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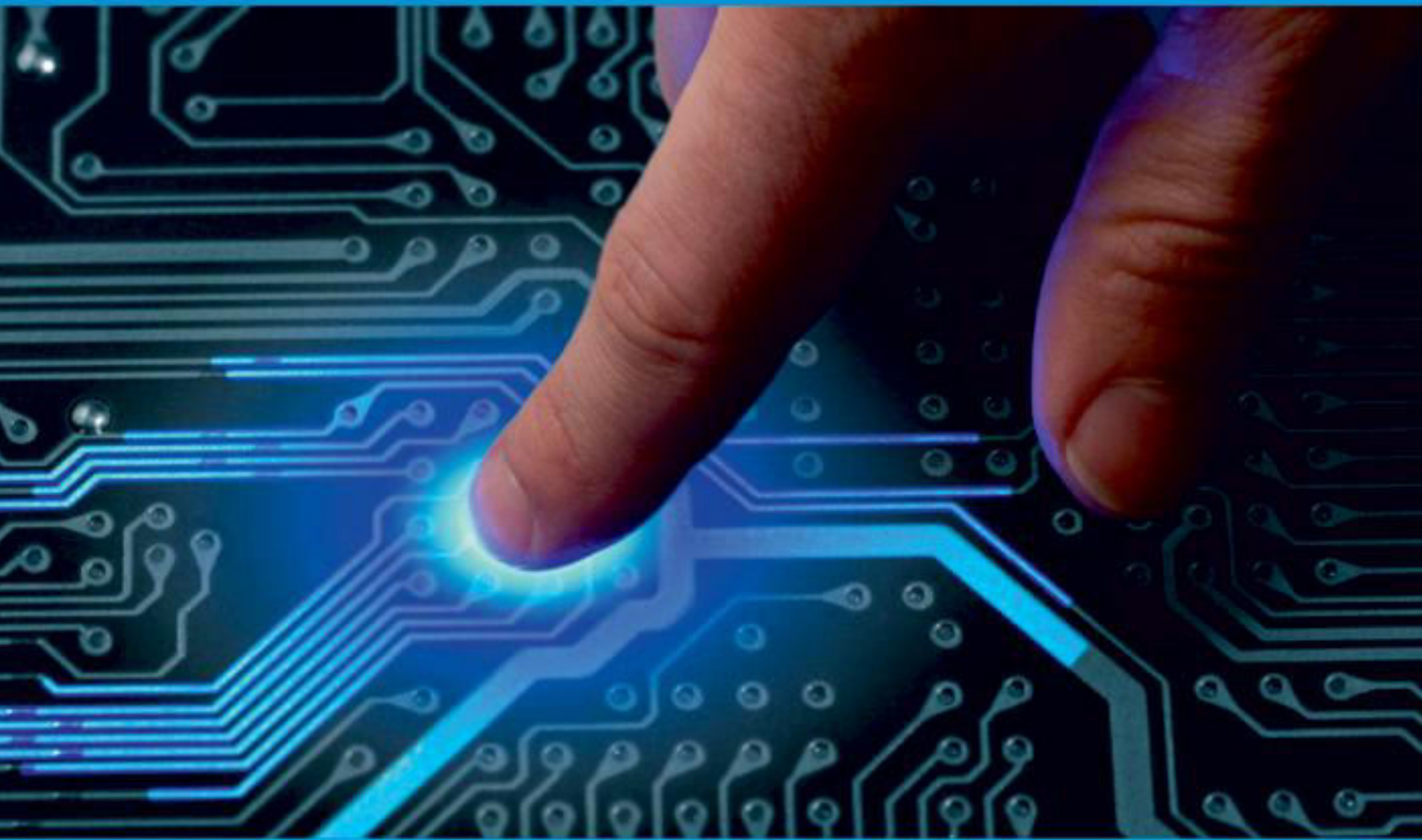

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IoT Based River Water Quality Monitoring and Sensor Fault Diagnosis Using SVM

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Abstract: Internet of things and smart sensor technology can play significant role in river water quality monitoring. There are few system exist like smart sensor network using zigbee, gsm and many more to monitor the quality of river water with sets of different sensors. Here we proposed the system that can monitor the river water quality by analyzing parameters like pH, odor, conductivity and flow rate and displayed it over platform integrated with Internet of Thing (IoT) continuously. Depending on the data the government can clean the river area, inform locals about quality of water, also to the farmers who are using river water for farming and the researchers will get data to make models for water cleaning. The result will be the graphical representation of each parameter and numerical values which can be used for machine learning.

KEYWORDS*:* Contamination, Ecology, Internet of Thing, Monitor, Network, Parameters, Polluted, Treatment, Water.

I. INTRODUCTION

Environment around us consists of five key elements. These are soil, water, climate, natural vegetation and land forms. Among these water the most essential element for human to live. It is also important for the survival of other living habitants. Whether it is used for drinking, domestic use, and food production or recreational purposes, safe and readily available water is must for public health. So it is highly imperative for us to maintain water quality balance. Otherwise it would severely damage the health of the humans and at the same time affect the ecological balance among other species.

In the 21st century providing pure drinking water is becoming a major challenge worldwide.

International governing bodies such as United Nations (UN) and World Health Organization (WHO) also recognized human right to sufficient, continuous, safe, and acceptable, physically accessible, and affordable water for personal and domestic use. According to research of WHO 844 million people lack even a basic drinking –water service, including 159 million people who are dependent on surface water. Impure drinking can cause life threatening disease such diarrhea, cholera, dysentery, typhoid, and polio. The research alarmingly estimates that every year diarrhea alone is causing around death of five lakh people**.** Figure 1 illustrates how water crisis becoming an epidemic in twenty first century. Now a day's Internet of things is a revolutionary technological phenomenon. It is shaping today's world and is used in different fields for collecting, monitoring and analysis of data from remote locations. Internet of things integrated network if everywhere starting from smart cities, smart power grids, and smart supply chain to smart wearable. Though internet of things is still under applied in the field of environment it has huge potential. It can be applied to detect forest fire and early earthquake, reduce air population, monitor snow level, prevent landslide and avalanche etc. Moreover it can be implemented in the field of water quality monitoring and controlling system. We can design a water quality monitoring system in smart city where there will be a network of devices connected to remote stations and the parameters from the water sources will be stored in a microcontroller via WSN. City dwellers can easily get notified about of the quality of the water via SMS or they can view it on webpage and also local authority can take necessary actions.

II. LITERATURE SURVEY

Many systems have already been developed based on the topics of remote monitoring various researches have been performed to monitor the quality of water:

B O'Flyrm, R Martinez, J.Cleary, C.Slater, F.Regan, D.Diamond and H. Murphy (2007)[8] developed a multisensory system measuring water parameters such as temperature, dissolved oxygen, conductivity, ph, turbidity, phosphate and water level for water quality monitoring. The market demand for novel, miniaturized, intelligent monitoring systems

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for freshwater catchments, transitional and coastal waters is high very across worldwide. Moreover they also work on building custom sensors and integration of Tyndall based integrated sensor network.

Yue and Ying [7] presented novel system architecture of distributed sensor nodes and a base station which collects real –time sample from different field sites. They used wireless sensor network for collecting data and solar power panel for power supply. Low CO2 emission, low power consumption and flexibility are few notices worthy pros of this system.

Barabde and Danve (2015) [20] paper presented three layers of system architecture of water quality monitoring system. Those three are nodes for data monitorization, a base station and a remote station. They connected all the layers with wireless communication protocol and data being send to the base station from data monitoring nodes via microcontroller. Collected data was displayed on a local host PC. Matlab was used to create a GUI (graphical User Interface) for data visualization and water parameters such as ph, turbidity, conductivity were displayed. If the compared value exceeds standard value a SMS will be sent to the client.

Wang, Ma and Yang (2011) [19] focus on theoretic issues such as routing algorithm, network lifetime, and so on and apply wireless network into online zigbee and GPRS based water monitoring system. Data transmission was done by zigbee protocol and data collected by GPRS shield. MySQL was employed in the database side.

Yazhini and Maruthi (2017) proposed model showed us how internet of things platform can be used for water management. Remote Sensing techniques and Internet of things can be applicable for wider spectrum of research domain for monitoring, collecting and analyzing data.

K.Raghu Sita Rama Raju and G.Harish kumar Varma (2017) performed a work entitled as “Knowledge Based Real Time Monitoring System for Aquaculture Using IoT” which uses several sensors such as Dissolved Oxygen, Temperature, Ammonia, Salt, pH, Nitrate and Carbonates [9]. But maintaining lots of sensors is costly and tedious.

Rao, Marshal, Gubbi, Palaniswami, Sinnott and Pettirogrove [51] in their research, a low cost wireless sensor network for sensing physical and chemical parameters is proposed. This system observes the behaviors of aquatic animals due to water population using data analysis.

Zhenan, kai and Bo (2013) developed an intelligent system combining remote sensing technology and control applications. In this system they monitored and controlled river and lake water quality. They overcome the technical challenges such as sensor selection and control over wireless network by adopting appropriate algorithm for system design.

III. PROBLEM DEFINITION

The population of our world is growing rapidly and percentages of drinkable water sources are dropping down very fast. As a result of that meeting the need of ever growing people, major water sources like rivers, ponds, seas, canals etc are being filled up and large industrial in fractures are made. According to World Health Organization (WHO) by 2025, half of the world’s population will be living in water-stressed areas. For the developing country like India, the river water will be monitored continuously and to stop the contamination from various sources to avoid water crisis.

3.1 Technology :

A. **Internet of Things:** Internet of Things is a technology wherein the devices get connected to internet. The connected devices likewise communicate either among one another or with the people. Finally they provide the sensed data to the cloud. The data can bring out an insight to the info Therefore, the smart connected devices find applications in health monitoring, home automation, predictive analysis, industrial monitoring to call a couple of . The smart devices are connected to the data aggregator i.e., the cloud.

B. **ThingSpeak support toolbox in Matlab :**ThingSpeak is a web service hosted by MathWorks to collect, analyzes and act on sensor data, and develop Internet of Things applications easily. The ThingSpeak Support Toolbox uses MATLAB to read data from ThingSpeak and write data to ThingSpeak platform. It also provides functions to visualize and access data stored on ThingSpeak.com as shown in figure 1. The ThingSpeak Support Toolbox has the functions: thingSpeakRead – Read data stored in ThingSpeak channel ThingSpeak Write- Write data to a ThingSpeak channel url Filter- Scrape numbers from web page ThingSpeakRead syntax and description [data,timestamps,chInfo] = thingSpeakRead(chId) thingSpeakRead(chId) reads the most recent data from all fields

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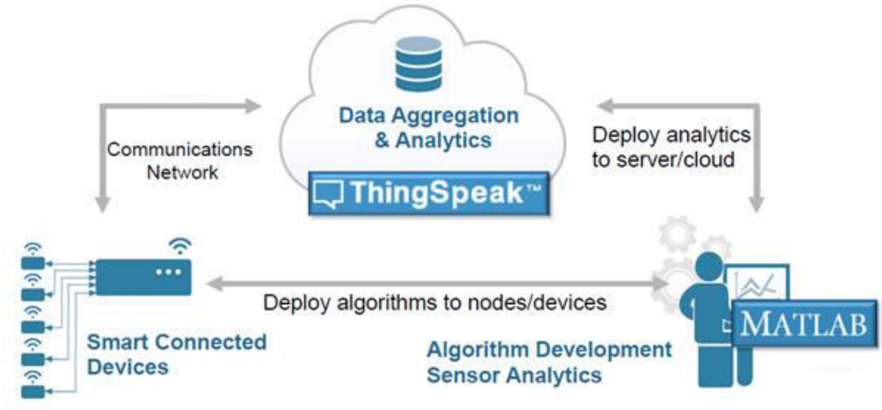

Figure 1. ThingSpeak with MATLAB and smart devices network

of the specified public channel on ThingSpeak.com and returns the data, times-tamp, and channel information. This will fetch the channel data that is the sensor values from Thingspeak.

[data,timestamps,chInfo] = thingSpeakRead (chId,Name,Value)

thingSpeakRead command with variables (chId,Name,Value) uses additional options specified by one or more Name, Value pair arguments. The sensors data is fetched with the time stamp which requires the specific channel ID of patient account. the fetched data comes in tabular form which practically shown in result.

C. Computer vision

"MATLAB It is a application-oriented language and interactive environment for computer computation, visualization, and programming. Image Processing Toolbox is an application available to be used in MATLAB, which provides a comprehensive set of reference-standard algorithms, functions, and apps for image processing, analysis, visualization, and a algorithm development stage." Using these tools provides a quick and convenient Methods to process and analyze images without the necessity for advanced knowledge of A very complex coding language.

IV. PROPOSED SYSTEM

4.1 Proposed System Hardware Architecture

The main aim is to develop a system for continuous monitoring of river water quality at remote places using wireless sensor networks with low power consumption, low-cost and high detection accuracy. pH, conductivity, turbidity level, etc. are the limits that are analyzed to improve the water quality. Following are the aims of idea implementation (a) To measure water parameters such as pH, dissolved oxygen, turbidity, conductivity, etc. using available sensors at a remote place. (b) To assemble data from various sensor nodes and send it to the base station by the IoT. (c) To simulate and evaluate quality parameters for quality control.

Temperature pronouncedly affects biological and chemical procedures. Rates of biological and chemical responses double for each 10°C increment in temperature in general. Temperature significantly influences chemical treatments. Fish have poor resistance to sudden changes in temperature. Often, a quick change in temperature of as low as 5°C will stress or even slaughter fish. pH, DO, conductivity, salinity etc. are directly dependent on temperature. So, temperature should be in the expected range first before checking other parameters. General threshold range for temperature is 21°C-33°C which can be maintained easily. For these reasons, we consider temperature as our first working parameter.

The pH is a ration of the hydrogen ion concentration and designates whether the water is acidic or basic in reaction. Phytoplankton and other marine plant life eliminate carbon dioxide from the water during photosynthesis, so the Ph water body increases during the day and drops during the night. Waters with low aggregate alkalinity regularly have pH estimations of 6 to 7.5 preceding sunrise, however when phytoplankton development is substantial, at evening pH esteems may ascend to 10 or significantly higher. The pH of natural waters is significantly impacted by the convergence of carbon dioxide which is an acidic gas [8]. pH changes in pond water are for the most part affected via carbon dioxide and ions in harmony with it. Control of pH is necessary for diminishing ammonia and H2S poisonous.

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Architecture

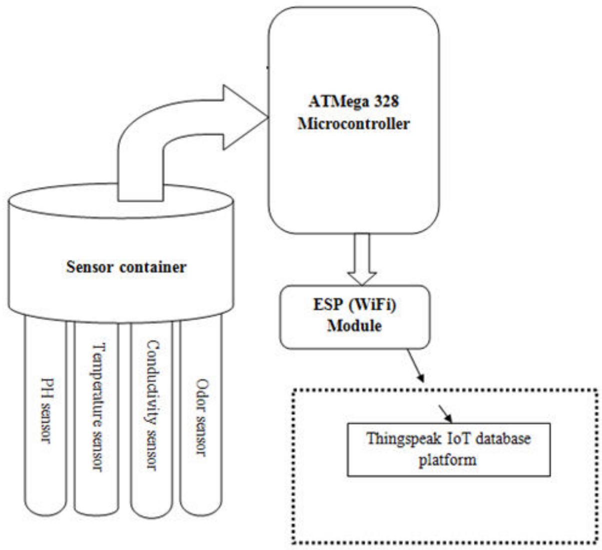

Figure 2.: Architecture of proposed system

As the sensors we use in this work are specially designed for Arduino, we use Arduino for sensor acquisition. Our Arduino version is Arduino UNO.Arduino Uno is a microcontroller board which is based on the ATmega328P.The WI-FI module will use in this project is ESP8266. It follows TCP/IP stack and is a microchip which is less in cost. This microchip allows the microcontroller to connect to a WI-FI network, by using Hayes style command connections will do through TCP/IP connection. ESP8266 has 1MB of built-in flash, single chip devices able to connect WI-FI. Espressif systems are the manufacturers of this module, and it is a 32-bit microcontroller. This sensor is an "integrated circuit sensor". The yield voltage is linearly proportional to the Celsius temperature. The "LM35 sensor" will use in this project because the user cannot convert Kelvin to centigrade temperature. It is not suitable for remote applications and directly measures in Celsius.The co2 sensor is a device which is used to measure the carbon dioxide in the water.

4.2 Software Architecture

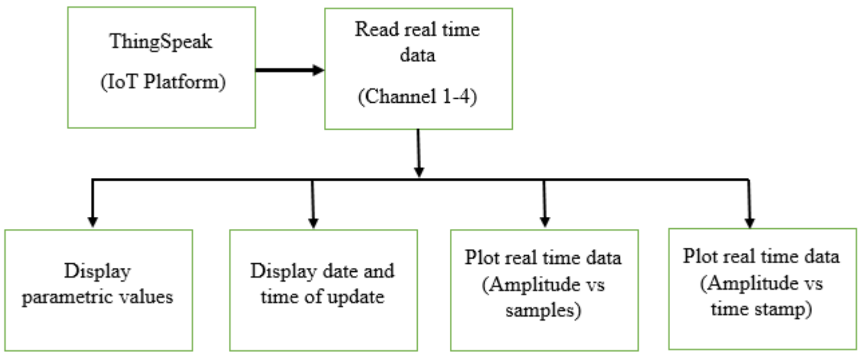

Figure: Proposed system software architecture for real time data.

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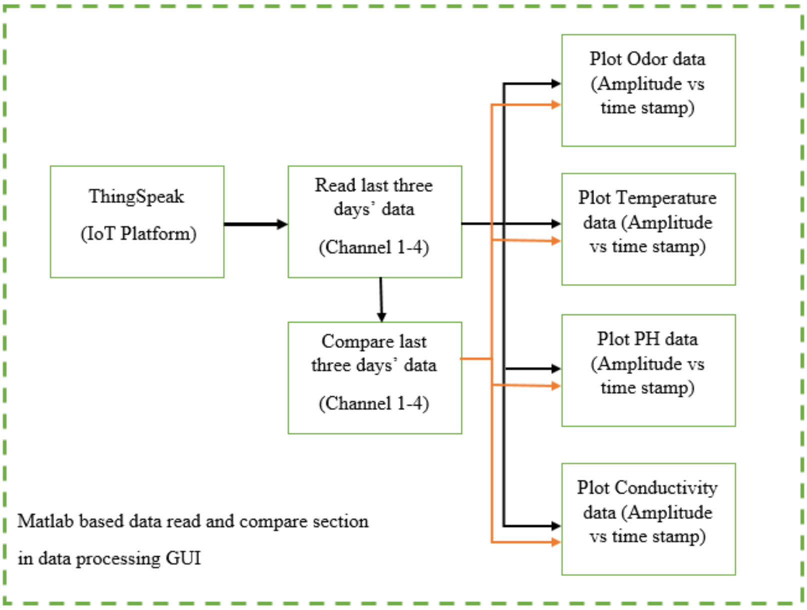

Figure: Proposed system software architecture for data compare in data processing GUI.

Drinking water quality standards are determined according to World Health Organization [11] guidelines for drinking-water quality as well as other pertinent organizations. These organizations set the standards for drinking water quality parameters and indicate which microbiological, chemical and indicator parameters must be monitored and tested regularly in order to protect the health of the consumers and to make sure the water is wholesome and clean. The selection of the physicochemical parameters to be monitored was based on extensive scientific literature review on the relation between certain physicochemical parameters and chemical or biological contaminations that present in water. Table enumerates the suggested parameters to be monitored from high to low correlation significance when interpreting water contaminations (assess hazard). Table I also presents the measurement cost (for purchase and maintenance) associated with these parameters based on recent review [20] of measurement and instrumentation methods, compensation and calibration procedures and probe lifetime concerning these parameters. Thus, the parameters selected to monitored are the following: 1) Turbidity(optional), 2) Oxidation Reduction Potential (instead of Free Chlorine) (optional), 3) Temperature 4) pH, and 5) Electrical Conductivity. It is noted that Free Chlorine concentration can be estimated as a function of the ORP, pH and temperature measurements. Nitrates, though considered as an important parameter for human health is not selected because measurement methods are subjected to failures (Ion-Selective Electrodes) or are cost prohibitive (UV Spectro photo metric Method). Finally, dissolved oxygen is not selected due to several compensations and frequent membrane replacement needed for accurate measurements.
The data acquisition system consists of sensors nodes to measure the parameters such as temperature, pH value, conductivity, foul smell detector and ammonia in the water. The data from different sensors are collected and is given to the Arduino microcontroller. The microcontroller has been programmed such that it will read the sensors values and process it and send it using WiFi module on Thingspeak. In the proposed design, it is observed that most of systems neglect the standard rules for measurement and also the floating system orientation, as per the Indian environment. We will send the parameters over the Thingspeak platform which will store and also gives graphical plot for data, depending on which the water quality will be defined.

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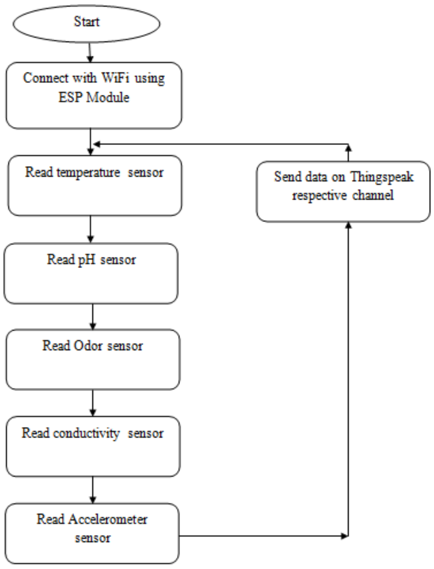
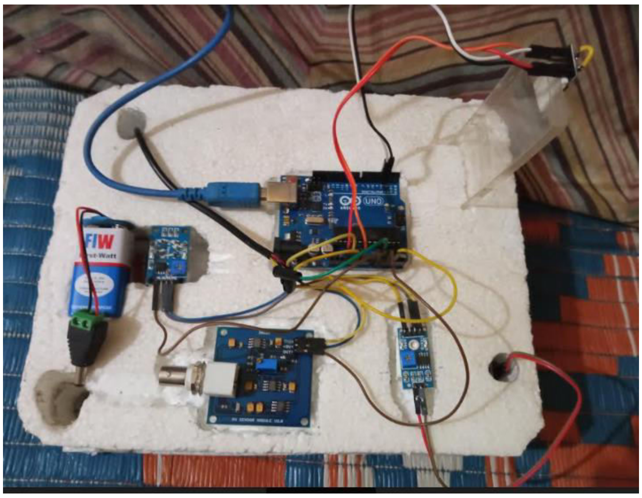


Figure : FLOWCHART

Table : Algorithm with Different Parameter

Algorithm	Prediction Speed	Training Speed	Memory Usage	Required Tuning	General Assessment
Logistic Regression (and Linear SVM)	Fast	Fast	Small	Minimal	Good for small problems with linear decision boundaries
Decision Trees	Fast	Fast	Small	Some	Good generalist, but prone to overfitting
(Nonlinear) SVM (and Logistic Regression)	Slow	Slow	Medium	Some	Good for many binary problems, and handles high-dimensional data well
Nearest Neighbor	Moderate	Minimal	Medium	Minimal	Lower accuracy, but easy to use and interpret
Naive Bayes	Fast	Fast	Medium	Some	Widely used for text, including spam filtering
Ensembles	Moderate	Slow	Varies	Some	High accuracy and good performance for small- to medium-sized datasets
Neural Network	Moderate	Slow	Medium to Large	Lots	Popular for classification, compression, recognition, and forecasting

Actual Design Module



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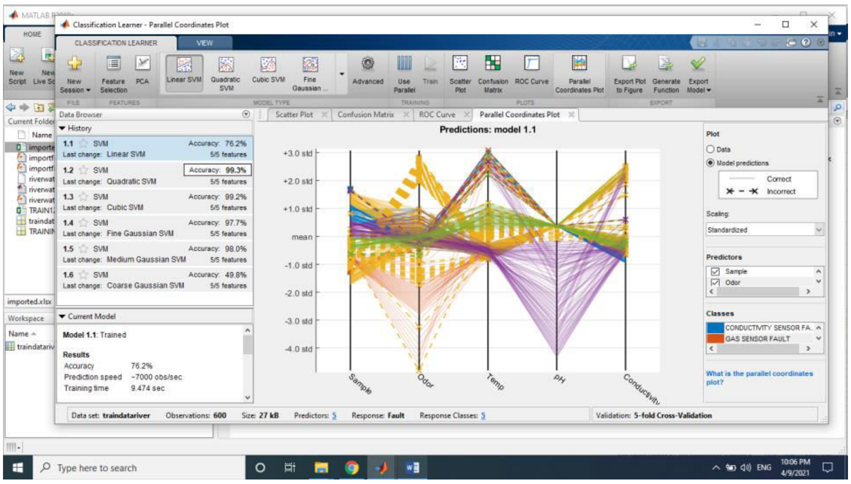
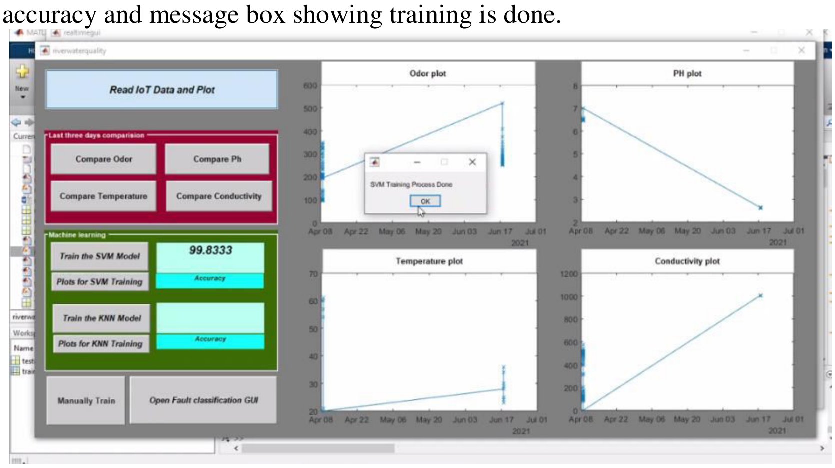
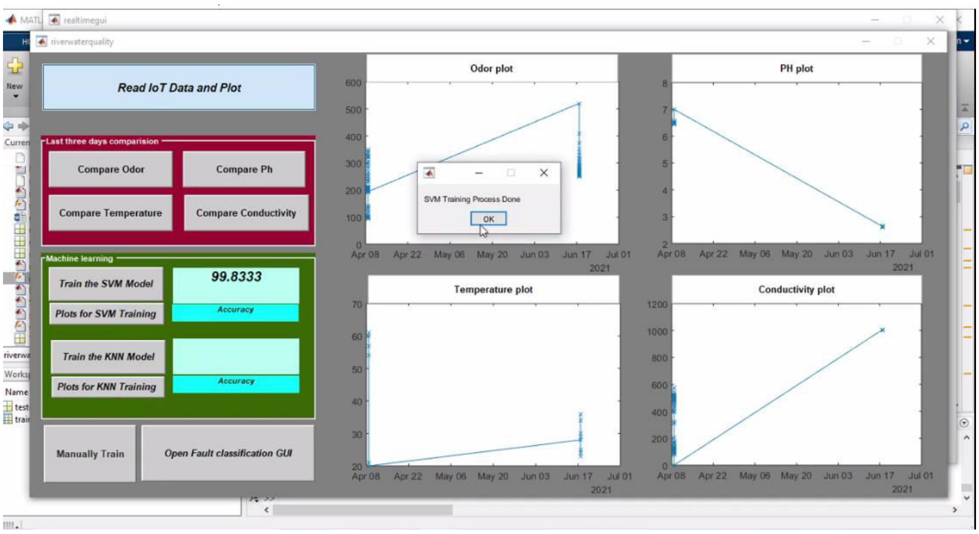


Figure: Multi SVM Classification modules and accuracies and parallel confusion plot. (Model 1.1)

Compare the last three days values of each sensor and plot using the “last three days comparison” section.
Now press “train the SVM model” and select file as shown
It will show training accuracy and message box showing training is done.



Same procedure to train KNN model.



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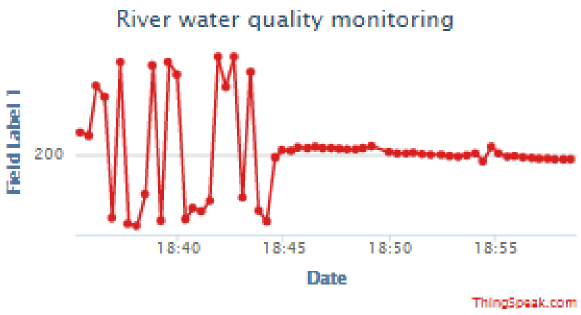
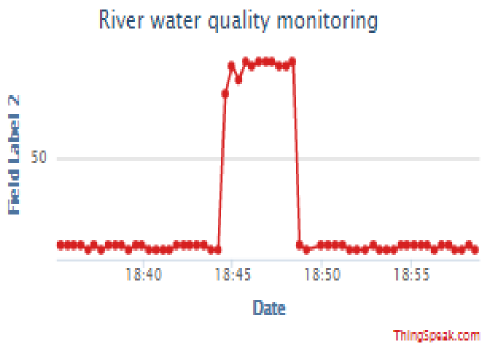
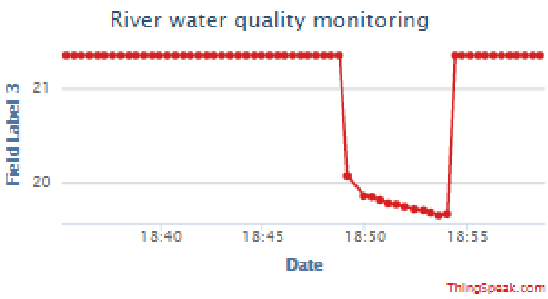
4.3 Result Analysis: In the analysis part we have taking live real time value with the graph



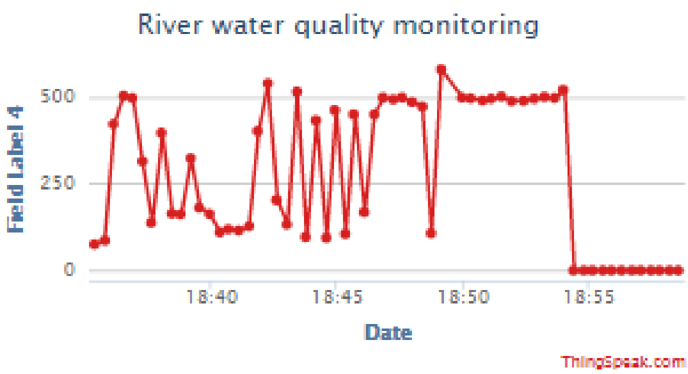
Odor sensor plot



Temperature plot



PH plot



Conductivity plot

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V. CONCLUSION

In this project, the system was designed to follow the rules and regulation by Central Pollution Control Board (CPCB) of India for manual water quality monitoring standards which we are monitoring regular basis and providing the basic data of river water quality over IoT and we also implemented the proposed system orientation so as the data can be validate and the z-axis will gives the distance from base surface. We gather multiple node data at various points or locations to identify the pollution source. Another contribution is that the here we detect sensor fault diagnosis using Multiclass SVM proposed algorithm and result was compare with some other algorithm like RF and ANN. Our main motive is to improve our objective.

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