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Deep learning for sea cucumber detection using stochastic gradient descent algorithm

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ABSTRACT
A large number of natural products secluded from sea atmosphere has been identified for the pharmacodynamic probable in varied illness handleings, such as, tumor or inflammatory states. Sea cucumber culturing and fishing is mainly reliant on physical works. For quick and precise programmed recognition, deep residual networks with various forms used to recognize the submarine sea cucumber. The imageries have been taken by a C-Watch distant worked submarine automobile. To improve the pixel quality of the image, a training algorithm called Stochastic Gradient Descent algorithm (SGD) has been proposed in this paper. It explains how efficiently fetching the picture characteristics to expand the accurateness of sea cucumber detection, that might be reached by higher training information set and preprocessing information set with remove and denoising procedures towards increase picture eminence. Furthermore, the DL network might be linked through faster expertise to settle the location, also recognize the number of sea cucumber in images, and weightiness valuation modeling is similarly required to be progressed to execute programmed take actions. The functioning of the planned technique specifies excellent latent for manual sea cucumber detection.

Introduction

Sea cucumber belongs to the family of echinoderms and the class Holothuroidea (Bordbar, Anwar, & Saari, 2011) which lies in the bottom or shallow surfaces of the sea. Starfish and sea urchin also belong to the family of echinoderms. This ocean consists of 1200 sea cucumber species. Sea cucumbers have been utilized by the Asians for medicine and food. Sea cucumber is used as food because it is rich in vitamins, nutrients, iron, zinc, calcium and magnesium. Since it has this much properties, it is rich in antioxidants and prevents cancer. Additionally, it has more inflammatory properties, prevents the formation of tumors, reduces hypertension and increases the process of wound healing. The physical characteristics of the sea cucumber such as cylindrical body shape, dark color and thick skin make it seems like a cucumber.

However, truly, it is not a cucumber, and it does not have a delightful look. The dimensions vary from 2 cm to 6 ft. long. Once it involves distinctive the ocean cucumber within the deep ocean, that’s once the quality arises. Ocean cucumbers camouflage themselves with the dirt, dead species and different possessions to hide them from the attack of predators. Ocean cucumbers consume fundamental invertebrate correspondence; they are denied arms like echinoderm. As an alternative, the oral–anal distance is significantly enhanced, leading to a standard cucumber-shaped structure. Sea cucumbers have one branched sex gland. Eggs area unit sometimes expelled into the ocean where, after fertilization, unattached larvae develop. After a second larval stage, metamorphosis happened and also the anatomy form develops. Sea cucumbers occur altogether in the sea and in the least depth. The one linear unit of sea cucumber is 30.5 cm long; however, Stichopus variegatus from the Philippines could reach three linear unit (91 cm) long, so-called sea cucumber or beche-de-mer, and a variety of species area unit caught on heat coasts of Australia and Pacific Island Nations. Holothurian may be solely known with machine vision within the deep ocean. Sea cucumbers sleep in the deep dark ocean wherever no lighting is gift, and therefore, the pictures developed there posses no clarity. Typically, the image is known as a holothurian, but it cannot be termed as a holothurian suddenly as a result of the dirty fragments found deep within the ocean and therefore the holothurian seems identical (Qiao, Bao, Zeng, Zou, & Li, 2017). The most quality arisen is to separate the sea cucumber totally from the underwater image captured.

For many years, making a pattern-appreciation or machine-learning scheme needed engineering and right smart area experience to style a feature extractor that remodeled the information into an appropriate content or feature vector from that training system, typically a classifier, may notice or classify patterns
within the input; however with simplification ability restricted, popularity accurateness perpetually influences a bottleneck. Sea cucumber is an area unit soft-bodied worm-like marine invertebrate from the category Holothuroidea. They need a leather-like skin associate in Nursing an elongated body containing one branched sex gland. In recent years, scientists heavily used area unit in looking for bioactive compounds from ocean cucumbers to be used as potential medicine within the pharmaceutical business and as nutraceuticals within the food business. Deep learning (DL) will reach more things within the near future; it needs little engineering by hand and might simply benefit which will increase the quantity of the obtained data. The important fact of DL is that human engineers do not style these sheets of topographies; they are cultured from knowledge employing an overall learning process (Qiao, Bao, Zeng, Zou, & Li, 2017, Redmon, Divvala, Girshick, & Farhadi, 2016; Wei & Wu, 2016).

The paper is further systematized as follows: The section on “Related Works” familiarizes the existing idea of sea cucumber detection. The section on “Proposed Method” explains the proposed method (Qiao, Bao, Zeng, Zou, & Li, 2017) for sea cucumber detection. The “Results and Discussion” section explains the results and discussion. The Conclusion section concludes this paper and suggests the future directions of this work.

Related works

For ocean cucumber recognition, Qiao established a technique based on active contour to section the subsurface of ocean cucumber. The typical time to process the algorithmic rule for whole imageries was 4.28 s (Li & Li, 2018). In current years, image processing techniques have been utilized for the detection of sea cucumber (Chan & Vese, 2001; Guo & Li, 2015). The ocean cucumber was placed in an exceedingly glass tank with even brilliant cameras were put in rock lowermost and borders or at highest part to capture ocean cucumber imageries. These imageries have strong substances and dull circumstances. The strategies reinforced threshold precisely metameric the ocean cucumber (Lee, Kim, Kim, Myung, & Choi, 2012). However, the photographs of ordinary underwater surroundings are not clear. This issue leads to low distinction and blurs the images which are captured from underwater.

To resolve the above-mentioned issues, recently, many inventors have deliberated various image segmentation procedures for splitting numerous varieties of subsurface things from the background. Chen, Chuang, and Wang (2015) used three phases to divide a rope from the background during a mirky subsurface surrounding. Lee, Kim, Kim, Myung, and Choi (2012) used feature-based and template-based methods for object recognition. Within the feature-based technique, the important points were mined and unbroken within the information to check with important points of input and section the objects. However, the outcome was simply laid low with contextual objects.

Within the template-based technique, previous patterns become to tie the objects of input imageries (Barat & Phlypo, 2010). Kass, Witkin, and Terzopoulos (1987) used a prompt machine-controlled vigorous contour-based technique to segment the objects in subsurface surroundings. Active contours were first planned, and an obstacle is used to provide initial contours automatically. During this technique, a visible care theme was mechanically tailored to the region where things most analogized the background.

Sea cucumbers are marine invertebrates generally found in tropical shallow coasts and coral reefs; however, they distributed over most of the marine ecosystems. They prey on dead organic matter and waste deposited on the ocean bottom and work as natural utilization machines of the oceans. Regarding 1200 famed echinoderm species exist within the world ocean, 60 of them are commercially exploited (Otsu, 1979). Sea cucumbers are used as food supply in several countries for hundreds of years. They are terribly made in mucopolysaccharide chondroitin sulphate, protein, vitamin A, riboflavin, niacin, calcium and iron. Setyawastuti and Purwati successfully listed 54 species of sea cucumbers that are still being exploited in Indonesian water. These data were based on field inventory at four locations and compilation of many sources on sea cucumber industries. However, out of all, only 33 species have been taxonomically confirmed, and the remaining 21 species are yet to be verified not only for their accurate identification but also for their species name validation (Setyawastuti, 2014).

Sea cucumbers are harvested in artisanal fisheries that are scattered throughout the many islands of Indonesia since Indonesia is known as an archipelago country that possessed more than 17,000 islands. Thus, the number of species involved in the trade will change along with more samples from more localities. In general, fishermen experienced that sea cucumber is much difficult to collect; they have to dive deeper than the past couple of decades. Furthermore, the size of the individual found is mostly smaller when compared to the past time. The global perspective indicated that sea cucumber fishery status in Indonesia is overexploited. However, this opinion is mostly inferred from the Indonesian export statistics. In fact, Indonesian natural stock of sea cucumber is not quantified properly, due to the lack of information. Indeed, it is also admitted that the natural
population of sea cucumber species exploited for trade are sparse because the area is too large to cover with limited access, whereas the expert who focused on this alarming issue is only a few.

Inventory on commercial sea cucumber in Bakaheuni water, Lampung, was conducted to bridge the gap in fisheries data by addressing the diversity of species exploited for trade. However, even though Lampung was known as one of the sea cucumber fishing sites in Indonesia, detailed information on its local distribution has never been described. The method used during the survey was rendered us to explore a wider area covering both intertidal and subtidal.

Sea cucumber is a normal food in Asia, has newly develop an upscale energizer sustenance. For the past 20 decades, echinoderm became one among the foremost valued marine nutrients in Asian states. Presently, sea cucumbers have been utilized for the production of many deep processing products, like dried and canned echinoderm and echinoderm capsules. With the fast growth and intensification of the echinoderm marketplace, a sequence of economic deceptions seemed, including mistagging and replacement of high-value species with low-value species. The fast recognition of echinoderm is vital for keeping better quality and protective proper to customers.

About 1300 types of echinoderm around the biosphere belong to 25 ancestors, half dozen guidelines [15]. Over 140 species of echinoderm are represented in China ocean; out of them, some 20 various types of echinoderm believed to own high industrial price as food. The standard ways of characterising echinoderm to domestic or order usually supported their features, like tentacles, appendage surgical instrument muscles, internal metabolic process plants, stem daises, pipe feet, musculature chalky trinkets and dermal ossicles. However, to species, the distinction in features is sometimes too delicate to be utilized. Because of ossicles of body walls, most features of a species are extremely inconstant, and therefore, the structure of body wall spicules is not appropriate to recognition of echinoderm species. Additionally, visual authentication of ocean cucumbers is commonly troublesome as most of the morphological features can evaporate throughout the procedure, significantly once echinoderm is considered as small-grained items. An alternate of echinoderm recognition is a species-specific organic structure with success applied the spreading of various triterpene glycosides to the catalogue of echinoderm so as Aspidochirotida.

So as to resolve the above issues of species recognition on features and biochemical structure, numerous ways of recognition on characteristic aquatic species over deoxyribonucleic acid study are reportable. The sequence divergence of the mitochondrial haemoprotein enzyme sequence may be used to recognising strictly connected species of most animals (Setyastuti, 2015).

**Proposed method**

For this experimentation, sea cucumber images are gathered from the ocean. Figure 1 displays the execution procedure for sea cucumber recognition using a stochastic gradient descent (SGD) algorithm. The recognition method includes various steps of dataset acquisition and segmentation and SGD algorithm.

**Data acquisition**

For data acquisition, the sea cucumber images have been taken by a subsurface automobile in an exceedingly holothurian piscary at Haiyang Qiandao Lake in Shandong Province, China (Figure 2(a)). The typical holothurian piscary has been placed outside with the depth of water about 2–3 m, and the intensity of subsurface images has taken from normal light. Electric battery packet confined within subsurface automobile (Figure 2(b)) offered power for entire units, as well as orientation unit, sensor, gravity device and camera (Figure 2(c)) with a frame expedient.

**Segmentation**

The outline of the planned methodology to phase out the ocean cucumber from real scenes with normal light is shown in Figure 3. The subsurface color image is unpleasant into R, G, B channels individually. Therefore, G – B + R and R + G – B area units are individually used for channel fusion. The distinction-restricted accommodative bar graph feat is planned to reinforce the distinction of image. Then, An initial holothurian contour model supported sting of ocean cucumber and the site of sting is made. Finally, the initial contour of active contour formula area unit accustomed phase the improvement image, severally.

**Image fusion**

The images with RGB model (Qiao, Bao, Zeng, Zou, & Li, 2017) are first unpleasant to their individual
channels, so $f_1 = G - B + R$ and $f_2 = R + B - G$ area units are used several times for image fusion, which creates the ocean cucumber body and spine stand out from image. Subsequently, to reinforce the low-contrast subsurface image, CLAHE is employed to process the grayscale image $f_1$ by $f_3 = adapthisteq$.

**Edge recognition**

To expand the accurateness of separation of ocean cucumber from the sophisticated background, fusion image is handled via cagey edge recognition: $f_4 = edge(f_3, \text{"canny"}, 0.6)$. To make this accurate, a position refurbishment is deceased as follows: first,

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**Figure 2.** Devices used to capture sea cucumber.

**Figure 3.** Outline of segmentation technique.
dilatation is dead to “grow” and “thicken” objects, \( f_4 = \text{imdilate}(f_3, \text{size}) \); during this effort, the scale is ready to a diameter one constituent of spherical. Formerly, \( f_4 = \text{bwmorph}(f_4, \text{“majority”}) \) sets a constituent to one if 5 or additional pixels in its 3-by-3 neighborhood area unit are one; otherwise, it sets the constituent to zero. Lastly, a section gap operation \( f_4 = \text{bwareaopen} (f_4, 500) \) eliminates little substances from the 2-D image.

**Active contour segmentation**

Next, the associate algorithmic rule has been used to improve the active contour algorithmic rule. The algorithmic rule and its enhanced version are widely used for image segmentation in recent years. During this process, active contour algorithmic rule is employed for sea cucumber separation. The algorithmic rule is that the decrease of associate energy is primarily based on separation. The energy performance may be described as,

\[
E(C) = \mu_1(C) + V \cdot \text{Area} \left( \text{Inside}(C) \right) + E_{\text{in}}(C) + E_{\text{out}}(C)
\]  
(1)

where \( \mu_1(C) \) is contour length. However, subsurface sea cucumber image comprises varied substances and is heterogenous.

**SGD algorithm**

SGD algorithm has been used to perform the improvement and to optimize the neural networks. Batch gradient descent performs spare calculations for giant datasets because it recomputes gradients for the associated instances before every parameter update. SGD algorithm is the quickest algorithm and might even be wont to learn online. It performs frequent updates with a high deviation that causes the target perform to oscillate heavily. It provides tight security to the info and is the main practical objective. The info file provided as input to the system is sent to the server in associate degree encrypted state. One issue to be distinguished is that, as SGD is usually noisier than typical GD, it always appropriated a better variety of repetitions to succeed in the minima, attributable to its casualness in its parentage. Despite the fact that it needs a better variety of iterations to succeed in the minima than typical GD, it is still calculationally a lot of of less costly than typical GD. Later, in most situations, SGD is most popular over batch GD for enhancing a learning rule. The pseudo-code for SGD has been presented as follows:

Pseudo code for SGD in Python:

```python
def SGD(f, theta0, alpha, num_iters):
    # Arguments:
    # f—the function of to optimize, it takes a single argument
    # theta0—the initial point to start SGD from
    # num_iters—total iterations to run SGD for
    # alpha—the parameter value after SGD finishes

    start_iter=0
    theta=theta0
    for iter in xrange (start_iter+1, num_iters):
        grad=f(theta)
        #there is NO dot product ! return theta
        theta=theta-(alpha*grad)

    return theta
```

SGD algorithm:

For \( i \) image, \((m_t): \theta_j = \theta_j - \alpha (\tilde{y}_j - y_j)x_j^i \)  
(2)

SGD is an optimization algorithm for liberty optimisation issues. In distinction to GD, SGD approaches truth gradient of \( E(w,b) \) by seeing one coaching sample at a period. The SGD Classifier executes a first-order SGD routine. The rule repeats over coaching samples and for every sample apprises the perfect restrictions consistent with the apprise law specified by,

\[
w < - w - \eta (\alpha \frac{\partial R(w)}{\partial w} + \frac{\partial L[w^T x_i + b y_i]}{\partial w})
\]  
(3)

where \( \eta \) is the learning rate. The \( \eta \) may be endless or step-by-step crumbling. For cataloguing, the avoidance learning rate plan is specified by,

\[
\eta^{(t)} = \frac{1}{\alpha(t_0 + t)}
\]  
(4)

where \( t \) is that time step. For regression, the default learning rate schedule is inverse scaling (learning_rate = “invscaling”), given by

\[
\eta^{(t)} = \frac{eta_0}{t^{(power_t)}}
\]  
(5)

where \( eta_0 \) and \( power_t \) are the square measure hyperparameters chosen by the user via \( eta_0 \) and \( power_t \), respectively.

**Results and discussion**

In this paper, 120 underwater images of ocean cucumbers area unit have been utilized to validate the effectiveness of the projected methodology. Out of the 120 images, 6 images of sea cucumber are utilized for this analysis. The projected methodology goals to exactly phase the ocean cucumber things from the background. The projected detection theme may additionally determine the individual sea cucumber from sandy area. It is a difficult problem since ocean cucumbers are in similar color with sandy area. Scrutiny with
standard object recognition schemes and accurateness in sophisticated surroundings have been considerably enhanced because of the great functioning of illustration using the Random Gradient Descent Algorithmic Rule.

For this simulation, six images have been simulated and analyzed. The simulation results of six images have been presented in Figures 4–9. In Figure 4, the exposed sample area unit for image-a is given in (a), gray image sea cucumber is displayed in (b), 100 strongest feature points from sea are extracted and are presented in (c), the matched points of sea cucumber are displayed in (d) and the detection results of sea cucumber are shown in (e).

In Figure 5, the exposed sample area unit for image-b is given in (a), gray image sea cucumber is displayed in (b), 100 strongest feature points from sea are extracted and are presented in (c), the matched points of sea cucumber are displayed in (d) and the detection results of sea cucumber are shown in (e).

In Figure 6, the exposed sample area unit for image-c is given in (a), gray image sea cucumber is displayed

![Image](image1.png)

**Figure 4.** Simulation results of sea cucumber detection for image-a.
(a) Sea cucumber image, (b) gray image conversion, (c) 100 strongest feature points from sea, (d) matched points of sea cucumber and (e) detection results of sea cucumber.

![Image](image2.png)

**Figure 5.** Simulation results of sea cucumber detection for image-b.
(a) Sea cucumber image, (b) gray image conversion, (c) 100 strongest feature points from sea, (d) matched points of sea cucumber and (e) detection results of sea cucumber.
in (b), 100 strongest feature points from sea is extracted and are presented in (c), the matched points of sea cucumber are displayed in (d) and the detection results of sea cucumber are shown in (e).

In Figure 7, the exposed sample area unit for image-c is given in (a), gray image sea cucumber is displayed in (b), 100 strongest feature points from sea are extracted and are presented in (c), the matched points of sea cucumber are displayed in (d) and the detection results of sea cucumber are shown in (e).

In Figure 8, the exposed sample area unit for image-c is given in (a), gray image sea cucumber is displayed in (b), 100 strongest feature points from sea are extracted and are presented in (c), the matched points of sea cucumber are displayed in (d) and the detection results of sea cucumber are shown in (e).

In Figure 9, the exposed sample area unit for image-c is given in (a), gray image sea cucumber is displayed in (b), 100 strongest feature points from sea are extracted and are presented in (c), the matched points of sea cucumber are displayed in (d) and the detection results of sea cucumber are shown in (e).

Figure 6. Simulation results of sea cucumber detection for image-c. (a) Sea cucumber image, (b) gray image conversion, (c) 100 strongest feature points from sea, (d) matched points of sea cucumber and (e) detection results of sea cucumber.

Figure 7. Simulation results of sea cucumber detection for image-d. (a) Sea cucumber image, (b) gray image conversion, (c) 100 strongest feature points from sea, (d) matched points of sea cucumber and (e) detection results of sea cucumber.
of sea cucumber are displayed in (d) and the detection results of sea cucumber are shown in (e).

In the simulation process, initially, the input image is converted into a gray image. Next, the gray image will be scanned and the sea cucumber is detected. The ocean cucumber recognition has been consequently verified for online imageries. Recognition accurateness on new information was 98.8%. The trial outcomes displayed that the DL-based recognition method is conceivable to resolve the manual sea cucumber recognition problems. Table 1 displays that the proposed technique has the most appropriately graded pixels in each image class (Obj-object, Background- Bkg).

The accuracy values of the proposed method for various six images are determined using the above confusion matrix and tabulated in Table 2. Here, six images are taken for the experimental process. Each of the images is separately processed under the proposed method. The values of the proposed method will be compared with various existing methods. The first image is indicated as “a”. The pixel values from the
proposed method are 10,992 and 5060. These values are used to determine the accuracy.

Figure 10 displays values of accurateness for various existing models such as Otsu (1979) and Chan and Vese (2001) and Vese’s Active Contour methods. The elapsed time for the proposed method is around 3.90 s, which specifies that the proposed technique is appropriate for real-time applications. The ocean cucumber recognition has consequently verified on web pictures. Recognition accurateness on new info was 98.8%. From the analysis of accuracy values of each cucumber image, the proposed method produces higher accuracy when compared with other existing methods such as Otsu and Chan and Active Contour methods.

The average values of accuracy for the proposed method and the various existing methods such as Otsu and Vese’s Active Contour methods are calculated and tabulated in Table 3. The graphical exemplification of the same is depicted in Figure 11. From the above figure, it is visually noticed that the proposed method yields better accuracy of 97.9% when compared with other techniques such as Chan and Vese’s Active Contour of 88.4% and the Otsu method of 68.0%. Therefore, this proposed method is most suitable for the detection of sea cucumber. This method also produces a recognition rate of 98.8% which is better than other existing methods.

**Conclusion**

In this paper, sea cucumber detection using the SGD algorithm has been developed. The developed

| Image | Predict Obj (pixels) | Bkg (pixels) | Otsu Obj (pixels) | Bkg (pixels) | Chan and Vese’s Active Contour Obj (pixels) | Bkg (pixels) | Proposed method Obj (pixels) | Bkg (pixels) |
|-------|---------------------|--------------|------------------|--------------|------------------------------------------|--------------|----------------------------|--------------|
| a     | Obj                 | 9743         | 118,234          | 8156         | 7867                                     | 10,922       | 5060                       |
| b     | Bkg                 | 4646         | 98,729           | 6140         | 208,096                                  | 7899         | 2232                       |
| c     | Obj                 | 6845         | 77,720           | 6588         | 15,693                                   | 2227         | 218,525                    |
| d     | Bkg                 | 1878         | 143,754          | 2225         | 205,599                                  | 7525         | 2377                       |
| e     | Obj                 | 7443         | 83,846           | 7493         | 67,165                                   | 720          | 219,786                    |
| f     | Bkg                 | 553          | 138,603          | 429          | 153,364                                  | 10,582       | 5060                       |

**Table 2. Accuracy values of various existing methods.**

| Images | Proposed method | Chan and Vese’s Active | Otsu |
|--------|-----------------|------------------------|------|
| a      | 97.5            | 94                     | 48.5 |
| b      | 98.5            | 92.2                   | 67   |
| c      | 98.8            | 72                     | 64   |
| d      | 97.5            | 95                     | 78   |
| e      | 98.5            | 95.2                   | 77   |
| f      | 96.8            | 82                     | 74   |

**Table 3. Comparison of average value of accuracy.**

| Methods                         | Accuracy |
|---------------------------------|----------|
| Proposed method                 | 97.9     |
| Chan and Vese’s Active [9]      | 88.4     |
| Otsu [11]                       | 68.0     |
recognition model has been superior in numerous forms or with obstructions from natural site. It is distinguished that advanced recognition instances are active on innovative information taken underneath completely dissimilar states. The simplification capability of DL strategies is exceptional even qualified on tiny information array. Detection accuracy ought to be enhanced by aggregation illustrative coaching models and enhancing recognition model for sensible applications. The sea cucumber recognition rate is consequently verified on web imageries. However, a shadow within images disturbs the exactness of segmentation; particularly, once the shadow is created by ocean cucumber, the recognition accurateness on new info is 98.8%. In future, optimization algorithms can be used to improve the recognition rate of the sea cucumber detection.

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