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Research of ecological environment monitoring based on artificial intelligence

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Abstract. Traditional models of environmental supervision no longer suffice to meet the challenges of contemporary environmental governance as the tension between protecting the environment and fostering economic development grows. Given this context, ecological environment intelligent supervision has become an essential way and means to safeguard the green mountains. Comprehensive environmental regulation requires the use of cutting-edge technology like artificial intelligence, big data analytics, cloud computing, the internet of things, and online monitoring systems. Simultaneously, the internet and digital technology can enhance the quality of environmental protection decisions and the extent to which they are monitored. Artificial intelligence has the potential to improve the effectiveness of ecological environment supervision and protection, addressing issues such as a lack of human resources and an overabundance of job pressure. This paper used a literature review as its research method, studying articles in the field to learn about the current state of artificial intelligence technology in ecological environment monitoring and governance, its potential future uses, and how to best protect the planet's delicate ecosystems.

Keywords: artificial intelligence, intelligent supervision, environmental protection, economic development.

1. Introduction

As environmental issues around the world have worsened in recent years, so too has the public's focus on the need to conserve its natural resources. New possibilities and problems have emerged in the area of ecological environment monitoring and preservation as a result of the rapid development of artificial intelligence technology. Since the term "artificial intelligence" was coined, the technology has found many applications. Particularly in the realm of ecological environmental supervision, the monitoring activity has shown accelerated expansion as a result of the advent of information and digitalization, and the application of big data has become a focal point. There have been new demands and difficulties brought on by the explosion of ecological environment data. Artificial intelligence technology has emerged as a new generation of regulatory tools [1] with the dual goals of increasing regulatory efficiency and decreasing personnel costs. However, environmental pollution is a problem that cannot be disregarded in China's process of continuous economic development, and it has a detrimental effect on both sustainable development and people's lives. Amazing progress has been made in ecological and environmental governance as a result of ecological civilization creation. Traditional forms of government, however, have flaws and fall short of what is needed in the modern world. Ecological resources can be allocated more effectively, and governance effects enhanced, with the help of artificial intelligence technology. Therefore, we should acknowledge the significance of AI in advancing ecological civilisation and systematically apply AI to ecological environment governance to speed up the pace at which ecological civilization is being built [2].

This study uses a literature review approach to research, investigates the state of the field in terms of research direction, and then examines in depth the use of AI for forecasting extreme weather, protecting ecosystems, monitoring air quality, and checking water quality. This investigation on the use of AI in ecological monitoring yields important findings and forecasts. These results can be used to improve environmental monitoring systems and help managers take swifter action and make more informed decisions in response to environmental indicators. The study also offers helpful advice for future work in the area, such as areas where the monitoring system should be enhanced or where more work needs to be done on the underlying system or algorithm.

2. Extreme weather prediction

Traditional weather forecasting relied on physical analysis and dynamic analysis. Weather variables like temperature, precipitation, pressure, wind speed, humidity, and cloud cover are analyzed one by one in these methods using large-scale computer simulations, a process that can take hours. More accurate weather forecasting is essential for helping communities plan for and respond to disasters as climate change makes weather more volatile and extreme and temperatures rise everywhere. New artificial intelligence (AI) systems can greatly hasten this procedure, leading to more precise weather forecasts and early warnings of hazardous weather. These systems utilize AI technology to swiftly and reliably evaluate and understand massive volumes of weather data, allowing scientists and meteorologists to provide more accurate forecasts and alarms that may be used to better prepare for extreme weather in advance [3].

2.1. Weather forecast

The weather forecast can be broken down into two primary categories: long-term likelihood forecasts and shorter-term immediate forecasts.

1) The SVM mathematical model and the TempRiskApollo model based on deep learning have made substantial contributions to rainstorm prediction in the extended term forecast (15-30 days). The SVM model is able to anticipate and deliver early warnings for heavy rain events by analyzing meteorological factors with greater accuracy and reliability than conventional techniques. The TempRiskApollo model predicts heavy rain with high accuracy by combining deep neural networks with weather records. Image recognition and deep learning methods are incorporated to enhance the reliability of rainfall predictions. These developments have significant bearing on meteorological early warning systems and decision-making, protecting people and property and reducing the societal and economic costs of flooding.

2) Techniques such as image recognition and deep learning have been used to provide short-term (0-12 hour) forecasts, with great success thanks to data fusion modeling and the use of convolutional neural networks (CNNs). These developments allow for timely weather services for localized to regional weather systems and improve the accuracy of short-term forecasts.

2.2. Extreme weather forecast

Heavy rainfall and snow forecasts, hail forecasts, and El Nino forecasts are the main categories of extreme weather predictions.

First, scientists have started using a wide range of AI technologies and data mining techniques to foretell extreme precipitation events like snowstorms. The neural network and genetic algorithm combined backpropagation temperature prediction model allows for the early forecasting of extreme rains. The complicated meteorological data can be mined for the rainfall weather model using a multi-dimensional time series data mining model, which in turn enhances the reliability of the forecast.

Pseudo-nearest neighbor method and mixed model have also been used to greatly boost the accuracy index of precipitation and rain forecasting.

Second, there have been notable advancements in the use of artificial intelligence for hail forecasting. AI algorithms with robust identification capabilities can be built for hail recognition and near prediction by employing machine learning methods like those used to process three-dimensional jigsaw data derived from Doppler weather radar in Guangdong. Furthermore, hail may be judged in real time at national scale utilizing deep learning technology, depending on the granularity of latitude and longitude levels, and hail can be predicted within a specified time period.

Third, artificial intelligence is crucial in El Nino forecasting. El Nino episodes on the medium and long term can be predicted with the help of deep learning network models and sequence-to-sequence models, which pick regional sea level temperature anomalies. Experimentally based El Nino predictions have also been successful when using machine deep learning models with strong predictive ability. To better anticipate El Nino episodes than conventional approaches, other researchers have employed deep learning models to do so up to 15 months in advance.

3. Ecosystem protection

There are many benefits to using AI technology for environment conservation and monitoring. Through its self-learning, automated reasoning, and intelligent judgment, it can successfully cope with the problems associated with sampling methods, data collecting discontinuities, and insufficient data processing and analysis in conventional ecological monitoring and evaluation approaches. More precise problem identification and prediction, discovery of environmental trend, and development of scientific ecological protection measures are all made possible by the analysis and processing of enormous volumes of data by artificial intelligence technology. To effectively protect the ecological environment and promote the realization of sustainable development, artificial intelligence technology can play a pivotal role in monitoring and managing ecological environments, achieving real-time monitoring and management of ecological environments and intelligent use and allocation of ecological resources.

The Qinghai-Tibet Plateau's Sanjiangyuan region, which supplies water to the north and northeast of China and has significant ecological and environmental importance, is the focus of this research [4]. The three primary areas of artificial intelligence application studied in this study are:

Firstly, the convolutional neural network (CNN)-based bird identification system can be used for ecological monitoring in light of the rich avian resources found in the Sanjiangyuan region and the limitations of conventional methods of bird identification. The system can efficiently monitor and manage bird resources in the Sanjiangyuan area thanks to the training of models and the use of equipment like cameras and drones to gather photos of birds, allowing for the automatic extraction of features and classification of birds with high accuracy, stability, and real-time advantages.

Secondly, due to the inefficiency and variability introduced by human intervention in traditional wildlife monitoring practices, a reinforcement learning-based intelligent monitoring system can be combined with tools like drones and cameras to achieve intelligent monitoring and identification of wildlife. The system can automatically alter the recognition method to enhance the accuracy as it gathers wildlife images from drones and uses a reinforcement learning algorithm to identify and recognize wild creatures. With its high efficiency, accuracy, and self-adaptability, this intelligent monitoring approach based on reinforcement learning may greatly enhance the monitoring and preservation of wildlife resources in the Sanjiangyuan region.

Thirdly, a survey of the plant life in wetlands: It takes a lot of time, effort, and resources because traditional techniques of assessing marsh vegetation coverage might be influenced by human error. Thus, wetland vegetation coverage can be evaluated using techniques based on remote sensing photos. Vegetation information can be collected and coverage can be calculated by processing and analyzing high-resolution remote sensing photos. High-resolution satellite remote sensing photos can be utilized to evaluate the extent of wetland vegetation in the Sanjiangyuan region. The wetland ecology in the Sanjiangyuan area can be swiftly monitored and managed thanks to this evaluation approach based on remote sensing images, which boasts high efficiency, high precision, and strong repeatability.

4. Air quality monitoring

Statistical forecasting, numerical forecasting, and ensemble forecasting are examples of conventional air quality forecasting approaches, however they also have their drawbacks. Short-term forecasts can benefit from the statistical forecasting method, but severe polluted weather is difficult to predict. For regional long-term forecasting, the numerical forecasting method has its benefits, but only after a significant investment in technology and hardware facilities. The ensemble forecasting method has good accuracy but significant processing complexity [5] because it can run numerous air quality models simultaneously.

The topic of ambient air quality prediction is currently experiencing a period of intense research and development focused on artificial intelligence and machine learning techniques. In particular, deep learning theory's recent explosion in popularity has led to its widespread use in areas like computer vision, speech recognition, and natural language processing. By intelligently analyzing and summarizing a large amount of historical air quality and meteorological data, we can uncover the internal relationship between air quality index and meteorological conditions like pollutant factors, temperature, humidity, and wind speed using deep learning to interpret complex unstructured data. Simultaneously, sophisticated computational models can be developed to characterize the interplay between air quality and its many contributing variables. Effective deep learning models may be trained to forecast air quality [6].

Air quality prediction neural networks and air quality grid neural networks are the backbone of the AI-based air quality prediction system.

1) Neural network for forecasting air quality: It is possible to train a model to predict air quality into the future using a Long Short-Term Memory network (LSTM) module. Features with long-term dependencies are retrieved layer by layer by stacking air quality data and building input vectors. When meteorological data is combined with the fully connected network layer, pollution forecast results for the following 7 days and hours can be achieved. When meteorological data is used, forecasts become more precise. In order to increase the model performance and generalizability, the air quality prediction neural network takes the form of a convolutional neural network and employs training on historical data to determine the network structure's weight and offset value.

2) Neural grid for monitoring air quality: The air quality feature map can be extended to include the full region's grid by using a depth residual network (ResNet) to map the feature map within the region. To produce a grid-based air quality map, the trained ResNet-50 model is fed a two-dimensional map with pollutant and meteorological data, which is then superimposed over the three-dimensional data.

5. Water quality monitoring

The state increases the efficiency of sewage treatment plants by enacting legislation and providing financial support to treatment equipment manufacturers in an effort to remedy the water environment crisis. Nonetheless, the disparity between environmental carrying capacity and demand [7] is at the heart of water's environmental concerns. Adopting scientific countermeasures and effective technical means according to local conditions is essential for achieving scientific control of the water environment. Improvements in the concept, technology, and management of ecological water environment remediation will be possible thanks to the widespread use and integration of Internet of Things and artificial intelligence technologies, allowing for comprehensive planning of intelligent management and service level. Ecological water environment governance will be more effective with the widespread application of cutting-edge technical tools, allowing it to better address people's needs in this area [8].

AI technology's ecological water environment application concept is intricate, and it requires vast data for continued functioning. Using neural networks as its primary backbone, it is able to carry out deep machine learning, simulate data without any external help, and construct a model's appropriate structure based on the data it receives. Specifically, this research focuses on four distinct types of AI and how they can be applied in this particular setting:

The first one is a simulation of the couple's interaction. Simulation of biological water environments requiring reasonable coupling calls for smart functionalities. The first involves meeting accuracy standards across many scales. distinct spatial scales necessitate distinct adjustments to the models in order to provide the precision and timeliness needed, from the watershed down to the polder area. Administrative or water conservancy districts serve as the smallest level of nesting below river basins, regions, cities, and polders. As for the second point, this is about the real-time refresh of fundamental information. It is essential to develop an intelligent system that takes into account the ever-changing nature of the underlying surface, technical modifications, scheduling considerations, and water supply, among other elements, in order to meet forecasting requirements. Third, in order to achieve intelligent decoupling and splicing, it is necessary to define topological relations based on river classification, coarser and thinner models, the realization of large-scale to meet small-scale simulation, and the utilization of model nesting coupling technology to achieve data interaction and automatic updating of boundary conditions. Hydrologic and hydrodynamic simulation requirements can be met with the help of the smart model's parameter adjustment and self-tuning capabilities.

Second, the technology anticipates future changes in reservoir capacity based on current conditions and historical data, allowing for intelligent decision-making. The platform is universal, including real-time data from rivers and lakes into its decision-making process. Using hydrological data, you can predict how a shift in the weather would affect water levels.

Third, environmental sensors, such as those for gas, water, and soil pollution, allow data collecting and monitoring through the use of cloud service technology. Cloud-based services for the water environment process and mine raw data for use as a decision-making foundation. Device administration, network health monitoring, and automated upkeep are all part of what the cloud has to offer.

Fourth, to monitor water pollution, solid waste pollution, and soil pollution, and to provide decision support for environmental governance, intelligent water environment field equipment and the Internet of Things use surveillance cameras paired with artificial intelligence vision technology.

6. Conclusion

The use of AI in ecological environment monitoring and governance has the potential to boost regulatory efficacy and protection outcomes. Environmental problems can be better diagnosed and forecasted, and scientific ecological protection strategies can be established, by fully utilizing artificial intelligence's self-learning, automated reasoning, and intelligent judgment.

While much progress has been made, this study still has certain limitations, including a lack of field inquiry, a lack of complete research data support, and a lack of an in-depth analysis of the effects and obstacles of implementation. Strengthening field inquiry and collecting more experimental data, broadening the scope of research, and improving the comprehensiveness and credibility of research are all areas that could benefit from further study in the future.

The use of AI technology in ecological environment monitoring and preservation is expected to grow in importance in the next years. The accuracy and precision of monitoring and prediction can be enhanced by additional optimization and improvement of artificial intelligence algorithms and systems. Concurrently, it is important to enhance integration with technologies like the Internet of Things, big data analysis, and cloud computing in order to create an intelligent ecological environment supervision system and advance the development of an ecological civilization.

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