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Implementing Artificial Intelligence to Reduce Marine Ecosystem Pollution

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Abstract

Industrial growth has a positive impact because it brings prosperity to humans. But on the other hand, it also has a negative effect, mainly due to industrial pollution produced. The pollution impacts environmental damage, one of which is the marine environment. This damage can be reduced by increasing understanding of the marine environment by monitoring it using technology. Although efforts have been made to monitor the marine environment, there are difficulties interpreting the large amount of data collected. To overcome these obstacles, we need technology that can process big data. One of the technologies that can be used is Artificial Intelligence which will be discussed in this study. This study aims to provide further understanding regarding the application of Artificial Intelligence to monitor the marine environment. This study uses a literature review method from several studies related to Artificial Intelligence. The final result of this study explains the potential and impact of applying Artificial Intelligence in reducing pollution of the marine environment sustainably. Although there have been many efforts to monitor the ocean for pollutants remotely, classifying the data is challenging because of the high volume of data. Therefore, the novelty of this research is to discuss a use case of a new approach to monitoring the ocean with the help of Artificial Intelligence. This research is expected to be motivated to develop better solutions in overcoming marine environment pollution using Artificial Intelligence technology.

Keywords: Artificial Intelligence, Machine Learning, Marine Pollution, Monitoring System

1. Introduction

The current rapid industrial growth has a positive impact because it increases human prosperity [1], [2]. But on the other hand, it also brings adverse effects, mainly due to industrial pollution and increasing human population growth [3]. The increasing human population results in a high need for resources, such as food sources. In addition, industrial pollution causes

damage to the environment, which destroys existing resources [4]. Industrial pollution also drives climate change on the earth and harms the planet. Because the impact is terrible for humans, it is essential to monitor pollution to reduce its adverse effects on the environment that can damage the availability of existing resources for future generations [5].

Currently, technology is developing very rapidly. These technologies have been applied to various fields, such as industry, education, health, and others [6], [7]. These technologies have changed the way people live today. Many technologies have been used in terms of environmental conservation, such as using laser technology, nanotechnology, chemical methods, and sensors to detect and control pollution [8]. One of the new technologies that can solve environmental pollution is Artificial Intelligence. Artificial Intelligence combined with Machine Learning can monitor pollution to reduce corruption [9], [10].

This research comprises four parts, namely introduction, method, results and discussion, and conclusion. This study aims to provide an understanding of the potential and impact of implementing Artificial Intelligence to reduce pollution, especially in the marine environment, which is the main focus of this research. Various literature is used to collect data related to technology in reducing pollution of the marine environment, including Artificial Intelligence technology. With this research, it is hoped that it can increase the motivation for researchers to continue to develop the potential of Artificial Intelligence technology so that it can be used to preserve the environment.

2. Research Method

This section describes the literature that discusses efforts to overcome marine environment pollution using various technologies. One such technology is Artificial Intelligence. The collected literature is used to deepen understanding of the potential of technology in reducing pollution of the marine environment.

The industrial revolution has brought about an increase in per capita income and population globally. This results in increased urbanization, which impacts increasing pollution, both on land and sea [11]. According to Hanlon [12], the lack of attention to pollution makes the pollution on earth worse every year. As the population on earth increases, the need for resources also continues to grow. As a result, exploitation of resources on land and at sea is increasingly being carried out. According to Kandziora [13], it is estimated that 80% of marine environmental pollution is caused by activities carried out on land. Coupled with the increasing use of fossil fuels, it causes drastic climate change, so it impacts increasing sea level and increasing sea temperature [14]. According to Diez [15], this disturbs the marine ecosystem and disrupts the availability of marine natural resources.

Various efforts have been made to reduce marine environment pollution to preserve existing natural resources. Natural resources are vital for human life, so it is necessary to monitor pollution to reduce and prevent its negative impact on the environment [16]. The aircraft was initially used to monitor the marine environment, but only when the weather was favourable. In addition, the data collected is not consistently consistent. Then in 1972, satellites were used to monitor land and sea. Detection devices with sensors then began to be developed along with the development of various sensor technologies [17].

Currently, various detection systems are being developed to monitor multiple variables related to the marine environment, such as temperature, acidity, oxygen levels, and marine pollution. The system utilizes satellites, ships, and robots. However, there are obstacles in processing the number of variables that have been collected [18]. According to Agarwala [9], the latest Artificial Intelligence technology combined with Machine Learning can process extensive data accurately. In addition, Artificial Intelligence can detect, predict, and analyze the collected data to support efforts to reduce pollution of the marine environment [19].

Based on some of the literature above, it can be concluded that the obstacle experienced in monitoring the marine environment to reduce pollution is the difficulty of processing extensive data. Therefore, technology is needed that can process big data accurately. Artificial Intelligence is the solution. By combining Machine Learning and Artificial Intelligence, the collected big data can be processed accurately to detect, predict and analyze impacts and provide solutions to marine environmental pollution problems. In the next section,

this research will provide several case studies of the application of Artificial Intelligence in overcoming pollution of the marine environment.

3. Findings

This section will describe several case studies of the use of Artificial Intelligence technology to reduce marine environment pollution. In addition, it will face the challenges that will be encountered.

3.1 Oil Spill Monitoring

Oil spills in the marine environment can occur due to natural and human factors. However, naturally occurring oil spill incidents are infrequent [20]. Generally, these incidents are caused by humans, either intentionally or not. Because the impact of an oil spill is very dynamic and erratic due to wave motion, it is necessary to have a tool to monitor it [21]. This is intended so that the oil spill does not spread to a broader area, which can cause damage to the marine environment.

Some of the tools used to monitor oil spills include laser fluorosensor (LF), side-looking airborne radar (SLAR), and thermal infrared and ultraviolet video cameras . However, the tool can only be used effectively if the area of the oil spill is known beforehand [22]. Due to the unpredictable movement of oil spills, it can be difficult to identify them accurately.

To identify oil spills quickly and accurately before they spread widely, the use of Synthetic Aperture Radar (SAR) is considered very effective. SAR is a monitoring system that uses satellites. It works by measuring the roughness of seawater, where the area covered by the oil spill will be visible. However, a sea area covered in seaweed will also look the same as covered in an oil spill [23]. Developing Artificial Intelligence can help distinguish these situations to make the identification process more accurate. One example of its use is the Canadian Environmental Hazards Detection System (CEHDS) which uses two satellites.

3.2 Waste Monitoring and Disposal

Naturally, garbage on land will move to the ocean, and this happens because the two environments are interconnected. Therefore, whatever happens on the ground directly impacts the oceans [24]. Most of the pollution in the marine environment is caused by pollution originating from land and generally in the form of plastic waste [25]. Plastic waste varies and takes a long time to decompose. In the long term, plastic will impact the damage to the marine environment, thereby disrupting the life of organisms in the sea. There are two main methods to reduce marine environment pollution, namely through monitoring and waste disposal. Both processes use Artificial Intelligence and work automatically and in real-time [26].

3.2.1 Waste Monitoring

Garbage in the oceans of various kinds is generally in the form of plastic. Identifying the location of the waste is necessary to map the marine environment [27]. The main principle is to observe the sea surface and compare the different colours of the sea. The sea surface is observed using satellites or drones, then the data in the form of images collected will be used to mark objects floating in the ocean by researchers, as shown in figure 1. The marked images can then be used as a data source for Machine Learning [28]. Combined with the algorithm on Artificial Intelligence, it can be used to detect garbage and its types. Several monitoring systems have been developed, including Marine Debris Tracker by NOAA, MarineLitterWatch by the European Environment Agency, CleanSwell by the Ocean Conservancy and Coastbuster by the Ocean Networks [29].

Picture 1. Ocean debris detector

Figure 1 above is the ocean debris classified using Artificial Intelligence. The data model is created by collecting photos of ocean debris using a camera. The dataset is then used in neural network training using Tensorflow Object Detection API.

3.2.2 Waste disposal

There are two ways to deal with existing waste. The first way is to throw garbage in the sea directly, and the second way is to collect debris from the river so that it doesn't pollute the ocean. By applying the first method, a Dutch company, the Ocean Cleanup, has developed a system for cleaning the marine environment [30]. The system is an automated ship that uses Artificial Intelligence technology, as shown in figure 2. Furthermore, the system will explore the oceans automatically to collect trash. As for the second method, the Interceptor system is placed in the river to manage waste that drifts before it reaches the sea, as shown in figure 3. The system uses renewable energy to operate [31].


Picture 2. Ocean garbage collector

Figure 2 above is an automated system that uses computer modelling from data collected to target highly concentrated garbage in the ocean to improve recycling efficiency. The model used is steadily improved using data collected during the process, which can improve the system's efficiency. One fundamental design improvement is the incorporation of active propulsion to move the system slightly faster than the flow of plastic in the water and maintain a continuous stable speed difference. It also introduced the ability to steer the system to reposition operations as needed into zones with the highest density of plastic.

Picture 3. River garbage collector

Rivers are the primary source of ocean plastic pollution. Therefore a supporting system is required to rid the ocean of plastic. Figure 3 above is an automated river garbage collector which uses solar-powered mechanics, intelligent processing, and connectivity for easy performance tracking. A barrier is deployed in the river to guide waste into the system. The waste is then extracted from the water and distributed into a dumpster. The system will automatically notify the operator when the dumpster is full.

3.2.3 Monitoring marine life

Artificial Intelligence combined with Machine Learning can recognize human faces. By developing existing models, Artificial Intelligence can be used to identify patterns of marine animals. Artificial Intelligence also makes it possible to observe the marine environment without disturbing marine diversity [32]. Some of the technologies that have been created include FathomNet, iNaturalist, and Bio-Image Semantic Query User Environment (BISQUE).

3.2.4 Monitoring coral health

Coral reefs are life support in the marine environment, and without coral reefs, there will be no life in the sea [33]. Therefore, it is crucial to protect and conserve coral reefs. Several attempts have been made to prevent damage to coral reefs. One of the businesses that use Artificial Intelligence technology is CoralNet, a system for analyzing coral reefs. Data was collected using the image and video analysis using Artificial Intelligence. It is easier for researchers to understand marine ecosystems and understand the right strategy to protect them [34].

The development of the Machine Learning paradigm is growing rapidly. This paradigm has created a new method for research and development, thus providing a new way of processing data. Although using Machine Learning is not simple, researchers are still trying to

develop it. Constraints that are generally experienced are the selection of algorithms, limited data, and optimization of the training process. This, of course, has an impact on increasing processing costs [35].

This study does not explain the development of artificial intelligence monitoring tools but describes how these tools can overcome problems related to marine environmental pollution. This study aims to increase the motivation of researchers to create innovations to preserve marine ecosystems using Artificial Intelligence technology. It is essential to know that Artificial Intelligence works effectively when combined with Machine Learning. Therefore, accurate data is needed for the training process on Machine Learning so that the output is accurate. That way, Artificial Intelligence can be used effectively and can be a solution to help reduce pollution of the marine environment.

4. Conclusion

Due to the importance of monitoring the marine environment to maintain its sustainability, various tools have been used, such as aircraft, ships and satellites. This causes an increase in the data collected, so we need a tool that can analyze the data quickly and accurately. To overcome this, Artificial Intelligence can be used.

Solutions using Artificial Intelligence are very suitable for monitoring large areas involving many variables. These various variables can be processed quickly and accurately by utilizing Artificial Intelligence. In addition, Artificial Intelligence can provide useful outputs for researchers to take appropriate strategies to reduce marine pollution.

This research has discussed various case studies of the use of Artificial Intelligence to preserve the marine environment. However, Artificial Intelligence requires Machine Learning to work effectively. Therefore, large amounts of training data are needed to be accurate. Several challenges are still open to continue developing the potential of Artificial Intelligence, primarily through the development of Machine Learning algorithms to increase the accuracy of the Artificial Intelligence system.

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