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Rapid Approach to Quantify the Industrial Pollution in The Water Bodies Using Machine Learning and Satellite Imaging

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Abstract:

Chemical Industries in India and across the world are polluting the water bodies near them. Which affects the water quality of that water body and also the quality of the ground water of the area. This has affected many farmers of India where agriculture is an important occupation in the northern states. Chemical Factories near water bodies usually just dispose of their waste in the water, rendering the water toxic, and not fit for use.There is a need for a solution that can do the rapid testing of water from these types of water bodies which are near to the industry. Our solution tackles this situation by doing the rapid quality testing of the water bodies using the satellite images. We have collected the images of pune city using the mapbox api. Then after that we have made a machine learning code to detect the water bodies in the pictures. And after detecting the water bodies we are detecting the quality of the water using image processing. All these processes help us segregate the normal and clean water bodies from polluted water bodies. And later polluted water bodies can be tested further using a sensing device that we have made to measure the pH and TDS of the extracted water sample from the polluted water body. Our machine learning model is made using the Convolution Neural Network algorithm and it works with an accuracy of above 95% in the detection of the water bodies.So to conclude we can say that our solution can provides a reliable and a rapid solution to the quality checking of the water bodies and also calculate the impact of the nearby industry on the water.

Keywords: *Water Bodies, Satellite imaging, Pollution detection, CNN, Industrial water pollution*

Introduction:

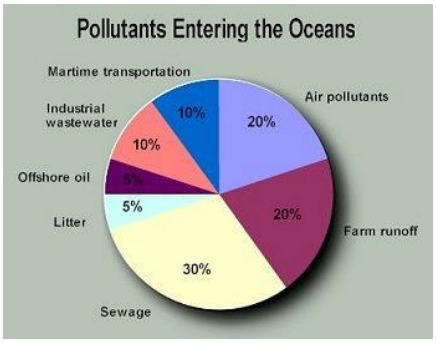
Water is one of the most important elements on Earth when it comes to sustaining life. Unfortunately, it is also extremely susceptible to pollution. This is largely because water is a universal solvent that can dissolve many substances. While this is a wonderful quality that we take advantage of for everyday tasks such as cooking, cleaning, and taking medication, it is also the exact quality that causes water to become polluted so easily.

Industries and industrial sites across the world are a major contributor to water pollution. Many industrial sites produce waste in the form of toxic chemicals and pollutants, and though regulated, some still do not have proper waste management systems in place. In those rare cases, industrial waste is dumped into nearby freshwater systems. When industrial waste is not treated properly (or worse, not treated at all), it can very easily pollute the freshwater systems that it comes into contact with.

Industrial waste from agricultural sites, mines and manufacturing plants can make its way into rivers, streams and other bodies of water that lead directly to the sea. The toxic chemicals in the waste produced by these industries not only have the potential to make water unsafe for human consumption, but they can also cause the temperature in freshwater systems to change, making them dangerous for many water dwelling organisms.

Effect of Industrial Pollution on Water Bodies

Extraction and mining of minerals has caused pollution of industrial water. This polluted water when seeps into agricultural land, renders the land uncultivable and barren. This has affected many farmers of India where agriculture is an important occupation in the northern states. Chemical Factories near water bodies usually just dispose of their waste in the water, rendering the water toxic, and not fit for use. However, one of the major sources of water pollution is waste sewage, disposed of without treatment.



Where Does it Occur?

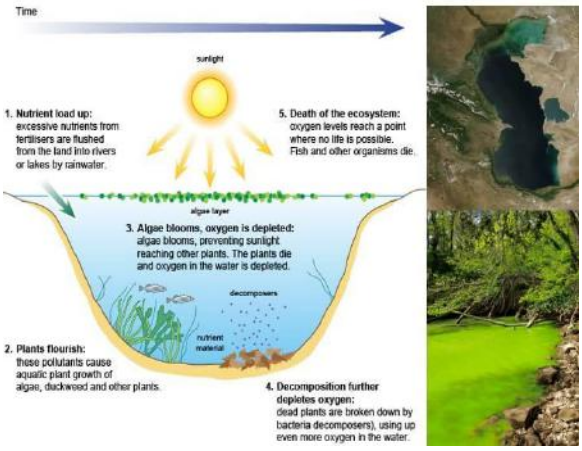
Many important rivers such during the same time that the river ganga, which provides irrigation as well as enriches the agricultural land near the delta, have been polluted by human wastes as well as industrial contaminants. This water body provides water to 40% of India's population over 11 states as well as 500 million people. The Ganges absorbs more than an existing billion gallons that belongs to waste each day, three-quarters that belongs to it raw sewage as well as domestic waste as well as the rest industrial effluent, as well as happens to be one that belongs to the ten most polluted rivers inside of the world.

What Are Its Effects?

1) Impact on the Environment

Wastewater runoffs from industries firstly cause an increase in growth of algae (the green substance that you may have seen cover still lakes). As the algae growth grows exponentially, it covers a large portion of the water body. This does not allow light and oxygen to penetrate the surface of the water, and eventually kills most of the fishes, and aquatic plants present in the water. This process is called Eutrophication and is a threat to all flora and fauna.

Additionally, grease and oil in wastewater are harder to degrade and tend to float to the top of the water. This blocks the light that aquatic plants that use photosynthesis need. It has the potential to entangle birds' feathers and choke fish. These are hazardous to both humans and animals, just as heavy metals like lead and mercury. If someone drank from or ate fish from a contaminated water source, they could also suffer from serious health effects. The same happens with the animals and plants living in the water.

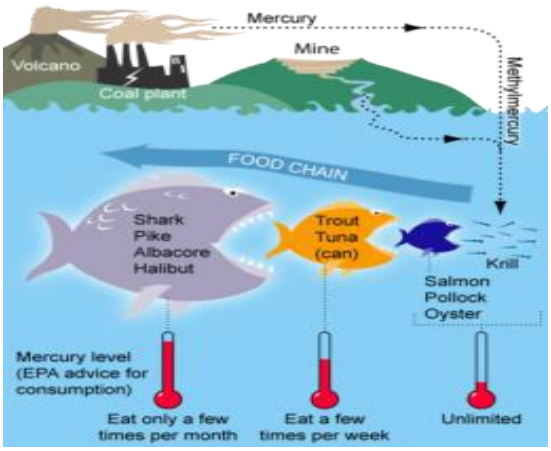


2) Impacts on Humans

Aside from the environmental impact, this water pollution also affects humans through various mediums such as through fishery, and direct water consumption. Fishes living in toxic water become toxic as well. This toxicity increases through the food chain and may have harmful effects on humans too. This process, biomagnification, may also enter humans through crops grown in soil exposed to polluted waters.

One of the worst causes and carriers of disease is wastewater. A World Health Organization report claims that more than 3.4 million individuals worldwide pass away each year because of a waterborne illness.

It is common practice to clean and recycle wastewater for irrigation. When wastewater isn't properly handled, chemicals that are hazardous to crops may end up in the soil. The soil will produce less crops at a slower rate because of these contaminants. Also consider the fact that these crops will eventually be eaten, which can also harm humans.



Literature Review:

1. **Environmental effect of reservoirs accumulating highly mineralized oil-field waste waters:**

According to this research the impact of oil-field wastewater (OFWW) storage ponds on grounds, soils and ground waters has been studied for forty years. Forty years after polluting, chernozems usually display herbal desalination and decolonization strategies due to washing water conditions and genetically defined excessive content material of carbonates and gypsum within the soil profile and soil-forming rock. Yet they have got an accelerated content material of water-soluble salts, exchangeable sodium, and electric resistance regular for alkali soils and solonetzs. Humus accumulative horizons show a hydrophobic property, because of leaching carbonates content material, cation alternate capacity, mobile nitrogen, and phosphorus content material decreases. Pollution of soils via wastewater effects in accumulation of toxic factors on areas through ways exceeding regions of direct effect.

2. **Industrial Wastewater and Its Toxic Effects:**

The elevated population has led to a growth in the demand for items which in flip has brought on rapid industrialization. In turn, the boom in commercial set-up has caused the extended production of industrial wastes. Those business wastes motive main environmental havoc by polluting the water, air, and soil. The amount of wastewater generated depends on the kind of enterprise it can include, non-biodegradable waste which includes heavy metals, pesticides, plastic etc. and biodegradable compounds consisting of paper, leather, wool and so forth. Business wastewater may be toxic, reactive, carcinogenic, or ignitable. Therefore, without proper treatment and management strategies, the discharging of the waste into water bodies can pose dreadful environmental and health results. Numerous waterborne pathogens proliferate in wastewater and bring pollutants, affecting the earth's atmosphere and human fitness. The pollution in industrial wastewater motivates acute poisoning, immune system suppression and reproductive failure. According to the WHO, around eighty% of sicknesses are waterborne. To cope with the environmental and fitness issues created via commercial wastewater, it's vital to obliterate its toxicity by ok treatment with bodily, chemical, and biological manner so that it could be recycled for water conservation.

3. **Pollution of Sedimentary Ponds at an Industrial Plant in Janikowo (Poland):**

The aim of the work was to decide whether the waste amassed on the reclaimed a sedimentary pond near the

Janikosoda manufacturing Plant in Janikowo continues to be a source of groundwater pollution. On one of the ponds near the manufacturing Plant in Janikowo, 3 points have been located, in which drilling turned into done up to the lowest layer of solid waste. In every point, samples of sediments had been taken to decide electrolytic conductivity and chloride awareness. In an effort to study the level of groundwater pollution in the area of the production Plant, 4 points around the sedimentary ponds were diagnosed, in which regular monitoring of chloride ions has been completed since the 1980s. Based totally on analysis, it was concluded that chlorides are leached from the sediments deep into the soil profile with the aid of rainwater and, with high possibility, additionally with the aid of water seeping from the adjoining slag pond. Sedimentary ponds are nevertheless an essential supply of pollutants released into soils and groundwater around the plant. However, chloride attention in solid waste and groundwater in the place of sedimentary ponds has decreased within the remaining twenty years.

4. **Wastewater Treatment & Water Reclamation:**

Wastewater treatment is the means through which water that has been used and/or infected via humans or nature is restored to an appropriate first-class state. Treatment might also encompass chemical, organic, or physical strategies or a mixture thereof. Water can be dealt with to any stage of best desired; but, as its purity will increase, so does the fee of accomplishing that purity. The specified exception of water is dictated by its meant use, as an example, aquatic existence, ingesting water, or irrigation. The cause of this chapter is to describe wastewater remedy technologies predominantly in use today. In the long run, the technology selected as appropriate for one utility may not be the most reliable for some other. Selection can be based totally on the website-unique elements, along with assets to be had, weather, land availability, economics, and so on.

5. **Water Pollution control in India:**

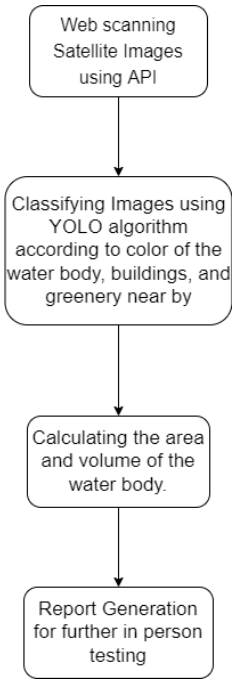
The Water (Prevention and Control of Pollution) Act of 1974 (the "Water Act") is the primary piece of law in India for regulating water pollution. The Water Act, which forbade the discharge of contaminants into the water system more than limits, was passed in an effort to prevent and regulate water pollution. Additionally, it provides for the establishment of State Pollution Control Boards (SPCBs) for state governments and the Central Pollution Control Board (CPCB) for the federal government. Prior to the publication of the Environment (Protection) Act, 1986, the Water Act was passed and is still the first environmental regulation in India. The Environment (Protection) Act, 1986 was aligned with the Water Act's provisions by an amendment made in 1988.The Indian Constitution grants the states the authority to regulate water, and, no water regulations can be passed at the federal level. Therefore, the creation of an all-encompassing plan for the management of water resources and state coordination constitutes the fundamental duties of the central government. But as an extraordinary national water law, the Water Act was passed under Article 252 of the Constitution. The Water (Prevention and Control of Pollution) Rules, 1975, a subsidiary regulation of the Water Act, were established in 1975. The Rules provide a detailed explanation of CPCB's compensation, authority, budget, and duties.

Our Solution:

Our solution uses an array of technology to identify, locate, and test the water bodies in different areas (especially industrial areas) to mark them as safe or toxic.

To build this solution, we created a system that uses satellite images of the Pune area, to detect polluted water bodies. We used an API (Application Program Interface) to web scan which enabled us to get high resolution pictures of the entire Pune area, and a huge dataset to analyze (consisting of more than 2000 pictures).

The solution uses the YOLO algorithm to classify the images, after which it can calculate the area and volume of the water body. In the end, it generates a final report for further in person testing.



Methodology:

There are multiple steps that we have followed to make a viable solution. These steps are as follows:

1. Location Detection
2. Data collection
3. Detecting water bodies using Machine Learning
4. Image Processing to detect the color of the water body
5. Testing the water sample with a electronic device to give final results regarding the water quality

Location Detection:

We have made a program that takes the name of the area and then provides us the longitude and latitude of the area. Using this code, we can do map any city and collect the satellite images of the area using map box

```
from geopy.geocoders import ArcGIS
import folium
import pyautogui as gui
import time

nom = ArcGIS()
s = nom.geocode('pune')
print(s)
print(s.longitude)
print(s.latitude)
```

Results:

```
Pune, Maharashtra
73.85286000000008
18.504230000000064
```

Data Collection:

First of all to make a solution work with the satellite images we needed to collect the zoomed images of an area. We have tried multiple websites to get that like google maps, Nasa maps etc. But in the end, we planned to go with map box.

Mapbox provides a free api to download 50000 images for free. So we used mapbox api in our python code to collect the image of the whole pune city. We have collected 2400 images of the city area.

We have written a code that take the longitude and latitude of any given city and clicks multiple high zoom photos of that area

Code:

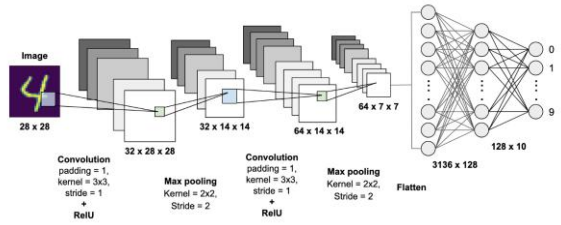
```
import requests
from tqdm import tqdm


URL = "https://api.mapbox.com/styles/v1/mapbox/satellite-v9/static/"
temp = "[73.8528,18.5042,73.8544,18.5058]"

# temp = "[73.8512,18.5058,73.8528,18.5042]"
token = "/300x300?access_token=sk.eyJ1IjoicmVqaW4iLCJhIjoiY2w0cWtkcmtpMHJ5bjNjcXZxZ2FyamVuZCJ9.pskdR5TgXRZg4Cm8nrLyZw"
response = requests.get(URL+temp+token)
open("images/map0.jpg", "wb").write(response.content)

x_step = 0.0016
y_step = 0.0016
```

```
x = 73.8528
y = 18.5042

count = 1
for i in tqdm(range(1,25)):
    # getting the top row
    left = x-(i*x_step)
    top = y+(i*y_step)
    right = left + x_step
    bottom = top - y_step
    for j in range((i*2)+1):
        left = left + (j*x_step)
        right = right + (j*x_step)
        # print(left,top,right,bottom)

        loc = [left,bottom,right,top]
        loc_Str = str(loc)
        loc_Str = loc_Str.replace(" ",")

        response = requests.get(URL+loc_Str+token)

        open("images/map"+str(count)+".jpg",
"wb").write(response.content)
        count = count+1



    # getting the bottom row
    left = x-(i*x_step)
    top = y-(i*y_step)
    right = left + x_step
    bottom = top - y_step
    for j in range((i*2)+1):
        left = left + (j*x_step)
        right = right + (j*x_step)
        # print(left,top,right,bottom)

        loc = [left,bottom,right,top]
        loc_Str = str(loc)
        loc_Str = loc_Str.replace(" ",")

        response = requests.get(URL+loc_Str+token)

        open("images/map"+str(count)+".jpg",
"wb").write(response.content)
        count = count+1
```

```
    # getting the left column excluding the top and
bottom
    left = x-(i*x_step)
    top = y+(i*y_step)
    right = left + x_step
    bottom = top - y_step
    top = top-x_step
    bottom = bottom-x_step
    for j in range((i*2)-1):
        top = top-(j*y_step)
        bottom = bottom-(j*y_step)
        # print(left,top,right,bottom)

        loc = [left,bottom,right,top]
        loc_Str = str(loc)
        loc_Str = loc_Str.replace(" ",")

        response = requests.get(URL+loc_Str+token)

        open("images/map"+str(count)+".jpg",
"wb").write(response.content)
        count = count+1



    # getting the right column excluding the top and
bottom
    left = x+(i*x_step)
    top = y+(i*y_step)
    right = left + x_step
    bottom = top - y_step
    top = top-x_step
    bottom = bottom-x_step
    for j in range((i*2)-1):
        top = top-(j*y_step)
        bottom = bottom-(j*y_step)
        # print(left,top,right,bottom)

        loc = [left,bottom,right,top]
        loc_Str = str(loc)
        loc_Str = loc_Str.replace(" ",")

        response = requests.get(URL+loc_Str+token)

        open("images/map"+str(count)+".jpg",
"wb").write(response.content)
        count = count+1
```

Detecting Water body using machine learning:

We have used a water detection library to detect the water bodies in the picture. This code works on the Convolutional neural network. It works with above 95% accuracy in the detection of water bodies inside any picture.



Code:

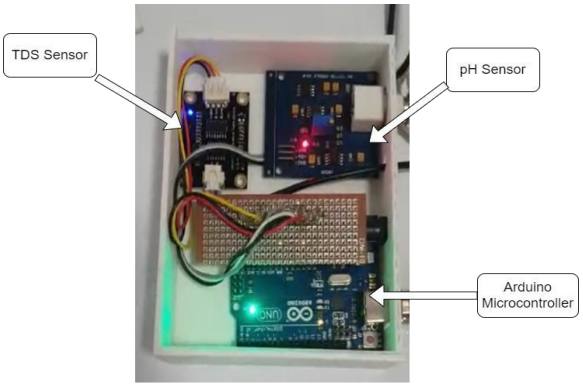
```
args = parser.parse_args()

    # If GetConfig option, just copy the WaterDetect.ini to the current working directory
    if args.GetConfig:
        src = Path(__file__).parent/'WaterDetect.ini'
        dst = Path(os.getcwd())/'WaterDetect.ini'

        print(f'Copying {src} into current dir.')
        dst.write_text(src.read_text())
        print(f'WaterDetect.ini copied into {dst.parent}.')
    elif args.version:
        print(f'WaterDetect version: {waterdetect.__version__}')

    elif args.debug:
        debug(args)

    else:
        if (args.input is None) or (args.out is None):
            print('Please specify input and output folders (-i, -o)')

        else:

waterdetect.DWWaterDetect.run_water_detect(input_folder=args.input,

output_folder=args.out,

shape_file=args.shp,

product=args.product,

config_file=args.config,
                                    pekel=args.pekel,

single_mode=args.single)
```

Image Processing to detect the color of water body: After water body detection in the images from the database we have made a program to detect the color of the water body using image processing.

```
import cv2
import numpy as np
import os
fn = []
def load_images_from_folder(folder):
    images = []
    for filename in os.listdir(folder):
        fn.append(filename)

load_images_from_folder(r'C:\Users\Admin\Downloads\images')
print(fn)
for i in fn:
    path = r'C:\Users\Admin\Downloads\images\{}'
    path = path.format(i)
    img = cv2.imread(path)
    #                   gray                   = cv2.cvtColor(img,cv2.COLOR_BGR2GRAY)
    hsv = cv2.cvtColor(img,cv2.COLOR_BGR2HSV)

    lower = np.array([56,118,55])
    upper = np.array([95,223,109])

    mask = cv2.inRange(hsv,lower,upper)

    # mask2 = cv2.Canny(gray,50,200)
    cont,har                                    = cv2.findContours(mask,cv2.RETR_TREE,cv2.CHAIN_APPROX_SIMPLE)

    for j in cont:
        area = cv2.contourArea(j)
        x,y,w,h  = cv2.boundingRect(j)
        if area>5000:
            cv2.drawContours(img,[j],-1,(0,255,255),2)
            name = r'C:\Users\Admin\Desktop\blue\{}'
            name = name.format(i)
            cv2.imwrite(name,img)
            print('image saved with name',i)
```

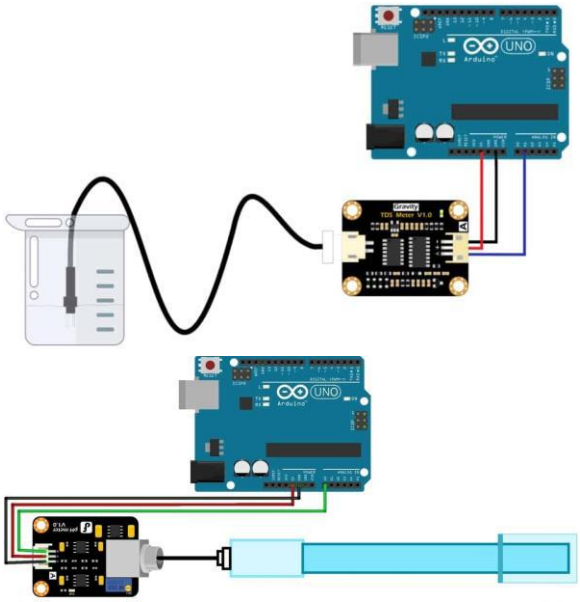
Result Output:

Testing the water sample with a electronic device to give final results regarding the water quality:
We have made a small device using a pH sensor and a TDS sensor to measure the quality of water samples. This device works on an Arduino microcontroller.



Circuit Diagram:

The circuit is really simple as both the sensors are analog sensors and in this circuit, we have connected pH sensor on the A0 pin and TDS Sensor on the pin A1. Arduino is connected to the computer serially via USB port.



Conclusion: Our solution is a stepwise rapid solution that can help in rapid testing of the water bodies nearby industry and tell the impact of the industry on the water body like river or pond. Our solution starts with segregation of water bodies based on the analysis done on satellite images using machine learning and image processing. After that if our software detects that the water body is contaminated then we can go and collect the sample of the water from there and do the further analysis. Our machine learning model and image processing code works with an accuracy of above 95% in the detection of the water body and its color. Once the detection is done the device can easily tell us about the other important information like pH and TDS using highly accurate sensors. So, to conclude we can say that our solution can provide a reliable and a rapid solution to the quality checking of the water bodies and also calculate the impact of the nearby industry on the water.

Future Scope:
There are few things that can be added to improve the quality of our solution. First, we have done the analysis on the image of only Pune city. So, to increase

the approach of the solution we need to incorporate more images of different areas. This will make our solution better. Second thing is to proceed with the field testing. Our solution is only tested on a few data sets, and it is only tested for accuracy. We need to proceed with the field testing to check the consistency and persistence of the solution. We also need to share our solution with field experts and take their feedback for the improvement of the solution.

References:

1. I.M. Gabbasova, R.R. Suleymanov, "Environmental effect of reservoirs accumulating highly mineralized oil-field waste waters", Department of soil science, Institute of Biology, Ufa Research Centre, Russian Academy of sciences. 69, Prospekt Octyabrya, Ufa 450054 Russia. Tel./Fax.: +73472356247;
2. Adam Gołub and Janina Piekutin, "Pollution of Sedimentary Ponds at an Industrial Plant in Janikowo (Poland)", Department of Technology in Environmental Engineering, Bialystok University of Technology, Wiejska 45A, 15-351 Białystok, Poland; j.piekutin@pb.edu.pl
3. Wiater, J. Influence of waste disposal sites on the ground water quality and soil properties. In ̇z. Ekol. 2011,26, 133–146.
4. Gromiec, M.; Sadurski, A.; Zalewski, M.; Rowi ́nski, P. Hazards related to water quality. Nauka 2014, 1, 99–122.
5. Kaczor-Kurzawa, D. Tectonically conditioned brine leakage into usable freshwater aquifers—Implications for the quality of groundwater exploited in central Poland. In Proceedings of the E3S Web of Conferences,Gda ́nsk, Poland, 17–22 June 2018; Volume 54, pp. 1–5.
6. Raghunathan, C.; Tewari, A.; Khambhaty, Y.; Jothinayagam, J.T. Effect of soda ash industry effluent on seaweed epiphytic and ambient fauna in in situ condition in northwest coast of India. Nat. Environ. Pollut. Technol. 2007, 6, 1–14.