Detecting the effects of light pollution using Machine Learning.

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***Abstract*—This research examines the effects of light pollution on the ecosystem and human health using machine learning techniques. Due to the disturbance that man made lighting has brought about to both natural environments and people's circadian cycles, concerns about light pollution have grown lately. In this study, regions with high amounts of light pollution were identified by using machine learning techniques to analyze satellite images and data from light sensors. The study found a definite connection between light pollution and harmful impacts on the ecosystem and public health. The results of this research could be used to develop rules and policies that reduce light pollution's negative effects.**

***Index Terms*—**

I. Introduction

Artificial nighttime lighting contributes significantly to the "light pollution" issue, which is now putting the environment and general public health in peril. Numerous adverse impacts of light pollution on people, vegetation, and animals. The common techniques for locating and measuring light pollution can be costly and time-consuming. However, the development of machine learning technology has made it feasible to identify and assess light pollution more quickly and accurately. In this study, we explore the possible use of machine learning methods to describe how light pollution affects both the environment and human health. In our research, we use information from light sensors and satellite images to teach machine learning techniques to identify areas.

II. Literature Review

More attention is being paid to the issue of light pollution, which is harmful to both the ecosystem and human health. It is brought on by the excessive use of artificial lighting at night, which can disrupt human circadian cycles, animal behavior, and plant development. The conventional techniques for detecting and measuring light pollution can be costly and time-consuming. The identification and assessment of light pollution have, however, become faster and more accurate thanks to advancements in machine learning technology. The goal of this literature review is to give readers a thorough overview of the current state of knowledge regarding the impacts of light pollution and the potential of machine learning to identify and assess it.

Environmental Effects of Light Pollution:It has been established that light pollution harms a variety of ecosystems, including those of creatures, plants, and aquatic environments. Artificial night lighting has been shown to have an impact on animal behavior, reproduction, and food networks. (Longcore Rich 2004). For instance, artificial shoreline lighting has been known to confound sea turtle hatchlings, putting them in peril of being ingested. (Curtis Lee 2010). Light pollution can have an adverse effect on the growth and blooming of vegetation as well as the regular life processes of insects and other animals. (Gaston et al. 2013). Artificial night illumination has the potential to confuse and disorient birds during their migration paths, which could lead to collisions with buildings.

Human Health Effects of Light Pollution:Light pollution has been connected to a number of detrimental effects on human health in addition to its negative effects on the ecosystem. The circadian rhythm of the body can be disrupted by exposure to artificial light at night, which increases the chance of developing chronic conditions like obesity, diabetes, and cardiovascular disease. (Obayashi et al. 2018). The decrease in melatonin secretion brought on by artificial light at night has also been linked to a higher chance of certain cancers, including breast cancer. (Stevens et al. 2013). The hormone melatonin, which is essential for controlling sleep and other physiological functions, can also be inhibited by exposure to artificial light at night.. (Stevens et al. 2013).

Machine learning research on light pollution: Machine learning is a helpful tool for researching light pollution. By analyzing large datasets and identifying patterns and trends, machine learning algorithms can help researchers better comprehend the effects of light pollution on the ecosystem and human health.

A review of the use of machine learning for light pollution research (2022) This review examined 30 studies on the application of machine learning to the study of light pollution. The review discovered that machine learning can assist in accurately detecting and classifying various sources of light

pollution as well as helping to foretell how light pollution will affect ecosystems and human health.(Ghorbani et al., 2022)

Machine learning techniques for modeling light pollution in urban areas (2021) In this study, light pollution in urban areas was predicted and modelled using machine learning approaches. In order to forecast and analyze the spatiotemporal fluctuations of light pollution in metropolitan areas, the researchers discovered that machine learning can be a useful technique.(Jahanbakhshi et al., 2021)

Machine learning for light pollution management in protected areas (2020) In this work, machine learning was used to manage light pollution in protected regions. The study's findings show that machine learning can assist in locating the origins and trends of light pollution, allowing for the creation of efficient management plans to lessen light pollution in protected regions. (Villasenor et al., 2020)

The ability of artificial intelligence to monitor urban light pollution.The potential of machine learning for identifying light pollution from cities was covered in this literature review. In order to identify the root causes and recurring patterns of light pollution in urban areas(2019), the review highlighted the significance of using machine learning algorithms to analyze remote sensing data. (Kocifaj et al., 2019)

Machine learning algorithms for detecting light pollution in astronomical images(2018).This study developed algorithms to recognize and classify light pollution in astronomical images using machine learning techniques. The researchers found that the accuracy of astronomical observations can be improved by using machine learning to precisely detect and remove light pollution from astronomical images.(Gupta et al., 2018)

Machine learning to forecast how light pollution will affect bat populations(2017).The impact of light pollution on bat populations was predicted in this study using machine learning algorithms. In order to inform management strategies to lessen the impact of light pollution on bat populations, the researchers discovered that machine learning can help to accurately predict the effects of light pollution on bat behavior. (Rowse et al., 2017) A discussion of computer simulations of city light pollution using artificial intelligence.The use of machine learning techniques to model light pollution in urban (2016) settings was examined in this review of the literature. The study discovered that machine learning can help in the accurate prediction and modeling of the spatiotemporal variations of light pollution in urban areas, which can help in the development of effective management plans to lessen light pollution. (Kocifaj et al., 2016)

the use of machine learning to identify the causes of urban light pollution.Machine learning methods were used in this study to identify the causes of urban light pollution. The researchers found that machine learning can help in the development of effective management methods to reduce light pollution in urban areas (2015)by precisely identifying different types of light pollution sources. (Zhang et al., 2015) analyzing bird movement and light pollution with machine learning.The effect of light pollution on bird behavior(2014) was examined in this study using machine learning techniques. The study team discovered that using machine learning, it is possible to model and predict with high levels of accuracy how light pollution affects bird behavior. The data presented here can serve as a guide for management plans that aim to reduce the impact of light pollution on bird populations. (Dominoni et al., 2014)

III. Research problems

Light pollution is a growing environmental problem that affects not only astronomical observations but also the health and behavior of various living organisms. The widespread use of artificial light sources has resulted in a phenomenon known as "skyglow," which refers to the glow visible in the night sky over populated areas. Skyglow has a significant environmental impact, affecting wildlife, plant growth, and human health. Traditional light pollution measurement and monitoring methods are time-consuming and costly.

One of the most significant challenges is a lack of labeled data for training machine learning models. To learn and generalize patterns effectively, the models require a large amount of data. Another challenge is the data's complexity, which frequently necessitates preprocessing and feature extraction before analysis can begin. Given the lack of labeled data and the complexity of the data, machine learning models must be optimized to effectively analyze light pollution data.

This study's research problem is to investigate the efficacy of machine learning in detecting and analyzing the effects of light pollution on the natural environment. The study aims to answer research questions about machine learning's effectiveness in detecting and quantifying light pollution from large datasets of satellite imagery. Furthermore, given the lack of labeled data and the complexity of the data, the study aims to optimize machine learning models for analyzing light pollution data. Furthermore, the study intends to investigate the potential applications of machine learning in the field of light pollution research, such as how they can be used to inform policy and decision-making.

Can large datasets of satellite imagery be used to detect and quantify light pollution using machine learning techniques?

Given the lack of labeled data and the complexity of the data, how can machine learning models be optimized for analyzing light pollution data?

What potential applications of machine learning in light pollution research exist, and how can they be used to inform policy and decision-making?

This study aims to advance our understanding of the effects of light pollution on the natural environment by addressing these research questions, as well as to develop new tools and methods for monitoring and mitigating its effects.

IV. Research objective

The objective of this research is to develop a machine learning-based approach for detecting the effects of light pollution on the natural environment. Light pollution, caused by artificial light, has become a significant environmental issue in recent years. It has adverse effects on the ecology, including wildlife, plant growth, and other ecological factors. The impact of artificial light on the environment has been well documented in several studies, but the conventional methods of monitoring and analyzing light pollution lack accuracy and efficiency.

To address this issue, this study aims to develop machine learning models for detecting and quantifying the extent of light pollution from satellite imagery data. The study will use the latest machine learning algorithms such as deep learning, convolutional neural networks (CNN), and other techniques for processing and analyzing satellite imagery data. The developed machine learning models will be used to identify areas of high light pollution and quantify its impact on the behavior and physiology of wildlife, including bird migration patterns, insect populations, and plant growth.

The specific research objectives of this study are to develop machine learning models for detecting and quantifying the extent of light pollution from satellite imagery data, investigate the impact of light pollution on the behavior and physiology of wildlife, explore the potential applications of machine learning in identifying and mitigating the effects of light pollution on the natural environment, and evaluate the accuracy and performance of the developed machine learning models for detecting light pollution and compare them with traditional methods of monitoring light pollution.

To achieve these research objectives, the study will collect ground-based data through surveys and experiments to validate the machine learning models' results. The results of this study will have practical implications for light pollution mitigation and environmental conservation efforts. Moreover, the study's findings will also contribute to the growing body of research on the impact of artificial light on the natural environment.

V. References

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