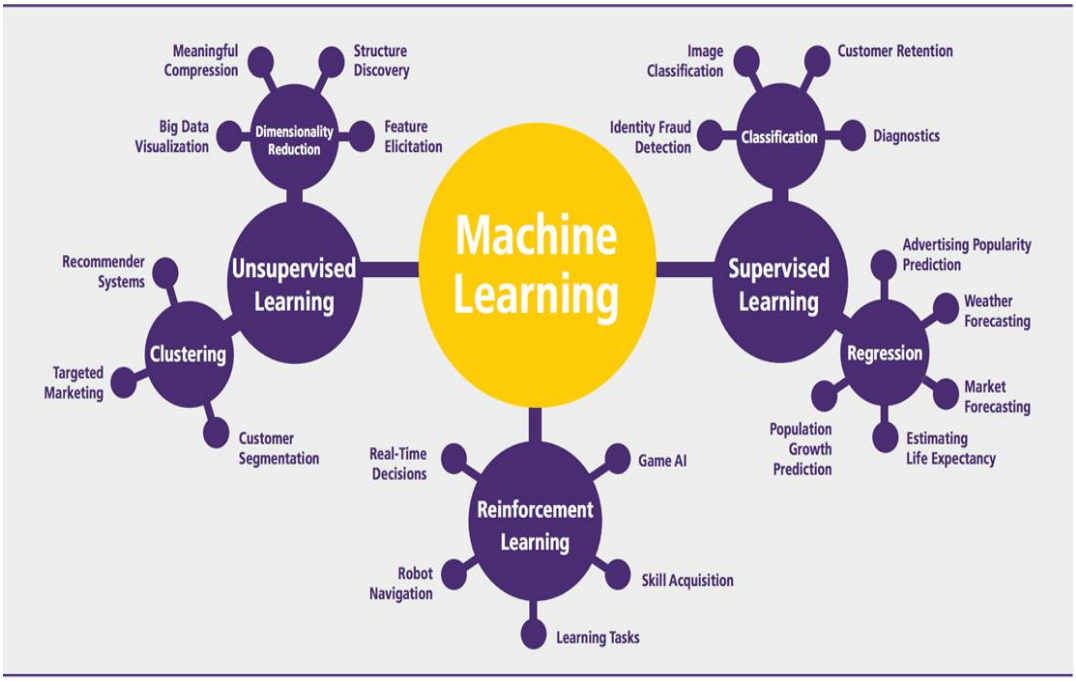


Figure 1.11 : Types of ML

- **Supervised Learning (SL) :**

SL is the learning functions of Machine Learning that change an input data into an output based on existing input-output example pairs. In supervised learning, a data-set

includes pair of an input data or object and a corresponding output value, the desire example is used for learning process that have input and desire value(output). A SL algorithm analyze the training data from data set and produces a function, this function can be further used for mapping another examples. Supervised machine learning work on existing data that SL algorithms. There are many algorithms available for supervised learning, some of them are widely used supervised learning algorithms are known as k-Nearest Neighbors, Decision Trees , Naive Bayes , Logistic Regression , Support Vector Machines [21].The knowledge extracted from supervised learning is often utilized for prediction and recognition [16].

- **Unsupervised Learning (UL) :**

UL is a type of machine learning that looks for previously unsolved patterns in a data-set which has no labels and with a marginal supervision of human. As comparison of SL that usually has labeled data, UL, which is also known as self-learning technique do not use labeled-data for learning process. Basically two methods used in UL are principal component and cluster analysis. Cluster analysis is used in UL to group or segment of data or data-sets, with shared characteristics in order to generalize algorithmic relationships. Cluster analysis categories the data that has not been labelled, classified or categorized. Cluster analysis identifies similarities in the data and response based on the presence of data similarities or absence of data similarities in each new data set that forms. This approach helps to detect anomaly of data points that of which group the data belongs. The algorithms for unsupervised learning are k-means clustering, Cluster Identification and Principle Component Analysis [21].

- **Reinforcement Learning (RL) :**

Reinforcement learning is also part of machine learning. The reinforcement learning technique is dynamic programming technique that trains algorithm using reward and punishment method. It will be rewarded and punished based on performance of algorithm. The RL method concerned with how software agents performs in a situation or environment in order to maximize the assumption of cumulative reward. RL is not needed labeled data or labeled input and output, instead it focuses on finding balance between exploration and exploitation. RL is used in many fields like game theory, operations research, control theory, information theory, multi-agent systems, statistics and genetic algorithms etc.

- **Deep Learning (DL) :**

DL is a part of artificial intelligence. Deep learning draws its roots from an Artificial Neuron Network (ANN) introduced by Kunihiko Fukushima in 1980 [43]. It follow the workings of the human brain to analyzing the data, processing the data and creating patterns for enhancing the decision making capability. DL is a subset of machine learning that has networks and capability of learning unstructured or unlabeled data. DL is also known as 'deep neural learning'.

- **Deep Reinforcement Learning :**

DRL uses DL's and RL's basic principles to create efficient algorithms which can be used in many areas such as video games, robotics, computer vision, NLP, education,

transportation, finance and healthcare. Implementing DL architectures with RL algorithms is capable of scaling to previously unsolvable problems, that is because deep reinforcement learning is able to learn from raw sensors or image signals as input.

1.5.4.2 Applications of ML :

- Health Care
- Transport
- Social Media Services.

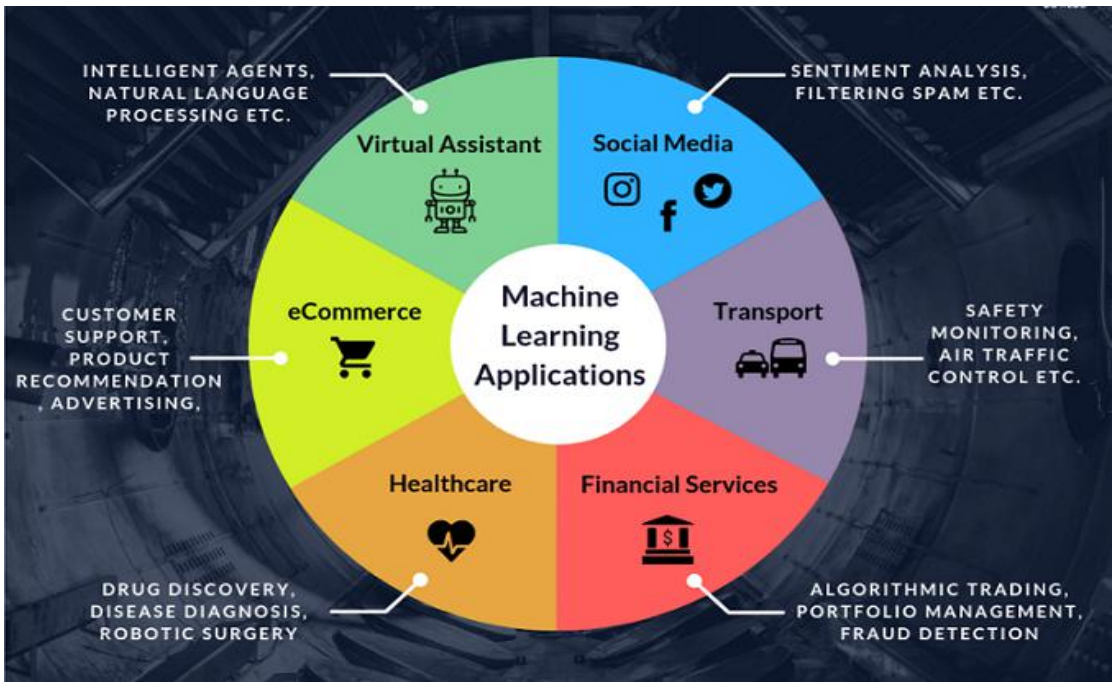


Figure 1.12 : Applications of ML

- Virtual Personal Assistants such as Alexa, Google Now, Siri etc.
- Predictions while Commuting.
- Email Spam
- Malware Filtering.

- Videos Surveillance.
- e-Commerce
- Financial Services

1.6 PROBLEM DEFINITION :

The problem statement of WQM system is that manual testing is very costly and ineffective process of monitoring water quality and this process is not a real-time monitoring system, thus it is require a cheap and effective water quality monitoring system in real-time.

The problem comes with IoT device is storage capacity, an IoT device can store large number of data but it also have a limitation and it needed a large storage IoT device. To processing these data is also a critical process and taking decision when alert message send to user about water quality is also a problem that needed to be solved.

It is very expensive to use different sensors to measure different parameter of water. IoT provide sensors to the devices that examines different parameter of water like pH value, temperature of water, minerals of water and stores its data in to the cloud server through WSN. Due the dynamic nature of network topology, WSN may harm the sensor nodes.

Nowadays Machine Learning is used very broadly because of it's several learning technique and algorithms. This is why it require a large computational power and transmission of large number of data. The computation and the transmission capability can be limited due to processing capability and throughput limitation of IoT devices and protocols.

1.7 PROPOSED GOAL :

The objective of WQM System is to aware the authority or people about quality of water.

- The objective is to process the real-time monitoring data that will be received from IoT sensor device. and
- Comparing the received data to the water quality parameter given by CPCB to categorize water for different purposes such as drinking , outdoor bathing, fish and wild life, irrigation and industrial needs etc.

1.8 MOTIVATION :

In India on an average rainfall in a year is approximately 1170mm, after that almost 80% of India's surface water is polluted. Due to the impure and polluted water many kind of health problems, land problems and many other problems are arising. Health problem arises due to the waterborne pathogens that contaminates the water and cause diseases like diarrhea, cholera, amoebiasis etc. polluted water also cause may land problems like reduction in productivity of crops, plant and trees, degradation in the quality of soil leading to the increment in barren lands loss habitat due to consumption of impure and polluted surface water. Due to contaminated water, animals and marine life are also in danger. What this project do?, to solve the problem of real-time WQM system that ensure and alert the authority and people about the quality of water regularly.

1.9 METHODOLOGY :

The methodology of this approach consist following steps :

Step 1 : Problem Identification : Water is the main source of life. Without water we can't imagine life but nowadays quality of water depleting day by day. So we need a real-time WQM system.

Step 2 : Literature Study : After problem identification we need to understand the basic problems of WQM system, for that we need to study previous works on WQM system.

Step 3 : Building Simulation : We create an environment according to the problem's requirement. By this process we get results. The gathered results analyzed in next step.

Step 4 : Result Analysis : After getting result we analyze and compare these results to the other results. By our approach, according to water quality parameter (pH, minerals and temperature) it categories the utility of water.

1.10 DISSERTATION OUTLINE

The document is organized as follows.

Chapter 2

In this chapter, I have discuss the security background of this approach. Here I discuss about the security challenges, threats and attacks. The objective of this chapter are discuss about the security aspects of different technologies which is used in our approach.

Chapter 3

In this chapter I reviewed various national and international journals and publications to identify the real problem statement for doing appropriate research to create a water quality monitoring system.

Chapter 4

In this chapter, our proposed work discusses and explained in detail for an intelligent IoT based Wireless Sensor Network for Monitoring Water Quality by using RNN in Real-Time.

Chapter 5

In this chapter, I discuss about the result and it analysis. The results are discussed with the help of training data set and graphs. The algorithm of this approach is also discuss in this chapter.

Chapter 6

In this chapter conclusion and some of the future scopes discussed of this work.

CHAPTER : 2

SECURITY BACKGROUND

2.1 INTRODUCTION :

Security is an important characteristics of any system. Consumer demands high security aspect of any device or technology. Nowadays the world is constantly moving toward technologies such as wireless sensor network and cloud computing. To ensure the security of these technology there are some security parameters are defined on the basis of the significant characteristics of these technologies. The systems security is measure on the basis of the characteristics of systems which are Availability, Authentication, Authorization, Data confidentially and Data Integrity, Non-Repudiation [26].

The need of security services is to provide security to the networks, channels, data packets etc. from the anomaly or attacks. Nowadays, Wireless Sensor Network used in many application such as health monitoring, water quality monitoring, military surveillance etc. The sensor nodes main work is to sense environmental or physical conditions like humidity, temperature, pressure or quality etc. The sensed data are travels from source node of sensor to destination node of sensor through intermediate nodes. They make this system secure but some characteristics of WSN like irregularity of network topology (means network topology changes constantly because of its dynamic nature), it can damage or kill the some of sensor node and Ad-hoc deployment of sensor node helps attacker to attacks from active state of system to passive state of system in WSN.Basically attacks are classified as active attacks and passive attacks [38] this make system vulnerable. This is important to protect WSNs by any attack or anomaly.

IoT is a group of interconnected devices or interconnected sensor nodes. The things which is connected via internet have security threats same as traditional networks. The sensitive nodes becomes threat due to limited resource and capability of a device, network security and software security are also concern. IoT to solve day-to-day problems by the applications like Smart monitoring system, Smart water supply, Smart street light, Smart cities etc [28].

Cloud computing is very demanding innovation of IT sector. The Cloud computing is a computing model that provide services via internet, it has some characteristics like broad access of network, on-demand self-services, rapid elasticity, resource pooling and measured service, with these characteristics it has also some security issues like availability, confidentiality, data integrity, reliability, loss of control etc. These issue occurs because of threat of attacker. There are many type of attack can be launch on cloud computing [44].

Denial-of-service attacks are describe here because they attack on limited sensor nodes energy in WSN and overload or flood the cloud server. DoS prevent sensor node to send the sense data to the other sensor node or network and also stops user to use cloud services.

2.2 DoS-(DENIAL OF SERVICE) ATTACK :

DoS attacks are challenging threat to the computer network because of its easiness. The DoS tools are easily available on internet and it can be downloaded from internet, DoS tools can be use by normal computer. The Denial of Service attacks are serious threat to network security[32]. The attacker wants to control over channel or network they maliciously performing DoS attacks against these channel or network which is totally

illegal. DoS attacks may harm the organizations which relay on internet and becomes a threat for such organization. DoS attack happens in active and passive state of the system.

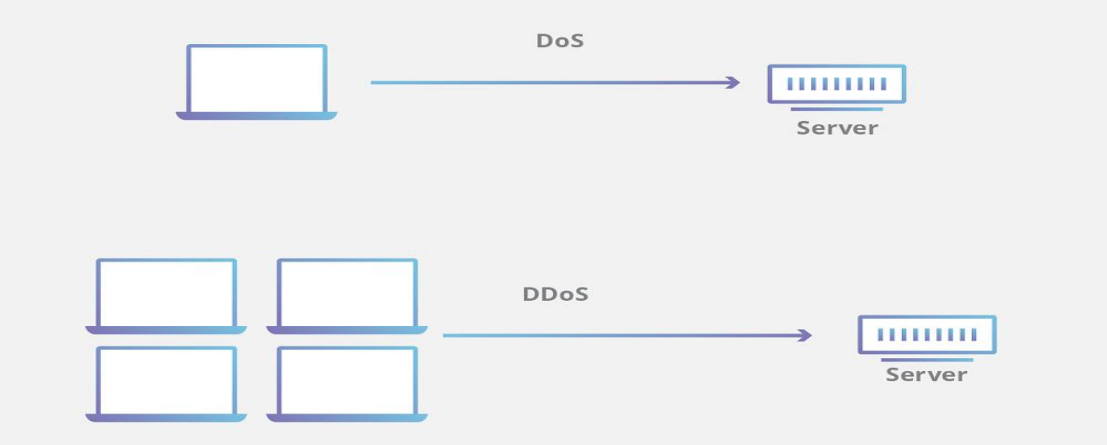


Figure 2.1 : DoS attack and DDoS attack

DoS is a form of attack that makes systems, websites, network or even single program slow and malicious and prevent users to access it. The DoS attacks can be perform in internet by targeting its resource that can be network computing, services that provided such as bandwidth, TCP connection etc. The distributed attacking hosts launch DoS attacks in the internet by many computer because it is hard for attacker to overload the targeted resource via single computer to disrupt the network, this attack known as Distributive Denial of Service (DDoS). DDoS (Distributed Denial of Service) is an attack where a number of compromised systems attack a single target, thereby causing denial of service for users of the targeted system [27]. The distributed devices which are connected globally via internet referred as botnet. DDoS is differ from DoS because it flood the target via malicious traffic.

2.3 TYPE OF ATTACKS :

2.3.1 DoS Attack and DDoS Attack :

These attacks mainly divided in three categories :

- Volume Base Attack
- Protocol Base Attack
- Application Layer Attack

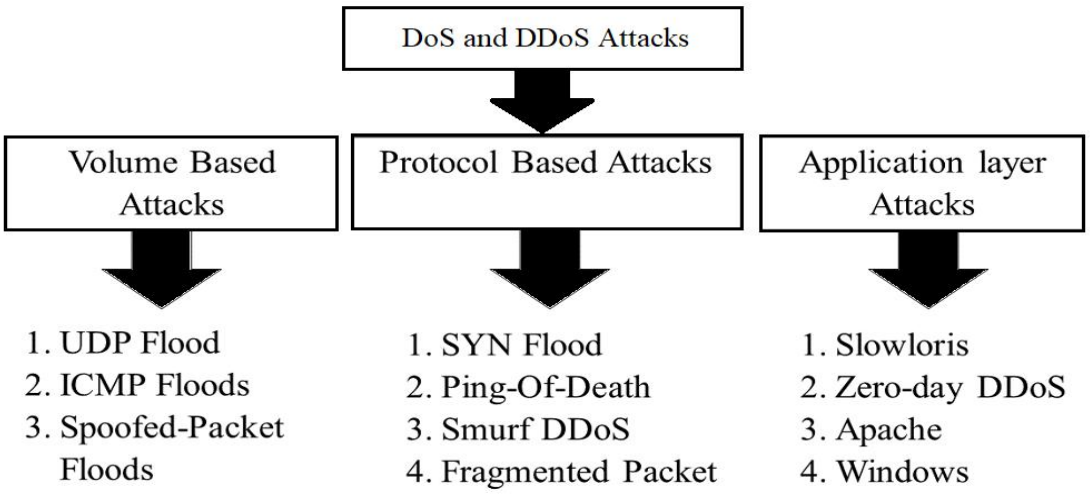


Figure 2.2 : Type of DoS attack and DDoS attack

2.3.1.1 Volume Based Attack :

It is a form of attack where attackers flood the victim with high volume of packets or connections that overload or disrupt the networks, servers or bandwidth resources. The volume based attack includes UDP and ICMP floods and other spoofed floods [45].

2.3.1.2 Protocol Based Attack :

Protocol attack is a form of attack where it consumes server resources or intermediate equipment like firewall and load balancer. These attacks are known as Ping of Death, fragment packet attacks, SYN floods, Smurf DDoS [45].

2.3.1.3 Application Layer Attack :

Application Layer Attack is a form of attack which specifically design for attacking targeted applications or web servers. It attack the application it self by focusing on specific issue or damage for interrupting the the application to not send or receive the data to the client. The Application Layer Attack includes low-and slow attacks, GET and POST floods [45].

Some attacks are define below :

- **UDP Flood :**

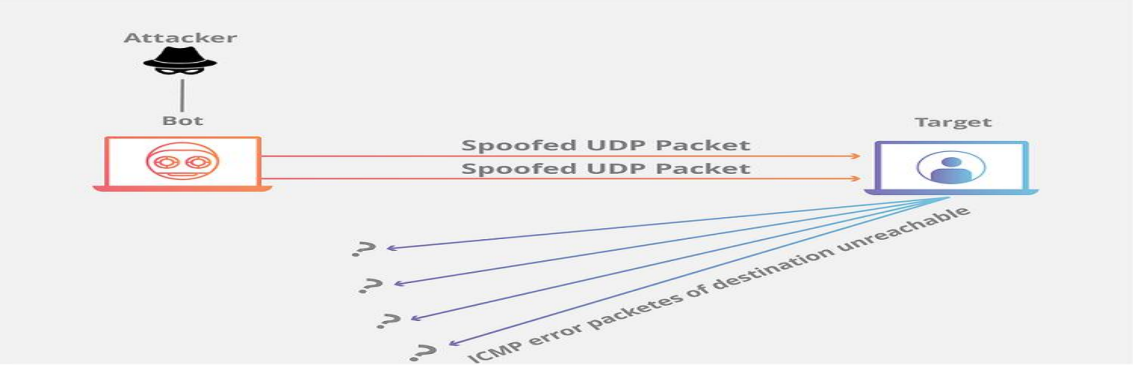


Figure 2.3 : Attack of UDP Flood

User Datagram Protocol (UDP) flood is a volume base DDoS attack that floods the target by numerous UDP packets. The aim of UDP flood is to attack on connectionless or sessionless computer networking protocol by sending lots of UDP packets, that resulted

as repeatedly checks on the application availability at the port and it gives response with an ICMP error packets of destination unreachable.

- **ICMP Flood :**

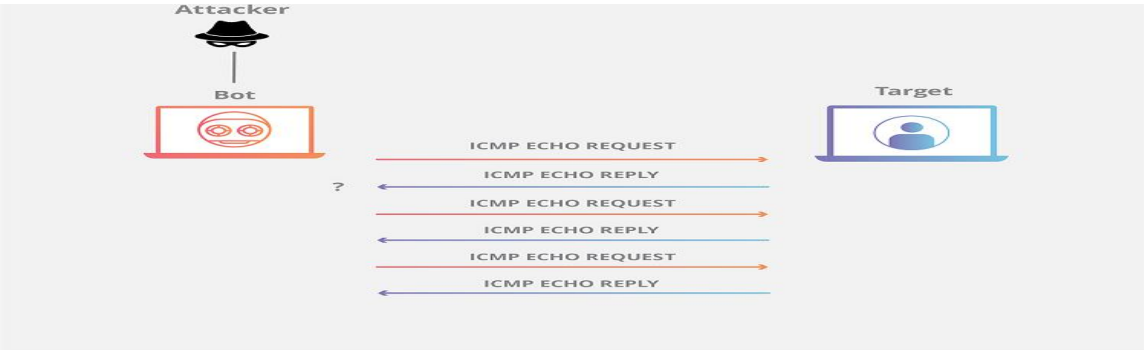


Figure 2.4 : Attack of ICMP Flood

ICMP flood attack is similar to the UDP flood attack, that here attacker sends packet as fast as he can without waiting for any replies. The target resource is full with ping (also known as ICMP Echo Request) packets that consume bandwidths (incoming and outgoing) tat resulted as a system slowdown [37].

- **SYN Flood :**

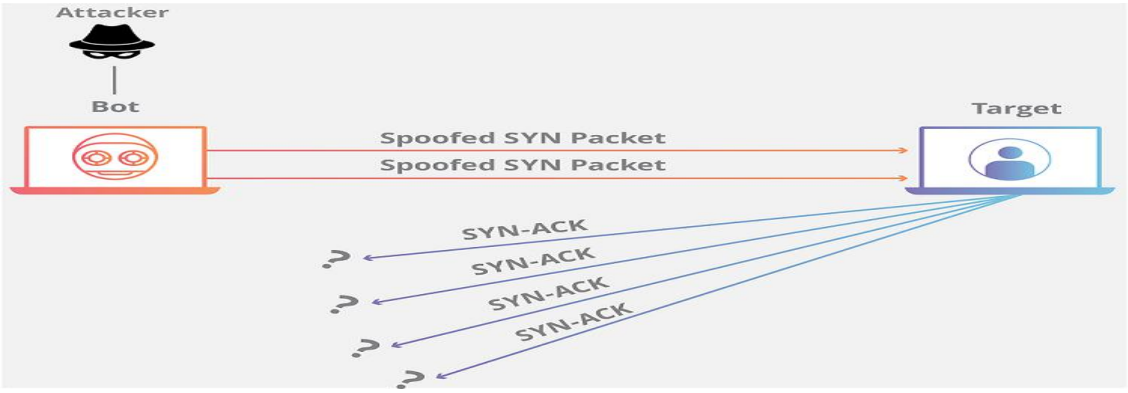


Figure 2.5 : Attack of SYN Flood

SYN flood attack is a form of protocol based DoS attack. It attacks on TCP connection sequence which is also known as three-way-handshake, the tree-way-handshake is a connection making process, where a host sends a SYN request to start a TCP connection, the host get SYN-ACK

response from server and the connection confirm by the ACK response by the host. The host sends SYN request but SYN flood attack stops the SYN-ACK response this resultant either host wait for acknowledgement or destroy the connection.

- **Ping of Death :**

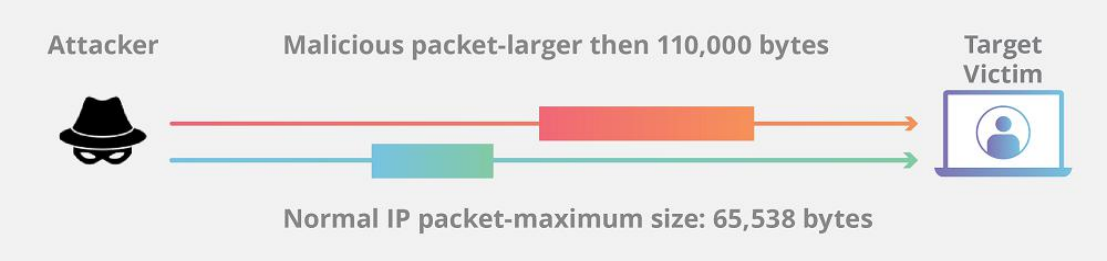


Figure 2.6 : Attack of Ping of Death

Ping of death attack is an attack where attacker send large number of malicious and corrupted pings (known as ICMP Echo Request packets) to a targeted victim. This attack is resulted as denial of service by overflowing memory buffers.

- **Slowloris Attack**

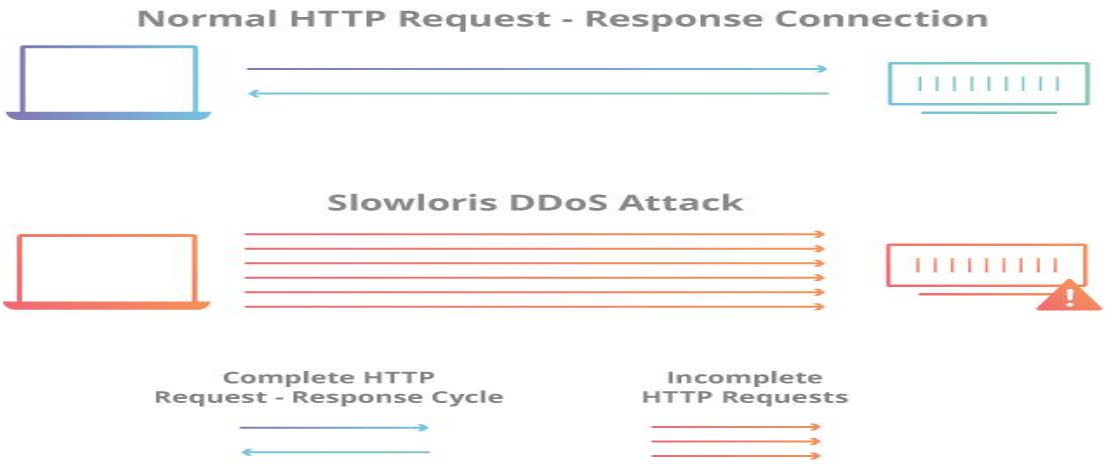


Figure 2.7 : Attack of Slowloris

Slowloris is a form of Application Layer based DoS attack. This attack is launched from one web server by single computer to take down other computer's web web server without affecting other unrelated services or ports.

- **Zero-day DDoS Attacks :**

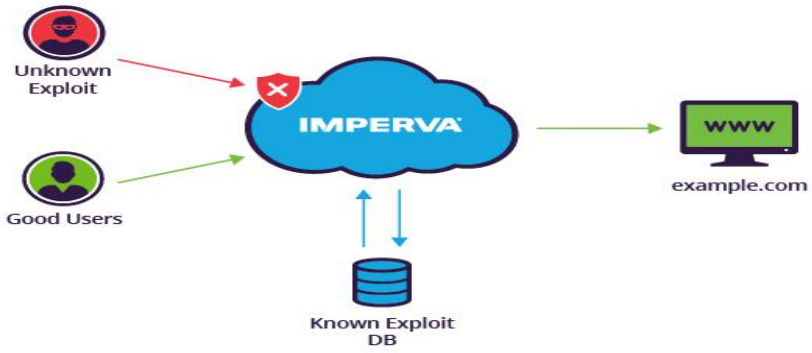


Figure 2.8 : Attack of Zero-Day DDoS

Zero-day attack is a form of attack that is completely unknown or new attacks. This attack is very dangerous because when it happens the manufacturer have no idea how to patch them.

2.3.2 Attacks on Cloud Server are :

2.3.2.1 Cloud Malware injection :

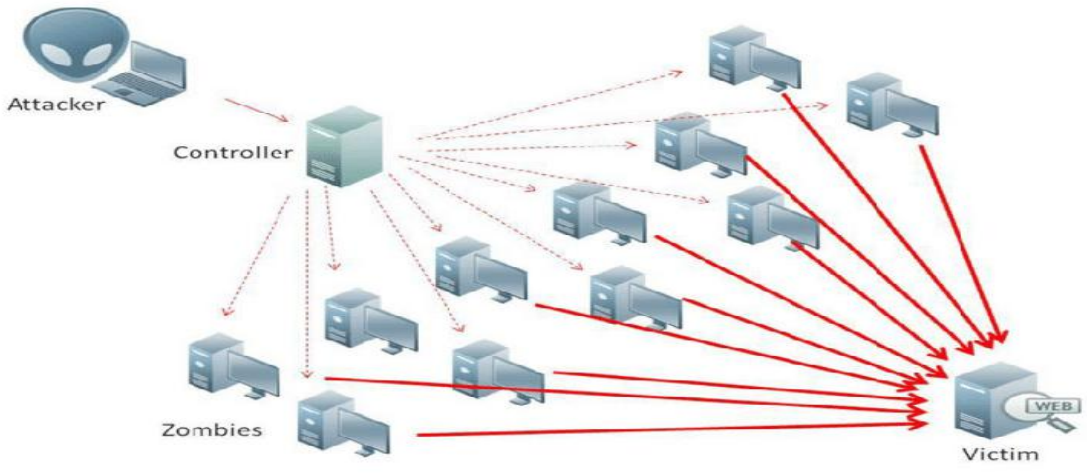


Figure 2.9 : Attack by cloud Malware Injection

As name suggesting that it inject malicious service implementation into SaaS or PaaS or IaaS. The aim of this Malware injection attack is to take control over user's information

in cloud server [22]. SQL injection attacks and Cross- site scripting attack are most used attack of Malware injection attack.

2.3.2.2 Abuse of Cloud-Services :

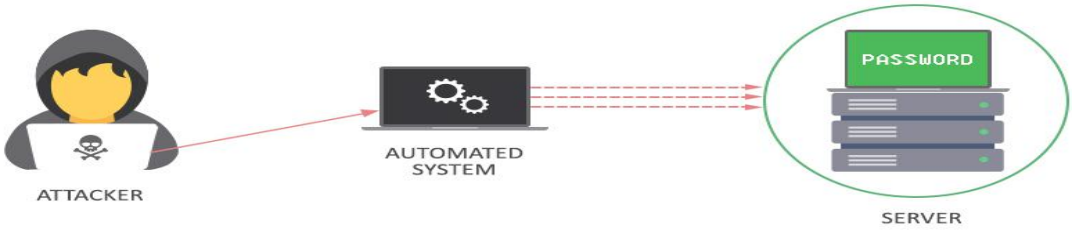


Figure 2.10 : Abuse of Cloud-Services

By using low-cost cloud services to attack targeted users, companies or cloud service provider, attacker uses brute force or DoS attacks. Brute Force is an attack where attacker used thousands of password to crack the targeted user's account security or privacy.

2.3.2.3 Side channel attacks :

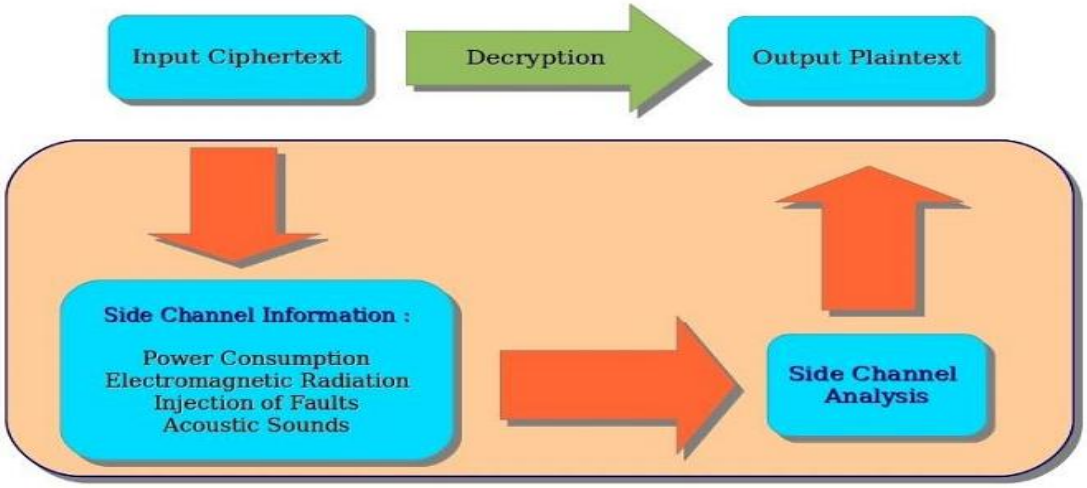


Figure 2.11 : Attack by Side channel

The side channel attack is an attack where attacker place the malicious virtual machine to a targeted cloud-server and the launching the side channel attack [22]. The aim of the

side channel attack is targeted to the cryptographic algorithms of a system implementation.

2.3.2.4 Wrapping attacks :

Wrapping attack allows attacker to modify or corrupt the message. Man-in-the-middle attack is one of the example of wrapping attack. An XML signature is used to protect user's credential information from unauthorized access, but signature can not secure the XML documents, thus XML signature element wrapping allows attacker to manipulate or modify the XML document.

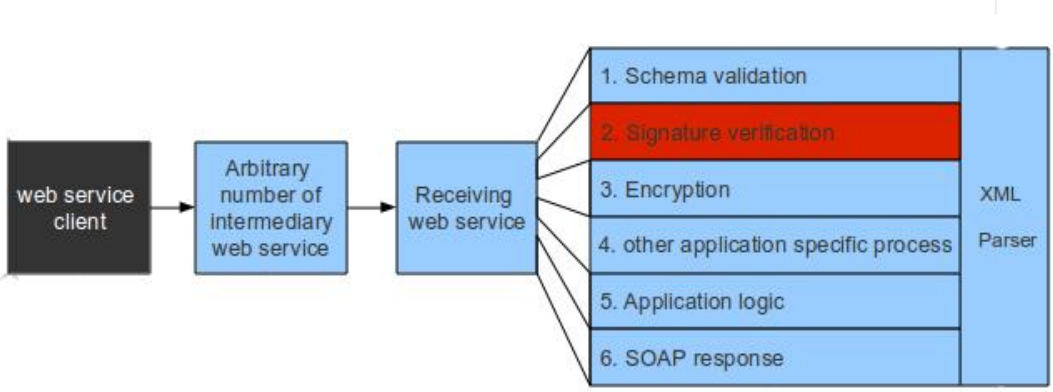


Figure 2.12 : Wrapping attack

2.3.2.5 Man-in-the-Middle attacks :

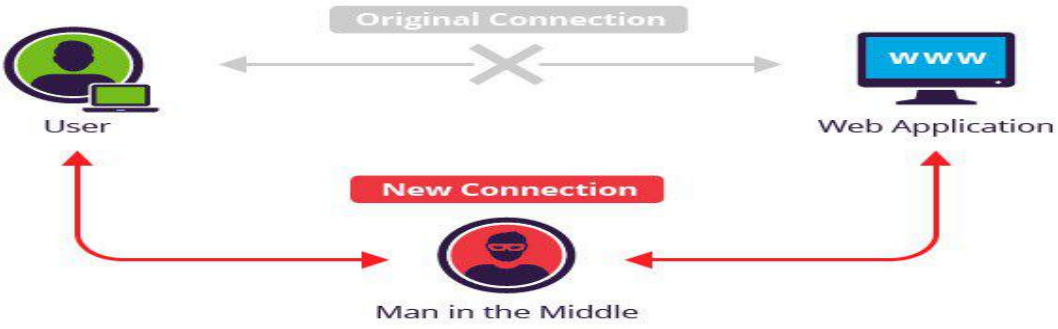


Figure 2.13 : Attack by Man-In-The-Middle

Man-in-the-Middle attack happens when attacker place himself between two users, the attacker intercept the communication. Attacker can also reconfigure the cloud services by exploiting synchronization system.

2.3.3 Attacks on IoT System are :

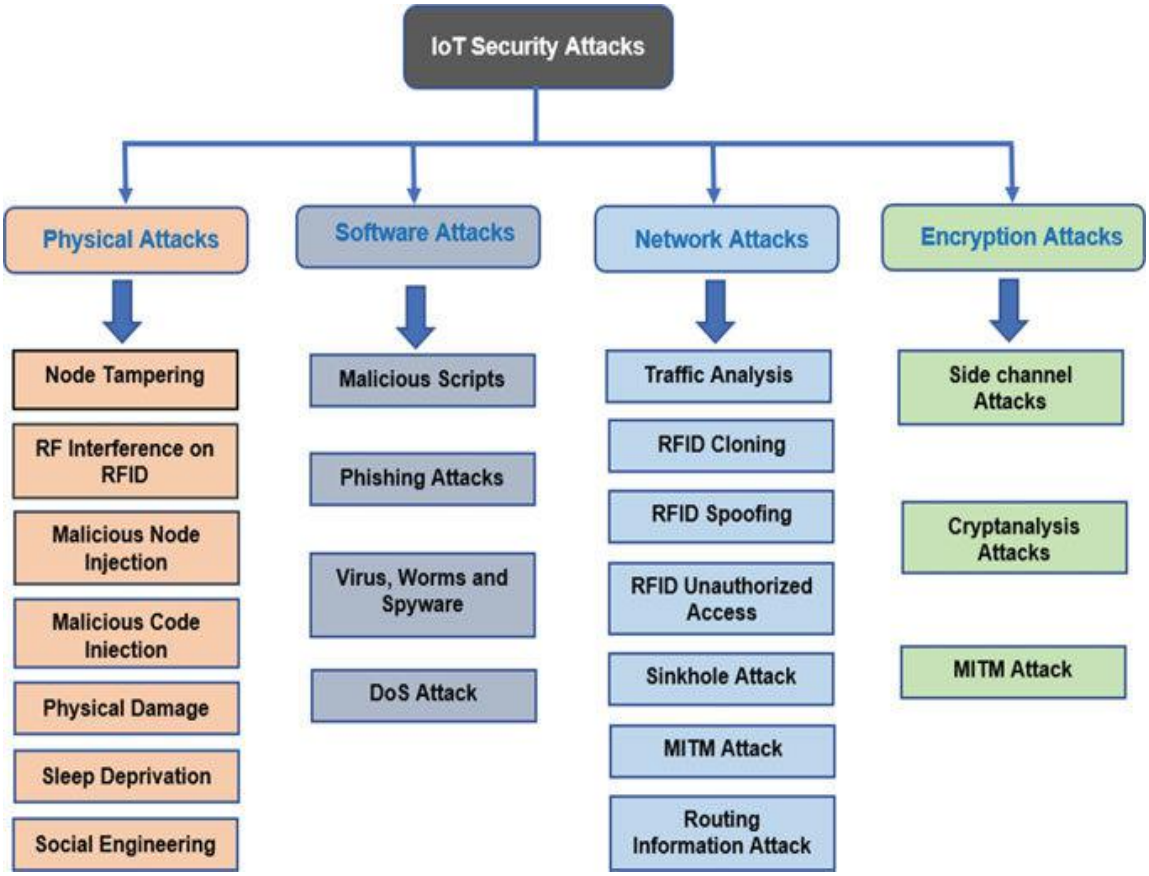


Figure 2.14 : Type of attacks in IoT System

2.3.3.1 Physical Attacks :

The physical attacks include node tempering, node jamming and malicious node injecting, these attack prevent communication between two nodes or stealing data from these nodes. Attacker can also physically damage the component of IoT system that leads the DoS. These attacks result from breaches to the IoT device's sensors [46].

2.3.3.2 Network Attacks :

Network attacks includes traffic attack, spoofing, cloning, unauthorized access man-in-the-middle attack and DoS or DDoS attack, these attack prevent the user to access the IoT system via internet. Attacker can access the network or steal the data without knowing the user.

2.3.3.3 Software Attacks :

Software attack includes phishing attack,virus, worms, Trojan horse, spy-ware and malicious code, these software threats, may damage the software, software may work slow or corrupted. Attacker aims by these treats to destroy the application software.

2.3.3.4 Encryption Attacks :

Encryption attack includes side channel attack, crypt-analysis attack and man-in-the-middle attack, these encryption attacks analyse and deduce the encryption key and may attacker change or modify the algorithms. Attackers aim to control the system by changes in the main algorithm of the system.

2.4 CONCLUSION :

The impure and polluted water needed a WQM system that has been most secure and safe. Many threats and attack can be damage the physical and software properties of the WQM system. The WQM system needed a secure and safe system that gives accurate and effective result to the public or authority in real-time environment. The technology must be insure their security procedure when it going to be used. Every systems have their ups and down in different cases or situation.

CHAPTER : 3

LITERATURE REVIEW

3. 1 LITERATURE REVIEW :

Nikhil Kumar Koditala (2018, IEEE), [1] has works on WQM system with help of IoT, Machine Learning and Cloud Computing. The author basically focused on rural areas water quality. The author says that the old method of monitoring water quality is a time taking and less reliable process. IoT and Machine Learning make WQM system easy in real-time environment. In this paper Author use sensors which monitor the chemical composition of water like pH value, turbidity and temperature. The author shows monitor data on cloud with help of cloud computing services. Monitor data are then passed to Node MCU micro controller and with the help of Wi-Fi data passed to the Azure Event Hub (AEH) and then Stored on Azure Storage Hub (ASH) in form of structured data. The Author also uses temperature sensor to sense the stored water is 'hot' or 'cold'. In this part of the paper the author wants say that by using machine learning system, he can predict the water condition and control the heat and cold temperature according to the temperature of water.

N.Vijayakumar (2015, ICCPCT), [2] has focus on low-cost system for monitoring the quality of water in real- time environment with help of IoT. In this design author use Raspberry PI B+ as a core controller. This paper is helpful for creating low cost monitoring system, because it reduces to installation of a high cost water plant. The raspberry PI B+ runs on LINUX kernel. The Raspberry PI B+ sends data to the IoT module and IoT transmit data to the internet with help of cloud computing and Wi-Fi for accessing on remote device.

Theofanis P. Lambrou, Christos G. Panayiotou, Christos C. Anastasiou and Marios M. Polycarpou (2014, IEEE), [3] has focus on low-cost monitoring system for WQM system and water distribution system. The approach of the paper is to create a low cost

reliable monitoring system to measure physic o-chemical of water. This paper basically work on distributed water quality using low-cost, low-power and tiny in-pipe sensors for consumers.

Brinda Das and P.C.Jain (2017, IEEE), [4] has propose real-time WQM system by using Internet of Things. The approach of this paper collects the monitoring data of water by the sensors and transmit the data via ZigBee module from sensors to micro-controller wirelessly and GSM module transfer the the data from micro-controller to PC or mobile. this system also alert the officials by sending message.

K. Saravanan, E.Anusuyu, Raghvendra Kumar Le Hoang Son (2018, Springer), [5] has proposes a SCADA system that integrated with IoT. With help of SCADA, the WQM system in real-time environment gets more efficient than other system. The contribution of SCADA is easily integrated with sensors by using 'Play and Plug', use of wireless technologies like Global System and Mobile communication(GSM) for real-time transfer of SCADA data on internet and SCADA server generates a report for web and mobile application.

Thinagaran Perumal, Md Nasir Sulaiman, Leong.C.Y (2015, IEEE), [6] has shown basic fundamental of measuring the level of water in real-time environment. By this paper author describe how to prevent floods occurrences in dangerous areas. Author proposes IoT based water leveling monitoring system that measures level of water in real-time. When the measured data are reaches the desired parameter the system sends the alert signal on the twitter by using cloud server. This paper is basically focused on water level of rivers that are reaches the above to the parameter that are the dangerous to flood.

Prasad M. Pujar, Harish H. Kenchannavar, U.P.Kulkarni (2016, IEEE), [7] has completed the survey using different wireless sensor network based WQM system that monitors different water threats like physical, biological, chemical and radioactive contamination. In this survey system monitor water quality continuous, if any changes in happens in water quality like pH, turbidity, temperature etc. Then it report to the data center for instant investigation. By this survey the central authority aware about the water quality and take action if the water quality compromised.

Gaganjot Kaur Kang (2017, IEEE), [8] has completed a survey on water quality and prediction of water quality. This paper classified the applied big data analytics approach and compare the big data based prediction model for WQM assessment.

O'Flynn, Rafael MartínezCatalà, S. Harte, C. O'Mathuna (2007, IEEE), [9] has implemented of the Water Framework Directives (WFD) across EU. This system presents 'SmartCoast' multi sensor for water quality that aims to meet the monitoring requirement of water framework directives.

Zulhani Rasin and Mohd Rizal Abdullah (2014, IJET), [10] has introduce the fundamental design of WSN featuring high-power transmission 'Zigbee' based technology. The application of WSN consist lots of sensor nodes with network capability for continuous monitoring water quality. The parameter involved pH, turbidity and temperature for monitoring water quality in real-time by sensors and send data to the control room. This paper propose a low-cost and easy ad-hock installation for maintenance of monitoring system.

Anuadha T (2018, IJRST), [11] has helps to create a low-cost monitoring system for water plant by reducing time, high-cost and human effort. To supply safe and pure

water for drinking, it is needed a low cost WQM system. For supplying safe and pure water this paper presents Raspberry PI B+ module that takes input from sensors and IoT connects the remote object. IoT also provides sensor data to the public.

Prathamesh Vyas, Vikrant Walavalkar, Bhaiyasab Wankar and Pranjal Yadav (2018, IRJET), [12] has presents IoT device that helps to manage and monitor the level of water from tank. With help of IoT, it can regulate the use of water. The sensor records the level of water in the tank and send these data to the cloud-server by using Wi-Fi, these data can be read by user on websites using Smart phone or laptop. The IoT device is also control the automatic functioning of level of water in the tank by controlling water-motor by switching it 'on' or switching it 'off'.

Maneesha V Ramesh, Nibi K V and Anupama Kurup (2017, IEEE), [13] has proposed WQM and waste management technique by using IoT. Author basically focus on the condition of Pettipalam Colony in Kerala that how water quality is degrading day by day due to the waste contamination in water. Due to these contamination many health related issues occurs among the colony resident. Authors aims to develop an monitoring system by using IoT that sense the condition of water and soil and deliver the information of water quality and soil quality and take action according to the conditon of water and soil.

Arivoli Appavu, Sathiamoorthi Thangavelu, Satheeshkumar Muthukannan, Joseph Sahayarayan Jesudoss and Boomi Pandi (2016, JGBS), [14] has work on the parameter of water quality of cauvery river in Erode district. The study is focused on physic o-chemical parameter like pH, turbidity, hardness, chlorides etc. The samples taken from different points and measure the physic o-chemical parameter of water. The study

shows that how cauvery river water contaminated the bio and physic o-chemical compounds. By this study water quality management is require to achieve water quality standards determine by the WHO or national quality standard.

Tharam Dillon, Chen Wu and Elizabeth Chang (2010, IEEE), [15] has discuss about cloud computing. Here we study cloud computing and issues and challenges of cloud computing. Here we discuss service-oriented cloud computing and grid-oriented cloud computing. At last the author highlight interoperability issue.

Umair Ahmed, Rafifia Mumtaz, Hirra Anwar, Asad A. Shah, Rabia Irfan and José García-Nieto (2019, MDPI), [16] has introduce a prediction model for efficient water quality. This paper proposed a supervised machine learning based water quality prediction model. The proposed methodology is based on four inputs like pH, turbidity, temperature and TDS.

Joy Shah (2017, IJIRSET), [17] has introduced the water distribution is carried out zone or area wise. While distributing water there is need for better water distribution technology and also consider quality of water. This paper explains how to distribute high quality water for drinking. Hence, it is focused on smart water distribution technology that checks water quality continuously. For that author use Raspberry PI model and different sensor which can upload data on cloud server. This paper is important for distribution high quality water for particular area or zone.

Keyur K Patel, Sunil M Patel (2016, IJESC), [18] has discuss about the IoT. The paper is about to the definition of IoT, the challenges occurs in IoT, the basic architecture of IoT. The paper also includes the challenges and application of IoT.

Parneet Kaur, Kamaldeep Kaur, Er. Sharanjit Singh (2014, IJSER), [19] has elaborate the survey on WSN. The paper discuss about the architecture of WSN which is based on OSI model. The paper also includes design issues and applications.

Ab Rashid Dar, Dr. D. Ravindran (2018, IJARSE), [20] has introduce paper of a comprehensible study on CC. In this paper we will study the NIST definition of cloud-computing, service models, deployment model, limitations etc. Of cloud-computing.

3. 2 CONCLUSION

There are many solutions available for WQM system like monitoring by using manual procedure or IoT or WSN or with the help of other technologies. The water quality parameters like pH, turbidity, salinity etc are use for measuring the water quality. In this proposed approach the water quality measured by using IoT and WSN in real-time situation. This is very effective and secure procedure to monitor the water quality in real-time situation. By this approach water can categorize for different purpose like drinking, outdoor bathing, irrigation, industrial use or house hold use. In this approach we use Naive Bayes and Recurrent Neural Network for classification and prediction of water quality. This is helpful for aware the people or authority.

CHAPTER : 4

PROPOSED WORK

4.1 PROPOSED APPROACH :

To aware the people or authority about water quality in real-time, proposed technique help to implement an environment for different use of water in different field. Our technique is to monitors the water quality in real-time situation by using sensors. In this technique sensors helps to monitor the quality parameter of the water like temperature, minerals and pH in different situation or condition and send these data on the cloud. The presented WQM system is more sufficient than the oldest WQM system which is manually monitoring the water quality.

In this approach, sensors monitor the parameter of water in real-time condition or situation. The sensed data send to the cloud server, where data processing get started. The processed data is classified by using algorithm, Naive Bayes, into different class, and the range predicted by using algorithm Recurrent Neural Network and make a tested water data set. The final result shows the use of water for different purpose.

Steps of our proposed approach are :

Start

Step 1 : Sensors sensed the water quality parameters like pH, minerals and temperature.

Step 2 : Sensed data send to the cloud server.

Step 3 : Cloud server receive the sensed data.

Step 4 : After receiving the sensed data cloud server process or compute the received data.

Step 5 : The processed data classified by using Naive Bayes algorithm and training data set.

Step 6 : Classified data convert into the tested data set and predict the range of water quality by using Recurrent Neural Network.

Step 7 : The final result aware the people or authority about the water quality by the sending them alert message.

Stop

Propose technology is focusing to the awareness of water quality. We know that 'precaution is better then cure', the WQM system aware the people about water quality in real-time situation. This technology is not a manual working process, it is completely automated for the user. The manual process of WQM system is taking much time and manual process is also expensive and inefficient process. The WQM system is really efficient and inexpensive technique.

4.2 MODEL OF PROPOSED APPROACH :

In this approach, we use sensors for sensing the water quality parameter, on the basis of the of sensed data we classify the data and predict the range of water quality that for what purpose water can be used ? The NB and RNN algorithms are used in this technique for classification and categorization of use of water. The following model explain our approach.

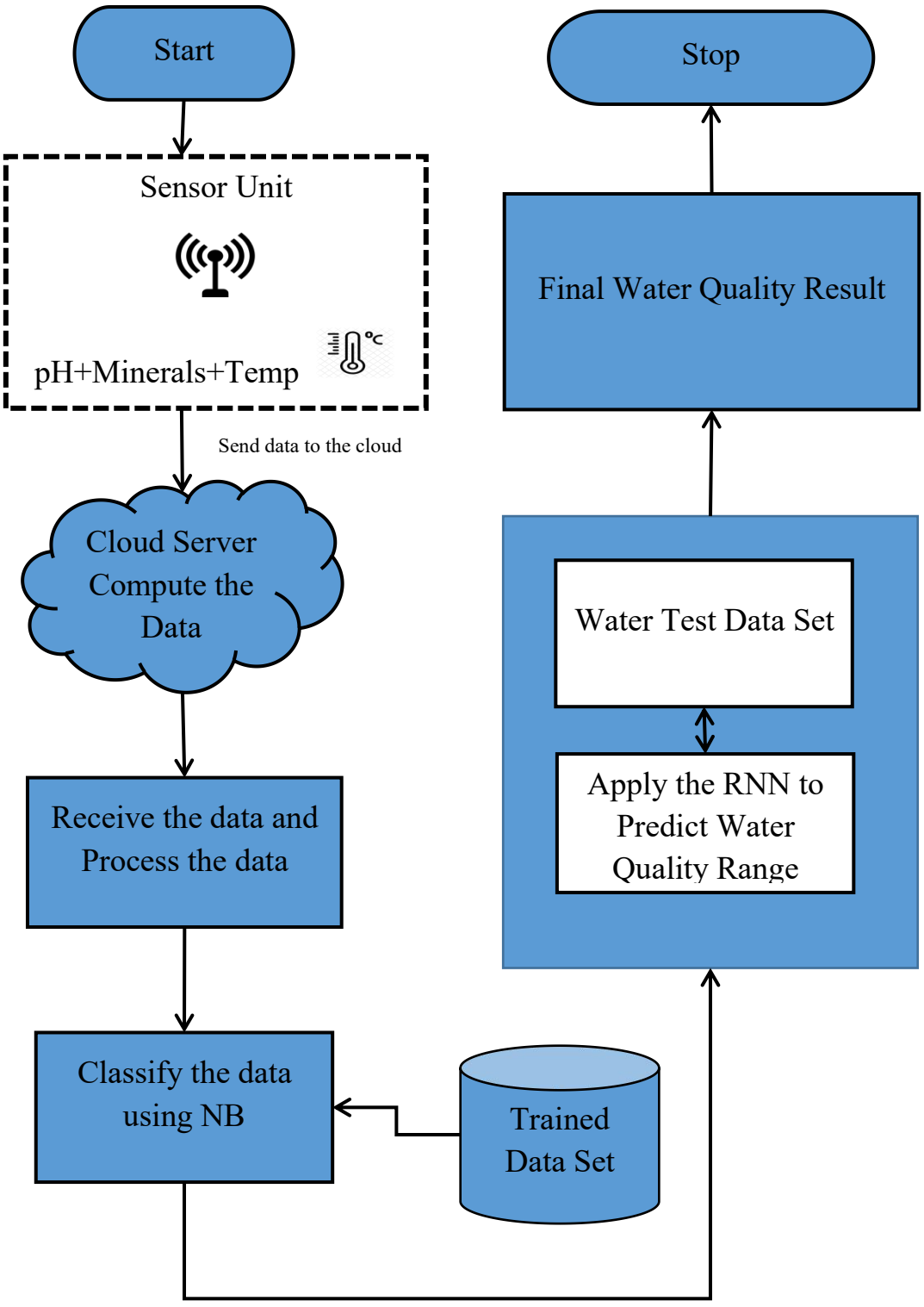


Figure 4.1 : Model of Proposed Approach

4.3 NAIVE BAYES :

NB is a easy and simple technique used for constructing classifiers base on Bayes' Theorem. It labels the classes in the basis of some strong independence assumption which is a particular feature of a object that present in the class and it is not related to the other feature of class.

Naive Bayes model is a probability model of a Bayesian theorem that can be trained easily in supervised learning mode. Naive Bayes algorithm does not needed large data set to learn.

4.3.1 Steps in Naive Bayes algorithms :

Step 1 : Convert data set according to pH, Minerals and Temperature.

Step 2 : Create likelihood of water parameter for different probability.

Step 3 : With the help of Naive Bayes algorithm, data sets can be classified.

4.3.2 Model of NB :

Naive Bayes algorithm is use for classification of data set. It labeled the classes according to the training data set. Naive Bayes algorithm is easy to use and it gives efficient result in supervised learning mode. It is useful for processing huge data set and gives high accuracy.

In our approach, Naive Bayes use for classify the data set according to the training data set. These data set includes water quality parameters such as pH, minerals and temperature of water.

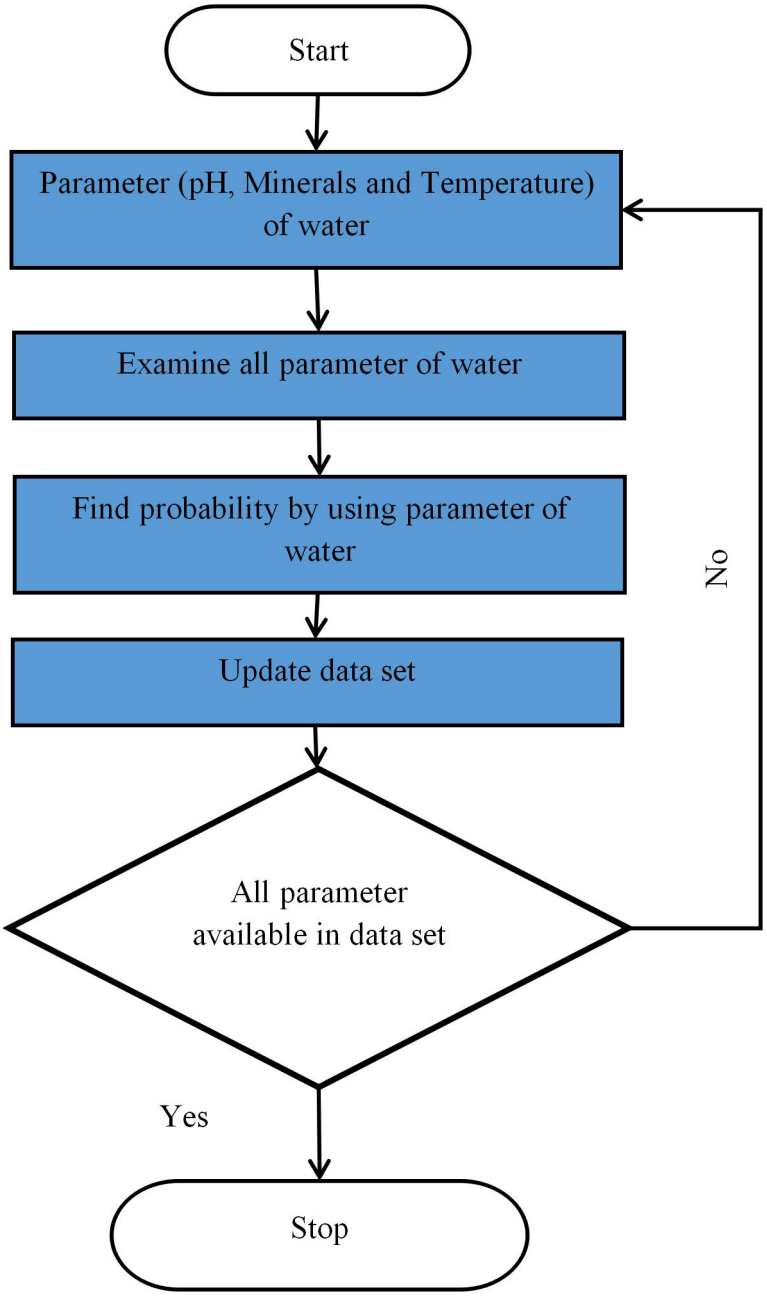


Figure 4.2 : Model of Naive Bayes

4.4 RECURRENT NEURAL NETWORK :

RNN is a part of Neural Network that fed the previous output as input to the current state. In RNN, all inputs and output are independent but if system requires to predict something, it requires the previous output and for this it need to remember previous output for that RNN have “memory” it remembers some information about ‘what has been calculated so far?’. RNN comes in existence to solve the issue of input data with help of hidden layer. To produce an efficient output, it uses same values or parameters for each input as it performs same task on all inputs or hidden layers. It reduces the complexity of parameters.

4.4.1 Steps in RNN algorithms :

Step 1 : An input is provided to the network.

Step 2 : Calculate current state by using current input and previous state output, hence current output fed as previous output to the next step.

Step 3 : Step 2 will be repeated until the final current state is use to calculate the output.

Step 4 : After calculating the output it compares the provided output.\

Step 5 : If the output is same as the provided output

Then final output is correct.

Else

Back-propagate to the Step 2 and update the input.

4.4.2 Model of RNN :

In our approach, RNN is use to calculate the final output, RNN takes classified data set as current input and calculate the final output. Final output compare with the provided data sets, if the current output is matched with the provided data set then the water is usable otherwise water is not usable.

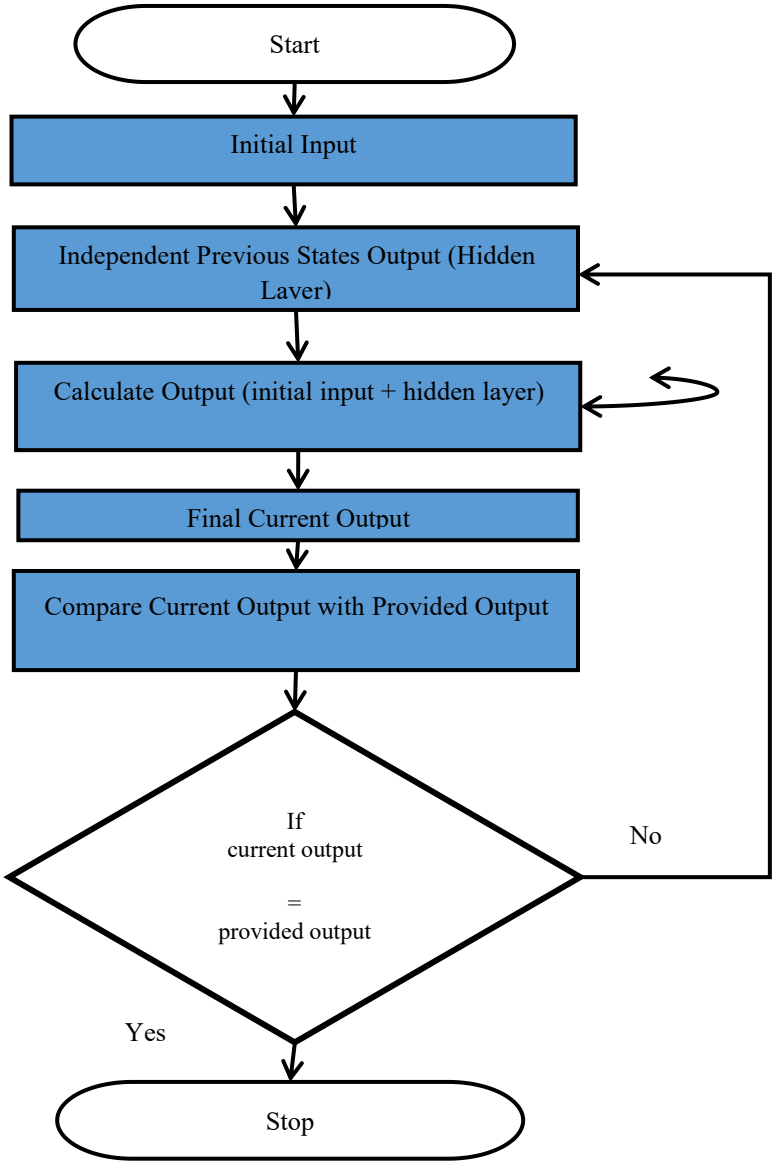


Figure 4.3 : Model of Recurrent Neural Network

CHAPTER : 5

ALGORITHM AND RESULT ANALYSIS

5.1 ALGORITHM :

The collecting data from sensor nodes and processing data into cloud the algorithm includes following steps to predict the water quality and categories the utility of water in different field.

Step 1 : Install the Raspbian Stretch Operating system on Raspberry Pi 4.

Step 2 : Connect the pH sensor, water temperature sensor and TDS sensor with Raspberry Pi 4.

Step 3 : Since all sensor would detect the all values of water such as, pH value, current temperature and mineral values and send these values to the cloud.

Step 4 : In next step we collect the data set of different pH values, water temperature and mineral sets and water result for training.

Step 5 : After formation of all values, it is trained. Once the training is completed, it crates a .pickle file, is generated for matching feature to know the water quality. After the training the system is prepare to decide good water quality and bad water quality.

Step 6 : Water quality is decided by the Naive Bayes algorithm and Recurrent Neural Network algorithm predict the water utility for specific field.

5.2 RESULT ANALYSIS :

The IoT and WSN creates a system which monitor water quality in real-time environment, by this approach, the collected sensed data process on the cloud and aware the people by sending message or storing it on the cloud. This approach creates training data sets of minerals and pH values for prediction and analysis.

5.2.1 Result analysis for pH value :

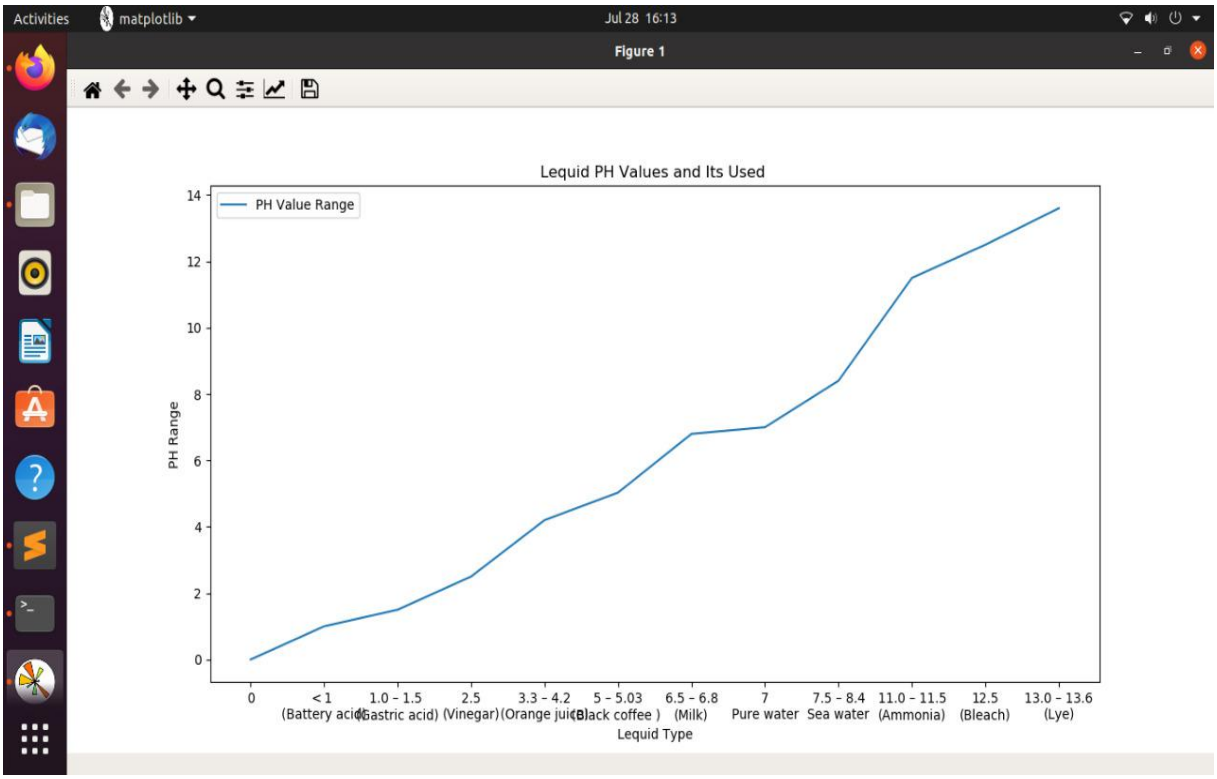


Figure 5.1 : Liquid pH value and its use

As we can see the graph, which is a training graph of pH value, shows the taste of water on different point. The water with lower than 7 pH value is considered acidic and the water with greater than 7 pH value considered basic. The pH value 7 is pure water.

The pH value lies between 6.5 - 8.5 can be use for different purpose like drinking, out-door bathing, propagation of wildlife and fisheries and Irrigation, Industrial Cooling, Controlled Waste disposal etc.

Liquid pH value tastes shown in a table :

Table 5.1 : for less than 7 pH value

pH	Taste
6.5 to 6.8	The pH value lies between 6.5-6.8 tastes like milk
5.0 to 5.3	The pH value lies between 5.0-5.03 tastes like black coffee
3.3 to 4.2	The pH value lies between 3.3-4.2 tastes like fruit juice (orange juice)
2.5	When the pH value is 2.5 then it tastes strongly acidic (vinegar)
1.0 to 1.5	The pH value lies between 1.0-1.5 is gastric acidic
0 to 1.0	If the pH value is less than 1.0 then it is very strongly acidic which is like battery acid

Table 5.2 : for more than 7 pH value

pH	Taste
13.0 to 13.6	If the pH value lies between 13.0-13.6 the it is like Lye (sodium hydroxide (NaOH))
12.5	When the pH value is 12.5 then it is like bleach
11.0 to 11.5	The pH value lies between 11.0-11.5 it is like ammonia (NH_3) water
7.5 to 8.4	The pH value lies between 7.5-8.4 is basically sea water

5.2.2 Result analysis for TDS (minerals) values :

The next training graph shows TDS value, it shows range of TDS by which it shows the use of water that, water is acceptable or not acceptable for different purpose.

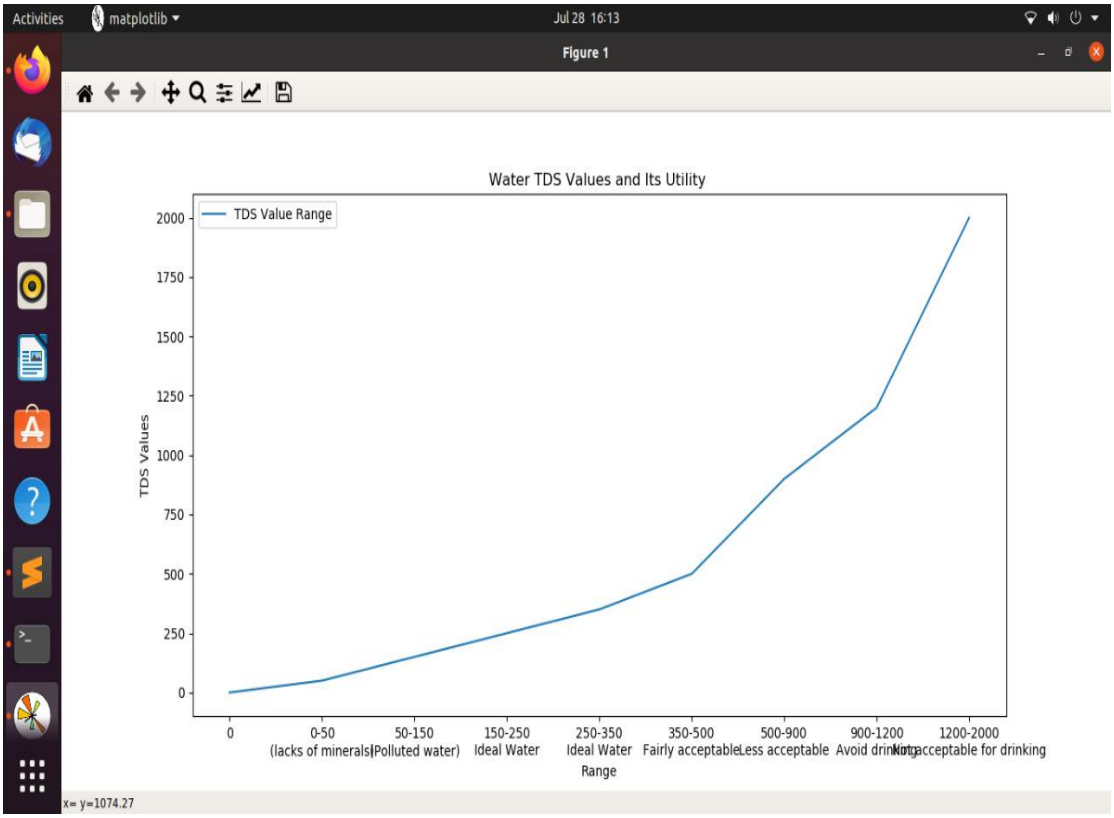


Figure 5.2 : Water TDS and its utility

TDS (total dissolve solid) is in water known as minerals, salt, metals etc., which is completely dissolve by water. The graph shows the range of TDS (range in ppm) in water, safe for drinking or not. The TDS range lies between 0-50 is unacceptable for drinking because of lake of minerals or polluted water. The TDS range lies between 50-150 is acceptable for drinking. The TDS range lies between 150-250 is ideal water and TDS range lies between 250-350 is also ideal water for drinking. The TDS range lies between 350-500 is fairly acceptable for drinking. The TDS range lies between

500-900 is less acceptable for drinking. If the TDS range lies between 900-1200 then avoid to drinking the water. If the TDS range lies between 1200-2000 or more than 2000 the water is unacceptable for drinking.

The TDS range of water other uses like irrigation, fisheries and outdoor bathing are classified as : TDS range in water for irrigation should be lies between 0-500 is acceptable for all crops. The TDS range lies between 500-1500 is acceptable for highly tolerant crops and the TDS range is grater than 1500 is not acceptable for crops. The ideal TDS range of water for outdoor bathing is should be lies 200-400 and the maximum TDS range for swimming pools are 1500. The fresh water-fishes should have TDS range 400 or less than 400 and the other side salt-water fishes needed high level TDS range which is lies between 5000 to 50,000.

5.2.3 Water Quality Accuracy and Comparison :

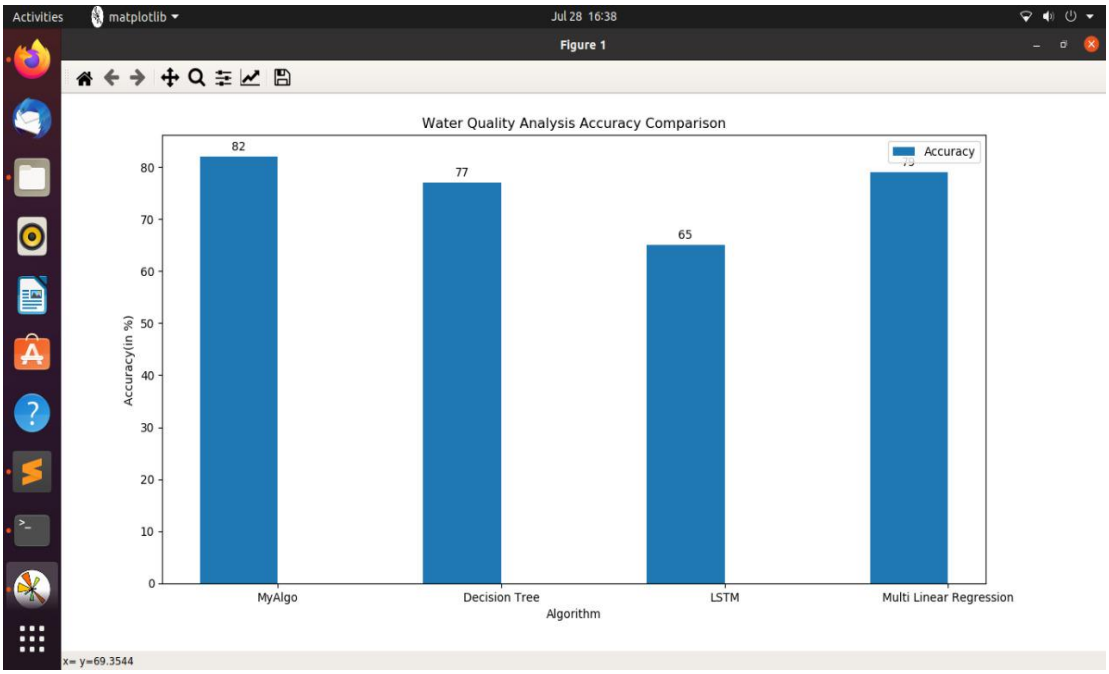


Figure 5.3 : Water Quality Accuracy and Comparison

The above graph is the accuracy comparison graph of water quality. Our approach of water quality monitoring system gives more accuracy by using NB and RNN algorithm than other algorithms. Our algorithm gives 82 % accuracy than other algorithm like LSTM gives 65% accuracy, Decision tree gives 77% accuracy and Multi Linear Regression gives 79 % accuracy comparatively.

5.2.4 : Response Time and Comparison :

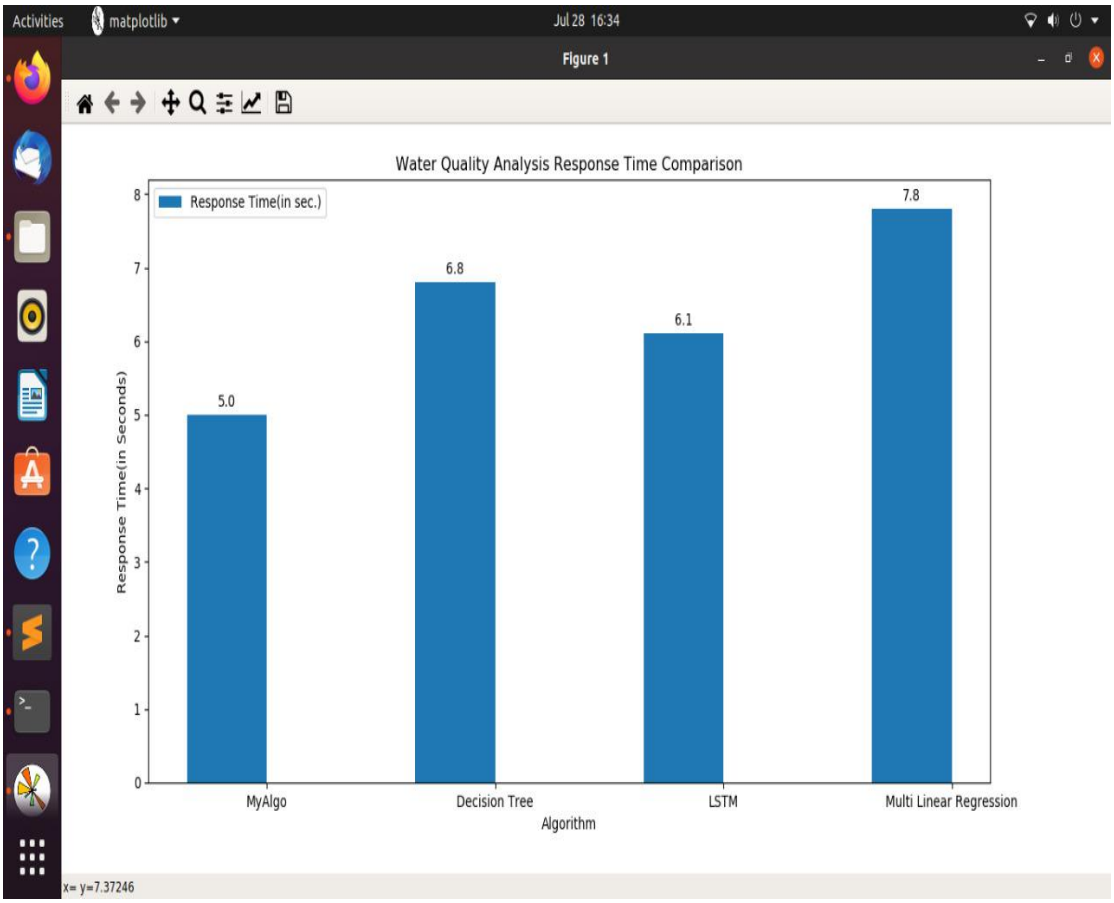


Figure 5.4 : Water Quality Response Time and Comparison

The above graph is response time comparison graph of water quality. The response time of our approach is less than the other approaches. The response time means the

response of our algorithm is faster than others like if there are any impurity in water occurs, our approach gives fast response that good quality water or bad quality water. Response time of our approach is 5 second which is less than other approach, like Multi Linear Regression response time is 7.8 second, Decision Tree response time is 6.8 seconds and the LSTM response time is 6.1 seconds comparatively.

5.3 Hardware used

- **Generic pH electrode sensor :**

The term pH is a measure of the concentration of hydrogen ions in diluted solution

- **DS18B20 water proof temperature sensor :**

To measure temperature we are using waterproof DS18B20 temperature sensor which has are range from -55 to +125 degrees [1] and [11]. This is a waterproof temperature sensor which gives accurate result.

- **TDS 407 ppm**

Total dissolve solid (TDS) measure the TDS value in ppm for water.

CHAPTER: 6

CONCLUSION AND FUTURE WORK

6.1 Conclusion :

This approach is helpful to alert the people or authority about water quality in real-time. This project helps people about current quality of water by processing the sensed data of the water. The IoT and WSN creates a system which monitor water quality in real-time environment, by this approach, the collected sensed data process on the cloud. Sensors sensed real-time condition of water and transmit these data to the cloud for processing where data are classified and compare with the trained data set and this system predict the water utility for different use. The water quality parameters like pH value, TDS value and temperature are monitored by the sensors for measuring the water quality. Water can categorize for different purpose like drinking, outdoor bathing, irrigation, industrial use or house hold use. In this approach we use Naive Bayes and Recurrent Neural Network for classification and prediction of water quality. In this project we create a data set of pH value and minerals. The pH value lies between 6.5 - 8.5 can be use for different purpose. The TDS range lies between 150-250 is ideal water. By theses data set we can categories the utility of water. The impure and polluted water needs a WQM system that has been safe and secure. This approach is a cheap and effective approach for WQM system.

6.2 Future Work :

We have proposed an approach of an intelligent IoT based Wireless Sensor Network for Monitoring of Water Quality by using RNN in Real-Time.

For future work, few suggestion of WQM system is to study the physical impurity of water and create a system to locate the source of physical wastage for detection and

prevention of wastage dumping in water. A monitoring system can be developed by using IoT , ML and GPS to track the contamination source.

REFERENCES

1) Nikhil Kumar Koditala, Dr.Purnendu Shekar Pandey “Water Quality Monitoring System using IoT and Machine Learning” 978-1-5386-2599-6/18/2018 IEEE.

2) N.Vijayakumar, R. Ramy “The Real Time Monitoring of Water Quality in IoT Environment” 2015 IEEE International Conference on Circuit, Power and Computing Technologies [ICCPCT].

3) Theofanis P. Lambrou, , Christos G. Panayiotou, Christos C. Anastasiou and Marios M. Polycarpou (2014) “A Low-Cost sensor Network for Real Time Monitoring and Contamination Detection in Drinking Water Distribution System” IEEE SENSOR JOURNAL, VOL. 14, NO. 8, AUGUST 2014.

4) Brinda Das, P.C. Jain “Real-Time Water Quality Monitoring System using Internet of Things” 2017 IEEE International Conference on Computer, Communications and Electronics (Comptelix).

5) K.Saravanan, Raghvendra Kumar, E. Anusuya and Le Hoang Son “Real-time water quality monitoring using Internet of Things in SCADA” 2018 Springer Nature Switzerland.

6) Thinagaran Perumal, Md Nasir Sulaiman, Leong.C.Y “Internet of Things (IoT) Enabled Water Monitoring System” 2015 IEEE 4th Global Conference on Consumer Electronics (GCCE).

7) Prasad. M. Pujar, Harish. H. Kenchannavar, U. P. Kulkarni “ Wireless Sensor Network Based Water Monitoring Systems: A Survey” 2016 IEEE 2nd International

Conference on Applied and T heoretical Computing and Communication Technology (iCATccT).

8) Gaganjot Kaur Kang, Jerry Zeyu Gao, Gang Xie “Data-driven Water Quality Analysis and Prediction: A Survey” 2017 IEEE Third International Conference on Big Data Computing Service and Applications.

9) B O’Flynn, Rafael Martínez,Català, S. Harte, C. O’Mathuna, John Cleary, C. Slater, F. Regan, D. Diamond, Heather Murphy “SmartCoast : A Wireless Sensor Network for Water Quality Monitoring” 32nd IEEE Conference on Local Computer Networks.

10) Zulhani Rasin, Mohd Rizal Abdullah “Water Quality Monitoring System Using Zigbee Based Wireless Sensor Network” 2012 International Journal of Engineering & Technology IJET Vol: 9 No: 10 91410-7575 IJET-IJENS @ International Journals of Engineering and Sciences IJENS.

11) Anuadha T “The Monitoring of Water Quality in IoT Environment” 2018 IJSRST Volume 4. Issue 5. International Journal of Scientific Research in Science and Technology.

12) Prof. Savita Lade, Prathamesh Vyas, Vikrant Walavalkar, Bhaiyasab Wankar, Pranjal Yadav “Water Management System Using IoT with WSN” 2018 IRJET Volume: 05 Issue: 03 International Research Journal of Engineering and Technology.

13) Maneesha V Ramesh, Nibi K V, Anupama Kurup“Water Quality Monitoring and Waste Management using IoT” 978-1-5090-6046-7/17/2017 IEEE

14) Arivoli Appavu, Sathiamoorthi Thangavelu, Satheeshkumar Muthukannan, Joseph Sahayarayan Jesudoss and Boomi Pandi “Study Of Water Quality Parameters Of

Cauvery River Water In Erode Region" 2016 JGB Volume 5, Number 9, pp. 4556-456, Journal of Global Biosciences.

15) Tharam Dillon, Chen Wu and Elizabeth Chang "Cloud Computing: Issues and Challenges" 2010 24th IEEE International Conference on Advanced Information Networking and Applications

16) Umair Ahmed, Rafifia Mumtaz, Hirra Anwar, Asad A. Shah, Rabia Irfan and José García-Nieto "Effiffifficient Water Quality Prediction Using Supervised Machine Learning" 2019 MDPI, doi:10.3390/w11112210

17) M.B.Kawarkhe, Sanjay Agrawal "Smart Water Monitoring System Using IOT at Home" 2019 IOSR Volume 21, Issue I, Journal of Computer Engineering IOSR-JCE.

18) Joy Shah "An Internet of Things Based Model for Smart Water Distribution with Quality Monitoring" 2017 IJIRSET Vol. 6, Issue 3, International Journal of Innovative Research in Science, Engineering and Technology.

19) Keyur K Patel "Internet of Things-IOT: Definition, Characteristics, Architecture, Enabling Technologies, Application & Future Challenges" 2016 IJESC International Journal of Engineering Science and Computing.

20) Kamaldeep Kaur,Parneet Kaur "Wireless Sensor Network: Architecture, Design Issues and Applications"2014 IJSER, Volume 2 Issue 11, International Journal of Scientific Engineering and Research.

21) Ab Rashid Dar, Dr. D. Ravindran “A Comprehensive Study on Cloud Computing Paradigm” 2018 IJARSE, Volume 4, Issue no. 4,International Journal of Advance Research in Sscience and Research.

22) Ajey Singh, Dr. Maneesh Shrivastava “Overview of Attacks on Cloud Computing” 2012 IJEIT, Volume 1, Issue 4, International Journal of Engineering and Innovative Technology.

23) Rashmi “IoT (Internet of Things) Concept and Improved Layered Architecture” 2018 IJEDR Volume 6, Issue 2 International Journal of Development and Research.

24) Naseer Amara, Huang Zhiqui, Awais Ali “Cloud Computing Security Threats and Attacks with their Mitigation Techniques” 2017 IEEE DOI 10.1109, International Conference on Cyber-Enabled Distributed Computing and Knowledge Discovery.

25) Ruchi Mittal, M.P.S Bhatiab “Wireless Sensor Networks for Monitoring the Environmental Activities” 2010 IEEE.

26) Kejie Lu, Yi Qian, Domingo Rodriguez, Wilson Rivera, Manual Rodriguez “Wireless Sensor Networks for Environmental Monitoring Applications: A Design Framework” 2007 IEEE Globecom.

27) Sonali Swetapadma Sahu, Manjusha Pandey “Distributed Denial of Service Attacks: A Review” 2014 MECS, Doi: 10.5815ijmecs.2014.01.07, I.J. Modern Education and Computer Science.

28) Soumyalatha, Shruti G Hegde “Study of IoT: Understanding IoT Architecture, Applications, Issues and Challenges” 2016 IJANA, International Journal of Advanced Networking & Applications.

29) NIST “The NIST Definition of Cloud Computing” 2011 NIST Special Publication 800-145.

30) Ahmad Abed Alhameed Alkhatib, Gurvinder Singh Baicher “Wireless Sensor Network Architecture” 2012 CNCS, IPCSIT vol.12, International Conference on Computer Networks and Communication Systems.

31) Soundarya Pappu, Prathyusha Vudatha, Niharika.A.V,Karthick.T and Suresh Sankaranarayanan “Intelligent IoT Based Water Quality Monitoring System” 2017 IJAER, Volume 12, Issue no. 16, International Journal of Applied Engineering Research.

32) Zecheng He, Tianwei Zhang, Ruby B. Lee “Machine Learning Based DDoS Attack Detection From Source Side in Cloud” 2017 IEEE,DOI 10.1109/CSCloud.2017.58, IEEE 4th International Conference on Cyber Security and Cloud Computing.

33) Santosh Kumar and R. H. Goudar “Cloud Computing – Research Issues, Challenges, Architecture, Platforms and Applications: A Survey” 2012 IJFCC, Vol. 1, No. 4, International Journal of Future Computer and Communication.

34) R.Rajagopal, Michael Wichman and Edwin Brands “Definitions, availability, and distribution of and access to drinking water” 2017 The International Encyclopedia of Geography.

35) Water quality Standard “Indian Standard For Drinking water - Specification IS-10500: 2012 ”

36) Prof. A. Balasubramanian “THE WORLD’S WATER” 2015 Centre for Advanced Studies in Earth Science, University of Mysore.

37) Krushang Sonar, Hardik Upadhyay “A Survey: DDOS Attack on Internet of Things” 2014 IJERD, Volume 10, Issue 11, International Journal of Engineering Research and Development.

38) Varsha Nigam, Saurabh Jain, Dr. Kavita Burse “Profile based Scheme against DDoS Attack in WSN” 2014 IEEE, DOI 10.1109/CSNT.2014.31, Fourth International Conference on Communication Systems and Network Technologies.

39) Keshav Sood, Shui Yu and Yong Xiang *“*Software Defifined Wireless Networking Opportunities and Challenges for Internet of Things: A Review*” 2015* IEEE Internet of Things Journal.

40) Rajkumar, Dr H G Chandrakanth, Dr D G Anand and Dr T John Peter “Research Challenges and Characteristic Features in Wireless Sensor Networks” 2017 IJANA, Volume: 09 Issue: 01, Int. J. Advanced Networking and Applications.

41) Mohd Fauzi Othman, Khairunnisa Shazali “Wireless Sensor Network Applications: A Study in Environment Monitoring System” 2012 International Symposium on Robotics and Intelligent Sensors

42) Ghasem Farjamnia and Yusif Gasimov “Wireless Sensor Networks Architecture” 2016 IRJCS, Issue 01, Volume 3, International Research Journal of Computer Science

43) Annina Simon, Mahima Singh Deo, S. Venkatesan and D.R. Ramesh Babu “An Overview of Machine Learning and its Applications” 2015 IJESE, Volume 1, Issue 1, International Journal of Electrical Sciences & Engineering.

44) Most common attacks on cloud computing "https://www.apriorit.com/dev-blog/523-cloud-computing-cyber-attacks"

45) Distributed Denial of Service "https://en.wikipedia.org/wiki/Denial-of-service_attack"

46) Type of Attacks "https://www.l-tron.com/iot-security-risks-4-types-of-cyber-attacks/"

PLAGIARISM CHECK REPORT

ABSTRACT

SmallSEOTools

PLAGIARISM SCAN REPORT

Words	311	Date	August 07,2020
Characters	1912	Exclude Url	

0%	100%	0	13
Plagiarism	Unique	Plagiarized Sentences	Unique Sentences

Content Checked For Plagiarism

ABSTRACT Water uses is increasing day by day. As development continues, the demand for water is increasing. Water is require for daily routine, for irrigation, for fish and wildlife and for industrial use, not only water but pure water is require. As

CHAPTER 1

SmallSEOTools

PLAGIARISM SCAN REPORT

Words	913	Date	August 07,2020
Characters	5566	Exclude Url	

0%	100%	0	50
Plagiarism	Unique	Plagiarized Sentences	Unique Sentences

Content Checked For Plagiarism

CHAPTER: 1 INTRODUCTION 1.1BACKGROUND : Water is the main source of life. The good quality water in not only needed for drinking but also in various other activities like agriculture, industry and many more. Now the question is arise, the water we

SmallSEOTools

PLAGIARISM SCAN REPORT

Words	979	Date	August 07,2020
Characters	5681	Exclude Url	

0%	100%	0	37
Plagiarism	Unique	Plagiarized Sentences	Unique Sentences

Content Checked For Plagiarism

Characteristics Designated best use A B C D E Dissolved-Oxygen mg/l, min 6 5 4 4 - Biochemical-Oxygen (BO) demand mg/l, max 2 3 3 - - Total coliform-organisms (TCO) MPN/100ml, max 50 500 5,000 - - pH value 6.5-8.5 6.5-8.5 6.0-9.0 6.5-8.5 6.0-8.5 Colour, Hazen units, max. 10 300 300 - - Odour Un-objectionable - - Taste Tasteless - - - - Total dissolved solids, mg/l, max. 500 -

SmallSEOTools

PLAGIARISM SCAN REPORT

Words	976	Date	August 07,2020
Characters	6452	Exclude Url	

0%	100%	0	46
Plagiarism	Unique	Plagiarized Sentences	Unique Sentences

Content Checked For Plagiarism

1.4.3BIOLOGICAL IMPURITIES : Biological impurities of water impurity is causes by the living organisms such as bacteria, algae, pathogens, protozoa, Viruses, microbes, Parasites and their eggs etc [34]. These living organisms are collectively called

SmallSEOTools

PLAGIARISM SCAN REPORT

Words	923	Date	August 07,2020
Characters	6318	Exclude Url	

0%	100%	0	45
Plagiarism	Unique	Plagiarized Sentences	Unique Sentences

Content Checked For Plagiarism

Application Layer : This is the toppest layer of IoT and it is also an user interface layer. The IoT project such as Smart Transportation, Smart Building, Smart City, Smart Lifestyle, Smart Retail, Smart Agriculture, Smart Factory, Smart Supply

SmallSEOTools

PLAGIARISM SCAN REPORT

Words	947	Date	August 07,2020
Characters	6358	Exclude Url	

0%	100%	0	42
Plagiarism	Unique	Plagiarized Sentences	Unique Sentences

Content Checked For Plagiarism

Gateway : The interface between sensor nodes and outside networks is known as gateway. Their are various type of gateways available like microprocessor, micro-controller etc. The sensor need connectivity to the sensor gateways can be LAN

SmallSEOTools

PLAGIARISM SCAN REPORT

Words	956	Date	August 07,2020
Characters	6556	Exclude Url	

2%	98%	1	43
Plagiarism	Unique	Plagiarized Sentences	Unique Sentences

Content Checked For Plagiarism

1.5.3Cloud Computing (CC) : CC is a computing model that provide services via internet. Cloud Computing is development of grid computing, parallel computing and distributed computing and it is the combination and evolution of Virtualization and

SmallSEOTools

PLAGIARISM SCAN REPORT

Words	631	Date	August 07,2020
Characters	3888	Exclude Url	

0%	100%	0	32
Plagiarism	Unique	Plagiarized Sentences	Unique Sentences

Content Checked For Plagiarism

It is very expensive to use different sensors to measure different parameter of water. IoT provide sensors to the devices that examines different parameter of water like pH value, temperature of water, minerals of water and stores its data in to the

CHAPTER 2

SmallSEOTools

PLAGIARISM SCAN REPORT

Words	969	Date	August 07,2020
Characters	6159	Exclude Url	

0%	100%	0	46
Plagiarism	Unique	Plagiarized Sentences	Unique Sentences

Content Checked For Plagiarism

CHAPTER : 2 SECURITY BACKGROUND 2.1INTRODUCTION : Security is an important characteristics of any system. Consumer demands high security aspect of any device or technology. Nowadays the world is constantly moving toward technologies

SmallSEOTools

PLAGIARISM SCAN REPORT

Words	855	Date	August 07,2020
Characters	5367	Exclude Url	

0%	100%	0	39
Plagiarism	Unique	Plagiarized Sentences	Unique Sentences

Content Checked For Plagiarism

ICMP Flood : Figure 2.4 : Attack of ICMP Flood ICMP flood attack is similar to the UDP flood attack, that here attacker sends packet as fast as he can without waiting for any replies. The target resource is full with ping (also known as ICMP Echo

CHAPTER 3

SmallSEOTools

PLAGIARISM SCAN REPORT

Words	990	Date	August 07,2020
Characters	6172	Exclude Url	

0%	100%	0	48
Plagiarism	Unique	Plagiarized Sentences	Unique Sentences

Content Checked For Plagiarism

CHAPTER : 3 LITERATURE REVIEW 3.1LITERATURE REVIEW : Nikhil Kumar Koditala (2018, IEEE), [1] has works on WQM system with help of IoT, Machine Learning and Cloud Computing. The author basically focused on rural areas water quality. The

SmallSEOTools

PLAGIARISM SCAN REPORT

Words	618	Date	August 07,2020
Characters	3964	Exclude Url	

0%	100%	0	36
Plagiarism	Unique	Plagiarized Sentences	Unique Sentences

Content Checked For Plagiarism

Maneesha V Ramesh, Nibi K V and Anupama Kurup (2017, IEEE), [13] has proposed WQM and waste management technique by using IoT. Author basically focus on the condition of Pettipalam Colony in Kerala that how water quality is degrading day by

CHAPTER 4

SmallSEOTools

PLAGIARISM SCAN REPORT

Words	933	Date	August 07,2020
Characters	5424	Exclude Url	

0%	100%	0	49
Plagiarism	Unique	Plagiarized Sentences	Unique Sentences

Content Checked For Plagiarism

CHAPTER : 4 PROPOSED WORK 4.1PROPOSED APPROACH : To aware the people or authority about water quality in real-time, proposed technique help to implement an environment for different use of water in different field. Our technique is to

CHAPTER 5

PLAGIARISM SCAN REPORT

Words	997	Date	August 07,2020
Characters	5673	Exclude Url	

0%	100%	0	50
Plagiarism	Unique	Plagiarized Sentences	Unique Sentences

Content Checked For Plagiarism

CHAPTER : 5 ALGORITHM AND RESULT ANALYSIS 5.1 ALGORITHM : The collecting data from sensor nodes and processing data into cloud the algorithm includes following steps to predict the water quality and categories the utility of water in different

CHAPTER 6

SmallSEOTools

PLAGIARISM SCAN REPORT

Words	312	Date	August 07,2020
Characters	1843	Exclude Url	

0%	100%	0	16
Plagiarism	Unique	Plagiarized Sentences	Unique Sentences

Content Checked For Plagiarism

CHAPTER: 6 CONCLUSION AND FUTURE WORK 6.1 Conclusion : This approach is helpful to alert the people or authority about water quality in real-time. This project helps people about current quality of water by processing the sensed data of the water.

PUBLICATION FROM THIS WORK

1) **"Review on an Intelligent IoT based wireless sensor network for water quality monitoring system."** has been accepted in the International Conference on Recent Trends in Electrical and computer Science Engineering (ICEECS-2020) held at Uma Nath Singh Institute of Engineering and Technology, Purvanchal Univercity, Jaunpur, Uttar Pradesh and published in Scopus Index Journal.

2) **"An intelligent IoT based Wireless Sensor Network for Monitoring Water Quality by using RNN in Real-Time."** has been Accepted in the Scopus Index Journal International Journal of Innovative Technology and Exploring Engineering (IJITEE) ISSN: 2278-3075, Volume-9, Issue-11, September 2020 (IJITEE)