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Object Detection from the Satellite Images Using Divide and Conquer Model

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Abstract: ***Object detection is the technique of detection of the object type is sub-type of automatic computer vision. This is a growing research area. Object detection in oceans is called oceanology or oceanological computer vision. In the oceans, the object detection is used to find the information about the ships, Islands and other objects. The ocean imaging is done by the satellites and falls under the SAR or aerial imaging category. In this paper, we are proposing a new method of object detection by using the shape and color analysis, followed by divide and conquer model. The proposed algorithm can be used to detect the crashed aeroplanes, floating containers and many other objects. The proposed system can be used to find any physical object whose colour pattern and shape can be specified (known). Proposed system will be produce accurate results than any existing object detection algorithm. Proposed algorithm will perform more in-depth analysis because it uses the combination three popular approaches: object based analysis, pixel based analysis and shape based analysis.***

Keywords: object based analysis, pixel based analysis, shape analysis, ship detection, debris detection

1. Introduction

Remote sensing has long been heralded for its utility in furthering ecological research, in particular, for its ability to facilitate assessment and monitoring of biodiversity [1,2]. In previous decades, much of this research focused on the indirect assessment of biodiversity through mapping of parameters, such as habitat extent and landscape pattern, relating this to biodiversity [3]. In recent years, however, the increased spatial and spectral resolution of remote sensors has made it increasingly feasible to conduct direct mapping of biodiversity, through the mapping of plant and tree canopies and assemblages and, in some cases, through identification of individual species of trees [4,5].

Very high spatial resolution imagery enables the accurate identification of the spatial contours of small objects, such as tree canopies, but challenges still exist in terms of actual use. For one, at the spatial resolution afforded by current hyperspatial sensors, such as IKONOS, GeoEye and QuickBird, differences between sunlit leaves, bark and shade become prominent, making it difficult to delineate tree crowns [6]. Under such circumstances, traditional, pixel-based classification of tree canopies becomes challenging, due to the high contrast between pixels that represent different parts of a single object [7]. Instead, object-oriented classification algorithms have been proposed as being particularly useful, wherein the units of classification are not single pixels, but instead considered to be segments within an image that share similar characteristics, such as a particular spatial texture or pattern [8]. Classification is then performed on these objects, making use of spatial information, such as on their location, area, shape, texture or directional pattern, to produce more informed classifications [7,9]. Object-oriented classification generally begins with the delineation and generation of segments at multiple scales, which then become the fundamental unit of image analysis in contrast to per-pixel approaches, which consider a single pixel as the basic unit of analysis, omitting information about shape and spatial context [7]. Most object-oriented classification approaches further adopt an approach of multi-resolution image segmentation, representing image information in multiple object layers that are overlaid at different scales, enabling the analysis of objects at a certain scale based on spectral or textural information, while other objects, perhaps at more detailed scales, can be analyzed based on expert or field knowledge of local context [6].
Ocean currents are like huge rivers in the ocean that can be approximately 50 miles wide and can travel at up to 5 miles per hour. An example is the Gulf of Mexico that carries warm water northward along the eastern coast of the United States and across the Atlantic. It joins another current—the North Atlantic Drift—and travels as far as Ireland and Great Britain.

Generally, water has the capacity to absorb heat and transport it over great distances before releasing it. These ocean currents function similarly and are able to carry absorbed heat from locations near the equator all the way to up towards the northern latitudes that are usually associated with cold climates.

These ocean streams on traversal form water rings, also called eddies. Eddies are sections of moving water that swirl off from the main stream current and loop back to themselves, forming something like whirlpools. These eddies consist of water that is of different temperature than the water that surround them. On the surface, eddies are usually about 100–300 km in diameter. However, they are not just surface features. They are cylinders of water that can reach to depths of almost 4000 m. There are two types of eddies, one being the cold eddies in which the eddy center is cold and surrounding temperature is greater, and warm eddies in which the eddy center is warm and surrounding temperature is lower.

Cold eddies bring about an increase in organisms that comprise the marine food web, attracting fish and fishermen. The swirling motion of eddies cause nutrients that are normally found in colder, deeper waters to come to the surface. Normally surface waters are nutrient-limited, and when an eddy occurs, the cold-water upwelling substantially increases chlorophyll and plankton production.

Chlorophyll is a plant pigment found in microscopic ocean plants called phytoplankton. Phytoplankton are the primary source of food for marine life. Increases in phytoplankton cause higher levels of the green chlorophyll pigment, which in turn change the color of the ocean surface. Although microscopic, phytoplankton can bloom in such large numbers that they can change the color of the ocean so much that they can be measured from satellites. Microscopic animals called zooplankton feed on phytoplankton. Still larger animals, in turn, feed on zooplankton. Thus, the presence of phytoplankton often results in larger fish moving into an area for food.

2. Related Work

Most of the previous work in learning about mesoscale and fine-scale ocean features has been done using computer based Ocean Modeling. Time varying simulations and observations are commonly used to study the evolution of different physical phenomena. Once the evolution is understood, their underlying cause could be determined and predictive models can be built upon them. For example environmentalists study the change in the ozone "hole" to understand about the greenhouse effect and meteorologists track cloud formations for weather predictions and hurricane warnings. Computer models can help provide researchers with tools to highlight the evolutionary pattern of these phenomena.

Computer models were originally developed extensively for atmospheric fluid primarily for weather forecasting. Ocean Modeling has now established an important role in understanding world ocean circulation and obtaining information necessary for nowcasting and forecasting. JPL (Jet Propulsion Laboratory) has conducted a 40-year simulation of an ocean model for the North Atlantic Ocean using Parallel Ocean Program (POP).

However, the great energy of mesoscale features and their relatively small spatial scales, the high thermal and chemical capacity of the oceans and the slowness of their circulation conspire to challenge computer models. Currently, short duration experiments (a few decades) are being carried out that resolve the global field of field eddies, intense currents, and wind driven gyres.. Given that simulations describing ocean motions require processing of datasets in terabytes, supercomputer based parallel visualization systems such as Remote Interactive Visualization and Analysis (RIVA) and PARallel VOXel renderer (PARVOX) have been developed to analyze huge 2-D and 3-D datasets respectively. Types of Visual Remote Sensing: 1. Parallel Visualization systems 2. Real-time Ocean Modeling systems 3. Feature Oriented Regional Modeling Systems 4. Feature detection algorithms

Remote sensing and visualization has contributed immensely in understanding ocean features on both spatial and temporal scales. Radiometers on satellites record images at various spectral bands. Synthetic Aperture Radars (SAR) have also become a valuable measurement tool for marine parameters like wind speed, ocean wave spectra and sea ice parameters. These measurements are subsequently analyzed using already established and currently evolving visualization schemas and algorithms. Visualization techniques provide mechanisms to aid researchers to observe physical phenomena with respect to ocean sciences. Most of the work has focused on presenting qualitative information. Some of the approaches have used include digital elevation models, wire frame overlays, and grayscale and color-shading mapping techniques. Visualization has gained immense popularity as an important tool for processing and understanding of large data sets. A tool called Oceanographic Visualization Interactive Research Tool (OVIRT) has been developed to explore the utility of scalar field volume rendering in visualizing environmental ocean data and to extend some of the classical 2D oceanographic displays into a 3D visualization environment. It has five major visualization tools: cutting planes, minicubes, isosurfaces, sonic-surfaces, and direct volume rendering.

However, effective schemas should be able to extract regions, accurately classify and visualize them, abstract the regions of interest for easier interpretation and track their evolution. Coherent features are easily recognized when datasets are visualized as they are spatially and temporally localized. The overwhelming size of time-variant datasets makes the task of visualization difficult [22]. Many identification and tracking algorithms for satellite weather imagery have been developed and implemented for mesoscale convective systems however not the same can be said for satellite ocean imagery. A lot of emphasis in recent times has been placed on evolution of individual eddies from satellite data as well as interaction of eddies with western boundary currents and formation of meanders. Feature-based algorithms vastly simplify exploration of large datasets. Each domain has its own set of important features and analytical studies of their behavior become simpler.

Much attention has been paid in oceanography on the detection of "fronts". Oceanic fronts are created as an interface between water masses of varying physical characteristics. The interface is usually between colder fresh coastal water mixing with warm salty current water. Fronts are characteristics of strong thermal profiles with sharp transitions in temperature. Frontal detection algorithms have been developed to identify and help analyze and understand frontal properties of major oceanographic regions. Frontal occurrence and frequency distribution maps are now available for almost all regions of the World Oceans.

These frontal detection algorithms are fully automated and objective in their operations, which processes pixel-level information and stores frontal locations, which are defined as primarily an "edge", or a differential drop in temperature within a certain distance. However, it is difficult, if not inapplicable in certain cases, to apply this algorithm for interpreting features such as eddies, upwelling regions, jets and squirts, mushroom vortices etc. Even for the Gulf Stream front and its rings, manual/visual analysis schemes are favored over the automated algorithms because of the simplicity and applicability of the former to feature identification and scene description, which is valuable for numerical model initialization, assimilation and evaluation. The manual/visual approach also has an important element of educational and research value for a particular oceanographic feature in a given region.

3. Problem formulation

When an Aero-plane or ship undergoes accidents in the oceans, it is very difficult to spot the debris of those Aero-planes or ships due the size of the oceans. The only effective solution to spot the debris is satellite images. Existing technologies are not capable of differentiating between the debris and other materials when applied to the satellite images. In the latest accident, missing Malaysian Aero-plane (which went missing on the oceans) could not be spotted by the satellites yet. This shows the lack in the technology of spotting the objects and marking the debris from the satellite images.

4. Proposed System

The objects from the satellite images can be spotted using various technologies like pixel based or object based approaches to detect the objects floating in the oceans. After the detection of objects in the oceans, there is a requirement of high quality object analysis to identify if spotted objects are debris of some missing plane or ship. There are a lot of object floating in the oceans, for example, containers dropped from ships, garbage dropped by ships, objects dragged to the oceans by natural hazards like sunami, twister, etc. The object based and pixel based approaches can be combined to create a new hybrid approach to spot and analyze the objects floating in the oceans using the high quality satellite images. The proposed system can be used to find any physical object whose colour pattern and shape can be specified (known). Proposed system will be produce accurate results than any existing object detection algorithm. Proposed algorithm will perform more in-depth analysis because it uses the combination three popular approaches: object based analysis, pixel based analysis and shape based analysis.

5. Research Methodology

We will start our research project by conducting a detailed literature review on oceanography and object detection from SAR images to know the problem in detail. Then, a detailed object analysis mechanism would be also studied to fulfil the requirements for object shape analysis in the debris detection and shape analysis algorithm design. The simulation would be implemented using MATLAB equipped with image processing toolbox. The obtained results would be examined and compared with the existing object detection mechanisms for oceans to address the similar issues.

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