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Research Paper

Oil Spill Detection on Sea Surface By Using Sentinel-1 SAR Images

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ABSTRACT:
Identification of an oil spill is additionally essential to evaluate the potential spread and float from the source to the adjacent coastal terrains. In such a manner, usage of Synthetic Aperture RADAR (SAR) information for the recognition and checking of oil spills has gotten extensive consideration as of late, because of their wide zone inclusion, day-night, and all-weather capabilities. The present examination studies an oil spill that occurred in some regions by applying Sentinel 1 SAR- C images. Approaches dependent on MATLAB images examination have been produced for distinguishing oil spills from referred common leaks just as oil slick procedures. In this work, the Oil spill is located on the ocean/sea using the YOLO algorithm. An oil spill is the release of a liquid petroleum hydrocarbon into the environment, especially the marine ecosystem, due to human activity, and is a form of pollution. The term is usually given to marine oil spills, where oil is released into the ocean or coastal waters. Hence, oil spill detection should be considered an essential research issue. So, here oil spill will be located with the YOLO algorithm with MATLAB. The results will give better outputs when compared to existing works.

KEYWORDS: *MATLAB, GSM, Arduino, SAR-C, Sentinel 1, YOLO algorithm.*

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I. INTRODUCTION:

Oil spill, leakage of petroleum onto the surface of a large body of water. Oceanic oil spills became a major environmental problem in the 1960s, chiefly as a result of intensified petroleum exploration and production on continental shelves and the use of supertankers capable of transporting more than 500,000 metric tons of oil. Spectacular oil spills from wrecked or damaged supertankers are now rare because of stringent shipping and environmental regulations. Nevertheless, thousands of minor and several major oil spills related to well discharges and tanker operations are reported each year, with the total quantity of oil released annually into the world's oceans exceeding one million metric tons. The unintentional or negligent release of used gasoline solvents and crankcase lubricants by industries and individuals greatly aggravates the overall environmental problem. Combined with natural seepage from the ocean floor, these sources add oil to the world's waterways at the rate of 3.5 million to 6 million metric tons a year Oil pollution of the oceans is mainly caused by accidents in the offshore industry and oil tankers as well as by operative discharges of oil products from ships. According to 29% of pollution in the ocean annually is crude oil and about 48% - are fuels. They both are a great threat to the marine environment and the ecosystem of the oceans and that is why it is of great importance to have a good surveillance system for observation of the sea surface. Spaceborne SAR systems are now commonly used as a complement to existing ground-based monitoring systems, ship and aircraft observation with their advantages, including wide-area coverage and capabilities to monitor ocean surface day and night in all-weather conditions Ships on the sea surface can be detected as bright spots on the SAR images, while oil spills can be detected as dark spots.

The costs of oil spills are considerable in both economic and ecological terms. Oil on ocean surfaces is harmful to many forms of aquatic life because it prevents sufficient amounts of sunlight from penetrating the surface, and it also reduces the level of dissolved oxygen. Crude oil ruins the insulating and waterproofing properties of feathers and fur, and thus oil-coated birds and marine mammals may die from hypothermia.

Moreover, ingested oil can be toxic to affected animals, and damage to their habitat and reproductive rate may slow the long-term recovery of animal populations from the short-term damage caused by the spill itself.

Fig 1: Brown pelican, waiting to be cleaned of oil from the Deepwater Horizon oil spill

Damage to plant life can be considered as well; saltwater marshes and mangroves are two notable shore ecosystems that frequently suffer from oil spills. If beaches and populated shorelines are fouled, tourism and commerce may be severely affected, as may power plants and other utilities that either draw on or discharge into seawater at the shore. One of the industries most affected by oil spills is fishing. Major oil spills are frequently followed by the immediate suspension of commercial fishing, at the least to prevent damage to vessels and equipment but also to prevent the catch and sale of fish or shellfish that may be contaminated.

II. RELATED WORKS

[1] The Editors of Encyclopaedia Britannica, Adam Augustyn, Adam Zeidan, AlicjaZelazko, Alison Eldridge: Oil spill is leakage of petroleum onto the surface of a large body of water. Oceanic oil spills became a major environmental problem in the 1960s, chiefly as a result of intensified petroleum exploration and production on continental shelves and the use of supertankers capable of transporting more than 500,000 metric tons of oil. Spectacular oil spills from wrecked or damaged supertankers are now rare because of stringent shipping and environmental regulations. The unintentional or negligent release of used gasoline solvents and crankcase lubricants by industries and individuals greatly aggravates the overall environmental problem. Combined with natural seepage from the ocean floor, these sources add oil to the world's waterways at the rate of 3.5 million to 6 million metric tons a year.

[2] Anima Pramanik, SobhanSarkar and J. Maiti: Oil spill at the workplace is one of the potential hazards in industry. Though it has not attracted more importance from the research point of view, it can lead to economic loss for the industry through the occurrence of accident phenomena like slipping, firing, or pollution to the environment. Hence, oil spill detection should be considered an essential research issue. To address this, the present study endeavors to use the image processing technique for oil spill detection using the image data retrieved from an integrated steel plant in India.

[3] Andrea Montali, Giorgio Giacinto, Maurizio Migliaccio, and Attilio Gambardella: Oil spill detection using SAR images is possible because of the damping effect of the short wind waves caused by the presence of oil on the sea surface. As a consequence, an oil spill is physically a dark patch in SAR images. The sea radar image is a representation of the backscatter return, and the intensity of the pixel is proportional to the surface roughness at the scale of radar wavelength (Bragg scattering). The radar backscatter coefficient is a function of the viewing geometry of the SAR. In this study, classical features extracted from Synthetic Aperture Radar (SAR) Images and used in oil spill classification procedures have been examined/evaluated and ranked in the function of their effectiveness. The best features have been used to perform the classification task using Support Vector Machine (SVM) using GLCM features

[4] European Space Agency (ESA): The European Space Agency (ESA) is Europe's gateway to space. Its mission is to shape the development of Europe's space capability and ensure that investment in space continues to deliver benefits to the citizens of Europe and the world. The data access types ranging from open access to a simple authentication (with a personal EO Sign In account) while a data access request or a project proposal are needed from the users for collections subject to access restrictions.

[5] Jorge E. Espinosa, Sergio A. Velastin: This paper presents a comparative study of two deep learning models used here for vehicle detection. Alex Net and Faster RCNN are compared with the analysis of an urban video sequence. Several tests were carried out to evaluate the quality of detections, failure rates, and times employed to complete the detection task. The results allow us to obtain important conclusions regarding the architectures and strategies used for implementing such networks for the task of video detection, encouraging future research on this topic.

[6] Rohith Gandhi: Computer vision is an interdisciplinary field that has been gaining huge amounts of traction in recent years (since CNN) and self-driving cars have taken center stage. Another integral part of computer vision is object detection. Object detection aids in pose estimation, vehicle detection, surveillance, etc. The difference between object detection algorithms, and classification algorithms is that in detection algorithms, we try to draw a bounding box around the object of interest to locate it within the image. Also, you might not necessarily draw just one bounding box in an object detection case, there could be many bounding boxes representing different objects of interest within the image and you would not know how many beforehand

III. MATERIALS AND METHODS

Requirements:

The proposed prototype requires the following Hardware:

Arduino, LCD display, GPS Module, GSM Module. The specifications of this hardware are presented in Table 1:

Table 1: Hardware Specifications

S.NO:	Hardware Names	Specifications
1	Arduino UNO	The Arduino Uno Board A000066 R3 is a microcontroller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button.
2	GPS Module	NEO-6M GPS Receiver Module makes use of signals sent by satellites in space and ground stations on Earth to accurately determine its position on Earth. The NEO-6M GPS receiver module uses USART communication to communicate with the microcontroller or PC terminal.
3	GSM Module	A customized Global System for Mobile communication (GSM) module is designed for wireless radiation monitoring through Short Messaging Service (SMS)
4	16*2 LCD display	The outline size of 80.0*36.0 mm and VA size of 66.0*16.0 mm and the maximum thickness is 13.2mm.

The algorithm of the proposed model is developed in Embedded C and simulated on Arduino IDE. Arduino IDE is an open-source platform that is used to program the microcontroller to perform some specific task. In this work, we are using Arduino IDE software version 1.0.6.

Software Details:

- Arduino IDE software:

The open-source Arduino Software (IDE) makes it easy to write code and upload it to the board. It runs on Windows, Mac OS, and Linux. The environment is written in C and based on Processing and other open-source software. This software can be used with any Arduino board.

- MATLAB:

MATLAB is a proprietary multi-paradigm programming language and numeric computing environment developed by MathWorks. MATLAB allows matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces, and interfacing with programs written in other languages

- Fritzing:

Fritzing is an open-source initiative to develop amateur or hobby CAD software for the design of electronics hardware, to support designers and artists ready to Sciences Potsdam. Fritzing is free software under the GPL 3.0 or later license, with the source code available gratis on GitHub and the binaries at a monetary cost, which is allowed by the GPL.

Proposed model:

Here we proposed to detect an oil spill that occurred in some regions by applying Sentinel 1 SAR-C images, we have to detect that and send a message to particular members and also display it on LCD. Approaches dependent on MATLAB images examination have been produced for distinguishing oil spills from referred to common leaks just as oil slick procedures. The below figure indicates the block diagram of the proposed method.

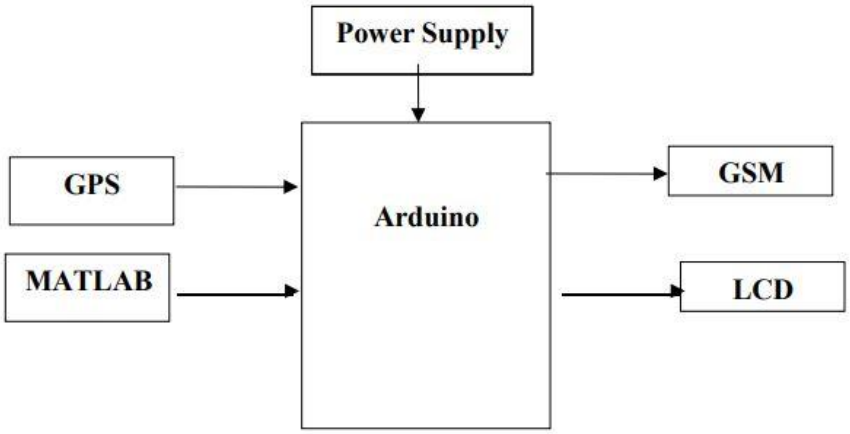

Fig.1:Block Diagram of proposed system

In this work, an Oil spill is located on the ocean/sea using the YOLO algorithm. An oil spill is the release of a liquid petroleum hydrocarbon into the environment, especially the marine ecosystem, due to human activity, and is a form of pollution. The term is usually given to marine oil spills, where oil is released into the ocean or coastal waters. Hence, oil spill detection should be considered an essential research issue. So, here oil spill will be located with the YOLO algorithm with Matlab. The results will give better outputs when compared to existing works.

IV. EXPERIMENTAL RESULTS

This project describes an algorithm and software application for oil slicks detection on the sea surface.
Some experimental results demonstrate the application's ability to process SAR images and to detect oil slicks on the sea surface automatically.

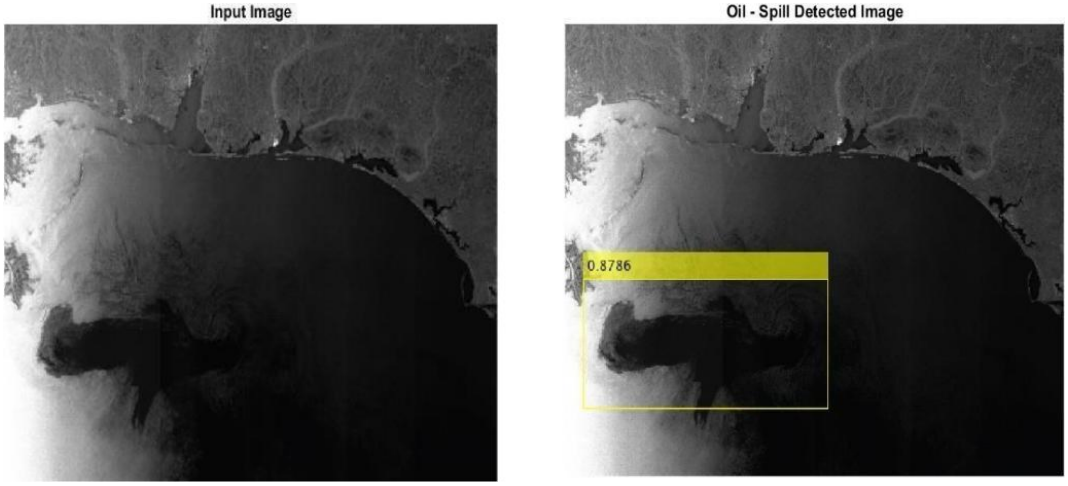

Fig 2: Input Image and Output Image

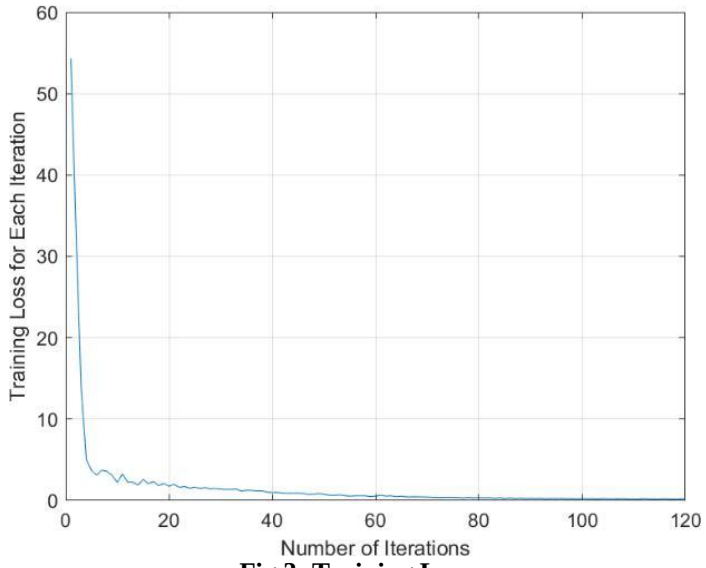

Fig 3: Training Loss

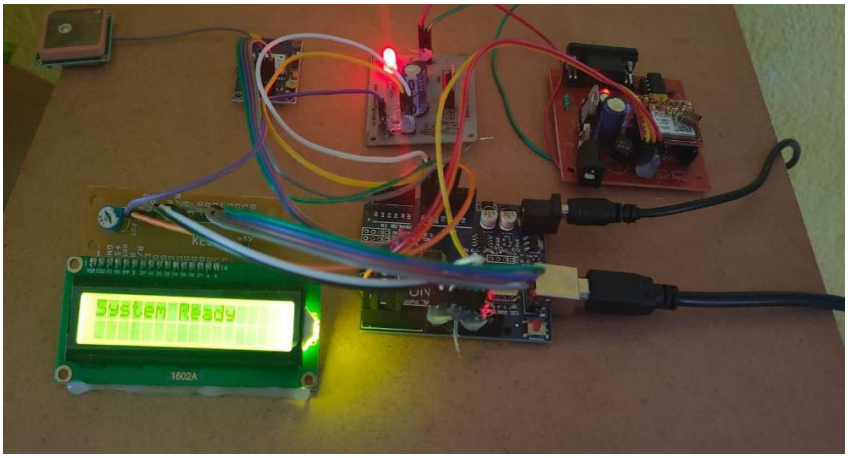

Fig 4: Connection Diagram

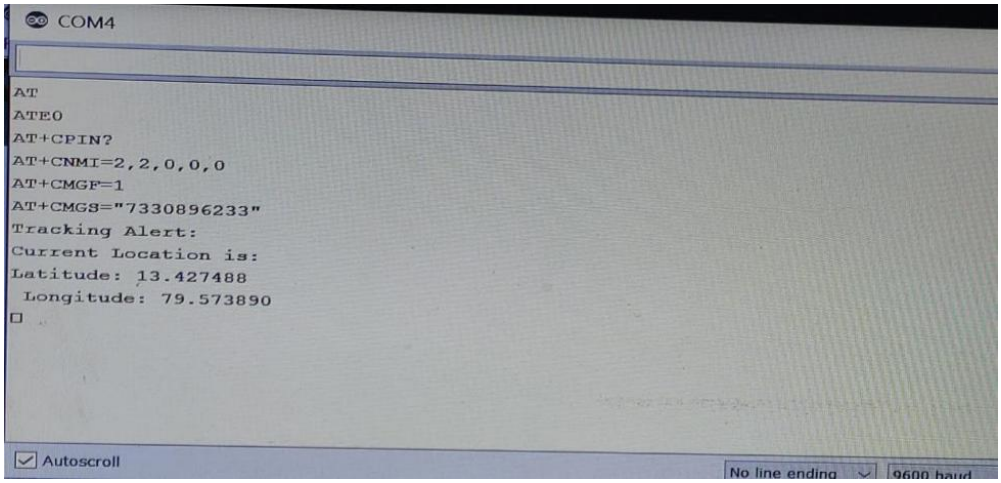

Fig 5: Serial Monitor

Fig 6: LCD Message and Message received with Location

V. CONCLUSION

This project describes an algorithm and software application for oil slicks detection on the sea surface. Some experimental results demonstrate the application's ability to process SAR images and to detect oil slicks on the sea surface automatically. In this work, we have used the YOLO v2 object detector. YOLO v2 improves the ability of the system by adding detection at multiple scales to help detect smaller objects. Moreover, the loss function used for training is separated into mean squared error for bounding box regression. Results of this work will show that our work gives better outcomes compared to existing works. SAR sensors are efficient RS tools for oil spill detection, and various techniques have been proposed to cope with the monitoring of oil pollution using SAR data in recent decades. Nevertheless, there is a need to develop real-time monitoring systems. Providing techniques based on cloud computing services and proposed automatic DL models, considering the continuous development in computer vision will significantly increase the success in this area. It is also expected from the scientific community, i.e., from RS experts to environmental monitoring specialists, to access various multi-sensor images collected over different locations and open-source annotated datasets related to oil spill events. This will increase the speed of achieving new detection algorithms that are desperately needed to protect the marine environment. A detailed investigation and review of oil spill detection methods in the literature are also absent

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